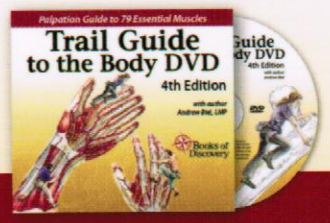
Fully Revised 4th Edition

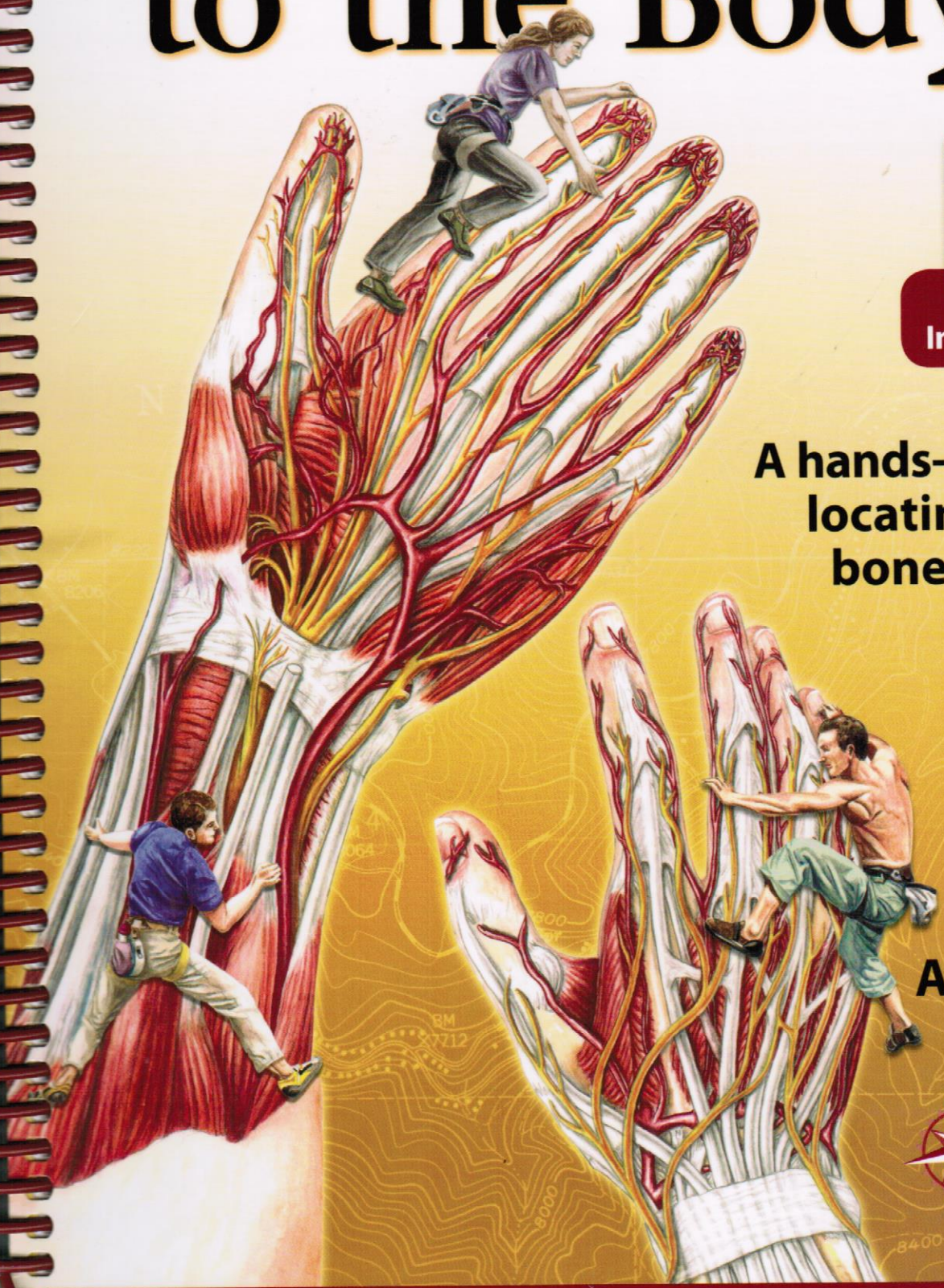
Trail Guide to the Body

500,000 SOLD!



Includes new DVD!

A hands-on guide to locating muscles, bones and more



Andrew Biel

Books of Discovery

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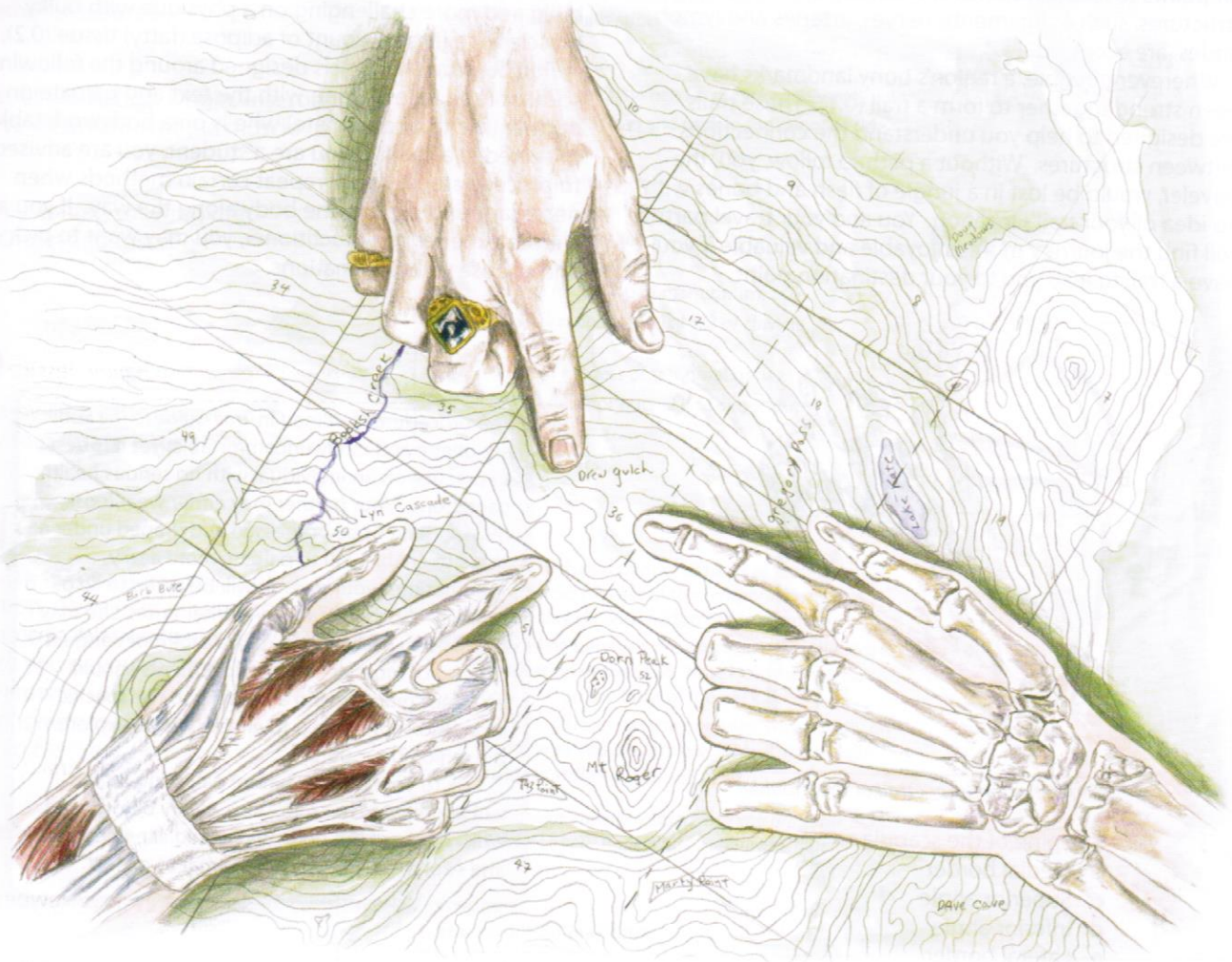


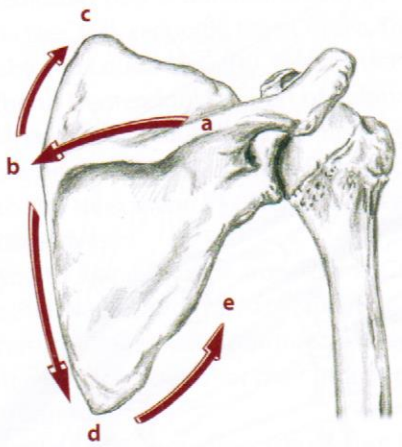
How To Use This Book

Trail Guide to the Body has seven chapters, six of which focus on different regions of the body. The topographical contours that can be seen on the surface of the skin and exercises to explore the skin and fascia are outlined first. These are followed by the bones and bony landmarks (the bone's hills, dips and ridges). The bony landmarks can be thought of as "trail markers." They are used as stepping-off points to locate muscles and tendons. Finally, other structures, such as ligaments, nerves, arteries and lymph nodes, are accessed.

Wherever possible, a region's bony landmarks have been strung together to form a trail (0.1). These trails are designed to help you understand the connections between structures. Without a path to follow, you, the traveler, would be lost in a jungle of flesh and bones with no idea of your trail's location. You and your travel partner will find the journey more enjoyable and valuable if you have a trail to lead you to your destination point.

Since bodies come in a variety of sizes and shapes, it might seem unrealistic that one trail guide could apply to all of them. If the terrain is never the same, what is the use of a map? Even though the topography, shape and proportion of each person are unique, the body's composition and structures are virtually identical on all individuals. The differences are simply qualitative: It is easy to find many structures on a person with a slender build and more challenging on a physique with bulky muscles or a large amount of adipose (fatty) tissue (0.2).

Trail Guide to the Body is designed around the following scenario: You follow along with the text and palpate on a partner (friend or classmate) who is on a bodywork table or seated in a chair. If you are a student, you are advised to proceed step by step, repeat certain methods when necessary, and explore the body along the way. If you are a more experienced practitioner, you may want to pick and choose your destinations.



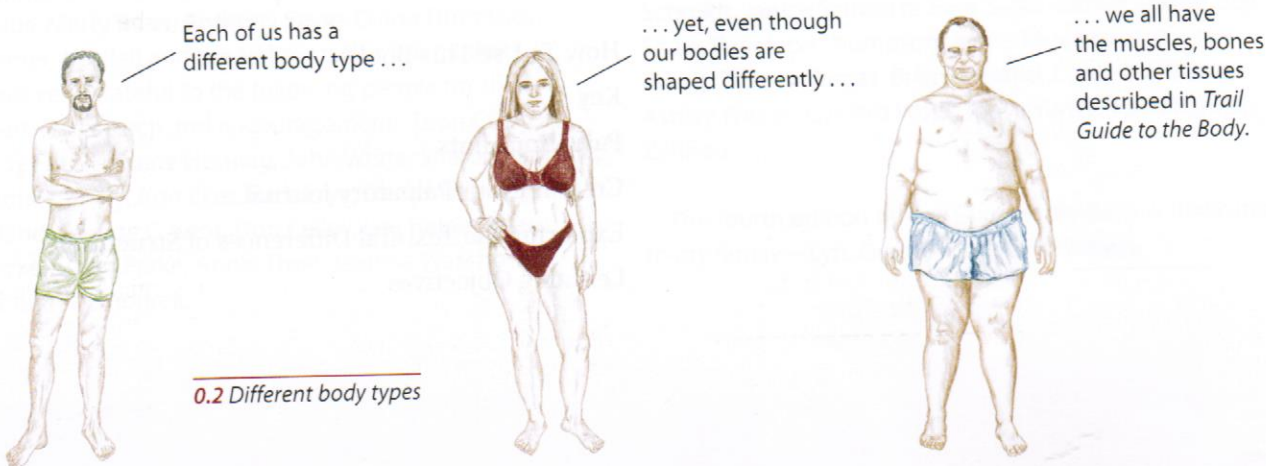
0.1 A bony landmark trail of the shoulder

a Spine of the scapula
b Medial border
c Superior angle
d Inferior angle
e Lateral border

The procedures outlined in *Trail Guide to the Body* are gentle and rarely uncomfortable, yet it is best to practice on an individual with no serious health conditions. Your partner may either wear loose, thin clothing or be undressed and draped under a sheet to enable you to palpate more easily.

Sometimes your partner will be asked to lie or sit passively on the table. At other times, she may be asked to move a limb, bend a joint or contract a group of muscles. These movements should be done smoothly and according to the specific instructions of the text to enable you to explore the region thoroughly.

Talk to your partner before palpating so she will understand her role. Also, clarify beforehand which areas of the body you would like to palpate and explore so she will know what to expect.



0.2 Different body types

Name of structure
(icon indicates if it is on the DVD)

Introduction describing a structure's function, depth and relationship to other structures

A list of the **A**ction, **O**rigin, **I**nsertion and **N**erve innervation of the muscle

O Illustration showing the
I **O**rigin and **I**nsertion

Step-by-step instructions on how to **palpate** a structure

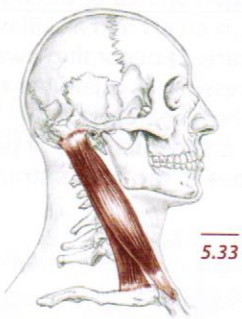
"Check It" questions will confirm your location. They may ask you about your location in relation to a nearby structure or ask you or your partner to create a movement. Unless otherwise indicated, the answers to the questions should be, "Yes!"

Alternative palpatory routes

Sternocleidomastoid

DVD

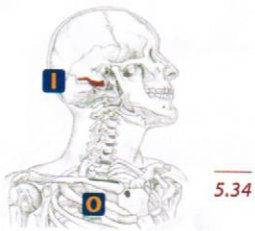
The sternocleidomastoid (SCM) is located on the lateral and anterior aspects of the neck. It has a large belly composed of two heads: a flat, clavicular head and a slender, sternal head (5.33). Both heads merge to attach behind the ear at the mastoid process. The carotid artery passes deep and medial to the SCM; the external jugular lies superficial to it.



5.33

A *Unilaterally:*
- Laterally flex the head and neck to the same side
- Rotate the head and neck to the opposite side

Bilaterally:
- Extend the neck
- Flex the neck
- Assist in inhalation



5.34

O *Sternal head:* Top of manubrium
Clavicular head: Medial 1/3 of clavicle

I Mastoid process of temporal bone, lateral superior nuchal line of occiput

N C(1), **2**, 3

1) Supine with practitioner at head of table. Locate the mastoid process of the temporal bone, the medial clavicle and the top of the sternum.
2) Draw a line between these landmarks to delineate the location of the SCM. Note how the two SCMs form a "V" on the front of the neck.
3) Ask your partner to raise her head very slightly off the table as you palpate the SCM. It will usually protrude visibly (5.35).

5.35 *Partner supine*

With your partner relaxed, can you grasp the SCM between your fingers and outline its shape?

ster-no-**kli**-do-**mas**-toyd

Pronunciation and etymology of anatomical terms

Look for **Mr. Bones** sharing cautionary advice or other helpful hints

Look for the small yellow boxes showing the position of you and your partner.

Check out the boxes for palpation tips, comparative anatomy and other curiosities

The techniques described in *Trail Guide to the Body* should be viewed as helpful tour guides. When first palpating, it is best to follow the specific instructions. After you have located a structure, it is recommended that you adapt and explore other methods to find the approach that works best for you. Wherever possible, an optional method for locating a structure has been included. As with any worthwhile journey, veering off course to explore other areas often leads to wonderful discoveries. Please feel free to veer.

etymology **et**-i-**mol**-o-gee the science of the origin and development of a word

Palpation Hints

Palpation means "to examine or explore by touching (an organ or area of the body), usually as a diagnostic aid." It is an art and a skill which involves **1) locating** a structure, **2)** becoming **aware** of its characteristics and **3) assessing** its quality or condition so you can determine how to treat it.

The first two aspects of palpation—locating and being attentive to the body's structures—require a thorough knowledge of functional anatomy and experience through mindful, hands-on practice. This is the focus of *Trail Guide to the Body*. Assessment—the third aspect of palpation—is a vast subject requiring a book of its own.

As an experience involving all the senses, **palpation requires receptive hands and fingers, open eyes, listening ears, calm breath and a quiet mind.** As you explore the terrain and texture of the body, be sure to bring along all of your sensing tools.

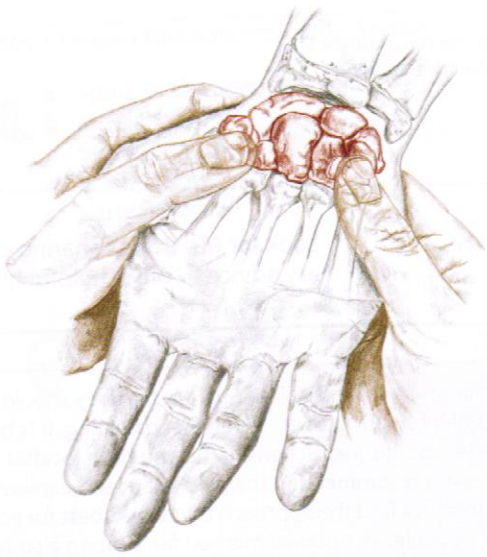
0.3 A firm top hand and a soft bottom hand

Making Contact

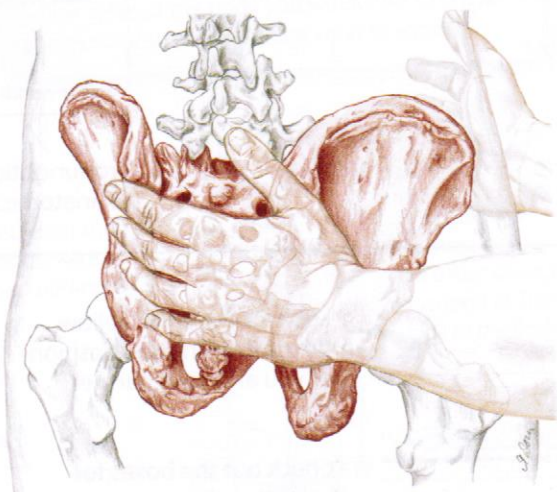
Let your hands and fingers be **responsive** and **sensitive**. Relaxed, patient hands will allow the body's contours, temperature and structures to come more easily into your awareness.

For greater sensitivity and stability, **try laying one hand upon the other**, using the top hand to create the necessary pressure, while the bottom hand remains relaxed (0.3). This will allow the bottom hand to stay receptive as the top hand directs movement and depth.

Smaller structures can be located by using one or two fingertips (0.4). **Larger structures** are best palpated with your whole hand. By sculpting out all of the sides and edges, full-hand contact helps to define the complete shape of a region or structure and also allows for a greater understanding of the interrelationships of structures (0.5). When palpating, you may want to **close your eyes** (0.6) periodically to enhance your awareness.



0.4 Using your thumbpads to explore the small carpal bones in the wrist



0.5 Using your entire hand to palpate the pelvis and sacrum

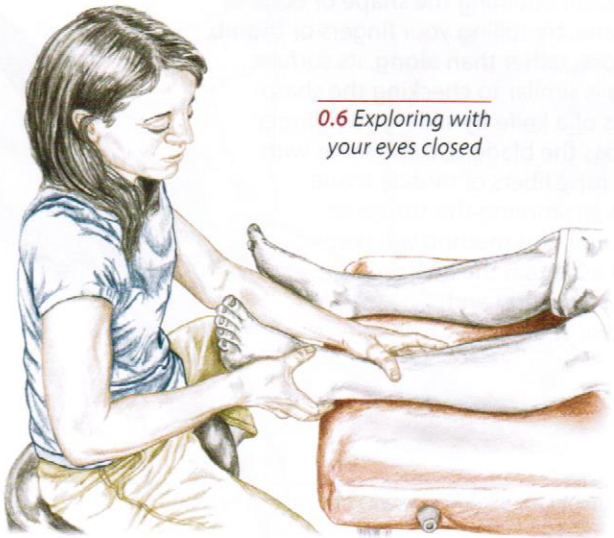
palpate **pal**-pate L. *palpare*, to touch

Working Hard vs. Working Smart

Often in the excitement of trying to locate something (whether it be a muscle or a set of car keys), you search so earnestly that your mental and physical awareness begins to diminish. Frustration arises, your breath stalls and your hands ultimately become insensitive. You begin to **work hard**. Instead of working hard, you can work smart by reading the information about the structure before you palpate. Also, as you palpate, **visualize** what you are trying to access and **verbalize** to your partner what you are feeling.

Work smart by first locating the structure you wish to palpate on your own body before palpating it on your partner's. **Self-palpation** will improve your kinesthetic understanding of what you are looking for on your partner. Also, **read** the information **aloud**. Hearing the language as you are reading the text will improve your understanding and retention of the information.

Lastly, **be patient** with your learning process. Allow yourself to "make a wrong turn and get lost" on the body. Chances are you are close to what you are seeking. By letting your senses recognize the body's trail signs, you will get to where you want to be.



0.6 Exploring with your eyes closed

Dogs, cats, horses and other animals offer a wonderful opportunity to compare musculoskeletal anatomy through palpation. For example, the next time you are petting your neighbor's cat, take a moment to locate its scapula. Compare the scapula's shape, location and surrounding tissues to those of a human's or dog's. The anatomical differences may surprise you, but the similarities will amaze you.

Less Is More

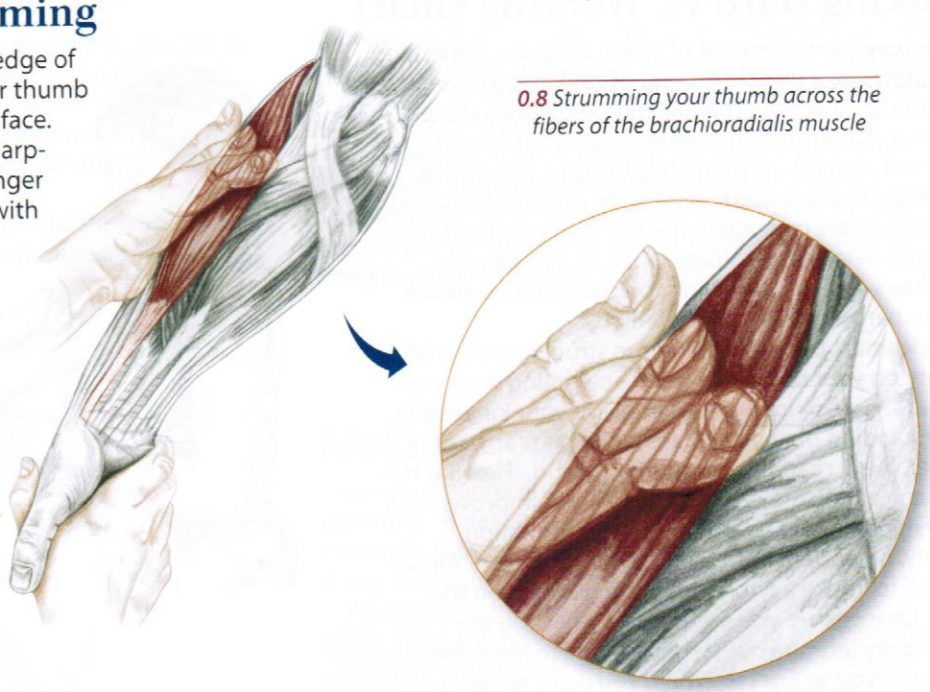
As you begin exploring the body, you might not be able to access things as readily as you wish. A common reaction is to press harder and deeper with your hands and fingers; however, instead of pushing into the muscles and other tissues, **try to invite the tissues into your hands**. Gentle contact will allow your hands to be sensitive, while excessive pushing only numbs the fingers, making for an uncomfortable experience for your partner (0.7).

Even deep structures are best accessed with mild pressure. Paradoxically, the **deeper you move** into the body, the **slower and softer your touch** needs to be. Ultimately, palpation at different levels of the body is not a question of pressure, but of **intention**. Having a clear intention as you seek out various structures will make for an easier, smoother journey.

0.7 Less is more

Rolling and Strumming

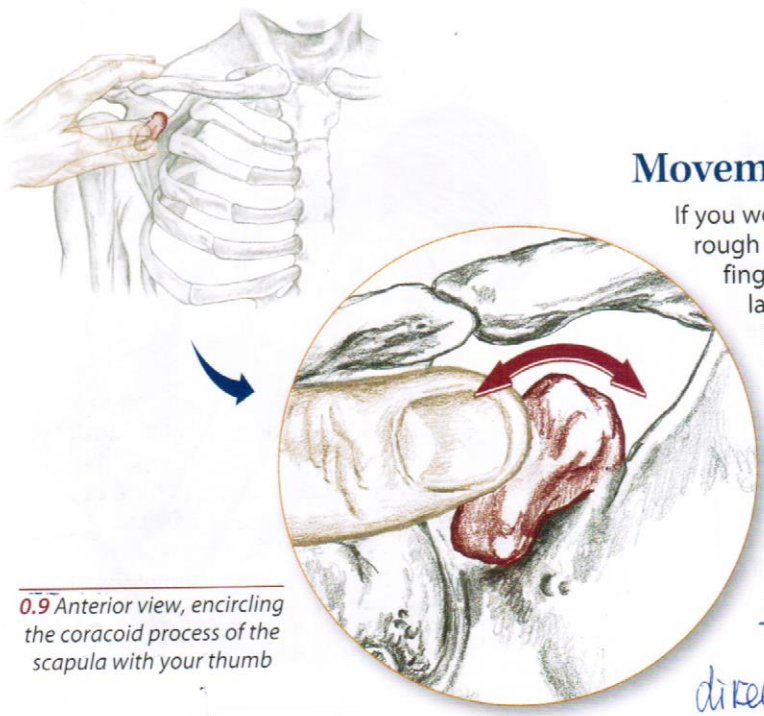
When outlining the shape or edge of a bone, try rolling your fingers or thumb **across**, rather than **along**, its surface. This is similar to checking the sharpness of a knife by sliding your finger across the blade. Do the same with the ropy fibers of muscle tissue. Like strumming the strings of a guitar, this method will help you ascertain the muscle's fiber direction and tensile state (0.8).



0.8 Strumming your thumb across the fibers of the brachioradialis muscle

Here is a simple exercise to increase your tactile sensitivity and palpatory skills. You will need a phone book and a human hair. Lay the hair beneath a single page of the phone book. Close your eyes and palpate through the

page, trying to locate the hair. When you find the hair, reposition the hair and add another page. Continue to add pages until you can no longer locate the hair. How many pages can you palpate through? Five? Ten? Fifteen?!



0.9 Anterior view, encircling the coracoid process of the scapula with your thumb

Movement and Stillness

If you were to compare the texture of newspaper with rough sandpaper, you would naturally want to rub your fingers across their surfaces. In contrast, when you lay your hand on an expectant mother's abdomen, hoping to feel the fetus move, you naturally keep your hand still and quiet. Similarly, when you want to determine the fiber direction of a muscle or sculpt the shape of a bone, **move your hands along its surface** (0.9). However, when you want to feel a muscle contract or a bone move, **keep your hands still** and follow the movement. Put simply, if the structure you are palpating is stationary, **move** your hands across it; if it is moving, stay **still**.

direction & shape, move
contract & bone move, still

Movement as a Palpation Tool

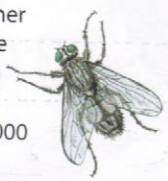
Throughout the text, you will be asked to create specific movement on a partner's body with or without that person's help. These movements will help to verify the location of structures as well as any changes occurring in the tissues as a result.

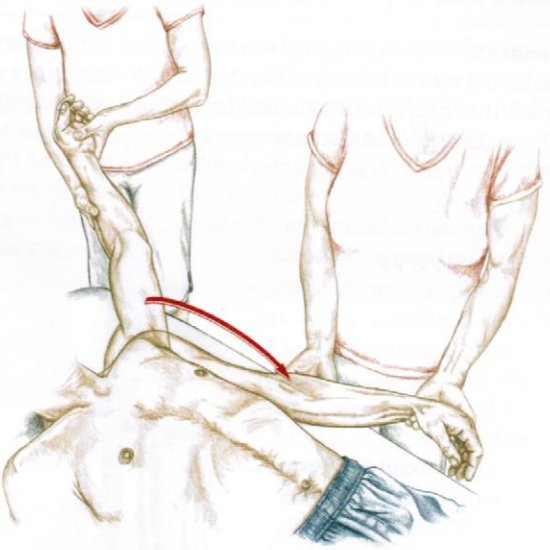
0.10 Active flexion and extension of the elbow

Active movement is performed by your partner. He actively moves his body while you palpate or observe the movement. For example, the text may say, "Ask your partner to slowly flex his elbow while you palpate his biceps brachii muscle." All active movements performed by your partner should be slow and smooth—as changes in tissue are difficult to follow during fast, jerky motions (0.10).

Sometimes you be instructed to ask your partner to contract and relax a muscle. For example, "To feel the forearm flexors, lay your hand on your partner's forearm and ask him to alternately flex and relax his wrist." The on-and-off aspect of this technique will not only help you locate muscles and tendons, but will also give you the opportunity to feel the difference between contracted and relaxed tissue.

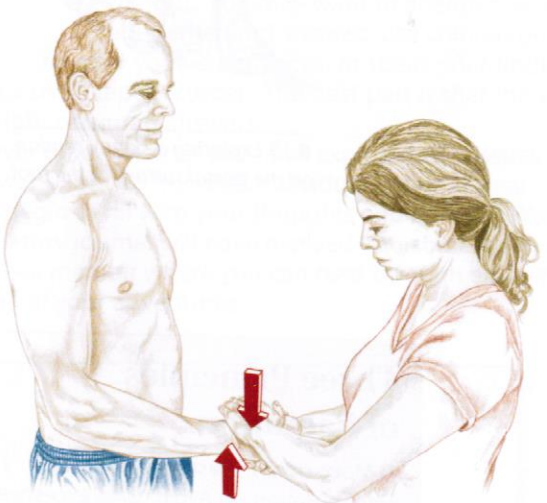
An adult has over 600,000 sensory receptors in the skin—more nerve endings than any other part of the body. The fingertips are among of the most sensitive areas, with up to 50,000 nerve endings every square inch. The fingertips are so sensitive that a single touch sensor can respond to a pressure of less than 1/1,400 of an ounce—the weight of an average house fly.





0.11 Passive flexion and extension of the shoulder

Passive movement is the opposite of active movement: Your partner relaxes while you move his body. For example, when the text says, "Passively abduct and adduct the shoulder," you will move the arm while your partner remains passive and allows the action to occur (0.11).



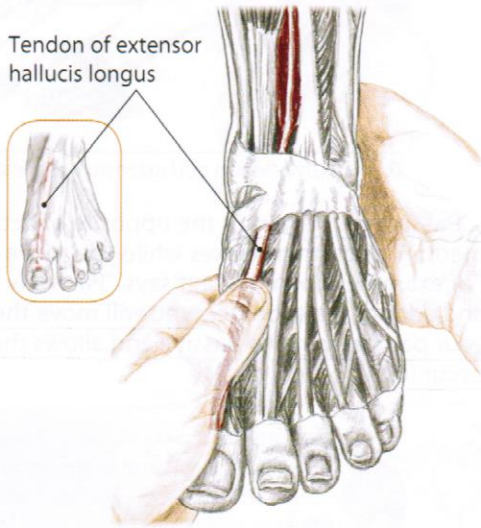
0.12 Resisted flexion of the elbow

Resisted movement requires both of you to act: Your partner attempts to perform an action against your gentle resistance. For example, "To feel the elbow flexors contract, ask your partner to flex his elbow against your resistance" (0.12). As he meets the gentle resistance of your hand, no movement will occur at your partner's elbow. In this text, resisted movements are used to distinguish and compare the lengths, shapes and edges of different muscle bellies and tendons.

Leonardo da Vinci (1452-1519), who dissected bodies secretly at night, was the first to depict his anatomical findings. His anatomical illustration, laid out in over 750 drawings, is not only detailed and accurate, but also reveals many of the structural variations that can be seen when comparing bodies.

The anomalies shown in the drawings were not a case of Leonardo the artist dominating Leonardo the scientist; as a true Renaissance man there can be little question that he drew exactly what he saw in the cadavers.

The structures of the human body do not always conform to the standard anatomical model. Structural differences have been recorded in almost every muscle, bone, major blood vessel and organ in the body. Recognizing that the guidebook may not always coincide exactly with the geography of a particular body will help to prevent confusion and possible frustration.



0.13 Exploring a skinny tendon on the dorsal surface of the foot

When in Doubt, Ask the Body

While palpating, you may be confused or have questions about the body's structures and their whereabouts. **When in doubt, ask the body you are palpating.** For example, you may wonder, "What skinny tendon is this I see running along the top of the foot?" (0.13) The best advice would be to follow it in both directions and see where it leads you. If it runs from the big toe to the ankle and becomes taut when the toe is extended, it is the tendon of extensor hallucis longus (p. 378). **Always remember, you are never alone; the body is waiting to help you.**

All of the structures outlined in *Trail Guide to the Body* with their Latin or Greek names, unique shapes and buried positions, are inside you, your partner and your patients. These structures have been there for years waiting for you to discover them. Have faith and you will be able to locate them.

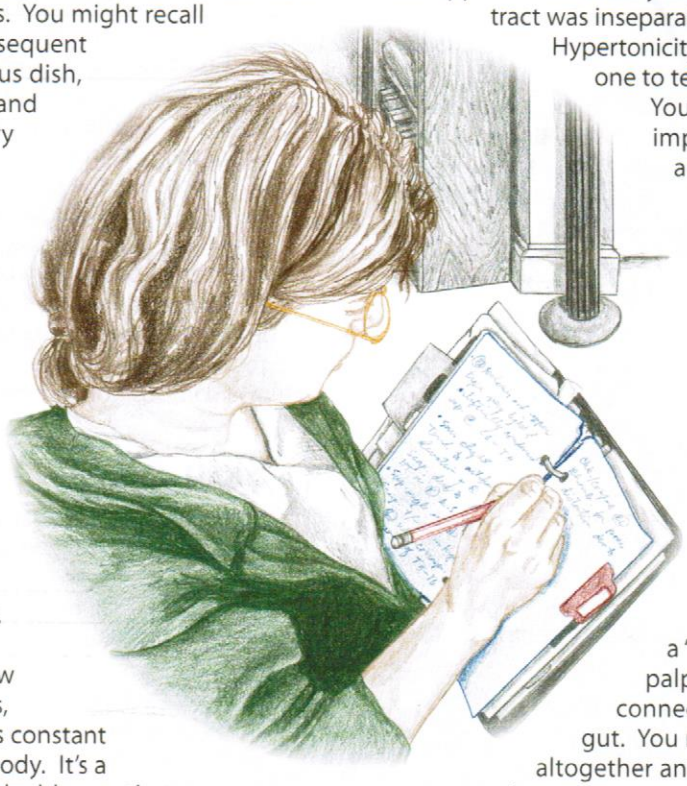
Three Principles of Palpation

1) Move slowly. Haste only interferes with sensation. 2) Avoid using excessive pressure. Less is truly more. 3) Focus your awareness on what it is you are feeling. In other words, be present.

Also, you can practice your palpation skills on yourself at any time. Yes, you may get a few curious glances, but daily routines such as waiting in line or riding the bus are wonderful opportunities to explore the malleable skin, tiny bones and sinewy muscles of your forearms and hands.

Creating Your Palpatory Journal

Do you remember the first movie you ever saw? How about that initial bite of (what would soon become) your favorite food? Chances are that these encounters created lasting impressions. You might recall details of later films or subsequent helpings of that scrumptious dish, but over time your senses and memory of those secondary encounters probably diminished.



Learning to palpate is no different. Our initial hands-on experiences can cast long shadows over future encounters. For example, exploring the shape, density and fibers of the deltoid muscle for the first time can be formative. But as you become more familiar and less surprised by the muscle, later encounters will leave less of an impact.

The repetitive practice involved with learning a new skill, such as the martial arts, dance or palpation, requires constant presence of the mind and body. It's a difficult journey, but an invaluable one that can be enhanced by creating a palpatory journal. Like a personal diary, your journal is a chronicle of your hands-on experiences. You could store your palpatory stories in your head, but it's certainly more effective to record them in a small notebook or on your computer.

Initially, your journal remarks may be broad and undefined. "The deltoid was tight." "The hamstrings felt ropy." As your palpatory instinct develops greater awareness of the body's nuances, so will your ability to articulate your findings. "I was able to shift the fascia of the upper chest caudally but not laterally." "Left iliotibial tract was inseparable from vastus lateralis. Hypertonicity was an eight on a scale from one to ten."

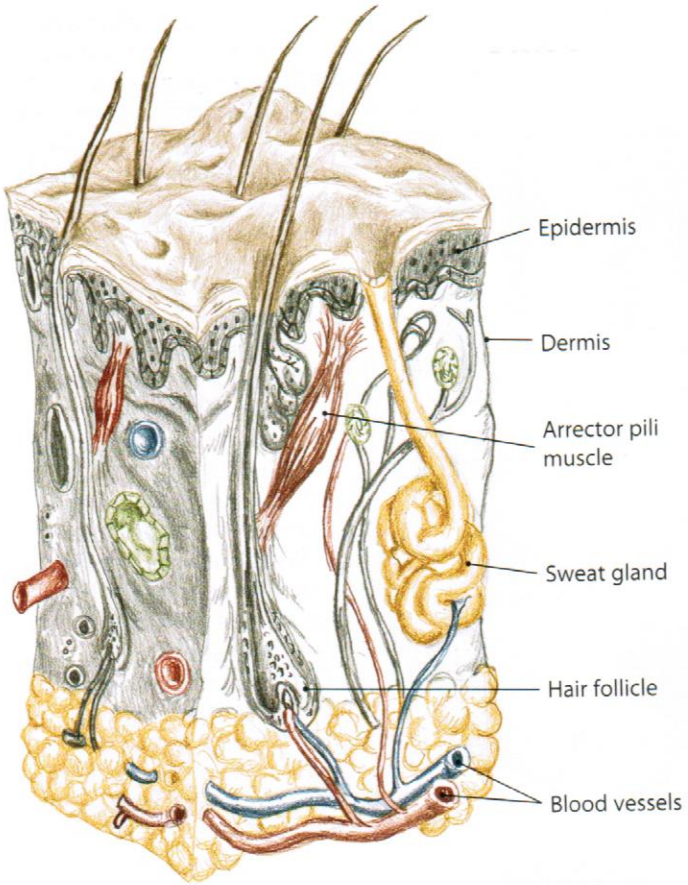
Your notebook can also include impressions, ideas, questions and correlations. For example, "This week I palpated several different gastrocnemius muscles and noticed that four were particularly tender and had limited range of motion. Is this common or just coincidence?" Or "sixty-seven-year-old male: The superficial fascia surrounding his hamstrings felt like bubble wrap. I've noticed this with two other seniors."

Of course, journaling is a "head-based" activity and palpation is strongest when it is connected to the hands, heart and gut. You may want to abandon words altogether and, instead, use colored pens to draw your experiences, or speak your findings into a small tape recorder. The best part is that there are no right or wrong answers.

Over time, whether you have explored the tissues of twenty or two hundred individuals, your journal will begin to fill with your thoughts and findings. Your palpatory journal will have evolved into something else—a memoir where you can read through and reflect on all of your adventures.

Palpating a variety of bodies in succession can create an unparalleled hands-on experience. This can be easily accomplished with a "round robin," where you rotate with others to palpate a series of people. Classroom settings (above), study sessions with friends or even social gatherings offer opportunities for a round robin. The key to a productive round robin is maintaining awareness of the similarities and differences you are feeling from one person to the next.

Exploring the Textural Differences of Structures



0.14 Cross section of the skin. If you do not like the skin you have, just wait a month. An average adult sheds about 600,000 particles of skin every hour, amounting to one and a half pounds of skin each year. Altogether, the outer skin changes about every twenty-seven days. Add it up and that is nearly 1,000 new skins in a lifetime.

This section is designed to help you identify and compare the physical characteristics of the various structures and tissues in the body. Understanding the textural differences between structures will help you to determine which techniques to apply on a particular body part in your hands-on practice.

Following are descriptions of various structures in their "normal," healthy condition. The tissue's basic structural design will be identical on everyone, but, of course, the particular quality or feel of a tissue will be as unique as the individual you are palpating. For example, a long-distance runner may have lean, sinewy bands of muscle tissue while an individual leading a sedentary lifestyle may have a very different quality to his muscles. Although the feel of the muscle tissue is different, its design and composition are the same.

Skin

Although often regarded as merely the body's covering, the skin is, in fact, the largest organ of the body (0.14). On an adult male, the skin can cover a surface area of nineteen square feet and weigh nearly ten percent of the total body weight. The skin averages about 1/20 of an inch in thickness, with the eyelids having the thinnest skin—less than 1/500 of an inch. The skin is intimately connected with the superficial fascia and deeper tissues, and its texture, thickness and flexibility vary throughout the body.

For example, palpate the skin on the back of your hand. Note its thin, delicate and pliable quality. Then turn your hand over and explore the palmar surface. Here the skin has a thicker, tougher layering.

You and Mr. Bones

Most anatomy classrooms are haunted by a human skeleton. Hanging from a hook or set on a stand, it is most likely plastic, since real skeletons are difficult to dig up these days (which is how they were often acquired in anatomy's scandalous past). Real or not, close examination of a skeleton with your eyes and hands is an opportunity not to be missed. Why? Because palpation, to a large degree, is all about visualization. So, whenever you get a chance to spend some quality time with Mr. Bones, take it. After inspecting its pelvis and other features, you might discover that *Mr.* Bones is actually *Mrs.* Bones!

Bone

Bones and bony landmarks (the hills, valleys and bumps on the surface of bones) are easy to distinguish from other tissues because they have a solid feel. Of course, the bones shift along with their surrounding structures during movement.

Sometimes other structures can feel like bone; for example, when a muscle contracts against resistance, its belly and tendons become very hard. Ligaments also can have a particularly solid quality. The shape and rigidity of bones and bony landmarks are constant, unlike muscles, which can transform from a soft to a hard state and back again.

Muscle

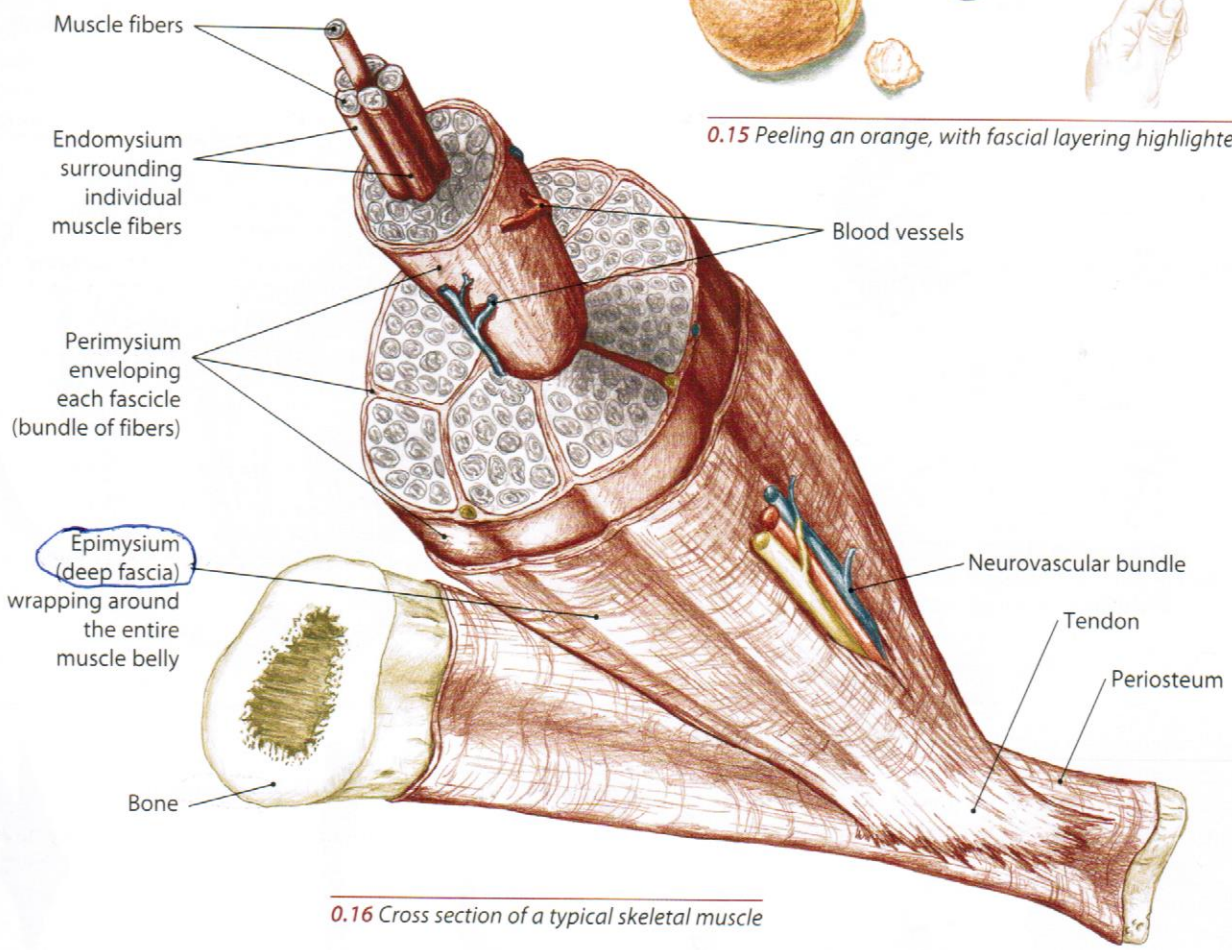
Skeletal muscle, the voluntary contractile tissue that moves the skeleton, is composed of muscle cells (fibers), layers of connective tissue (fascia) and numerous nerves and blood vessels.

A muscle's infrastructure is similar to that of an orange: A broad sheet of fascia encases the whole fruit, deeper layers of fascia separate the orange into "wedges" (the portions you eat after peeling) and, finally, a thin coating of tissue surrounds each individual, tiny "bud" of fruit (0.15).

If we then apply this analogy to a muscle, a layer of fascia (epimysium) encases the muscle "belly," a deeper layer (perimysium) wraps the long muscle fibers into bundles and, finally, each microscopic muscle fiber is bound in fascia (endomysium) (0.16). Unlike an orange, however, a muscle's layers of connective tissue merge at either end of the muscle to form a strong tendon. The tendon attaches the muscle to a bone.

Muscle tissue has three specific physical characteristics which help to distinguish it from other tissues. First, **muscle tissue has a striated texture**—similar to a plank of unsanded wood. This is different from tendons, which have a smoother feel. The fibrous quality of a muscle belly is caused by bundles of muscle fibers running in a particular direction.

0.15 Peeling an orange, with fascial layering highlighted



0.16 Cross section of a typical skeletal muscle

agonist . synergist . antagonist

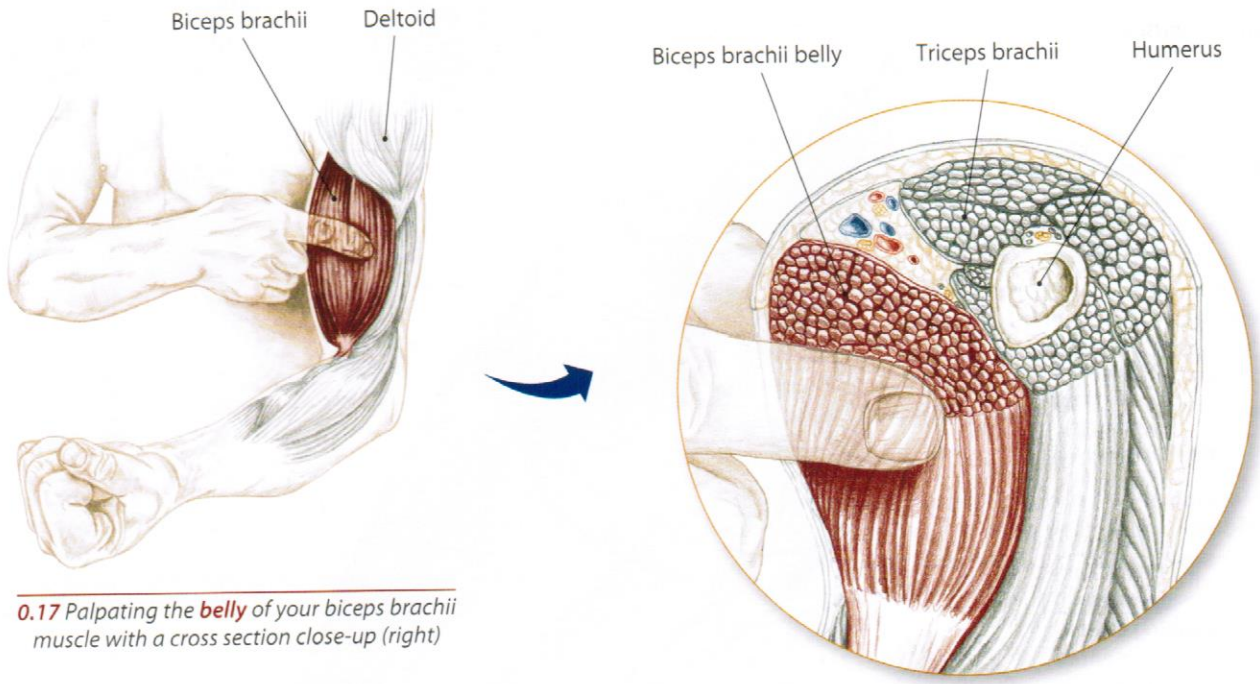
In order for a specific movement to occur, muscles have to play particular roles. A muscle (or group of muscles) that carries out an action is called the **agonist**, while a muscle that supports the agonist is called a **synergist**. A muscle that has an opposite action of the agonist is called an **antagonist**. So when you *dorsiflex* your ankle (p. 31), the agonist is the tibialis anterior. It is supported in this movement by two synergists, the extensor digitorum longus and extensor hallucis longus (p. 378). Playing the role of antagonists to the tibialis anterior are the gastrocnemius and soleus (p. 371). Conversely, when you *plantar flex* your ankle (p. 31), the roles reverse: Now the agonists are the gastrocnemius and soleus, the synergists are the other plantar flexors of the ankle and the antagonists are the tibialis anterior, extensor digitorum longus and extensor hallucis longus.

Second, **the direction of the muscle fibers** can be used to determine the specific muscle you are palpating. Depending on the shape and design of a muscle (see box below), the direction of its fibers may be parallel, convergent or diagonal. For example, the erector spinae muscles (p. 196) have vertical fibers that run parallel to the spine. Identifying their fiber direction can help you distinguish the erector spinae from the oblique and horizontal fibers of the other back muscles.

Lastly, **muscle tissue is unique because it can be in a contracted or relaxed state**. When a muscle is relaxed, it often has a soft, malleable feel; when contracted, it has a firm, solid quality. As the tension in muscle tissue changes, surrounding tissues like tendons and fascia also change, becoming taut or loose.

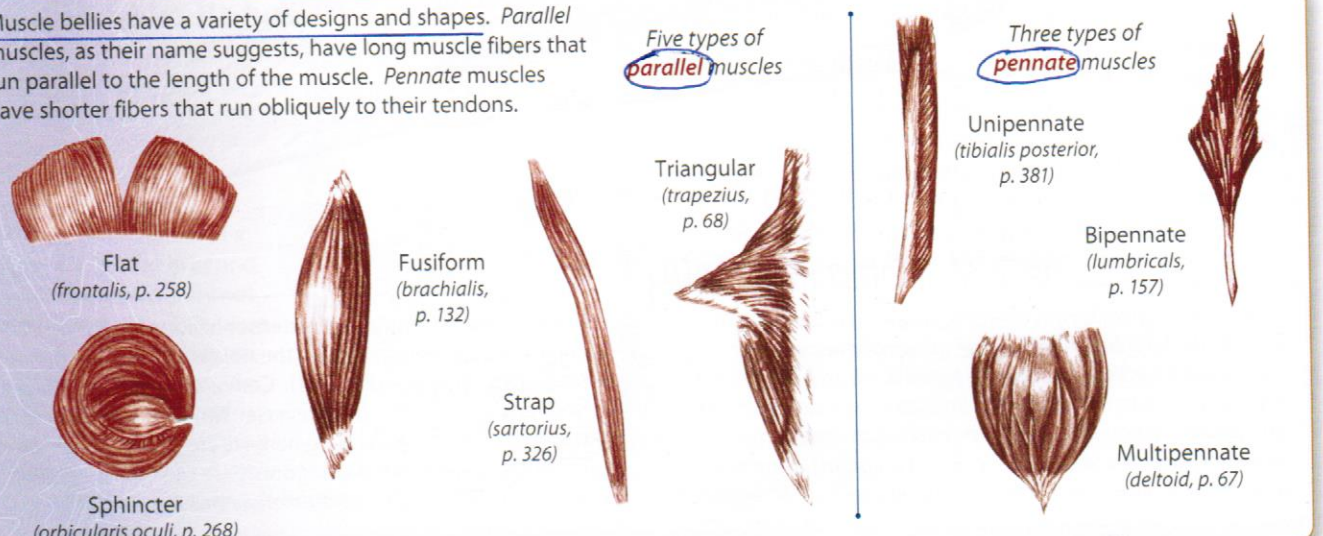
How can you palpate a muscle that is deep to a superficial, overlying muscle? In some areas, the overlying muscle can be shifted to the side. At other times, you can slowly compress your fingerpads beyond the superficial muscle into the deeper tissues, using the different textures and fiber directions as guides. This is similar to palpating through your sweater, shirt and skin to access a muscle in your arm.

Discover the three distinguishing features of muscle tissue by palpating your biceps brachii—the muscle on the front of the arm (0.17). Keep your arm relaxed and feel for the biceps' ropy fibers. Note how its fiber direction runs distally (down the arm). Then contract and relax the biceps and sense how it tightens into a solid mass and relaxes into a soft wad.



*0.17 Palpating the **belly** of your biceps brachii muscle with a cross section close-up (right)*

Muscle bellies have a variety of designs and shapes. *Parallel* muscles, as their name suggests, have long muscle fibers that run parallel to the length of the muscle. *Pennate* muscles have shorter fibers that run obliquely to their tendons.



aponeurosis **ap**-o-nu-**ro**-sis Grk. *apo*, from + *neuron*, nerve or tendon
ligament **lig**-a-ment L. a band

Tendon

Tendons attach muscle to bone. More accurately, they connect muscles to the periosteum—the connective tissue which surrounds the bone (p. 11). Tendons are composed of dense connective tissue shaped into bundles of parallel collagen fibers. Each end of a muscle has one or more tendons.

Tendons come in a variety of shapes and sizes. Some are short and wide like those of the gluteus maximus at the buttocks. Others are long and thin such as the tendinous cables of your wrist. A broad, flat tendon is called an aponeurosis. An example is the galea aponeurotica (p. 262) that extends across the top of your cranium. All tendons have a smooth, tough, almost resilient feel to them, regardless of their shapes.

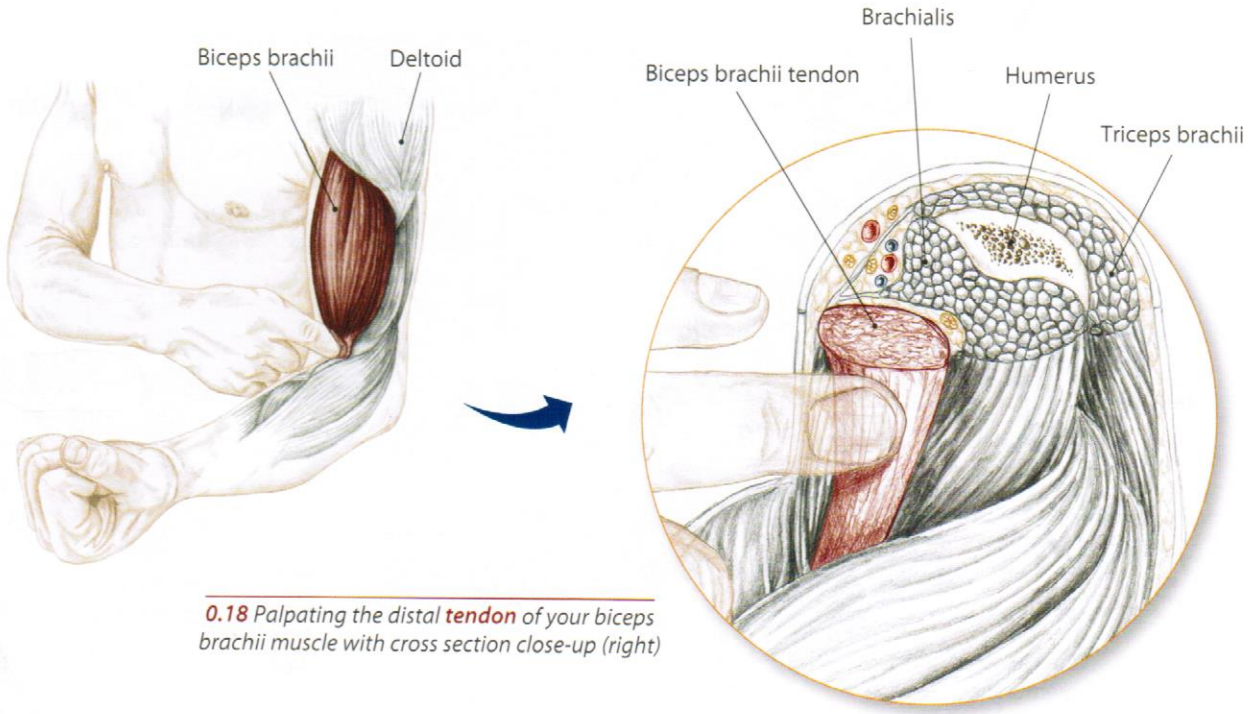
Locate the distal tendon of the biceps brachii by holding your elbow in a flexed position (0.18). First, locate the biceps' muscle belly and follow it distally toward your inner elbow. As you progress, the muscle belly will become more slender and, at the crease of the inner elbow, it will become a smooth, thin tendon. It may feel like a taut strand of cable. Explore around either side of this tendon.

Ligament

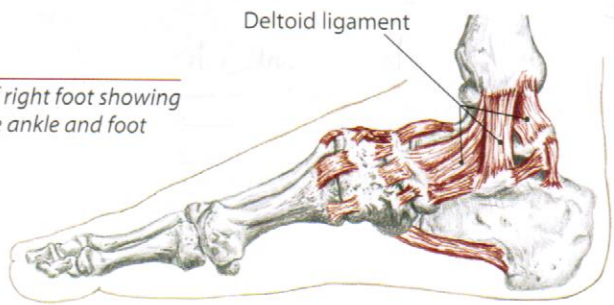
Ligaments connect bones together at a joint. Their task is to strengthen and stabilize joints. Like tendons, ligaments are made of dense connective tissue. But unlike a tendon's parallel fiber arrangement, a ligament's fibers have a more uneven configuration.

The design and length of ligaments vary. Many simply cross a joint and blend in with the deeper joint capsule, like the ankle's deltoid ligament (0.19). Others span a distance between several bones, like the supraspinous ligament of the back (p. 219).

Ligaments often have a dense, taut feel and sometimes their fiber directions are palpable. If you want to distinguish a tendon from a ligament, explore its attachments and variable tension. A *tendon* connects a muscle belly to a bone, while a *ligament* attaches a bone to another bone. A *tendon* will become taut or slack depending on whether it is shortened or lengthened or if its muscle belly is contracted. A *ligament* will remain taut throughout all movements or states of contraction.



0.18 *Palpating the distal* ***tendon*** *of your biceps brachii muscle with cross section close-up (right)*



0.19 *Medial view of right foot showing ligaments of the ankle and foot*

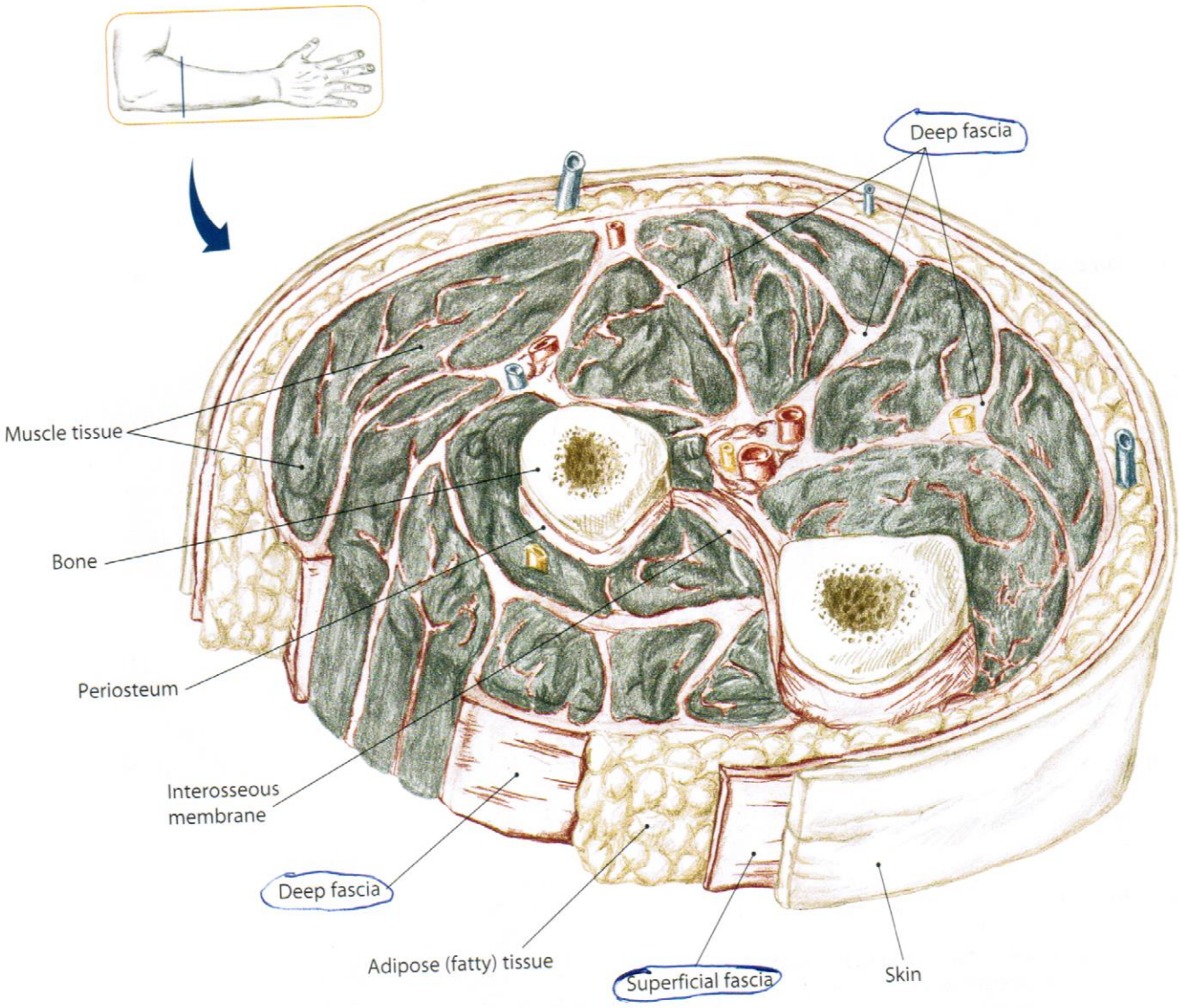
Fascia

Like tendons and ligaments, fascia is a form of dense connective tissue. It is a continuous sheet of fibrous membrane located beneath the skin and around muscles and organs. This fascial system forms a three-dimensional matrix of connective tissue extending throughout the body from head to toe.

There are two types of fascia: superficial and deep. **Superficial fascia** is located immediately deep to the skin and covers the entire body. Often perceived as a thin sheet, superficial fascia is actually a spacial layering filled with adipose tissue, nerves, blood and lymph vessels, and connective tissue (0.20). The density of the superficial fascia varies from very thin (on the back of the hand) to quite thick (the sole of the foot).

Deep fascia has a more complex design. It surrounds muscle bellies, holding them together and separating them into functional groups. It also fills in the spaces between muscles and, like superficial fascia, carries blood vessels and nerves. Portions of the deep fascia penetrate into the muscle belly and encase each tiny muscle fiber.

Because of its ubiquitous quality, precise palpation of the fascial system requires an experienced, sensitive touch. On the next page are three simple exercises that can help you get a basic feel of the fascia and its relationship to other structures.



0.20 Cross section of the forearm showing the arrangement of bone, muscle and fascia

septum septa	**sep**-tum **sep**-ta	L. enclosure plural for septum

Explore Your Fascia

Pull up the skin on the back of your hand (0.21). Notice how the skin does not pull up entirely (as when you pull a baggy shirt away from your body). This is because the fascia is holding the skin down. Try this on your knee and various other parts of your body and notice how it is easier to lift the skin and fascia in some areas and more difficult in others (0.22).

Here is an exercise to demonstrate the omnipresent, yet phantomlike, nature of fascia. Put a latex glove on your partner's hand, followed by a thick winter glove. If you explore your partner's hand, you will immediately detect the texture and thickness of the winter glove and the general shape of the hands and fingers. The latex glove (representing the fascia), however, may be more challenging to detect.

0.21, 0.22 *Exploring the fascia of the back of your hand (left) and on your knee (right)*

This exercise is designed to give you a sense of the continuity of the fascial sheet throughout the body and of how pulling on one portion of this sheet can affect another. Draw a small "X" on your forearm. Place your fingerpads approximately two inches away from the "X." Using the gentle pressure of your fingerpads, slowly move the skin of your arm in various directions away from the mark (0.23).

Notice how the "X" stretches and responds more easily when you pull in a certain direction, yet may not move as easily when pulled in another direction. As you continue, reposition your fingers farther away from the "X," so, eventually, you are pulling across the skin of the hand.

0.23 *Exploring the superficial fascia with an "X" drawn on the forearm*

Retinaculum 支持帶 韌帶

A retinaculum is a structure that holds an organ or tissue in place. In relation to muscular connective tissue, a retinaculum is a transverse thickening of the deep fascia which straps tendons down in a particular location or position. For example, the retinacula of the ankle stabilize the tendons which traverse the sharp curve of the ankle (0.24).

Most retinacula are superficial and accessible. A retinaculum can be distinguished from its deeper tendons by its different fiber direction. A retinaculum will have transverse fibers that run perpendicular to the deeper tendons.

0.24 *Retinacula of the ankle*

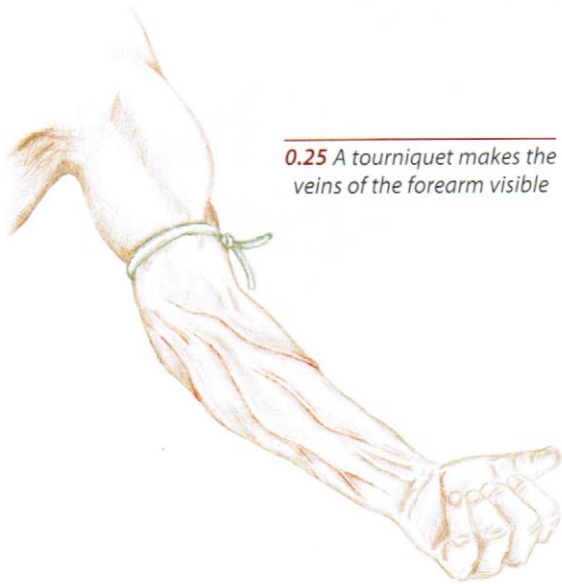
retinaculum	**ret**-i-**nak**-u-lum	L. halter, band, rope
retinacula	**ret**-i-**nak**-u-la	plural for retinaculum

Artery and Vein

Arteries and veins have distinct features that you can palpate. For example, the pulse of the heart can be felt when pressing on an artery but not on a vein. Arteries are often situated on the protected side of an appendage and buried deep to the musculature. Some veins can be palpated superficially and are easily seen on the dorsal surfaces of the hands and feet.

Locating an artery is not only necessary for determining the pulse, but also important when palpating other structures. For example, when palpating the sternocleidomastoid muscle in the neck, it is crucial for you to be aware of the location of the carotid artery (p. 271), the chief blood vessel supplying the head and neck, so you avoid pressing on it. If an artery is occluded for a sustained period of time during palpation, the distal portion of the appendage will begin to tingle or become numb.

Let your arm hang at your side for a minute, allowing the blood to fill the superficial veins of your hand and forearm. The veins will swell with the increased pressure and become visible (0.25). For more dramatic results, gently squeeze your forearm with your opposite hand or apply a tourniquet.

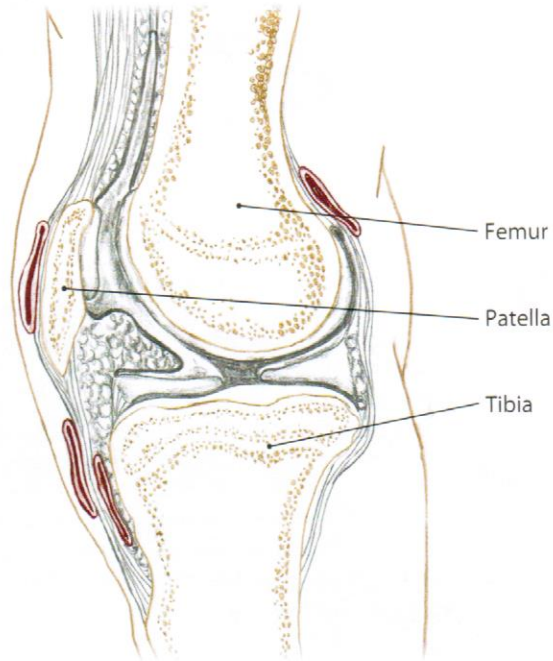


0.25 *A tourniquet makes the veins of the forearm visible*

Bursa

A bursa is a small, fluid-filled sack that reduces friction between two structures (0.26). Situated primarily around joints, most of the body's six hundred bursae cushion skin, tendons, ligaments, muscle or organs from the hard surfaces of bones. They are also located between two muscles, two tendons, a tendon and ligament, or a muscle and ligament.

Bursitis, inflammation of a bursa, is a common disorder accompanied by tenderness in the area and crepitation (cracking and clicking sounds) of the joint. When inflamed, superficial bursae are easily palpable and sometimes visible. In their normal state, however, bursae are generally not palpable.



0.26 *Cross section view of knee, some of the bursae of the knee highlighted in red*

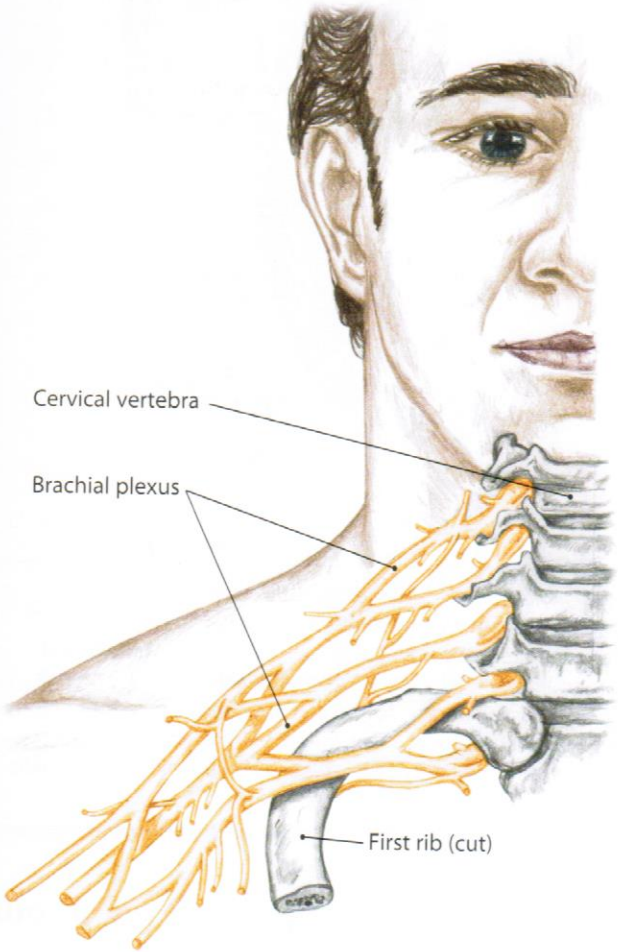
William Harvey (1578-1657), often regarded as the first experimental scientist, discovered that blood circulates throughout the body. Along with his descriptions of the cardiovascular system, he explained how veins are equipped with valves that prevent blood from flowing backwards between heartbeats. To prove his theory, Harvey tied a tourniquet around an

assistant's arm and allowed the blood to pool in the distal veins. He observed small swellings along the paths of veins, which he thought were valves. Harvey pressed on a valve and pushed the blood out of the vein to the next valve. As he held his finger on the distal valve, the proximal valve prevented blood from flowing backwards and the vein remained empty.

adipose	**a**-di-**pos**	L. fat, copious
bursa	**bur**-sah	L. a purse
plexus	**plek**-sus	L. interwoven

Nerve

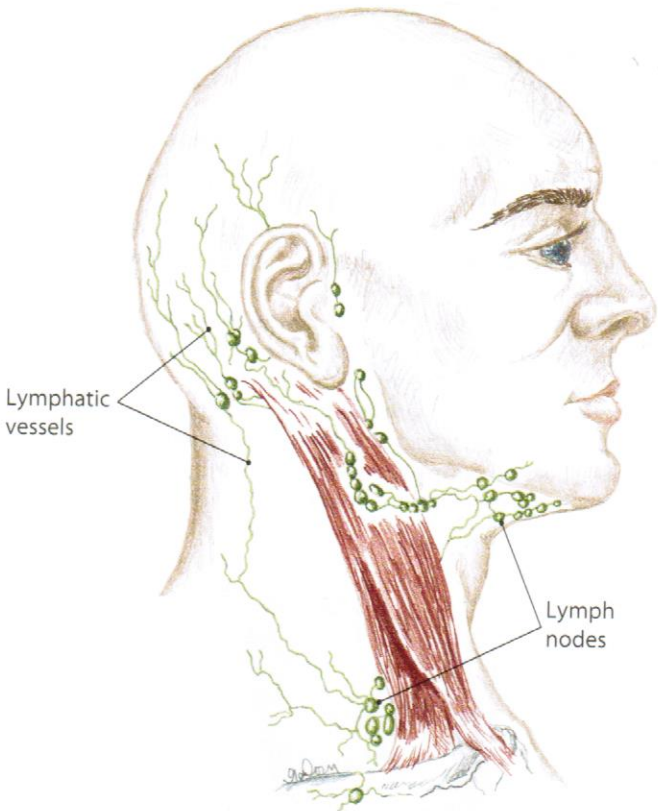
Nerve vessels are tube-shaped, mobile and tender when compressed (0.27). Although sections of nerves and plexuses (bundles of nerves) can be accessed throughout the body, they are best avoided. Compression or impingement of a nerve may create a sharp, shooting sensation locally or down the corresponding appendage.



0.27 Anterior view of the brachial plexus. Nerve impulses travel along nerve fibers at 210 miles an hour (or 320 feet a second).

Lymph Node

Lymph nodes collect lymphatic fluid from lymphatic vessels. They are bean-shaped and may range in size from a tiny pea to an almond. Lymph nodes are located throughout the body, with palpable groups of nodes found in the body's creases, such as the groin, axilla and neck (0.28). Healthy lymph nodes are roundish, slightly movable and nontender. They differ from other glands, which are usually larger and have irregular, lumpy surfaces.



0.28 Cervical lymph nodes

Adipose Tissue

Adipose (fatty) tissue is a form of loose connective tissue. It is deposited at many levels throughout the body, including the marrow of long bones, around the kidneys, the padding around joints and behind the eyeballs. Needless to say, some of these areas are outside the reach of this text. The most palpable location for adipose tissue is in the subcutaneous layer of tissue between the skin and superficial fascia. This layer of adipose varies in thickness throughout the body and may have different consistencies. Adipose usually has a gelatinous (jellylike) consistency, making it easy to sink the fingers into and detect deeper structures.

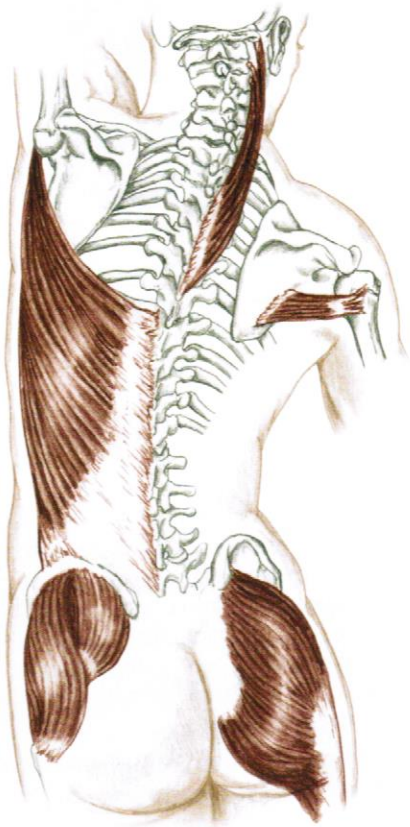
Stand up and squeeze the flesh of your own buttocks to feel adipose tissue. Yes, you might feel silly, but note the superficial layer of adipose. Then tighten the muscles of your buttocks and feel the textural difference between the adipose and the deeper muscles.

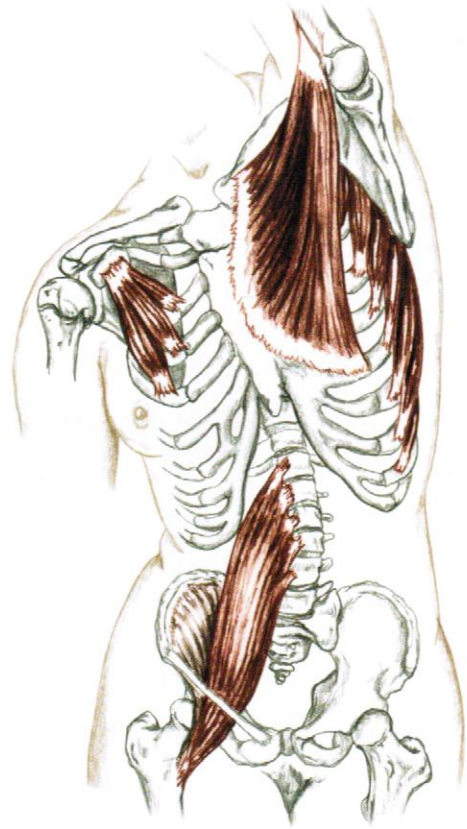
Learning Objectives

Why are you reading *Trail Guide to the Body*? To develop strong palpatory anatomy skills for your hands-on modality? Or because your instructor *told* you to read it? Well, in either case, it might be worthwhile to glance at *Trail Guide*'s learning objectives. Basically, these are the goals for you—the reader—as you explore the material. All eleven objectives listed below apply to chapters 2-7.

Trail Guide will help you build your skills so you will be able to:

1) Observe the surface anatomy of the body and confidently explore the **skin** and **fascial structures** of the body.
2) Palpate the **bones** and **bony landmarks** of each body region and explore the connections between them and the soft tissues.
3) Palpate each **muscle** from origin to insertion, feeling and describing its overall shape, edges and fiber direction(s).
4) Palpate the major joint structures, including **ligaments** and **bursa**, that are common sites of pain and injury in the region.
5) Palpate the landmarks within each body region that identify the location of underlying **nerves**, **blood vessels** and **lymph nodes** that you must be cautious of when practicing manual therapy.



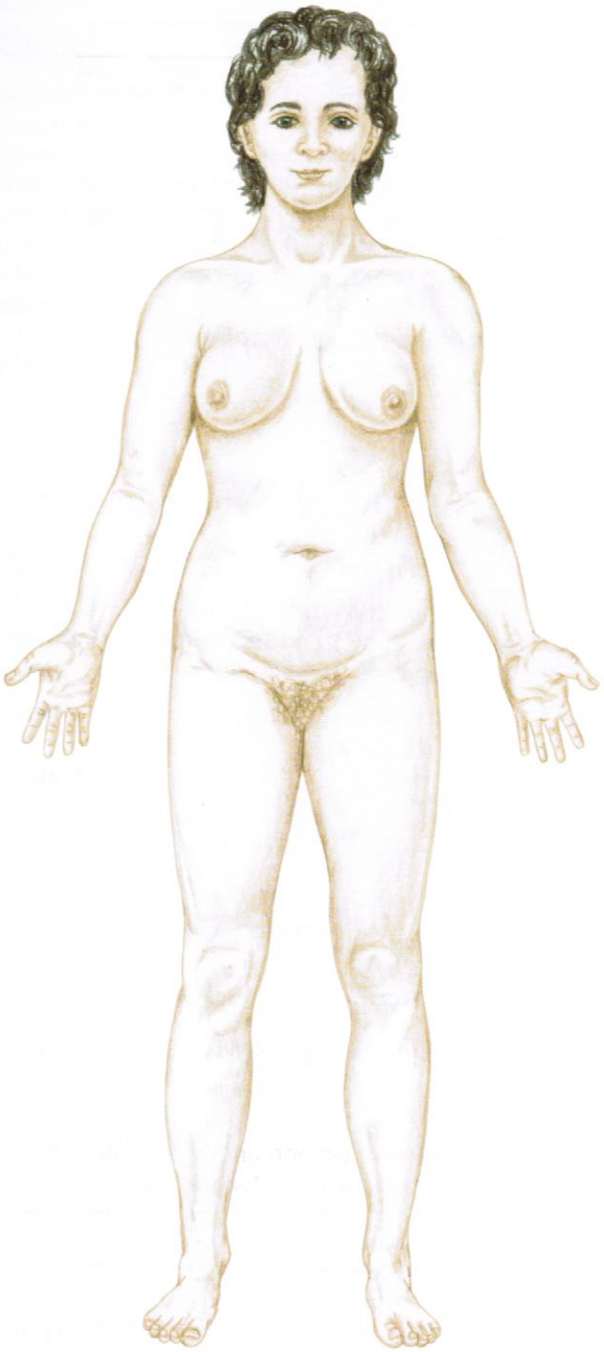


As a manual therapist, it is essential to be fluent in three palpatory anatomy languages. First, **verbal** literacy, so you can accurately document your manual therapy sessions and communicate effectively with other health care professionals. Second, **visual** literacy, so you can observe the skin, topography and physical contours of your clients. Third, **palpatory** literacy, so you can confidently assess tissue condition and provide safe and effective manual therapy.

Trail Guide will help you develop your knowledge so you will be able to:

1) Describe the relationships between the **topographical contours** and underlying **musculoskeletal** structures as well as the texture, thickness and mobility of the skin and fascial structures in each body region.
2) Name and locate the **bones**, **bony landmarks** and **joints** for each region of the body and describe the connections between them and the soft tissues of the region.
3) Name and locate the **muscles** of the region, including their specific origins and insertions.
4) List and demonstrate the **action(s)** of each muscle.
5) Name and locate major joint structures, including **ligaments** and **bursa**, that are common sites of pain and injury in the region.
6) Name and locate the major **nerves**, **blood vessels** and **lymph nodes** that you must be cautious of when palpating each body region.

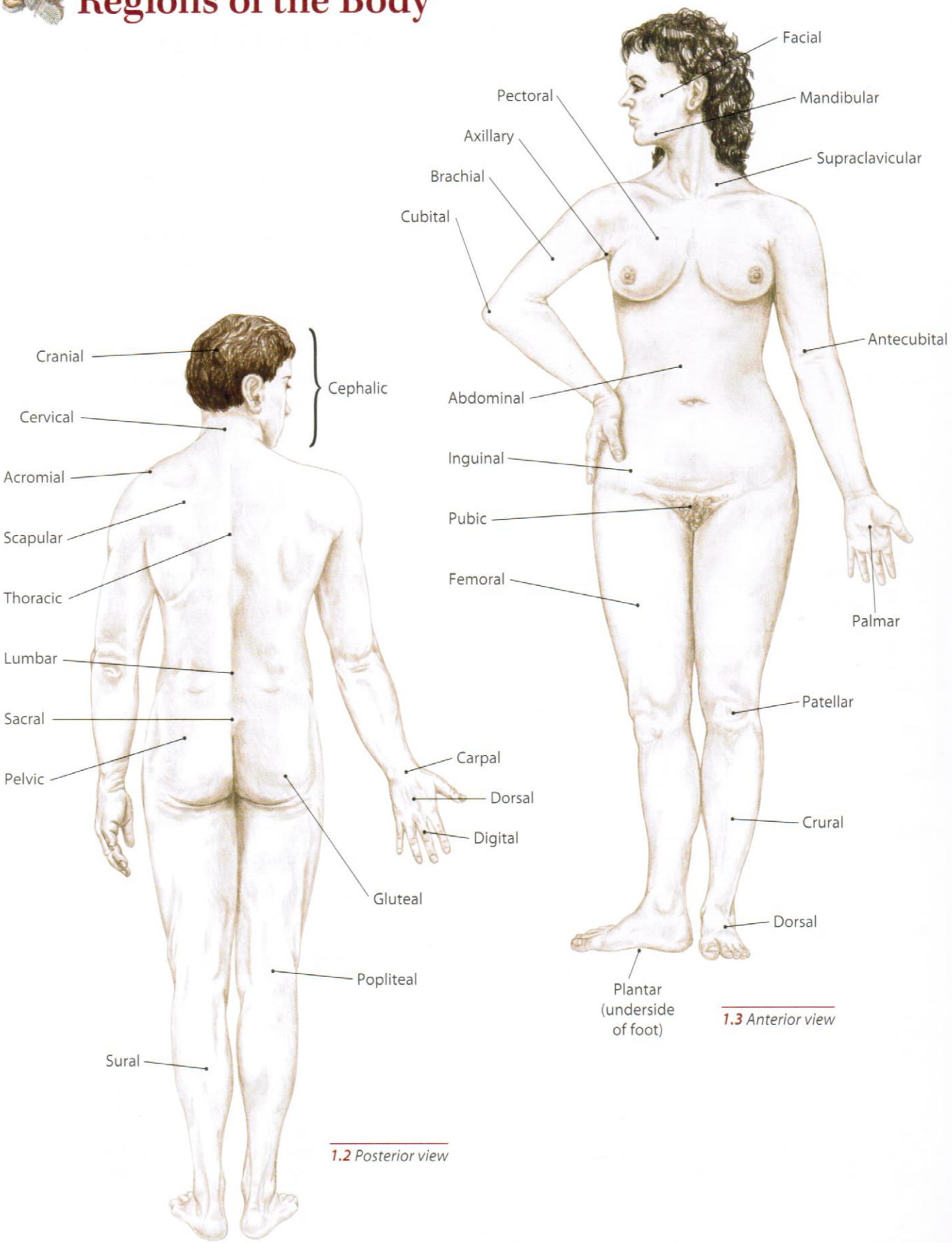
Navigating the Body 1



1.1 Anatomical position

The nature of this book demands that we explore specific, individual structures and regions on our journey. However, before we set out into the hills and valleys of the body, some preparation is in order. This chapter will familiarize you with important mapping and navigational terms. It will also show you the "big picture" of the body's systems highlighted in the text. This way, when the trail guide leads you in a certain direction, you will know which way to go!

Regions of the Body



1.2 Posterior view

1.3 Anterior view

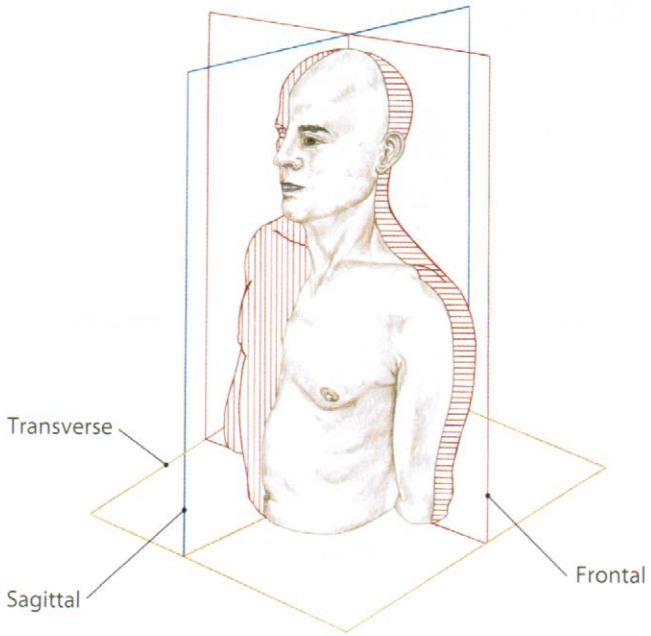
Planes of Movement

When the body is in the standard anatomical position, standing erect with the palms facing forward (p. 19), it can be divided into three imaginary planes (1.4). These planes help clarify and specify movements.

The **sagittal plane** divides the body into left and right halves. The descriptive terms medial and lateral correlate to the sagittal plane; the actions of flexion and extension occur along this plane. The midline (or midsagittal plane) runs down the center of the body, dividing the sagittal plane in two symmetrical halves.

The **frontal (or coronal) plane** divides the body into front and back portions. The terms anterior and posterior relate to the frontal plane; the actions of adduction and abduction happen along this plane.

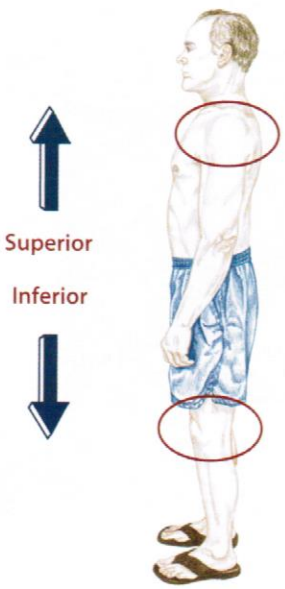
Dividing the body into upper and lower parts is the **transverse plane**. The terms superior and inferior refer to the transverse plane; rotation happens within this plane.



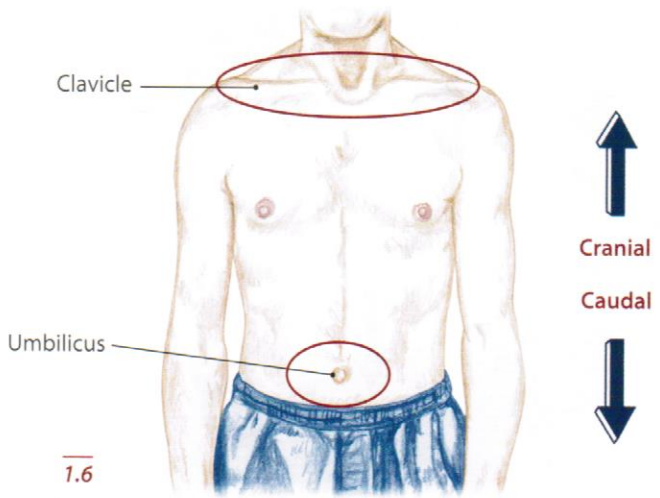
1.4 Planes of the body

Directions and Positions

Specific terms are used to help communicate location, direction and position of body structures. These terms replace more general references like "up there" or "north of here," which are less precise and can be confusing. Each direction is paired up with its complementary direction.



1.5

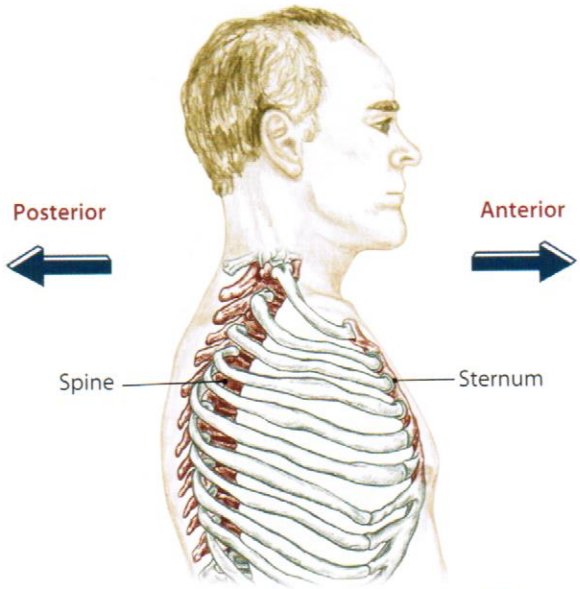


1.6

Superior refers to a structure closer to the head. **Inferior** means closer to the feet. "The shoulders are *superior* to the knees." "The knees are *inferior* to the shoulders." (1.5)

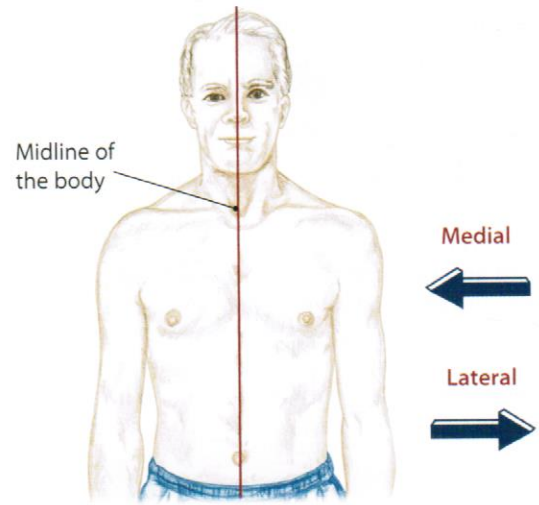
The terms **cranial** (closer to the head) and **caudal** (closer to the buttocks) are used when referring to structures on the trunk (1.6). For example, "The umbilicus is *caudal* to the clavicles." "The clavicles are *cranial* to the umbilicus."

sagittal	**saj**-i-tal	L. arrowlike
coronal	ko-**ro**-nal	L. crownlike
transverse	**trans**-verse	L. across, turned across



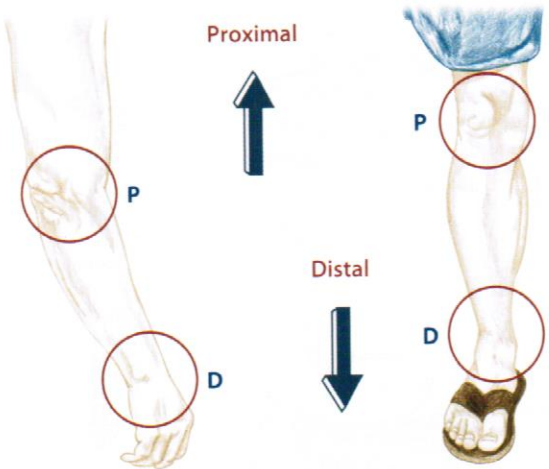
1.7

Posterior pertains to a structure further toward the back of the body than another structure. **Anterior** refers to a structure further in front. "The sternum is *anterior* to the spine." (1.7) These directions are also referred to as dorsal (posterior) and ventral (anterior).



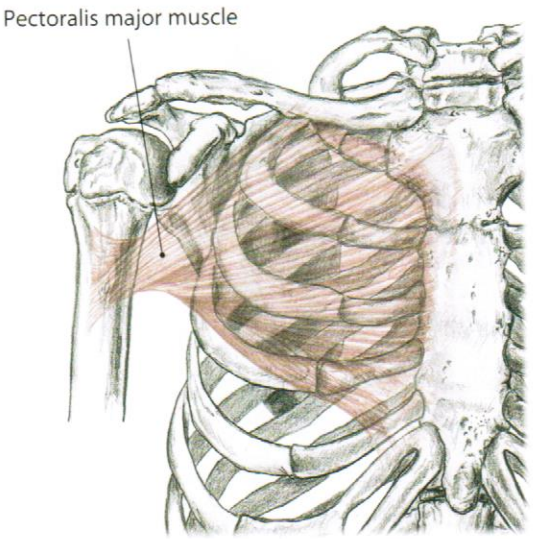
1.8

Medial pertains to a structure closer to the midline (or center) of the body. **Lateral** refers to a structure further away from the midline. "The nose is *medial* to the ears." "The ears are *lateral* to the nose." (1.8)



1.9

Distal means a structure further away from the trunk or the body's midline. **Proximal** designates a structure closer to the trunk. These directions are used only when referring to the arms and legs. "The elbow is *proximal* to the wrist." "The ankle is *distal* to the knee." (1.9)

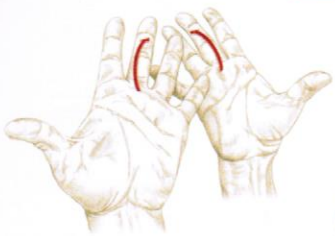


1.10

Superficial describes a structure closer to the body's surface. **Deep** refers to a structure deeper in the body. "The pectoralis major muscle is *superficial* to the ribs." "The ribs are *deep* to the pectoralis major." (1.10)

Movements of the Body

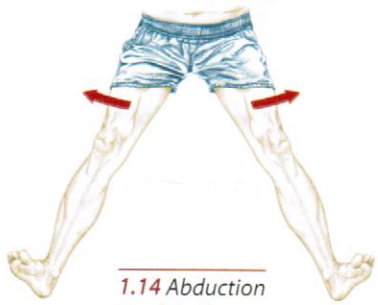
Movement of the body occurs at the joints, where bones articulate (or connect). Although movement affects the placement of bones, the terminology of movement always refers to joints. Bending your knee is called "flexion of the knee." "Flexion of the leg" would require an ambulance. See pages 26-31 for a description of movement at specific joints.



1.11 Extension of the fingers

1.12 Flexion of the fingers

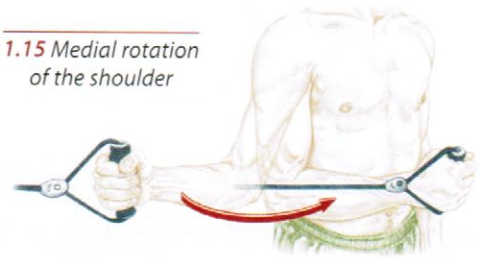
1.13 Adduction of the hips



1.14 Abduction of the hips

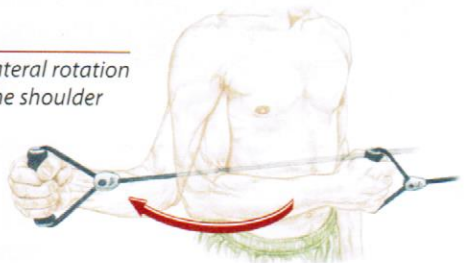
Extension (1.11) is movement that straightens or opens a joint. In anatomical position, most joints are extended. When a joint can extend beyond its normal range of motion it is called hyperextension. **Flexion** (1.12) is movement that bends a joint or brings the bones closer together. In a fetal position most joints are in a flexed position (1.17). Both flexion and extension take place along the sagittal plane.

Adduction (1.13) of a joint brings a limb medially toward the body's midline ("adding to the body"). **Abduction** (1.14) moves a limb laterally away from the midline ("abduct or carry away"). These actions happen along the frontal plane and pertain only to the appendages. To adduct the fingers or toes is to bring them together; to abduct is to spread them apart.



1.15 Medial rotation of the shoulder

1.17 In the fetal position most joints are flexed



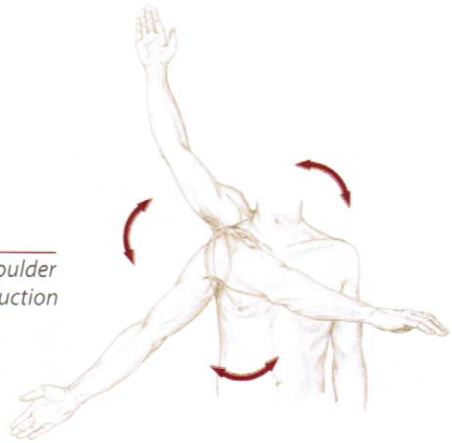
1.16 Lateral rotation of the shoulder

1.18 Rotation of the spine

Medial rotation (1.15) and **lateral rotation** (1.16) (sometimes referred to as internal and external rotation) occur at the shoulder and hip joints. When the joint medially rotates, the limb turns in toward the midline. Lateral rotation swings the limb away from the midline.

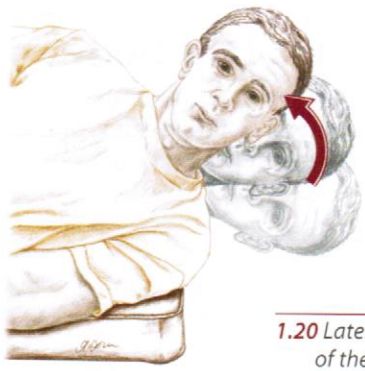
Rotation (1.18) pertains only to the axial skeleton (p. 32), specifically the head and vertebral column. Rotation of the head and neck occurs as a driver turns to check whether a car is coming from behind in the next lane. These movements happen along the transverse plane.

ab- (as in *abduct*) L. away from
ad- (as in *adduct*) L. toward



1.19 Shoulder circumduction

Circumduction (1.19) is possible only at the shoulder and hip joints. It involves a combination of flexion, extension, adduction and abduction; together these actions create a cone-shaped movement. Swimming the backstroke requires circumduction at the shoulder joint.



1.20 Lateral flexion of the neck

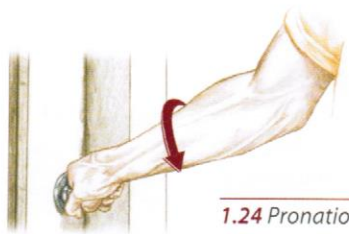
Lateral flexion (1.20) occurs only at the axial skeleton—for example, when the neck or vertebral column bends laterally to the side.

1.21 Elevation of the scapula

1.22 Depression of the mandible

Elevation (1.21) and **depression** (1.22) refer to the movement of the scapula and jaw. Elevation is movement superiorly. Depression is movement inferiorly.

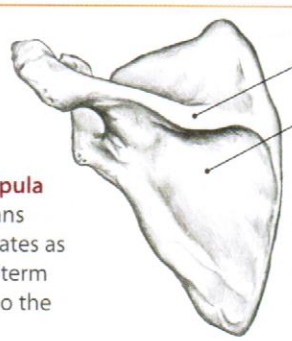
1.23 Supination of the forearm



1.24 Pronation of the forearm

Supination (1.23) and **pronation** (1.24) describe the pivoting action of the forearm. Supination ("carrying a bowl of soup") occurs when the radius and ulna lie parallel to one another. Pronation ("prone to spill it") takes place when the radius crosses over the ulna, turning the palm down. Supination and pronation also occur at the feet.

The names of many bones, bony landmarks and muscles may initially look and sound foreign. They are—most anatomical terms are Latin or Greek. However, the source or story behind the terms can help to clarify their meaning. Take the phrase "infraspinous fossa of the scapula." The **scapula** is a flat bone of the shoulder. In Latin, scapula means "shoulder blade"—its common name. **Fossa** translates as "shallow depression." **Infraspinous** is a directional term (like north or southwest). It means inferior (infra-) to the spine of the scapula (-spinous). Put this all together and the "infraspinous fossa of the scapula" translates as "the shallow depression located below the spine of the shoulder blade." Keep an eye peeled for translations and phonetic descriptions at the bottom of pages.



supinate **su**-pi-nate L. bent backward
pronate **pro**-nate L. bent forward

Depending on the structure being palpated, *Trail Guide* will ask you to position your partner in a few different ways.

Supine *("on your spine") is to lie face up. A bolster behind the knees might be nice for your partner.*

Prone *is to lie on the table face down. A bolster behind the ankles is nice is this position.*

For **side lying**, *consider a bolster between the knees and a pillow under the head.*

1.25

1.26

Inversion (1.25) and **eversion** (1.26) occur as a combination of movements of several joints of the feet. Inversion ("turn in") elevates the foot's medial side and brings the sole of the foot medially. Eversion ("turn out") elevates the foot's lateral side and moves the sole laterally.

1.27

1.28

Plantar flexion (1.27) and **dorsiflexion** (1.28) only refer to movement at the ankle. Plantar flexion is performed by moving the ankle to point your foot into the earth or stepping on a car's gas pedal. Dorsiflexion is the opposite movement, such as moving the ankle to let off the gas pedal.

1.29 Protraction

1.30 Retraction

Protraction (1.29) and **retraction** (1.30) pertain to the scapula, clavicle, head and jaw. Protraction ("protrude") occurs when one of these structures moves anteriorly. Retraction ("retreat") is movement posteriorly.

1.31 Deviation

1.32 Opposition

Deviation (1.31) means to wander from the usual course. Lateral deviation occurs at the mandible during talking or chewing.

Opposition (1.32) happens only at the carpometacarpal joint of the thumb. It occurs when the thumbpad crosses the palm toward the last (pinkie) finger.

dorsi	**dor**-si	L. of the back
plantar	**plan**-tar	L. the sole of the foot

Movements of the Body

Spine and Thorax

(vertebral column)

Flexion

Extension

Rotation

Lateral flexion

Neck

(cervical spine)

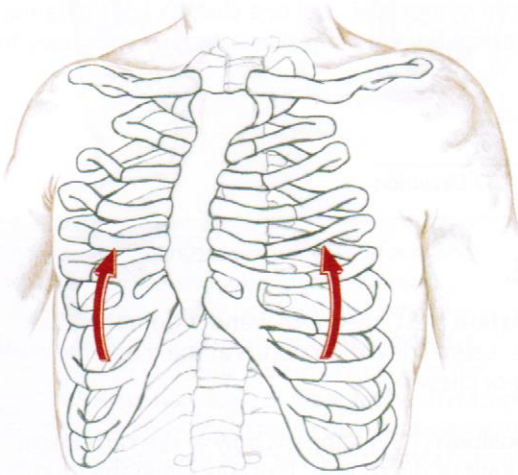
Flexion

Extension

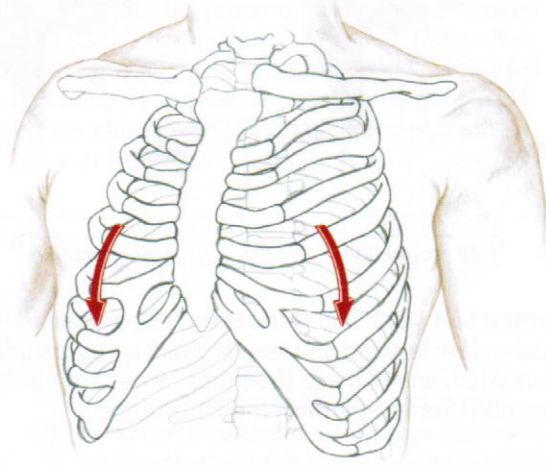
Rotation

Lateral flexion

Ribs/Thorax



Elevation/expansion
(inhalation)



Depression/collapse
(exhalation)

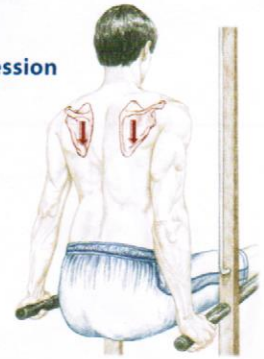
Scapula

(scapulothoracic joint)

Elevation

Adduction
(retraction)

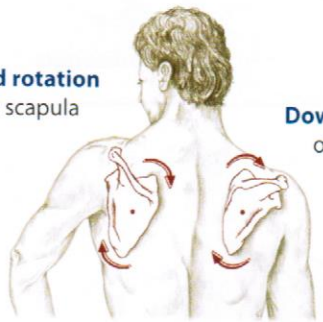
Abduction
(protraction)



Depression

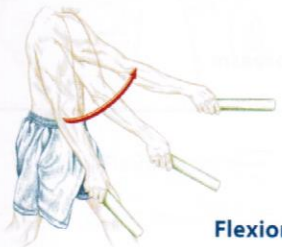
Upward rotation
of left scapula

Downward rotation
of right scapula



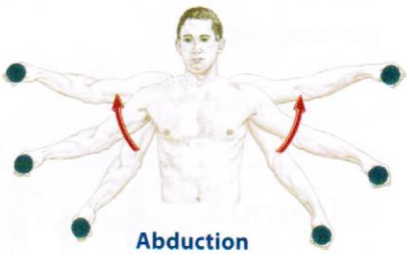
Shoulder

(glenohumeral joint)

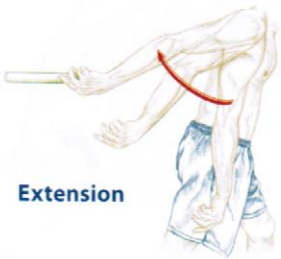


Flexion

Adduction

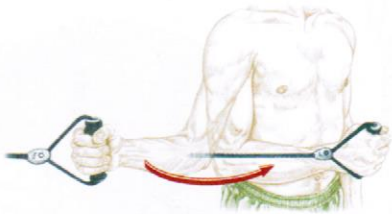


Abduction



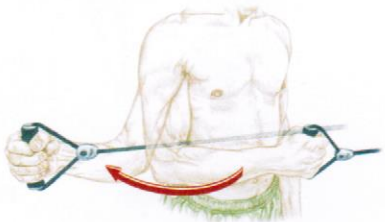
Extension

Horizontal adduction



Medial rotation
(internal rotation)

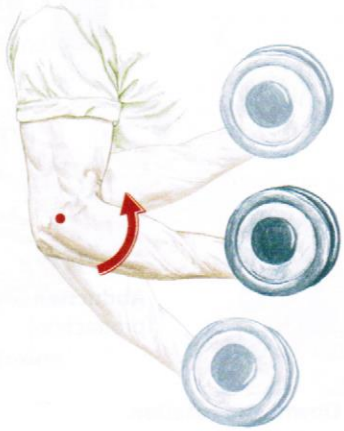
Horizontal abduction



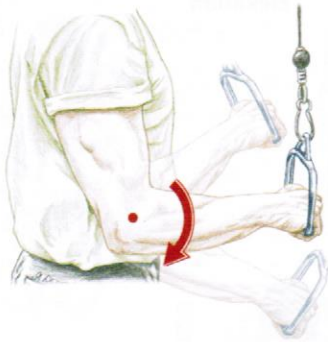
Lateral rotation
(external rotation)

Elbow and Forearm

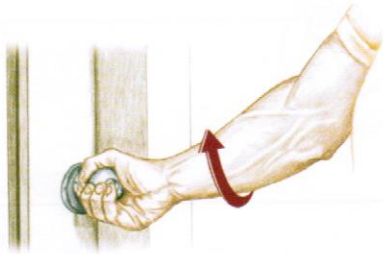
(humeroulnar and humeroradial joints—elbow, proximal and distal radioulnar joints—forearm)



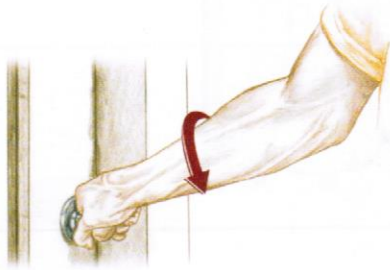
Flexion of the elbow



Extension of the elbow



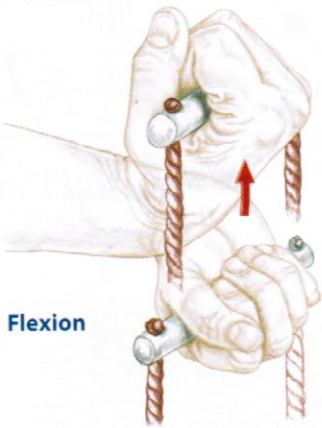
Supination of the forearm



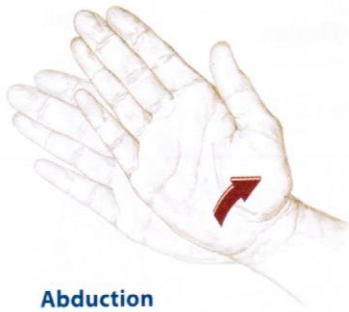
Pronation of the forearm

Wrist

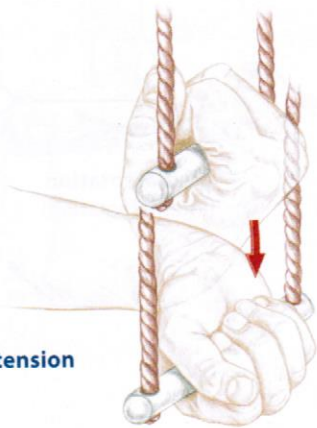
(radiocarpal joint)



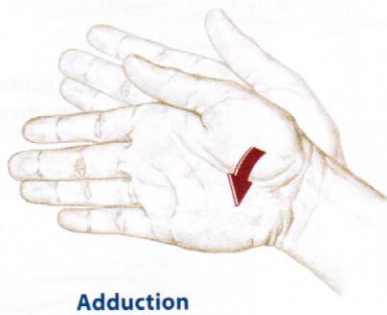
Flexion



Abduction
(radial deviation)



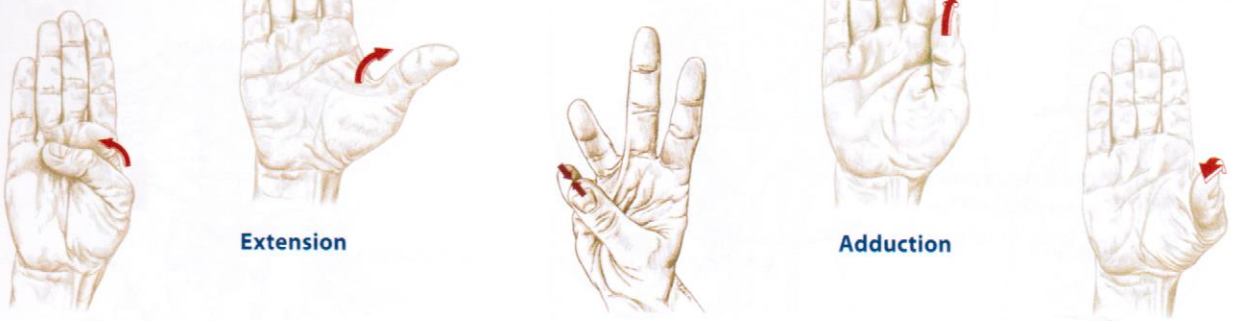
Extension



Adduction
(ulnar deviation)

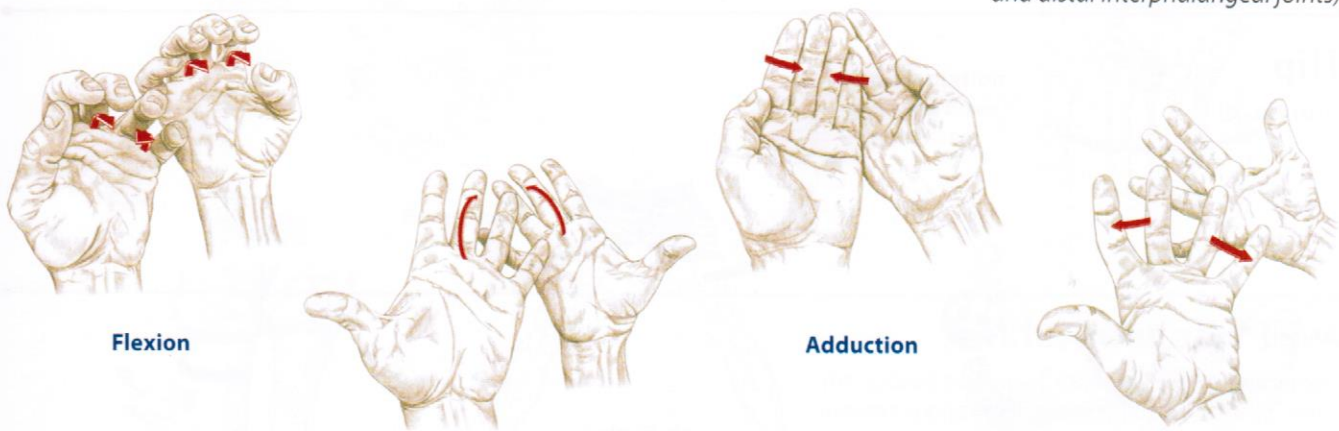
Thumb

(first carpometacarpal and metacarpophalangeal joints)



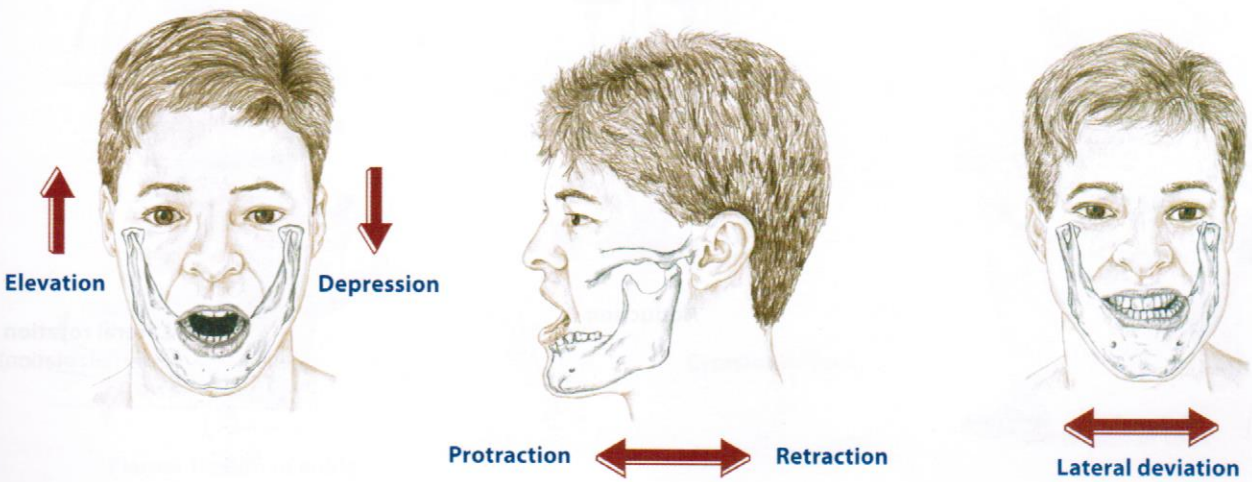
Fingers

(metacarpophalangeal, proximal and distal interphalangeal joints)

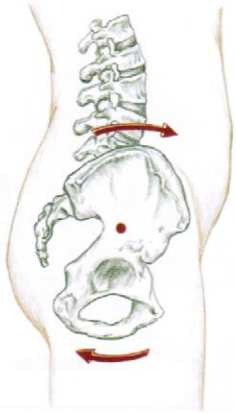


Mandible

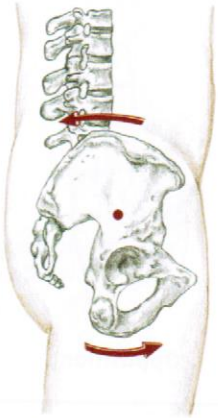
(temporomandibular joint)



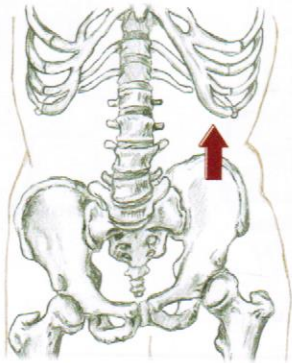
Pelvis



Anterior tilt
(downward rotation)



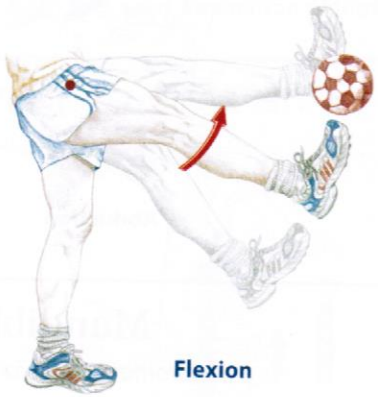
Posterior tilt
(upward rotation)



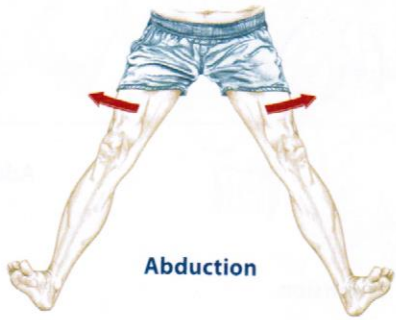
Lateral tilt
(elevation)

Hip

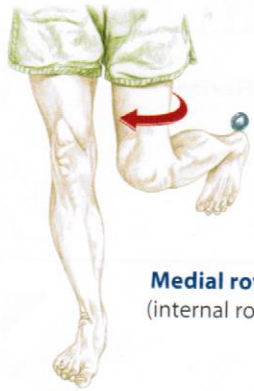
(coxal joint)



Flexion

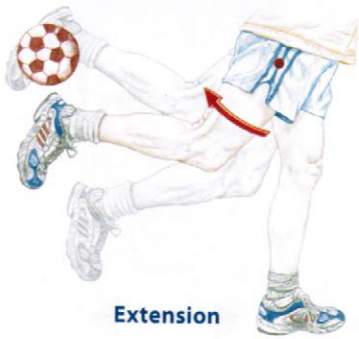


Abduction

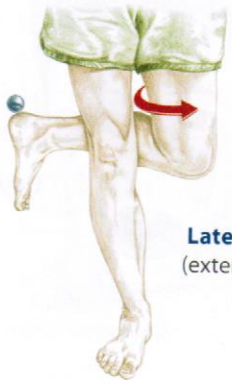


Medial rotation
(internal rotation)

Adduction



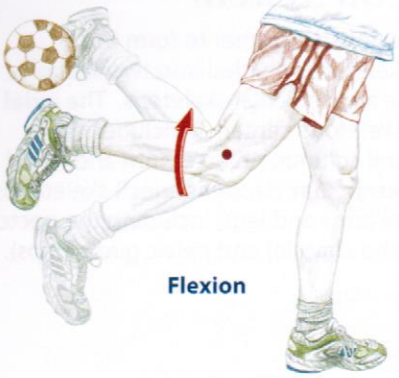
Extension



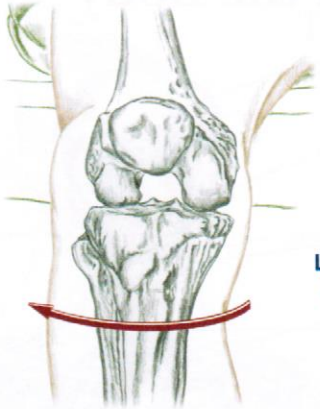
Lateral rotation
(external rotation)

Knee

(tibiofemoral joint)

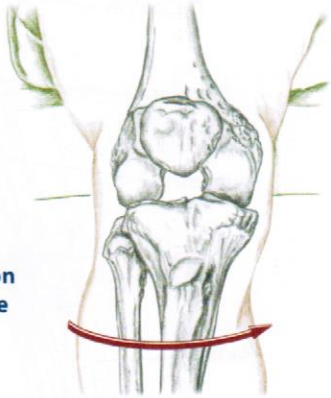


Flexion



Lateral rotation of flexed knee
(right knee)

Extension



Medial rotation of flexed knee
(right knee)

Ankle, Foot and Toes

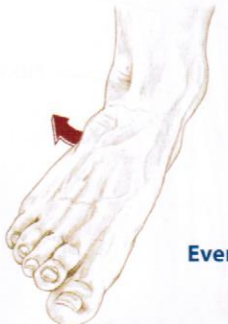
(talocrural, talotarsal, midtarsal, tarsometatarsal, metatarsophalangeal and interphalangeal joints)

Dorsiflexion of ankle

Inversion of foot

Flexion of toes

Plantar flexion of ankle

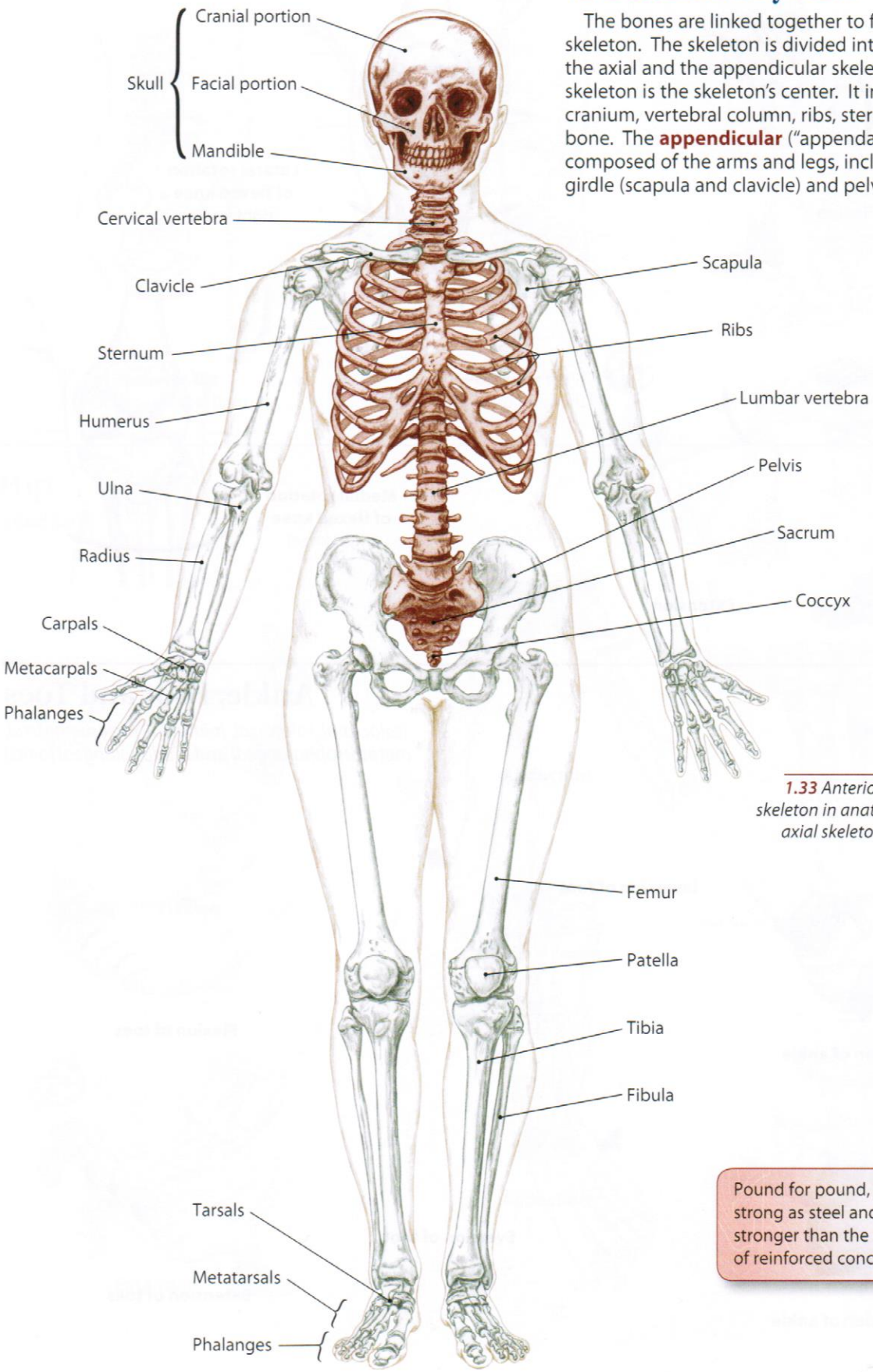


Eversion of foot

Extension of toes

The Skeletal System

The bones are linked together to form the skeleton. The skeleton is divided into two sections: the axial and the appendicular skeletons. The **axial** skeleton is the skeleton's center. It includes the cranium, vertebral column, ribs, sternum and hyoid bone. The **appendicular** ("appendages") skeleton is composed of the arms and legs, including the pectoral girdle (scapula and clavicle) and pelvic girdle (hips).

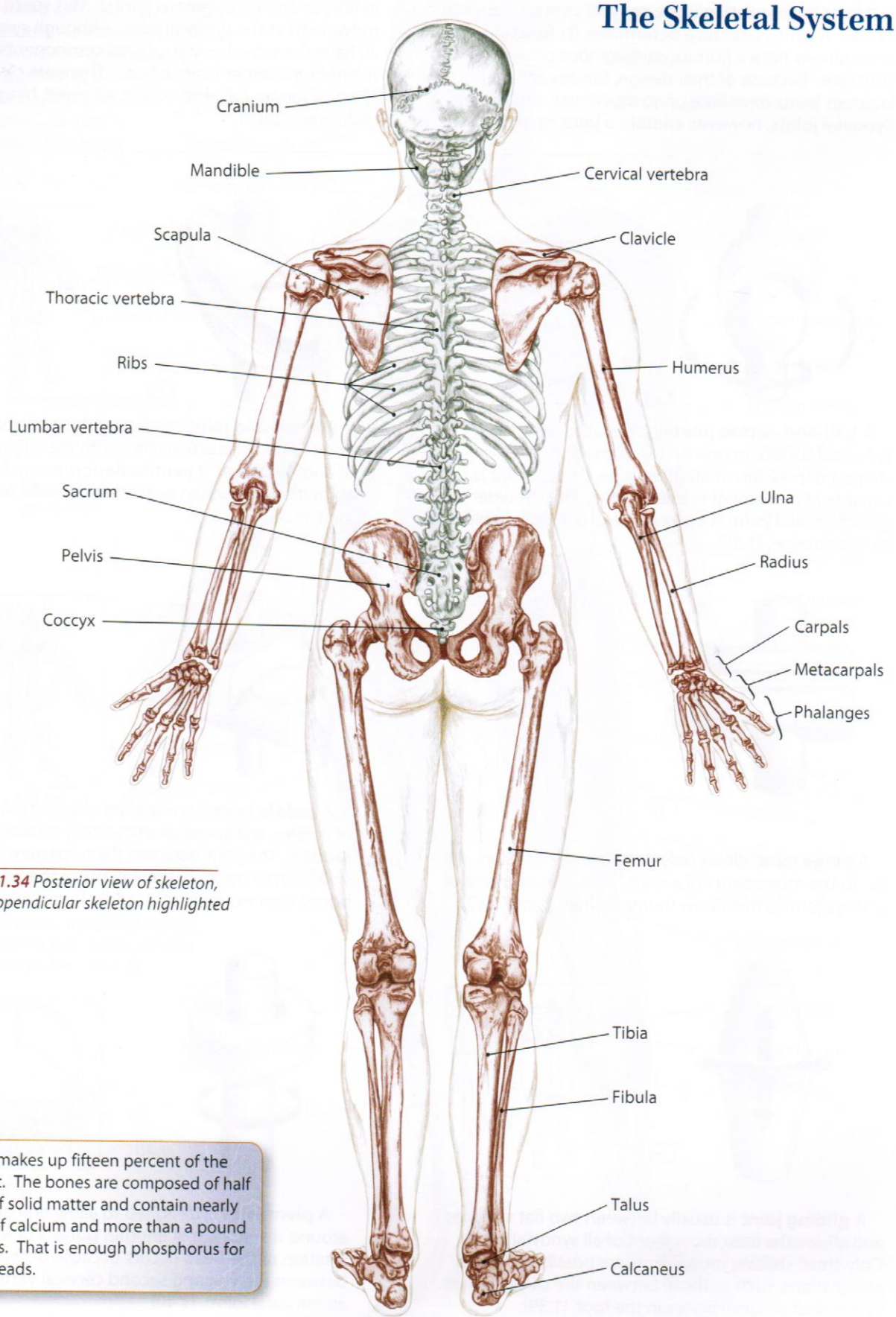


1.33 Anterior view of the skeleton in anatomical position, axial skeleton highlighted

Pound for pound, bone is as strong as steel and three times stronger than the same quantity of reinforced concrete.

appendicular	**ap**-en-**dik**-u-lar	L. to hang to
axial	**ak**-see-al	L. axle
skeleton	**skel**-et-on	Grk. dried up

The Skeletal System

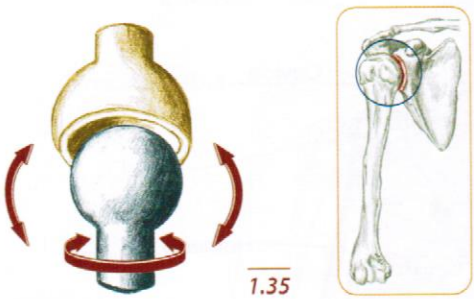


1.34 Posterior view of skeleton, appendicular skeleton highlighted

The skeleton makes up fifteen percent of the body's weight. The bones are composed of half water and half solid matter and contain nearly two pounds of calcium and more than a pound of phosphorus. That is enough phosphorus for 2,000 matchheads.

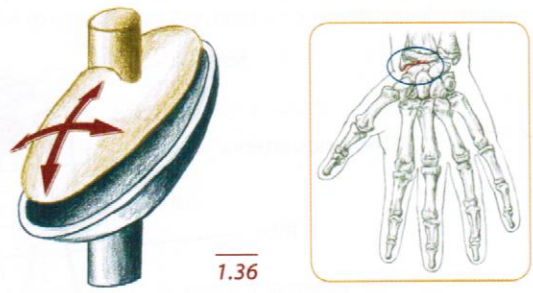
Types of Joints

A joint or articulation is the point of contact between bones. A joint's **structure determines its function**. All articulations have a fibrous, cartilaginous or synovial structure. Because of their design, fibrous and cartilaginous joints have little or no movement capability. **Synovial joints**, however, **contain a joint cavity** (absent in fibrous and cartilaginous joints). This space allows for movement at the synovial joint. Although synovial joints all have the same basic structural components, they have different movement capabilities. There are six types of synovial joints: ball-and-socket, ellipsoid, hinge, saddle, gliding and pivot.



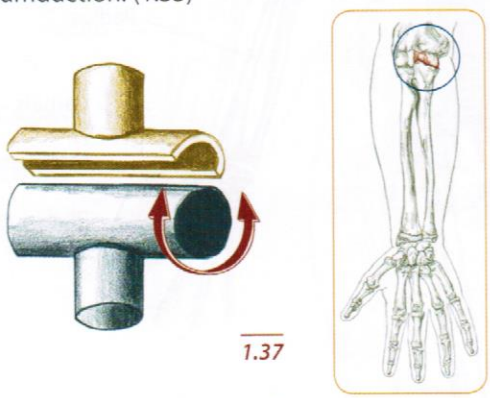
1.35

A **ball-and-socket joint** is self-explanatory: A spherical surface of one bone fits into the dish-shaped depression of another bone. Such a joint is capable of movement in every plane. The shoulder (or glenohumeral joint) is an example of a joint capable of circumduction. (1.35)



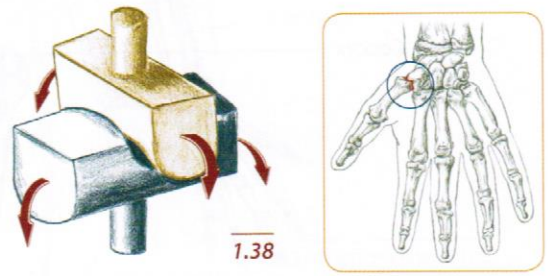
1.36

An **ellipsoid joint** consists of the oval-shaped end of one bone articulating with the elliptical basin of another bone. It permits flexion/extension and abduction/adduction as seen at the wrist (radiocarpal) joint. (1.36)



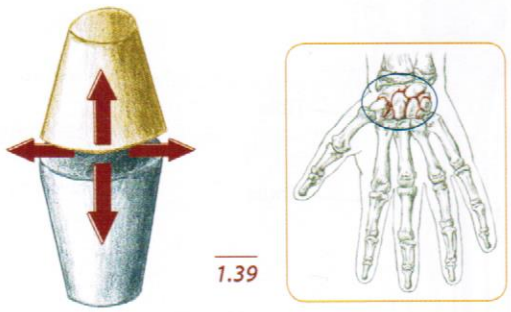
1.37

A **hinge joint** allows only flexion and extension, similar to the movements of a door hinge. An example of a hinge joint is the elbow (humeroulnar) joint. (1.37)



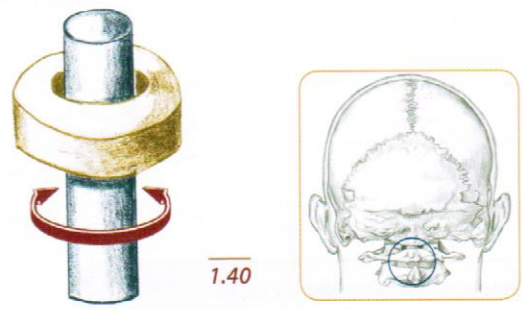
1.38

A **saddle joint** is a modified ellipsoid joint composed of convex and concave articulating surfaces—like two saddles. The joint between the trapezium (one of the small carpal bones in the wrist) and the first metacarpal bones is an example of a saddle joint. (1.38)



1.39

A **gliding joint** is usually between two flat surfaces and allows the least movement of all synovial joints. Only small shifting movements are possible at these articulations, such as those between the carpal bones in the wrist or tarsal bones in the foot. (1.39)



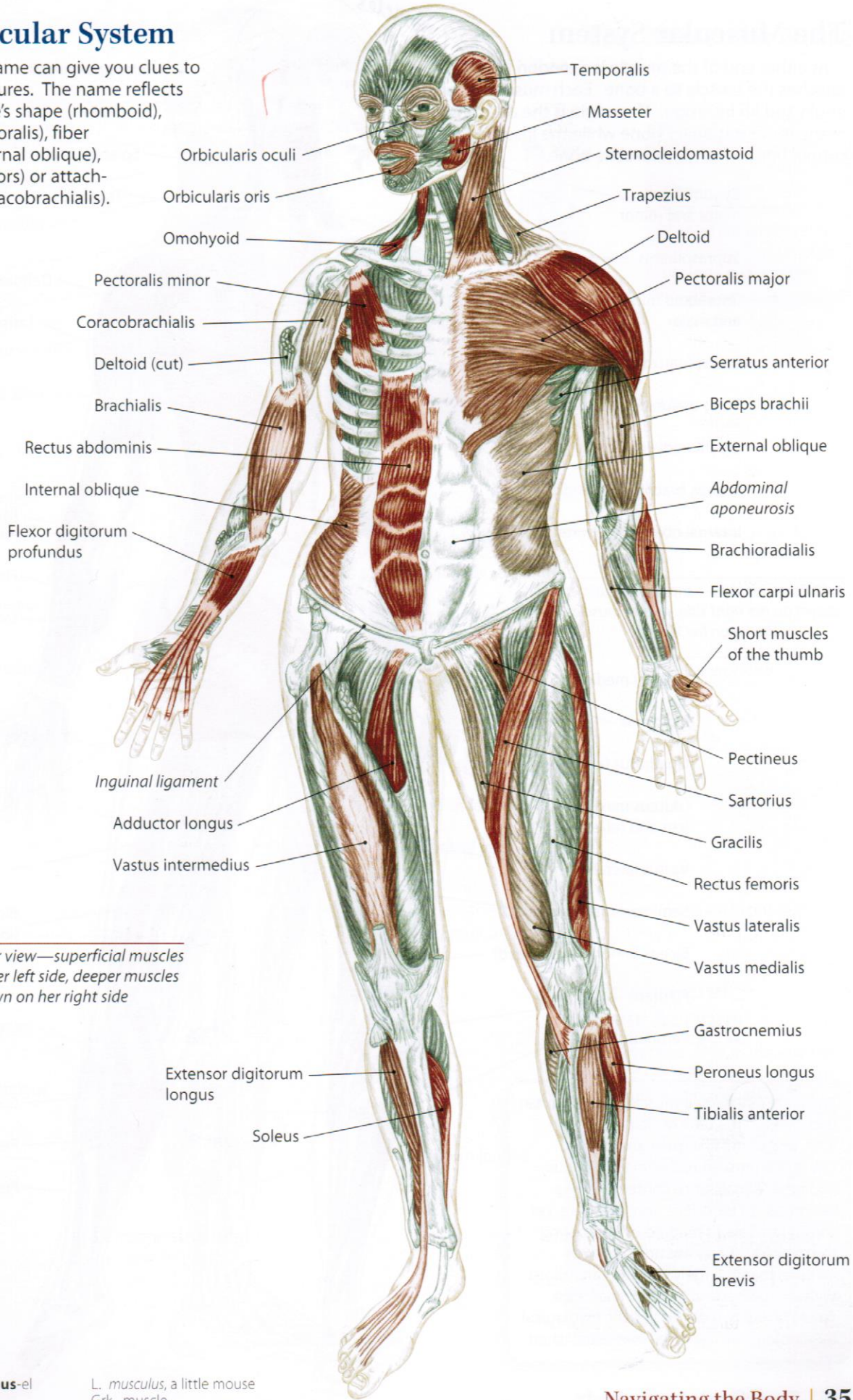
1.40

A **pivot joint** is designed to allow one bone to rotate around the surface of another bone. For example, rotation of the head occurs because of the pivot joint between the first and second cervical vertebrae (the atlantoaxial joint). (1.40)

joint
synovial — sin-**o**-ve-al — L. to join; L. *synovia*, joint fluid

The Muscular System

A muscle's name can give you clues to its specific features. The name reflects either a muscle's shape (rhomboid), location (temporalis), fiber direction (external oblique), action (adductors) or attachment sites (coracobrachialis).



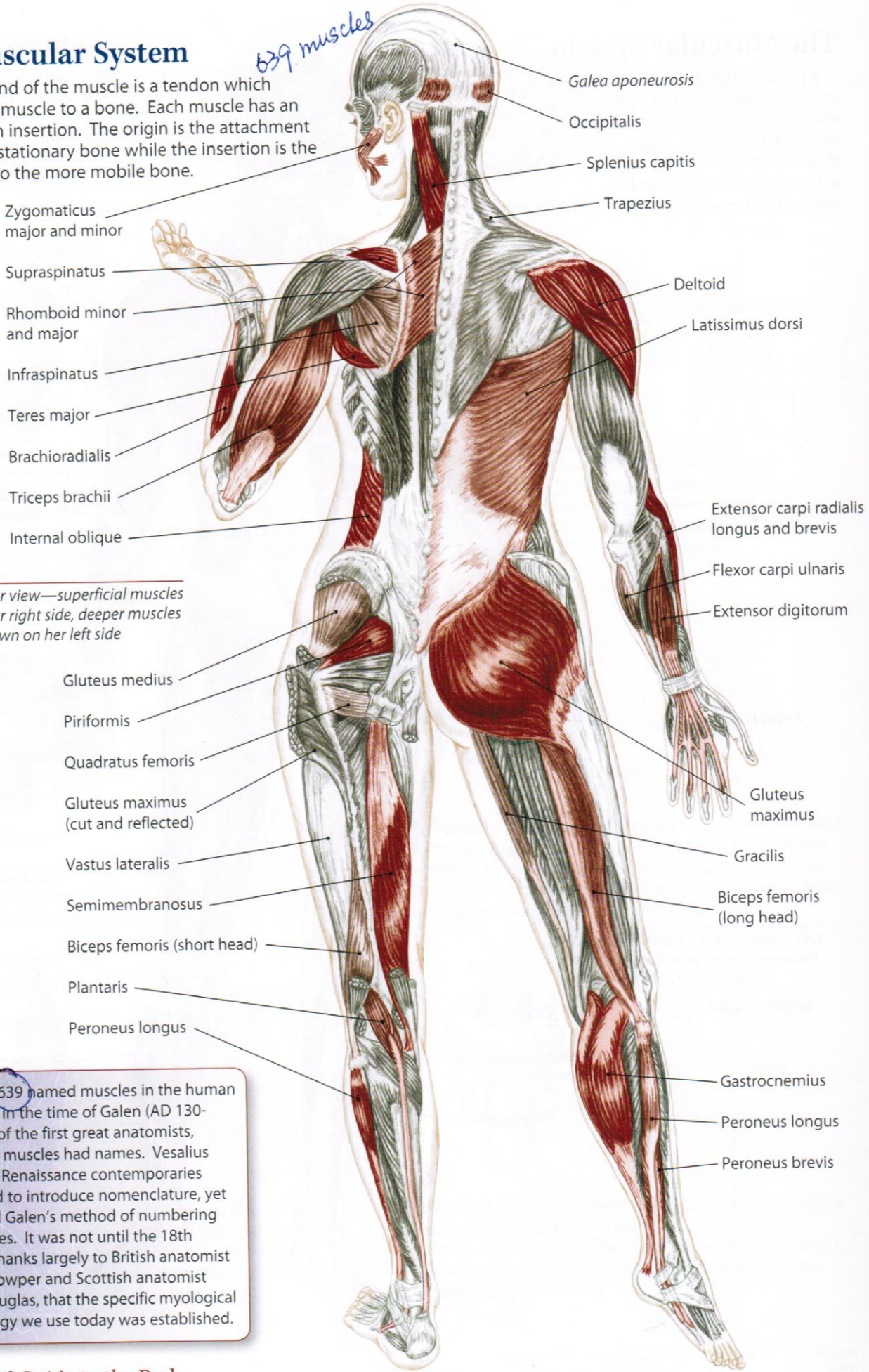
1.41 Anterior view—superficial muscles shown on her left side, deeper muscles shown on her right side

muscle	**mus**-el	L. *musculus*, a little mouse
myo-		Grk. muscle
tendon	**ten**-dun	L. to stretch

The Muscular System

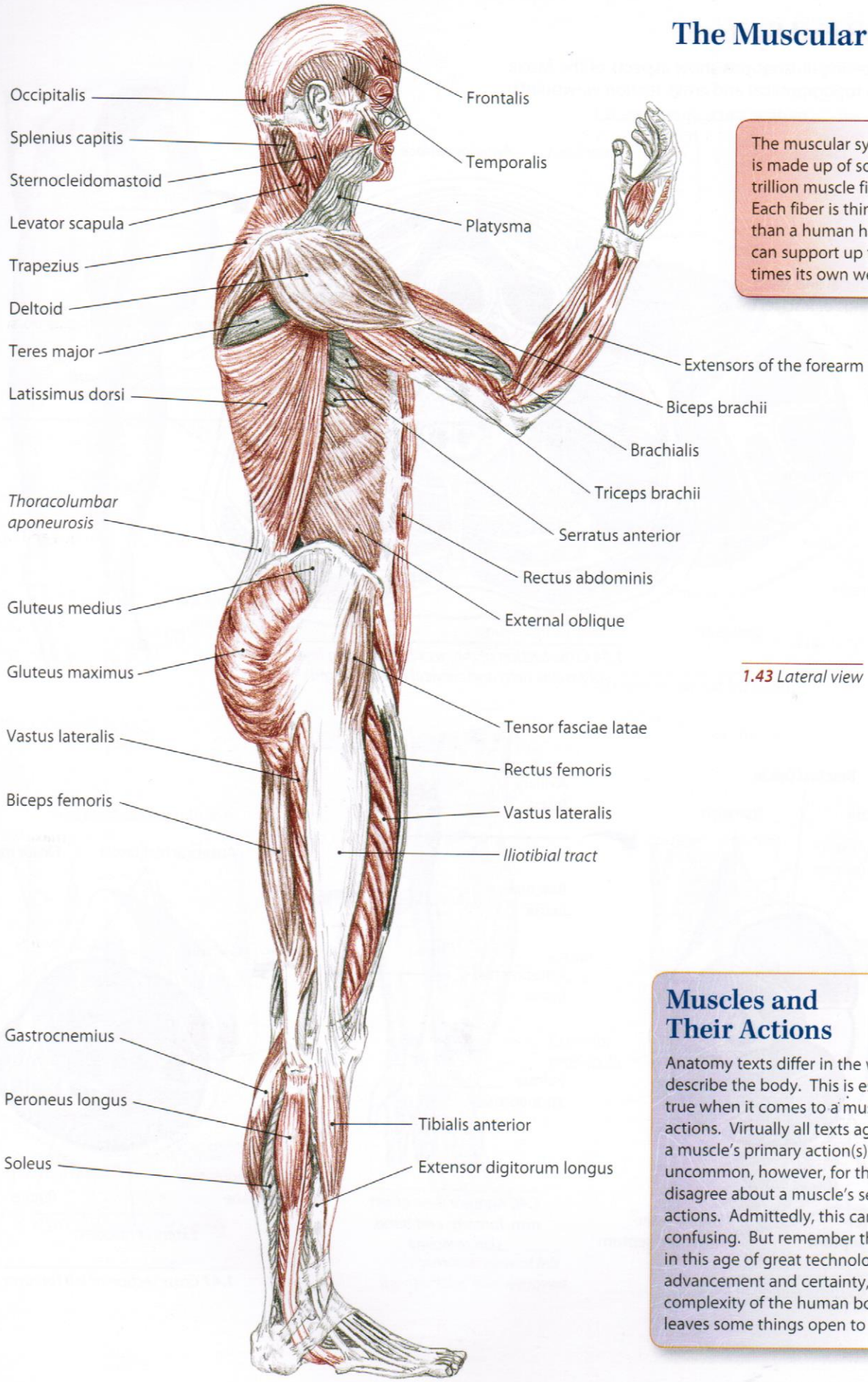
639 muscles

At either end of the muscle is a tendon which attaches the muscle to a bone. Each muscle has an origin and an insertion. The origin is the attachment to the more stationary bone while the insertion is the connection to the more mobile bone.



1.42 Posterior view—superficial muscles shown on her right side, deeper muscles shown on her left side

There are 639 named muscles in the human body. Yet in the time of Galen (AD 130-200), one of the first great anatomists, few of the muscles had names. Vesalius and other Renaissance contemporaries attempted to introduce nomenclature, yet continued Galen's method of numbering the muscles. It was not until the 18th century, thanks largely to British anatomist William Cowper and Scottish anatomist James Douglas, that the specific myological terminology we use today was established.



The muscular system is made up of some six trillion muscle fibers. Each fiber is thinner than a human hair, but can support up to 1,000 times its own weight.

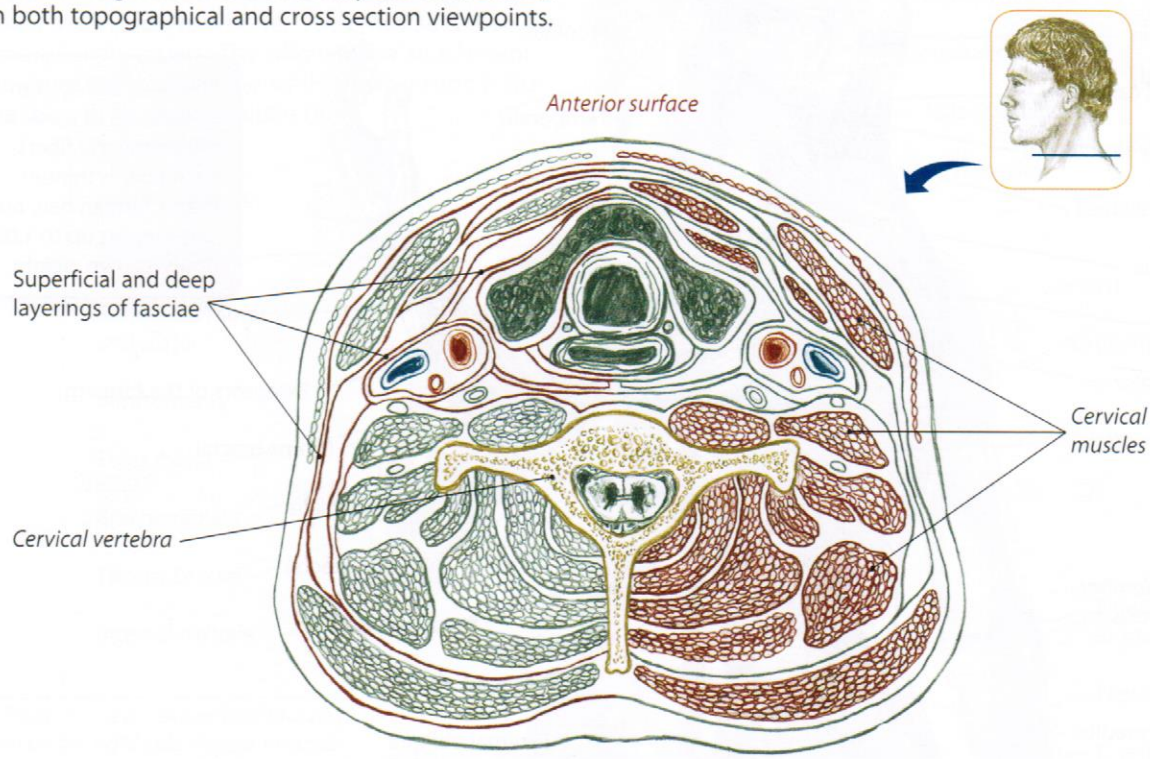
1.43 Lateral view

Muscles and Their Actions

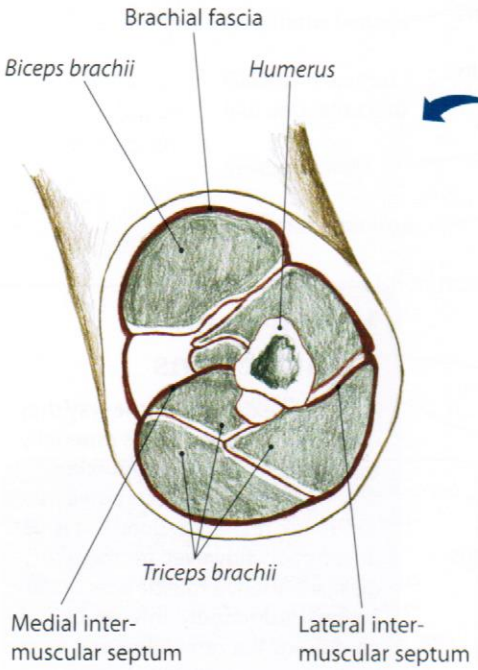
Anatomy texts differ in the way they describe the body. This is especially true when it comes to a muscle's actions. Virtually all texts agree upon a muscle's primary action(s). It is not uncommon, however, for them to disagree about a muscle's secondary actions. Admittedly, this can be confusing. But remember that even in this age of great technological advancement and certainty, the complexity of the human body still leaves some things open to debate.

The Fascial System

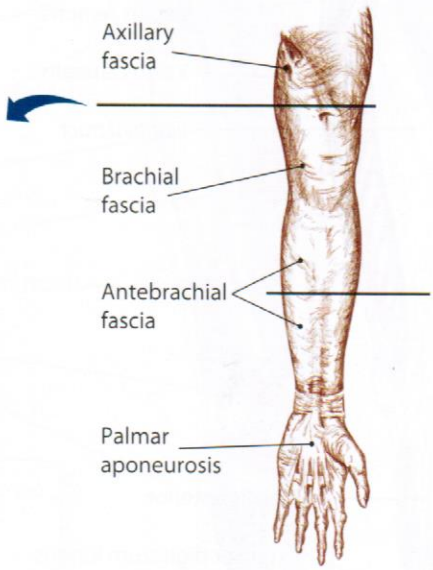
The following illustrations show aspects of the fascia from both topographical and cross section viewpoints.



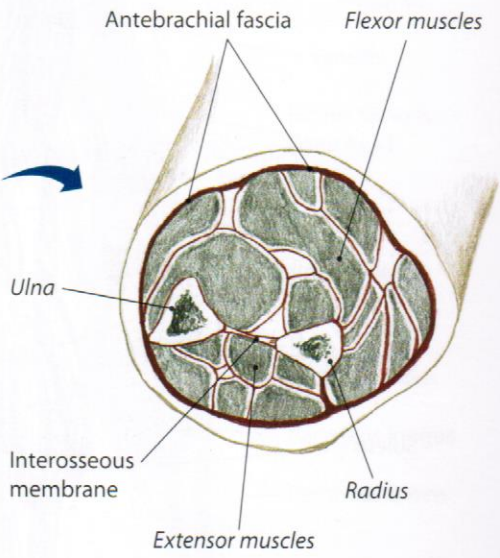
1.44 Cross section of the neck highlighting layers of fasciae (left) and cervical muscles (right)



1.45 Cross section of left arm

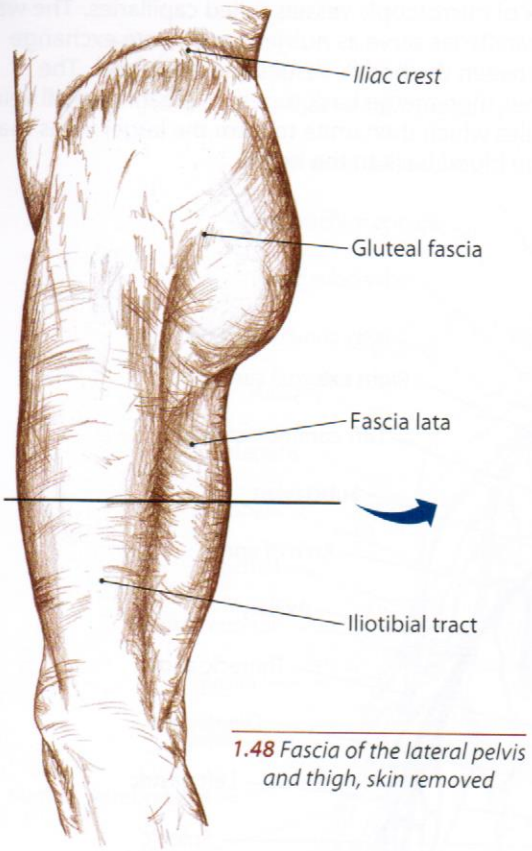


1.46 Anterior view of left arm, forearm and hand, skin removed

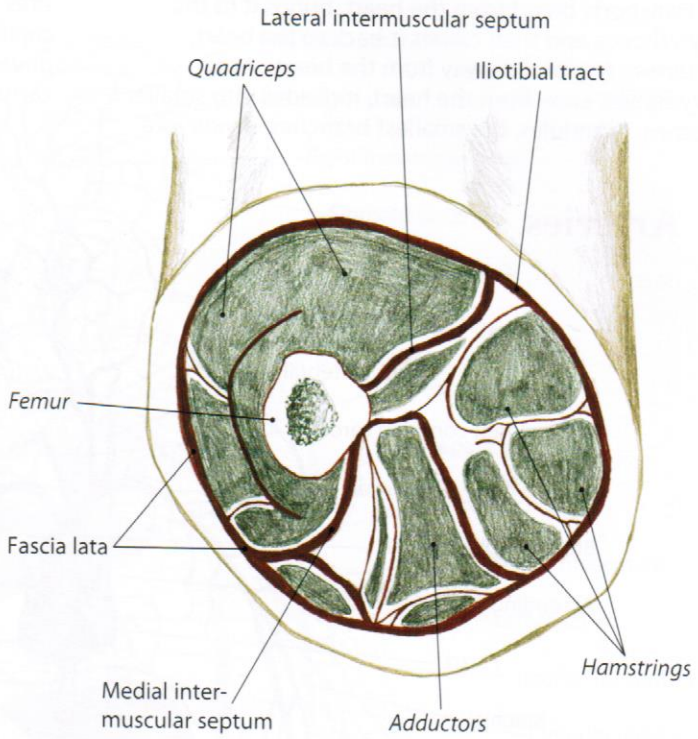


1.47 Cross section of left forearm

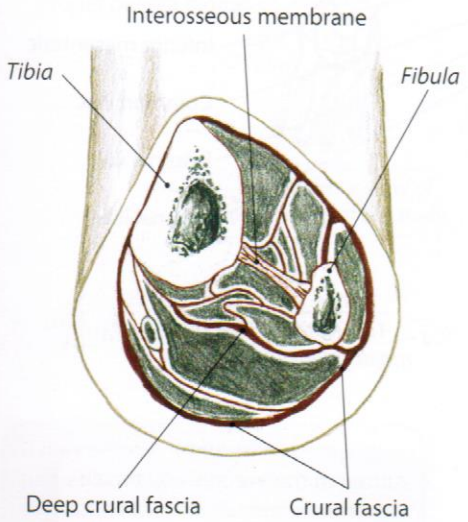
fascia	**fash**-ah	L. a band, bandage
retinaculum	**ret**-i-**nak**-u-lum	L. halter, band, rope
septum	**sep**-tum	L. enclosure



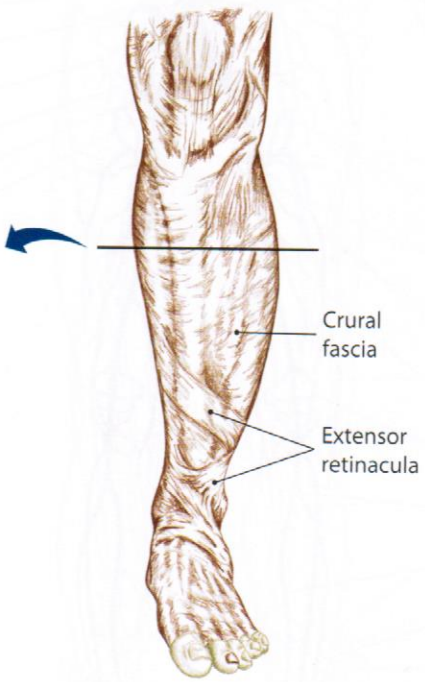
1.48 *Fascia of the lateral pelvis and thigh, skin removed*



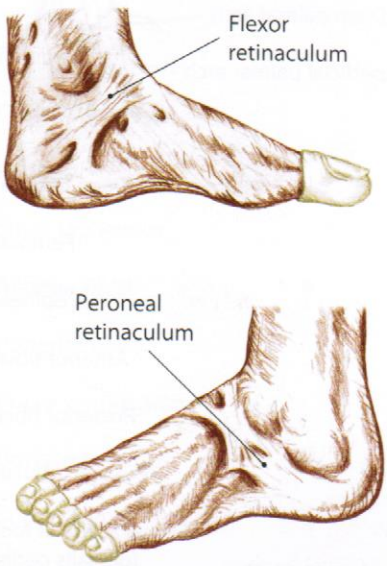
1.49 *Cross section of left thigh*



1.50 *Cross section of left leg*



1.51 *Anterior view of left leg and foot, skin removed*



1.52 *Medial and lateral views of left foot, skin removed*

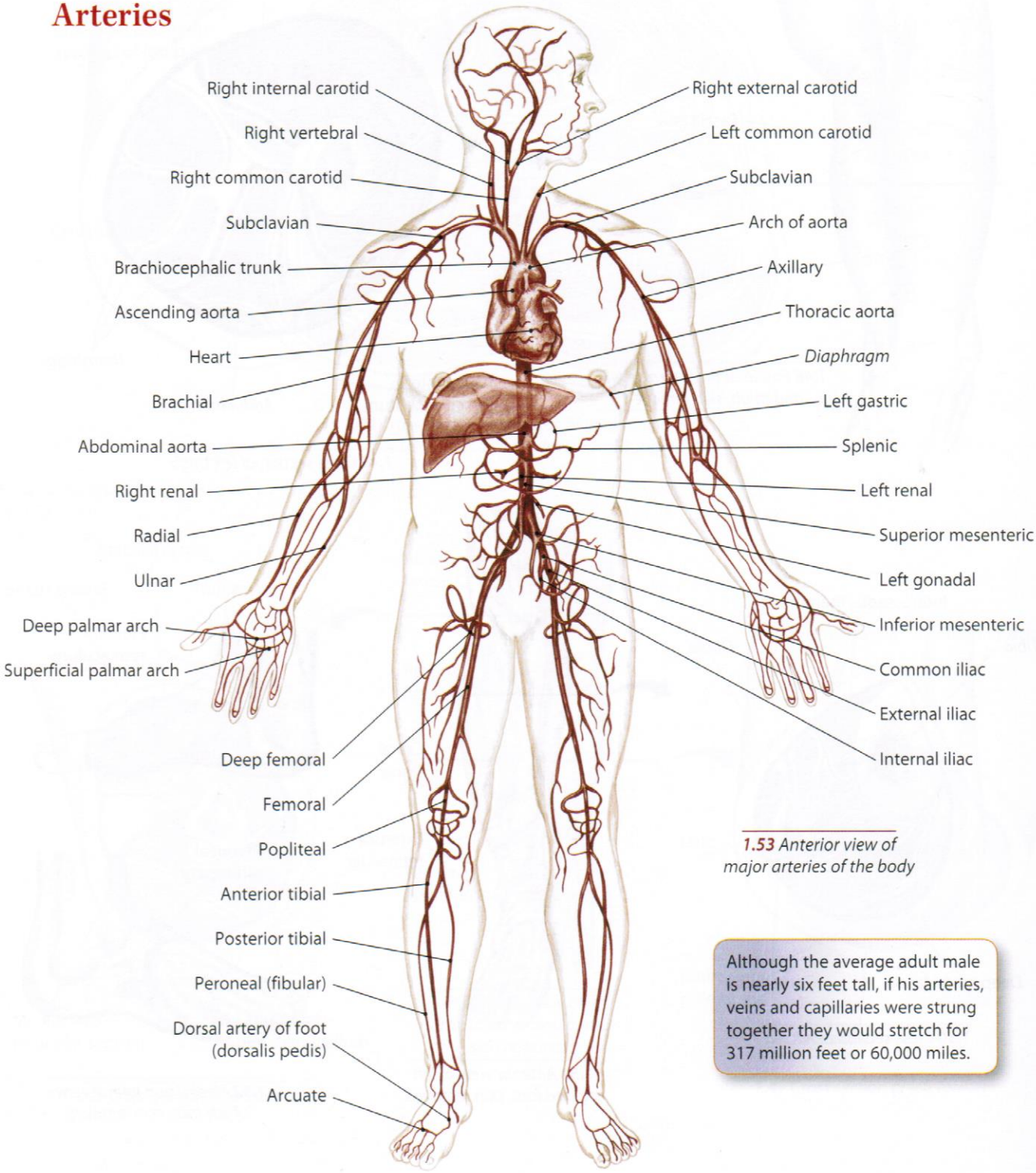
aponeurosis **ap**-o-nu-**ro**-sis Grk. *apo*, from + *neuron*, nerve or tendon

The Cardiovascular System

Arteries and veins are the blood vessels of the cardiovascular system. They form an amazing network that transports blood from the heart, brings it to the body's tissues and then carries it back to the heart.

Arteries carry blood away from the heart. As an artery moves away from the heart, it divides into smaller branches. Arterioles, the smallest branches, divide into millions of microscopic vessels called capillaries. The walls of the capillaries serve as nutrient and waste exchange sites between the body's tissues and the blood. The capillaries then merge back together, creating small veins or venules which then unite to form the larger veins that carry the blood back to the heart.

Arteries

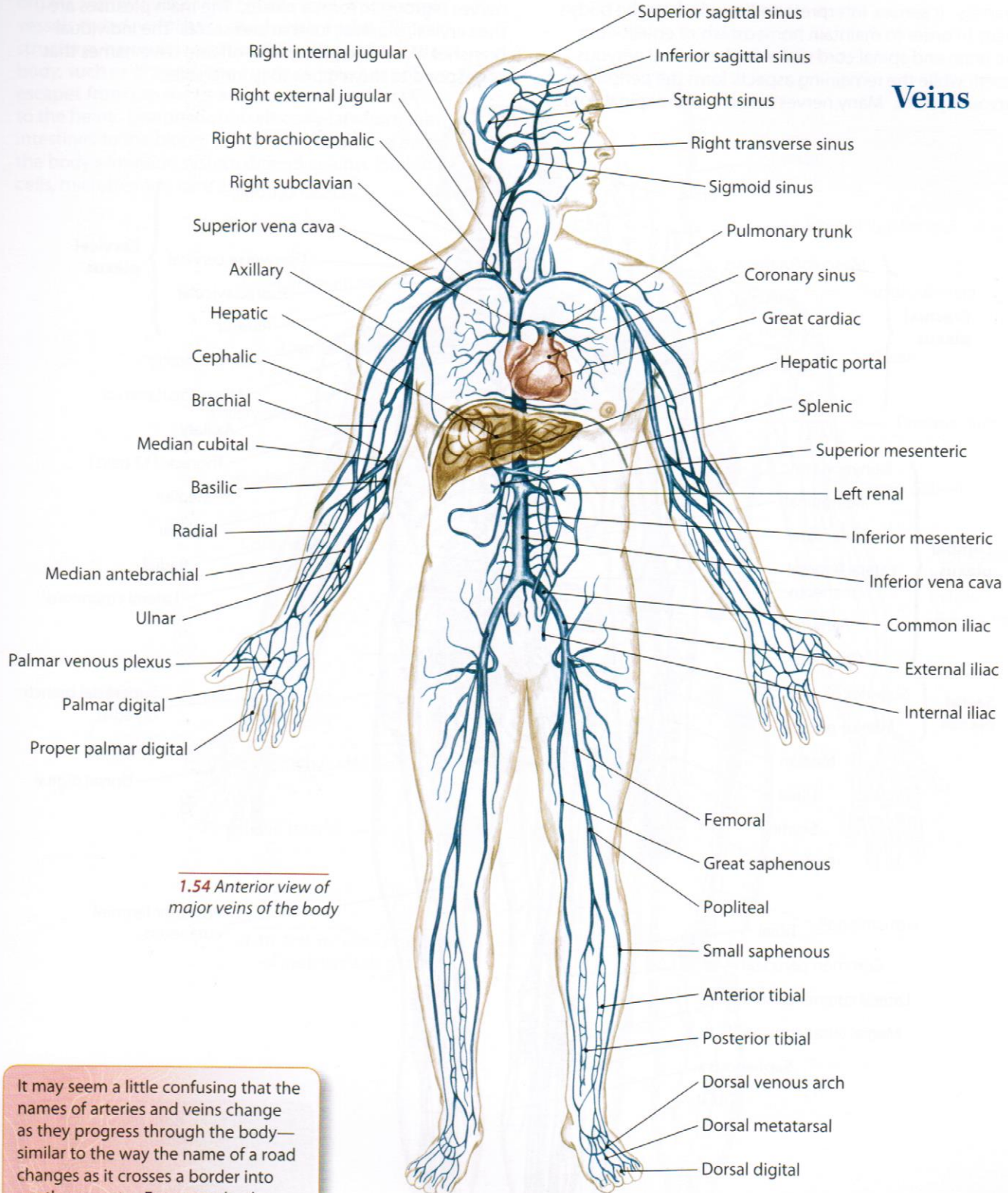


***1.53** Anterior view of major arteries of the body*

Although the average adult male is nearly six feet tall, if his arteries, veins and capillaries were strung together they would stretch for 317 million feet or 60,000 miles.

artery	**ar**-ter-ee	Grk. windpipe
capillary	**kap**-i-**lar**-ee	L. hairlike
vein		L. vessel

Veins

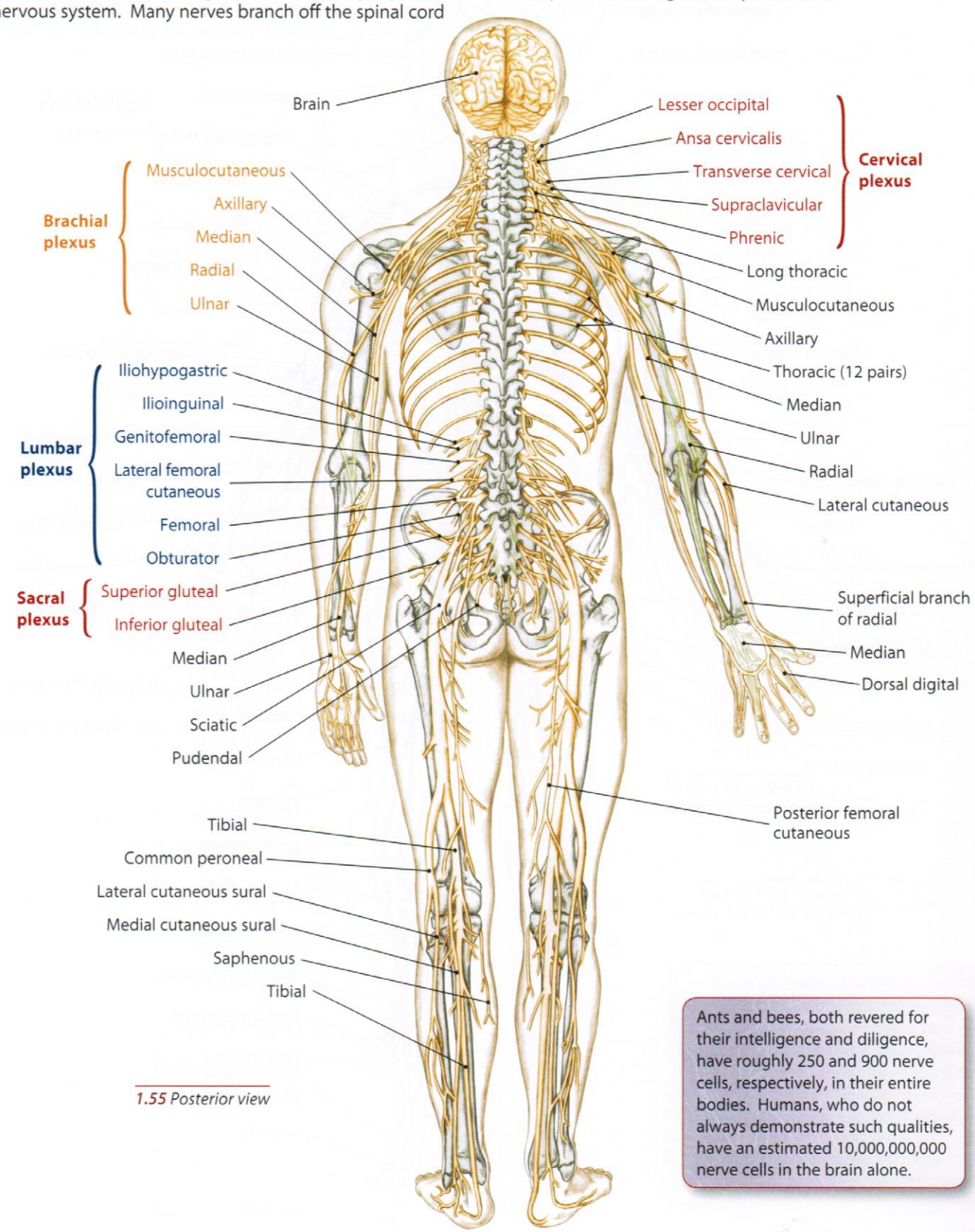


1.54 Anterior view of major veins of the body

It may seem a little confusing that the names of arteries and veins change as they progress through the body—similar to the way the name of a road changes as it crosses a border into another county. For example, the *subclavian* artery, *axillary* artery and *brachial* artery are all the same vessel; its name changes as it passes through those different regions of the body.

The Nervous System

The nervous system is the body's functional headquarters. It senses, interprets and responds to the body's needs in order to maintain homeostasis or equilibrium. The brain and spinal cord make up the central nervous system while the remaining aspects form the peripheral nervous system. Many nerves branch off the spinal cord and exit through the sides of the vertebrae. Some of these nerves regroup to form a plexus. The main plexuses are the cervical, brachial, lumbar and sacral. The individual branches of a nerve plexus split off and have names that correspond to the regions they innervate.

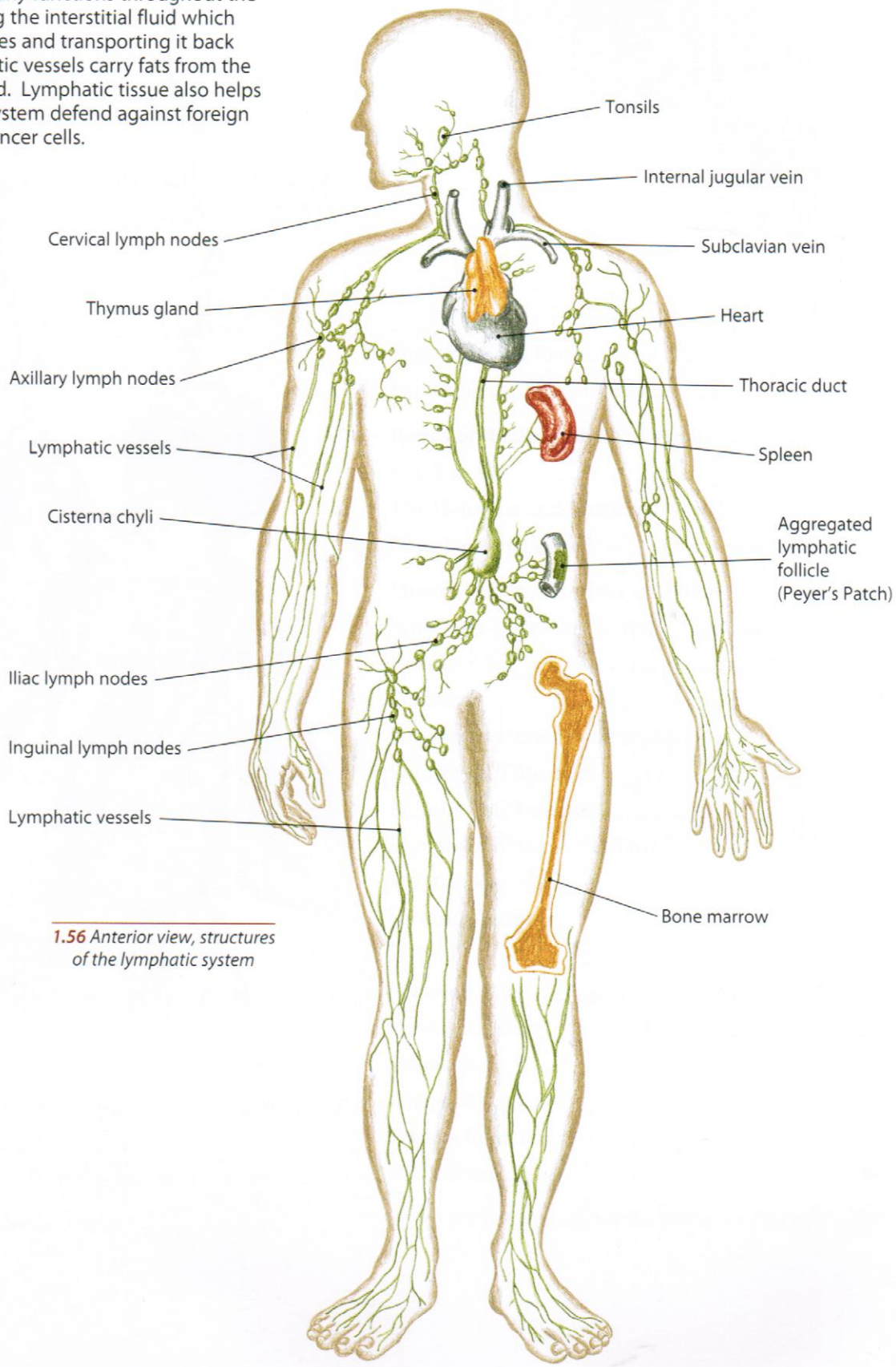


1.55 Posterior view

Ants and bees, both revered for their intelligence and diligence, have roughly 250 and 900 nerve cells, respectively, in their entire bodies. Humans, who do not always demonstrate such qualities, have an estimated 10,000,000,000 nerve cells in the brain alone.

The Lymphatic System

The lymphatic system is composed of several organs, yellow fluid called lymph, small microscopic vessels called lymphatics and lymph nodes. These structures perform many functions throughout the body, such as draining the interstitial fluid which escapes from capillaries and transporting it back to the heart. Lymphatic vessels carry fats from the intestines to the blood. Lymphatic tissue also helps the body's immune system defend against foreign cells, microbes and cancer cells.

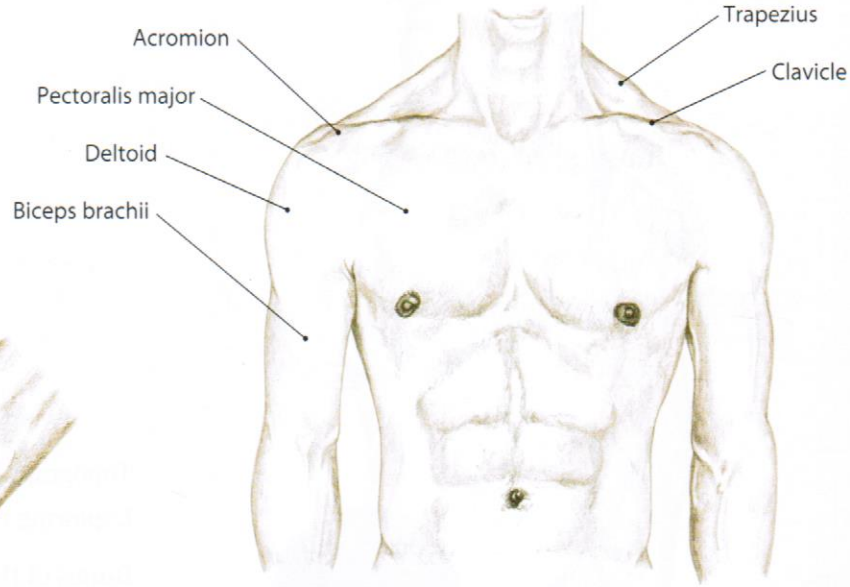


1.56 Anterior view, structures of the lymphatic system

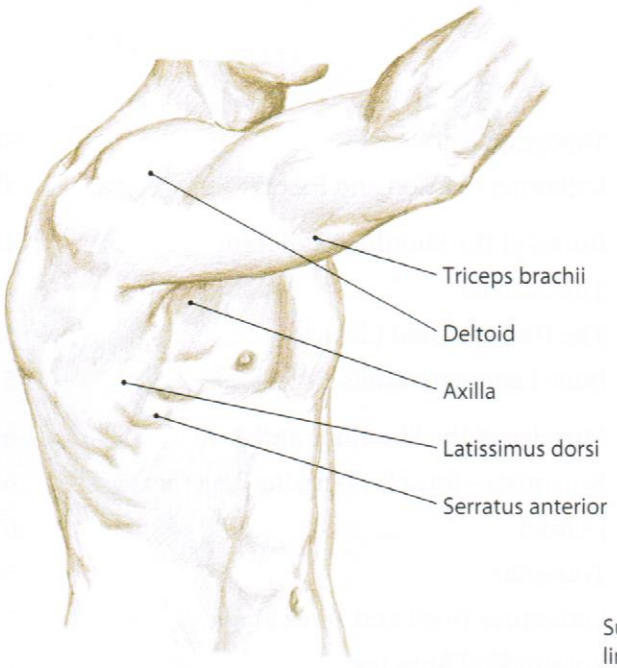
interstitial	**in**-ter-**stish**-al	L. placed between
lymph	limf	L. pure spring water
cisterna chyli	sis-**turn**-a **ki**-lee	L. resevoir + Grk. juice

Shoulder & Arm 2

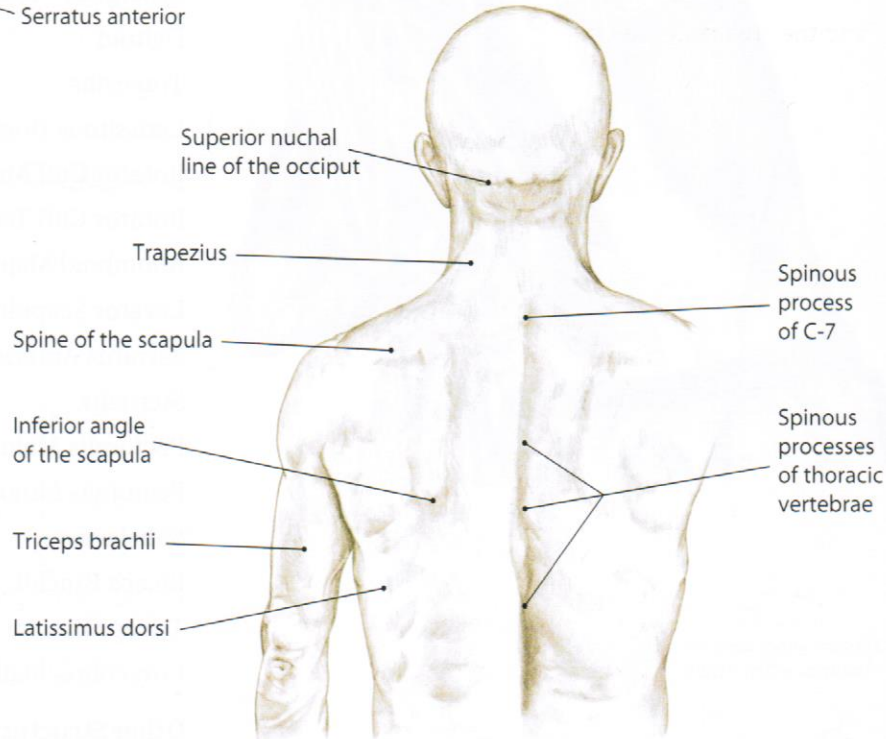
Topographical Views



2.1 Anterior view



2.2 Anterior/lateral view



2.3 Posterior view

Exploring the Skin and Fascia

2.4 *Partner prone*

1) Partner prone. Begin by gently lifting the skin and fascia of the upper back. As you raise it away from the thicker, deeper musculature, twist the tissue from side to side (2.4). Compare the changes in tissue as you explore the top of the shoulders, arms and upper chest.
2) Take particular note of the tissue's changes in thickness and elasticity. For example, the skin and fascia superficial to the spine of the scapula may be dense and matted, while the tissue at the top of the shoulder, only a few inches away, may be thin and mobile.

1) Partner supine. Slowly sink your fingers into the skin of the upper chest. Then gently shift the tissue from side to side (2.5). Try moving it in all directions, sensing its mobility, resistance and temperature.
2) Compare this tissue with other areas of the shoulder and arm, including the axilla (armpit) and the area near the clavicle.

2.5 *Partner supine*

2.6

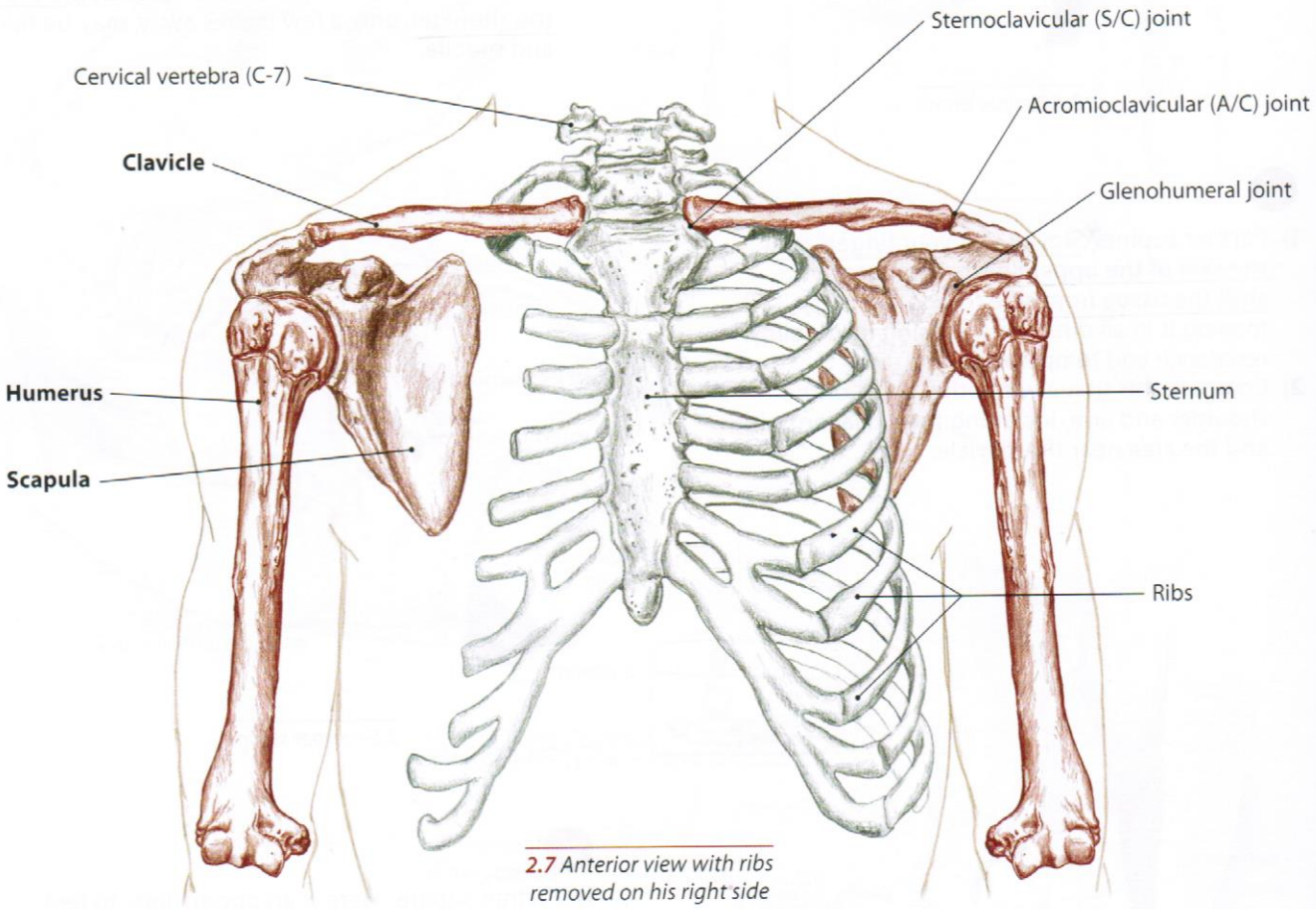
1) Partner supine. Here is an opportunity to feel the skin and fascia shorten or stretch. Holding your partner's arm at the wrist, gently grasp the tissue of the upper chest.
2) Encourage your partner to relax her arm as you passively move it up and down (horizontal abduction and adduction). Note the changes you feel in the tissues.
3) Try this same action while grasping the tissue near the clavicle, sternum or latissimus dorsi. Explore different movements at the shoulder, feeling how virtually all the skin of the upper chest, shoulder and arm shifts to accommodate even a simple action (2.6).

Bones of the Shoulder and Arm

The shoulder complex is made up of three bones: the clavicle, scapula and humerus (2.7). The **clavicle** or collar bone is superficial and runs horizontally along the top of the chest at the base of the neck. It articulates laterally with the acromion of the scapula (acromioclavicular joint) and medially with the sternum (sternoclavicular joint). Both joints are synovial joints. The sternoclavicular joint is the single attachment site between the upper appendicular and axial skeletons.

The **scapula** is the triangular-shaped bone of the upper back. Along with the clavicle, the scapula plays a vital role in stabilization and movement of the arm. The scapula has several fossae, corners and ridges that serve as attachment sites for sixteen muscles. The scapula glides across the posterior surface of the thorax to form the scapulothoracic joint. However, because this articulation does not have any of the usual joint components, it is considered a false joint.

The **humerus** is the bone of the arm. The proximal humerus articulates with the glenoid fossa of the scapula to form the glenohumeral joint. The glenohumeral joint is a synovial, ball-and-socket joint with a wide range of movement. The deltoid muscle and numerous tendons surround the proximal humerus and the glenohumeral joint.



2.7 Anterior view with ribs removed on his right side

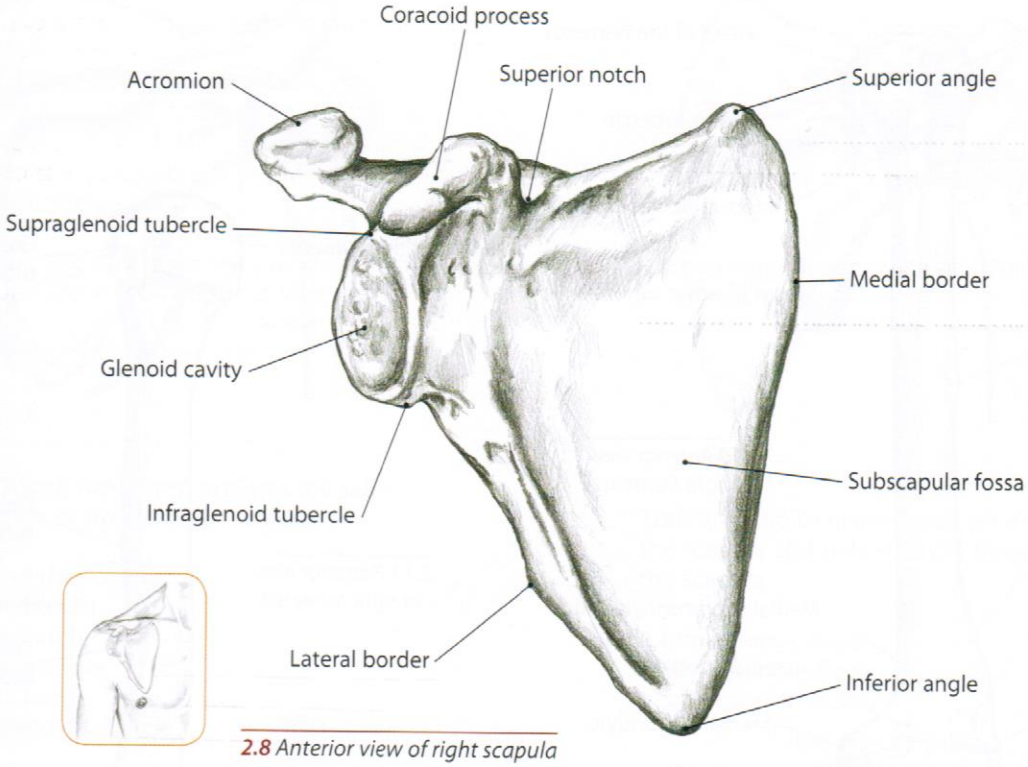
The clavicle is the first bone to start ossifying (hardening) in a human fetus, yet paradoxically it is the last to completely develop—often not until the late teens or early twenties. This fact, along with its superficial location, may explain why the clavicle is one of the most frequently broken bones in the body.

A quadruped, such as a dog or cat, however, is not concerned with breaking its clavicle. Since a quadruped's scapula is positioned on the lateral side of the trunk (as opposed to a human's, which lies on the posterior side of the trunk), its clavicle is not as essential to the movement of the shoulder complex. Actually, cats have a thin sliver for a clavicle while dogs have just a small piece of cartilage.

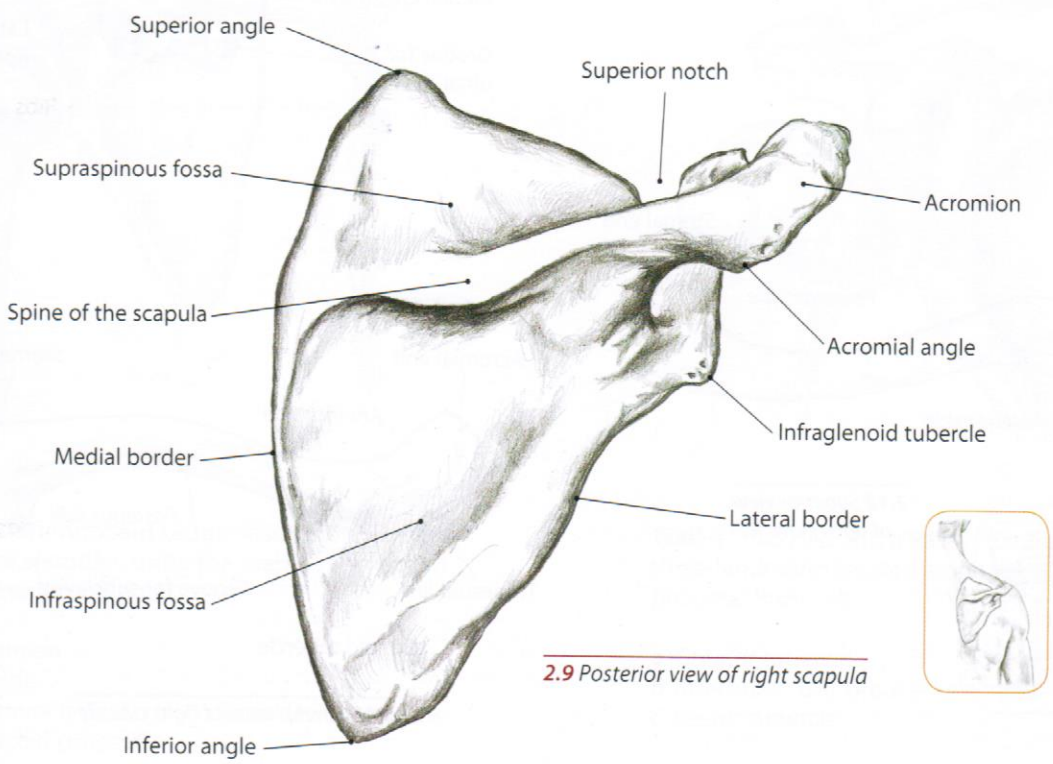
A bird's clavicles are joined to form a furcula. The single unit of the furcula acts as a strut, offering greater stability to the large pectoral muscles during flight. The furcula is what we split apart when vying for the long end of the "wishbone."

clavicle	**klav**-i-k'l	L. little key
furcula	**fur**-ku-la	L. a little fork
humerus	**hu**-mer-us	L. upper arm

The Scapula



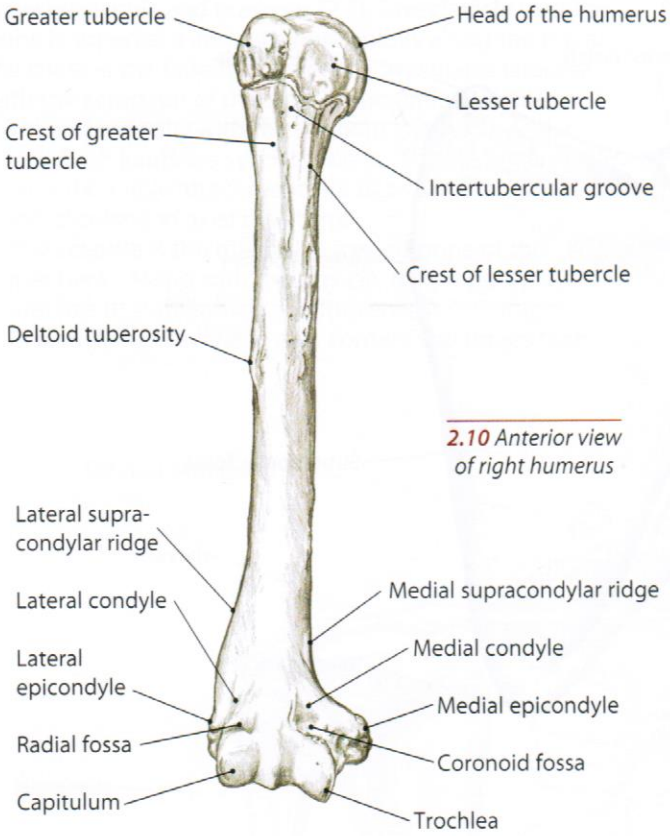
2.8 Anterior view of right scapula



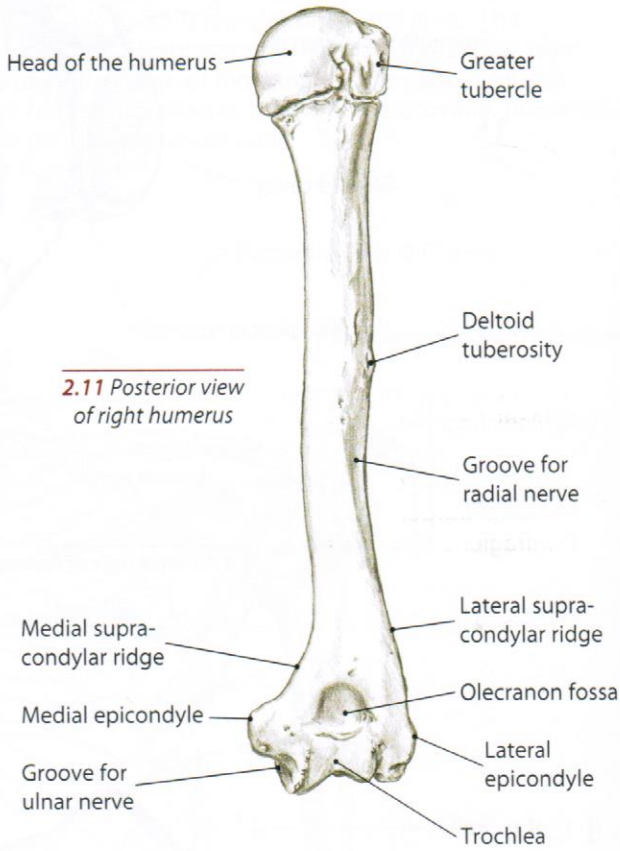
2.9 Posterior view of right scapula

process	**pros**-es	L. going forth
scapula	**skap**-u-la	L. shoulder, blade
scapulae	**skap**-u-lay	plural for scapula

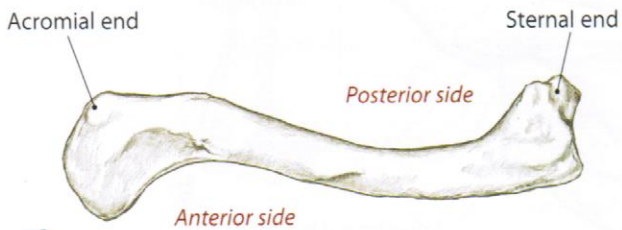
The Humerus and Clavicle



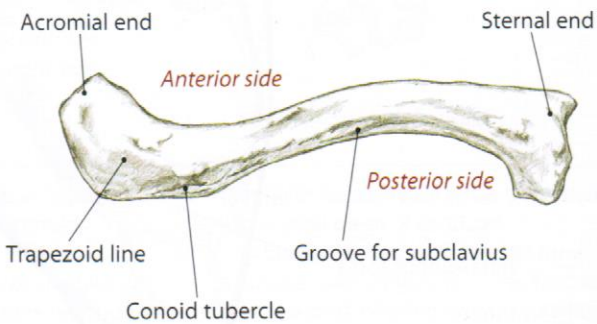
2.10 *Anterior view of right humerus*



2.11 *Posterior view of right humerus*

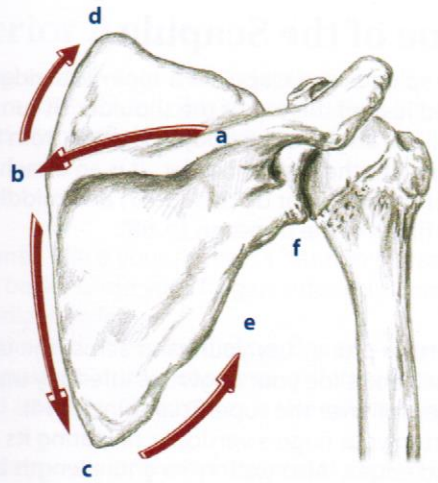


2.12 *Superior view of right clavicle*



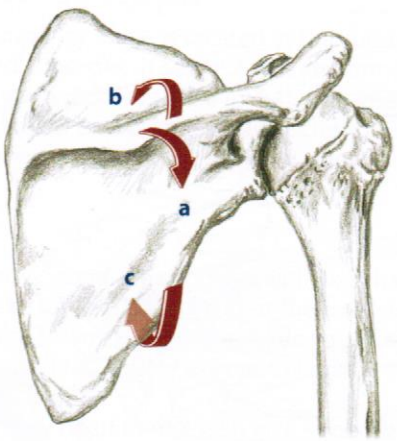
2.13 *Inferior view of right clavicle*

Bony Landmark Trails



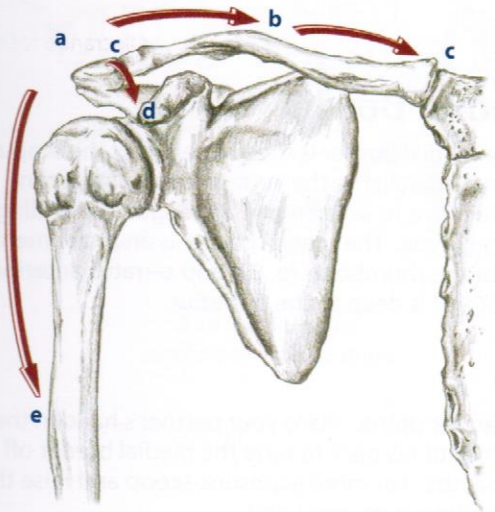
Trail 1 "Along the Edges" explores the sides and corners of the posterior scapula.

a Spine of the scapula
b Medial border
c Inferior angle
d Superior angle
e Lateral border
f Infraglenoid tubercle



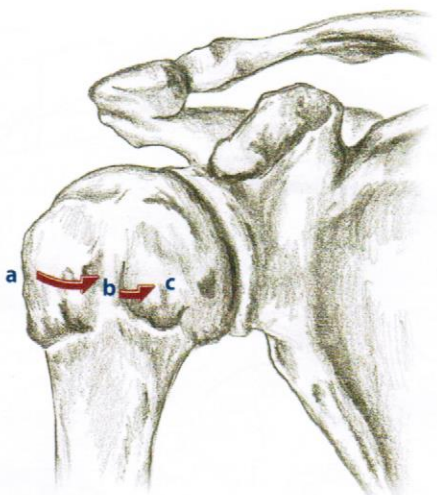
Trail 2 "In the Trenches" leaps off the spine of the scapula and sinks into the three basins of the scapula.

a Infraspinous fossa
b Supraspinous fossa
c Subscapular fossa



Trail 3 "Springboard Ledge" leads around to the anterior shoulder, using the scapula's acromion as a jumping-off point.

a Acromion
b Clavicle
c Acromioclavicular and sternoclavicular joints
d Coracoid process
e Deltoid tuberosity



Trail 4 "Two Hills and a Valley" focuses on the three landmarks located along the anterior, proximal humerus.

a Greater tubercle
b Intertubercular groove
c Lesser tubercle

Trail 1 "Along the Edges"

2.14 *Partner prone, locating the spine of the scapula*

Spine of the Scapula

The spine of the scapula is a superficial ridge located just off the top of the shoulder. It runs at an oblique angle to the body, spanning from the acromion to the medial border. It is an attachment site for the posterior deltoid (p. 67) and middle and lower fibers of the trapezius (p. 68).

1) Partner prone. Lay your hand across the upper back and slide your fingertips inferiorly until they roll over the superficial spine (2.14).
2) Strum your fingers vertically, palpating its width and edges. Also explore its entire length by palpating laterally toward the acromion and medially toward the vertebral column.

As you strum your fingers over the spine, do you feel a ditch of soft tissue above and below it? If your partner slowly elevates his scapula, does the spine elevate as well?

Because of its central location, the spine of the scapula makes a great base camp for locating other landmarks. If you become lost or confused while palpating the scapula, return to its spine.

2.15 *Sculpting out the medial border*

Medial Border

The medial border is the long edge of the scapula that runs parallel to the vertebral column. It can measure five to seven inches in length, depending on body type. The medial border is an attachment site for the rhomboids (p. 82) and serratus anterior (p. 86) and is deep to the trapezius.

1) Partner prone. Place your partner's hand in the small of his back to raise the medial border off the ribs. For more exposure, scoop and raise the shoulder with one hand.
2) Locate the spine of the scapula and glide your fingertips medially until they slide off the spine onto the medial border (2.15).
3) Follow the medial border inferiorly and superiorly; note that it extends further inferiorly from the spine of the scapula than superiorly.

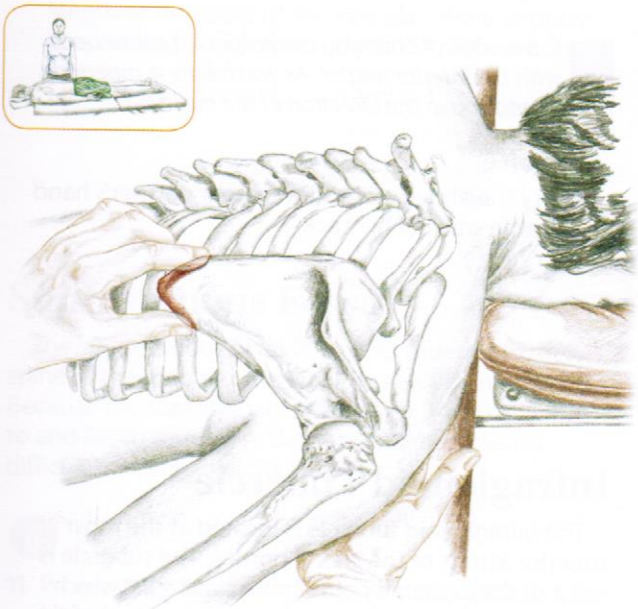
Does the edge you feel run vertically?

Inferior Angle

There are two angles of the scapula, one on either end of the medial border. The inferior angle is superficial and located at the medial border's lower end.

1) Prone. Place your partner's hand in the small of his back. Glide your fingers inferiorly along the medial border.
2) At the end of the medial border, the edge of the scapula will turn a corner and start to rise superiorly and laterally. This corner is the inferior angle (2.16).

Can you sculpt around the inferior angle and pinch it with your fingertip and thumb?



2.16 Partner prone, pinching the inferior angle

Superior Angle

The superior angle is located at the superior end of the medial border. It serves as an attachment site for the levator scapula muscle (p. 84). Because the angle is located deep to the trapezius muscles (p. 68), it may not be as easy to isolate as the inferior angle.

1) Prone. Scoop the shoulder with your hand to raise it off the table. This will soften the overlying muscles.
2) Locate the medial border. Slide your fingertips superiorly along the border to find the superior angle (2.17).
3) You may need to move an inch superior to the spine of the scapula to reach the superior angle.

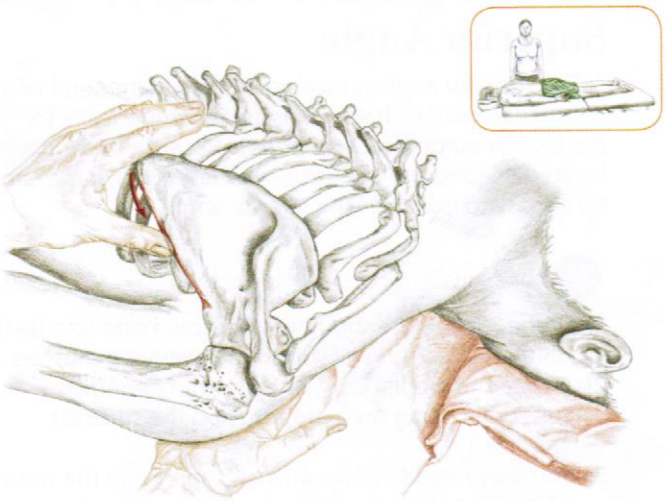
Sculpt out the superior angle and note if it is continuous with the medial border. Locate both the inferior angle and the superior angle. Note the distance between them and gently slide the scapula superiorly and inferiorly.

With your partner side lying, elevate the scapula toward the ear. As the scapula falls away from the rib cage, the superior angle will be quite palpable.

2.17 Isolating the superior angle

The term "winged scapula" refers to a postural condition in which the medial border falls away from the rib cage and visibly protrudes posteriorly. Often indicating a weak serratus anterior muscle, a winged scapula may also involve the muscles which pull the shoulder girdle anteriorly, such as the pectoralis major and minor.

Actually, a degree of scapular winging normally occurs with scapular abduction. For example, when a boxer throws a punch (and fully abducts the scapula) the glenoid fossa is facing anteriorly. In order for this to happen, the medial border must shift posteriorly away from the rib cage. If this winging of the scapula did not occur, the glenoid fossa would not move anteriorly and the boxer would be flat on the canvas in the first round.



2.18 Partner prone, palpating the lateral border

Lateral Border

The lateral border extends superiorly and laterally from the inferior angle toward the axilla or "armpit." It is an attachment site for the teres major and teres minor muscles (p. 71, 74) and, due to the thickness of these tissues, might not be as clearly defined as the medial border.

1) Prone. Drape the arm off the side of the table. Slide your thumb from the inferior angle superiorly along the lateral border.
2) Follow the border in the direction of the axilla. If the musculature is too thick to palpate through, try curling your thumb underneath the tissue (2.18). This is most effective when locating the infraglenoid tubercle (see below).

Is the edge of bone you are palpating continuous with the inferior angle? As you follow it superiorly, does it lead you in the direction of the axilla?

Try the above method with your partner's hand in the small of his back.

2.19 Partner prone, accessing infraglenoid tubercle

Infraglenoid Tubercle

The infraglenoid tubercle is located at the most superior aspect of the lateral border. The tubercle is not a distinguishable point, but a small spot which serves as an attachment site for the long head of the triceps brachii (p. 97). It lies deep to the teres minor and deltoid muscles.

Exploring the infraglenoid tubercle often elicits tenderness in the surrounding tissues. By using your broad thumbpad, you will be able to palpate more precisely without causing pain.

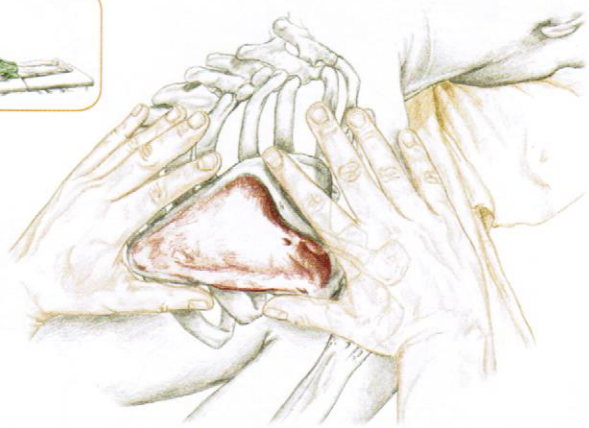
1) Prone. Locate the lateral border.
2) Slide along the lateral border to its most superior portion (2.19). To access the landmark directly, you can either compress through the overlying muscles or curl underneath them.

Are you along the edge of the lateral border? Are you on the posterior side of the axilla?

tubercle **tu**-ber-kl L. a little swelling

Infraspinous Fossa

The scapula contains three fossae or depressions: the infraspinous, supraspinous and subscapular. Each fossa is designed to accommodate a muscle belly and its tendinous attachments. The infraspinous fossa is the triangular area inferior to the spine of the scapula; it is filled with the infraspinatus muscle (p. 74).



2.20 Partner prone, isolating the infraspinous fossa

1) Prone. Palpate the spine of the scapula, its medial border and its lateral border to isolate the infraspinous fossa.
2) Cradle the inferior angle in the webbing between your index finger and thumb. Your index finger will rest along the medial border, your thumb along the lateral border (2.20).
3) Place a finger of the opposite hand along the length of the spine of the scapula. The triangular-shaped area you isolate is the infraspinous fossa.

Supraspinous Fossa

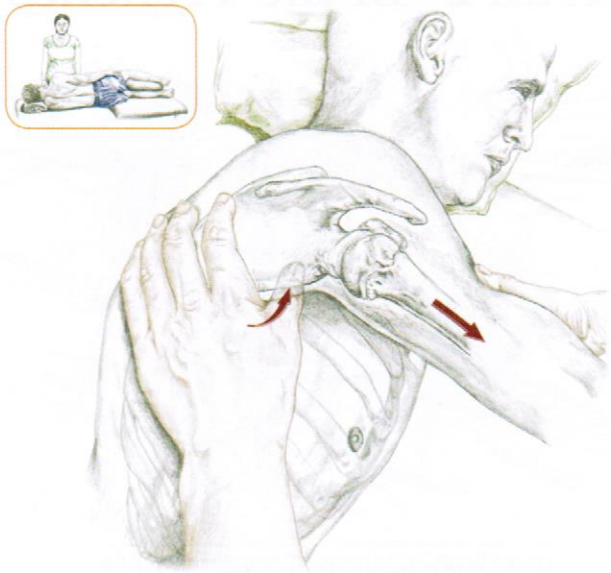
The supraspinous fossa is located superior to the spine of the scapula. It is small in size, yet quite deep. Because the supraspinatus muscle (p. 74) attaches to and lies in this basin, the supraspinous fossa is difficult to access directly.

2.21 Partner prone

1) Prone. Drop your thumbpad inferiorly and laterally from the superior angle into the fossa, or lay your thumb along the spine of the scapula and raise it superiorly into the fossa.
2) Although the fossa is covered by the trapezius and supraspinatus muscles, explore as much as you can of its size and shape (2.21).
3) Slide your thumbs laterally, noting how the fossa becomes thinner and finally ends at the junction of the acromion and clavicle. Actually, the fossa continues underneath the acromion although it is inaccessible.

Are you superior to the spine of the scapula? If you strum your thumbs vertically, can you palpate the supraspinatus fibers running horizontally toward the acromion?

fossa **fos**-a L. a shallow depression



2.22 Partner side lying, accessing the lateral side of the subscapular fossa. Palpating this fossa can be tender, so move slowly and check in with your partner.

2.23 Partner prone, palpating the lateral side of the subscapular fossa

Subscapular Fossa

The subscapular fossa is located on the scapula's anterior (or underside) surface, next to the rib cage. It is the attachment site for the subscapularis (p. 74) and the location of the serratus anterior muscle (p. 86).

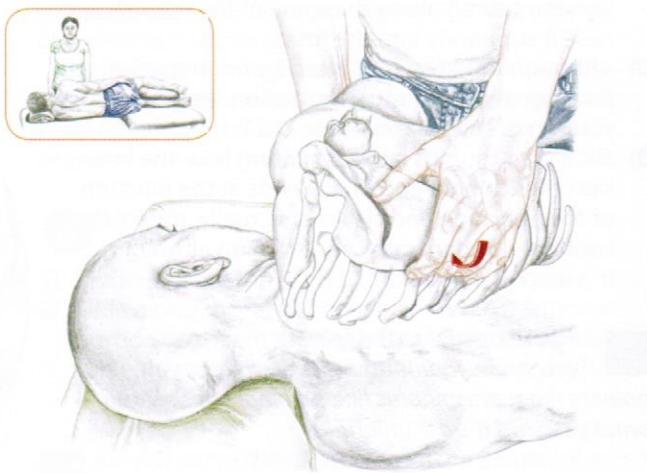
The fossa can be challenging to access, due to the scapula's close proximity to the rib cage and the numerous muscle bellies surrounding it.

1) Side lying. This position allows the scapula to slide away from the rib cage for easier access (2.22).
2) Place your thumb at the middle of the lateral border. Be sure to position your thumb anterior to the large mass of muscles along the lateral border.
3) Slowly sink and curl your thumbpad onto the surface of the fossa. Use your other hand to maneuver the arm and scapula for a position that best allows your thumb to sink into the tissue. You may only be able to sink an inch into the fossa.

Can you feel the rib cage and anterior surface of the scapula on either side of your thumb? Try this same approach with your partner prone (2.23).

Here is a method for palpating the medial portion of the subscapular fossa. The fossa may or may not be accessible, depending on the tissue's flexibility.

1) Side lying. Flex your partner's shoulder and lay your fingertips along the medial border. With the other hand, move the scapula posteriorly (bringing the medial border off the ribs) (2.24).
2) Slowly curl your fingers through the rhomboid and trapezius muscles, under the scapula and onto the fossa.



2.24 Partner side lying, accessing the medial side of the subscapular fossa

acromion a-**cro**-me-on Grk. *akron*, top + *omos*, shoulder

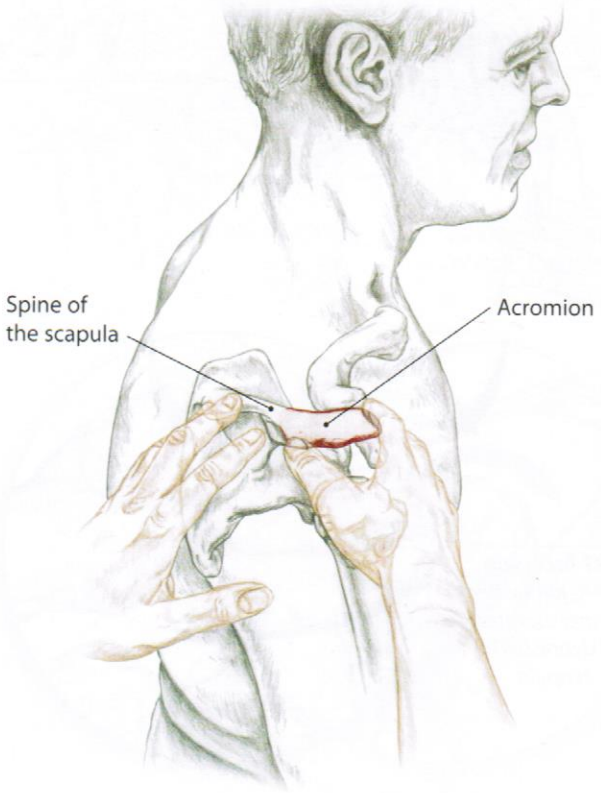
Acromion

The acromion is the lateral aspect of the spine of the scapula and is located at the top of the shoulder. It has a flat surface and articulates with the clavicle's lateral end. The acromion serves as an attachment site for the trapezius and deltoid muscles (p. 68, 67).

The acromial angle is the small corner that can be felt along the acromion's lateral/posterior aspect (see p. 49).

1) Seated or supine. Locate the spine of the scapula.
2) Follow the spine as it rises superiorly and laterally to the top of the shoulder. Use your fingerpads to explore the acromion's flat surface (2.25).
3) Explore and sculpt around all sides of the acromion and its attachment to the clavicle.

Is the bone you are palpating superficial and directly on the top of the shoulder? Can you feel the small point of the acromial angle on the posterior edge of the acromion?



2.25 *Partner seated*

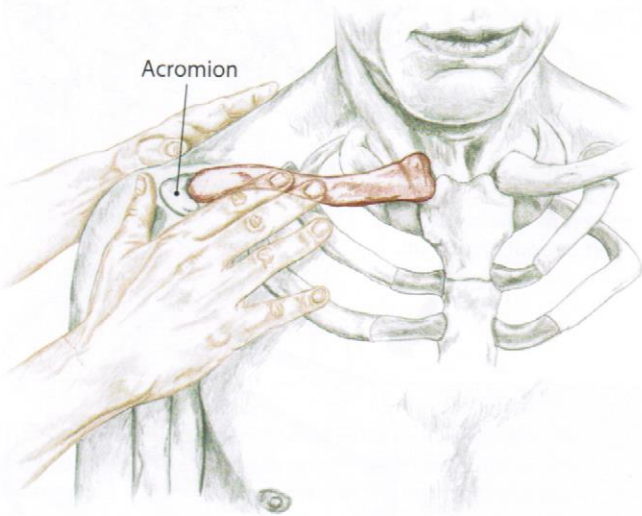
Clavicle

The superficial clavicle lies horizontally across the upper chest and has a gentle "S" shape. It is an attachment site for a number of muscles. Both ends of the clavicle are superficial and accessible. The lateral end is relatively flat and often rises slightly higher than the acromion. The medial end is round and articulates with the sternum.

1) Seated. Locate the acromion and walk your fingers medially onto the shaft of the clavicle.
2) Grasp the clavicle's cylindrical body between your finger and thumb and explore its length from the acromion to the sternum. Observe how its acromial end rises superiorly while its sternal end curves inferiorly (2.26).

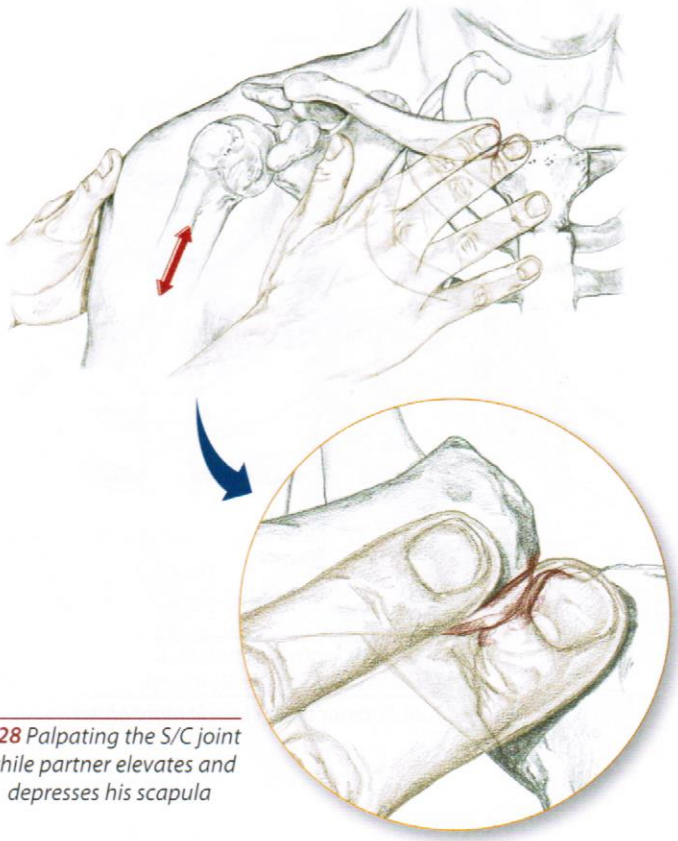
Have your partner move his shoulder anteriorly, and the shaft of the clavicle will protrude visibly. Can you locate the medial and lateral ends of the clavicle simultaneously?

With your fingers at either end of the clavicle, ask your partner to elevate and depress, then adduct and abduct his scapula. As the scapula moves, notice how the ends of the clavicle shift their positions.



2.26 *Anterior view, clavicle highlighted*

2.27 *Accessing the A/C joint while partner elevates and depresses his scapula*



2.28 *Palpating the S/C joint while partner elevates and depresses his scapula*

Acromioclavicular and Sternoclavicular Joints

The **acromioclavicular (A/C) joint** is the small articulation between the acromion of the scapula and the acromial end of the clavicle. The anterior and superior surfaces of this thin crevice can be palpated directly.

The **sternoclavicular (S/C) joint** is the articulation between the sternal end of the clavicle and the sternum. Unlike the slender, smooth A/C joint, the S/C joint is wedge-shaped and contains a small, impalpable fibrous disk. At rest, only the inferior portion of the sternal end makes contact with the sternum. When the clavicle is elevated, the sternal end pivots on the sternum.

A/C Joint

1) Seated or supine. Locate the acromion.
2) Glide medially toward the clavicle. Your finger will feel a small "step" as you rise up onto the surface of the clavicle.
3) Backtrack slightly. Just lateral to the step will be the A/C joint's slender ditch.

Does the acromial end of the clavicle lie slightly higher than the acromion? Place a finger where you believe the A/C joint to be and ask your partner to slowly elevate and depress his scapula (2.27). As the scapula rises, do you feel the joint space widen slightly? As it depresses, does the joint space diminish?

S/C Joint

1) Seated or supine. Slide your fingers medially along the shaft of the clavicle.
2) Just lateral to the body's centerline, the shaft will broaden to become the bulbous sternal end.
3) Locate the S/C joint by sliding your finger medially off the sternal end. Passively elevate, depress and abduct the scapula. Then explore the changes occurring at the S/C joint.

Place a finger where you believe the S/C joint to be and ask your partner to slowly elevate and depress his scapula (2.28). Can you feel the joint space widen and diminish?

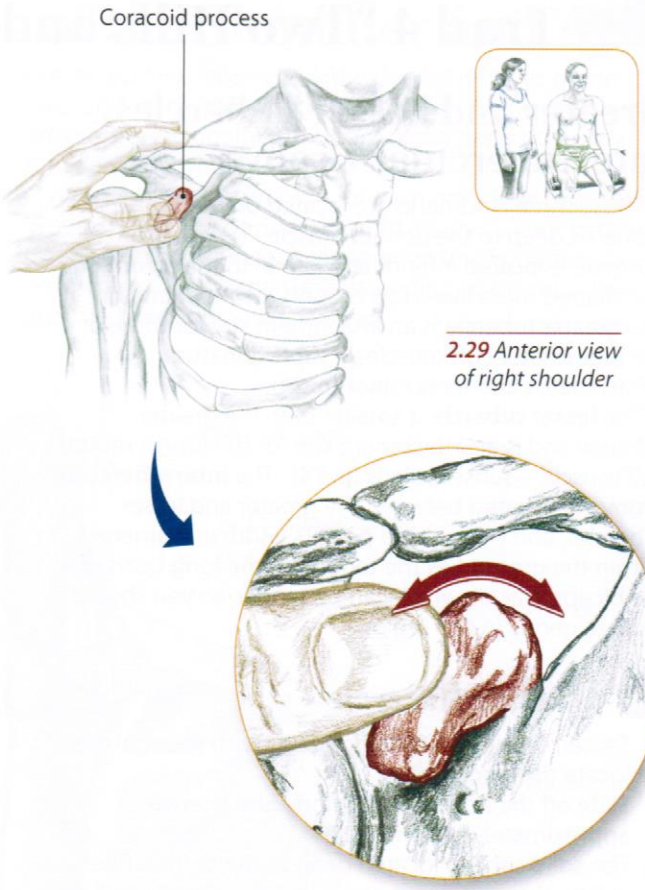
acromioclavicular a-**kro**-me-o-kla-**vik**-u-lar
sternoclavicular **ster**-no-kla-**vik**-u-lar

Coracoid Process

The coracoid process of the scapula is the beak-like projection found inferior to the shaft of the clavicle. Depending on the position of the scapula, it is often found in the deltopectoral groove (p. 62) between the deltoid and pectoralis major fibers. The coracoid process can be tender when palpated, so proceed carefully.

1) Seated or supine. Lay your thumb along the lateral shaft of the clavicle.
2) Slide inferiorly off the clavicle no more than an inch and a half. Locate the tip of the coracoid process by compressing your fingerpads into the tissue (2.29).
3) As the coracoid becomes more apparent, get a better understanding of its shape and size by sculpting a circle around its edges.

Are you inferior to the shaft of the clavicle? Passively move the scapula with your other hand and feel the coracoid follow your movements.



2.29 *Anterior view of right shoulder*

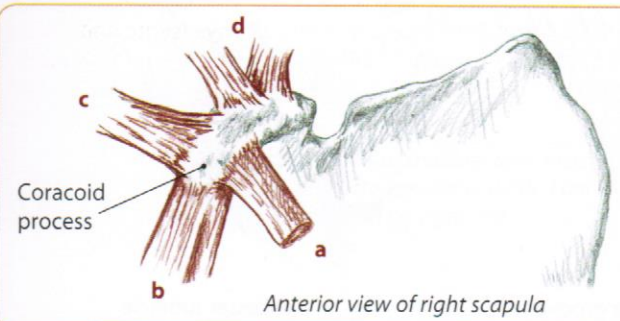
Deltoid Tuberosity

The deltoid tuberosity is located on the lateral side of the mid-humeral shaft. It is a small, low bump that serves as an attachment site for the converging fibers of the deltoid muscle (p. 67).

1) Seated or supine. Locate the acromion.
2) Slide off the acromion and down the lateral aspect of the arm (2.30).
3) When you reach the halfway point between the shoulder and elbow, there will be a small mound on the lateral side of the arm.

If your partner abducts his shoulder, do the deltoid fibers converge where you are palpating?

2.30 *Lateral view accessing the deltoid tuberosity*



Anterior view of right scapula

The coracoid process is an attachment site for several tendons and ligaments. The arrangement of these structures can be illustrated in a clockwise fashion. On the right scapula, the pectoralis minor tendon **(a)** connects at four o'clock, while the coracobrachialis and biceps brachii tendons **(b)** lie at seven o'clock. The coracoacromial ligament **(c)** attaches at ten o'clock and the coracoclavicular ligaments **(d)** attach further posteriorly on the coracoid process at eleven o'clock and midnight.

coracoid	**kor**-a-koyd	Grk. raven's beak
tuberosity	**tu**-ber-**os**-i-tee	L. a swelling

Trail 4 "Two Hills and a Valley"

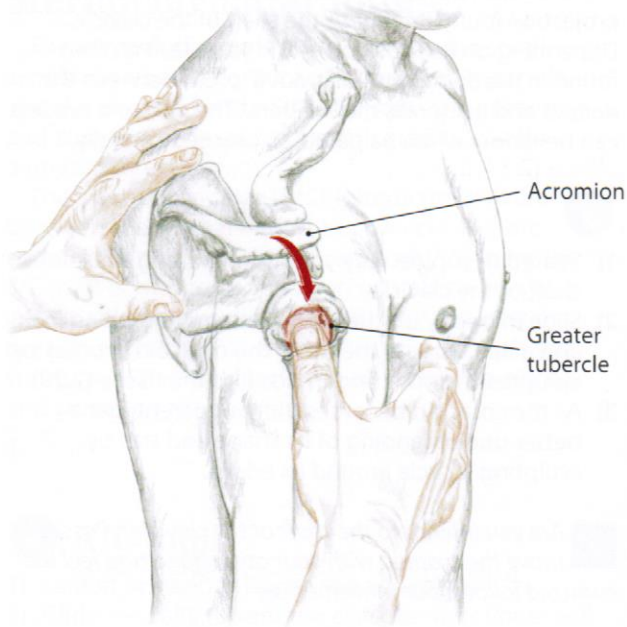
Greater and Lesser Tubercles, Intertubercular Groove

These three landmarks are located on the proximal humerus deep to the deltoid muscle. The **greater tubercle** is located inferior and lateral to the acromion. It is shaped more like a low mound than a pointy hill. The greater tubercle is an attachment site for three of the four rotator cuff muscles—supraspinatus, infraspinatus and teres minor (p. 74).

The **lesser tubercle** is smaller than the greater tubercle and is an attachment site for the fourth rotator cuff muscle—subscapularis (p. 74). The **intertubercular groove** is situated between the greater and lesser tubercles, and is roughly a pencil's width in diameter. Within the groove lies the tendon of the long head of the biceps brachii, which can be tender, so you should palpate gently in this region.

Greater tubercle

1) Seated or supine. Shaking hands with your partner, locate the acromion.
2) Slide off the acromion inferiorly and laterally approximately one inch (2.31).
3) The solid surface located deep to the deltoid fibers will be the greater tubercle. You may feel a small dip between the acromion and the tubercle.



2.31 Lateral view of right shoulder, sliding off the acromion to the greater tubercle

Intertubercular groove and lesser tubercle

1) Place your thumb on the greater tubercle (2.32, a).
2) Begin to rotate the arm laterally. As the humerus rotates, the greater tubercle (a) will move out from under your thumb and be replaced by the slender ditch of the intertubercular groove (b).
3) As you continue to laterally rotate the arm, your thumb will rise out of the groove onto the lesser tubercle (c).

Place your thumb at the greater tubercle and passively rotate the arm medially and laterally. Do you feel the "bump-ditch-bump" sequence as the three landmarks pass beneath your thumb? Are you horizontal to the level of the coracoid process?

2.32 Superior view of rotating the right humerus

a) Greater tubercle **b)** Intertubercular groove **c)** Lesser tubercle

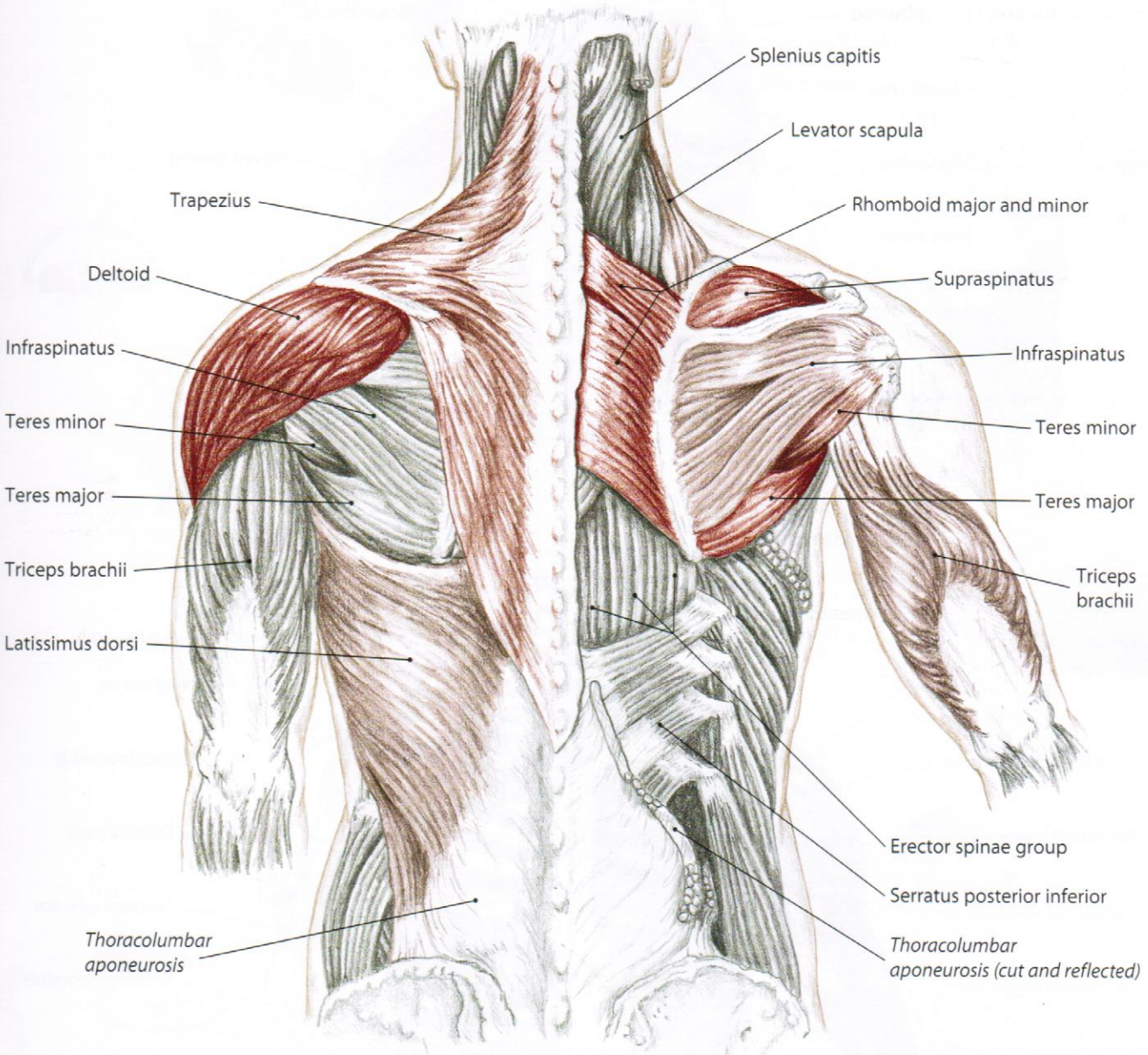
intertubercular **in**-tur-tu-**ber**-ku-lar

Muscles of the Shoulder and Arm

The muscles of the shoulder and arm are an amazingly diverse group. Some of them span across the back and rib cage, some attach at the cranium while others extend down to the elbow. All of the muscles create movement at the shoulder complex (formed by the scapula, clavicle and humerus). Some also elevate the ribs, extend the head and cervical vertebrae or bend the elbow (2.33–2.35).

The superficial muscles of the shoulder and back are presented first, followed by the deeper muscles of the back and, lastly, the muscles of the arm. Some muscles are presented together to better understand how they function as a group.

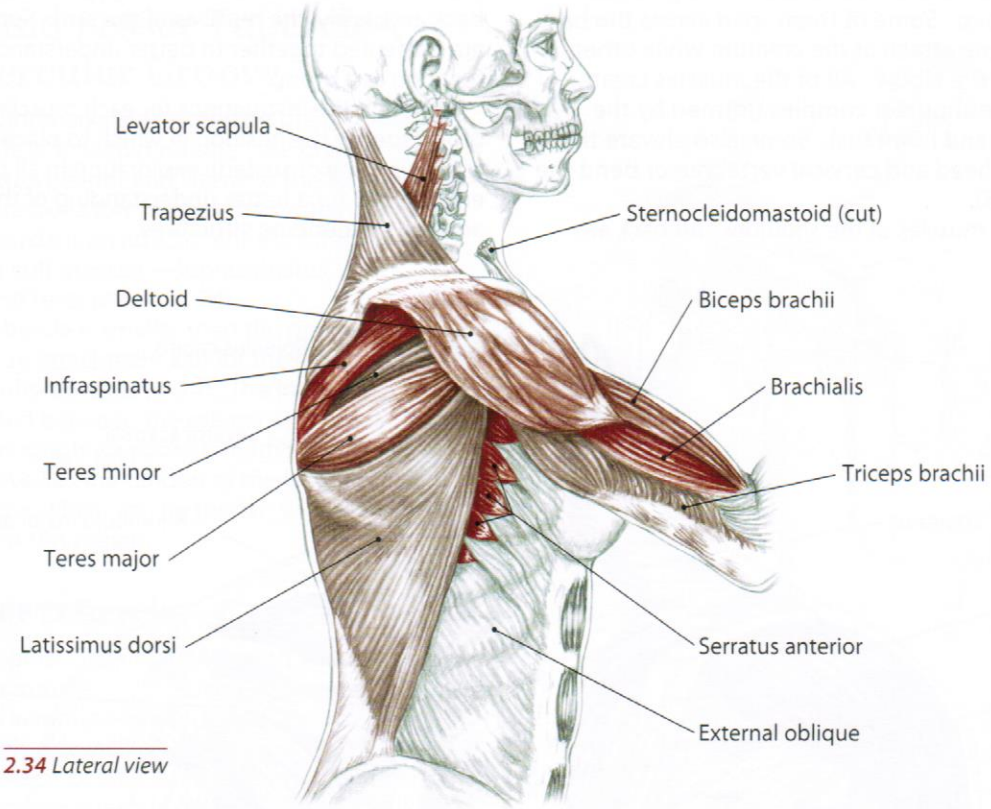
Although the instructions for each muscle or muscle group specify the position in which to place your partner (prone, supine or seated), exploration in all positions is encouraged for a better understanding of the muscle(s) and the surrounding structures.



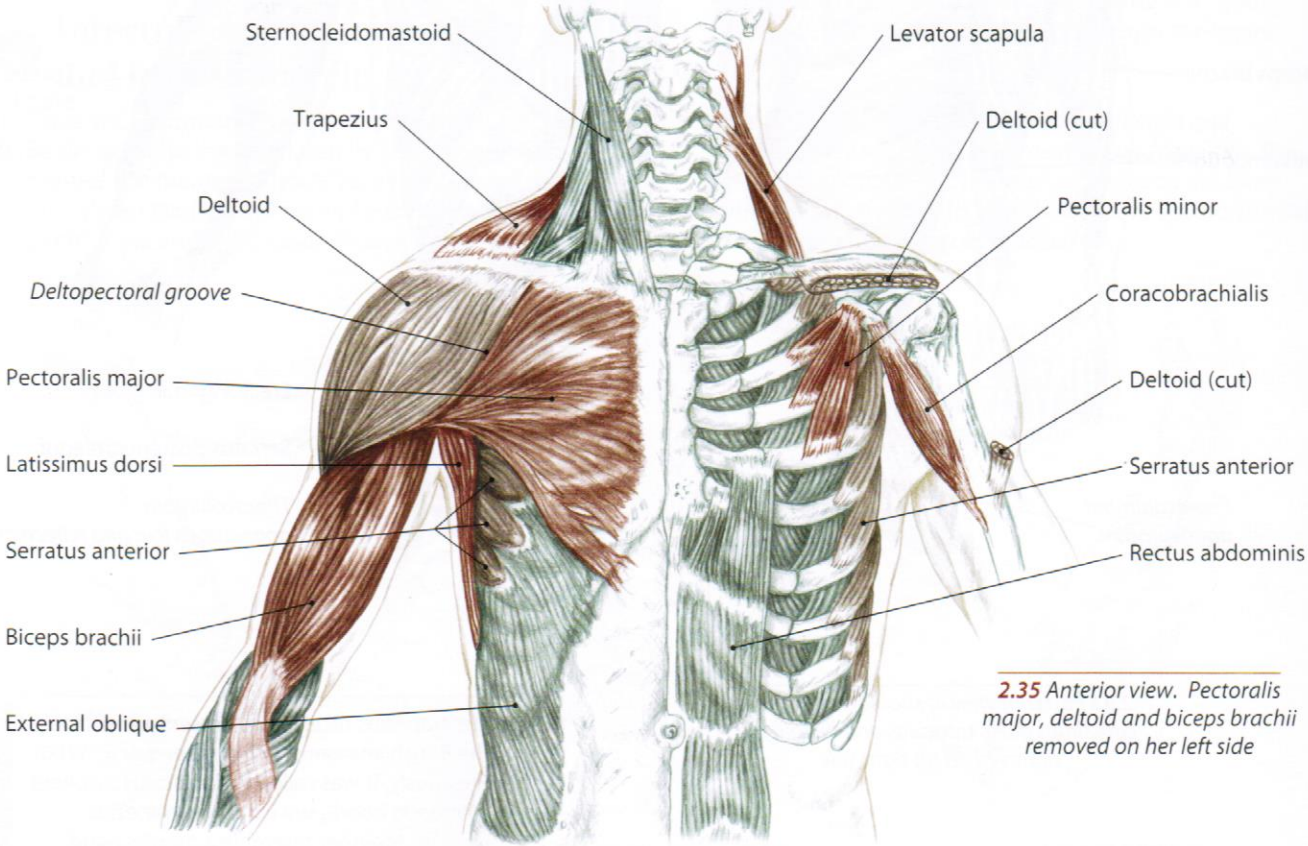
2.33 Posterior view of shoulder and back. Latissimus dorsi, trapezius and deltoid are removed on his right side.

The trapezius received its present name from the British anatomist William Cowper (c. 1700). Previously, it was called the *musculus cucullaris* (L. muscle hood), since the two trapezius muscles together resemble a monk's hood.

Muscles of the Shoulder and Arm



2.34 Lateral view



2.35 Anterior view. Pectoralis major, deltoid and biceps brachii removed on her left side

Synergists–Muscles Working Together

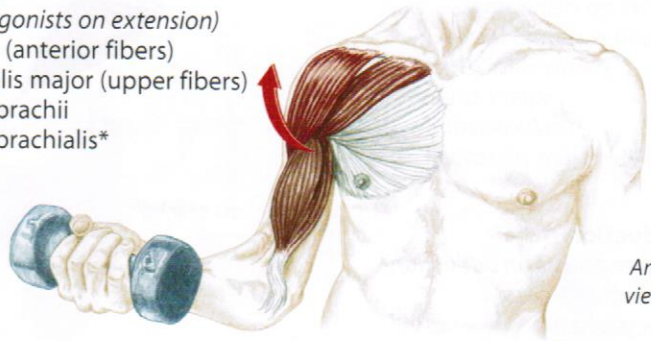
Muscles are listed in the order of their ability to create the movement. Asterisk indicates muscles not shown.

Shoulder

(glenohumeral joint)

Flexion

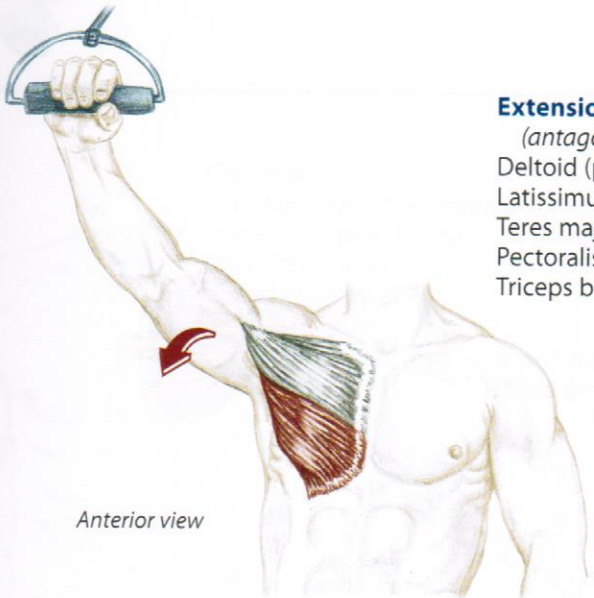
(antagonists on extension)
Deltoid (anterior fibers)
Pectoralis major (upper fibers)
Biceps brachii
Coracobrachialis*



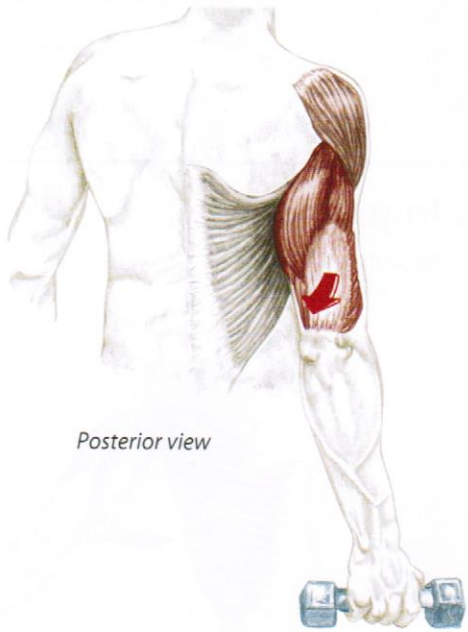
Anterior/medial view of right arm

Extension

(antagonists on flexion)
Deltoid (posterior fibers)
Latissimus dorsi
Teres major
Pectoralis major (lower fibers)
Triceps brachii (long head)



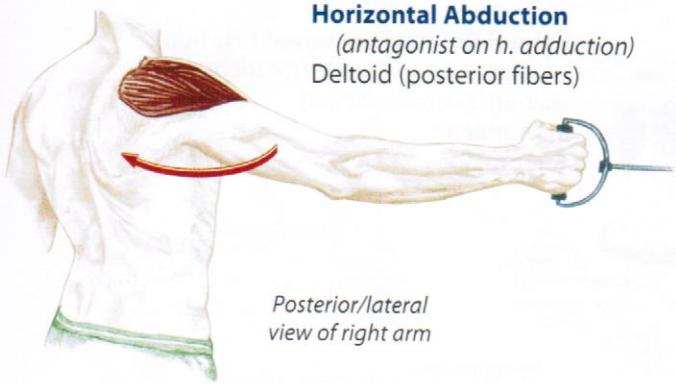
Anterior view



Posterior view

Horizontal Abduction

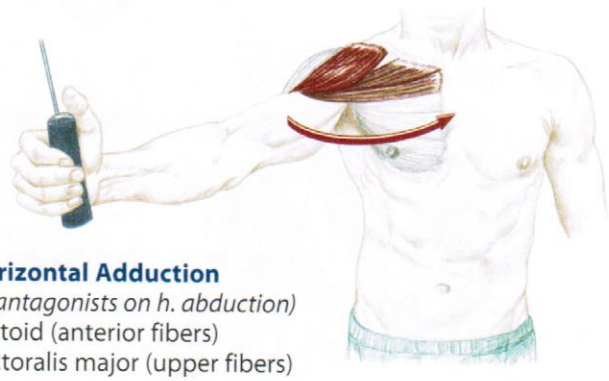
(antagonist on h. adduction)
Deltoid (posterior fibers)



Posterior/lateral view of right arm

Horizontal Adduction

(antagonists on h. abduction)
Deltoid (anterior fibers)
Pectoralis major (upper fibers)



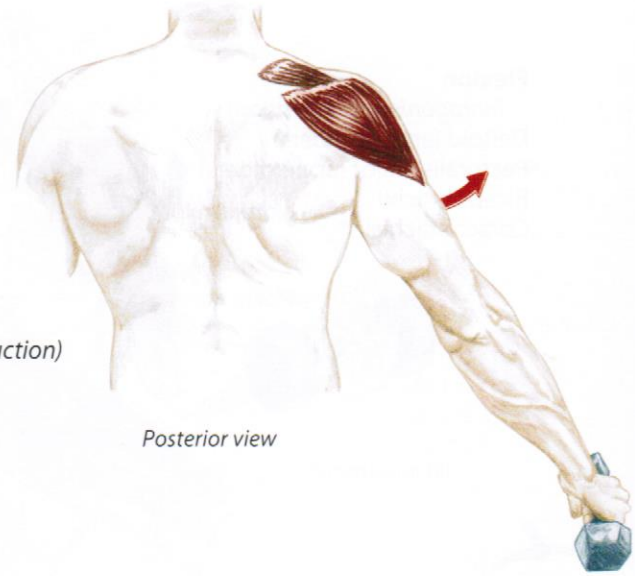
Anterior view

Shoulder

(glenohumeral joint)

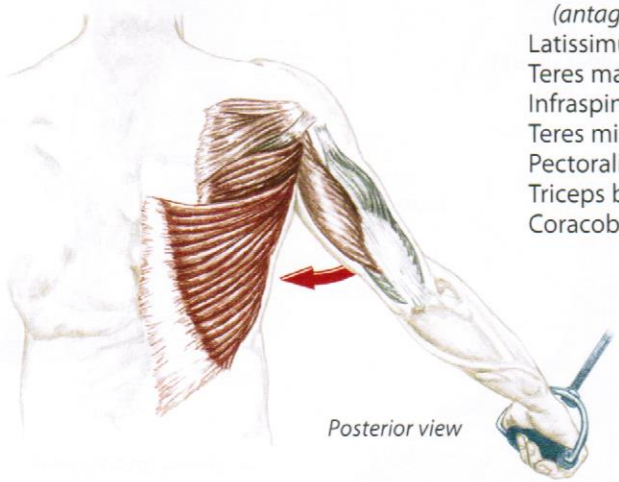
Anterior view

Abduction
(antagonists on adduction)
Deltoid (all fibers)
Supraspinatus

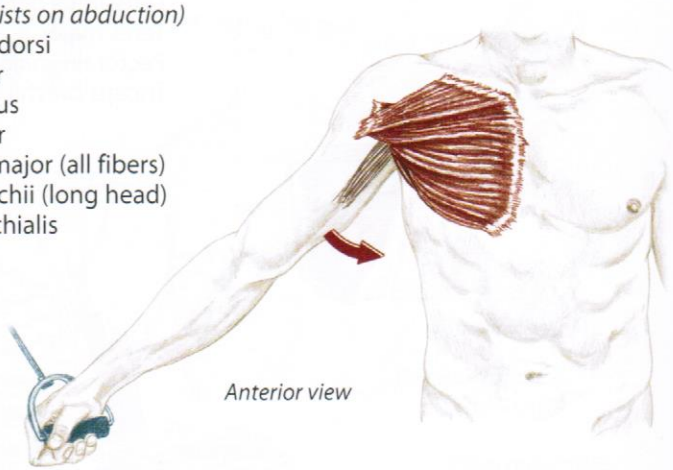


Posterior view

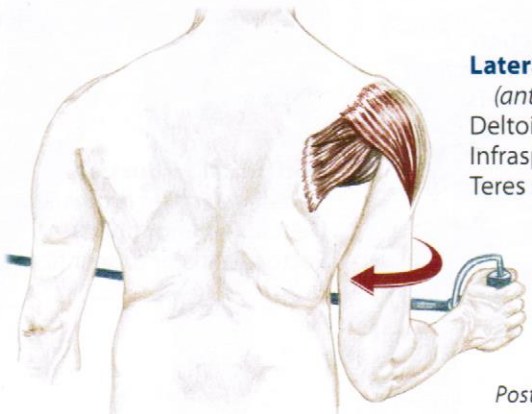
Adduction
(antagonists on abduction)
Latissimus dorsi
Teres major
Infraspinatus
Teres minor
Pectoralis major (all fibers)
Triceps brachii (long head)
Coracobrachialis



Posterior view



Anterior view

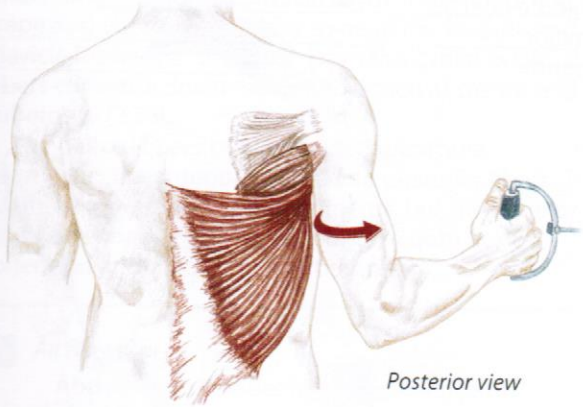


Lateral Rotation (external rotation)
(antagonists on medial rotation)
Deltoid (posterior fibers)
Infraspinatus
Teres minor

Posterior view

Shoulder

(glenohumeral joint)

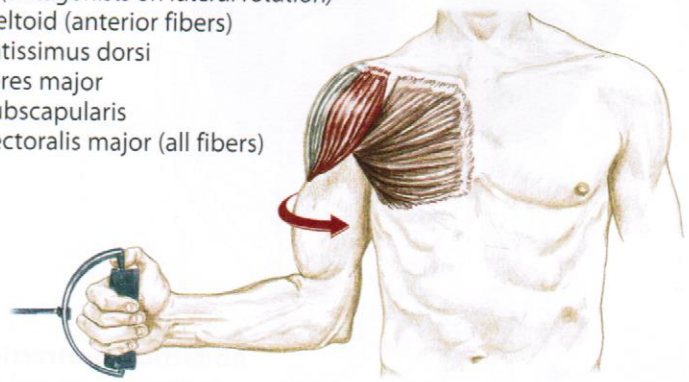


Posterior view

Medial Rotation
(internal rotation)

(antagonists on lateral rotation)

Deltoid (anterior fibers)
Latissimus dorsi
Teres major
Subscapularis
Pectoralis major (all fibers)



Anterior view

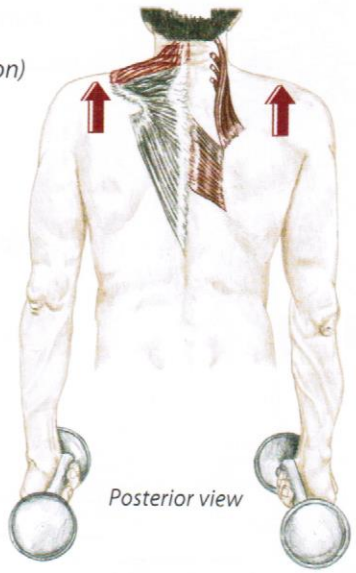
Scapula

(scapulothoracic joint)

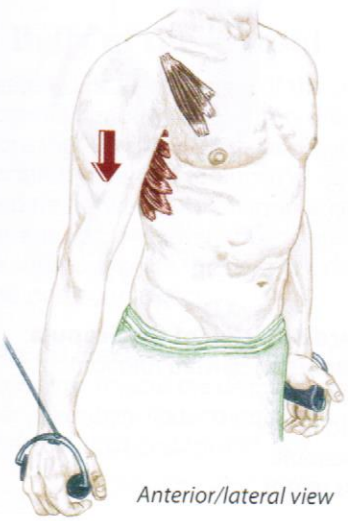
Elevation

(antagonists on depression)

Trapezius (upper fibers)
Rhomboid major
Rhomboid minor
Levator scapula



Posterior view

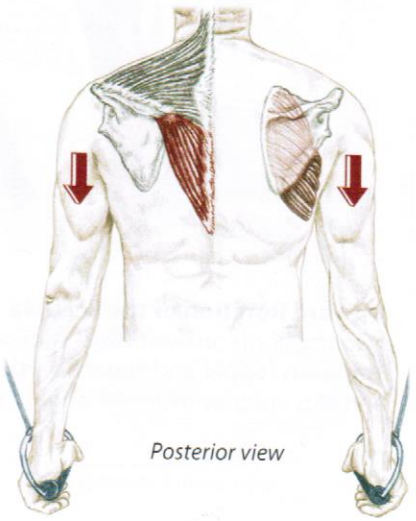


Anterior/lateral view

Depression

(antagonists on elevation)

Trapezius (lower fibers)
Serratus anterior (with the origin fixed)
Pectoralis minor



Posterior view

Scapula

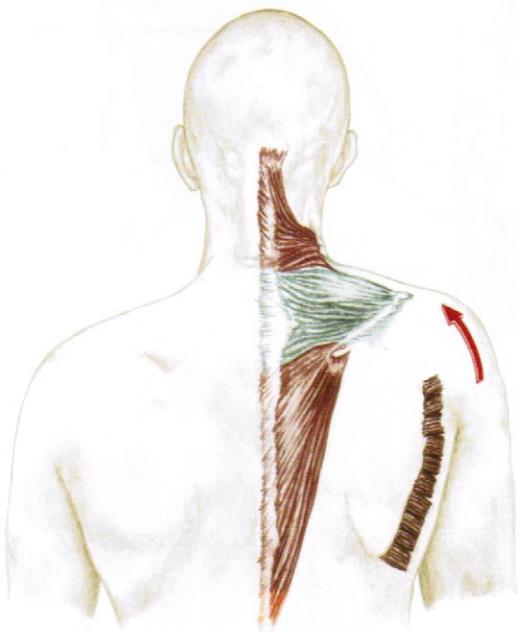
(scapulothoracic joint)

Anterior/lateral view

Adduction (retraction)
(antagonists on abduction)
Trapezius (middle fibers)
Rhomboid major
Rhomboid minor

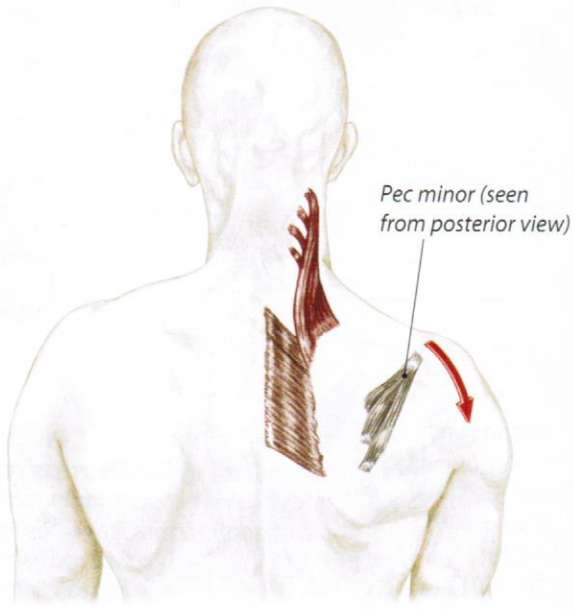
Abduction (protraction)
(antagonists on adduction)
Serratus anterior (with the origin fixed)
Pectoralis minor

Posterior/lateral view



Upward Rotation of the Scapula
(antagonists on downward rotation)
Trapezius (upper and lower fibers)
Serratus anterior (with the origin fixed)

Posterior views

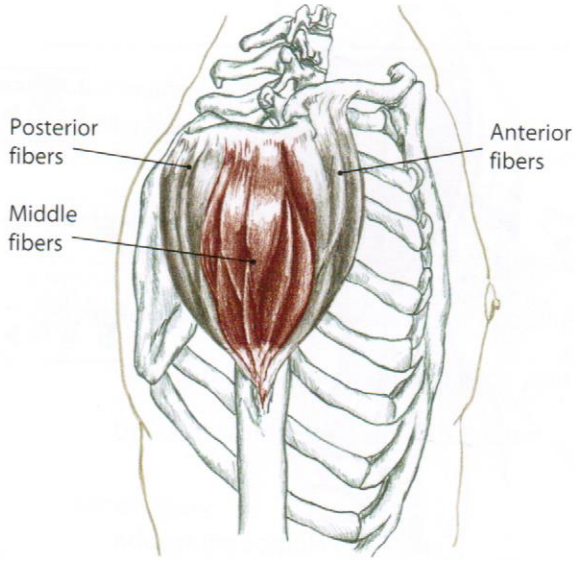


Downward Rotation of the Scapula
(antagonists on upward rotation)
Rhomboid major
Rhomboid minor
Levator scapula
Pectoralis minor

Deltoid

The triangle-shaped deltoid is located on the cap of the shoulder. The origin of the deltoid (which is, interestingly enough, identical to the insertion of the trapezius) curves around the spine of the scapula and clavicle forming a "V" shape. From this broad origin, the fibers converge down the arm to attach at the deltoid tuberosity (2.36).

The deltoid fibers can be divided into three segments: the anterior, middle and posterior fibers. All three groups abduct the humerus, but the anterior and posterior fibers are antagonists in both flexion/extension and medial/lateral rotation.



2.36 Lateral view of deltoid showing the three segments

A *All fibers:*

Abduct the shoulder (glenohumeral joint)

Anterior fibers:

Flex the shoulder (G/H joint)

Medially rotate the shoulder (G/H joint)

Horizontally adduct the shoulder (G/H joint)

Posterior fibers:

Extend the shoulder (G/H joint)

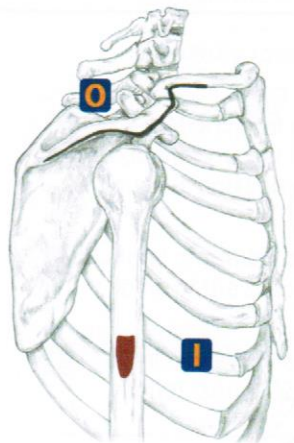
Laterally rotate the shoulder (G/H joint)

Horizontally abduct the shoulder (G/H joint)

O Lateral one-third of clavicle, acromion and spine of scapula

I Deltoid tuberosity

N Axillary C**5**, **6**



2.37 Origin and insertion of deltoid

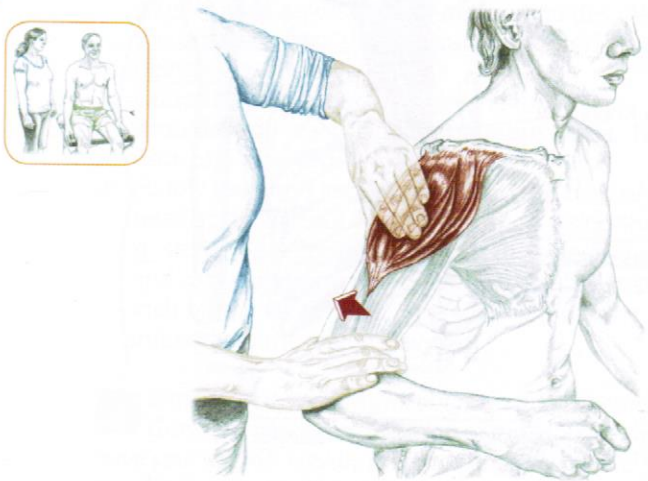
When Do You Use Your Deltoid?

- *Virtually all movements that involve the shoulder*
- *Slipping your arms into a jacket*
- *Raking, shoveling, sawing*
- *Rowing a dinghy*

Belly of the deltoid

1) Seated. Locate the spine of the scapula, the acromion and the lateral one-third of the clavicle. Note the "V" shape these landmarks form.
2) Locate the deltoid tuberosity.
3) Palpate between these landmarks to isolate the superficial, convergent fibers of the deltoid. Be sure to explore the deltoid's most anterior and posterior aspects.

Are the fibers you feel superficial and do they converge toward the deltoid tuberosity? If your partner alternately abducts and releases, do you feel the fibers contract and relax (2.38)?



2.38 Anterior/lateral view

deltoid **del**-toid Grk. *delta*, capital letter D (Δ) in the Greek alphabet

2.39 Lateral view of right shoulder. Use both hands to sculpt out the edges of the deltoid, following them down to the tuberosity.

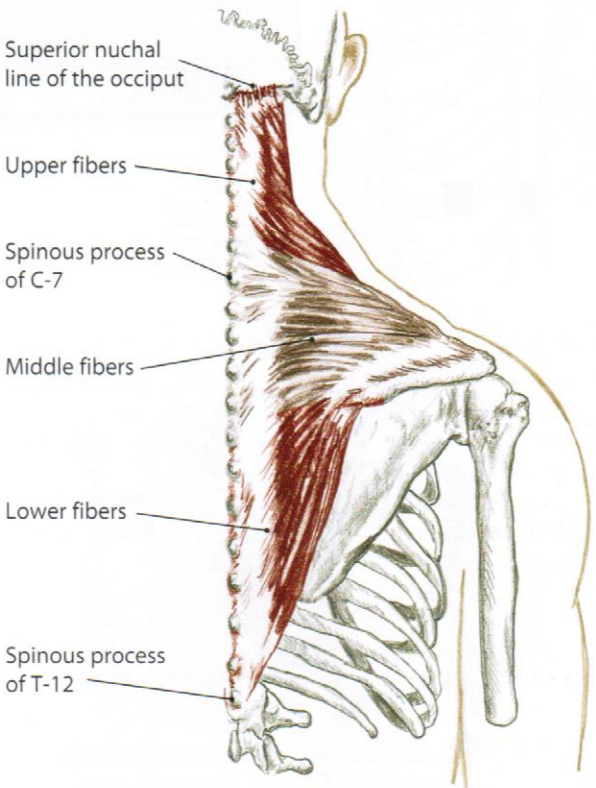
Deltoid as antagonist to itself

To feel the antagonistic abilities of the deltoid's anterior and posterior fibers: 1) Shaking hands with your partner, place your other hand on the deltoid. 2) Keeping his elbow next to his side, ask your partner to medially and laterally rotate his arm against your resistance. Can you sense the anterior fibers contracting upon medial rotation and relaxing upon lateral rotation, and vice versa for the posterior fibers?

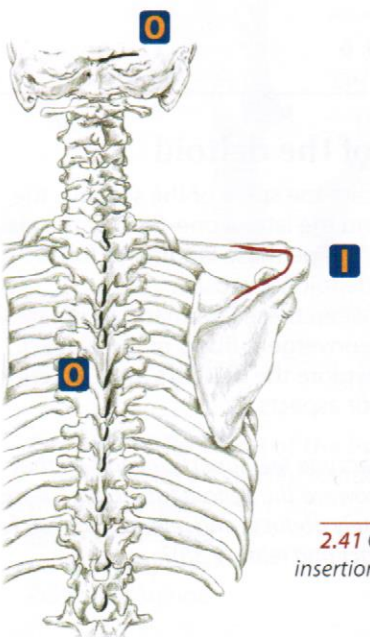
Trapezius DVD

The trapezius lies superficially along the upper back and neck. Its broad, thin fibers blanket the shoulders, attaching to the occiput (the bone at the base of the head, p. 231), lateral clavicle, scapula and spinous processes of the thoracic vertebrae (2.40, 2.42).

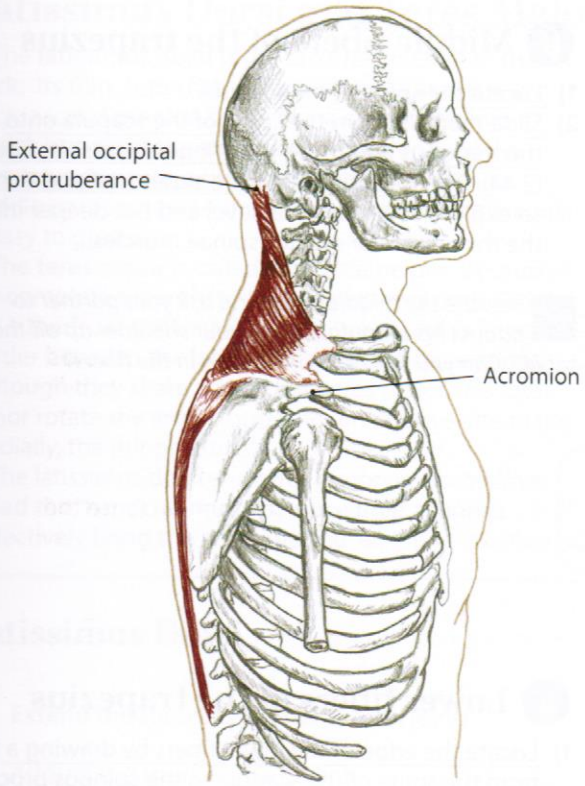
The trapezius fibers can be divided into three groups: upper (descending) fibers, middle fibers and lower (ascending) fibers. The upper and lower fibers are antagonists in elevation and depression of the scapula, respectively. All fibers of the trapezius are easy to palpate



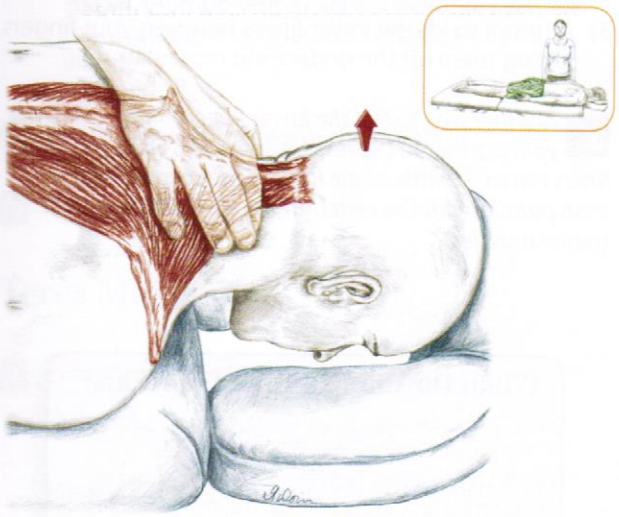
2.40 Posterior view of trapezius



2.41 Origin and insertion of trapezius



2.42 Lateral view of trapezius



2.43 Partner prone

As your partner extends his head, you will likely see two parallel "speed bumps" running along the posterior neck. These bulges are formed primarily by the deeper semispinalis capitis muscle (p. 201), with the trapezius muscles draped on top.

A *Upper fibers:*

Bilaterally

Extend the head and neck

Unilaterally

Laterally flex the head and neck to the same side

Rotate the head and neck to the opposite side

Elevate the scapula (scapulothoracic joint)

Upwardly rotate the scapula (S/T joint)

Middle fibers:

Adduct the scapula (S/T joint)

Stabilize the scapula (S/T joint)

Lower fibers:

Depress the scapula (S/T joint)

Upwardly rotate the scapula (S/T joint)

O External occipital protuberance, medial portion of superior nuchal line of the occiput, ligamentum nuchae and spinous processes of C-7 through T-12

I Lateral one-third of clavicle, acromion and spine of the scapula

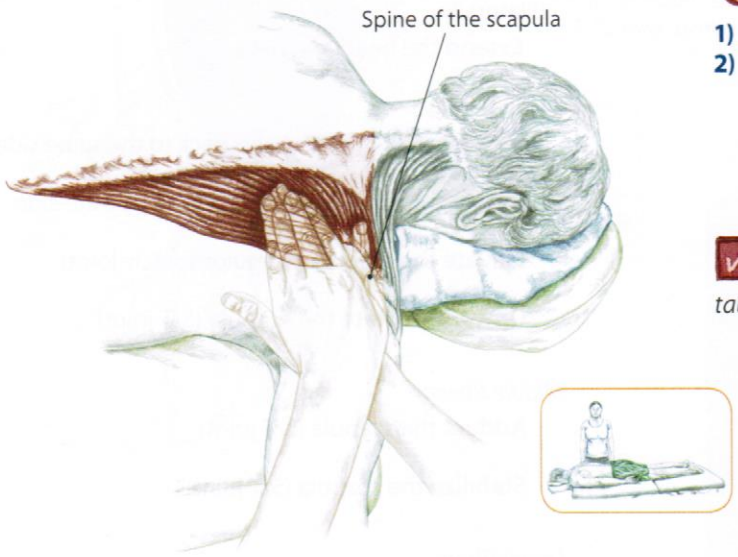
N Spinal portion of cranial nerve XI (accessory) and ventral ramus C2, **3**, **4**

Upper fibers of the trapezius

1) Prone. These fibers form the easily accessible flap of muscle lying across the top of the shoulder. Along the posterior neck they are surprisingly skinny, each being only an inch wide.
2) Grasp the superficial tissue on the top of the shoulder and feel the upper trapezius fibers. Take note of their slender quality (2.43).
3) Follow the fibers superiorly toward the base of the head at the occiput. To feel the fibers along the posterior neck contract, stand at the side of the table and ask your partner to extend his head "a quarter inch off the face cradle." Then follow the fibers inferiorly to the lateral clavicle.

☑ *Is the muscle you are grasping thin and superficial? Grasp the fibers along the top of the shoulder and have your partner elevate his scapula gently toward his ear. Do the muscle fibers become taut?*

trapezius	tra-**pee**-ze-us	Grk. a little table or trapezoid shape
nuchae	**nu**-kay	L. nape of neck
occiput	**ok**-si-put	L. the back of the skull

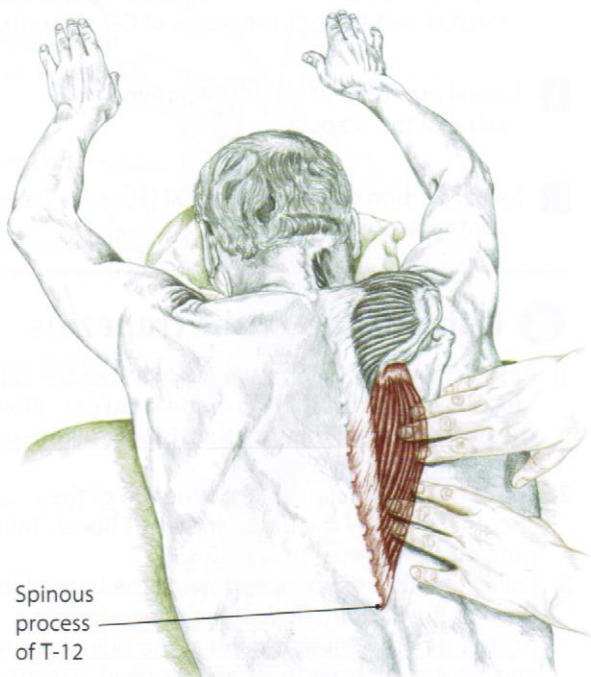


2.44 Partner prone, accessing the middle and lower fibers of the trapezius

Middle fibers of the trapezius

1) Locate the spine of the scapula.
2) Slide medially from the spine of the scapula onto the trapezius and move your fingers across its fibers (2.44). The trapezius fibers are superficial and thin, so explore at a superficial level and not deeper into the rhomboids or erector spinae muscles.

Palpate the middle fibers and ask your partner to adduct his scapula. "Bring your shoulder up off the table." Can you feel any contraction in the fibers?



2.45 Partner prone, with arms reaching out in front of him

Lower fibers of the trapezius

1) Locate the edge of the lower fibers by drawing a line from the spine of the scapula to the spinous process of T-12 (p. 177).
2) Palpate along this line and push your fingers into the edge of the lower fibers. Ask your partner to hold his arms out in front of him (like Superman) and feel for the superficial fibers of the trapezius (2.45).
3) Attempt to lift the lower fibers between your fingers, raising them off the underlying musculature.

Another way to feel the lower fibers contract is to ask your partner to depress his shoulder. Do the lower fibers run at a gentle angle toward the scapula (rather than parallel with the vertebral column like the erector spinae muscles)?

When Do You Use Your Trapezius?

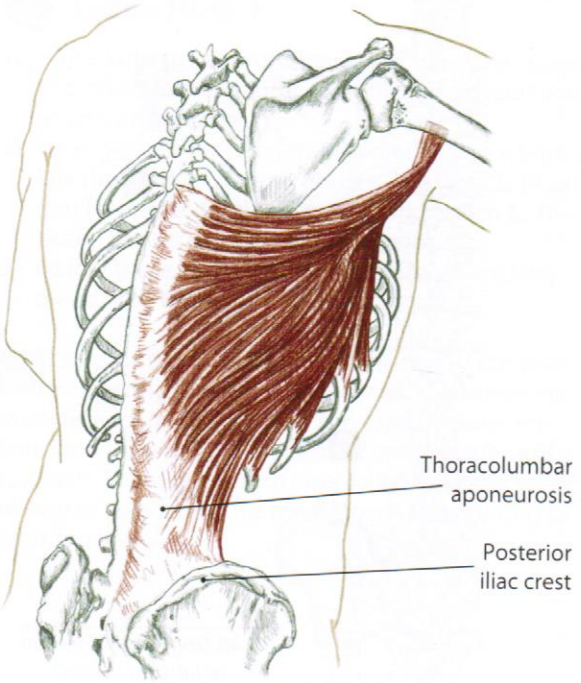
- *OK, not you—but when Lance Armstrong extends his neck over the handlebars of his bike*
- *Holding a phone between your shoulder and ear*
- *Carrying articles strapped across the shoulder (luggage, backpack, purse)*
- *Pulling shoulders posteriorly in a military fashion*

Latissimus Dorsi and Teres Major

The **latissimus dorsi** is the broadest muscle of the back. Its thin, superficial fibers originate at the low back, ascend the side of the trunk and merge into a thick bundle at the axilla (2.46). Both ends of the latissimus dorsi are difficult to isolate; however, its middle portion next to the lateral border of the scapula is easy to grasp.

The **teres major** is called "lat's little helper" because it is a complete synergist with the latissimus dorsi (2.47). It is superficial and located along the scapula's lateral border between the latissimus dorsi and teres minor. Although they share names, the teres major and teres minor rotate the arm in opposite directions—the major medially, the minor laterally.

The latissimus dorsi and teres major are sometimes called the "handcuff muscles," since their actions collectively bring the arms into the "arresting" position!



2.46 Lateral/posterior view of latissimus dorsi

Latissimus Dorsi

A **Extend** the shoulder (glenohumeral joint)

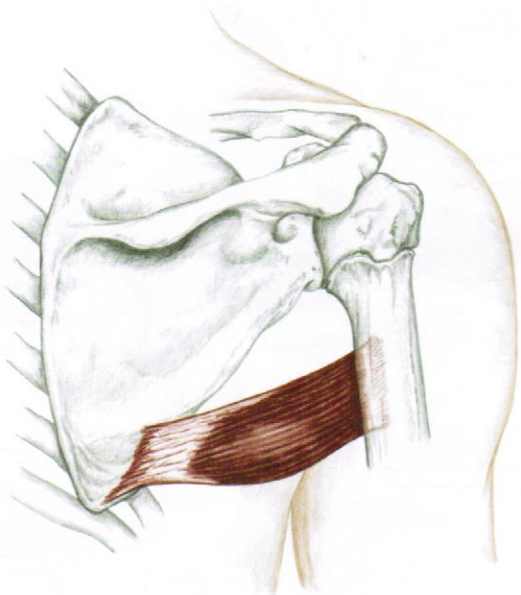
Adduct the shoulder (G/H joint)

Medially rotate the shoulder (G/H joint)

O Inferior angle of scapula, spinous processes of last six thoracic vertebrae, last three or four ribs, thoracolumbar aponeurosis and posterior iliac crest

I Intertubercular groove of the humerus

N Thoracodorsal C**6**, **7**, **8**



2.47 Posterior view of teres major

Teres Major

A **Extend** the shoulder (glenohumeral joint)

Adduct the shoulder (G/H joint)

Medially rotate the shoulder (G/H joint)

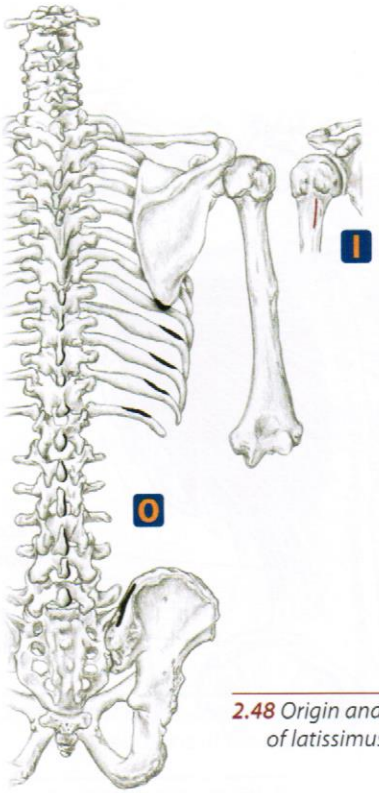
O Inferior angle and lower one-third of lateral border of the scapula

I Crest of the lesser tubercle of the humerus

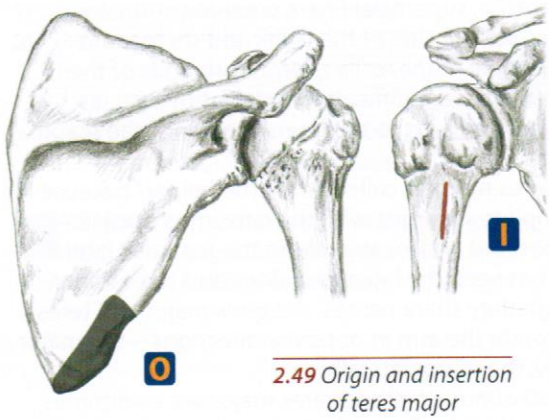
N Lower subscapular C5, **6**, 7

The latissimus dorsi not only moves the arm, but, because of its broad origin, can also affect the trunk and spine. Contraction of the left latissimus dorsi assists in lateral flexion of the trunk to the left. If the arm is fixed, as when hanging from a bar, the latissimus will assist in extension of the spine and tilting of the pelvis anteriorly and laterally.

latissimus dorsi	la-**tis**-i-mus **dor**-si	L. widest of the back
teres	**teh**-reez	L. rounded, finely shaped



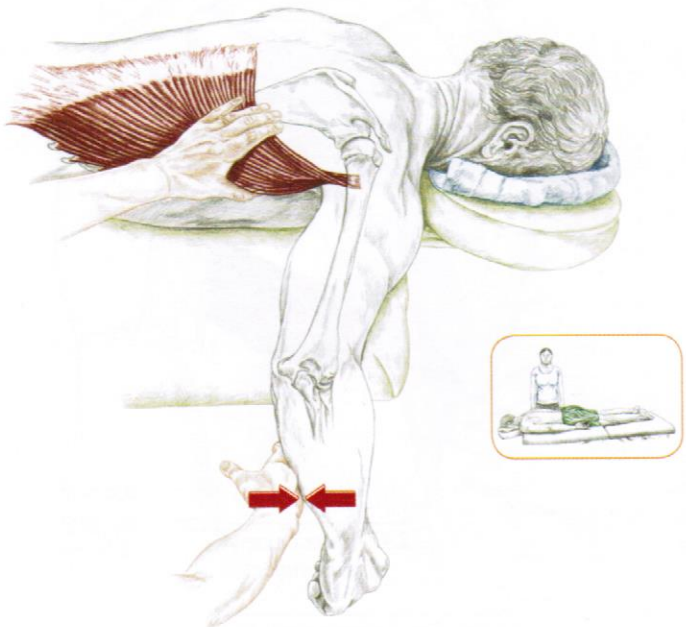
2.48 Origin and insertion of latissimus dorsi



2.49 Origin and insertion of teres major

When Do You Use Your Lat & Teres Major

- *Steering a kayak with a paddle*
- *Unzipping the back of your dress*
- *Walking with crutches*
- *Climbing up a rope when storming a castle*



2.50 Partner prone, medially rotating at the shoulder

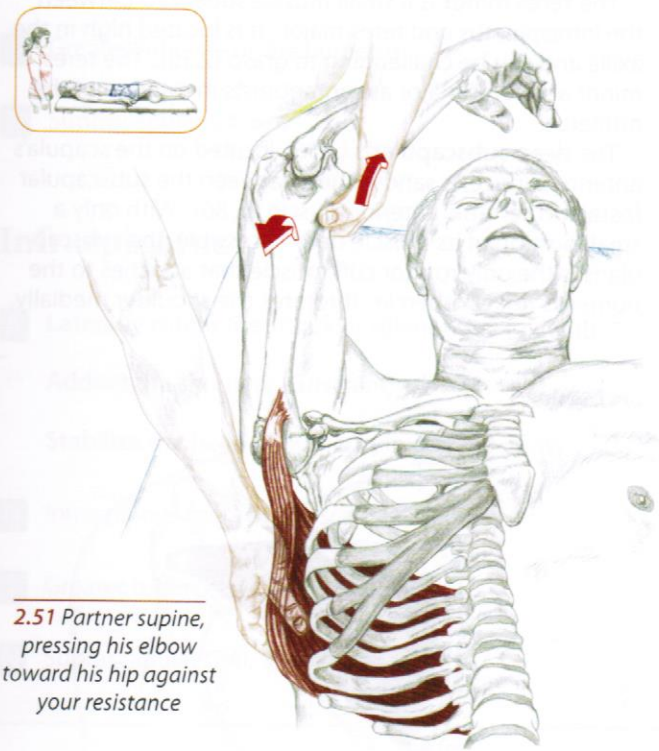
Latissimus dorsi

1) Prone with the arm off the side of the table. Locate the scapula's lateral border.
2) Using your fingers and thumb, grasp the thick wad of muscle tissue lateral to the lateral border. This is the latissimus dorsi (and perhaps some of teres major). Note how this muscle tissue flares off the side of the trunk.
3) Feel the latissimus fibers contract by asking your partner to medially rotate his shoulder against your resistance, "Swing your hand up toward your hip." (2.50) As this occurs, follow the latissimus fibers superiorly into the axilla and inferiorly on the ribs.

To ensure you are not just lifting the skin, grasp the tissue and let it slowly slip out between your fingers. Do you feel the muscle's fibrous texture or just the skin's jellylike quality?

Latissimus dorsi

1) With your partner supine, cradle the arm in a flexed position. Then grasp the tissue of the latissimus located beside the lateral border.
2) Ask your partner to extend his shoulder against your resistance, "Press your elbow toward your hip." This will force the latissimus to contract (2.51).



2.51 Partner supine, pressing his elbow toward his hip against your resistance

Teres major

1) Prone with the arm off the side of the table. Locate and grasp the latissimus dorsi fibers between your fingers and thumb.
2) Move your fingers and thumb medially to where you feel the scapula's lateral border. The muscle fibers that lie medial to the latissimus and attach to the lateral border will be the teres major.
3) Follow these fibers toward the axilla where they blend with the latissimus dorsi.

Lay your thumb on the inferior aspect of the lateral border and have your partner medially rotate the shoulder joint to distinguish the teres major from the latissimus dorsi (2.52). The fibers of both muscles will contract. Those that attach directly to the lateral border belong to teres major; the more lateral fibers belong to latissimus dorsi.

2.52 Partner prone, medially rotating at the shoulder

Rotator Cuff Muscles

Supraspinatus
Infraspinatus
Teres Minor
Subscapularis

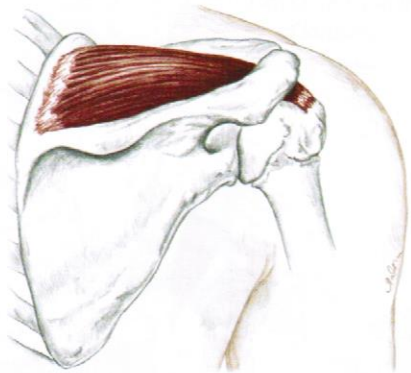
Supraspinatus, infraspinatus, teres minor and subscapularis are known as the rotator cuff muscles. Together they encompass, and therefore stabilize, the glenohumeral joint. All of the rotator cuff muscles are accessible, including their tendons, which attach to the head of the humerus.

The chunky **supraspinatus** is located in the supraspinous fossa, deep to the trapezius' upper fibers. Its belly runs underneath the acromion and attaches to the humerus' greater tubercle (2.53). The supraspinatus assists the deltoid with abduction of the shoulder and is the only muscle of the group not involved in shoulder rotation.

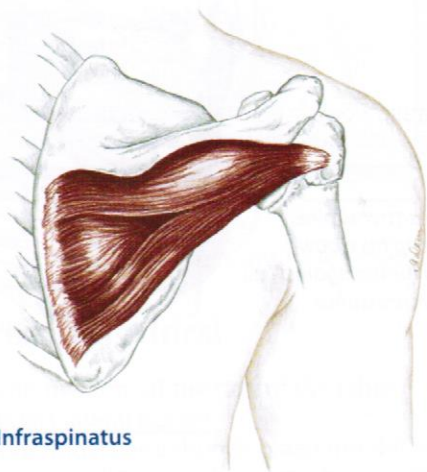
The flat, convergent belly of the **infraspinatus** is located in the infraspinous fossa. Most of its belly is superficial with a medial portion deep to the trapezius and a lateral portion beneath the deltoid (p. 67). The infraspinatus attaches immediately posterior to the supraspinatus on the greater tubercle (2.54) and is a synergist with the teres minor in lateral rotation of the shoulder. The unique, dense quality of the infraspinatus muscle is due to its multipennate fibers and thick, superficial fascia.

The **teres minor** is a small muscle squeezed between the infraspinatus and teres major. It is located high in the axilla and can be challenging to grasp (2.55). The teres minor and teres major are antagonists in rotation of the humerus.

The deep **subscapularis** (2.56), located on the scapula's anterior surface, is sandwiched between the subscapular fossa and serratus anterior muscle (p. 86). With only a small portion of its muscle belly accessible, the subscapularis is the only rotator cuff muscle that attaches to the humerus' lesser tubercle. It rotates the shoulder medially.

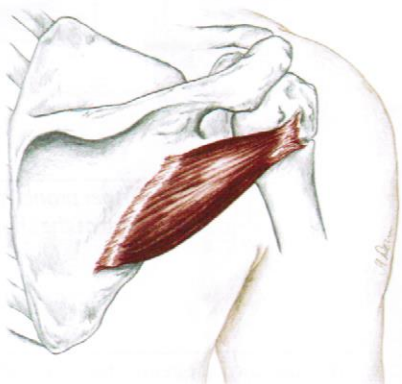


Supraspinatus

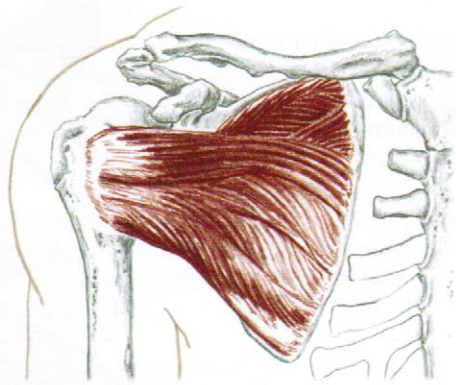


Infraspinatus

2.53, 2.54, 2.55
Posterior views of right shoulder



Teres minor



Subscapularis

2.56 Anterior view of right shoulder with ribs removed

infraspinatus	**in**-fra-spi-**na**-tus
subscapularis	sub-**skap**-u-**lar**-is
supraspinatus	**soo**-pra-spi-**na**-tus

Supraspinatus

A **Abduct** the shoulder (glenohumeral joint)

Stabilize the head of humerus in glenoid cavity

O Supraspinous fossa of the scapula

I Greater tubercle of the humerus

N Suprascapular C4, **5**, **6**

Infraspinatus

A **Laterally rotate** the shoulder (glenohumeral joint)

Adduct the shoulder (G/H joint)

Stabilize the head of humerus in glenoid cavity

O Infraspinous fossa of the scapula

I Greater tubercle of the humerus

N Suprascapular C(4), **5**, **6**

Teres Minor

A **Laterally rotate** the shoulder (glenohumeral joint)

Adduct the shoulder (G/H joint)

Stabilize the head of humerus in glenoid cavity

O Upper two-thirds of lateral border of the scapula

I Greater tubercle of the humerus

N Axillary C**5**, **6**

Subscapularis

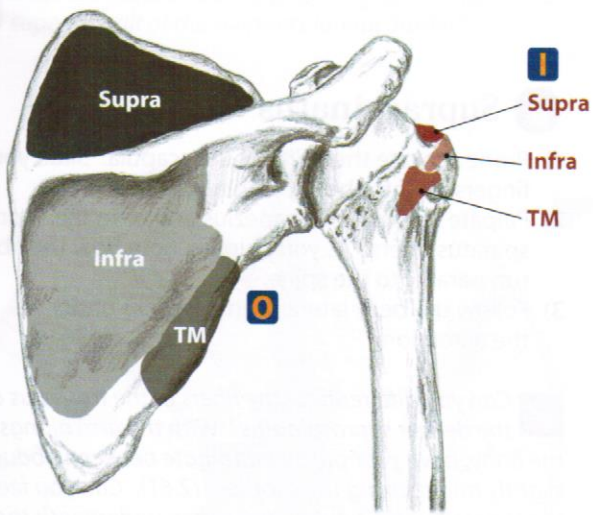
A **Medially rotate** the shoulder (glenohumeral joint)

Stabilize the head of humerus in glenoid cavity

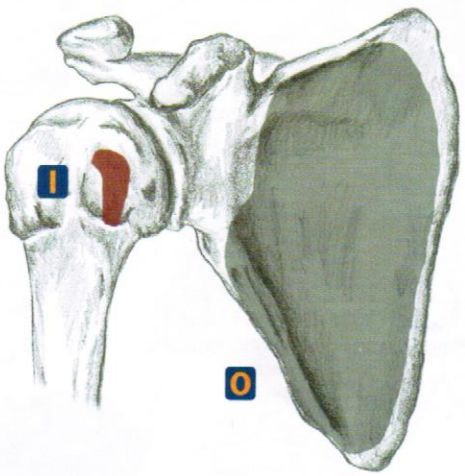
O Subscapular fossa of the scapula

I Lesser tubercle of the humerus

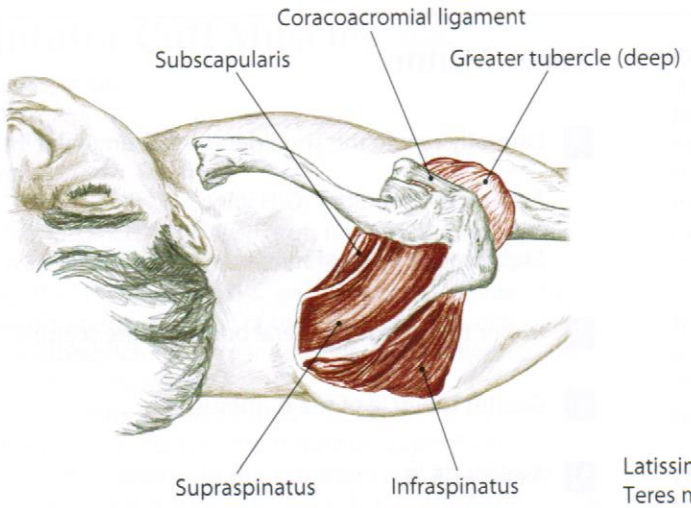
N Upper and lower subscapular C**5**, **6**, 7



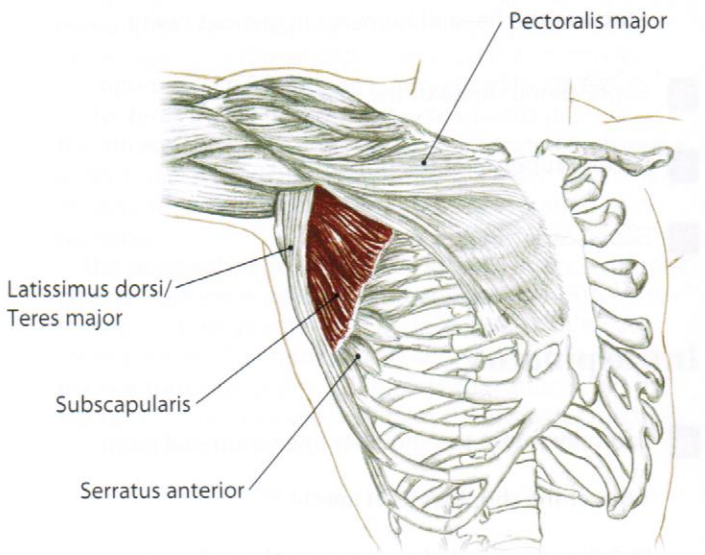
2.57 Posterior view of right shoulder showing origins and insertions of supraspinatus, infraspinatus and teres minor



2.58 Anterior view of right shoulder showing origin and insertion of subscapularis



2.59 Superior view of right shoulder



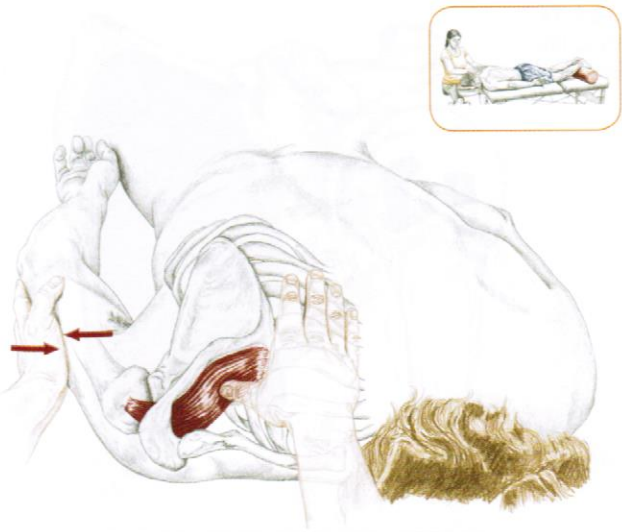
2.60 Lateral/inferior view of axilla

When Do You Use Your Rotator Cuff?

Supraspinatus
- *Conducting an orchestra*
- *Installing ceiling tiles overhead*

Infraspinatus/Teres Minor
- *Starting a pull-cord lawnmower*
- *Fanning a smoke-filled room with your arms*

Subscapularis
- *Reaching your hand around to scratch your back*
- *Clutching* Trail Guide to the Body *to your chest*



2.61 Partner prone, alternately abducting and relaxing his shoulder to feel the supraspinatus contract

Supraspinatus

1) Prone. Locate the spine of the scapula. Slide your fingers up into the supraspinous fossa.
2) Palpate through the trapezius and onto the supraspinatus fibers. As you palpate, note how the fibers run parallel to the spine.
3) Follow the belly laterally until it tucks under the acromion.

☑ *Can you differentiate the fibers of the trapezius and the deeper supraspinatus? With the arm alongside the body, have your partner alternate between abducting slightly and relaxing the shoulder (2.61). Can you feel the supraspinatus tighten and soften underneath the inactive trapezius?*

Infraspinatus

1) Prone, with the forearm off the side of the table. Locate the spine, medial border and lateral border of the scapula.
2) Form a triangle around the infraspinatus by laying a finger along each of these landmarks.
3) Palpate in the triangle and strum across the infraspinatus fibers. Follow them laterally as they converge underneath the deltoid to attach to the humerus.

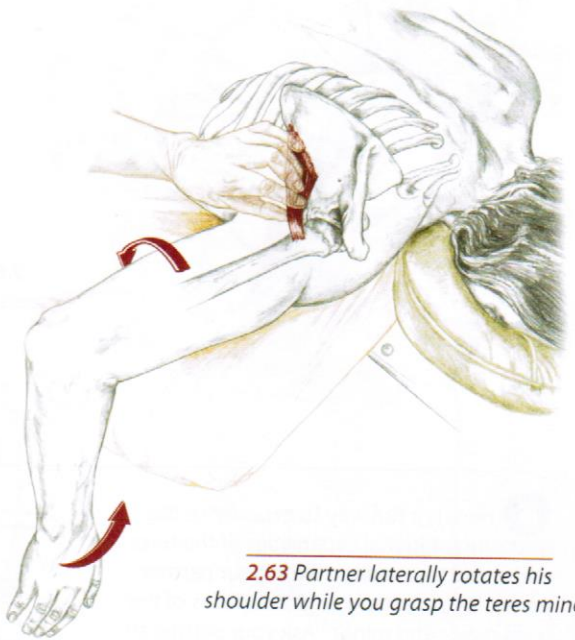
With the forearm off the side of the table, ask your partner to alternately raise his elbow one inch toward the ceiling and relax (2.62). Do you feel the infraspinatus contract and tighten?

2.62 *Partner prone, raising his elbow while you palpate the infraspinatus*

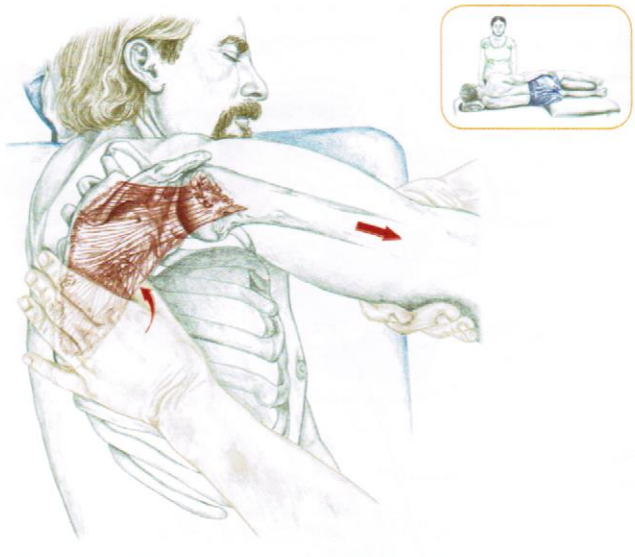
Teres minor

1) Prone, with the arm off the side of the table. Locate the lateral border of the scapula, specifically, its superior half. Slide laterally off the lateral border onto the surface of the teres minor.
2) Compress into and across its tube-shaped belly. Move inferiorly and compare it in size to the teres major. Also, reach your thumb up into the axilla and grasp the belly of the teres minor as you would a hamburger (2.63).
3) Ask your partner to laterally rotate his shoulder. "Swing your hand up toward your head." Bringing the elbow toward the ceiling also forces the teres minor to contract.

Does the muscle you are palpating attach along the superior half of the scapula's lateral border?



2.63 *Partner laterally rotates his shoulder while you grasp the teres minor*



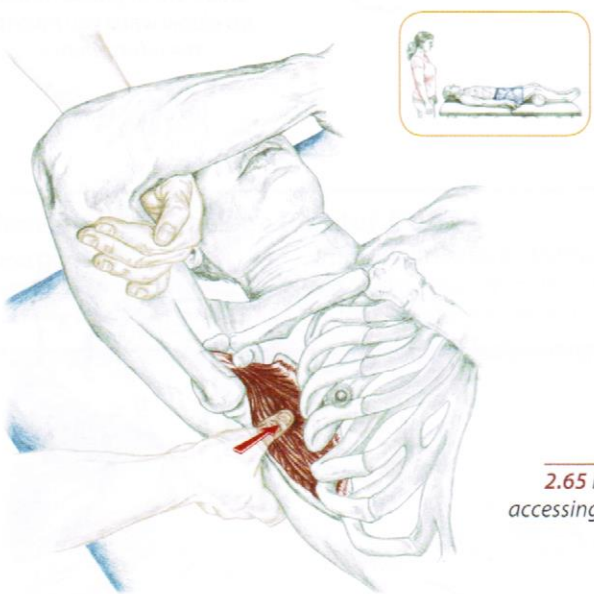
2.64 *Partner side lying, accessing the subscapularis*

Subscapularis

1) Side lying. Flex the shoulder and pull the arm anteriorly as much as possible. This will allow easier access to the scapula's anterior surface.
2) Hold the arm with one hand while the thumb of the other locates the lateral border. Hint: Slide your thumb underneath the latissimus dorsi and teres major fibers instead of going through them (2.64).
3) Slowly and gently curl your thumb onto the subscapular fossa. You might not feel the subscapularis fibers immediately, but if your thumb is on the anterior surface of the scapula, you will be accessing a portion of the fibers.

Ask your partner to gently rotate his shoulder medially. Can you feel the subscapularis fibers contract beneath your thumb? Explore the subscapularis by moving your thumb more superiorly or inferiorly.

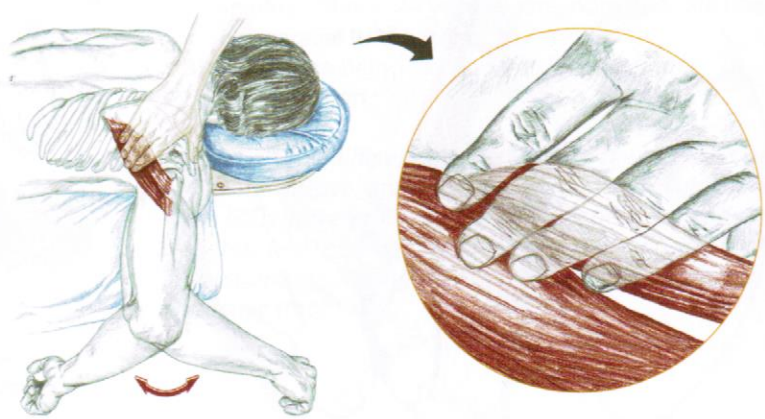
Supine. Cradle the arm in a flexed position and locate the lateral border. Slowly sink your thumbpad onto the subscapular fossa, adjusting the arm and scapula as you progress (2.65).



2.65 *Partner supine, accessing the subscapularis*

Here is a fun way to experience the opposite rotational capabilities of the teres major and teres minor. With your partner prone, lay your hand on the surfaces of the teres major and minor. Ask your partner to alternately medially and laterally rotate his arm. (Be sure he does not raise his elbow, because then they both contract.)

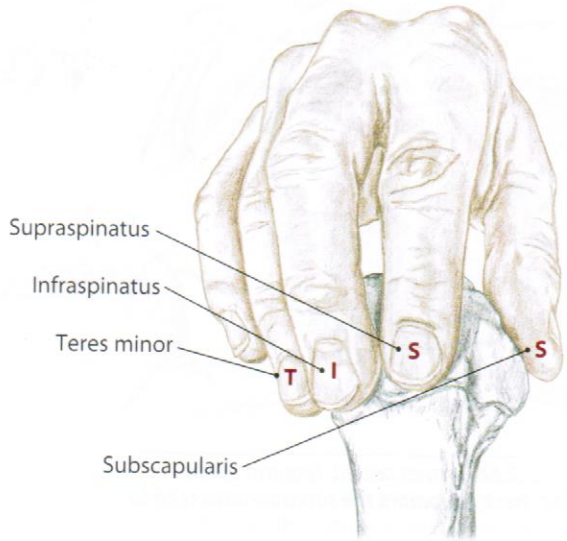
Can you feel the teres major contract while the teres minor softens upon medial rotation? Vice versa for lateral rotation?



Rotator Cuff Tendons

The tendons of the rotator cuff muscles can be difficult to access in anatomical position (2.66). The supraspinatus and infraspinatus tendons are situated deep to the acromion, while the tendons of the subscapularis and teres minor lie deep to the thick belly of the deltoid.

This dilemma can be overcome, however, and the individual tendons isolated by placing the humerus in the positions outlined below. Since the rotator cuff tendons lie against the surface of the greater or lesser tubercles of the humerus, they cannot be separated from the underlying bone.

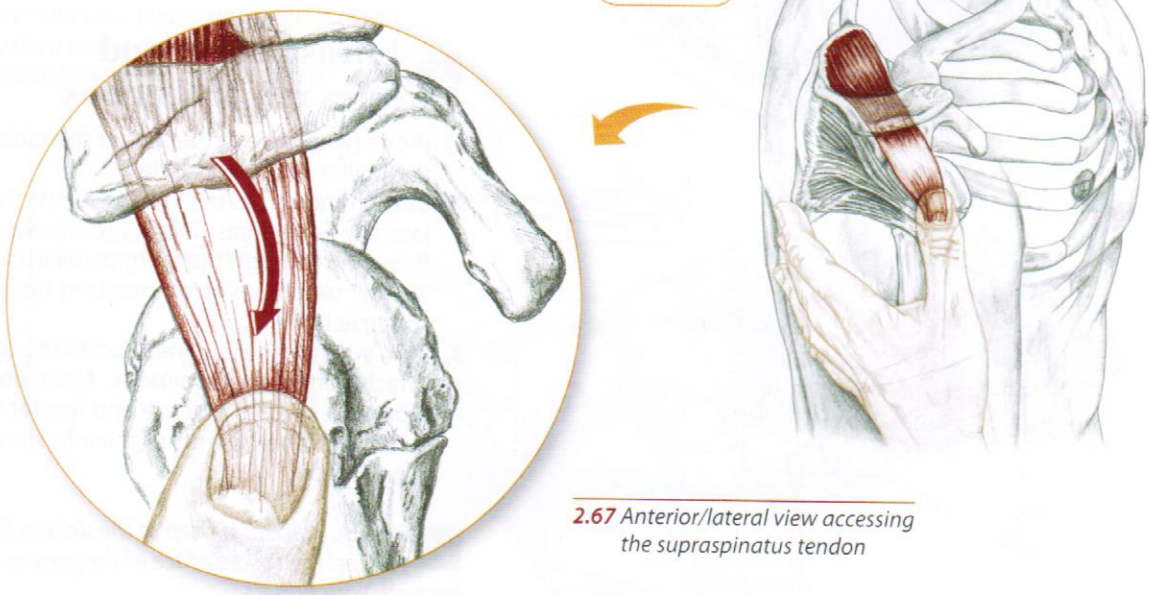


2.66 Anterior/lateral view of rotator cuff tendon attachment sites

Supraspinatus tendon

1) The attachment of the tendon will be located just distal to the acromion on the greater tubercle.
2) Supine or seated, with the arm at the side of the body. Locate the acromion and slide inferiorly onto the surface of the greater tubercle (2.67). Between these two landmarks will be a palpable portion of the tendon.
3) Sink your thumb tip through the deltoid fibers. Using firm pressure, roll your thumb across the small mound of the supraspinatus tendon.

Are you palpating on the surface of the greater tubercle or on the superficial deltoid fibers?



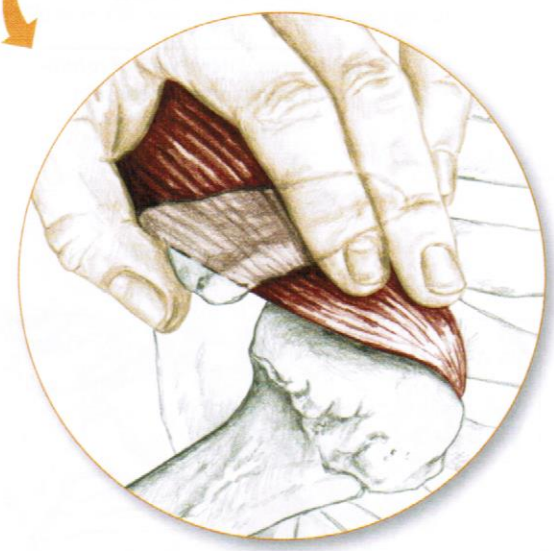
2.67 Anterior/lateral view accessing the supraspinatus tendon

2.68 *Partner seated, forearm behind her back, palpating the supraspinatus tendon*

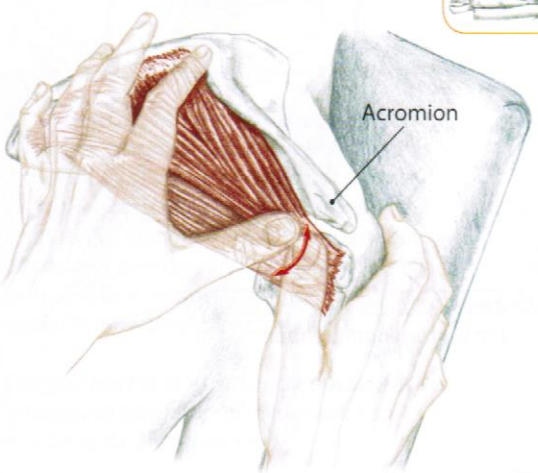
Supraspinatus tendon

1) Seated. Place your partner's arm behind her back. This position will medially rotate and extend the humerus.
2) Passively extend the arm as far as is comfortable for your partner (2.68). This position brings the supraspinatus tendon out from under the acromion, just anterior and inferior to the acromioclavicular (A/C) joint.

Is the arm medially rotated and extended as far as comfortably possible? Are you palpating inferior to the A/C joint?



The supraspinatus was long thought to be a mere "spark plug" for shoulder abduction, initiating the movement before the stronger deltoid took over. Research shows, however, that the supraspinatus contracts through the full movement of abduction and can single-handedly bring the arm to 90°.



2.69 *Partner prone, palpating the infraspinatus and teres minor tendons*

Infraspinatus and teres minor tendons

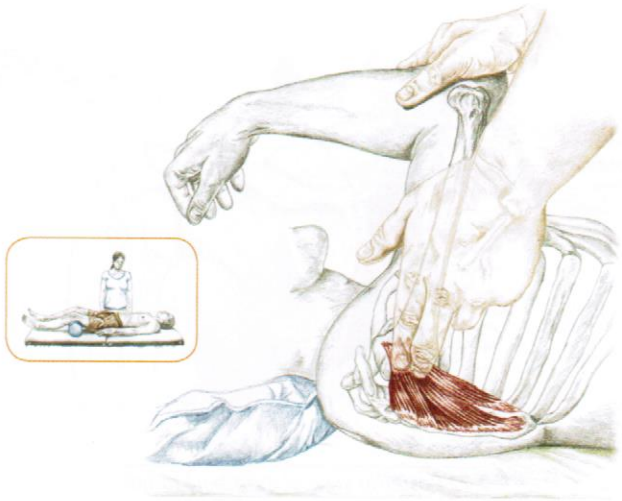
1) Prone (with arm off the side of the table). Locate the bellies of these muscles.
2) Strumming across their fibers, follow their bellies laterally as they pass inferior to the acromion. Palpating through the deltoid, roll across their slender tendinous attachments at the greater tubercle (2.69).
3) Turn your partner supine. Locate the tendinous attachment of supraspinatus. Move posteriorly along the greater tubercle and feel for the small tendinous attachments of the infraspinatus and teres minor.

Are you palpating deep to the deltoid fibers? Do you feel the solid surface of the greater tubercle beneath your fingers?

Infraspinatus and teres minor tendons

1) Supine or seated. Flex the shoulder to 90°. Then horizontally adduct and laterally rotate slightly (10–20°).
2) Although deep to the posterior deltoid, this position causes the infraspinatus tendon to move below the acromion and be accessible (2.70).
3) Locate the acromial angle. Drop inferiorly off the angle and explore this region.

Is the shoulder flexed, adducted and laterally rotated? Do you feel the solid surface of the greater tubercle beneath your fingers? Return the arm to a neutral position and notice how the posterior humerus slides back under the acromion.

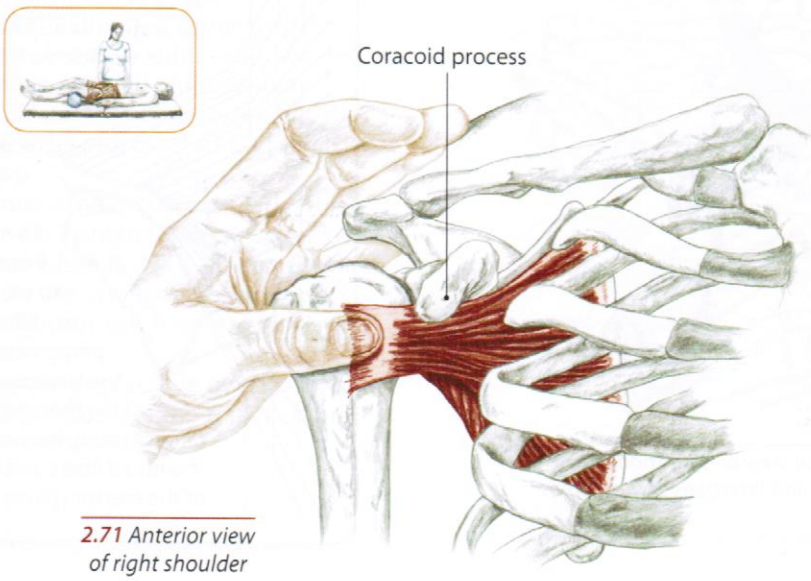


2.70 Lateral view of right shoulder, accessing the infraspinatus and teres minor tendons

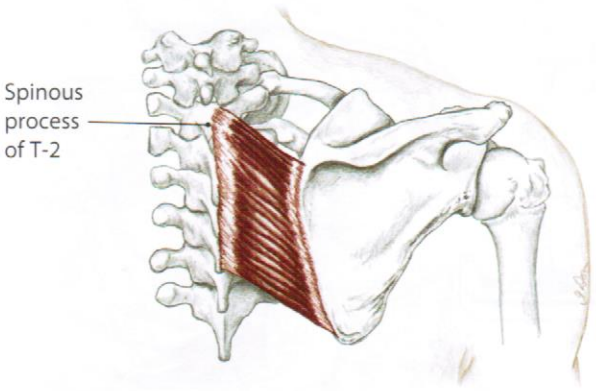
Subscapularis tendon

1) Seated or supine. Place the arm next to the trunk in anatomical position.
2) Locate the coracoid process of the scapula. Slide one inch inferiorly and laterally from the coracoid. You will be between the two tendons of the biceps brachii.
3) Palpate through the deltoid fibers, exploring the deeper tissue which lies along the lesser tubercle of the humerus (2.71). This is the location of the subscapularis tendon. Explore for more of the tendon by moving medially off the lesser tubercle.

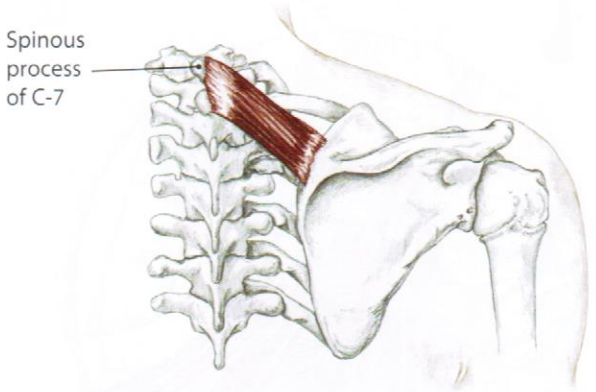
Is the arm positioned next to the body? Are you palpating deep to the deltoid fibers? Can you feel the solid surface of the lesser tubercle?



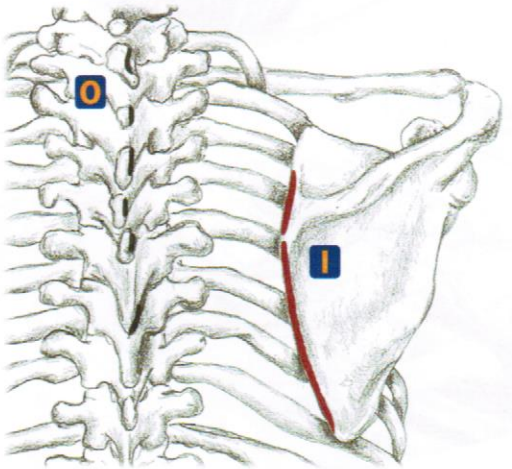
2.71 Anterior view of right shoulder



2.72 *Posterior view of rhomboid major*



2.73 *Posterior view of rhomboid minor*



2.74 *Posterior view of right shoulder showing origins and insertions of rhomboids*

Rhomboid Major and Minor

DVD

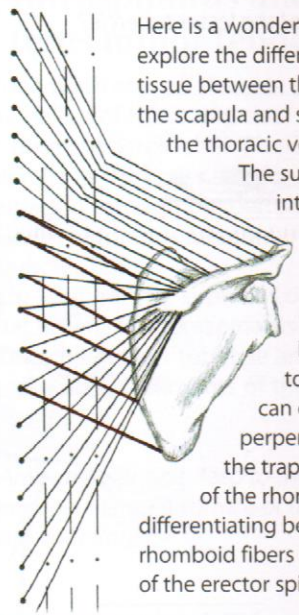
The rhomboid muscles are located between the scapula and vertebral column. Named for their geometric shape, the major (2.72) is larger than the minor (2.73). The muscles are difficult to distinguish individually. They have thin fibers that lie deep to the trapezius and superficial to the erector spinae muscles (p. 196).

A **Adduct** the scapula (scapulothoracic joint)
Elevate the scapula (S/T joint)
Downwardly rotate the scapula (S/T joint)

O *Major:*
Spinous processes of T-2 to T-5
Minor:
Spinous processes of C-7 and T-1

I *Major:*
Medial border of the scapula between the spine of the scapula and inferior angle
Minor:
Upper portion of medial border of the scapula, across from spine of the scapula

N Dorsal scapular C4, **5**



Here is a wonderful opportunity to explore the different layers of muscle tissue between the medial border of the scapula and spinous processes of the thoracic vertebrae. The superficial trapezius, intermediate rhomboids and deep erector spinae muscles all have different fiber directions. Palpate in this area to see whether you can differentiate the perpendicular fibers of the trapezius from those of the rhomboids. Also try differentiating between the diagonal rhomboid fibers and the vertical fibers of the erector spinae.

rhomboid **rom**-boyd Grk. in geometry, a parallelogram with oblique angles and only the opposite sides equal

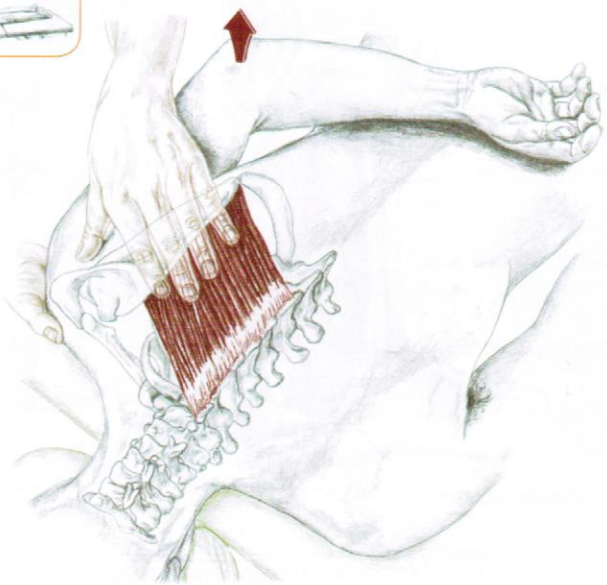
Rhomboids

1) Prone. Locate the scapula's medial border and the spinous processes of C-7 through T-5 (p. 178).
2) Palpating through the thin trapezius, explore the area you have identified and strum vertically across the fibers of the rhomboids. Palpate all sides of the rhomboids. On some individuals you can press your fingers into the lower border of the rhomboid major and locate its edge.

Are you deep to the trapezius fibers? Do the fibers you are palpating run at an oblique angle? Place your partner's hand in the small of his back and ask him to slightly raise his elbow toward the ceiling (2.75). Although this action will engage the superficial trapezius, can you feel the deeper rhomboids contract?

When Do You Use Your Rhomboids?

- *Sticking out your chest (pressing the scapulae together)*
- *Shrugging your shoulders when uncertain*
- *Squeezing through the entrance of a small cave*



2.75 Partner prone, raising his elbow toward the ceiling

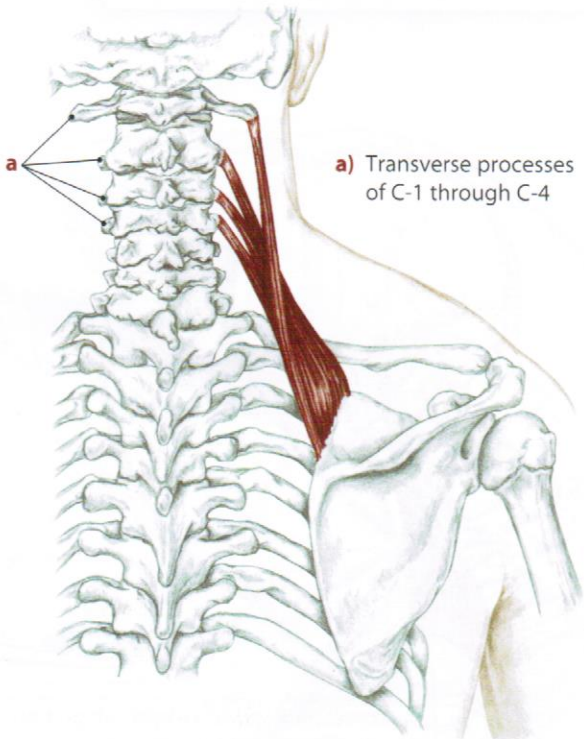
Levator Scapula

The levator scapula is located along the lateral and posterior sides of the neck. Its inferior portion is deep to the upper trapezius; however, as the levator ascends the lateral side of the neck, its fibers come out from under the trapezius and become superficial (2.77). Its belly is approximately two fingers wide with fibers that naturally twist around themselves (2.76).

The levator scapula attaches to the transverse processes of the cervical vertebrae (p. 180). Located on the lateral side of the neck, all of these small protuberances extend laterally at approximately the same width, except for the processes of C-1 which are broader.

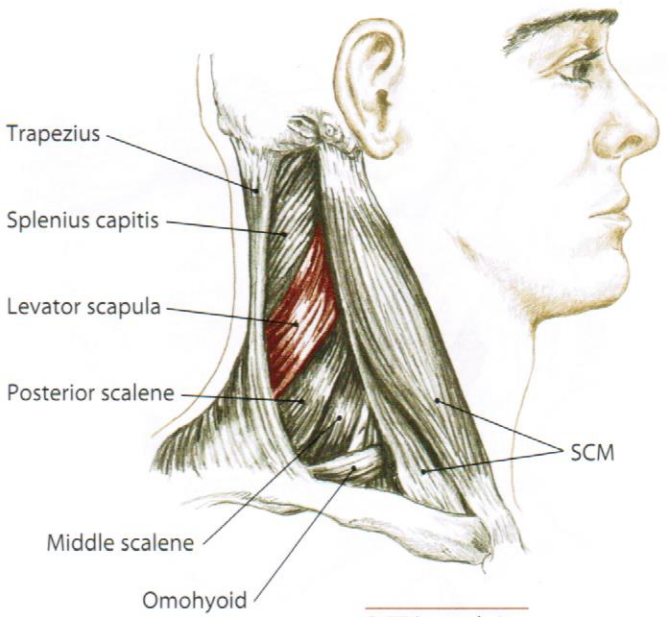
The brachial plexus, a large group of nerves which innervates the arm, exits from the transverse processes of the cervical vertebrae (see p. 274). When accessing the processes to locate the origin of the levator scapula, begin by using your soft fingerpads to avoid compressing a nerve.

The levator is completely accessible by palpating either through the upper fibers of the trapezius or directly from the side of the neck.



2.76 Posterior view of levator scapula

levator leh-**va**-tor L. lifter



2.77 Lateral view

Levator scapula

A *Unilaterally:*

Elevate the scapula (scapulothoracic joint)

Downwardly rotate the scapula (S/T joint)

Laterally flex the head and neck

Rotate the head and neck to the same side

Bilaterally:

Extend the head and neck

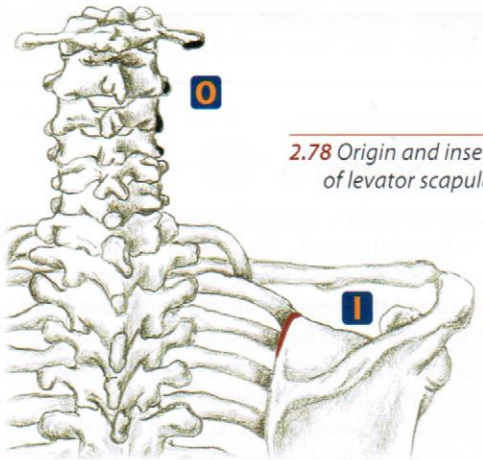
O Transverse processes of first through fourth cervical vertebrae

I Medial border of scapula, between superior angle and superior portion of spine of scapula

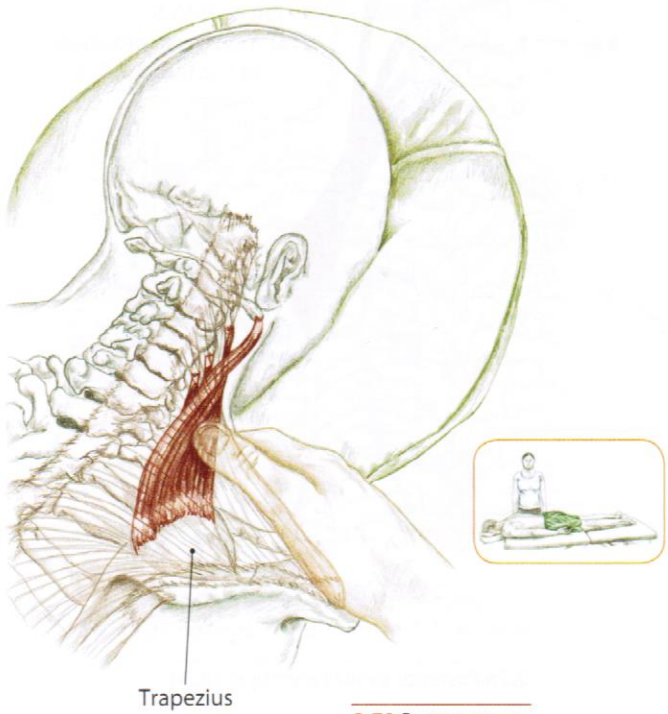
N Cervical **3**, **4**, and Dorsal scapular C**4**, **5**

When Do You Use Your Levator?

- *Rotating head when changing lanes in traffic*
- *Holding a phone between your ear and shoulder*
- *Lying on your side, snuggling your head into your pillow*



2.78 Origin and insertion of levator scapula



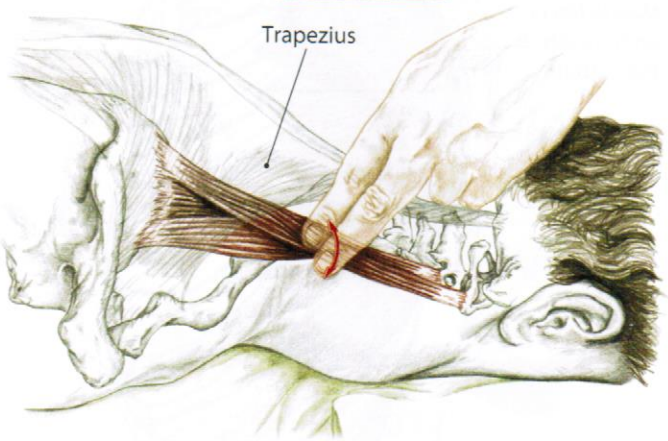
2.79 Partner prone

1) Prone, supine or side lying. Palpating through the trapezius, locate the superior angle of the scapula (p. 53) and the upper region of the medial border.
2) Place your fingers just off the superior angle and firmly strum across the belly of the levator. The fibers will likely have a ropy texture (2.79).
3) Follow these fibers superiorly as they extend to the lateral side of the neck to the transverse processes of the cervical vertebrae (p. 180).

Can you differentiate the levator fibers from the trapezius fibers? Do the fibers you are palpating lead toward the lateral side of the neck?

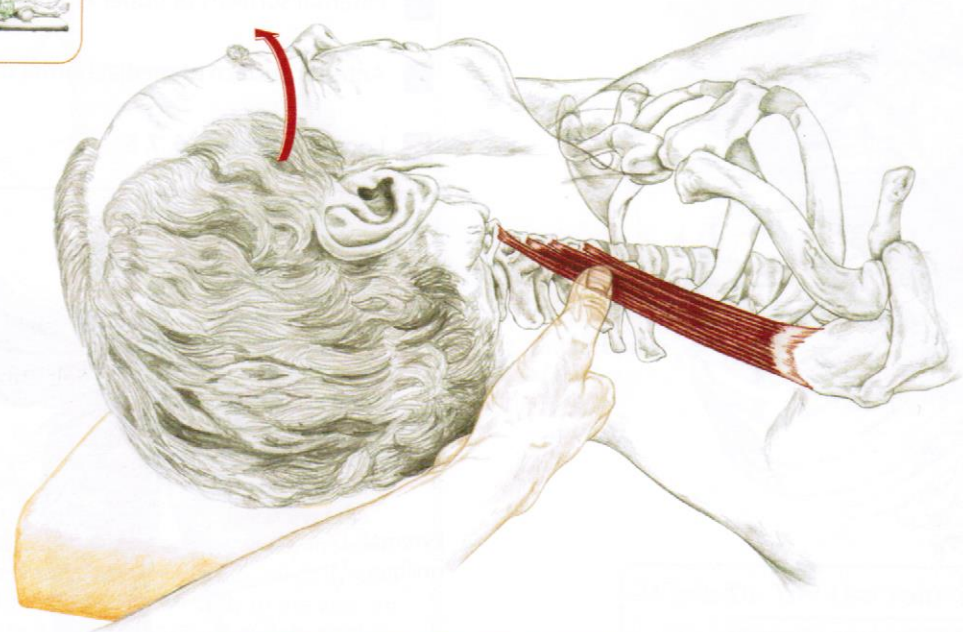
Here is an alternate route for palpating the levator's superficial fibers on the lateral side of the neck.

1) Prone, supine or side lying. Locate the upper fibers of the trapezius.
2) Roll two fingers anteriorly off the trapezius and press into the tissue of the neck.
3) Gently strum your fingers anteriorly and posteriorly across the levator fibers (2.80). Often you will feel a distinct band of tissue that leads superiorly toward the lateral neck and inferiorly under the trapezius.
4) Place your fingertips on the levator and ask your partner to alternately elevate and relax his scapula. Do you feel the levator scapula contract and relax beneath your fingertips?

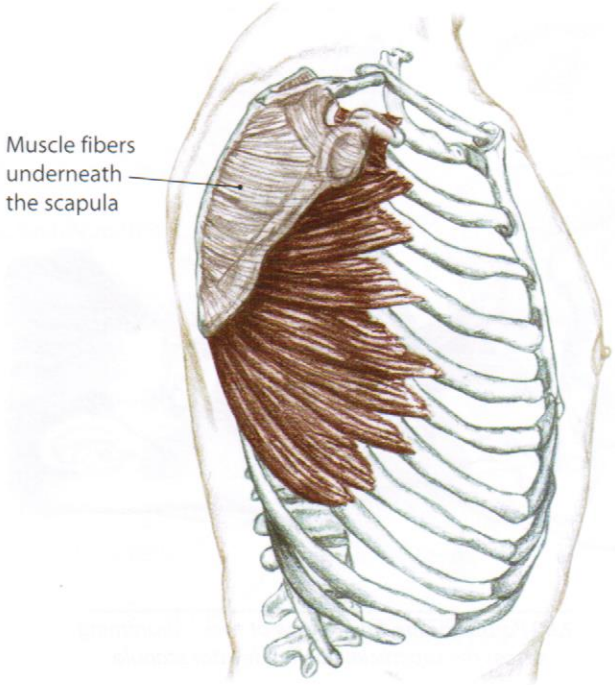


2.80 *Partner prone, lateral view of neck. Strumming across the superficial fibers of levator scapula.*

The levator scapula is situated between the splenius capitis and posterior scalene muscles on the lateral side of the neck (2.77). The levator can be distinguished from these neighboring muscles during palpation because it moves the scapula. No other muscle deep to the upper trapezius or attaching to the lateral cervical vertebrae is capable of this action.



2.81 *Partner supine. Passively rotating the head 45° away from the side you are palpating shifts the cervical transverse processes further anteriorly. Also, it gives the levator scapula more palpable tension. Conversely, this position shortens and softens the overlying trapezius fibers.*



2.82 *Lateral view of serratus anterior*

Serratus Anterior

Always well-developed on superheroes, the serratus anterior lies along the posterior and lateral rib cage. Its oblique fibers extend from the ribs underneath the scapula and attach to its medial border (2.82). Most of the serratus anterior is deep to the scapula, latissimus dorsi or pectoralis major; however, the portion of the serratus below the axilla (armpit) is superficial and easily accessible (2.84). This muscle is unique in its ability to abduct the scapula, making it an antagonist to the rhomboids.

Palpating along the sides of the ribs can tickle, so use slow, firm pressure. Also, if you are accessing the right serratus, it may be easier to stand on the left side of the table.

A *With the origin fixed:*

Abduct the scapula (scapulothoracic joint)

Upwardly rotate the scapula (S/T joint)

Depress the scapula (S/T joint)

Hold the medial border of the scapula against the rib cage

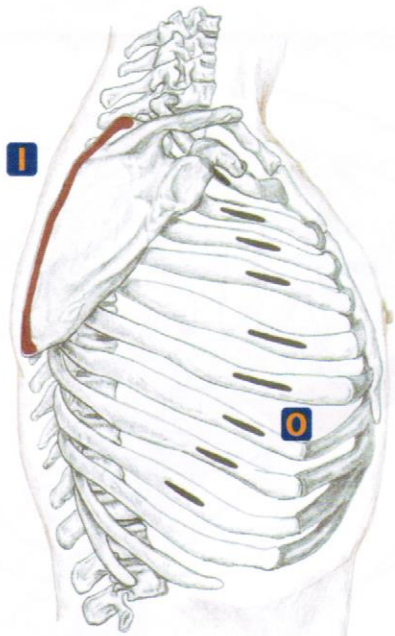
With the scapula fixed:

May act to **elevate** the thorax during forced inhalation

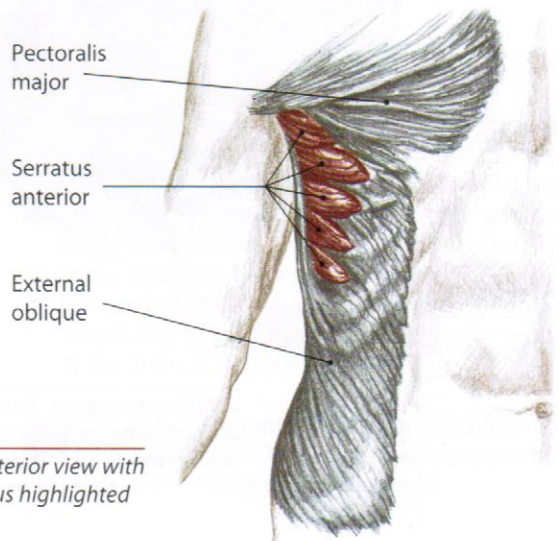
O External surfaces of upper eight or nine ribs

I Anterior surface of medial border of the scapula

N Long thoracic C**5**, **6**, **7**, 8



2.83 *Origin and insertion of serratus anterior*



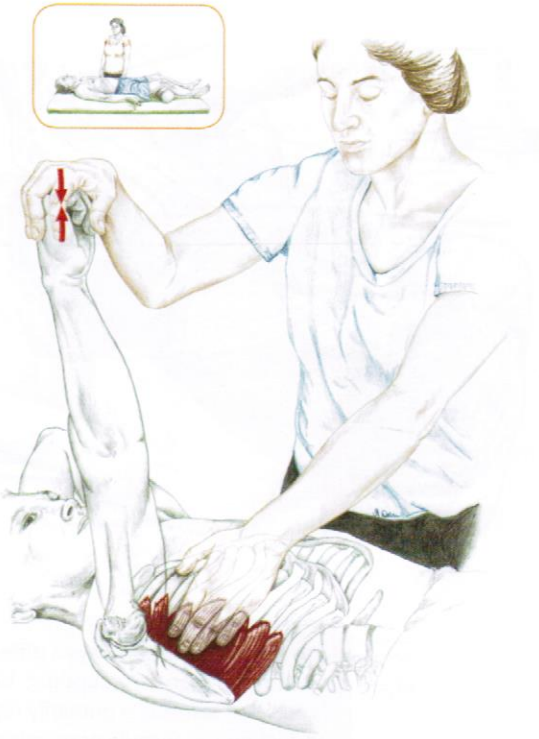
2.84 *Anterior view with serratus highlighted*

serratus ser-**a**-tus L. notched

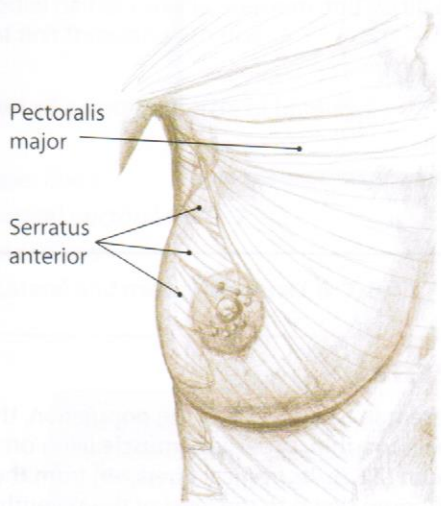
Serratus anterior

1) Supine. Isolate the location of the serratus by abducting the arm slightly and locating the lower edge of the pectoralis major (p. 89). Then locate the anterior border of the latissimus dorsi.
2) Place your fingerpads along the side of the ribs between the pectoralis major and latissimus dorsi.
3) Strum your fingers across the ribs and palpate for the serratus anterior fibers. To differentiate between the ribs and the serratus fibers (both have a similar "speed bump" shape), remember that the ribs are deep and have a solid texture while the serratus fibers are superficial and malleable.

To feel the serratus anterior contract (2.85): Ask your partner to flex his shoulder so his fist is raised toward the ceiling. Place one hand upon the serratus fibers and your other hand on top of his raised fist. Ask him to alternately abduct his scapula and relax. "Reach toward the ceiling and then relax." Do you feel the serratus fibers contract and soften? Can you follow the fibers along the ribs to where they tuck underneath the latissimus dorsi?



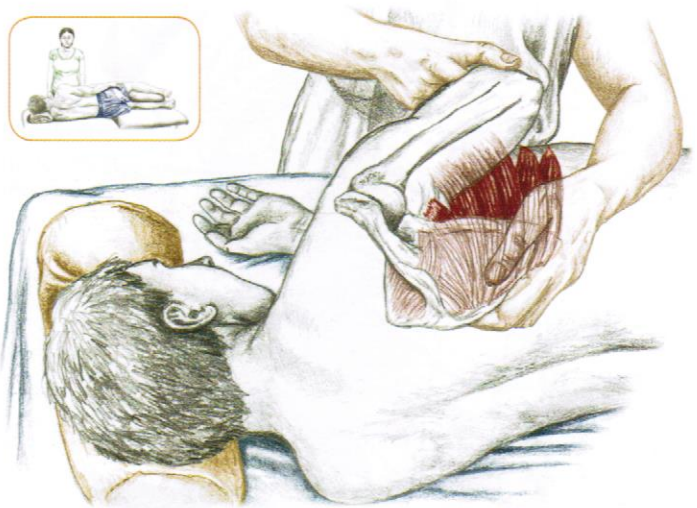
2.85 *Isolating the serratus while your partner reaches his hand toward the ceiling*



The breast is essentially made up of subcutaneous fat and is primarily supported by suspensory ligaments connecting the skin with the deep fascia over the pectoralis major. Although it varies widely in shape and size, the breast generally extends inferiorly from the second to the sixth ribs, medially to the sternum and laterally to the anterior axilla. Nearly two-thirds of the breast covers the pectoralis major while the inferior/lateral aspect covers the serratus anterior.

When Do You Use Your Serratus?

- *Doing a push-up*
- *Throwing a punch*
- *Pushing open a swinging door*

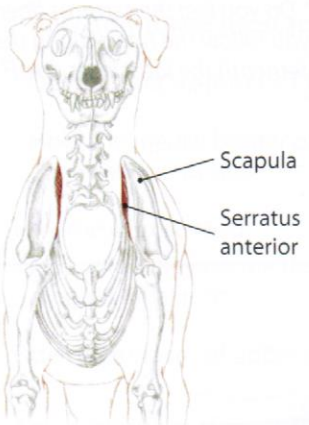


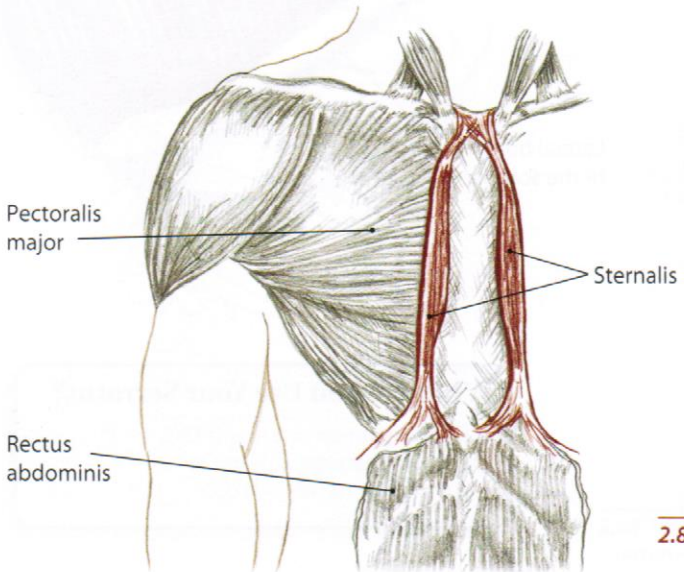
Turn your partner side lying with his arm at his side. Locate the medial border of the scapula to access the insertion of the serratus anterior. Curl your fingers beneath the medial border (and through the trapezius and rhomboid fibers) onto the beginnings of the subscapular fossa and explore the area where the serratus attaches (2.86).

2.86 Partner side lying, curling your fingers under the medial border of the scapula

The serratus anterior plays a different role on a quadruped than on an upright, bipedal human. For us, the serratus is primarily responsible for abducting the scapula or resisting a push against the shoulder.

But for a four-legged animal such as a dog (right, anterior view), which carries part of its body weight on its front legs, the serratus muscles ("serratus ventralis" in quadripeds) form a sling from the scapula to the thorax. This cradles and supports the weight of the trunk and stabilizes the limb against the thorax. Get down on your hands to do a pushup and you will see (and feel) how this position forces your serratus anterior muscles to function as a dog's would.





2.87 Anterior view

Sternalis

Present in roughly 5% of the population, the sternalis is a thin, superficial muscle lying on the sternum (2.87). Its vertical fibers run from the manubrium down to the level of the seventh costal cartilage. The function of the sternalis is unknown. Palpate the surface of your partner's sternum and explore for a sternalis.

Pectoralis Major

The pectoralis major is a broad, powerful muscle located on the chest. Except for the part beneath breast tissue, its convergent, superficial fibers are accessible. Pectoralis major is divided into three segments: the clavicular, sternal and costal fibers (2.88). The upper and lower fibers perform opposing actions at the shoulder joint—flexion and extension, respectively—making this muscle an antagonist to itself.

A *All fibers:*

Adduct the shoulder (glenohumeral joint)

Medially rotate the shoulder (G/H joint)

Assist to **elevate** the thorax during forced inhalation (with the arm fixed)

Upper fibers:

Flex the shoulder (G/H joint)

Horizontally adduct the shoulder (G/H joint)

Lower fibers:

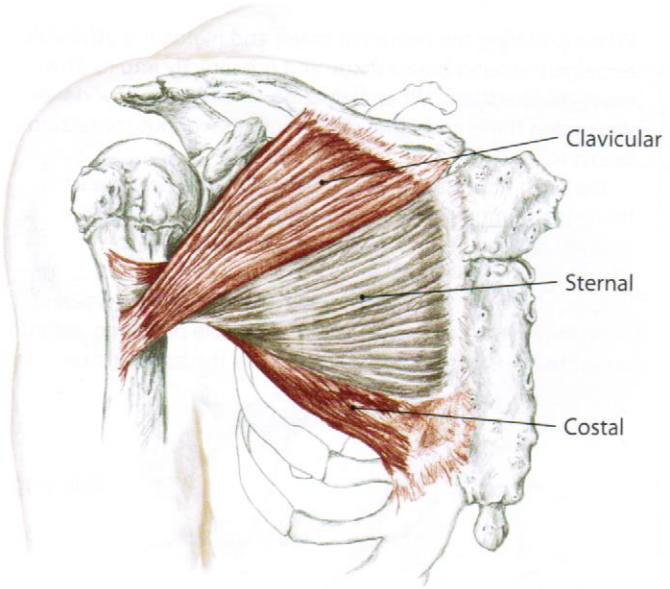
Extend the shoulder (G/H joint)

O Medial half of clavicle, sternum and cartilage of first through sixth ribs

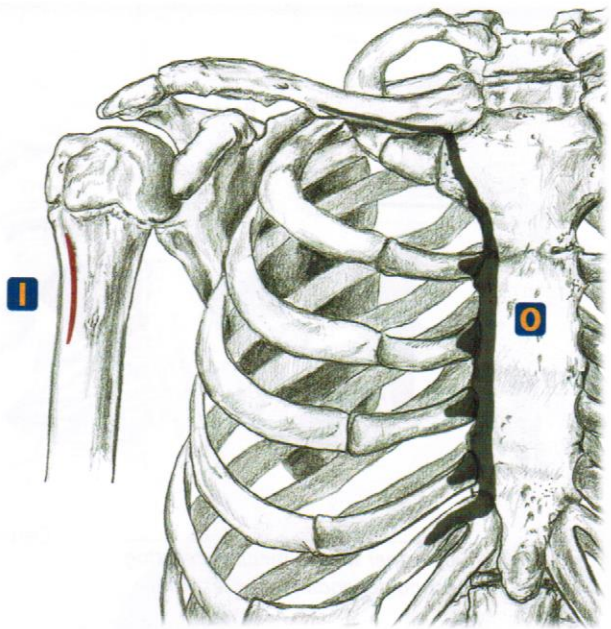
I Crest of greater tubercle of humerus

N *Upper fibers:*
Lateral pectoral C**5**, **6**, **7**
Lower fibers:
Lateral and medial pectoral C**6**, **7**, **8**, T**1**

The difference between the white and dark meat of a cooked bird is due to its different intramuscular connective tissues. Dark and white meat are present in all mammals, but are more distinct in birds. The reason is that light-colored musculature is rich in muscle fibers and poor in sarcoplasm—the tissue that surrounds the muscle fiber—while dark meat has the exact opposite composition. And if you are fond of the "breast," chew on this fact: a bird's pectoralis majors make up 20-35% of its body weight.



2.88 Anterior view identifying the three segments of pectoralis major



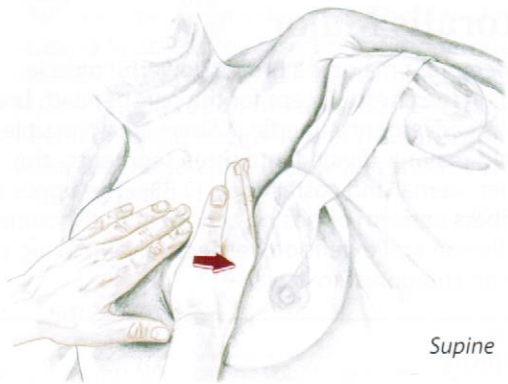
2.89 Origin and insertion of pectoralis major

pectoralis **pek**-to-**ra**-lis L. chest

When exploring the pectoralis major and minor, it is advisable to palpate around breast tissue and not directly into it. This raises the question, "When palpating on a female, how do you access these and other chest muscles without contacting breast tissue?"

The most important aspect when palpating near breast tissue is communicating your intentions to your partner. Also, encourage her to let you know if at any time she wishes to stop.

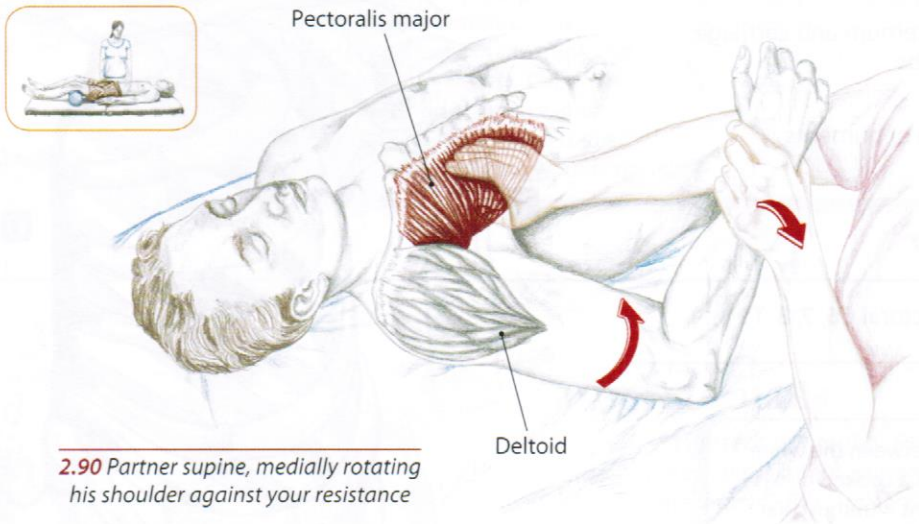
Assuming your partner is draped under a sheet or wearing a sports bra, the key to safe and comfortable palpation around breast tissue is positioning your client so the breast tissue will naturally shift away from where you are accessing. For instance, in a supine position (above), the breast will shift laterally, allowing easier access to the sternal and upper pectoral regions. In this position, however, larger breasts may crowd the axillary region. In such situations you could either ask your partner to shift and hold her breast medially, allowing you to access the axilla, or use the back of your own hand to push the tissue medially.



Supine

Side lying

In a side lying position (left), the breast will fall medially, opening up the axillary region. The axilla can be opened up further by passively shifting the shoulder anteriorly.



2.90 Partner supine, medially rotating his shoulder against your resistance

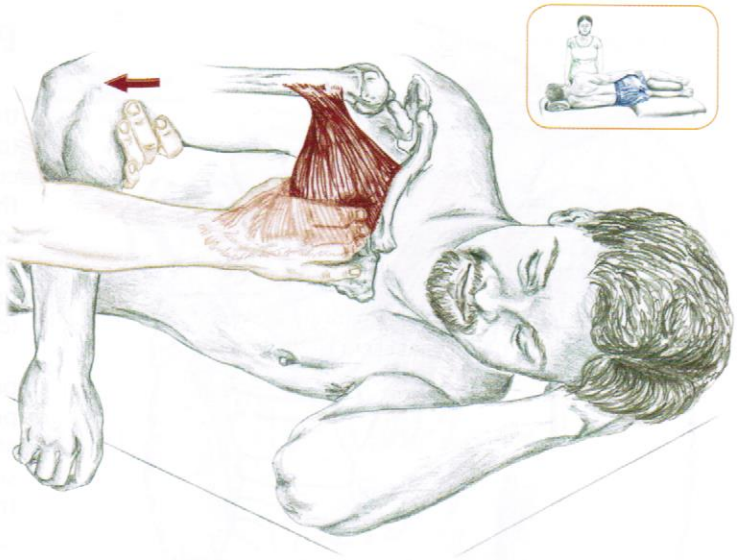
Supine

1) With your partner's shoulder slightly abducted, sit or stand facing him.
2) Locate the medial shaft of the clavicle and move inferiorly onto the clavicular fibers.
3) Explore the surface of the pectoralis major. Follow the fibers laterally as they blend with the deltoid and attach at the greater tubercle.
4) Grasp the belly of the pectoralis by sinking your thumb into the axilla. Ask your partner to medially rotate his shoulder against your resistance. "Press your hand toward your belly." (2.90) Note the contraction of the pectoralis.

Do the clavicular fibers run parallel with the anterior deltoid? As you grasp the belly, do you sense its thickness and how it lies across the rib cage?

Side lying

1) Supporting your partner's arm, flex the shoulder and pull it anteriorly toward you. This position not only brings the pectoralis major off the chest wall, but also allows the breast tissue to fall away from the area you are palpating.
2) Grasping the pectoralis major, explore its mass from the ribs to the humerus (2.91). Passively flex and extend the shoulder, perceiving the changes in the tension of the tissues.



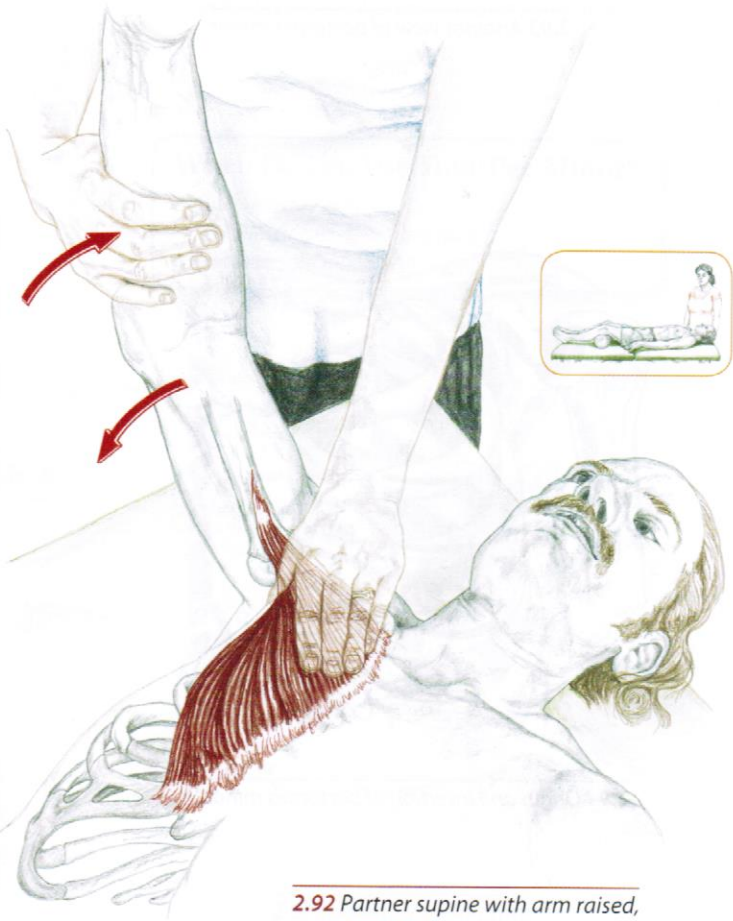
2.91 Partner side lying

Here is a way to get a sense of the antagonistic movements of the pectoralis major's upper and lower fibers.

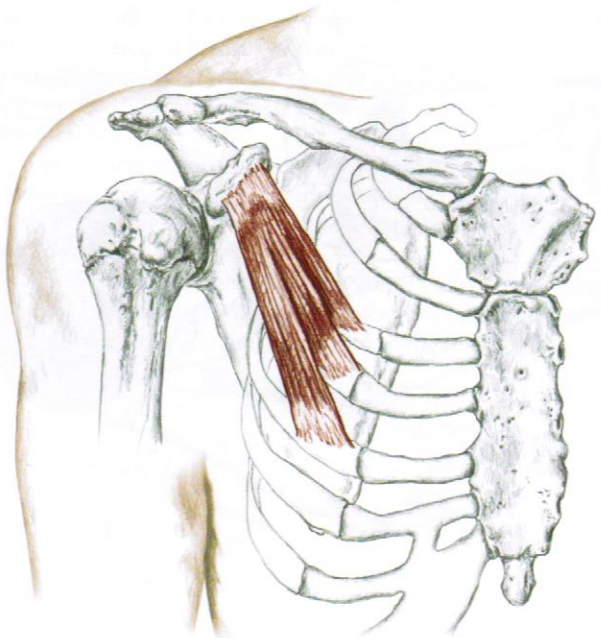
1) Supine. Begin with your partner's hand raised up toward the ceiling. As you create resistance, ask your partner to flex his shoulder. "Meeting my resistance, try to bring your hand over your head." The upper fibers will contract while the lower fibers remain lax.
2) Ask him to extend against your resistance. "Now try to bring your hand toward your hips." Here the lower fibers will contract while the upper fibers relax (2.92).

When Do You Use Your Pec Major?

- *Doing a chin-up*
- *Using almost any swim stroke ever invented*
- *Sawing a piece of wood (both directions)*



2.92 Partner supine with arm raised, feeling the lower fibers contract



2.93 Anterior view of pectoralis minor

Pectoralis Minor

The pectoralis minor lies next to the rib cage deep to the pectoralis major (2.93). Its fibers run perpendicular to the pectoralis major fibers from the scapula's coracoid process to the upper ribs. During aerobic activity the pectoralis minor helps to elevate the rib cage for inhalation. The major vessels serving the arm—the brachial plexus, axillary artery and vein—cross underneath the pectoralis minor, creating the potential for neurovascular compression by this muscle (2.95).

Access to the minor can be achieved by either pressing through or sliding underneath the thick pectoralis major. The second method is more specific and will be outlined here. The pectoralis minor can be sensitive, so palpate slowly, allowing your fingers or thumb to sink into the tissue.

A **Depress** the scapula (scapulothoracic joint)

Abduct the scapula (S/T joint)

Downwardly rotate the scapula (S/T joint)

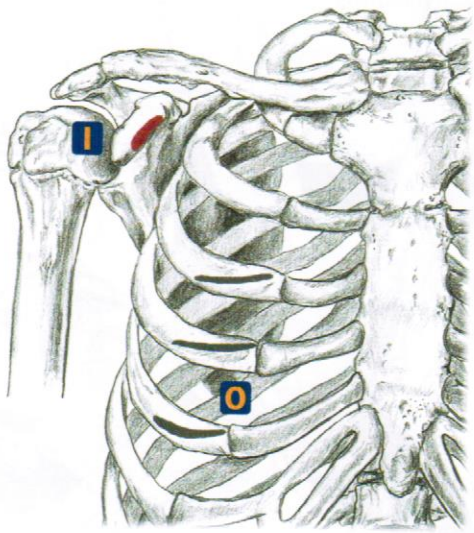
With the scapula fixed:

Assist to **elevate** the thorax during forced inhalation

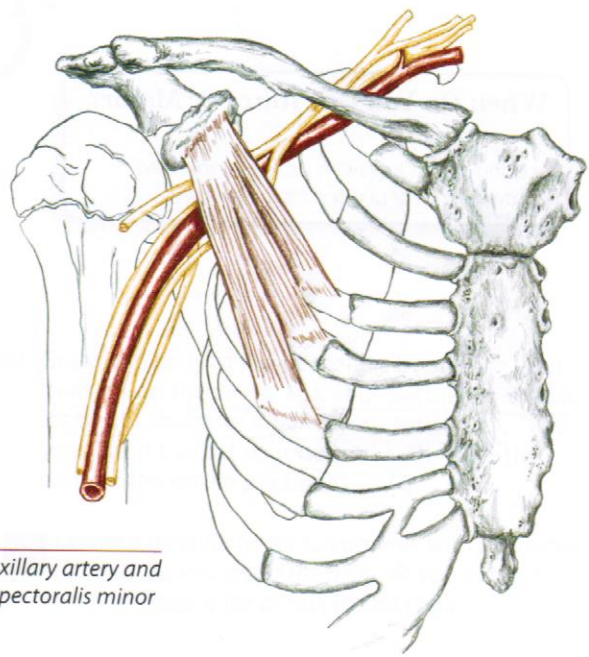
O Third, fourth and fifth ribs

I Medial surface of coracoid process of the scapula

N Medial pectoral, with fibers from a communicating branch of the lateral pectoral C(6), **7**, **8**, T1



2.94 Origin and insertion of pectoralis minor

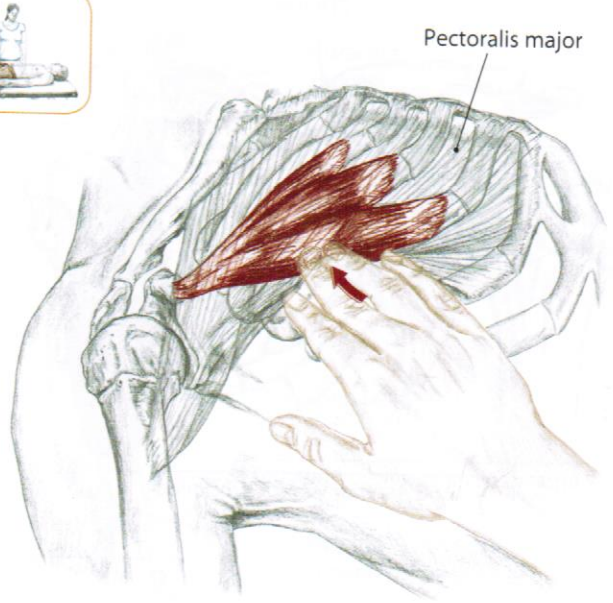


2.95 Brachial plexus, axillary artery and vein passing beneath pectoralis minor

Supine

1) Abduct the arm and place your fingerpads at the lateral edge of the pectoralis major.
2) Slowly and gently slide under the pectoralis major, following along the surface of the ribs.
3) Eventually your fingerpads will come in contact with the small wall of muscle lying next to the ribs (2.96). This is the side of the pectoralis minor. If you do not feel its tissue, visualize its location next to the ribs.

Ask your partner to depress his scapula. "Ever so slightly press your shoulder down toward your hip." When he depresses, do you feel the pectoralis minor contract? Do the fibers you feel run toward the coracoid process?



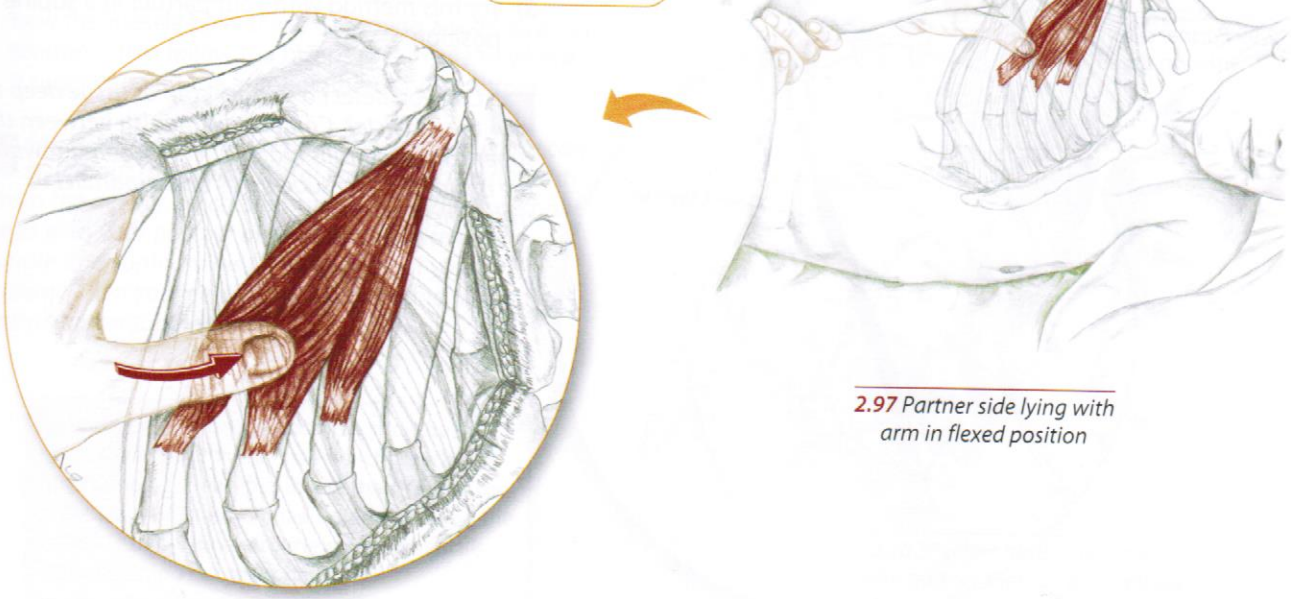
2.96 Partner supine, sliding under the pectoralis major to access the pectoralis minor

Side lying

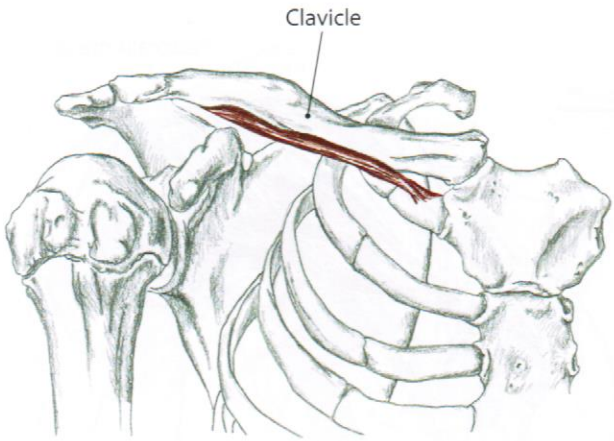
1) Support the arm in a flexed position and pull it anteriorly. This brings the pectoralis major off the chest wall and allows the breast tissue to fall away from the area you are palpating.
2) Slowly slide your thumb under the pectoralis major, following along the surface of the ribs (2.97). Your thumb will press into the side and onto the surface of the pectoralis minor. Then ask your partner to gently depress his scapula while you feel for the minor's contraction.

When Do You Use Your Pec Minor?

- *Throwing a punch*
- *Reaching into a deep front pocket*
- *Taking a deep inhalation*



2.97 Partner side lying with arm in flexed position



2.98 Anterior view of subclavius

Subclavius

As its name suggests, the subclavius is located underneath the clavicle. Its fibers run parallel to the clavicle, deep to the pectoralis major, and can be challenging to truly isolate (2.98).

On quadrupeds (four-legged animals), the subclavius is quite large and plays an important role in stabilizing the clavicle and shoulder girdle during locomotion. A human's subclavius, on the other hand, is a small, secondary muscle.

A **Depress** the clavicle and draw it anteriorly

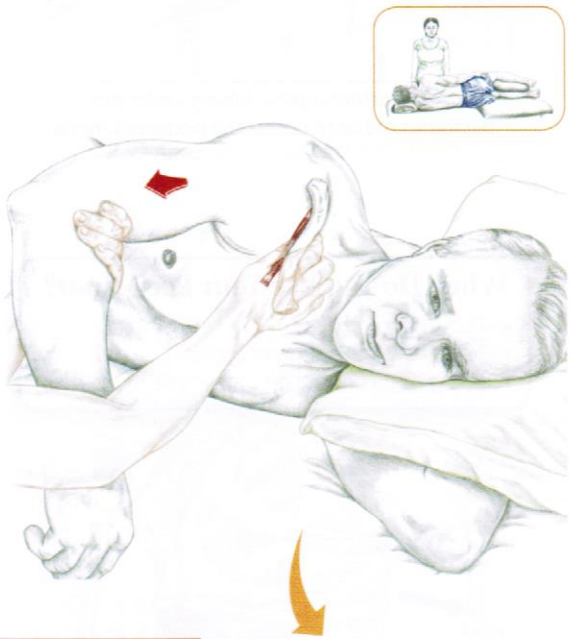
Elevate the first rib (to assist during inhalation)

Stabilize the sternoclavicular joint

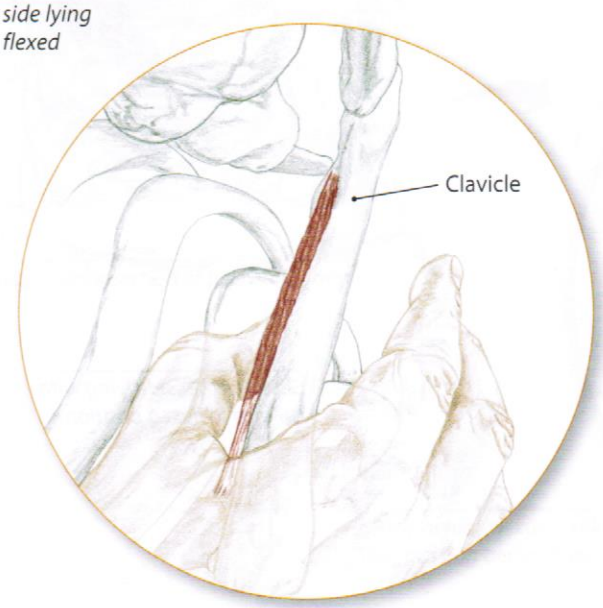
O First rib and cartilage

I Inferior surface of middle one-third of clavicle

N Subclavian C**5**, **6**



2.99 Partner side lying with arm flexed



1) Side lying. Support the arm in a flexed position and pull it anteriorly. This position brings the clavicle and pectoralis major off the rib cage and allows your thumb to curl even further around the clavicle.
2) Place your thumb and fingers at the center of the clavicle. Slowly curl your thumb around the clavicle's underside, trying to access the subclavius (2.99). You might not access a muscle belly, but might feel instead some slightly dense tissue tucked under the clavicle.
3) Try this method with your partner in a supine position.

Can you detect a slender strip of tissue deep to the clavicle? Can you distinguish between the superficial pectoralis major fibers (heading toward the axilla) and the subclavius fibers (parallel to the clavicle)?

subclavius sub-**klay**-vee-us

Biceps Brachii

The biceps brachii lies superficially on the anterior arm. It has a long head and a short head which merge to form a long, oval belly. The tendon of the long head passes through the intertubercular groove of the humerus (p. 60). This groove helps to stabilize the tendon as it rises over the top of the shoulder (2.100).

The distal tendon of the biceps dives into the antecubital space (inner elbow) to attach at the radius, allowing this muscle to be the primary muscle of forearm supination. The majority of the biceps brachii is easily palpable.

A **Flex** the elbow (humeroulnar joint)

Supinate the forearm (radioulnar joints)

Flex the shoulder (glenohumeral joint)

O *Short head:*
Coracoid process of scapula
Long head:
Supraglenoid tubercle of scapula

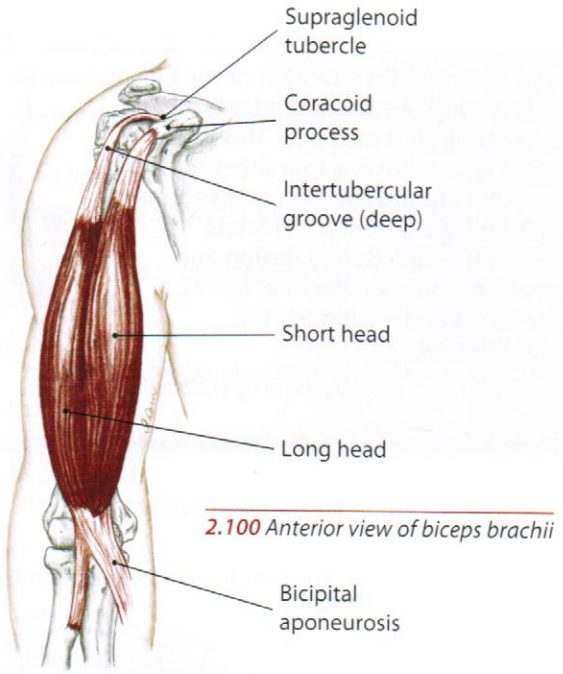
I Tuberosity of the radius and aponeurosis of the biceps brachii

N Musculocutaneous C**5**, **6**

1) Supine or seated. Bend the elbow and shake hands with your partner.
2) Ask your partner to flex his elbow against your resistance. Palpate the anterior surface of the arm and locate the hard, round belly of the biceps (2.102).
3) Follow the belly distally to the inner elbow. Note how the muscle belly thins, becoming a solid, distinct tendon. Then follow the biceps proximally to where it tucks beneath the anterior fibers of the deltoid.

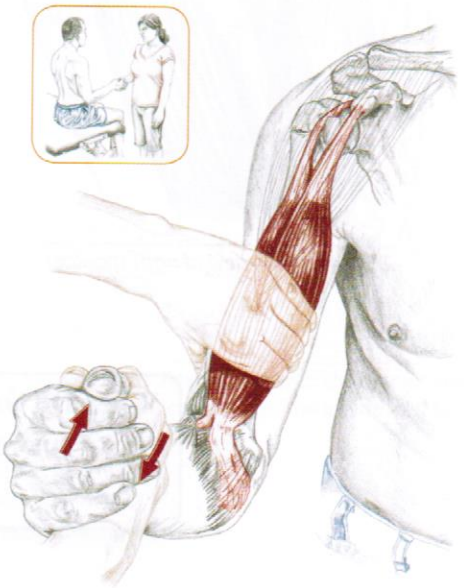
Ask your partner to flex his elbow and see if you can sculpt out the biceps' distal tendon and distinguish it from the deeper brachialis muscle (p. 132). Also, shake hands with your partner and ask him to alternately pronate and supinate his forearm against your resistance. Do you feel the muscle belly and tendon contract upon supination?

In addition to a long head and a short head, the biceps may have a head which attaches to the humerus. Reported in less than 10% of the population, this extra head originates along the medial humerus next to the coracobrachialis before joining the short head.



2.100 Anterior view of biceps brachii

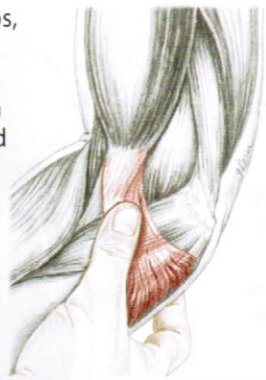
2.101 Origin and insertion of biceps brachii



2.102 Feeling biceps contract as your partner tries to flex his elbow

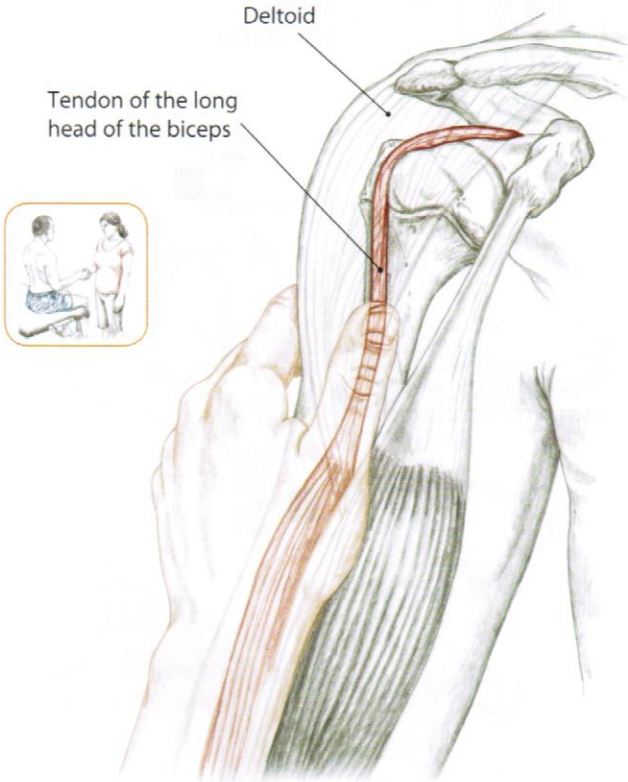
biceps brachii **bi**-seps **bray**-key-i L. two-headed muscle of the arm

In exploring the distal tendon of the biceps, you may notice a smaller tendonlike band that expands off it medially. This is the bicipital aponeurosis, a thin sheet of fascia that curves around the forearm flexors and blends into the antebrachial fascia. It stabilizes the ulna during flexion and supination, and—similar to a "tennis elbow" armband—supports the forearm flexors.



Medial view of right elbow

1) With the elbow flexed, shake hands with your partner. As you locate the biceps' distal tendon, ask your partner to flex her elbow against your resistance, making the tendon more discernible.
2) Slide over to the tendon's medial aspect and explore for the aponeurosis. When the biceps contracts, it is sometimes visible. Follow this fascial strip as far as you can around the medial forearm.



2.103 Anterior view of right shoulder

The Tendon of the Long Head of the Biceps Brachii

Because the biceps tendon is situated in the intertubercular groove of the humerus and runs parallel to the superficial deltoid fibers, it can be difficult to truly isolate.

1) Locate the intertubercular groove (p. 60). Laterally rotating the arm may make it easier to pinpoint the tendon (2.103).
2) Ask your partner to gently flex his elbow against your resistance in order to feel the biceps tendon become taut in the intertubercular groove. Be aware that the deltoid's anterior fibers will also contract upon flexion of the shoulder.

When Do You Use Your Biceps Brachii?

- *Holding a heavy hymnal while singing in the church choir*
- *With your right arm, using a screwdriver to tighten a screw*
- *Carrying an infant in your arms in a cradled position*

Triceps Brachii

The triceps brachii is the only muscle located on the posterior arm. Creating extension at the elbow and shoulder, it is an antagonist at both these joints to the biceps brachii.

The triceps has three heads: long, lateral and medial (2.104, 2.105). The long head extends off the infraglenoid tubercle of the scapula (p. 54), weaving between the teres major and minor. The lateral head lies superficially beside the deltoid while the medial head lies mostly underneath the long head. All three heads converge into a thick, distal tendon proximal to the elbow.

Aside from its proximal portion, which is deep to the deltoid, the triceps is superficial and easily accessible.

A *All heads:*
Extend the elbow (humeroulnar joint)

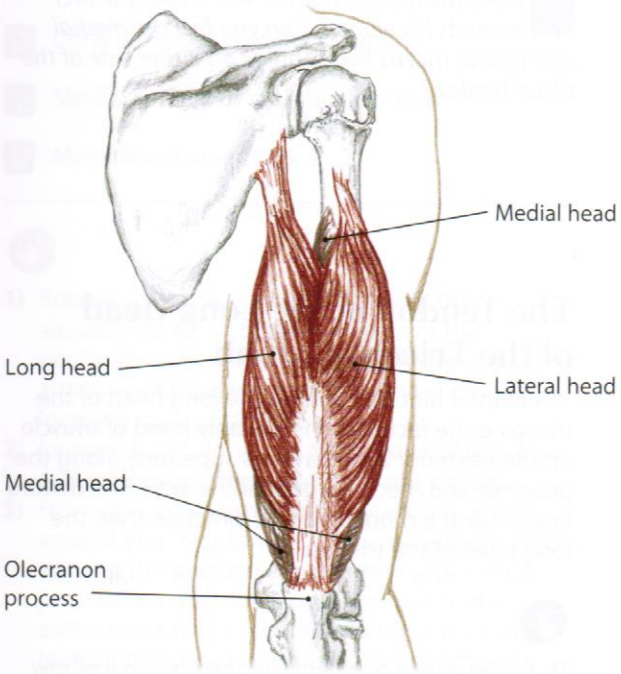
Long head:
Extend the shoulder (glenohumeral joint)

Adduct the shoulder (G/H joint)

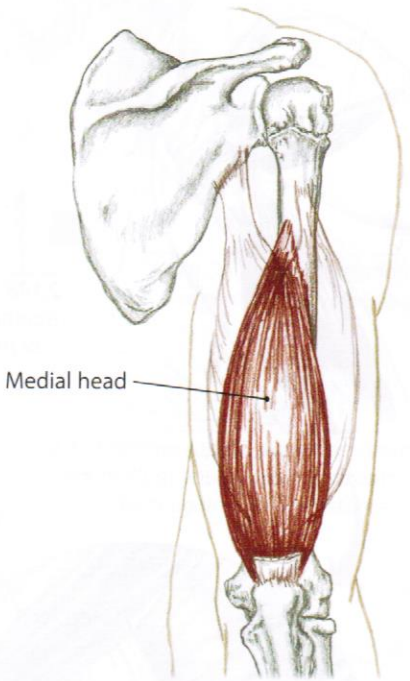
O *Long head:*
Infraglenoid tubercle of the scapula
Lateral head:
Posterior surface of proximal half of the humerus
Medial head:
Posterior surface of distal half of the humerus

I Olecranon process of the ulna

N Radial C6, **7**, **8**, T1



2.104 Posterior view of triceps brachii



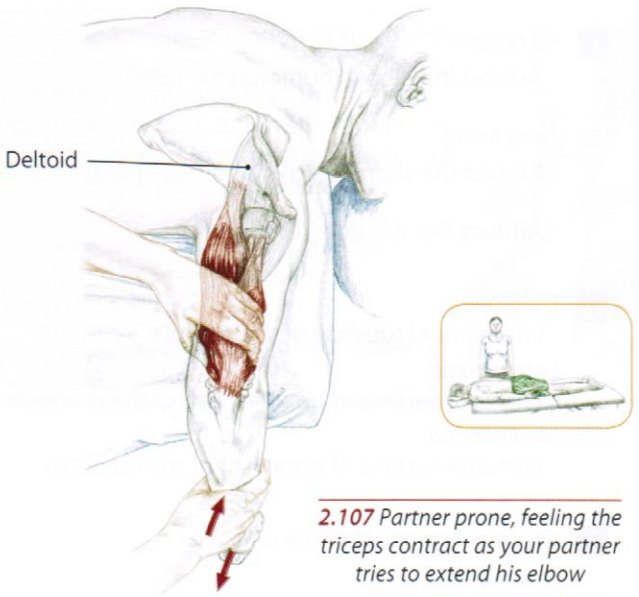
2.105 Posterior view of the medial head of triceps brachii, deep to the lateral and long heads

2.106 Origin and insertion of triceps brachii

When Do you Use your Triceps Brachii?

- *Slamming the trunk of a car*
- *Pounding in large nails with a big ol' hammer*
- *Raising your body during the up phase of a push-up*
- *Dribbling a basketball*

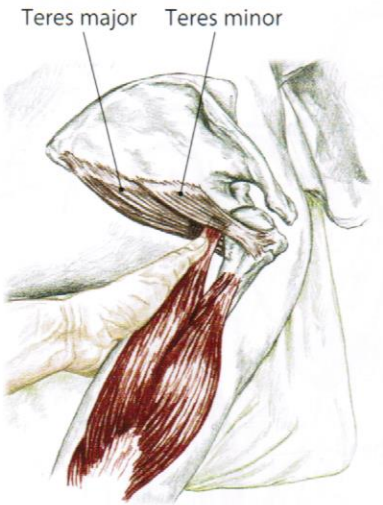
triceps brachii **tri**-seps **bray**-key-i L. three-headed muscle of the arm



2.107 Partner prone, feeling the triceps contract as your partner tries to extend his elbow

1) Prone. Bring the arm off the side of the table and palpate the posterior aspect of the arm. Outline the edge of the posterior deltoid and then explore the size and shape of the triceps.
2) Locate the olecranon process to outline the distal tendon of the triceps. Then ask your partner to extend his elbow as you apply resistance at his forearm (2.107). Slide your other hand off the olecranon process proximally and onto the broad triceps tendon.
3) With your partner still contracting, widen your fingers and palpate the medial and lateral heads on either side of the tendon.

Does the muscle tighten when your partner extends his elbow? Can you feel the medial and lateral triceps heads bulge on either side of the distal tendon?

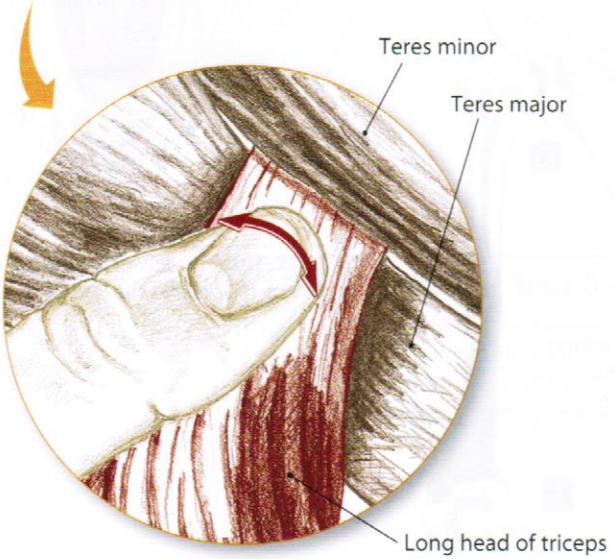


2.108 Partner prone, isolating the tendon of the long head

The Tendon of the Long Head of the Triceps Brachii

A helpful hint for locating the long head of the triceps is the fact that it is the only band of muscle on the posterior arm that runs superiorly along the proximal and medial aspect of the arm. The deltoid fibers run at a more diagonal direction than the long head of the triceps.

1) Prone. Place one hand on the proximal elbow and ask your partner to bring his elbow toward the ceiling against your resistance. This action will contract the long head of the triceps.
2) Locate its belly along the proximal and medial aspect of the arm. Follow the muscle proximally by strumming across the belly. Note how it disappears underneath the posterior deltoid toward the infraglenoid tubercle.
3) With the arm relaxed, press through the posterior deltoid and strum across its skinny tendon as it attaches to the infraglenoid tubercle.



The long head of the triceps crosses over the teres major and under the teres minor (2.108). Can you follow the long head up to the division of the teres muscles? Have your partner medially and laterally rotate his shoulder to differentiate the teres muscles (p. 71, 74).

Coracobrachialis

The coracobrachialis is a small, tubular muscle located in the axilla (2.109). Sometimes known as the "armpit" muscle, it is a secondary flexor and adductor of the shoulder. In anatomical position, the coracobrachialis is deep to the pectoralis major and anterior deltoid and lies anterior to the axillary artery and brachial plexus. Abducting the shoulder (opening up the axilla) brings the belly of the coracobrachialis to a superficial and palpable position.

A **Flex** the shoulder (glenohumeral joint)

Adduct the shoulder (G/H joint)

O Coracoid process of the scapula

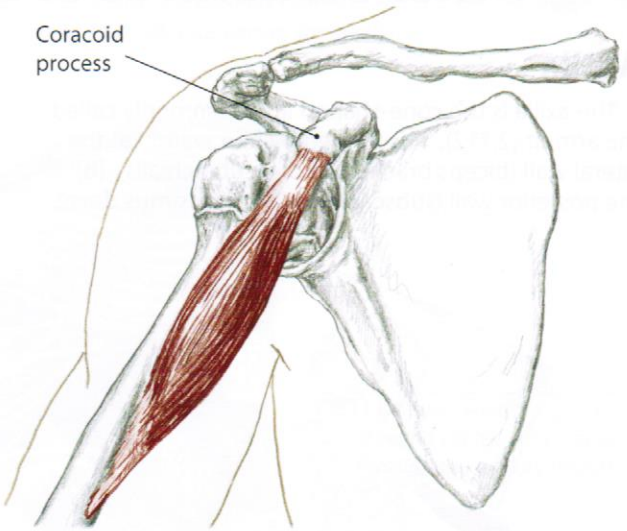
I Medial surface of mid-humeral shaft

N Musculocutaneous C**6**, **7**

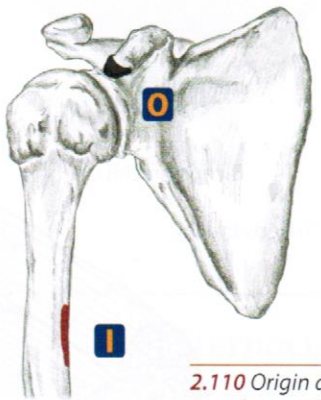
---

1) Supine. Laterally rotate and abduct the shoulder to 45°. Locate the fibers of the pectoralis major. This tissue forms the axilla's anterior wall and will be a reference point for locating coracobrachialis.
2) Lay one hand along the medial side of the arm and move your fingerpads into the armpit.
3) Have your partner horizontally adduct gently against your resistance (2.111). Isolate the solid edge of the pectoralis major then slide off the pectoralis major fibers posteriorly (into the axilla) and explore for the slender, contracting belly of the coracobrachialis. Its belly may be visible upon adduction.

Is the muscle you are palpating on the medial side of the upper arm? Does its belly lie posterior to the overlying flap of the pectoralis major? Can you strum along its cylindrical belly?



2.109 Anterior view of coracobrachialis



2.110 Origin and insertion of coracobrachialis

2.111 Partner supine, palpating coracobrachialis as your partner horizontally adducts against your resistance

When Do You Use Your Coracobrachialis?

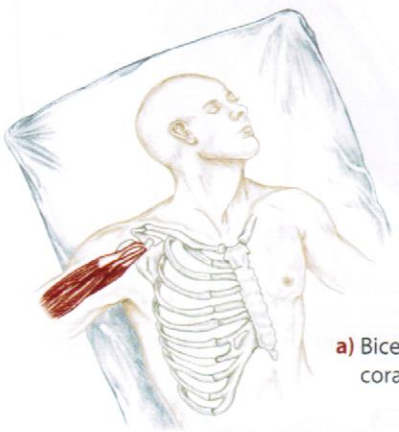
- *Reaching around your face to scratch your opposite ear*
- *Weightlifting—doing a bench press*
- *In martial arts—a forearm block in front of your chest*

coracobrachialis **kor**-a-ko-**bra**-kee-**al**-is

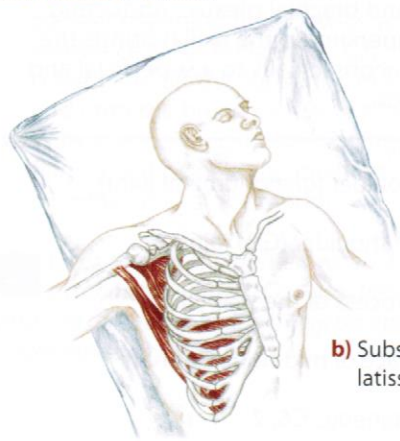
Other Structures of the Shoulder and Arm

Axilla

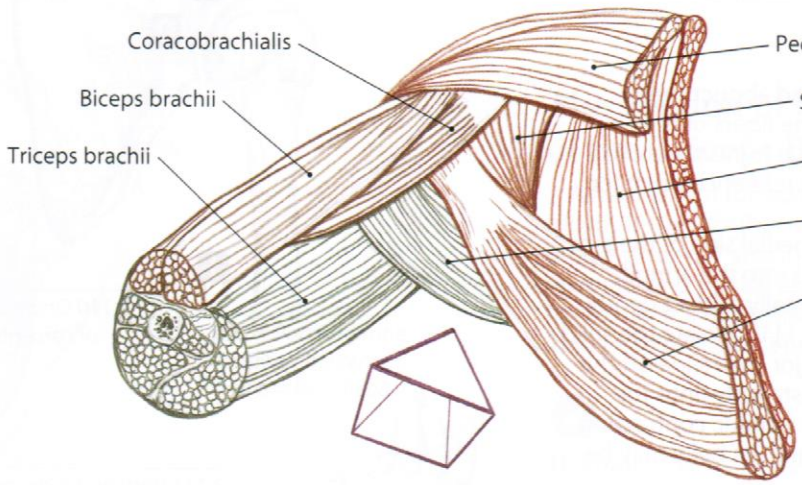
The axilla is the cone-shaped area commonly called the armpit (2.112). It is formed by four walls: **(a)** the lateral wall (biceps brachii and coracobrachialis), **(b)** the posterior wall (subscapularis and latissimus dorsi), **(c)** anterior wall (pectoralis major), and **(d)** the medial wall (rib cage and serratus anterior). There are several important vessels which pass through the axillary region (2.113), including the brachial artery and the brachial plexus (nerves).



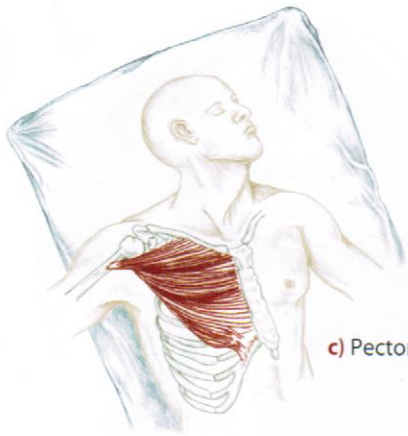
a) Biceps brachii and coracobrachialis



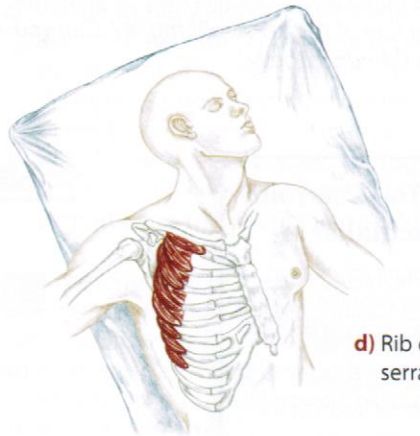
b) Subscapularis and latissimus dorsi



2.112 Inferior view of right axilla showing the muscles which form the axilla's four walls



c) Pectoralis major

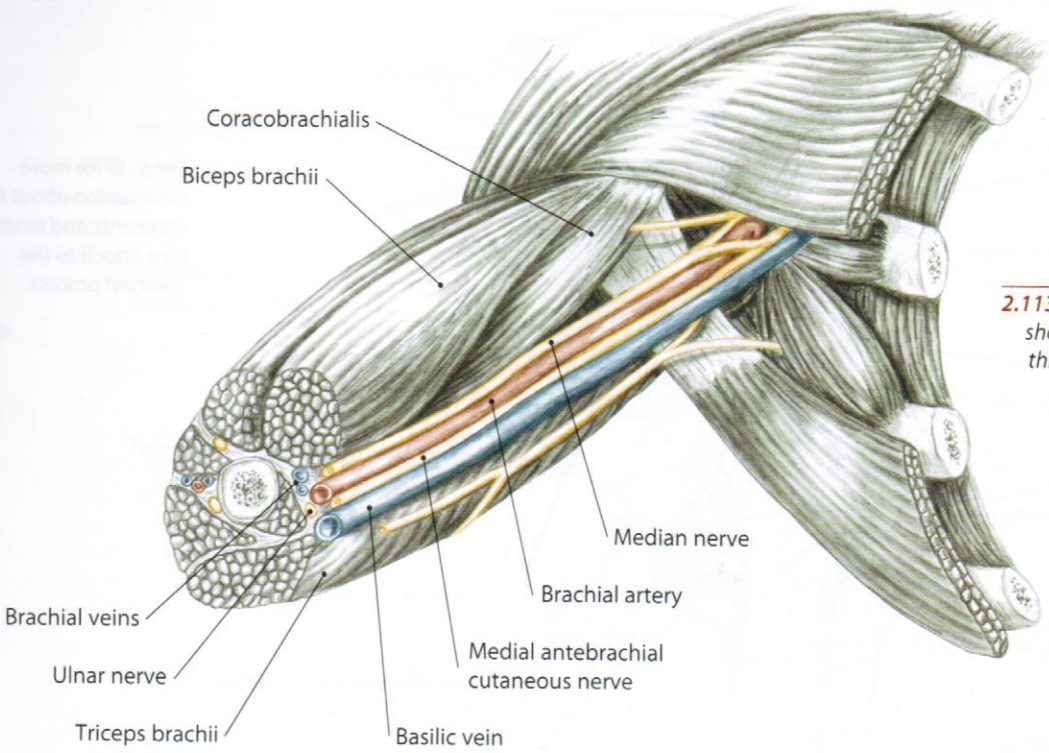


d) Rib cage and serratus anterior

axilla	**ak**-sil-a	L. armpit
axillary	**ak**-si-**lar**-ee	

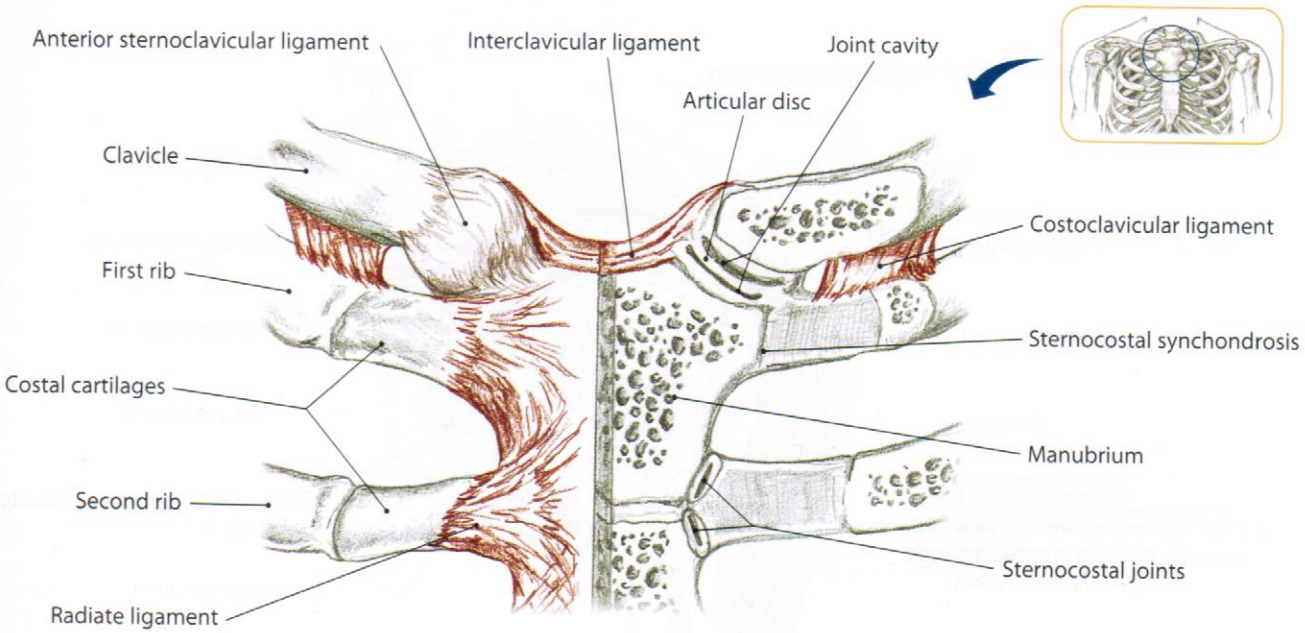
Compression or impingement of the brachial plexus or one of its nerves can create a sharp, shooting sensation down the arm. If this occurs, immediately release and adjust your position posteriorly. Also, ask your partner for feedback.

Axilla



2.113 *Inferior view of right axilla showing vessels which pass through the axillary region*

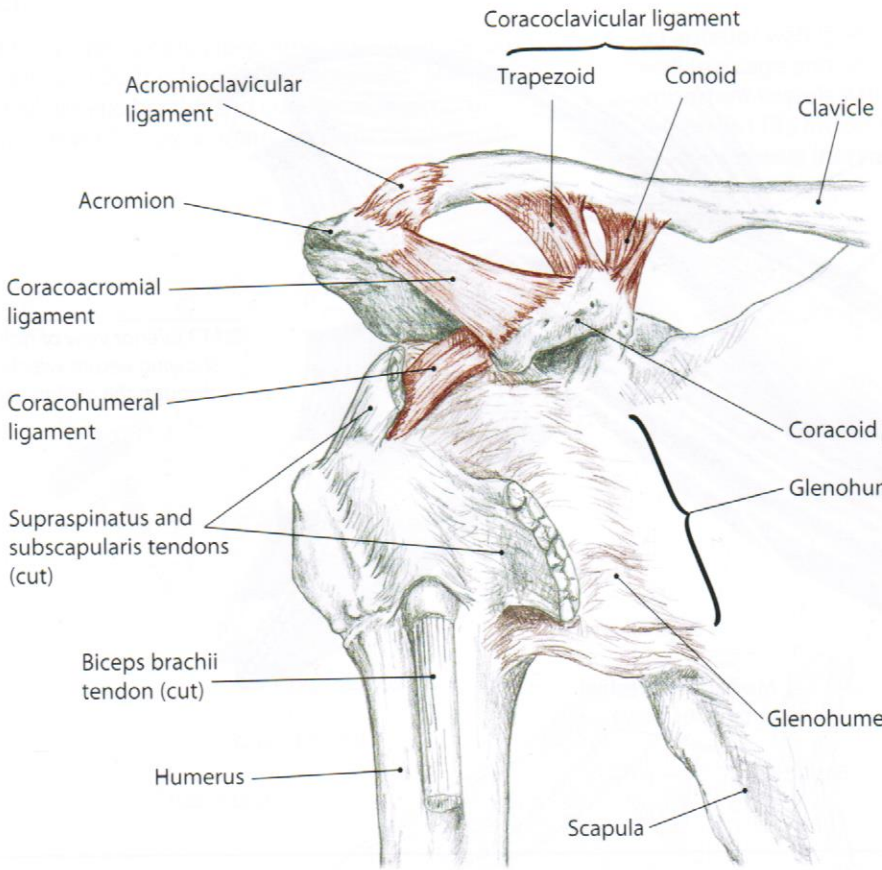
Sternoclavicular Joint



2.114 *Anterior view of superior portion of sternum, right side shown in coronal section*

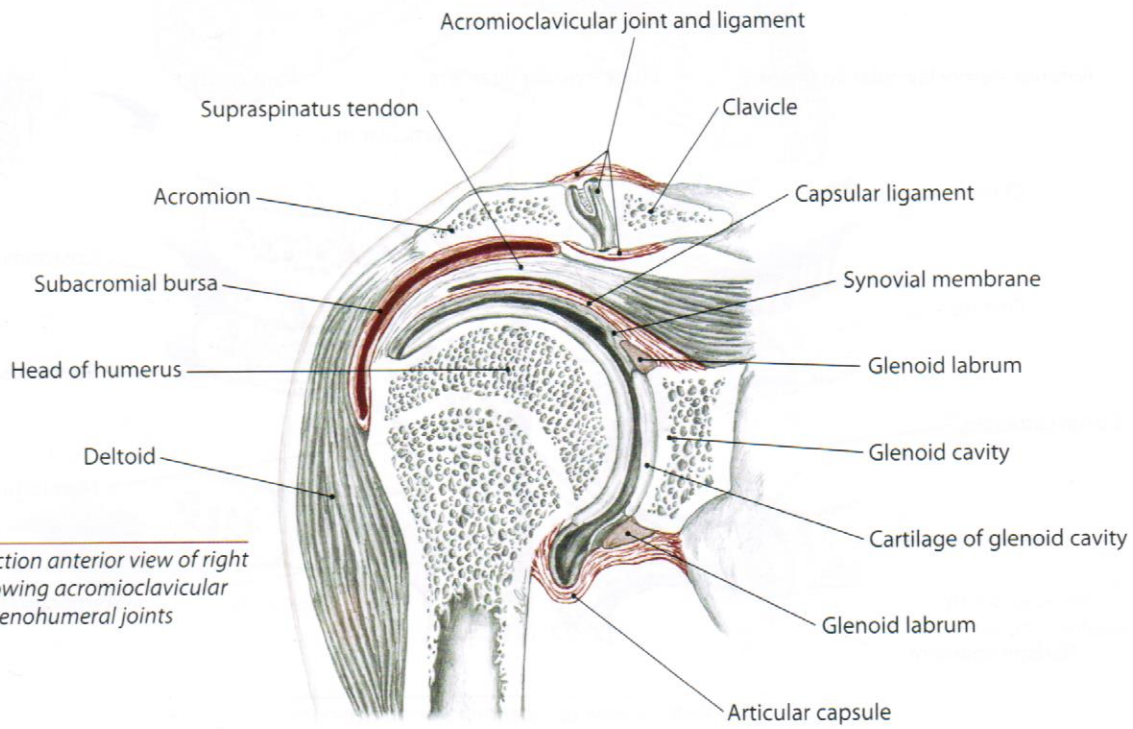
brachial	**bray**-key-al	L. relating to the arm
gland		L. acorn
synchondrosis	**sin**-con-**dro**-sis	

Ligaments of the Shoulder and Glenohumeral Joint



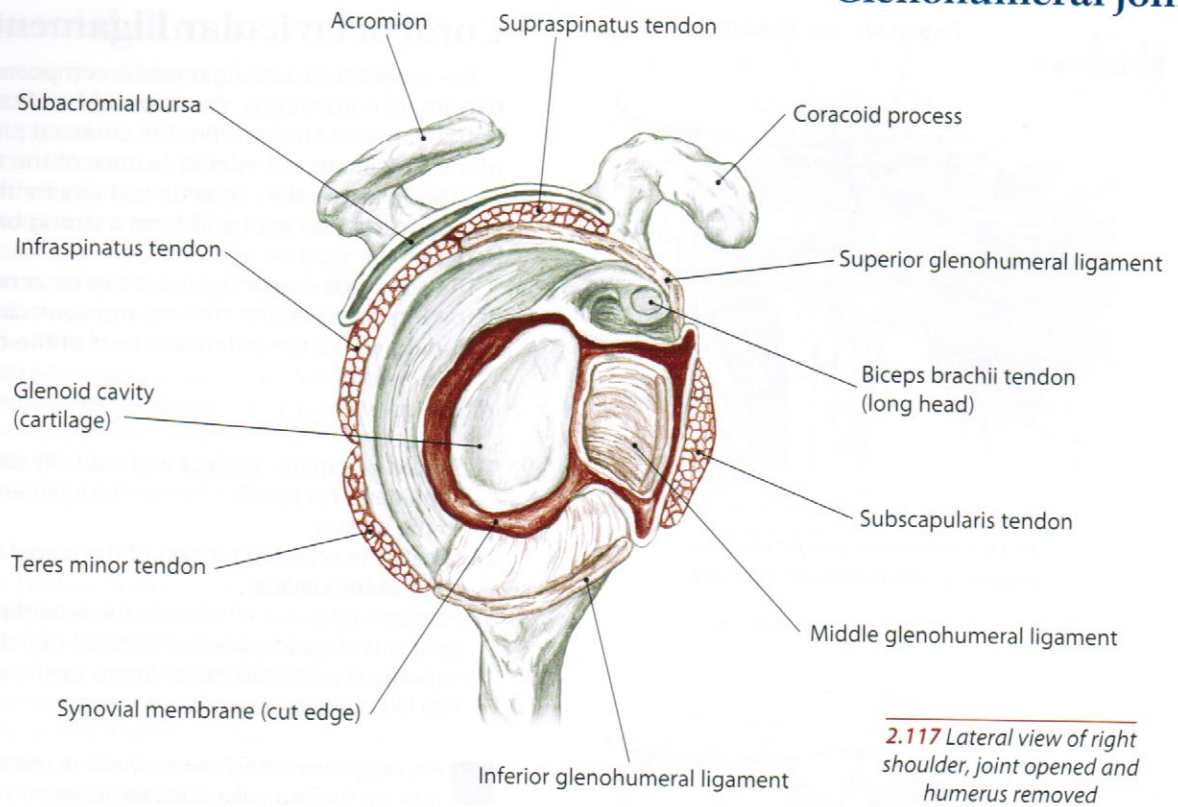
See p. 59 for more information about the ligaments and tendons that attach to the coracoid process.

2.115 Anterior view of right shoulder

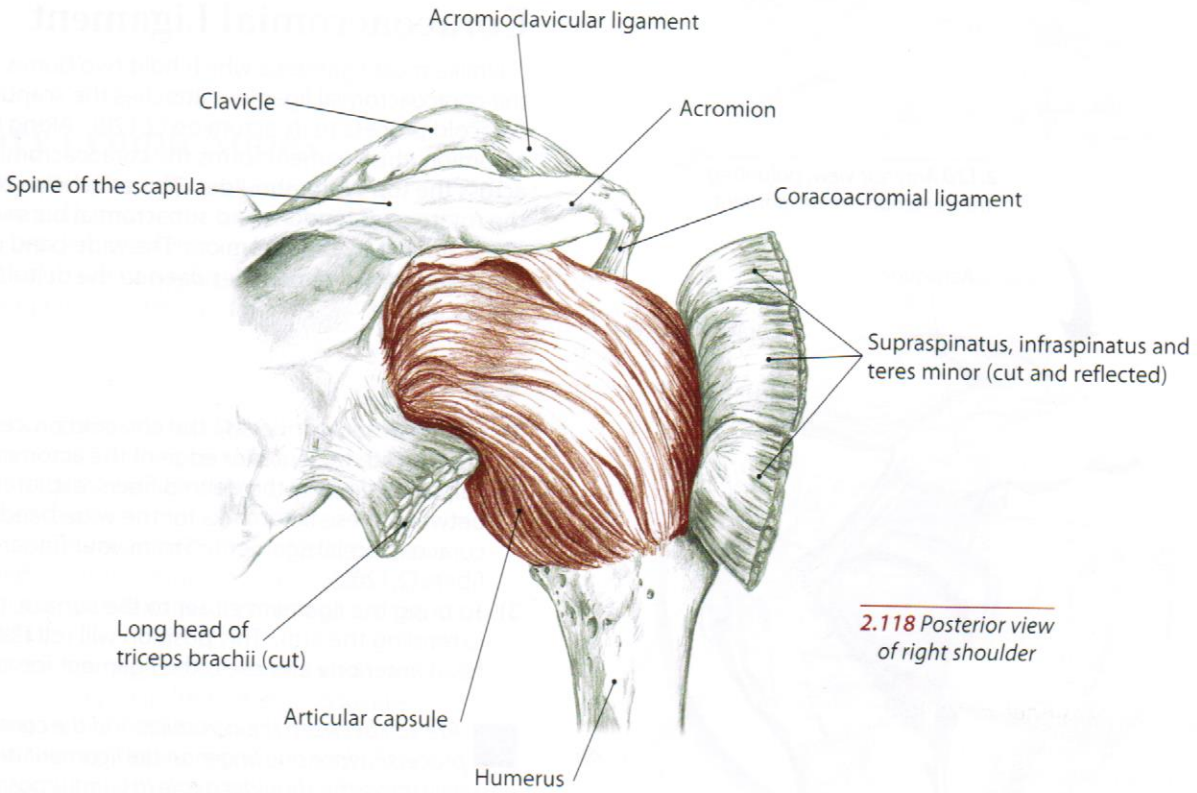


2.116 Cross section anterior view of right shoulder showing acromioclavicular and glenohumeral joints

coracoacromial	**kor**-a-**ko**-a-**kro**-mi-ul	
coracoclavicular	**kor**-a-**ko**-cla-**vic**-u-lar	
ligament	**lig**-a-ment	L. a band

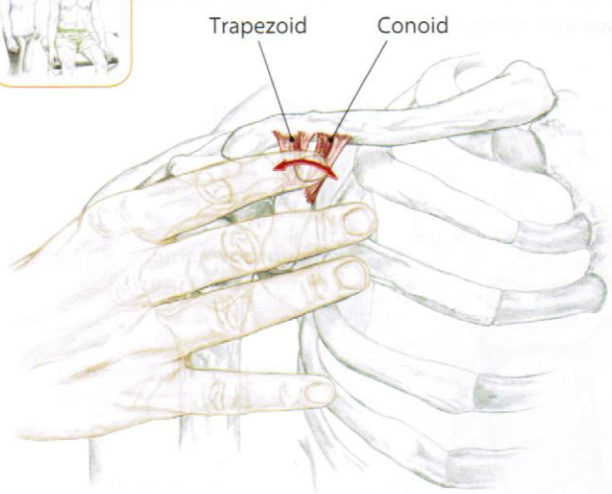


2.117 Lateral view of right shoulder, joint opened and humerus removed



2.118 Posterior view of right shoulder

labrum — **lay**-brum — L. lip
conoid — **ko**-noid — Grk. cone-shaped



2.119 Anterior view of right shoulder palpating coracoclavicular ligament

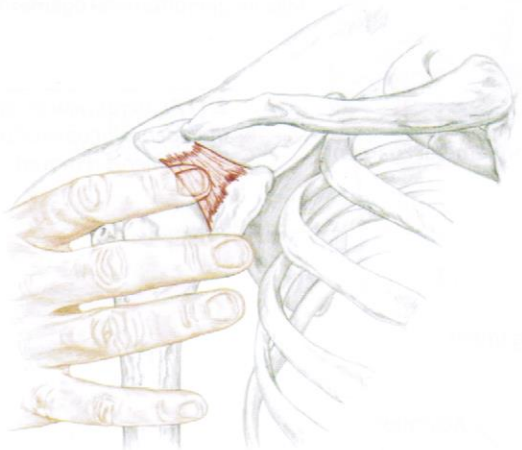
Coracoclavicular Ligament

The coracoclavicular ligament is composed of two smaller ligaments: the trapezoid and conoid. Both ligaments stretch from the coracoid process of the scapula to the inferior surface of the clavicle (2.115). Together they provide stability for the acromioclavicular joint and form a strong bridge between the scapula and clavicle.

The coracoclavicular ligament can be accessed by palpating between the clavicle and coracoid process or curling under the anterior aspect of the clavicle.

1) Seated or supine. Abduct and medially rotate the shoulder. This position brings the ligaments more to the surface.
2) Locate the coracoid process of the scapula and the shaft of the clavicle.
3) Palpate in the space between these landmarks. Roll your thumbpad across its fibers (2.119). Unlike the superficial pectoralis major fibers, the ligaments will feel like solid, taut bands.

Passively move the shoulder girdle in several directions and see if a particular position allows you greater access to the ligaments.



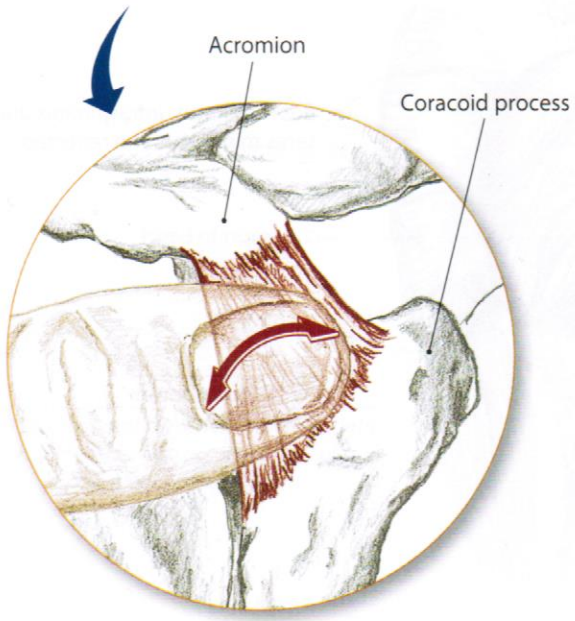
2.120 Anterior view, palpating the coracoacromial ligament

Coracoacromial Ligament

Unlike most ligaments which hold two bones together, the coracoacromial ligament attaches the scapula's coracoid process to its acromion (2.120). Along with the acromion, this ligament forms the coracoacromial arch across the top of the shoulder. This arch helps to protect the rotator cuff tendons and subacromial bursa from direct trauma by the acromion. The wide band of the coracoacromial ligament lies deep to the deltoid but is still accessible.

1) Supine or seated. Locate the coracoid process. Then locate the anterior edge of the acromion.
2) Palpating deep to the deltoid fibers, explore between these landmarks for the wide band of the coracoacromial ligament. Strum your finger across its fibers (2.120).
3) To bring the ligament closer to the surface, try extending the arm. This position will roll the humeral head anteriorly and press the ligament forward.

Are you between the acromion and the coracoid process? Place one finger on the ligament and passively move the shoulder girdle in various positions. Can you feel how the ligament's relationship to the surrounding tissues changes as the position of the shoulder changes?

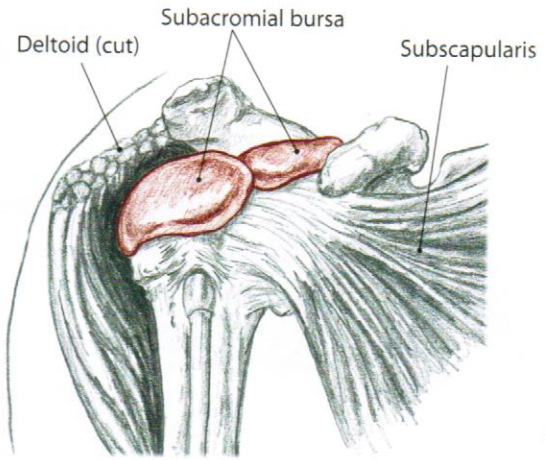


Subacromial Bursa

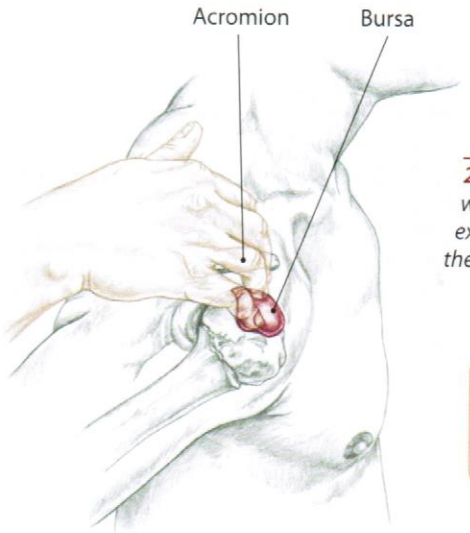
Also known as the subdeltoid bursa, this sizable fluid sac has two major sections (2.121). The lateral portion creates a smooth surface for the acromion and deltoid to glide over the head of the humerus and rotator cuff tendons. The medial part cushions the coracoacromial ligament from the supraspinatus tendon.

With the arm at the side, most of the bursa is underneath the acromion and inaccessible. Extending the shoulder joint, however, will bring the bursa forward. Since abduction of the shoulder compresses the bursa, this action (when accompanied by pain and tenderness) can be used as an indicator of subacromial bursitis.

1) With your partner seated, stand behind him and locate the acromion.
2) Drop your fingers off the anterior edge of the acromion. Then, with your other hand, slowly extend the shoulder by pulling the elbow posteriorly; this will bring the bursa out from under the acromion. You will be palpating at the depth between the deltoid and rotator cuff tendons (2.122).
3) A little hint—palpate gently. Bursae are delicate structures and best accessed with a soft touch. If it is inflamed it will be acutely tender.



2.121 Anterior view of right shoulder

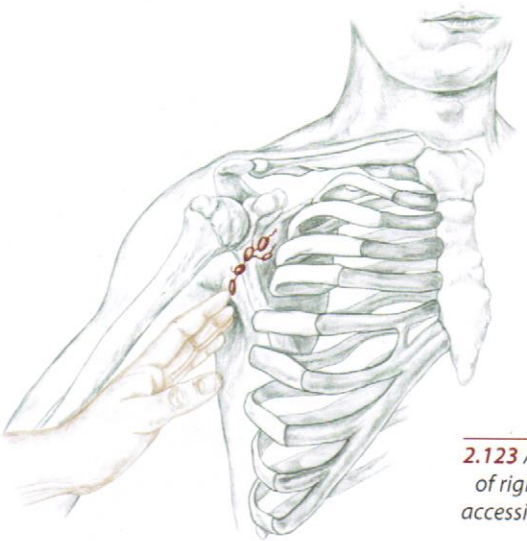


2.122 Lateral view with right shoulder extended, palpating the subacromial bursa

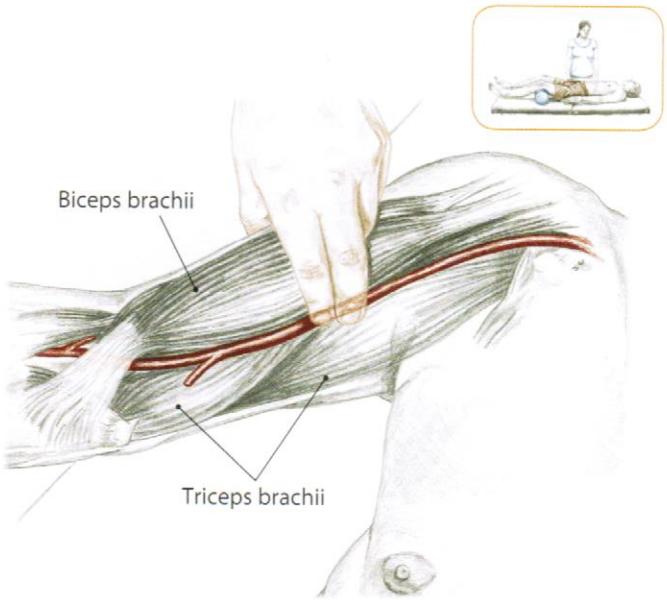
Axillary Lymph Nodes

The axillary lymph nodes are located in the axilla. When palpating in the axillary region, use a deliberate yet gentle touch to avoid tickling your partner. Also, move slowly, using gentle pressure to avoid impinging the artery and nerves.

1) Supine or seated. Abduct the arm and slowly sink two fingers up into the axilla. Then bring the arm back to the side of the body to soften the axillary tissue further.
2) Slide your fingers up to the top of the axilla and then medially toward the rib cage. Often there will be a few lymph nodes located against the ribs (2.123).
3) Move to the lateral side of the axilla and use light pressure against the humerus to locate the strong pulse of the brachial artery. The vessel will be positioned between the stringy coracobrachialis and long head of the triceps brachii muscle.



2.123 Anterior view of right shoulder, accessing the nodes



2.124 Anterior/medial view, palpating the brachial pulse between the biceps and triceps brachii

Brachial Artery

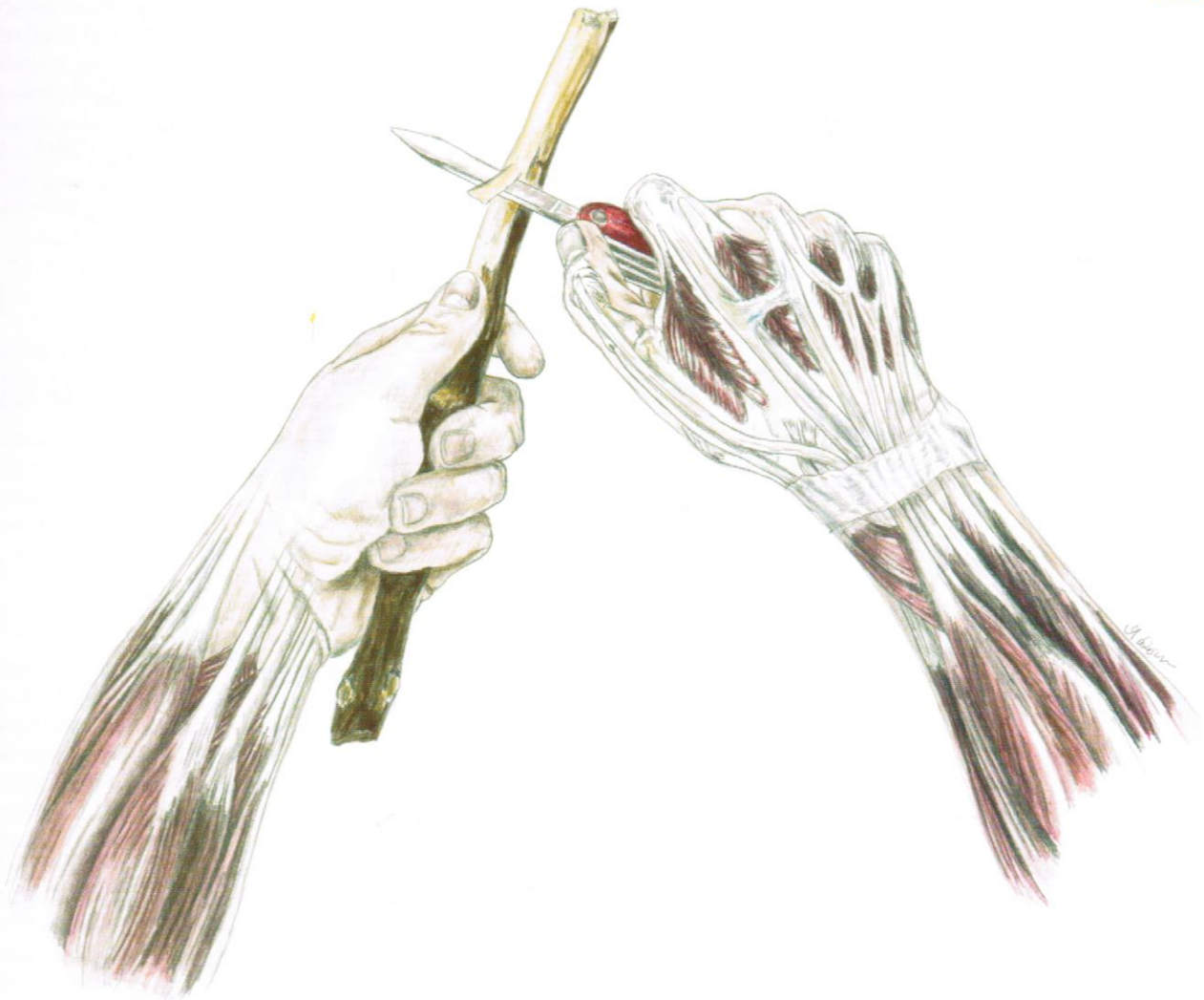
The brachial artery is a continuation of the axillary artery and runs between the biceps and triceps brachii. Its pulse can be felt between these muscles on the medial side of the arm (see p. 101). Before the brachial artery branches off to the radial and ulnar arteries, its pulse can be felt at the elbow, just medial to the biceps brachii tendon.

1) Supine or seated. Abduct the arm and place your fingerpads on the medial side of the arm. A helpful guide is the shallow dip which forms between the biceps and triceps (2.124).
2) Gently press your fingers toward the shaft of the humerus to feel the brachial pulse.
3) The brachial pulse can also be detected just medial to the distal tendon of the biceps brachii.

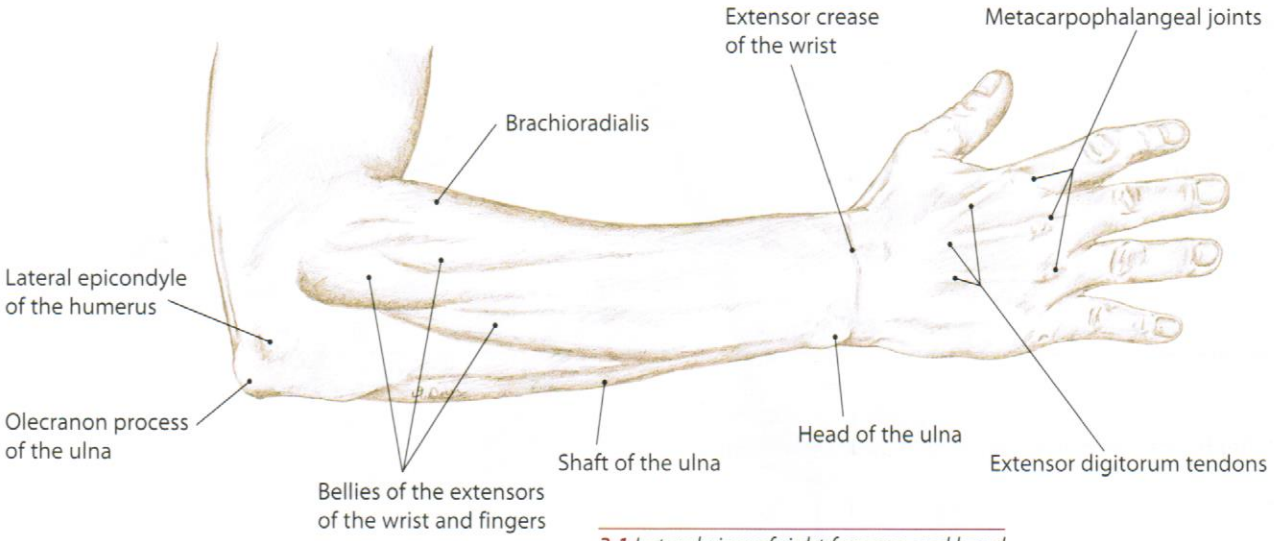
NOTES

On to the forearm and hand where we'll find flexors, extensors and an "anatomical snuffbox."

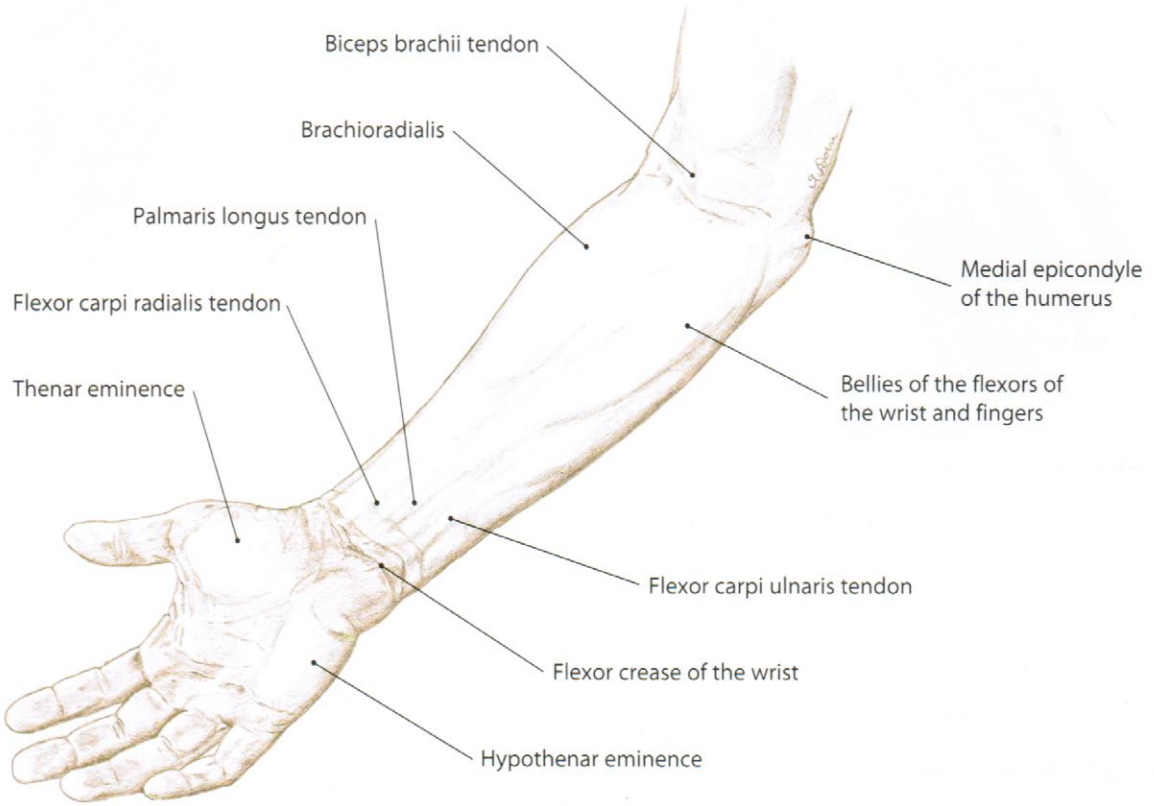
Forearm & Hand 3



Topographical Views



3.1 Lateral view of right forearm and hand



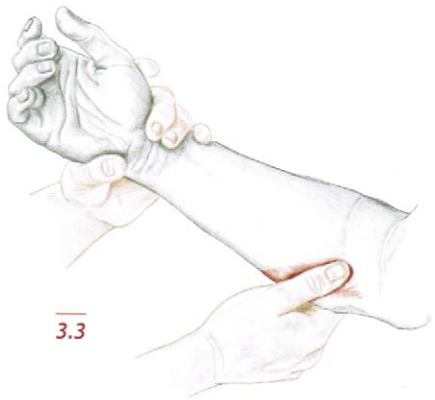
3.2 Anterior view of right forearm and hand

In everyday speech, "arm" usually refers to the region between the shoulder and wrist. As an anatomical term, however, "arm" refers to the region between the shoulder and elbow. The portion between the elbow and wrist is called the "forearm."

thenar	**thee**-nar	Grk. palm, flat of the hand
hypothenar	**hi**-po-**thee**-nar	Grk. *hypo*, under or below

Exploring the Skin and Fascia

1) Partner seated. Begin by gently lifting the skin and fascia of the forearm. Compare the thickness and elasticity of the posterior (hairy) side to the anterior (hairless) side (3.3).
2) Explore the length of the forearm. Note how the tissue along the shaft of the forearm might be more challenging to grasp than the tissue at the wrist and elbow regions.



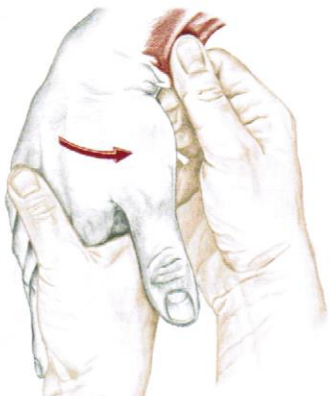
3.3

1) Using one hand to stabilize the forearm, use your other hand to gently twist the skin and fascia around the forearm's shaft (3.4).
2) Now try to tug the skin superiorly and inferiorly. Often the tissue will have more elasticity in a horizontal direction (around the forearm's shaft) than in a vertical one.

3.4

1) Here is an opportunity to feel your partner's skin and fascia stretch during passive movement. Grasp the tissue near the wrist and *passively* flex and extend the wrist joint (3.5). Feel how supple and plentiful the tissue is when the wrist is flexed. As the wrist is extended, however, the skin may be pulled from between your fingers.
2) Continue to move the wrist while grasping the tissue on all sides of the forearm. Supinate and pronate the forearm, feeling how these actions cause the tissue to move differently.
3) Ask your partner to *actively* move his wrist and fingers while you grasp the skin and fascia. Encourage him to move slowly. Play with isolating specific actions—for instance, extension of the wrist as opposed to extension of the fingers—to feel the tissues shift with different actions.

Extending the wrist



Flexing the wrist

Wrist in neutral

3.5 Grasping the tissue while passively moving the wrist

Bones of the Forearm and Hand

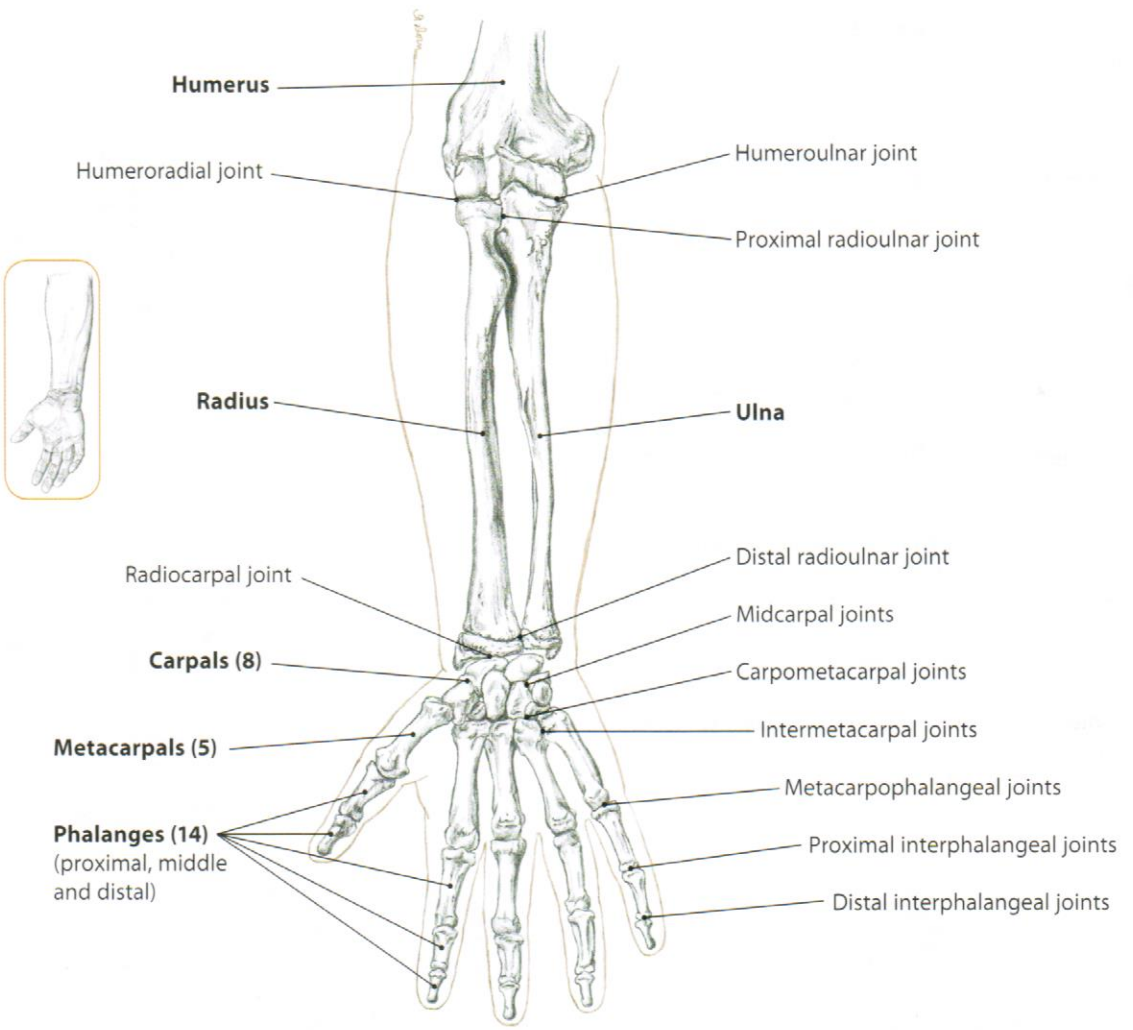
The **humerus** is the bone of the arm. Its proximal end articulates with the scapula to form the glenohumeral joint. Its distal end joins with the ulna and radius at the elbow. The elbow has two joints: the humeroulnar and humeroradial.

The **radius** and **ulna** make up the bones of the forearm (3.6). The ulna is superficial and has a palpable edge that extends from the elbow to the wrist. The radius ("on the thumb side") is lateral to the ulna and is partially buried in muscle. Pronation and supination of the forearm are created by the radius pivoting around the ulna at the proximal and distal radioulnar joints.

The three groups of bones in the wrist and hand are the carpals, metacarpals and phalanges. The **carpals** are eight pebble-sized bones that form two rows (proximal and distal), each containing four carpal bones (3.9). Located distal to the "flexor crease" of the wrist, the carpals are accessible from all sides—the palmar, dorsal, radial and ulnar surfaces of the hand.

The **metacarpals** are five long bones spanning the palm of the hand. The metacarpals' proximal end is the base, the long midsection is the shaft and the distal end is the head (3.7). The metacarpals are easily palpable along the hand's dorsal surface. They are deep to the muscles on the palmar side.

The **phalanges** are the bones of the fingers. The thumb has two phalanx bones and the fingers have three. All sides of the phalanges are accessible (3.8).



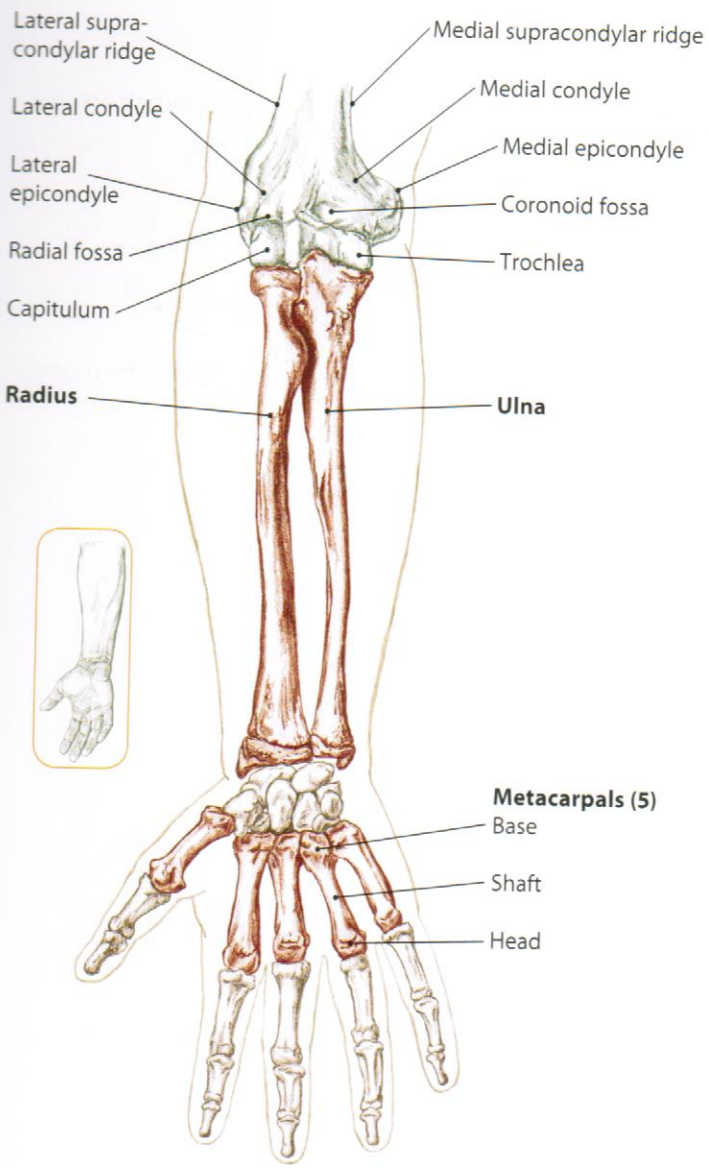
3.6 Anterior (palmar) view of right forearm and hand

Let's talk joints! The **radiocarpal** joint (wrist), formed by the radius and proximal carpals, is an ellipsoid joint. The gliding joints at the **midcarpal** and second to fifth **carpometacarpal** joints allow for only small, shifting movements.

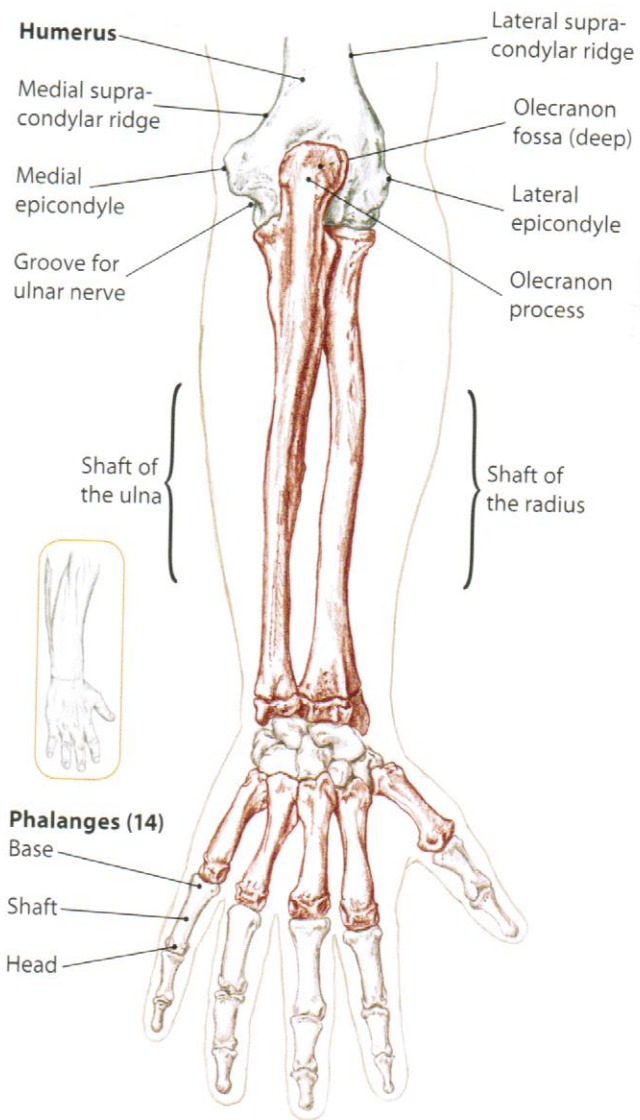
The first **carpometacarpal** joint of the thumb is an ellipsoid-shaped saddle joint. The **metacarpophalangeal** joints, the large "knuckles" of the hand, are also ellipsoid joints. The **interphalangeal** joints of the fingers are hinge joints.

humerus	**hu**-mer-us	L. upper arm
radius	**ray**-dee-us	L. staff, spoke of a wheel
ulna	**ul**-na	L. elbow, arm

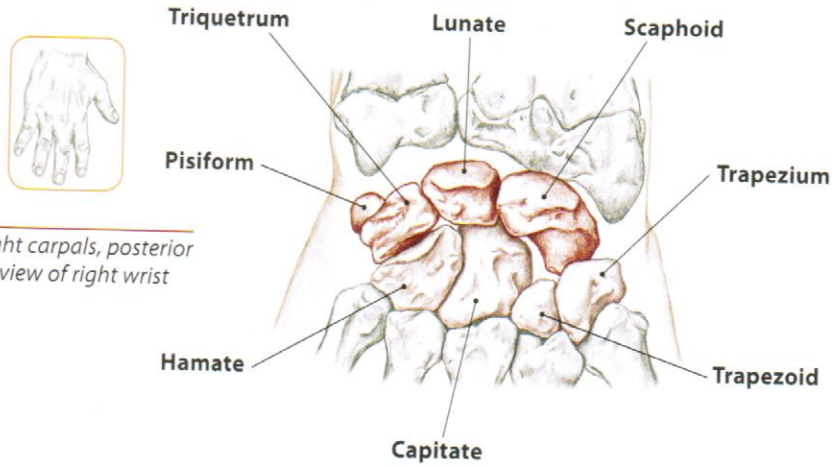
Bony Landmarks



3.7 Anterior (palmar) view of right forearm and hand



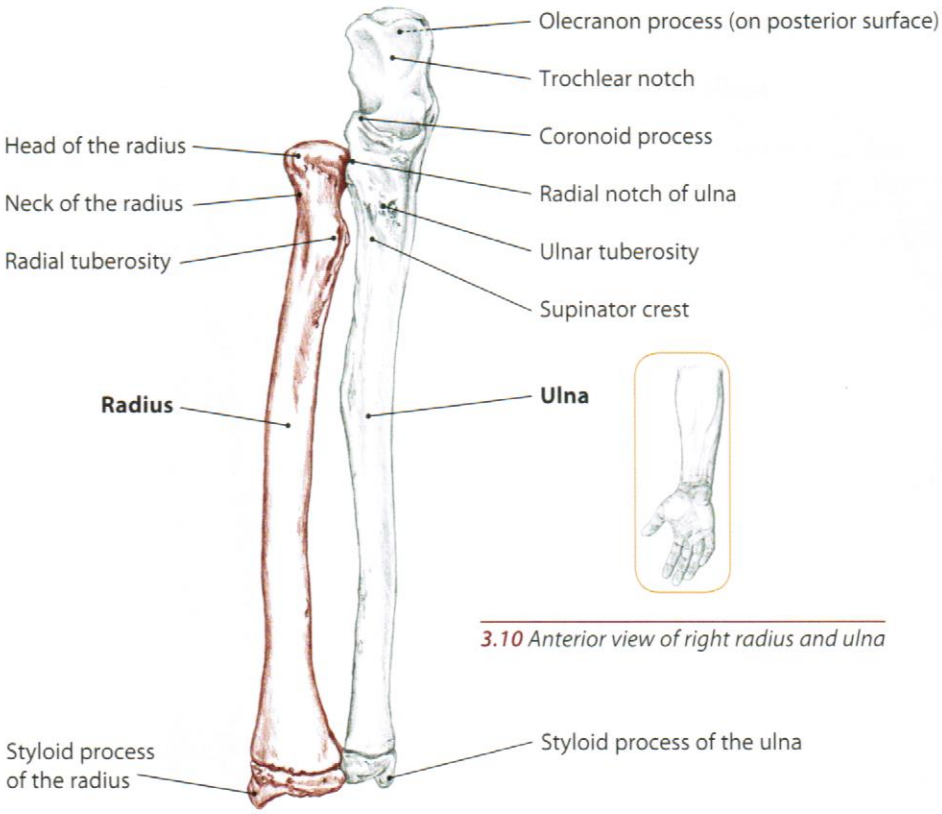
3.8 Posterior (dorsal) view of right forearm and hand



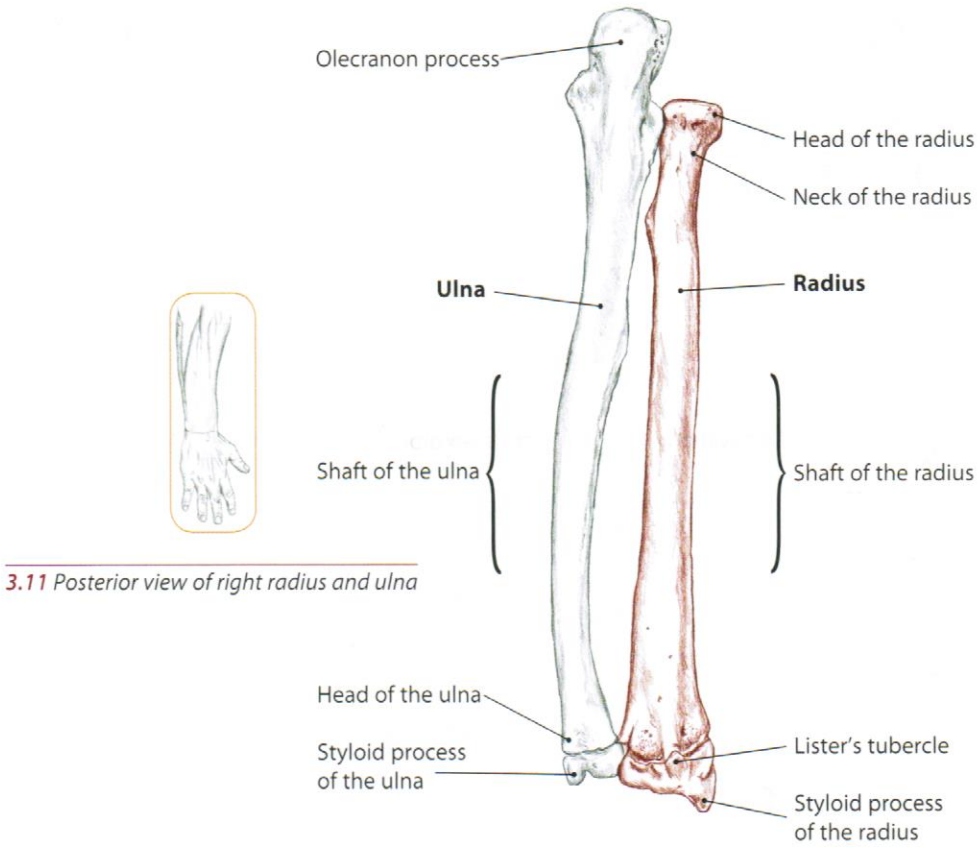
3.9 The eight carpals, posterior (dorsal) view of right wrist

carpal	**kar**-pul	Grk. pertaining to the wrist
metacarpal	**met**-a-**kar**-pul	Grk. *meta*, after, beyond

The Ulna and Radius

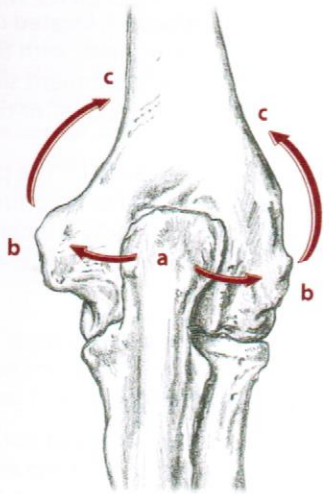


3.10 Anterior view of right radius and ulna



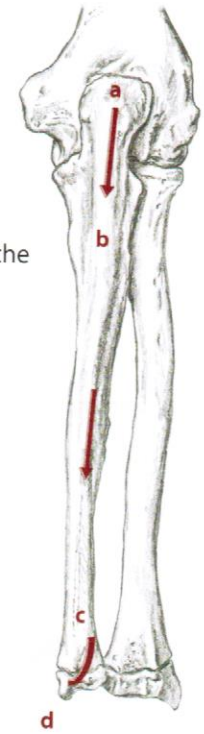
3.11 Posterior view of right radius and ulna

Bony Landmark Trails



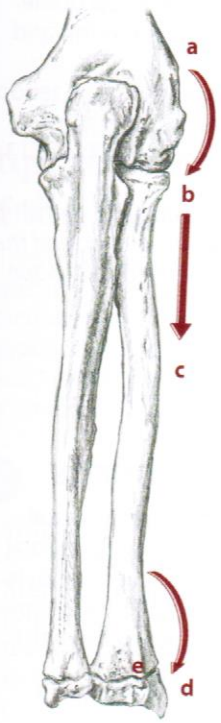
Trail 1 "Knob Hill" explores the elbow and distal humerus.

a Olecranon process and fossa
b Epicondyles of the humerus
c Supracondylar ridges of the humerus



Trail 2 "The Razor's Edge" follows the length of the superficial ulna.

a Olecranon process
b Shaft of the ulna
c Head of the ulna
d Styloid process of the ulna



Trail 3 "Pivot Pass" travels the length of the radius, the bone which creates the pivoting action of the forearm.

a Lateral epicondyle of the humerus
b Head of the radius
c Shaft of the radius
d Styloid process of the radius
e Lister's tubercle

Trail 4 "Walking On Your Hands" explores the small carpal bones of the wrist as well as the bones and joints of the hand.

Some translations for the names of bones may cause you to scratch your head and wonder what early anatomists were thinking. The carpals, luckily, cause no such puzzlement.

capitate	L. head-shaped	*scaphoid*	L. boat-shaped
hamate	L. hooked	*trapezium*	Grk. little table
lunate	L. crescent-shaped	*trapezoid*	Grk. table-shaped
pisiform	L. pea-shaped	*triquetrum*	L. three-cornered

Trail 1 "Knob Hill"

3.12 Palpating the olecranon process

Olecranon Process and Fossa

The olecranon process (or elbow) is located on the proximal end of the ulna and articulates with the distal humerus. Its large surface is the attachment site for the triceps brachii muscle. It forms the "point" of the elbow and is easily located.

The olecranon fossa is a large cavity on the posterior, distal end of the humerus designed to accommodate the olecranon process when the elbow is extended. Located deep to the triceps brachii tendon, the fossa is only partially accessible.

Olecranon process

1) Partner seated. Shake hands with your partner and explore the large, superficial knob at the elbow. Palpate and explore its angular surface and sides.
2) Passively flex and extend the elbow, noticing how the olecranon process feels in various positions (3.12).

3.13 Posterior view of right elbow, locating the olecranon fossa

Olecranon fossa

1) Flex the elbow and locate the olecranon process.
2) Roll your finger proximally around the top of the process, pressing through the triceps tendon and into the fossa.
3) Because of the presence of the triceps brachii tendon and the proximity of the olecranon process, only a small crescent-shaped ditch will be accessible (3.13).

When locating the fossa, are you proximal to the tip of the olecranon process? If you flex and extend the elbow slightly, do you feel a change in the fossa's shape and size?

3.14 Palpating the medial epicondyle

Epicondyles of the Humerus

As the humerus extends down the arm, its distal end broadens medially and laterally. Directly medial from the olecranon process is the medial epicondyle. It is superficial and has a protruding, spherical shape designed to accommodate the tendons of the wrist and finger flexors.

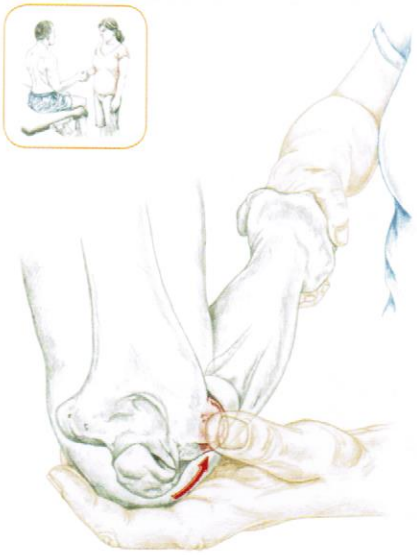
The lateral epicondyle is smaller than its medial counterpart and is located lateral to the olecranon process. It is an attachment site for the tendons of the wrist and finger extensors.

fossa	**fos**-a	L. a shallow depression
olecranon	o-**lek**-ran-on	Grk. elbow
process	**pros**-es	L. going forth

Epicondyles of the humerus

1) With your partner seated, shake hands and locate the olecranon process.
2) Slide your finger medially off the olecranon. You will encounter a small ditch before rising up onto the large, superficial medial epicondyle. Explore its bulbous shape (3.14).
3) Return to the olecranon. Slide laterally to the lateral epicondyle. Note that it is smaller than the medial epicondyle (3.15).

Set a finger on each epicondyle and slowly flex and extend the elbow. The surrounding muscle tissue might move, but the epicondyles should remain stationary. Do they?



3.15 Posterior view of right elbow, palpating the lateral epicondyle

The ulnar nerve (p. 162), which creates the "funny bone" sensation when struck, courses between the medial epicondyle and the olecranon process.

Supracondylar Ridges of the Humerus

These two ridges extend proximally from the respective epicondyles of the humerus. Both serve as attachment sites for the forearm muscles. The lateral supracondylar ridge is located superficially, while the medial ridge sinks into the arm and is situated close to the ulnar nerve.

1) With your partner seated, shake hands and locate the medial epicondyle.
2) Move proximally from the medial epicondyle. The bony ridge which extends from the epicondyle is the medial supracondylar ridge (3.16). Roll your fingers back and forth across the ridge to sense its distinct edge.
3) Explore the lateral supracondylar ridge.

Can you follow the ridges proximally a few inches before they disappear under the muscles of the arm?

3.16 Exploring the supracondylar ridges

condyle	**kon**-dial	Grk. knuckle
epi-	**eh**-pee	Grk. above, upon
lateral	**lat**-er-al	L. to the side

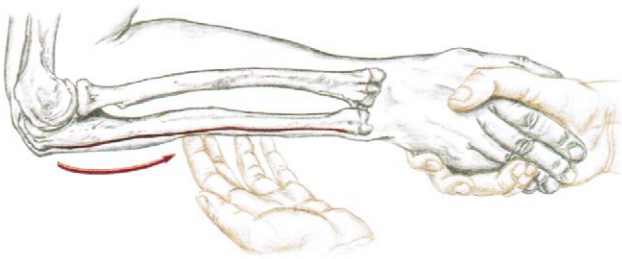
Trail 2 "The Razor's Edge"

Shaft of the Ulna

The long, straight shaft of the ulna extends from the olecranon process to the head of the ulna. Although numerous muscles lie beside the shaft, it has a superficial, palpable edge that runs along the forearm's posterior/medial aspect.

1) Shaking hands with your partner, locate the olecranon process. Slide your fingers distally along the shaft.
2) To define its shape and location, roll your fingers across its edge. Follow it down the length of the forearm.

Is the bone you are palpating superficial? Does it stretch the length of the forearm (3.17)?



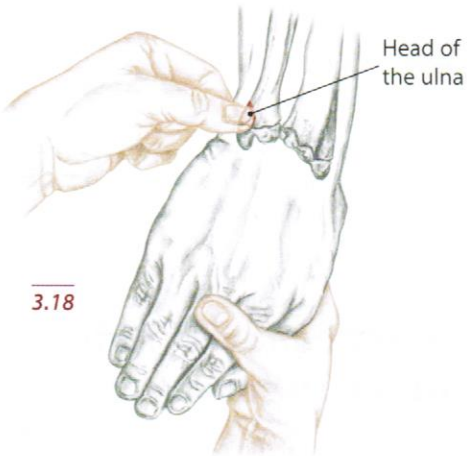
3.17 Lateral view of right forearm, palpating shaft of ulna

Head of the Ulna

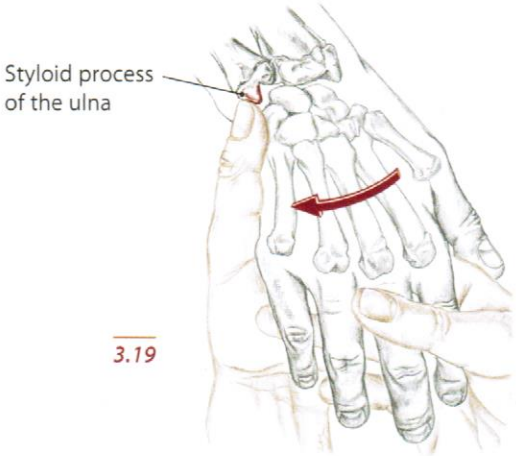
The shaft of the ulna swells to form the head of the ulna. The head is the superficial knob visible along the posterior/medial side of the wrist that can disrupt the placement of a watchband.

1) Slide your fingers distally along the ulnar shaft.
2) Just proximal to the wrist, the shaft will bulge to become the head of the ulna. Palpate all sides of the bulbous head (3.18).

Is the knob you are palpating connected to the shaft of the ulna? In a neutral position, is it on the posterior/medial side of the forearm?



3.18



3.19

Styloid Process of the Ulna

Both the ulna and the radius have styloid processes at their distal ends. The radius' styloid process (p. 118) is larger and extends farther distally. The ulna's styloid process is sharper and more pronounced. It is a toothlike projection pointing distally off the head of the ulna. It is located on the posterior/medial side of the wrist. Both styloid processes are superficial, and the tendons of the forearm muscles pass beside them.

1) Shake hands with your partner. Passively adduct the wrist to soften the surrounding tendons.
2) Use your thumb to locate the posterior aspect of the ulnar head. Slide distally off the head to palpate the small tip of the styloid process (3.19).

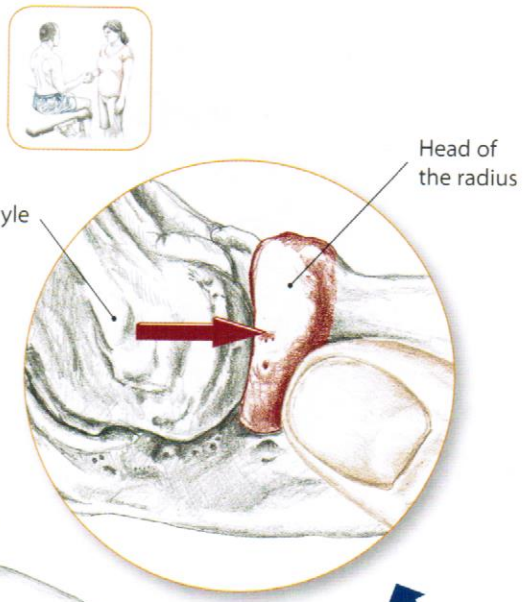
Is the bone you are palpating connected to the ulnar head (as opposed to a separate carpal bone)? If you slowly flex and extend the wrist, does it remain stationary?

Head of the Radius

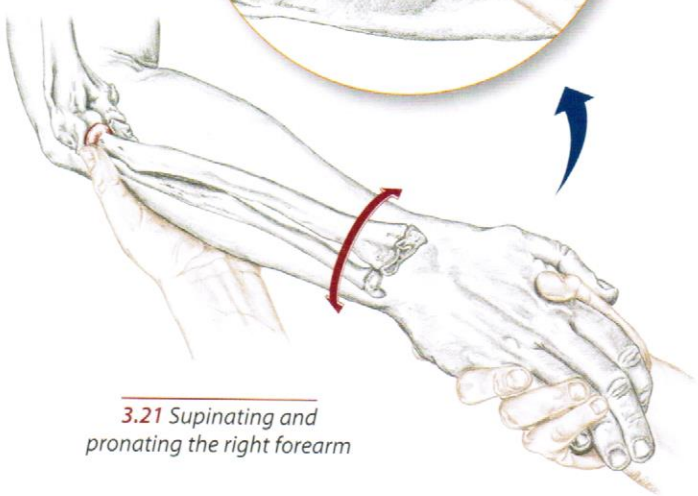
The head of the radius is distal to the humerus' lateral epicondyle. It forms the radius' proximal end and has a circular, bell shape. The head is stabilized by the annular ligament (p. 161) and is a pivoting point for supination and pronation of the forearm. Although it is deep to the supinator and extensor muscles, the head's posterior, lateral aspect can be accessed.

1) Shake hands with your partner and locate the lateral epicondyle.
2) Slide distally off the lateral epicondyle, across the small ditch between the humerus and radius and onto the head of the radius (3.20).
3) The head of the radius is the only bony structure in this vicinity. Explore its ring-shaped, superficial surface.

Are you distal to the lateral epicondyle? Place your thumb on the head and, with your other hand, slowly supinate and pronate the forearm (3.21). Do you feel the head's rotating movement under your thumb?



3.20



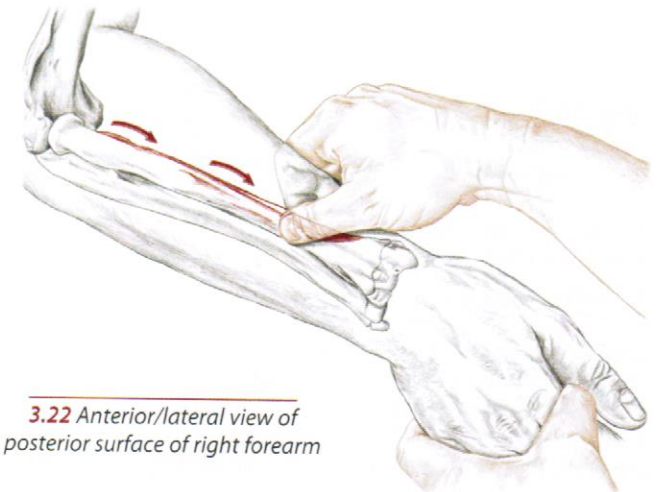
3.21 Supinating and pronating the right forearm

Shaft of the Radius

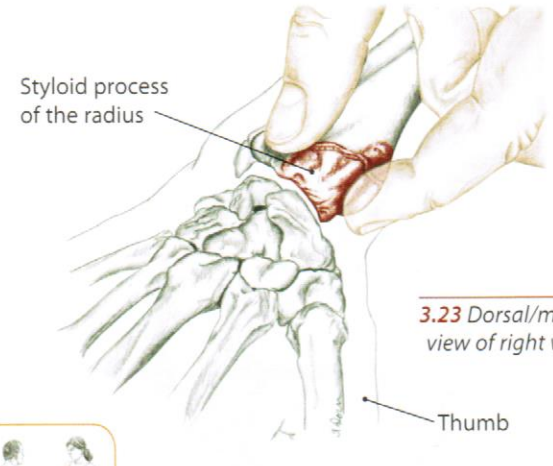
The shaft of the radius is located on the lateral side (thumb side) of the forearm. Unlike the superficial edge of the ulnar shaft, most of the shaft of the radius is buried under muscle tissue. Its distal portion, however, is superficial and can be directly accessed.

1) Flex the elbow to 90° and put the forearm in a neutral "handshake" position.
2) Locate the head of the radius. Slide distally off the head, noting how the radius sinks beneath the forearm muscles. Continue down the forearm and feel the radius become superficial near the wrist (3.22).
3) Along the distal forearm, explore all sides of the superficial shaft of the radius.

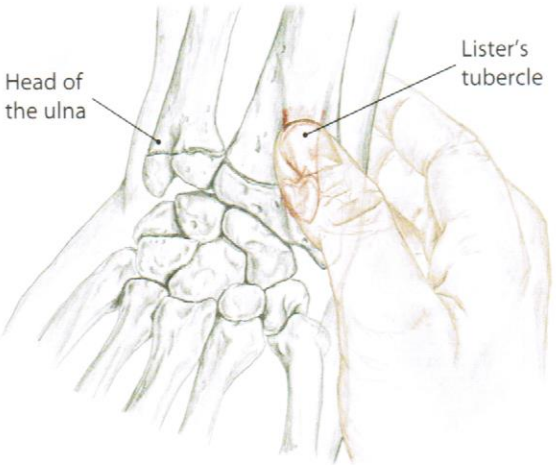
Is the bone you are palpating along the lateral side of the forearm? Place one hand upon the radial shaft, while the other hand slowly supinates and pronates the forearm. Do you feel the shaft of the radius pivot around the shaft of the ulna?



3.22 Anterior/lateral view of posterior surface of right forearm



3.23 *Dorsal/medial view of right wrist*



3.24 *Dorsal view of right wrist*

The styloid processes of the radius and ulna serve as important jumping-off points for locating the carpals. Locate both processes and determine if the radial styloid process extends farther distally than the ulnar. (It should.) Then explore just distal to the processes, noting how your fingers naturally sink into the tissue of the wrist. This is the general location of the proximal row of carpals.

Styloid Process of the Radius

The styloid process of the radius, in comparison to the toothlike styloid process of the ulna, is a wider, more substantial mound of bone. Located on the lateral side of the radius, the styloid process is surrounded by the extensor tendons and is the attachment site for the brachioradialis (p. 133).

1) Begin by grasping the distal radial shaft between your thumb and finger. Slide distally, noting how the radius broadens in all directions.
2) Palpate along the lateral side (thumb side) of the radius to the tip of the styloid process (3.23).

Are you proximal to the "flexor crease" of the wrist? Is the portion of bone you are palpating surrounded by several thin tendons? If you passively flex and extend the wrist, the styloid process should remain stationary. Does it?

Lister's Tubercle

Named in honor of Joseph Lister, father of modern antiseptic surgery, this superficial knob is located on the dorsal surface of the radial styloid process. With its oblong shape, Lister's tubercle (also known as the dorsal tubercle) acts as a hook for the extensor pollicis longus tendon (p. 151). For our purposes, however, it will serve as a bench mark for finding two of the carpals—the lunate and capitate.

1) Using your thumb, locate the dorsal surface of the styloid process of the radius.
2) Slide your thumb in the direction of the head of the ulna and explore for the oblong knob of Lister's tubercle.
3) The tubercle will be felt directly across from the head of the ulna—perhaps an inch away (3.24).

Are you on the dorsal surface of the radius? Is the bump you feel superficial, oval and across from the head of the ulna? If you passively flex and extend the wrist, the tissue over the tubercle should move, yet the tubercle itself should stay stationary. Does it?

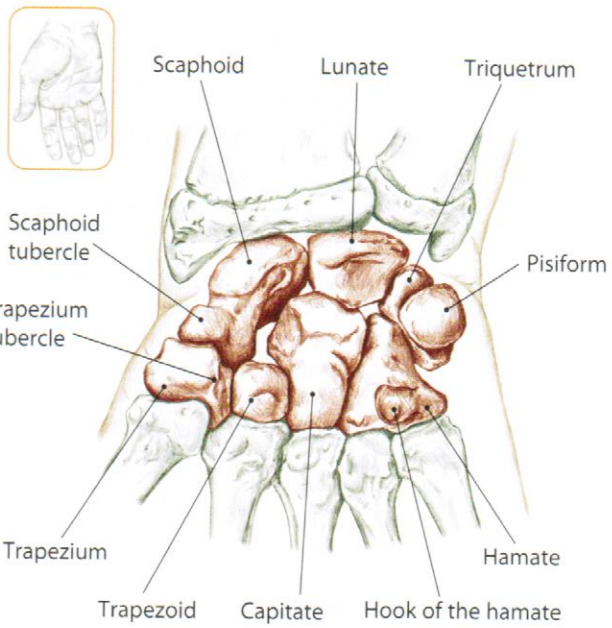
styloid **sti**-loyd Grk. a pillar

Carpals

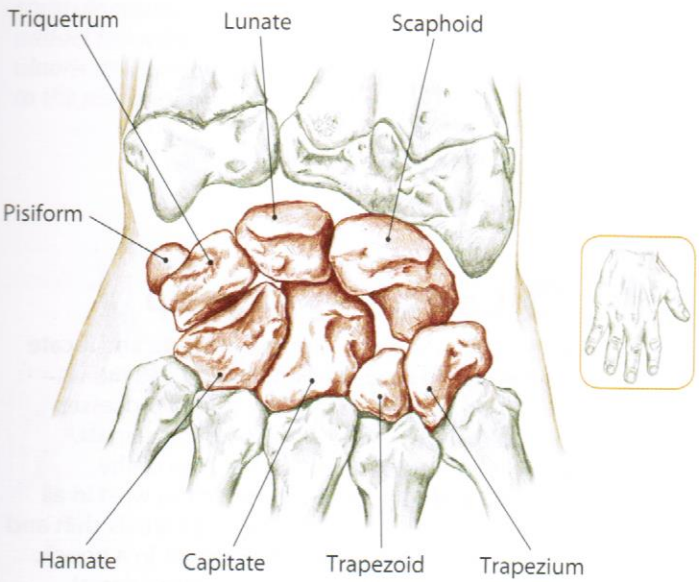
There are eight carpal bones located at the wrist. Small and uniquely shaped, the carpals are closely wedged together between the distal radius and ulna and the metacarpals. The carpals form two rows, each composed of four bones (3.27).

Located distal to the flexor crease at the wrist, under the heel of the hand, the carpals lie deep to numerous flexor and extensor tendons. These overlying tendons, combined with the carpals' compact arrangement, make isolating individual bones a challenge.

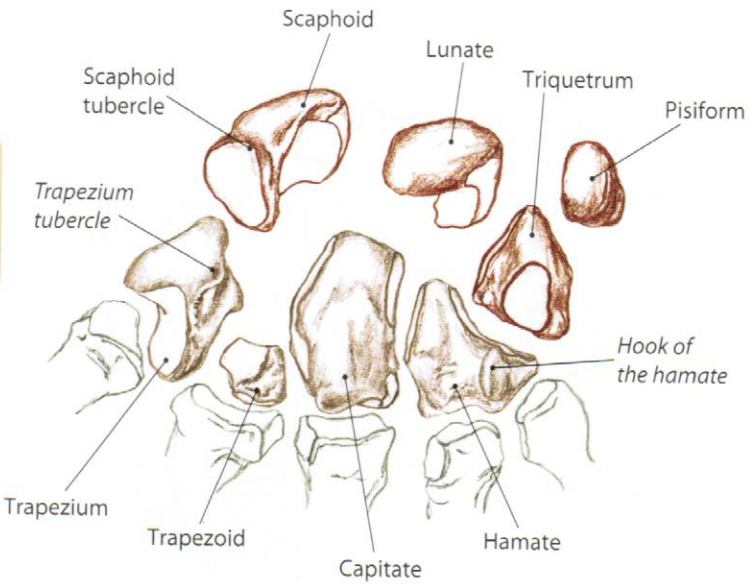
The next few pages present the carpals in pairs. We will begin by exploring the carpals as one large group. We will then access the pisiform, triquetrum and the hamate, as these are possibly the easiest to isolate.



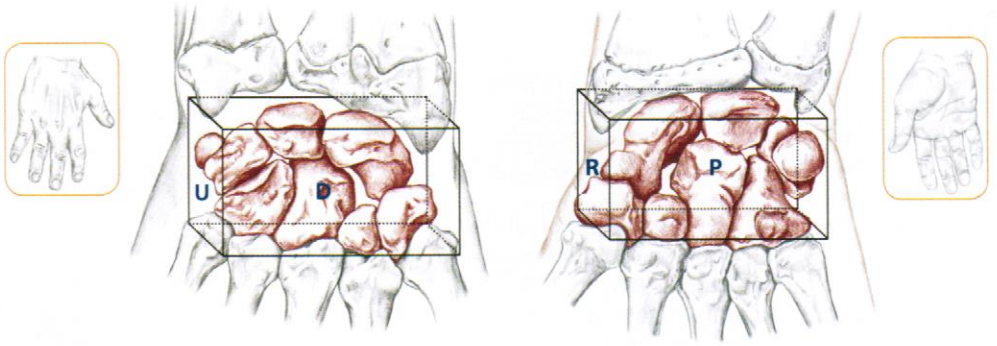
3.25 Palmar view of right wrist



3.26 Dorsal view of right wrist

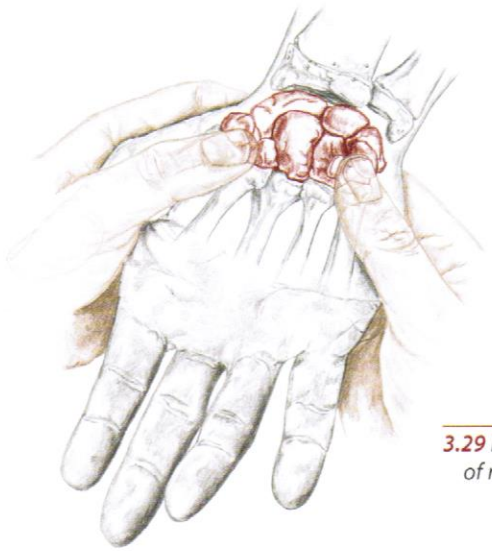


3.27 The expanded carpals—palmar view of right hand. The scaphoid, lunate, triquetrum and pisiform form the proximal row, while the trapezium, trapezoid, capitate and hamate make up the distal row.



Ulnar/dorsal view of right wrist *Radial/palmar view of right wrist*

3.28 Luckily, the wrist has four surfaces from which to explore—the Palmar, Dorsal, Radial and Ulnar sides. Some carpals are accessible from one side of the wrist, while others can be explored from a few sides. In any case, exploring all of the wrist's surfaces will allow you to feel at least a portion of each carpal.

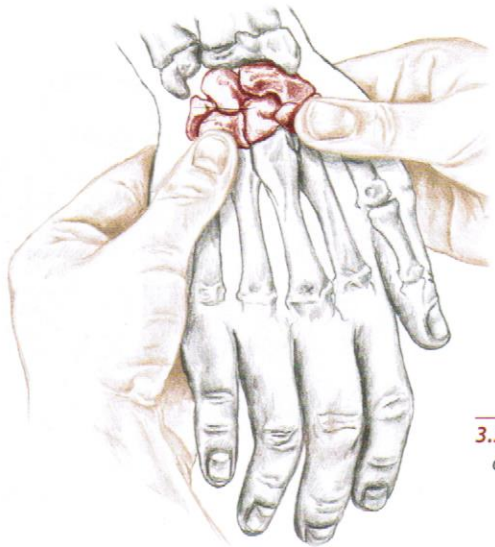


3.29 Palmar view of right hand

Carpals as a Group

1) Position the hand with the palm up and locate the styloid processes of the ulna and radius.
2) Sliding just distal from the styloid processes, explore the palmar surface for the carpals.
3) Rest your thumbpads on the heel of the hand and then passively move the wrist in all directions (3.29). Note how the carpals shift and undulate slightly, like small stones in a pouch. Turn the hand over and explore the dorsal surface (3.30).

Are you distal to the wrist's flexor crease? When the wrist is flexed, can you sense how the carpals press into the palm of the hand? When the wrist is extended, can you feel the carpals shift and become more prominent on the hand's dorsal surface?



3.30 Dorsal view of right hand

carpal	**kar**-pul	hamate	**ham**-ate
metacarpal	**met**-a-**kar**-pul	lunate	**lu**-nate
phalanges	fa-**lan**-jeez		

Pisiform

The knobby pisiform is an attachment site for the flexor carpi ulnaris (p. 140). Protruding along the ulnar/palmar surface of the wrist, the pisiform is just distal to the flexor crease.

1) Locate the flexor crease of your partner's wrist. Then slide over to the "pinky" side of the crease.
2) Move slightly distal to the crease, rolling your thumbpad in small circles. Explore under the thick tissue of the palm for the nuggetlike pisiform (3.31).

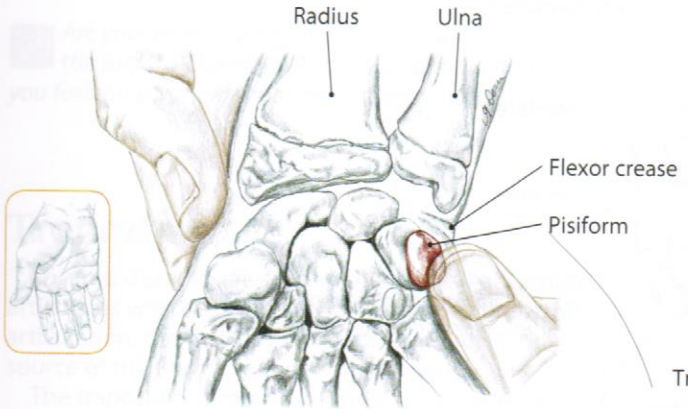
Passively flex the wrist and notice how the pisiform can be wiggled from side to side (3.32). Extend the wrist and observe how it becomes immobile. (This immobility is due to the tension created by the flexor carpi ulnaris tendon.) Then ask your partner to actively adduct her wrist. Can you feel the tendon of flexor carpi ulnaris as it comes down the medial wrist and attaches to the pisiform?

Triquetrum

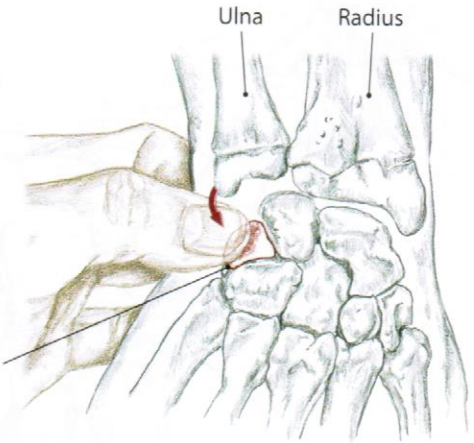
This pyramid-shaped bone is located on the dorsal surface of the pisiform, just distal to the styloid process of the ulna. In a neutral position, only the dorsal surface of the triquetrum is palpable; however, abduction shifts the triquetrum so it is accessible on the wrist's ulnar surface.

1) With the palm of your partner's hand facing away from you, locate the styloid process of the ulna. Slide distally, noting a slender ditch, before rising to the surface of the triquetrum (3.33).
2) Keeping your finger stationary, abduct the wrist and note how the triqetrum protrudes to the side (3.34). Adduct and feel the bone disappear back into the wrist.

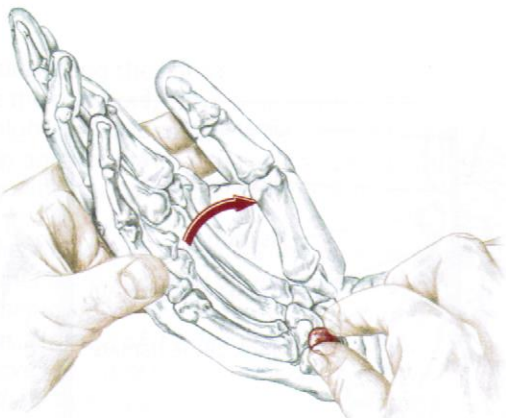
During abduction and adduction, do you feel the triquetrum protrude and then disappear? Locate the pisiform on the wrist's palmar surface. Can you locate the triquetrum by beginning at the pisiform and slowly sliding around to the ulnar side of the wrist?



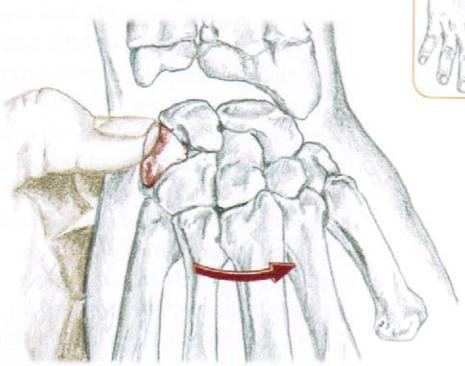
3.31 *Palmar surface of right hand*



3.33 *Dorsal view of right hand with wrist in neutral, accessing the triquetrum*

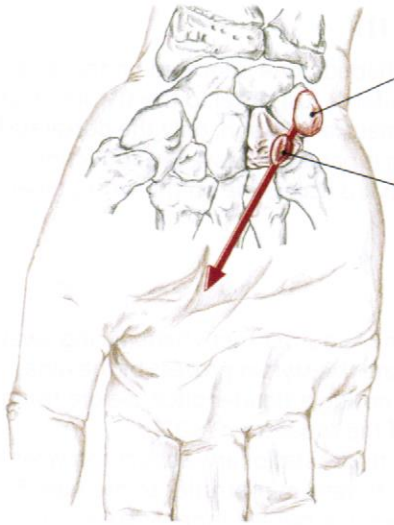


3.32 *Ulnar view of right hand, isolating the pisiform*



3.34 *Dorsal view of right hand with wrist abducted, palpating the triquetrum*

pisiform	**pi**-si-form	trapezium	tra-**pee**-ze-um
scaphoid	**skaf**-oyd	triquetrum	tri-**kwe**-trum
styloid	**sti**-loyd		



3.35 Palmar view of right hand

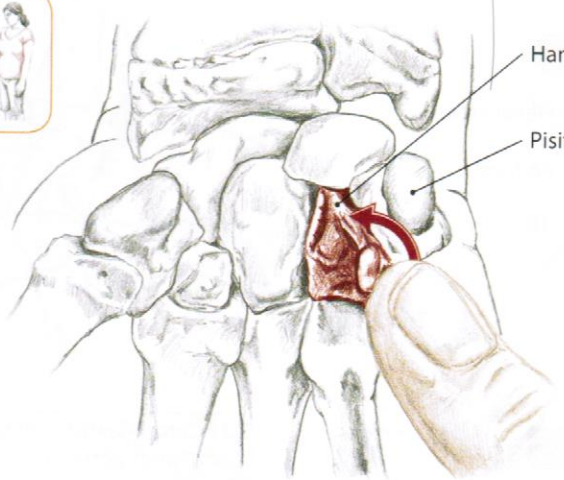
Keeping your thumbpad in place and rolling it gently around the hook will give you the best sense of its shape and locale!

Hamate

Located distal to the pisiform, the hamate has a small protuberance or "hook" that is palpable on the hand's palmar surface. The pisiform and the hook of the hamate serve as medial attachment sites for the flexor retinaculum, the connective tissue band that forms the "roof" of the carpal tunnel. The flat surface of the hamate's body is accessible on the hand's dorsal surface where the bases of the fourth and fifth metacarpals merge. When palpated, the hook is often tender.

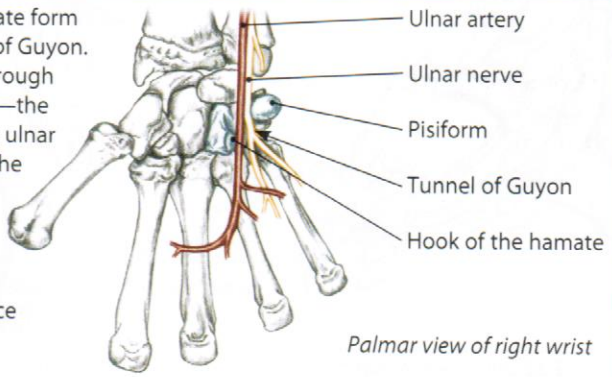
1) Locate your partner's pisiform. Draw an imaginary line from the pisiform to the base of the index finger (3.35).
2) Using your thumbpad, slide off the pisiform along this line. Approximately half of an inch from the pisiform, explore for this subtle mound beneath the padding of the hand (3.36).

Are you between the pisiform and the base of the index finger? Using gentle pressure, can you sense a small ditch between the pisiform and the hook of the hamate?



3.36 Palmar view of right wrist, encircling the hook of the hamate

The pisiform and hook of the hamate form a small channel called the Tunnel of Guyon. The ulnar nerve and artery pass through this canal, under shelter of its roof—the pisohamate ligament (p. 165). The ulnar nerve is particularly vulnerable in the vicinity of the Tunnel of Guyon to compression injuries. Activities such as repeated use of a pneumatic jackhammer or leaning on the handlebars during long-distance bicycling can put chronic pressure on the nerve.



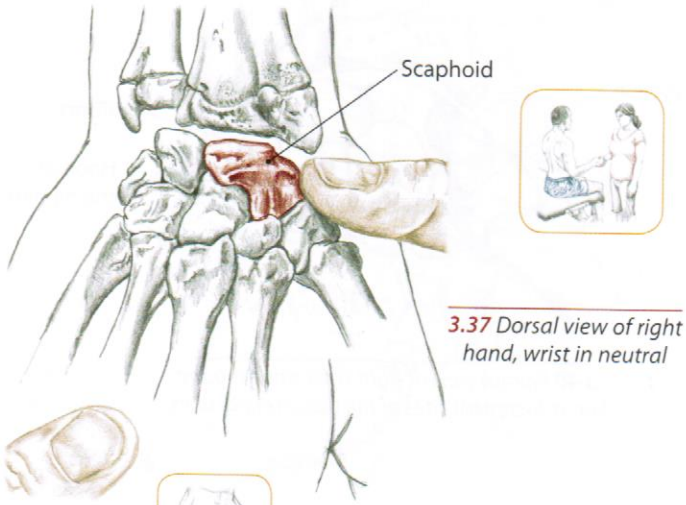
Palmar view of right wrist

Scaphoid

The peanut-shaped scaphoid (or navicular) is the most commonly fractured carpal. It is located on the radial side of the hand, distal to the styloid process of the radius. Although the scaphoid forms the floor of the tendinous "anatomical snuffbox" (p. 153), it is still accessible from the dorsal, palmar and radial sides of the wrist.

1) Beginning on the wrist's radial surface, locate the radius' styloid process. Slide your thumb distally off the process, falling between the superficial tendons and into the natural ditch where the scaphoid will be found (3.37).
2) Maintain your position and passively adduct the wrist. As you do so, feel for the scaphoid to bulge into your thumb (3.38). Now abduct the wrist and feel how the scaphoid disappears back into the wrist.
3) From here, explore the scaphoid's dorsal and palmar surfaces. On the palmar surface, along the flexor crease, is the scaphoid tubercle (p. 124).

Are you distal to the end of the styloid process of the radius? During adduction and abduction, do you feel the scaphoid protrude and then disappear?



3.37 Dorsal view of right hand, wrist in neutral

3.38 Dorsal view of right hand, wrist adducted

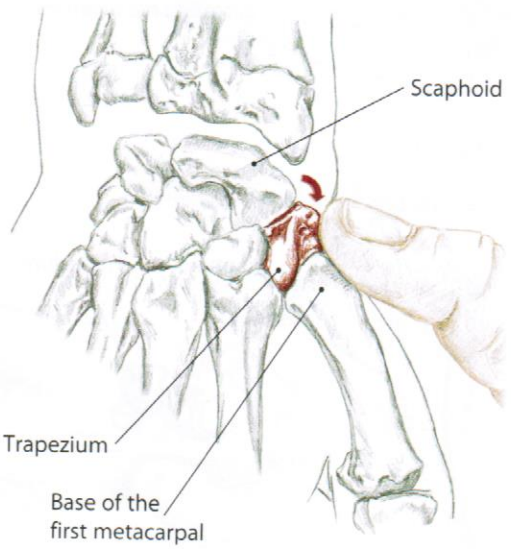
Trapezium

Located distal to the scaphoid, the small trapezium articulates with the base of the first metacarpal. This articulation, the first carpometacarpal joint, is the source of the thumb's unique movements.

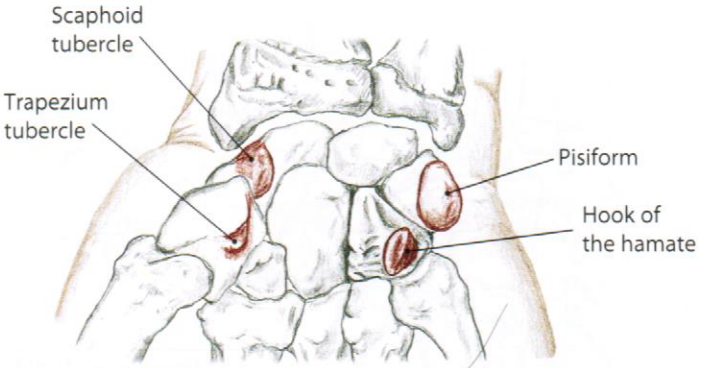
The trapezium is most accessible on its radial or dorsal side, and can be isolated either distally from the scaphoid or proximally from the first metacarpal.

1) Palpating along the hand's radial/dorsal side, locate the scaphoid. Then slide distally (3.39).
2) You might, by accident, pass the trapezium and ride up onto the base of the first metacarpal. If so, simply slide back proximally to the trapezium.

To check if you are indeed feeling the base of the first metacarpal instead of the trapezium, ask your partner to slowly flex and extend his thumb. With this action, the base of the first metacarpal should clearly move. To check for the trapezium: Are you distal to the scaphoid and proximal to the base of the first metacarpal?



3.39 Dorsal view of right hand



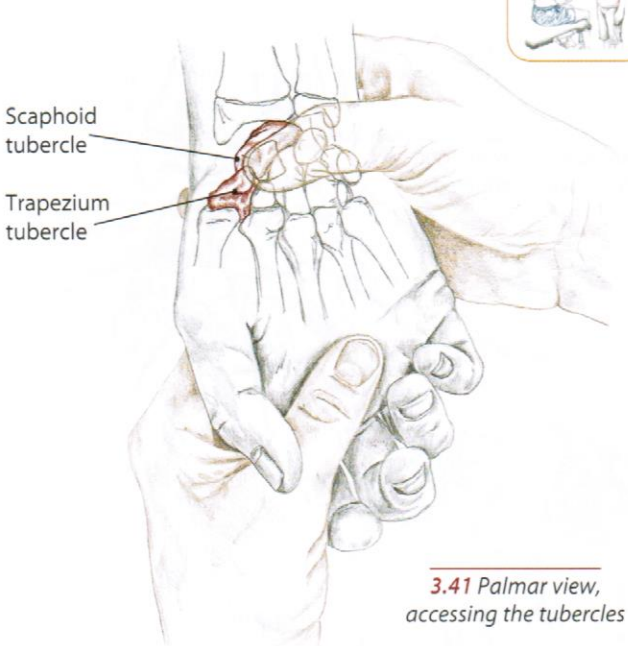
3.40 Palmar view of right wrist, showing the four attachment sites of the flexor retinaculum

Scaphoid and Trapezium Tubercles

The scaphoid and trapezium tubercles serve as lateral attachment sites for the flexor retinaculum (p. 163), the connective tissue band that forms the "roof" of the carpal tunnel (3.40). Both tubercles are located on the palmar surface of the wrist, near the flexor crease. Oftentimes, the tubercles are situated so closely to each other that they are difficult to distinguish individually. The two, however, are palpable, either separately or together.

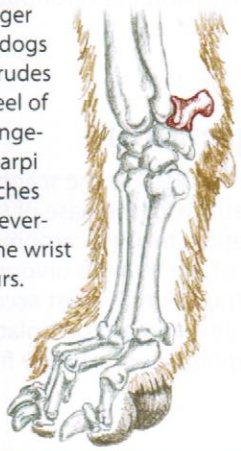
1) Locate the radial surface of the scaphoid, along the flexor crease. Then walk your thumb around to the palmar side of the scaphoid.
2) Using your thumbpad, explore just distal to the flexor crease for a prominent, bony knob (3.41).
3) Flex the wrist slightly to soften the surrounding tissue (3.42).

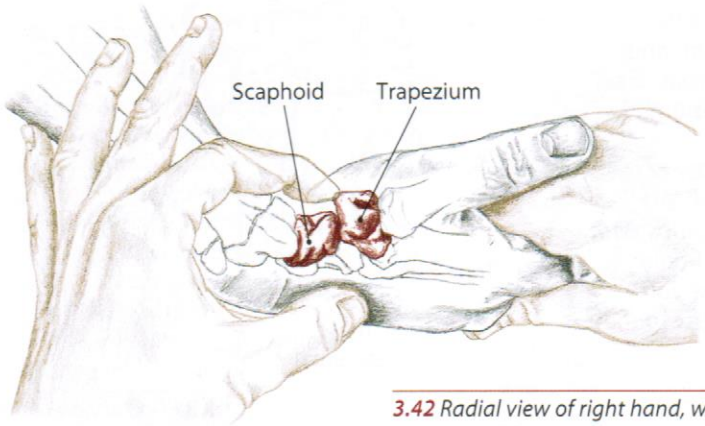
Are you distal to the end of the styloid process of the radius?



3.41 Palmar view, accessing the tubercles

The pisiform is much larger on quadrupeds such as dogs (right), on whom it protrudes posteriorly above the heel of the front paw. This arrangement allows the flexor carpi ulnaris muscle that attaches to the pisiform greater leverage and power to flex the wrist when running on all fours. A human's pisiform is only a pea-sized knob. It is, nevertheless, still useful for kneading bread dough.





3.42 Radial view of right hand, wrist flexed

Lunate and Capitate

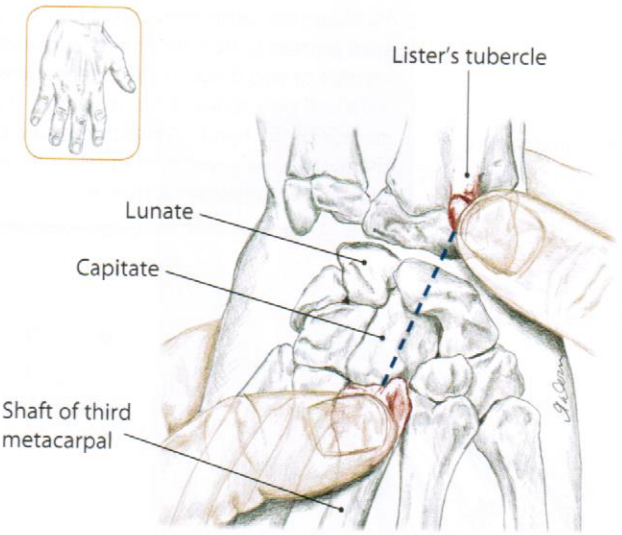
The **lunate** is the most frequently dislocated carpal. Located distal and medial to Lister's tubercle (p. 118), it is relatively inaccessible when the wrist is in a neutral position; flexing the wrist, however, will slide the lunate to the dorsal surface.

The **capitate** is the largest of the carpals and is located distal to the lunate. It has a shallow ditch on its dorsal surface that can be easily palpated.

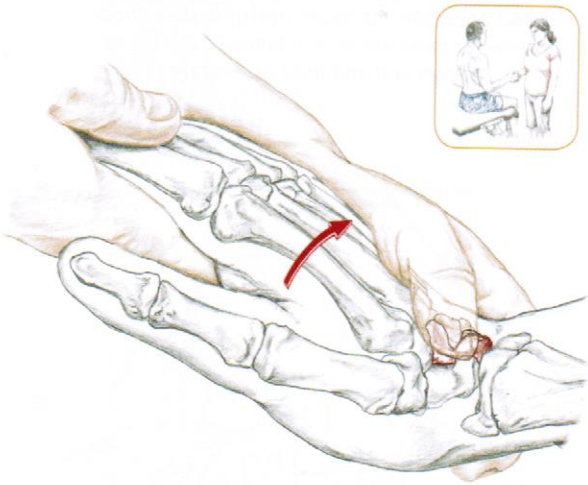
Although the lunate and capitate lie deep to the extensor tendons, both carpals are accessible on their dorsal surfaces and can be isolated between Lister's tubercle and the shaft of the third metacarpal (3.43).

1) Locate Lister's tubercle and the base of the third metacarpal. With the wrist slightly extended, lay your thumb between these points and notice how it falls into a small cavity. This is the location of the lunate and capitate (3.44).
2) Set your thumb at the proximal end of this cavity. Then flex the wrist and feel the lunate press into your finger (3.45). Next extend the wrist and feel this carpal disappear back into the wrist.
3) Shift your thumb to the distal end of the cavity and notice how it bumps into the base of the third metacarpal. Passively flex the wrist, noting how the capitate rolls into your finger, "filling" its own cavity.

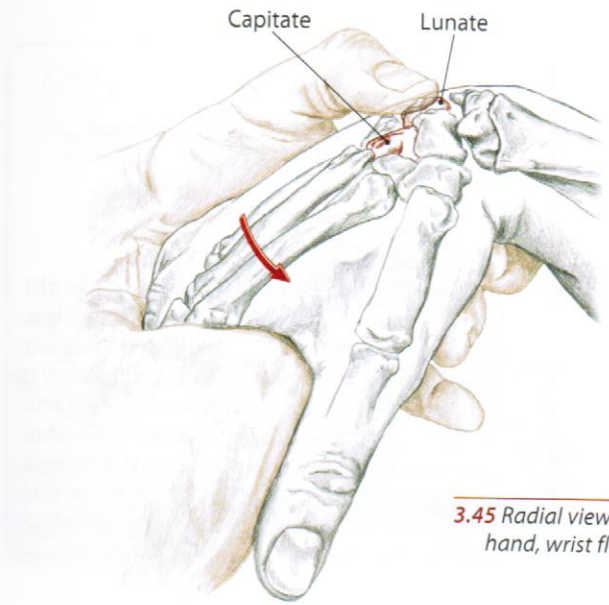
Are you between Lister's tubercle and the shaft of the third metacarpal? When isolating the lunate are you distal and lateral to the edge of Lister's tubercle? Do you feel a small knob press into your thumb upon flexion?



3.43 Dorsal view of right wrist. With the wrist in neutral, draw an imaginary line between Lister's tubercle and the base of the third metacarpal, marking out the location of the capitate.



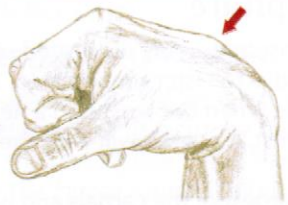
3.44 Radial view of right hand, wrist extended

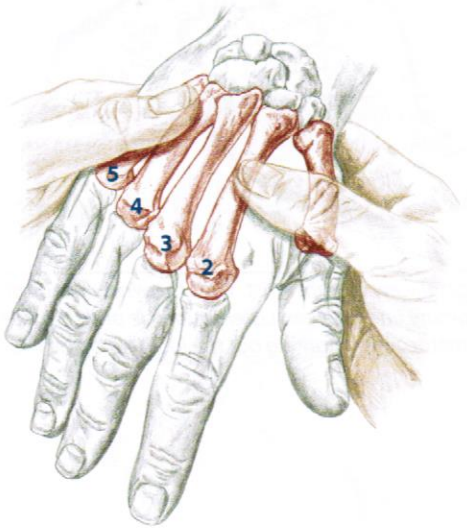


3.45 Radial view of right hand, wrist flexed

capitate **kap**-i-tate L. head-shaped
lunate **lu**-nate L. crescent-shaped

To locate the carpometacarpal joints (right), ask your partner to flex her fingers and wrist. Roughly an inch or two distal to the extensor crease at the wrist will be a series of bumps across the dorsal surface of the hand. These bumps are the bases of the metacarpals which articulate with the carpals to form the carpometacarpal joints.





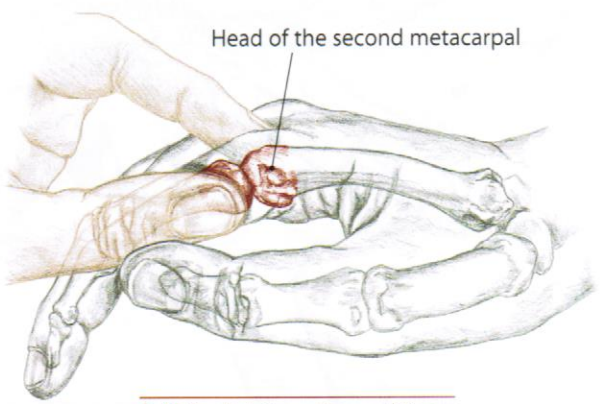
3.46 *Notice how the fourth and fifth metacarpals allow for more movement between them than the second and third metacarpals*

Metacarpals and Phalanges

The fingers contain no muscles, only the tendons of the digitorum muscles and strong ligaments which hold together the phalanges of each finger.

1) Palpate the dorsal surface of your partner's hand and feel the superficial metacarpal shafts. Explore the space between the metacarpals for the interossei muscles (p. 157). Then gently undulate the metacarpals up and down (3.46).
2) Turn the hand over, and explore the metacarpals and phalanges from the palmar surface, noting how they lie deep to the tissues of the palm (3.47).
3) Move distally and explore where the heads of the metacarpals join with the phalanges to form the large metacarpophalangeal "knuckle" joints (3.48). Passively flex a metacarpophalangeal joint and distinguish between the head of the metacarpal and the base of the proximal phalange.
4) Move distally to the phalanges and isolate the slender tendons, ligaments and connective tissue of the fingers. Also note the absence of any muscle tissue.

3.47 *Palmar view of right hand*



3.48 *Radial view of second finger*

metacarpophalangeal **met**-a-**kar**-po-**fa**-lan-**jee**-al

Muscles of the Forearm and Hand

The muscles of the forearm primarily create movement at the wrist and fingers. Many have small, fusiform bellies that connect to space-efficient tendons in the lower forearm. These tendons extend distally into the wrist, hand and fingers. The crowded muscle bellies and tendons of the forearm can be challenging to isolate. To simplify matters, the muscles of this chapter have been arranged into four primary groups:

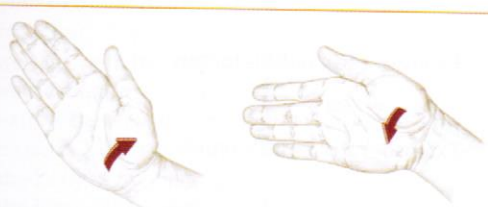
a) Muscles that act primarily at the **elbow**:
- Brachialis
- Brachioradialis

b) Muscles that move the **wrist and/or fingers** (*carpi*, *digitorum* or *palmaris* muscles). This group can be further subdivided into four smaller groups:
- Extensors of the wrist and fingers
- Flexors of the wrist and fingers
- Adductors of the wrist
- Abductors of the wrist

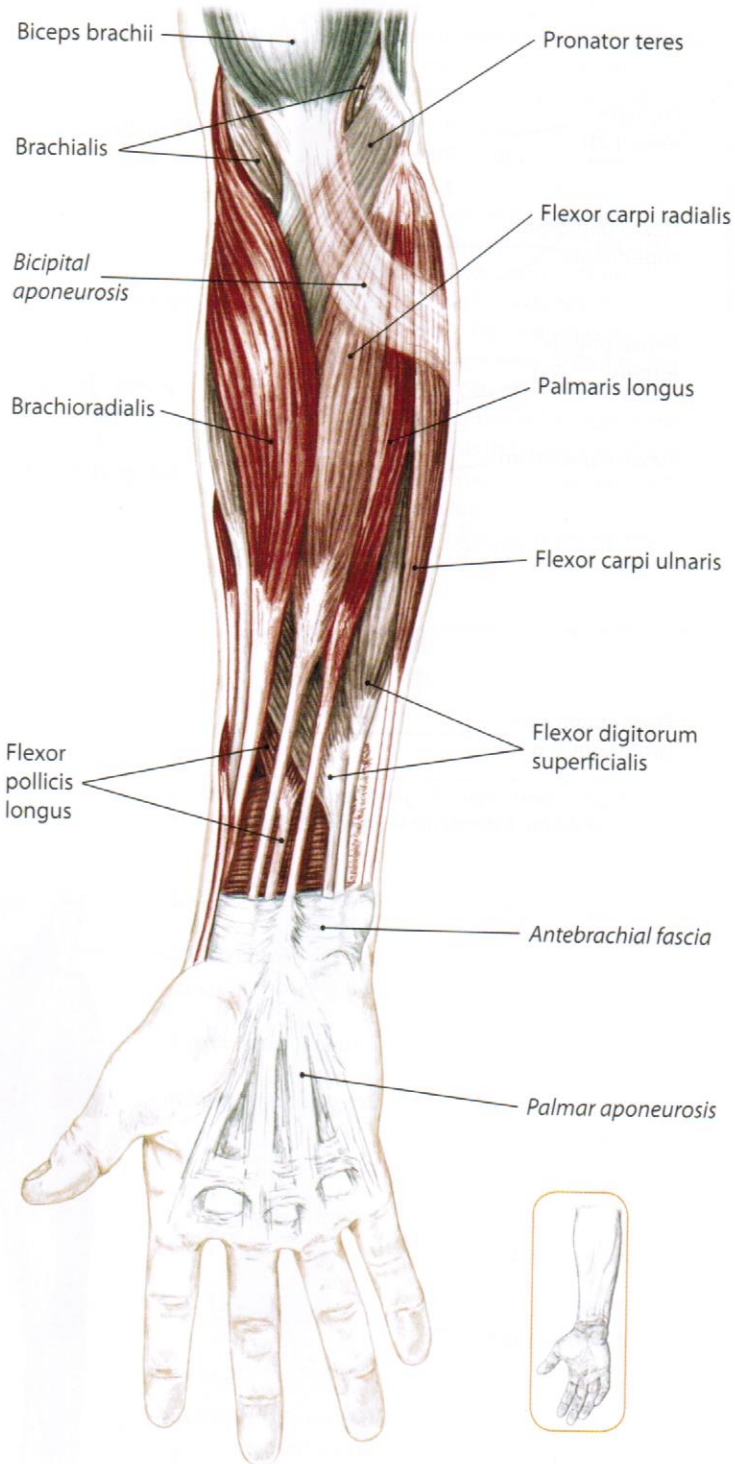
(Some muscles that act upon the wrist can actually move it in two directions. Flexor carpi ulnaris, for example, both flexes and adducts the wrist.)

c) Muscles that create the pivoting action between the **radius and ulna**:
- Pronator teres
- Pronator quadratus
- Supinator

d) Short and long muscles that maneuver the **thumb** (*pollicis* muscles).

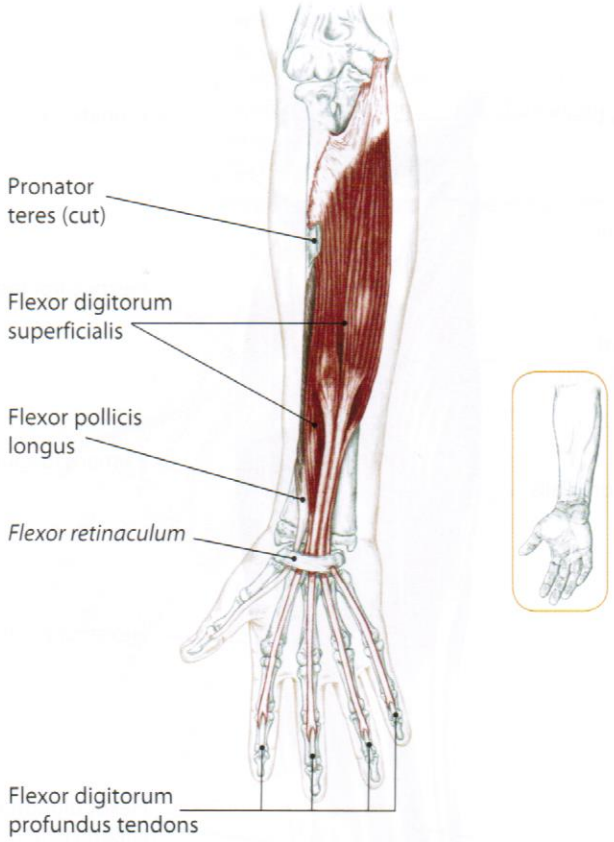


Distinguishing between abduction (left) and adduction (right) of the wrist can be confusing if the forearm is pronated or supinated. For instance, if you pronate your forearm (palm toward the floor) and then adduct at the wrist, your hand will move away from the centerline of your body and it will appear as though you have abducted your wrist. Not so: Both adduction and abduction remain the same regardless of the forearm's position.

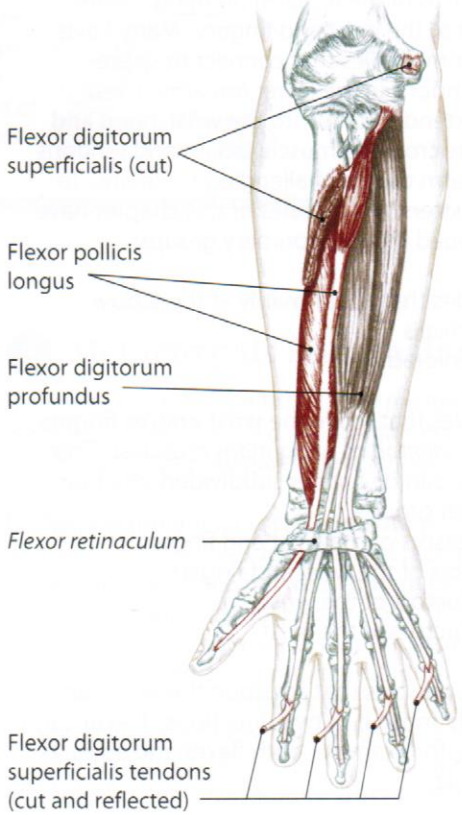


3.49 Anterior view of right forearm and hand, skin removed from palm of hand

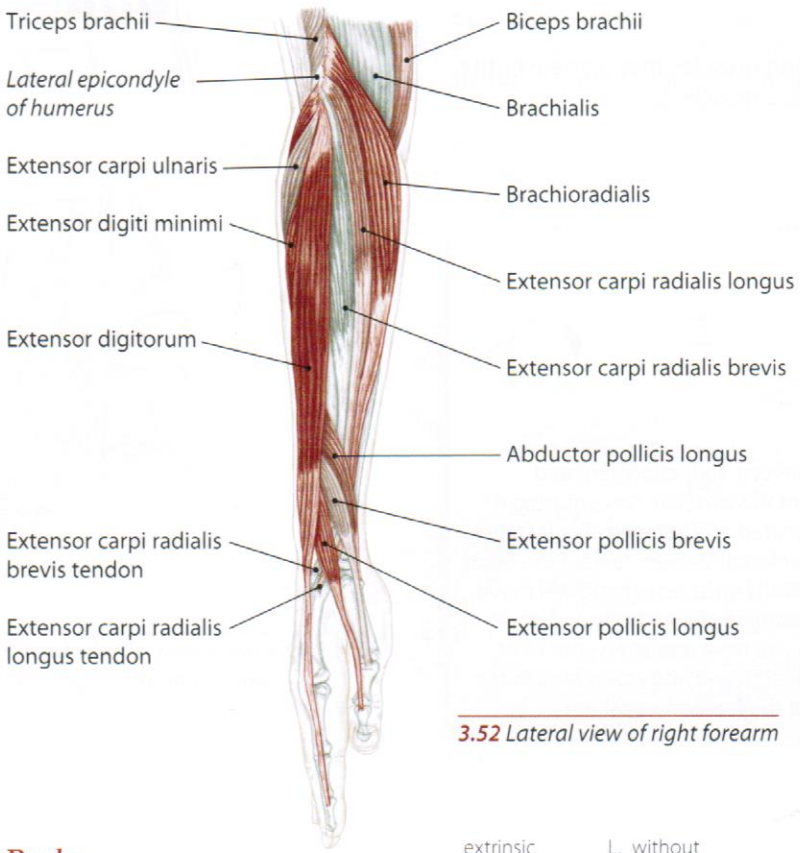
Muscles of the Forearm and Hand



3.50 *Anterior view of right forearm and hand showing intermediate layer of muscles*



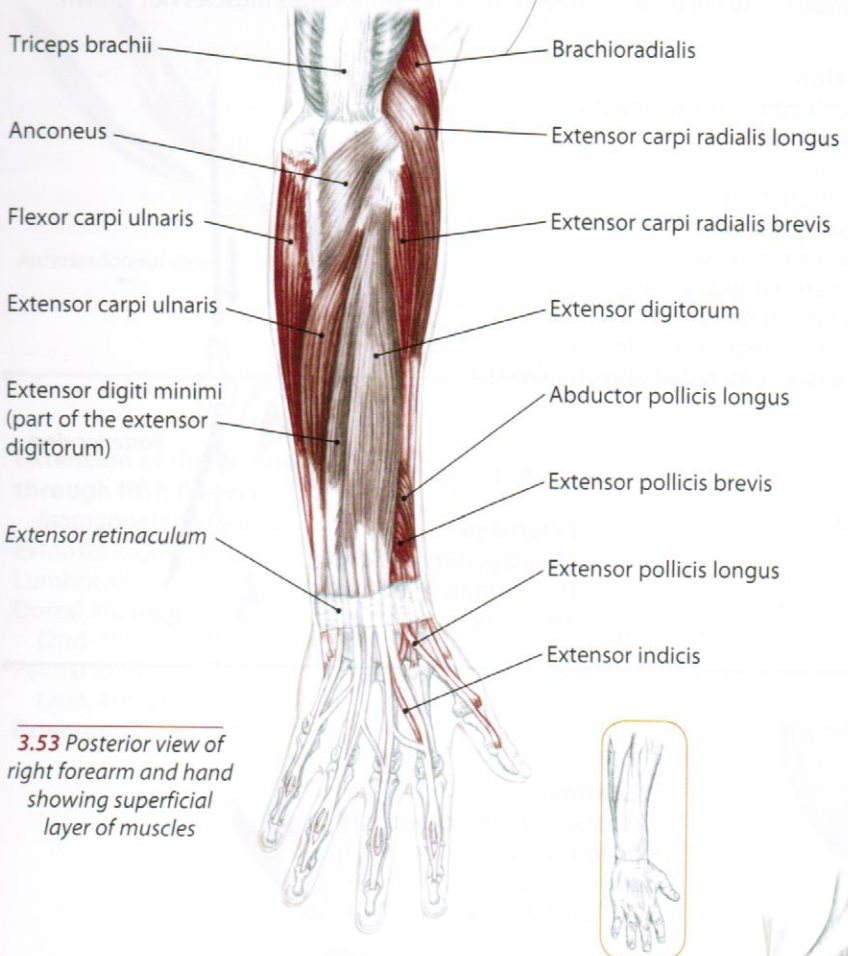
3.51 *Anterior view of right forearm and hand showing deep layer of muscles*



3.52 *Lateral view of right forearm*

extrinsic L. without
intrinsic L. within

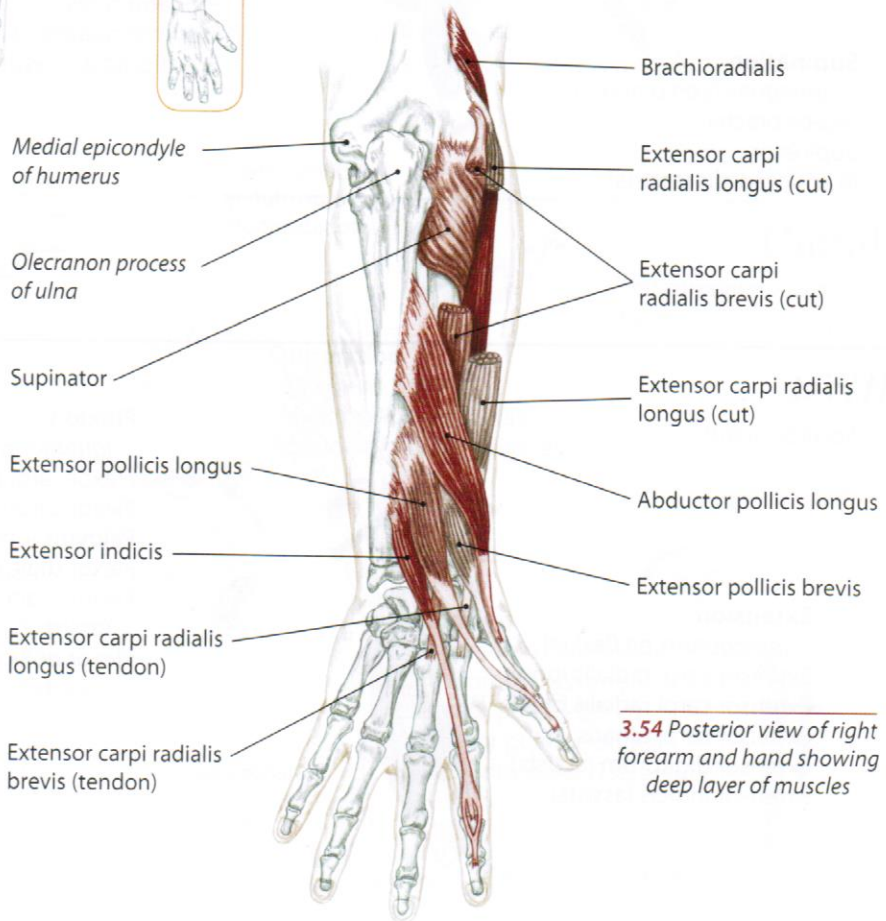
Muscles of the Forearm and Hand



3.53 Posterior view of right forearm and hand showing superficial layer of muscles

The names of the forearm muscles can be a mouthful. Nevertheless, these same names can be very helpful when it comes to understanding a muscle's function, location and more. Take, for example, the muscle **extensor carpi radialis longus**. What does its name reveal?

1) It is specified as an *extensor*, so it extends. This also indicates that there is a *flexor* carpi radialis.
2) *"Carpi"* means it extends the carpals (wrist joint). This indicates there is also a different muscle that moves the *digits*—extensor digitorum.
3) It runs along the *radial* side of the forearm. This indicates that there is also an extensor carpi ulnaris on the *ulnar* side.
4) If there is a *longus*, there must also be a *brevis*—extensor carpi radialis brevis.



3.54 Posterior view of right forearm and hand showing deep layer of muscles

The next time a tavern drunkard threatens to punch you in the nose, catch him off guard by inquiring, "Will you deliver that blow with your **extrinsic** or **intrinsic** muscles?" The long muscles with bellies in the forearm are the extrinsics, while the short muscles with bellies in the body of the hand are the intrinsics (p. 157).

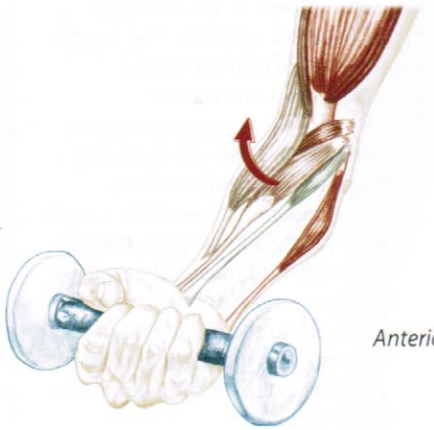
While the ruffian ponders your query (the correct answer would be "both"), you will have hopefully used the extrinsic and intrinsic muscles of your legs and feet—the same relationship applies—to tip-toe out of the tavern and into the street.

Synergists–Muscles Working Together

Muscles are listed in the order of their ability to create the movement. Asterisk indicates muscles not shown.

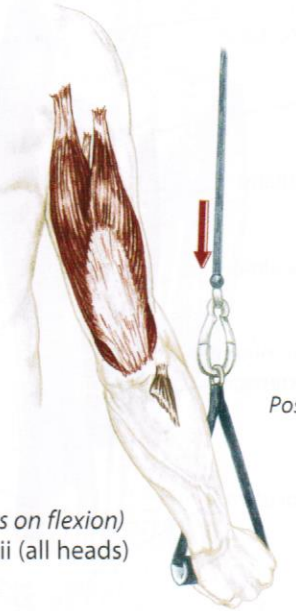
Elbow

(humeroulnar and humeroradial joints)



Anterior/medial view

Flexion
(antagonists on extension)
Biceps brachii
Brachialis
Brachioradialis
Flexor carpi radialis (assists)
Flexor carpi ulnaris (assists)
Palmaris longus (assists)
Pronator teres (assists)
Extensor carpi radialis longus (assists)*
Extensor carpi radialis brevis (assists)*



Posterior view

Extension
(antagonists on flexion)
Triceps brachii (all heads)
Anconeus

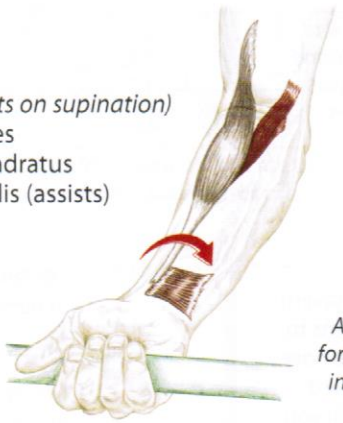
Forearm

(proximal and distal radioulnar joints)

Supination
(antagonists on pronation)
Biceps brachii
Supinator
Brachioradialis (assists)

Anterior view, forearm rotating into supination

Pronation
(antagonists on supination)
Pronator teres
Pronator quadratus
Brachioradialis (assists)

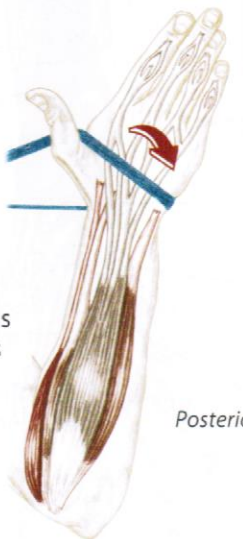


Anterior view, forearm rotating into pronation

Wrist

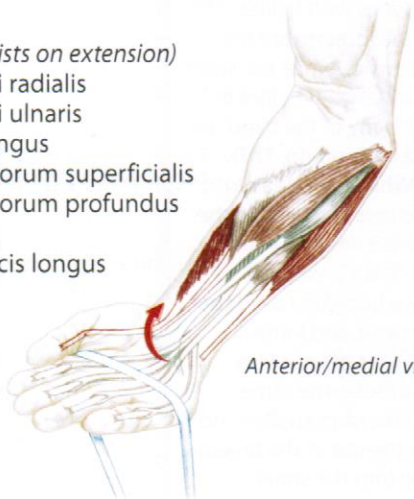
(radiocarpal joint)

Extension
(antagonists on flexion)
Extensor carpi radialis longus
Extensor carpi radialis brevis
Extensor carpi ulnaris
Extensor digitorum (assists)
Extensor indicis (assists)



Posterior view

Flexion
(antagonists on extension)
Flexor carpi radialis
Flexor carpi ulnaris
Palmaris longus
Flexor digitorum superficialis
Flexor digitorum profundus (assists)*
Flexor pollicis longus (assists)*

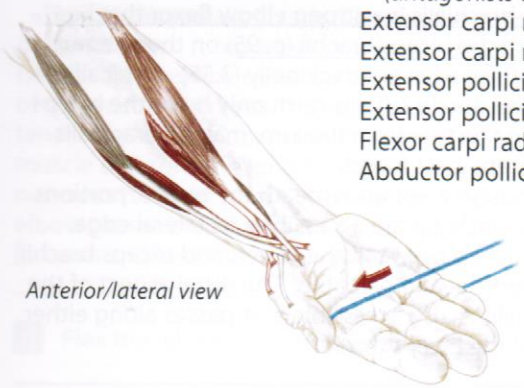


Anterior/medial view

Wrist

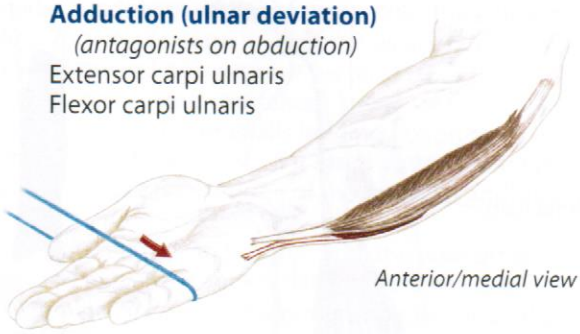
(radiocarpal joint)

Abduction (radial deviation)
(antagonists on adduction)
Extensor carpi radialis longus
Extensor carpi radialis brevis
Extensor pollicis longus
Extensor pollicis brevis
Flexor carpi radialis
Abductor pollicis longus



Anterior/lateral view

Adduction (ulnar deviation)
(antagonists on abduction)
Extensor carpi ulnaris
Flexor carpi ulnaris



Anterior/medial view

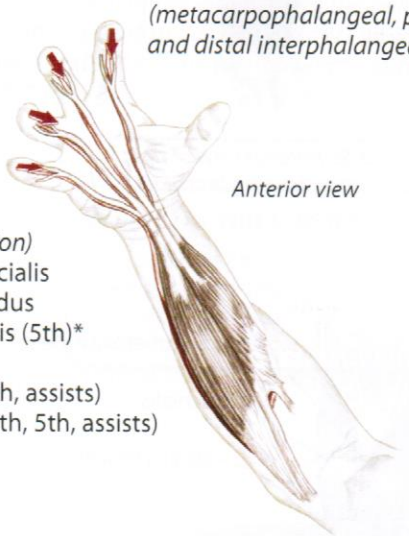
Hand and Fingers

(metacarpophalangeal, proximal and distal interphalangeal joints)

Extension of the second through fifth fingers
(antagonists on flexion)
Extensor digitorum
Lumbricals
Dorsal interossei
(2nd-4th, assists)
Palmar interossei
(2nd, 4th, 5th, assists)
Extensor indicis (2nd)*

Posterior view

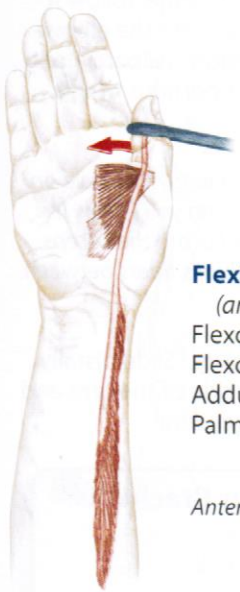
Flexion of the second through fifth fingers
(antagonists on extension)
Flexor digitorum superficialis
Flexor digitorum profundus
Flexor digiti minimi brevis (5th)*
Lumbricals
Dorsal interossei (2nd-4th, assists)
Palmar interossei (2nd, 4th, 5th, assists)



Anterior view

Thumb

(first carpometacarpal and metacarpophalangeal joints)

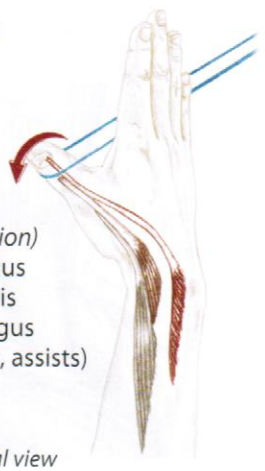


Flexion
(antagonists on extension)
Flexor pollicis longus
Flexor pollicis brevis*
Adductor pollicis (assists)
Palmar interossei (1st, assists)*

Anterior view

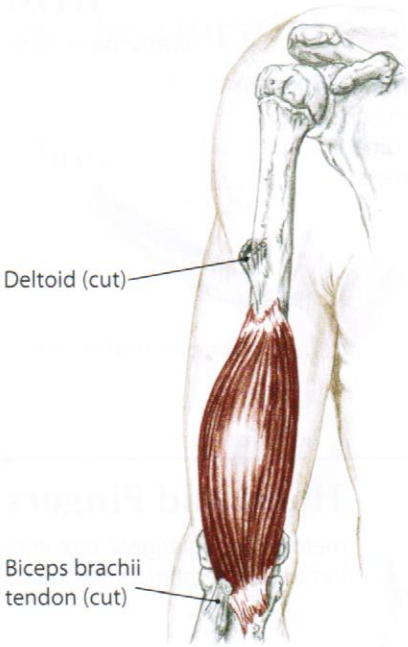
Opposition
Opponens pollicis
Flexor pollicis brevis (assists)*
Abductor pollicis brevis (assists)*

See p. 409 for a complete list of synergists for the fingers and thumb



Extension
(antagonists on flexion)
Extensor pollicis longus
Extensor pollicis brevis
Abductor pollicis longus
Palmar interossei (1st, assists)

Posterior/lateral view



3.55 *Anterior view of right arm showing brachialis*

3.56 *Origin and insertion*

Brachialis

The brachialis is a strong elbow flexor that lies deep to the biceps brachii (p. 95) on the anterior arm. It has a flat yet thick belly (3.55). Ironically, however, the brachialis' girth only helps the biceps to bulge further from the arm, making brachialis the biceps' best friend.

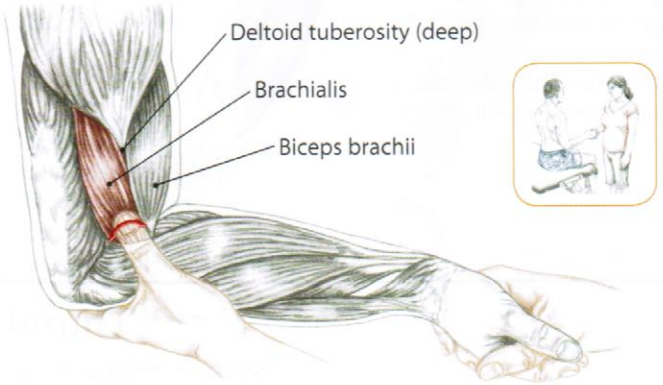
Although it lies underneath the biceps, portions of the brachialis are accessible. Its lateral edge, sandwiched between the biceps and triceps brachii, is superficial and palpable. The distal aspect of the brachialis is also accessible as it passes along either side of the biceps tendon.

A **Flex** the elbow (humeroulnar joint)

O Distal half of anterior surface of humerus

I Tuberosity and coronoid process of ulna

N Musculocutaneous, small branch from radial C**5**, **6**

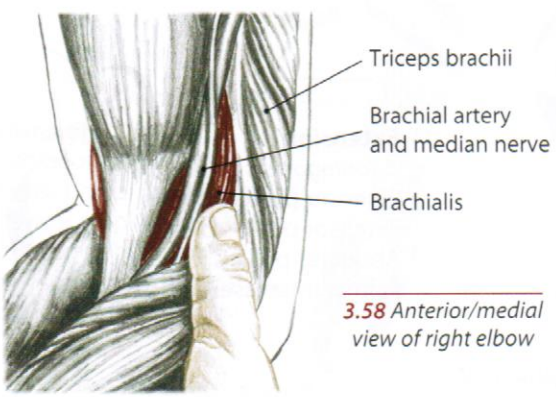


3.57 *Lateral view of right forearm, strumming across the edge of brachialis*

1) Shake hands with your partner and flex the elbow to 90°. It is important to distinguish the muscle tissue of the biceps brachii from that of the brachialis. Ask your partner to flex her elbow against your resistance and isolate the edges of the round biceps brachii belly.
2) With the arm relaxed, slide laterally half an inch off the distal biceps. The edge of the brachialis can be detected by rolling your fingers across its surface. As you strum across its solid edge, you will feel a pronounced "thump." (3.57)
3) Continuing to strum across its edge, follow it distally to where it disappears into the elbow.
4) Locate the distal biceps tendon. Palpate along either side of the tendon for portions of the deeper brachialis (3.58).

Can you roll across a distinct wad of muscle on the lateral side of the arm? Can you follow it distally toward the inner elbow? Locate the triceps and biceps brachii. Are the brachialis fibers between them on the lateral arm?

Locate the deltoid tuberosity. Slide distally straight down the lateral side of the arm and explore for the edge of the brachialis.



3.58 *Anterior/medial view of right elbow*

When Do You Use Your Brachialis?

- *Bringing food from the plate to your mouth*
- *Picking up a load of anatomy books*
- *Carrying a baby car seat*

brachial **bray**-key-al
brachialis **bray**-key-**al**-is
L. relating to the arm

Brachioradialis

The brachioradialis is superficial on the lateral side of the forearm. It has a long, oval belly which forms a helpful dividing line between the flexors and extensors of the wrist and fingers. Its muscle belly becomes tendinous halfway down the forearm. It is the only muscle that runs the length of the forearm but does not cross the wrist joint (3.59). Resisted flexion of the elbow causes brachioradialis to visibly protrude on the forearm and become readily palpable.

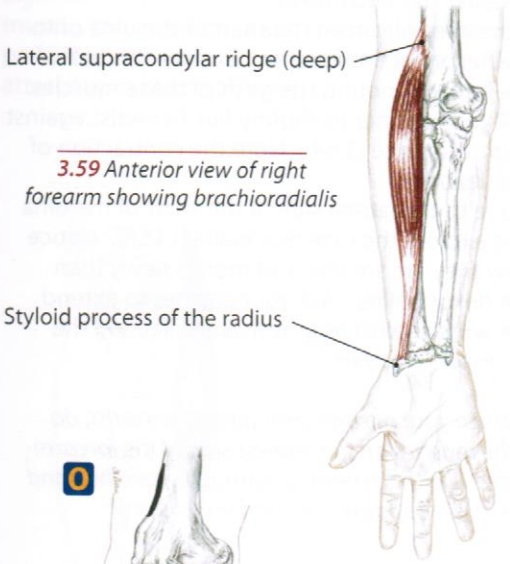
A **Flex** the elbow (humeroulnar joint)

Assist to **pronate** and **supinate** the forearm when these movements are resisted

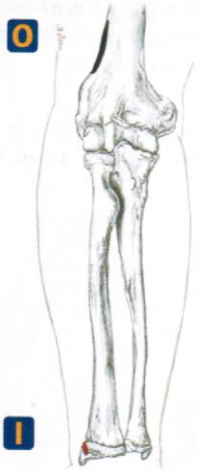
O Proximal two-thirds of the lateral supracondylar ridge of humerus

I Styloid process of radius

N Radial C**5**, **6**



3.59 Anterior view of right forearm showing brachioradialis



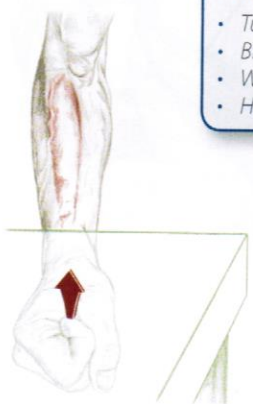
3.60 Origin and insertion

1) Shake hands with your partner and flex the elbow to 90°. With the forearm in a neutral position (thumb toward the ceiling), ask your partner to flex her elbow against your resistance.
2) Look for the brachioradialis bulging out on the lateral side of the elbow. If it is not visible, locate the lateral supracondylar ridge of the humerus and slide distally.
3) With your partner still contracting, use your other hand to palpate its superficial, tubular belly (3.62). Try to pinch its belly between your fingers and follow it as far distally as possible. As it becomes more tendinous, strum across its distal tendon toward the styloid process of the radius.

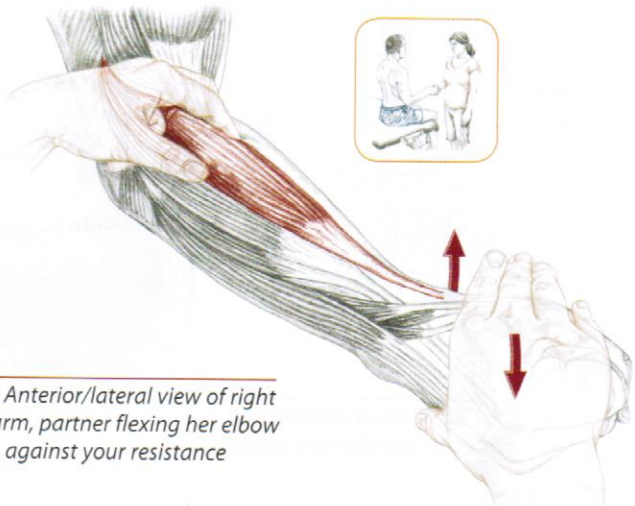
Upon resisted flexion of the elbow, does the belly you are palpating contract and bulge out? Is it superficial? Does it extend off the lateral supracondylar ridge of the humerus?

When Do you Use it?

- *Turning a door handle or screwdriver*
- *Bringing a beer stein up to your mouth*
- *Whisking cream in a bowl*
- *Hoisting a toddler out of their crib*

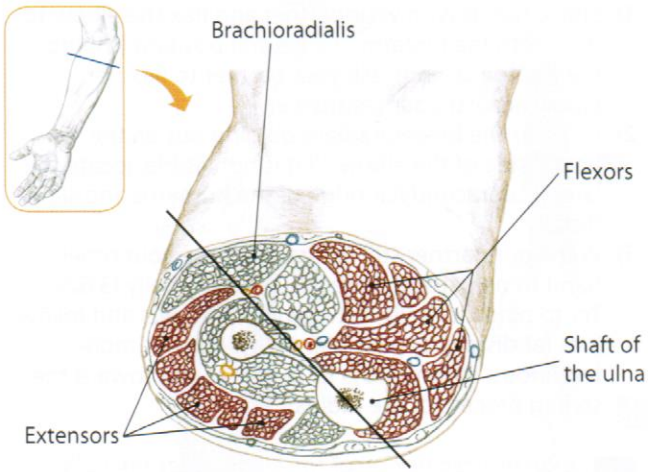


3.61 Pressing your fist up into a table is a great way to get the brachioradialis to pop out



3.62 Anterior/lateral view of right forearm, partner flexing her elbow against your resistance

brachioradialis **bray**-key-o-**ra**-de-**a**-lis



3.63 Cross section of the right forearm, diagonal line dividing the flexors and extensors

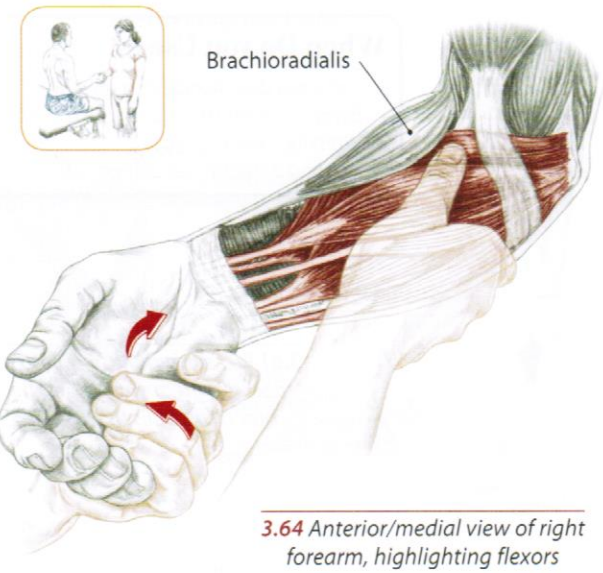
Distinguishing Between the Flexor and Extensor Groups of the Forearm

DVD

Before we isolate specific flexors and extensors, let us first determine the location of these two muscle groups. The flexors and extensors of the hand and wrist are located in the forearm. In anatomical position, the flexors are located on the anterior/medial (hairless) side of the forearm, while the extensors are positioned on the posterior/lateral (hairy) side.

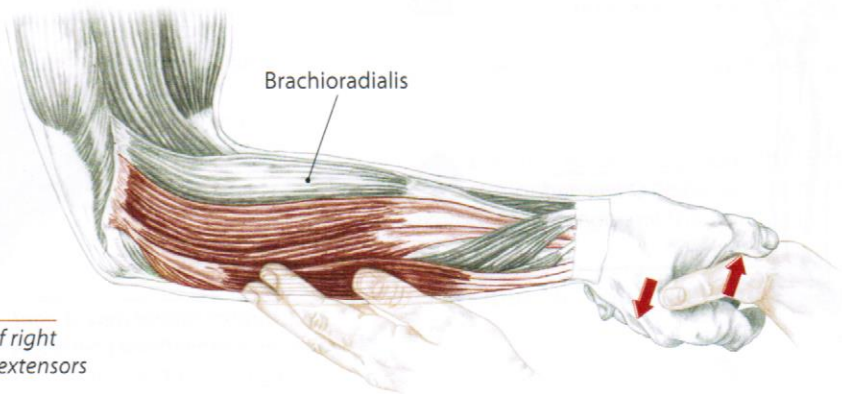
The brachioradialis and shaft of the ulna can be used as clear dividing lines between these muscle groups (3.63). Both of these structures run superficially down the opposite sides of the forearm, separating the flexors and extensors.

1) Shake hands with your partner and flex the elbow to 90°. Locate the brachioradialis and shaft of the ulna (p. 116). Palpate the length of these structures, observing how they divide the forearm into two halves.
2) Move medially from the shaft of the ulna onto the flexors of the forearm. Explore this half of the forearm, noting the girth of these muscles.
3) Ask your partner to slightly flex her wrist against your resistance (3.64). Note the contraction of the flexors.
4) Move to the lateral side of the shaft of the ulna and explore the extensor bellies (3.65). Notice how they are smaller and more sinewy than the flexor bellies. Ask your partner to extend her wrist against your resistance, feeling the extensors contract.



3.64 Anterior/medial view of right forearm, highlighting flexors

When your partner curls (flexes) her wrist, do the muscles on the hairless side of the forearm contract? Do the extensors contract when the hand moves in the opposite direction (extension)?



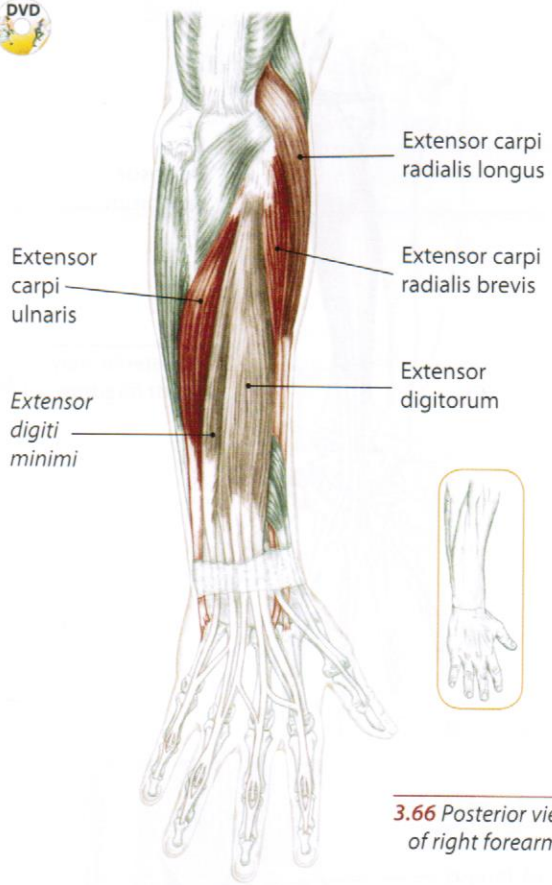
3.65 Lateral view of right forearm, highlighting extensors

Extensors of the Wrist and Fingers

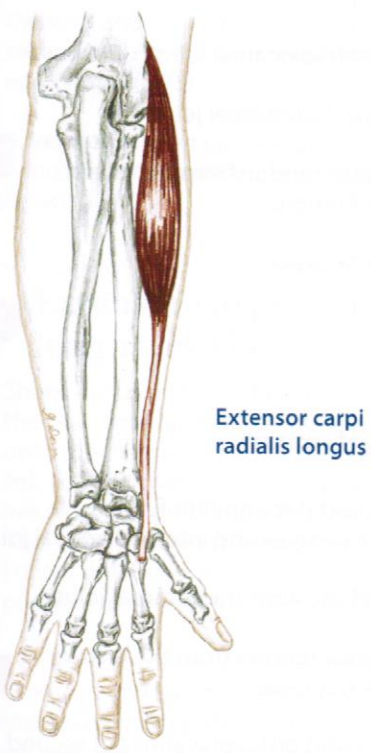
Extensor Carpi Radialis Longus
Extensor Carpi Radialis Brevis
Extensor Carpi Ulnaris
Extensor Digitorum

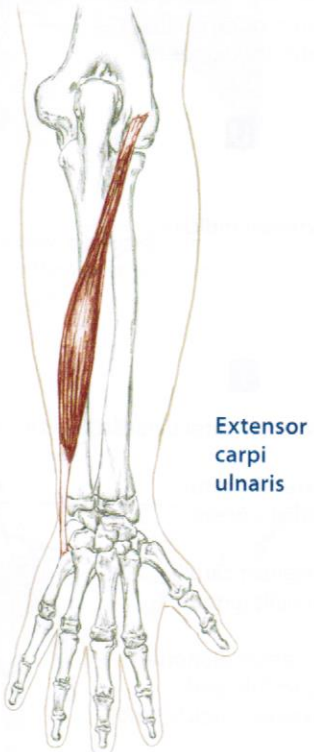
The four extensors create extension primarily at the wrist and fingers. They are situated between the brachioradialis and the shaft of the ulna along the forearm's lateral, posterior surface. All of these muscles are superficial and accessible, though challenging to truly isolate. Originating on the lateral side of the humerus, the bellies of the extensors become tendinous approximately two inches proximal to the wrist joint (3.66). As a group they are smaller and more sinewy than the forearm flexors.

Extensor carpi radialis longus and **brevis** are lateral/posterior to the brachioradialis (3.67, 3.68). **Extensor carpi ulnaris**, as its name suggests, lies beside the ulnar shaft (3.69). **Extensor digitorum** is located between these muscles and has four long, superficial tendons stretching along the dorsal surface of the hand and fingers (3.70). The *extensor digiti minimi* is sometimes classified as a separate muscle, but in reality is just the most medial portion of the extensor digitorum with a tendon attaching to the fifth finger.



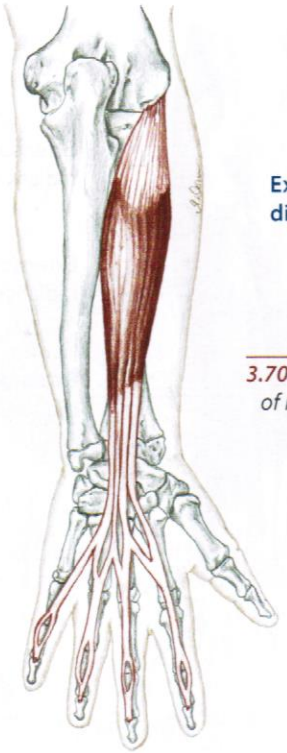
3.66 Posterior view of right forearm



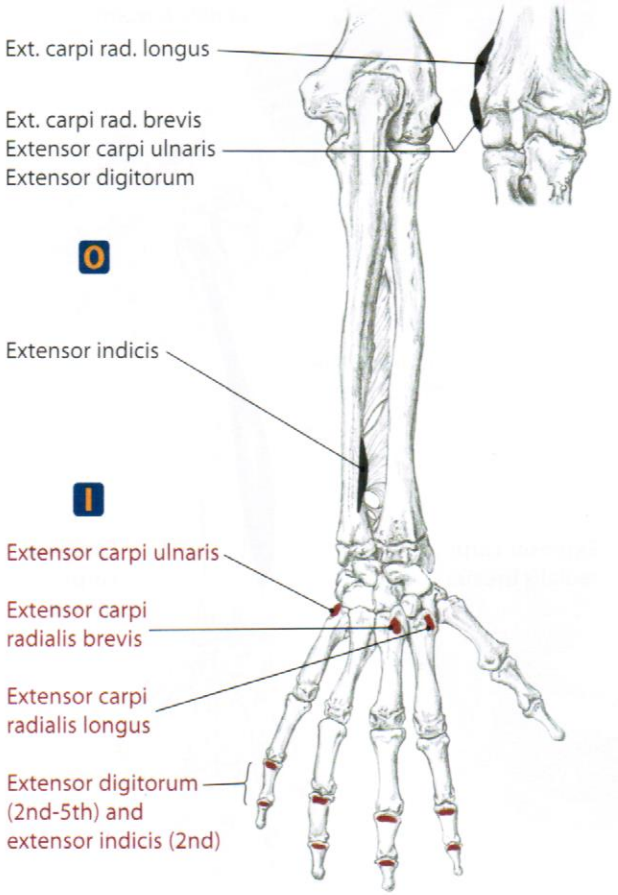


3.67, 3.68, 3.69 Posterior views of right forearm

brevis	**breh**-vis	L. short
carpi	**kar**-pi	L. of the wrist
digit	**di**-jit	L. finger



3.70 Posterior view of right forearm



3.71 Origins and insertions of extensors

Extensor Carpi Radialis Longus and Brevis

A **Extend** the wrist (radiocarpal joint)

Abduct the wrist (radiocarpal joint)

Assist to **flex** the elbow (humeroulnar joint)

O *Longus:*
Distal one-third of the lateral supracondylar ridge of humerus
Brevis:
Common extensor tendon from the lateral epicondyle of humerus

I *Longus:*
Base of second metacarpal
Brevis:
Base of third metacarpal

N *Longus:*
Radial C5, **6**, **7**, 8
Brevis:
Radial C**6**, **7**, 8

Extensor Carpi Ulnaris

A **Extend** the wrist (radiocarpal joint)

Adduct the wrist (radiocarpal joint)

O Common extensor tendon from the lateral epicondyle of humerus

I Base of fifth metacarpal

N Radial C6, **7**, **8**

Extensor Digitorum

A **Extend** the second through fifth fingers (metacarpophalangeal and interphalangeal joints)

Assist to **extend** the wrist (radiocarpal joint)

O Common extensor tendon from the lateral epicondyle of humerus

I Bases of middle and distal phalanges of second through fifth fingers

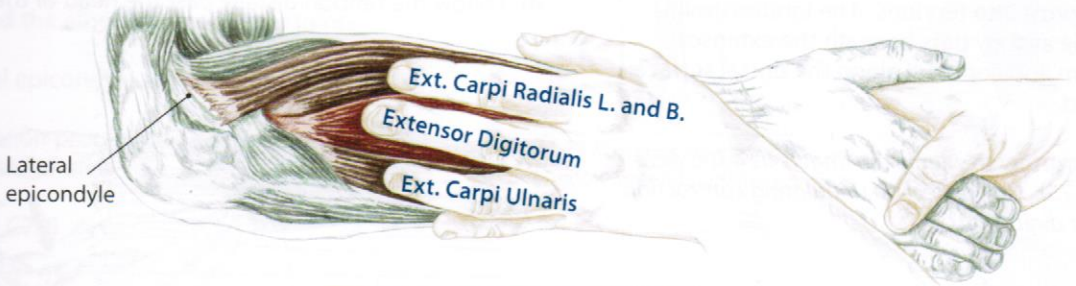
N Radial C**6**, **7**, **8**

When Do You Use Your Extensors?

Extensor Carpi Radialis
- *Stabilizing the wrist while gripping (opening a jar)*
- *Washing the dishes*
- *Turning off a faucet*

Extensor Carpi Ulnaris
- *Shaping soft clay for an art project*
- *Pulling a book off a tall library shelf*
- *Reaching into the back seat of your car*

Extensor Digitorum
- *Playing the piano or trumpet*
- *Holding your hand up to give the Vulcan hand greeting (extension of wrist and fingers)*
- *Releasing a handshake*

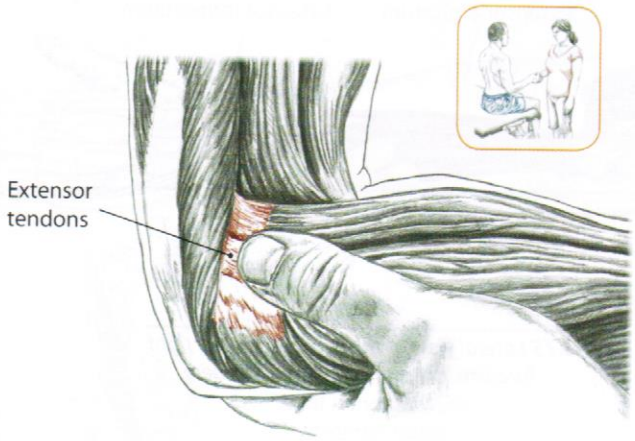


3.72 Lateral view of right forearm with fingers showing order of extensors

Extensor group

1) Shake hands and flex the elbow to 90°. Locate the brachioradialis and shaft of the ulna.
2) Lay the flat of your hand between these landmarks and ask your partner to alternately extend and relax her wrist against your resistance (see p. 134).
3) Explore the slender, sinewy fibers of these muscles and note how they contract upon extension. Access their origin at the lateral epicondyle (3.73).

Are you between the brachioradialis and ulnar shaft? Do the muscles contract on extension of the wrist?

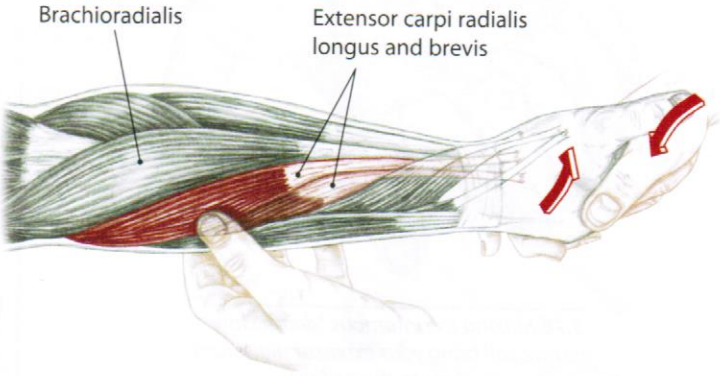


3.73 Lateral view of right elbow, palpating common extensor tendon located at the lateral epicondyle

Extensor carpi radialis longus and brevis

1) Shake hands and flex the elbow to 90°. Locate the brachioradialis. Slide laterally off its belly onto the extensor carpi radialis fibers.
2) Ask your partner to alternately abduct and relax her wrist against your resistance. Sense how the fibers tighten with this movement (3.74).
3) Follow their muscle fibers distally as far as possible to where they become tendinous.

Differentiate between the extensor carpi radialis muscles and brachioradialis by asking your partner to alternately abduct and relax her wrist against your resistance. The brachioradialis, which does not cross the wrist joint, will remain slack throughout this action while the extensor carpi radialis muscles will contract.

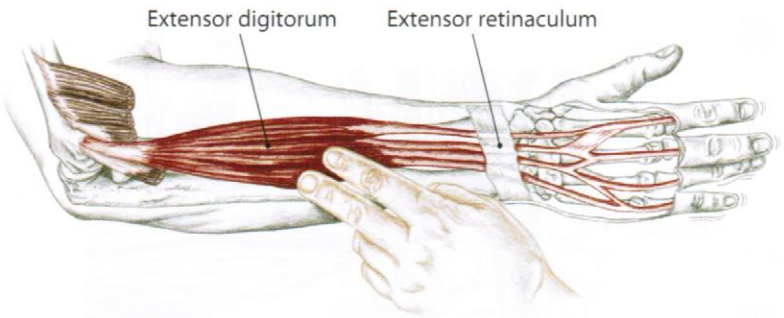


3.74 Lateral view of right forearm

Extensor digitorum

1) Shake hands with your partner and flex his elbow to 90°. Slide laterally off the extensor carpi radialis fibers.
2) As you move around the forearm, palpate the digitorum's flat surface and roll across its fibers.
3) Isolate its belly by asking your partner to extend her wrist and fingers. Follow the belly distally as it transforms into tendons. The tendons will be palpable as they pass beneath the extensor retinaculum and continue along the dorsal surface of the hand.

Ask your partner to wiggle her fingers as if she were typing (3.75). Do you feel an undulating contraction of the extensor digitorum?

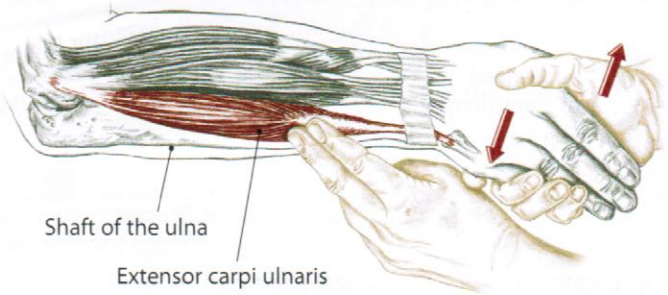


3.75 Lateral view of posterior surface of right forearm, partner wiggling his fingers

3.76 Making the infamous "death claw" gesture will bring your extensor digitorum tendons to the surface.

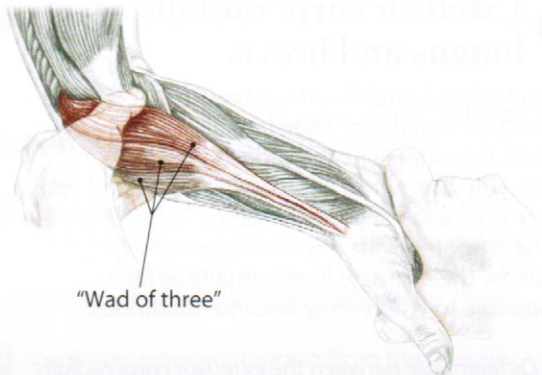
Extensor carpi ulnaris

1) Shake hands with your partner and flex the elbow to 90°. Locate the shaft of the ulna.
2) Slide laterally off the shaft onto the slender belly of the extensor carpi ulnaris.
3) Ask your partner to adduct her wrist against your resistance (3.77). Note how the tissue directly lateral to the ulna tightens with this movement.
4) Follow the tendon distally past the head of the ulna.



3.77 Lateral view of posterior surface of right forearm

Brachioradialis and extensor carpi radialis longus and brevis are sometimes known collectively as the "wad of three." Together they form a long mass of muscle which extends distally from the lateral supracondylar ridge of the humerus.



To locate the wad, shake hands with your partner and palpate just lateral to the inner elbow. The wad will be the thick, mobile tissue which can be easily grasped between your fingers and thumb. Follow it distally as far as possible.

Anconeus

The anconeus is a weak elbow extensor located lateral to the olecranon process. Triangular-shaped, it originates at the lateral epicondyle of the humerus and fans out to attach on the shaft of the ulna (3.78). The anconeus is superficial, yet can be difficult to differentiate from the surrounding extensors.

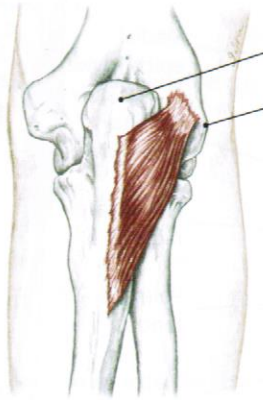
A **Extend** the elbow (humeroulnar joint)

O Lateral epicondyle of the humerus

I Olecranon process and posterior, proximal surface of ulna

N Radial C**7**, **8**

1) Locate the olecranon process, the proximal shaft of the ulna, and the lateral epicondyle of the humerus.
2) Then lay your index finger along the proximal ulna and the tip of your middle finger upon the lateral epicondyle. The "V" formed by your fingers is the outline of the anconeus (3.79).



3.78 Posterior view of right elbow showing anconeus

3.79 Strumming your thumb over the belly

Extensor Indicis

Located deep to the extensor digitorum and extensor carpi ulnaris, this small but crucial muscle assists the digitorum in specifically extending the index finger. Its tendon runs diagonally across the wrist and hand, sheathed with the extensor digitorum tendon (3.80). If you extend your index finger at the metacarpophalangeal joint, you might see two side-by-side tendons passing across the top of the knuckle (3.81). The medial tendon (closer to the middle finger) is the extensor indicis tendon.

A **Extend** the second finger (metacarpophalangeal joint)

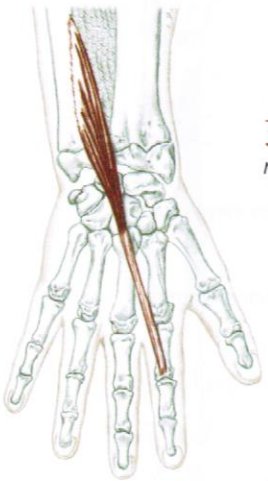
Adduct the second finger

May assist to **extend** the wrist (radiocarpal joint)

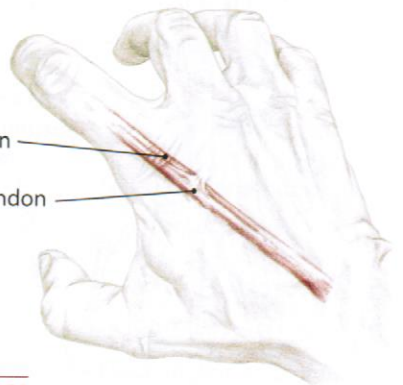
O Posterior surface of distal shaft of ulna and interosseous membrane

I Tendon of the extensor digitorum at the level of the second metacarpal

N Radial C6, **7**, **8**

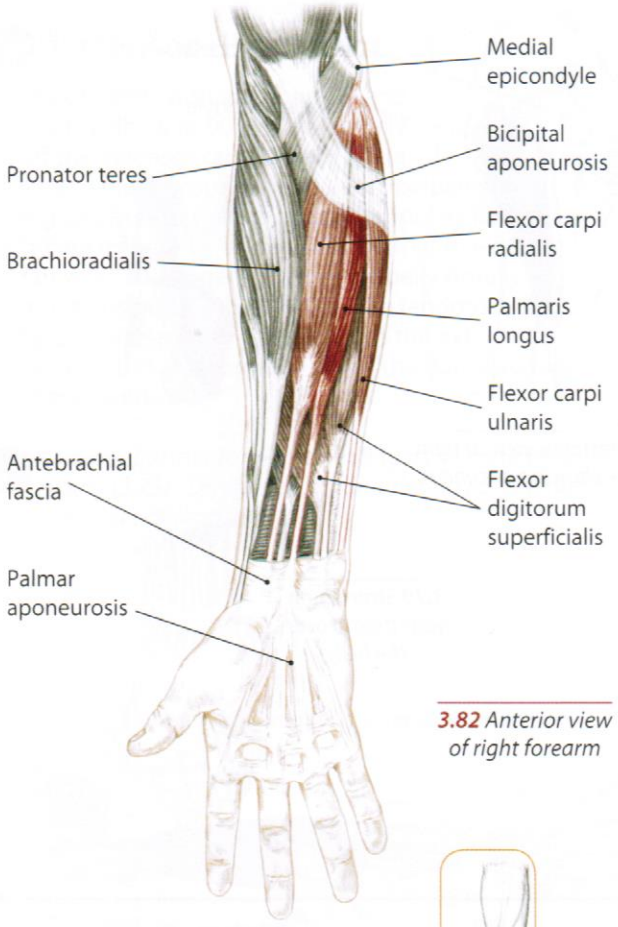


3.80 Dorsal view of right hand showing extensor indicis

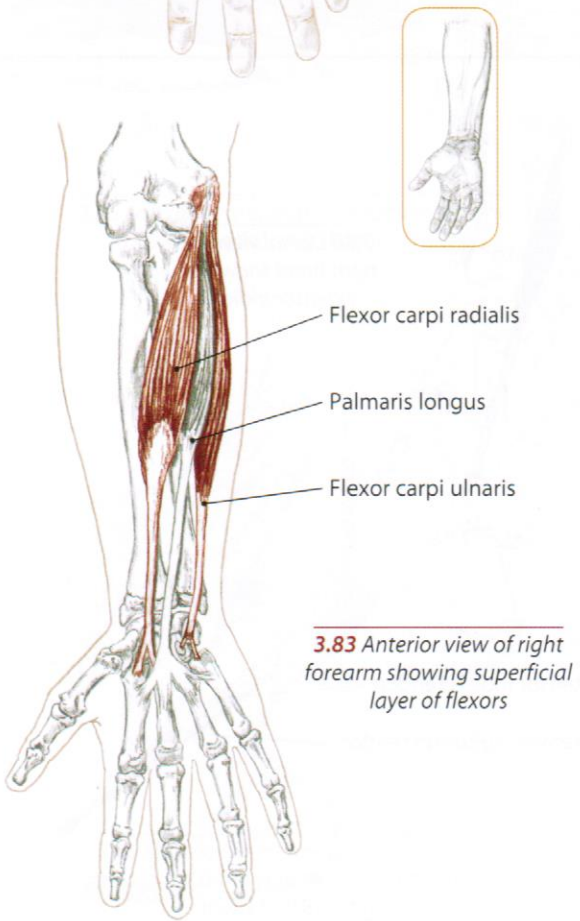


3.81

anconeus an-**ko**-nee-us Grk. elbow
indicis **in**-di-kis



3.82 *Anterior view of right forearm*



3.83 *Anterior view of right forearm showing superficial layer of flexors*

Flexors of the Wrist and Fingers

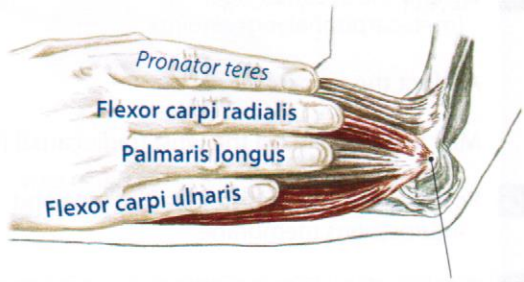
Flexor Carpi Radialis
Palmaris Longus
Flexor Carpi Ulnaris
Flexor Digitorum Superficialis
Flexor Digitorum Profundus

The five flexors included in this section create flexion primarily at the wrist or fingers (3.82). They are located on the forearm's anterior/medial surface between the brachioradialis and the ulnar shaft. Most of the flexors originate as one mass from the common flexor tendon at the medial epicondyle of the humerus (3.84). The bellies of the flexors extend down the forearm, becoming thin tendons roughly two inches proximal to the wrist.

As a group, the flexors are thicker and more pliable than the extensors. Although the flexors are easily accessed as a group, isolating specific muscle bellies can be challenging.

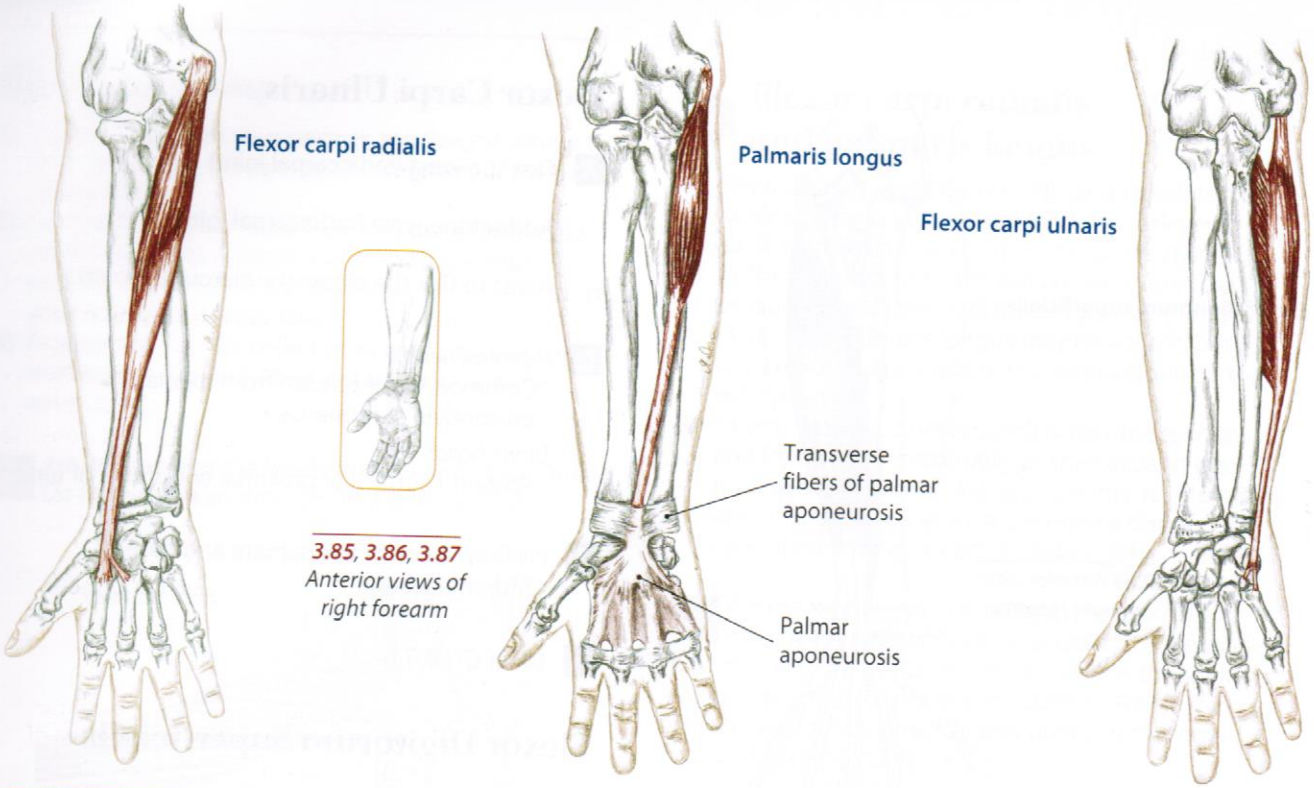
The flexors are arranged in three layers. The superficial layer is formed by the long bellies of flexor carpi radialis, palmaris longus and flexor carpi ulnaris (3.83). **Flexor carpi radialis** is medial to the pronator teres and brachioradialis (3.85). **Flexor carpi ulnaris** lies close to the ulnar shaft and has a distinct tendon attaching to the pisiform (3.87). The **palmaris longus** (3.86), which is sometimes absent, runs between flexor carpi radialis and flexor carpi ulnaris and attaches to the palmar aponeurosis (p. 163). Portions of all three muscles can be isolated for palpation purposes.

The middle and deep layers contain the wide bellies of **flexor digitorum superficialis** and **flexor digitorum profundus**, respectively (3.89, 3.90). Each digitorum muscle has four thin tendons which pass through the carpal tunnel (p. 163) and attach at the phalanges. The bellies of the digitorums are difficult to access directly, but their density can be felt beneath the superficial flexors.



3.84 *Medial view of right forearm with fingers showing order of muscles*

superficialis **soo**-per-**fish**-ee-**a**-lis L. on the surface
profundus pro-**fun**-dus L. deep



3.85, 3.86, 3.87 Anterior views of right forearm

Flexor Carpi Radialis

A **Flex** the wrist (radiocarpal joint)

Abduct the wrist (radiocarpal joint)

May assist to **flex** the elbow (humeroulnar joint)

O Common flexor tendon from medial epicondyle of humerus

I Bases of second and third metacarpals

N Median C**6**, **7**, 8

Palmaris Longus

A **Tense** the palmar fascia

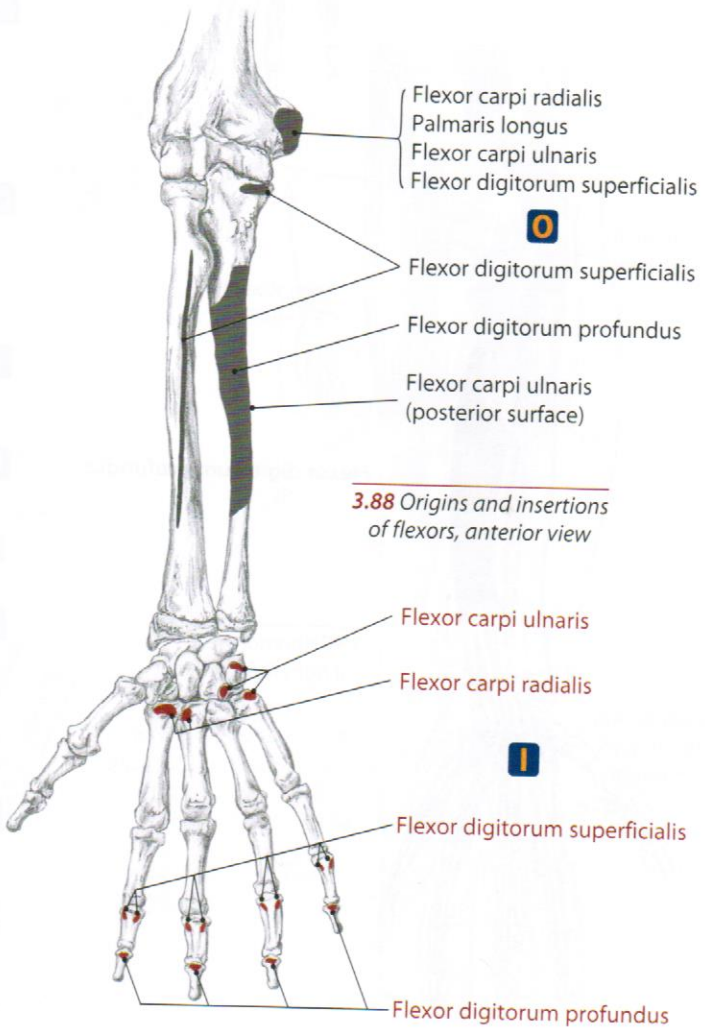
Flex the wrist (radiocarpal joint)

May assist to **flex** the elbow (humeroulnar joint)

O Common flexor tendon from medial epicondyle of humerus

I Flexor retinaculum and palmar aponeurosis

N Median C(6), **7**, **8**, T1



3.88 Origins and insertions of flexors, anterior view

Flexor digitorum superficialis

3.89 Anterior view of right forearm

Flexor Carpi Ulnaris

A **Flex** the wrist (radiocarpal joint)

Adduct the wrist (radiocarpal joint)

Assist to **flex** the elbow (humeroulnar joint)

O *Humeral head:*
Common flexor tendon from medial epicondyle of humerus
Ulnar head:
Posterior surface of proximal two-thirds of ulna

I Pisiform, hook of the hamate and base of fifth metacarpal

N Ulnar C7, **8**, T1

Flexor Digitorum Superficialis

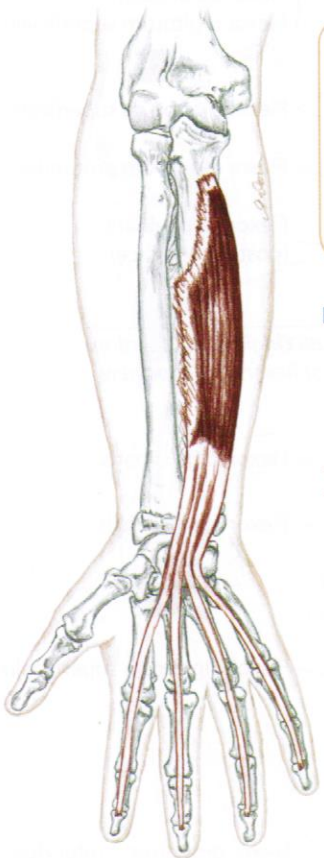
A **Flex** the second through fifth fingers (metacarpophalangeal and proximal interphalangeal joints)

Flex the wrist (radiocarpal joint)

O Common flexor tendon from medial epicondyle of humerus, ulnar collateral ligament, coronoid process of ulna, interosseous membrane and proximal shaft of radius

I Sides of middle phalanges of second through fifth fingers

N Median C**7**, **8**, T**1**



Flexor digitorum profundus

3.90 Anterior view of right forearm

Flexor Digitorum Profundus

A **Flex** the second through fifth fingers (metacarpophalangeal and distal interphalangeal joints)

Assist to **flex** the wrist (radiocarpal joint)

O Anterior and medial surfaces of proximal three-quarters of ulna

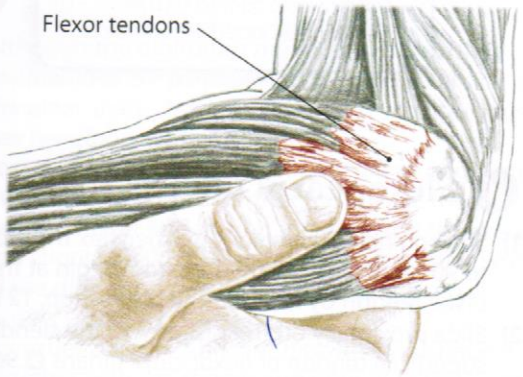
I Bases of distal phalanges, palmar surface of second through fifth fingers

N *First and second:* Median C7, **8**, T**1**
Third and fourth: Ulnar C7, **8**, T**1**

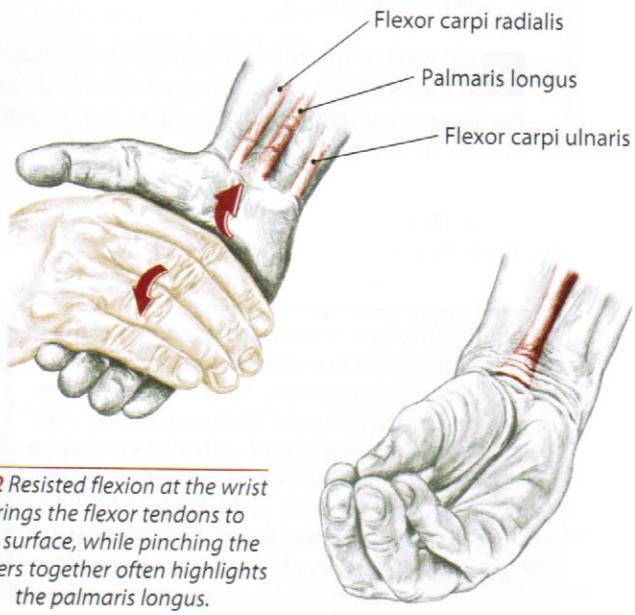
Flexor group

1) Shake hands with your partner and flex the elbow to 90°. Locate the brachioradialis and shaft of the ulna (see p. 116).
2) Lay the flat of your hand between these landmarks on the forearm's anterior surface and ask your partner to alternately flex and relax her wrist against your resistance (see p. 134).
3) Explore the chubby bellies from their origin at the medial epicondyle to their distal tendons at the wrist (3.91).

Are you between the brachioradialis and ulnar shaft? Do the muscles contract on flexion of the wrist?



3.91 Medial view of right elbow, palpating common flexor tendon located at the medial epicondyle

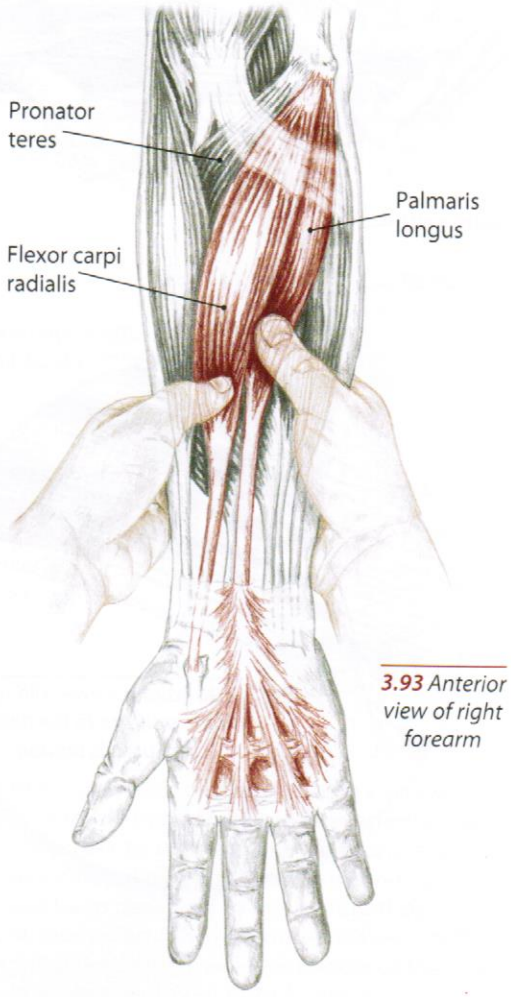


3.92 Resisted flexion at the wrist brings the flexor tendons to the surface, while pinching the fingers together often highlights the palmaris longus.

Flexor carpi radialis and palmaris longus

1) Flex your partner's elbow to 90° and supinate the forearm. Begin at the distal tendons. Ask your partner to flex her wrist against your resistance.
2) At the center of the wrist will be two superficial tendons, flexor carpi radialis and palmaris longus (3.92). The palmaris longus may be absent, but if both tendons are present, the palmaris will be the most medial.
3) As your partner contracts, roll across the tendons and follow them proximally as they expand into muscle bellies (3.93). Ask your partner to alternately abduct and relax her wrist to create a distinct contraction of flexor carpi radialis (3.94).

Are the tendons/muscle bellies superficial? If you palpate the belly of flexor carpi radialis, is it superficial and medial to the pronator teres (p. 146)? Is the palmaris longus medial to the flexor carpi radialis? Follow the bellies toward the elbow. Do they merge at the medial epicondyle of the humerus?



3.93 Anterior view of right forearm

3.94 Feeling the flexor carpi radialis by resisting abduction of the right wrist

When Do You Use Them?

Flexor Carpi Radialis

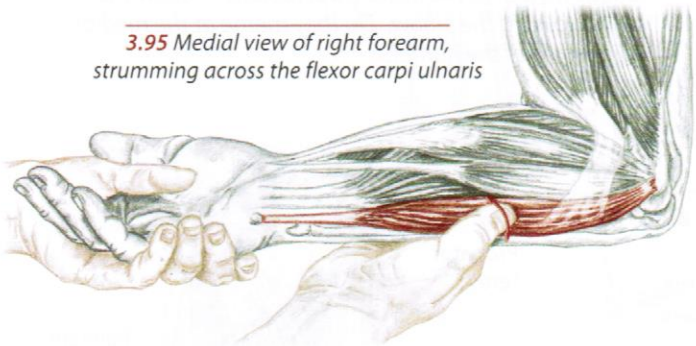
- *Squeezing the hand strap of a fast-moving train*
- *Turning a water valve*
- *Holding a cellphone*

Palmaris Longus

- *Palming a large grapefruit*
- *Doing fingertip push-ups*
- *Making a snowball*

Flexor Carpi Ulnaris

- *Using your hand to brush food off a kitchen table*
- *Unscrewing a tight lid on a jar*
- *Delivering an incredible judo chop*



3.95 Medial view of right forearm, strumming across the flexor carpi ulnaris

Flexor carpi ulnaris

1) Shaking hands with your partner, flex the elbow to 90° and supinate the forearm. Begin at the distal tendon by locating the pisiform (p. 121).
2) Slide proximally off the pisiform to the slender, superficial tendon of flexor carpi ulnaris (3.96).
3) As your partner alternately adducts and relaxes her wrist against your resistance, follow the tendon proximally, strumming across its surface (3.95). Feel how it widens into a muscle belly and heads toward the medial epicondyle. (Note: Unlike the extensor carpi ulnaris, the flexor carpi ulnaris lies roughly a finger's width away from the ulnar shaft.)

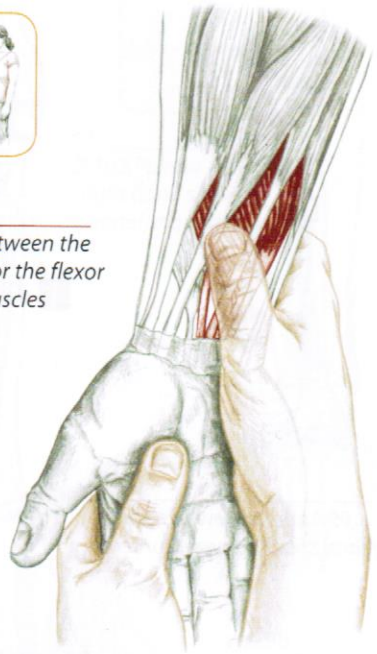
☑ *Do you feel the muscle contract upon adduction? Is the tendon/muscle belly superficial and along the forearm's anterior/medial surface? Is it medial to the palmaris longus?*

3.96 Palmar view—sliding off the pisiform to the flexor carpi ulnaris tendon

The palmaris longus is absent in about 11% of the population. The palmar aponeurosis, however, is always present. The palmaris longus may vary from a mere tendinous band to a distal muscle belly with a long, proximal tendon. On occasion, there may be two palmaris longus muscles. The insertion site is also variable. It may attach to the fascia of the forearm, the tendon of the flexor carpi ulnaris, the flexor retinaculum, the pisiform or the scaphoid.

Flexor digitorum superficialis and profundus

1) Beginning at the wrist, locate the tendons of the superficial flexors (carpi ulnaris, carpi radialis and palmaris longus). Passive flexion of the wrist will soften the tendons and allow for easier access.
2) Slowly work your thumb between the superficial tendons for the deeper digitorum tendons and bellies (3.97).



3.97 Palpating between the superficial flexors for the flexor digitorum muscles

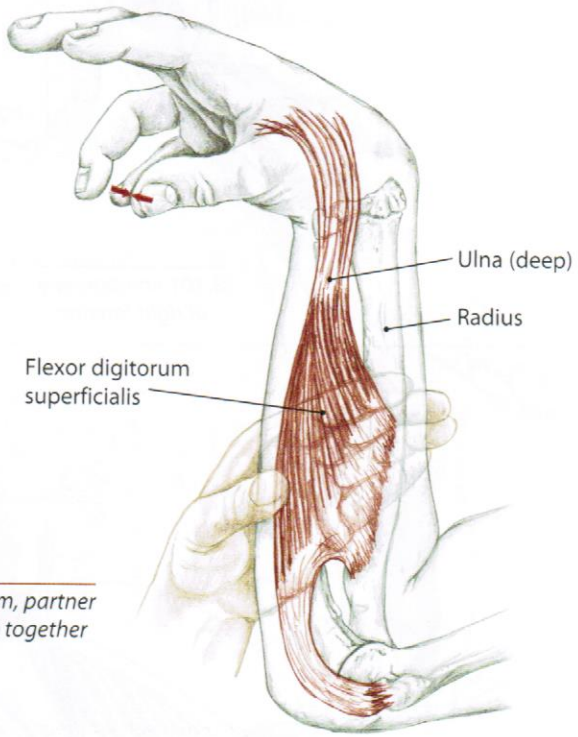
Is the tissue you are accessing deep to the first layer of flexors? If your partner wiggles the tips of her fingers can you detect any small, undulating contractions in the forearm?

1) Although the digitorum muscles are deep, their contractions are palpable along the medial side of the ulnar shaft. Ask your partner to simultaneously flex her elbow and wrist to 90°.
2) Locate the ulnar shaft, sliding just off its edge into the flexors. Ask your partner to squeeze the tips of her fifth finger and thumb together and then relax. You should feel the small but distinct contraction of the digitorum muscles as they bulge into your fingers (3.98).
3) Try squeezing the ring, middle and index fingers together with the thumb and note how this changes the contraction.

When Do You Use Them?

Flexor Digitorum Superficialis & Profundus

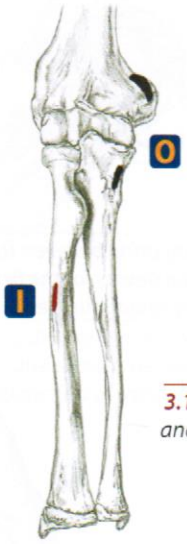
- *Picking up small objects such as crumbs, needles or coins*
- *Playing a guitar, typing a letter*
- *Tying your shoelaces*
- *Buttoning your shirt*



3.98 Medial view of right forearm, partner pressing fifth finger and thumb together

There are two primary supinators (biceps brachii and supinator) and two primary pronators (pronator teres and pronator quadratus). You might assume that this structural symmetry would mean a balance of strength between the pronators and supinators, but in reality, the size and power of the biceps brachii cause the scales to tip in favor of the supinators.

The expression "righty-tighty, lefty-loosey" is not only a reminder of the direction in which to turn a screw, but also applies to the hand that holds the screwdriver. We have more power to supinate than to pronate and the world is dominated by right-handed individuals, so screws have been designed to be tightened by right forearm supination. This, of course, leaves "south paws" to tighten with either weak pronators or the undeveloped supinators of the right forearm.



3.100 Origin and insertion

3.99 Anterior view of right forearm showing pronator teres

Pronator Teres

Located on the anterior surface of the forearm, the round pronator teres is tucked between the brachioradialis and forearm flexors (p. 140). It is partially superficial and the only muscle in this vicinity with oblique fibers (3.99). The pronator teres is an antagonist to the biceps brachii and supinator ("carrying a bowl of soup") muscles and creates pronation of the forearm ("prone to spill it"). The distal tendon of biceps brachii, situated just lateral to the pronator teres, is a good landmark for locating its fibers.

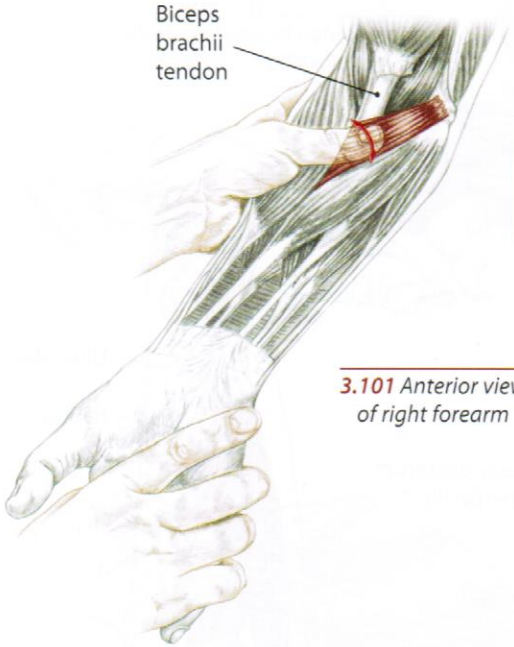
A **Pronate** the forearm (radioulnar joints)

Assist to **flex** the elbow (humeroulnar joint)

O Common flexor tendon from medial epicondyle of humerus and coronoid process of the ulna

I Middle of lateral surface of the radius

N Median C**6**, **7**



3.101 Anterior view of right forearm

1) Shake hands with your partner and flex the elbow to 90°. Locate the distal tendon of the biceps brachii. For assistance, ask your partner to flex her elbow against your resistance.
2) Slide distally off the tendon into the valley between the brachioradialis and forearm flexors. Sink your thumb into this space.
3) Explore for the finger-wide pronator belly running obliquely from the medial elbow across to the radius. Strum across its oblique fibers (3.102).
4) Follow it toward the medial epicondyle (noting how it blends into the other flexors) and the middle radius (feeling how it tucks under the brachioradialis).

Shake hands and ask your partner to pronate against your resistance (3.101). Does the belly of the muscle you are palpating form a solid contraction? Do the fibers you are palpating run diagonally toward the middle of the radius?

3.102 Anterior/medial view of right elbow, strumming across the pronator belly

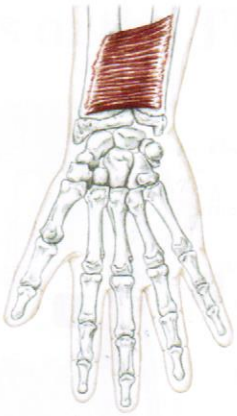
When Do You Use Your Pronator?

- *Turning a doorknob*
- *Arranging cups in the dishwasher*
- *Swimming the breaststroke (forearms pronated)*

pronate **pro**-nate L. bent forward

Pronator Quadratus

Although it lacks the pronator teres' power and speed, the small quadratus is still a capable pronator. It has transverse fibers that lie deep to the flexor tendons and the major nerve and blood vessels of the anterior forearm (3.103). The majority of the muscle is inaccessible, except for its most lateral portion. This small palpatory window, however, is also the location of the radial artery—so explore gently.



3.103 Palmar view of right hand showing pronator quadratus

A **Pronate** the forearm (radioulnar joints)

O Medial, anterior surface of distal ulna

I Lateral, anterior surface of distal radius

N Median C7, **8**, T**1**

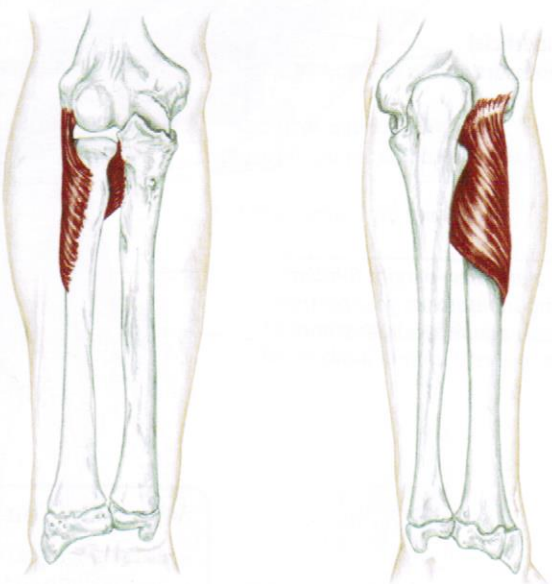
3.104

1) Shake hands with your partner. First, isolate the pulse of the radial artery (p. 164). Then locate the radius' styloid process, sliding around to its anterior surface.
2) Before accessing the quadratus, flex and pronate the wrist slightly, softening the overlaying flexor tendons. Then use your thumb to explore the thin band of tissue between the radius and the tendons (3.105).
3) You might not feel the fibers specifically, but asking your partner to pronate ever so gently can elicit a small contraction.

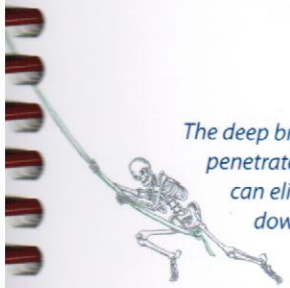
3.105 Palmar view of right hand and wrist

Supinator

Located on the lateral side of the elbow, the short supinator is deep to the forearm extensors and superficial to the head of the radius (3.106, 3.107). As its name suggests, it supinates the forearm and is an antagonist to the pronator teres. It has a slender muscle belly which can be difficult to truly isolate.

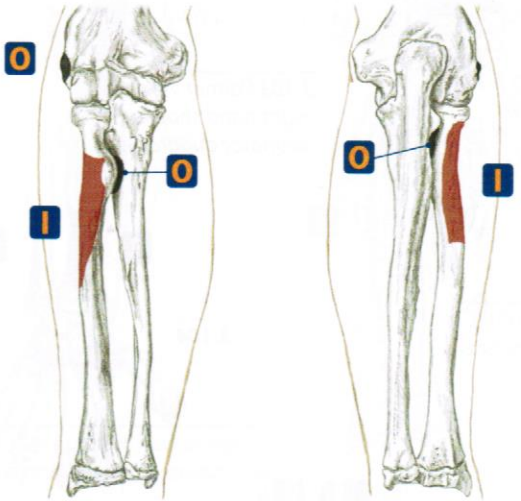


3.106, 3.107 Anterior view (left), posterior view (right) showing the supinator



The deep branch of the radial nerve penetrates the supinator's belly and can elicit a sharp, shooting sensation down the forearm when compressed.

supinate **su**-pi-nate L. bent backward



3.108, 3.109 Anterior view (left), posterior view (right) of origin and insertion of supinator

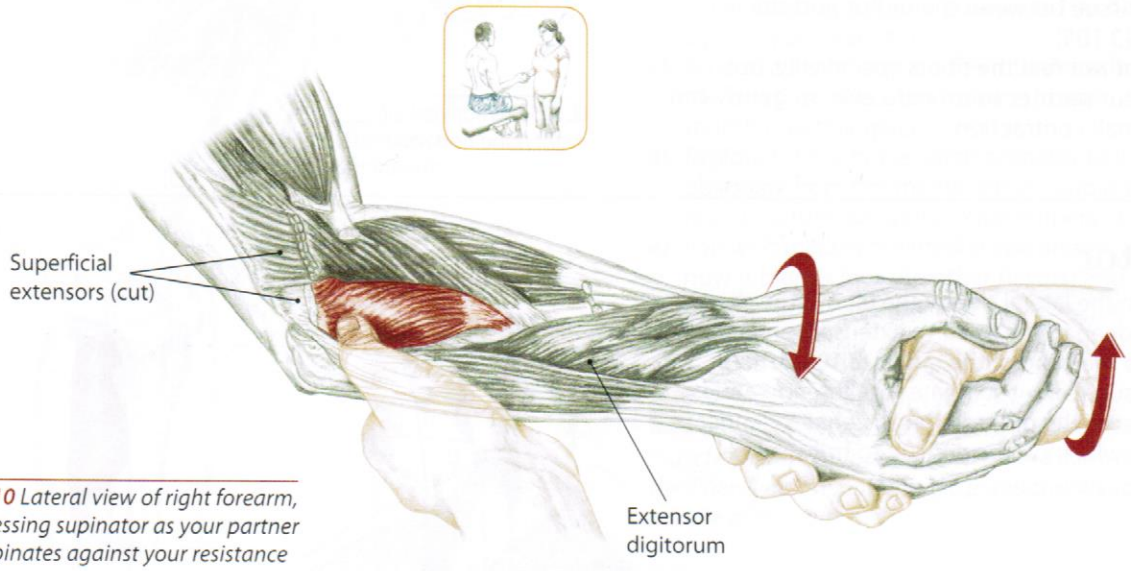
A **Supinate** the forearm (radioulnar joints)

O Lateral epicondyle of humerus, radial collateral ligament, annular ligament and supinator crest of the ulna

I Anterior, lateral surface of proximal one-third of radial shaft

N Radial C5, **6**, (7)

1) Shake hands with your partner and flex the elbow to 90°. Locate the lateral epicondyle of the humerus and the proximal shaft of the radius.
2) Place your fingerpads between these landmarks and palpate through the extensor fibers for the deep supinator belly (3.110).
3) Ask your partner to alternately supinate and relax her forearm against your resistance. The brachioradialis may contract with this movement, but it will be felt superficially, while the supinator is deep to the extensors.

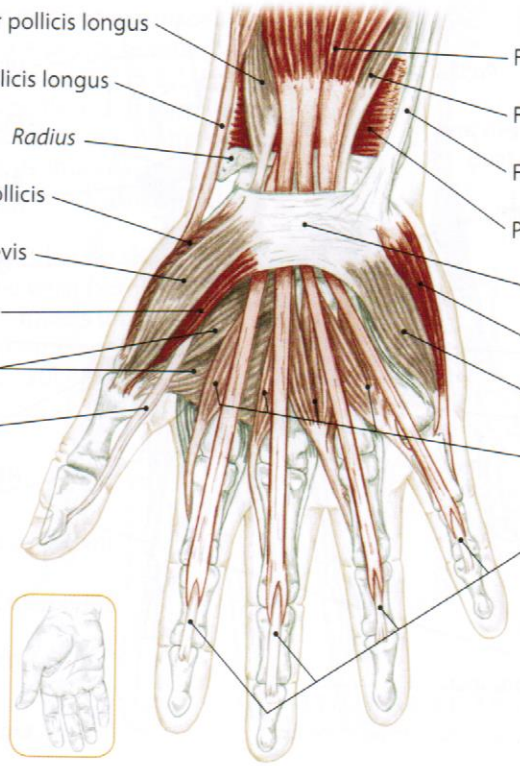


3.110 Lateral view of right forearm, accessing supinator as your partner supinates against your resistance

When Do You Use Your Supinator?

- *Digging out a big scoop of ice cream*
- *Swirling the water in a bathtub*
- *Folding your clothes*

Muscles of the Thumb and Hand



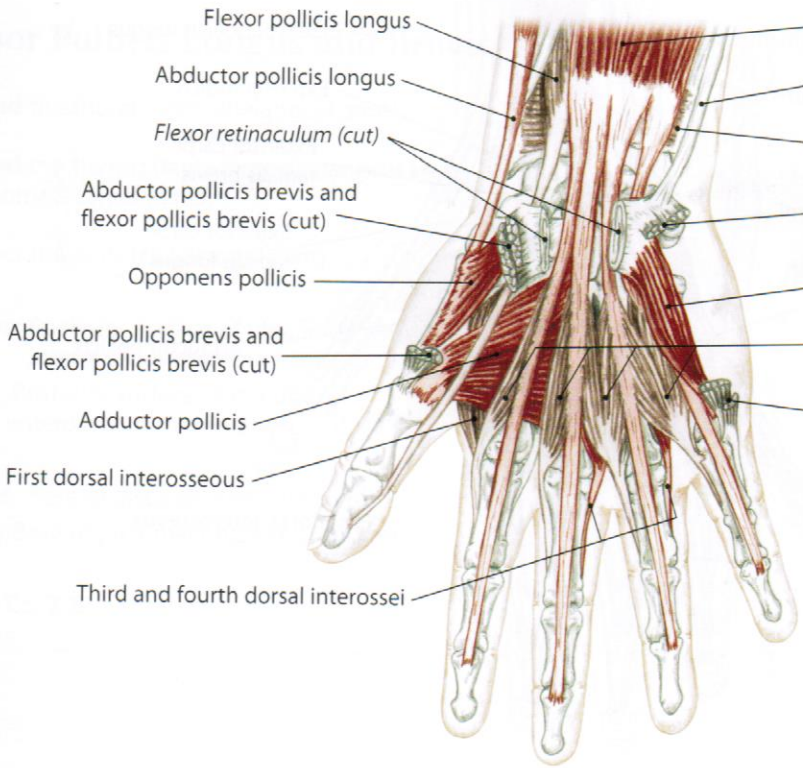
3.111 Palmar view of right hand and wrist, superficial layer

The eight muscles that move the thumb can be divided into two groups: short and long muscles. The four **short** muscles (p. 154) are located at the thenar eminence (the fleshy mass at the thumb's base).

Abductor Pollicis Brevis
Flexor Pollicis Brevis
Opponens Pollicis
Adductor Pollicis

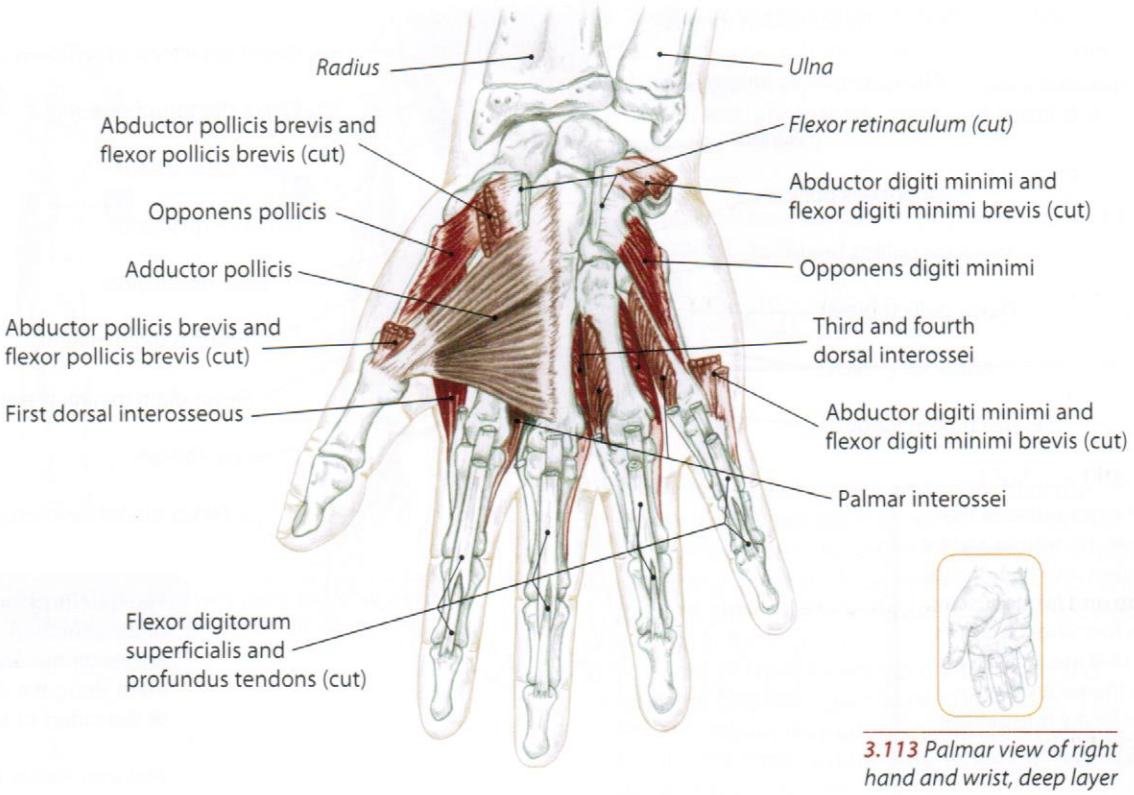
The four **long** muscles of the thumb (p. 151) are tendinous and originate along the shafts of the radius or ulna.

Abductor Pollicis Longus
Flexor Pollicis Longus
Extensor Pollicis Longus
Extensor Pollicis Brevis

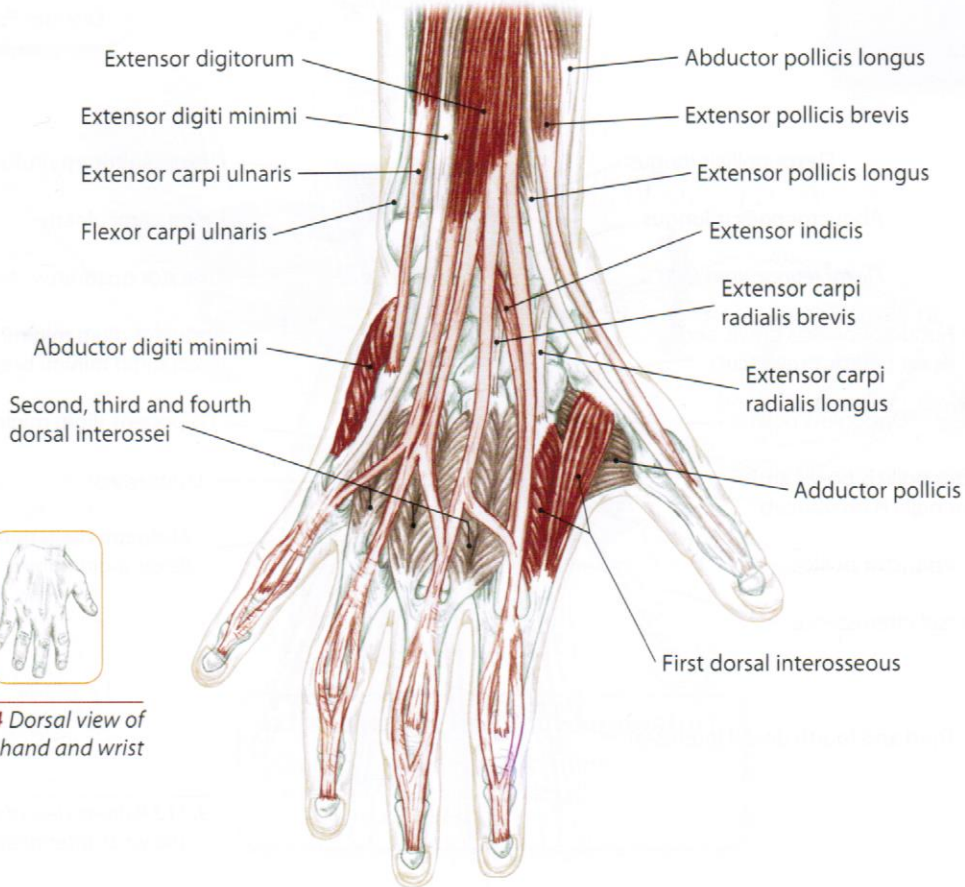


3.112 Palmar view of right hand and wrist, intermediate layer

Muscles of the Thumb and Hand



3.113 Palmar view of right hand and wrist, deep layer



3.114 Dorsal view of right hand and wrist

Long Muscles of the Thumb

The bellies of **abductor pollicis longus** and **extensor pollicis longus and brevis** lie along the posterior aspect of the forearm, deep to the wrist extensors (3.115-3.117). Their distal tendons, however, are superficial and form the "anatomical snuffbox." Used historically as a platform for inhaling a variety of substances, this small cavity is located along the dorsal surface of the hand, just distal to the styloid process of the radius.

The belly of the **flexor pollicis longus** lies on the forearm's anterior surface, deep to the wrist flexors, and is inaccessible. Its long, distal tendon travels through the carpal tunnel between the thenar eminence muscles to the distal phalanx of the thumb (3.120).

Abductor Pollicis Longus

A **Abduct** the thumb (carpometacarpal joint)

Extend the thumb (carpometacarpal joint)

Abduct the wrist (radiocarpal joint)

O Posterior surface of radius and ulna, and interosseous membrane

I Base of first metacarpal

N Radial C6, **7**, **8**

Extensor Pollicis Longus and Brevis

A **Extend** the thumb (interphalangeal joint)

Extend the thumb (metacarpophalangeal and carpometacarpal joints)

Abduct the wrist (radiocarpal joint)

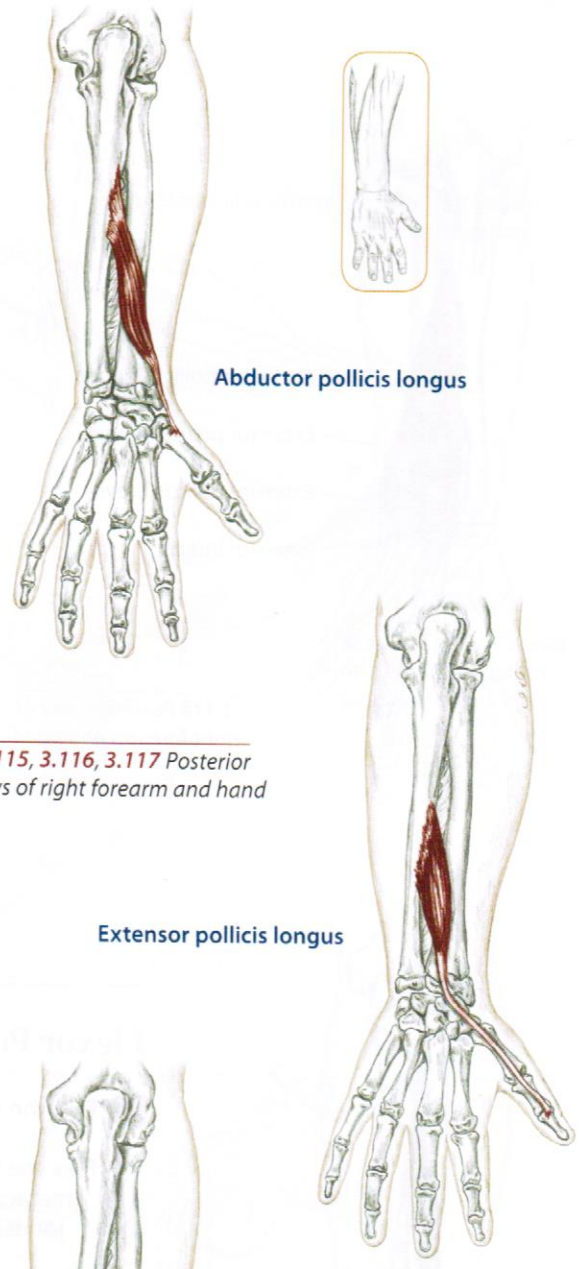
O *Longus:* Posterior surface of ulna and interosseous membrane

Brevis: Posterior surface of radius and interosseous membrane

I *Longus:* Base of distal phalanx of thumb

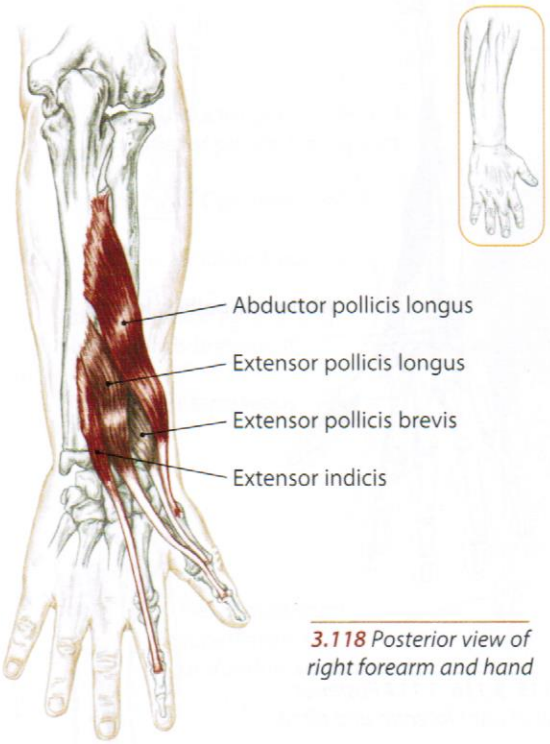
Brevis: Base of proximal phalanx of thumb

N Radial C6, **7**, **8**

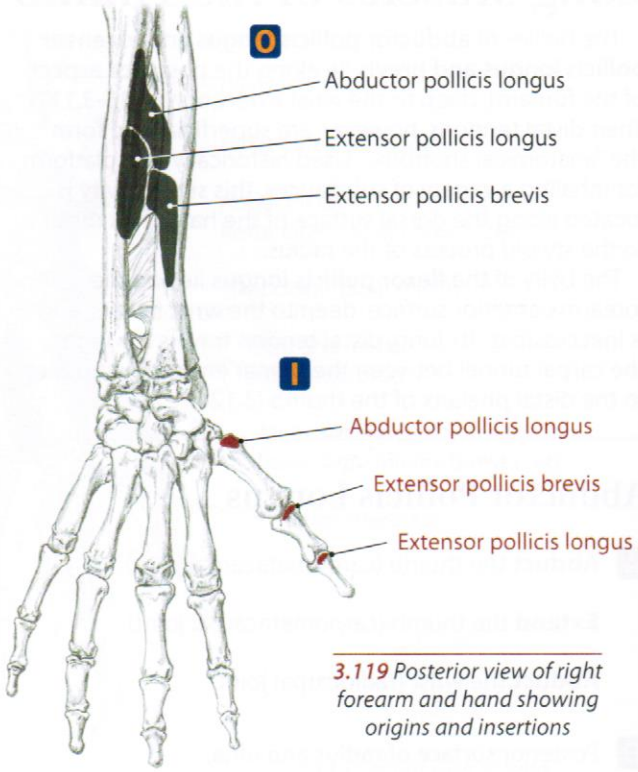


3.115, 3.116, 3.117 Posterior views of right forearm and hand

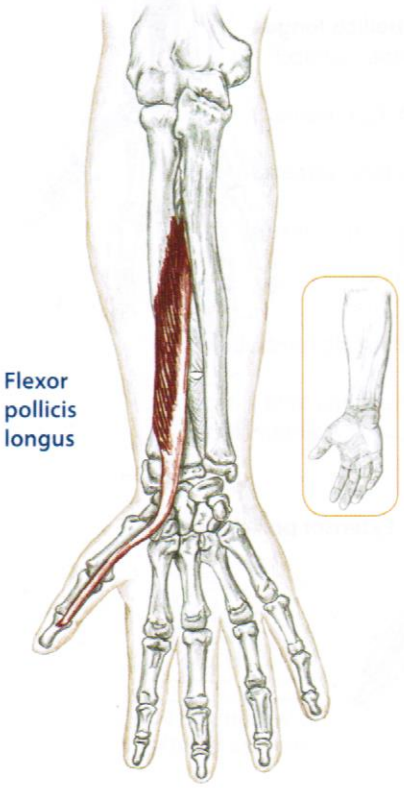
Long Muscles of the Thumb



3.118 Posterior view of right forearm and hand



3.119 Posterior view of right forearm and hand showing origins and insertions



3.120 Anterior view of right forearm and hand

Flexor Pollicis Longus

A **Flex** the thumb (interphalangeal joint)

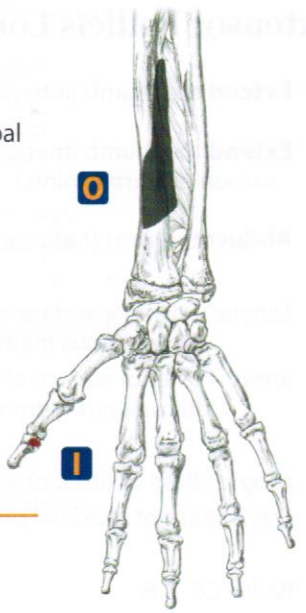
Flex the thumb (metacarpophalangeal and carpometacarpal joints)

Assist to **flex** the wrist (radiocarpal joint)

O Anterior surface of radius and interosseous membrane

I Base of distal phalanx of thumb

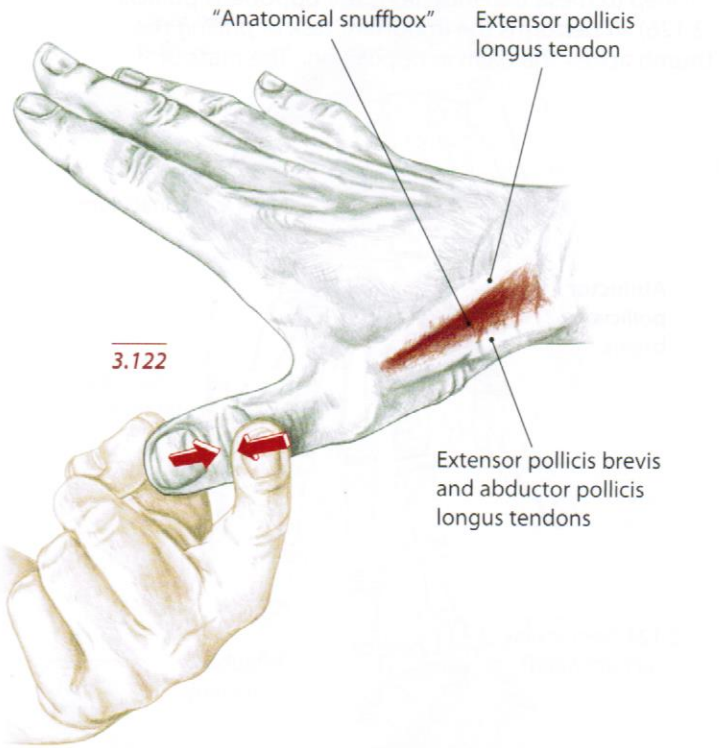
N Median C(6), 7, **8**, T**1**



3.121 Anterior view of right forearm and hand showing origin and insertion of flexor pollicis longus

Anatomical snuffbox and long muscles of the thumb

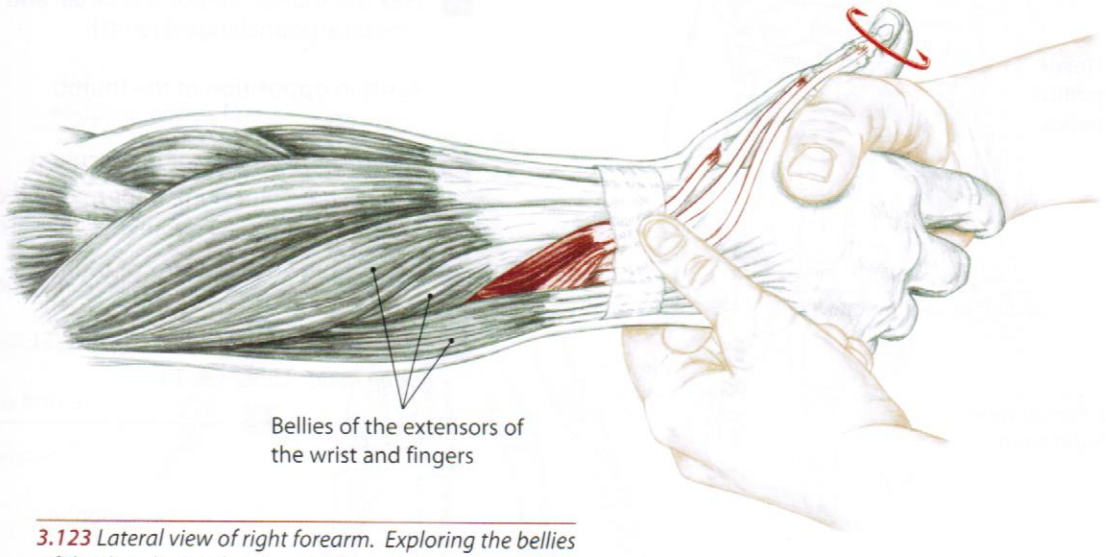
1) With your partner's wrist in a neutral position, ask her to extend her thumb. "Bring your thumbnail toward your inner elbow." (3.122)
2) Just distal to the styloid process of the radius will be a small trough formed by the surrounding tendons. This is the anatomical snuffbox. If not seen immediately, change the angle of the thumb.
3) Follow the tendons that form the snuffbox (extensor pollicis longus, brevis and abductor pollicis) proximally as they slide over the posterior surface of the radius. Lay your fingers along the posterior surface of the radius as your partner "circumducts" her thumb in order to feel a portion of these muscles contract (3.123).



3.122

When Do You Use Them?

- *Typing, gaming and texting*
- *Painting with a small brush*
- *Throwing a ball*
- *Holding a pencil when writing*
- *Grasping the handle of a tea cup*
- *Unlocking a door with a key*
- *Making a fist*
- *Giving a "thumbs-up" gesture*
- *Hitchhiking*
- *And, of course, milking a goat!*



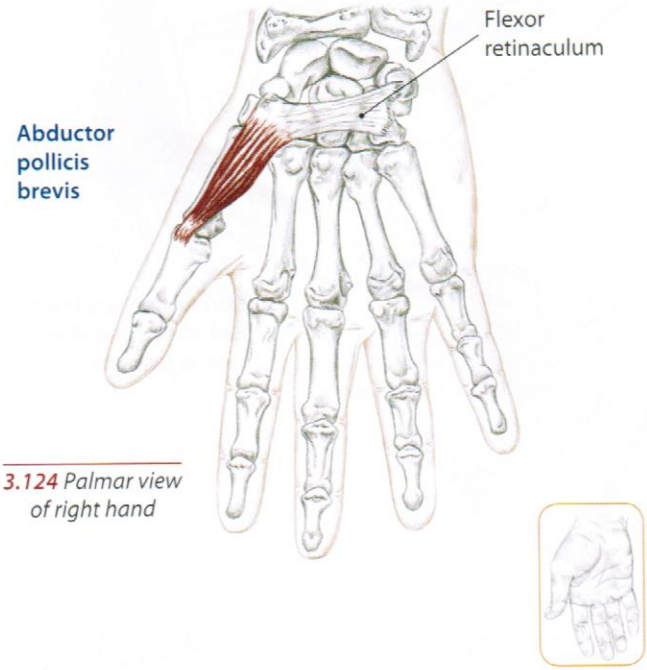
3.123 Lateral view of right forearm. Exploring the bellies of the thumb muscles, deep to the extensor group, while your partner circumducts her thumb.

Short Muscles of the Thumb

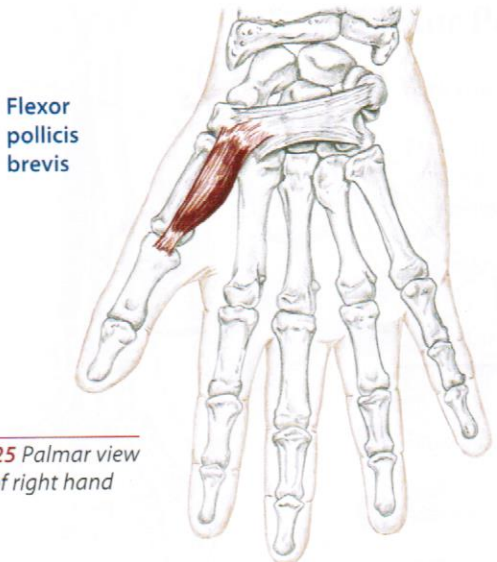
The **abductor pollicis brevis** and **flexor pollicis brevis** (3.124, 3.125) are the superficial and intermediate muscles of the thenar eminence (from a palmar view). As their names suggest, they are short, intrinsic muscles that help to abduct and flex the thumb.

Deep to these two muscles is the **opponens pollicis** (3.126). It performs the important task of pulling the thumb across the palm in opposition. The mass of these three muscles can be easily felt in the thenar eminence, but their specific bellies are difficult to specifically isolate.

The largest of the thumb's short muscles is the strong **adductor pollicis** (3.127). It lies deep along the palmar surface and draws the thumb toward the index and middle fingers (adduction). It can sometimes be felt in the web of the hand between the thumb and first finger.



3.124 Palmar view of right hand



3.125 Palmar view of right hand

Abductor Pollicis Brevis

A **Abduct** the thumb (carpometacarpal and metacarpophalangeal joints)

Assist in **opposition** of the thumb

O Flexor retinaculum, trapezium and scaphoid tubercles

I Base of proximal phalanx of thumb

N Median C6, 7, 8, T1

Flexor Pollicis Brevis

A **Flex** the thumb (carpometacarpal and metacarpophalangeal joints)

Assist in **opposition** of the thumb

O *Superficial head:* Flexor retinaculum
Deep head: Trapezium, trapezoid and capitate

I Base of proximal phalanx of thumb

N *Superficial head:* Median C6, 7, 8, T1
Deep head: Ulnar C**8**, T**1**

opponens pollicis	o-**po**-nens **pol**-li-sis	L. opposing L. thumb

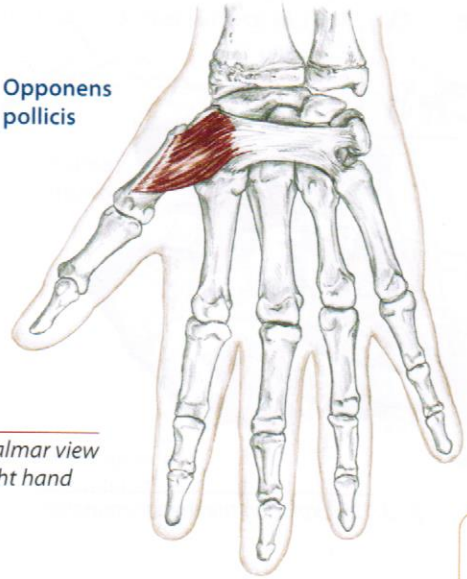
Opponens Pollicis

A **Opposition** of the thumb at the carpometacarpal joint (bringing the pads of the thumb and fifth finger together)

O Flexor retinaculum and tubercle of the trapezium

I Entire length of first metacarpal bone, radial surface

N Median C6, 7, 8, T1



3.126 Palmar view of right hand

Adductor Pollicis

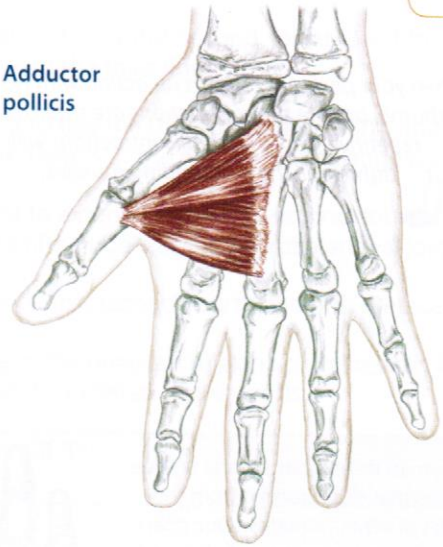
A **Adduct** the thumb (carpometacarpal and metacarpophalangeal joints)

Assist to **flex** the thumb (metacarpophalangeal joint)

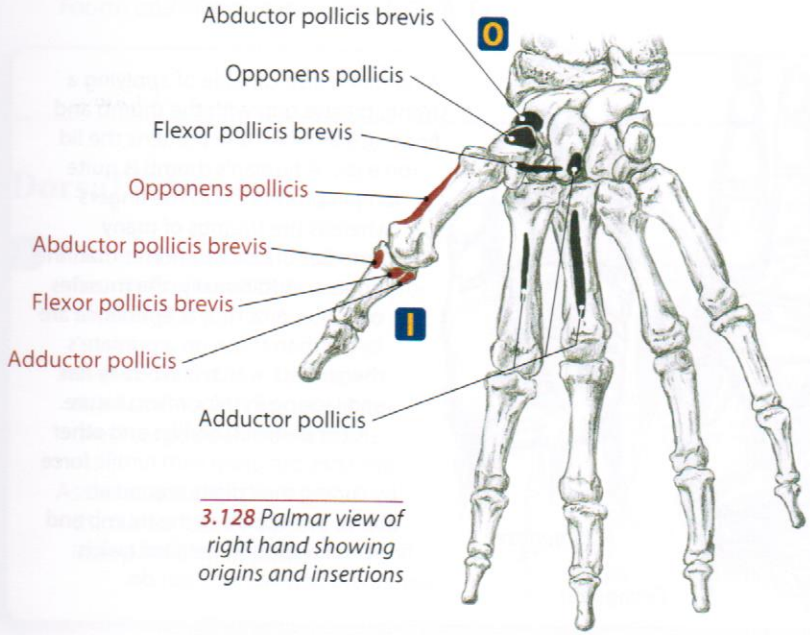
O Capitate, second and third metacarpals

I Base of proximal phalanx of thumb

N Ulnar C**8**, T**1**



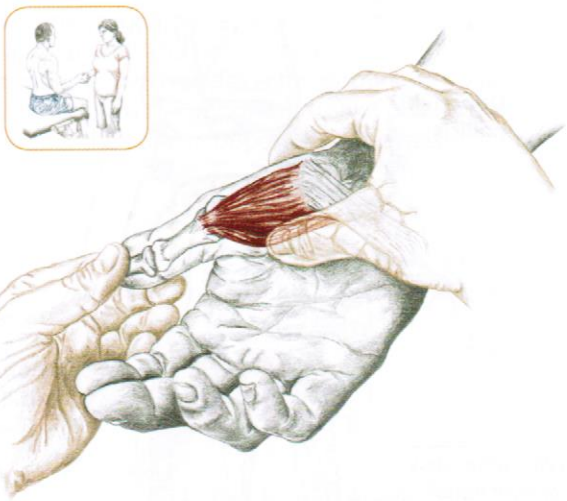
3.127 Palmar view of right hand



3.128 Palmar view of right hand showing origins and insertions

thenar **thee**-nar Grk. palm, flat of the hand

Short Muscles of the Thumb



3.129 *Exploring the thenar eminence*

Short muscles of the thumb

1) Locate the base of your partner's thumb and explore all sides of the thenar eminence's thick, movable tissue. Palpate from the shaft of the first metacarpal to the webbing between the thumb and finger (3.129).
2) Ask your partner to gently squeeze her thumb and fifth fingerpads together. Note how the thenar eminence becomes dense and compact (3.130).

3.130 *Feeling the thenar muscles contract during opposition*

When your partner performs an action with her thumb, be sure the contractions are small and repetitive. More forceful contractions will tighten all the surrounding muscles.

The human thumb has several unique qualities that distinguish it from the thumbs of other primates. One characteristic that is *not* distinctly human is the saddle joint of the first carpometacarpal joint. The joint's shape allows for opposition of the thumb and fingers, a skill shared by many higher primates including chimpanzees, orangutans and gorillas.

One reason for the dexterity of the human thumb is the separation between the flexor pollicis longus and flexor digitorum profundus muscles. In other primates these muscles are united, restricting the ability of the fingers and thumb to move independently.

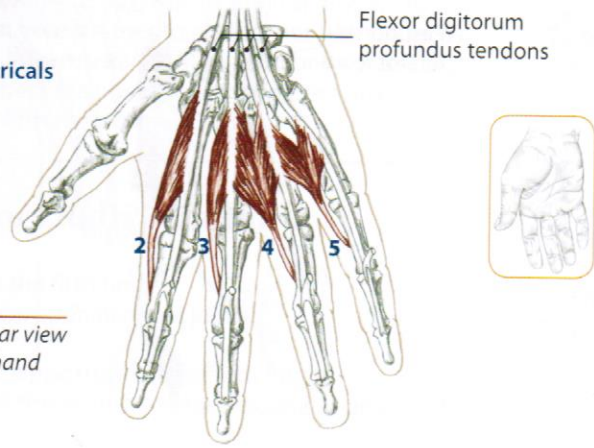
Orangutan *Chimpanzee*

A human is also capable of applying a strong, precise grip with the thumb and fingertips as when one tightens the lid on a jar. A human's thumb is quite long in proportion to the fingers whereas the thumbs of many primates are much shorter than the fingers. Additionally, the muscles on a human's thenar eminence are larger than those on a primate's thenar pad, which is typically flat and lacking in thick musculature.

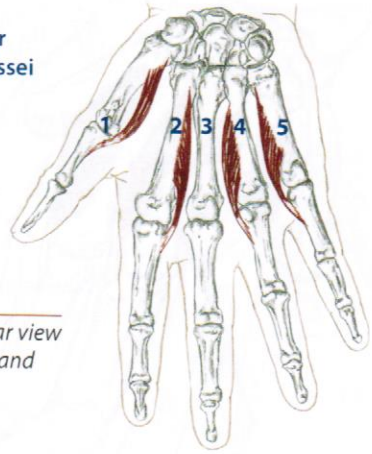
Chimpanzees, gorillas and other primates can grasp with terrific force by curling their digits around an object, but opposing the thumb and finger for a specific, detailed task is something only humans can do.

Lumbricals and Interossei

The **lumbricals** sprout from the sides of the flexor digitorum profundus tendons on the palmar side of the hand (3.131). Deep to the lumbricals, the **palmar interossei** (3.132) are located between the metacarpals and hence are difficult to access. The **dorsal interossei** (3.133), however, are accessible between the metacarpals from the hand's dorsal surface (3.134).



3.131 Palmar view of right hand



3.132 Palmar view of right hand

Lumbricals of the Hand

A **Extend** the second through fifth fingers at the interphalangeal joints

Flex the second through fifth fingers at the metacarpophalangeal joints

O Surfaces of the flexor digitorum profundus tendons

I Extensor aponeurosis on dorsal surface of phalanges

N *Second and third fingers:* Median C(6), 7, **8**, T**1**
Fourth and fifth fingers: Ulnar C(7), **8**, T**1**

Palmar Interossei

A **Adduct** the thumb, second, fourth and fifth fingers toward the third finger

Assist to **flex** the thumb, second, fourth and fifth fingers at the metacarpophalangeal joints

Assist to **extend** the thumb, second, fourth and fifth fingers at the interphalangeal joints

O Base of first, second, fourth and fifth metacarpals

I Base of the proximal phalanx of the related finger and the extensor aponeurosis

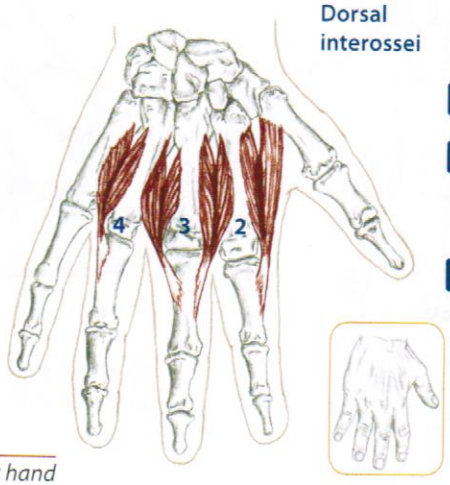
N Ulnar C**8**, T**1**

Dorsal Interossei

A **Abduct** the second, third and fourth fingers at the metacarpophalangeal joints

Assist to **flex** of the second, third and fourth fingers at the metacarpophalangeal joints

Assist to **extend** the second, third and fourth fingers at the interphalangeal joints



3.133 Dorsal view of right hand

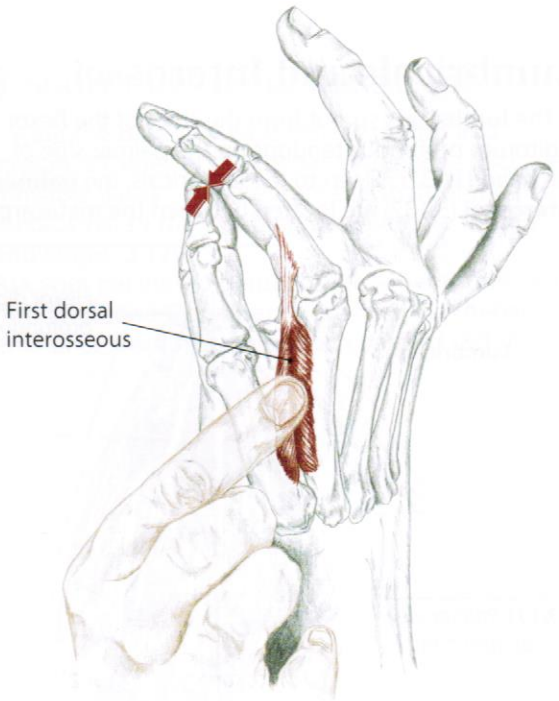
O Adjacent sides of all metacarpals

I Base of the proximal phalanx of the second, third and fourth fingers and the extensor aponeurosis

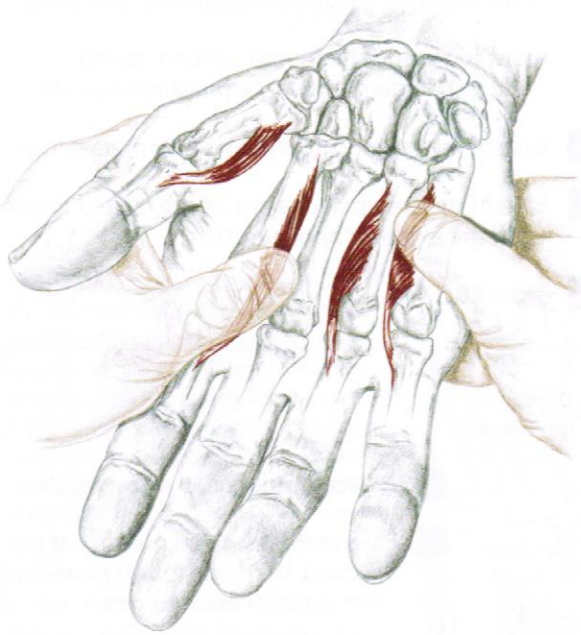
N Ulnar C**8**, T**1**

lumbrical — **lum**-bri-kal — L. earthworm
interroseus — **in**-ter-**ah**-see-us — L. between bones

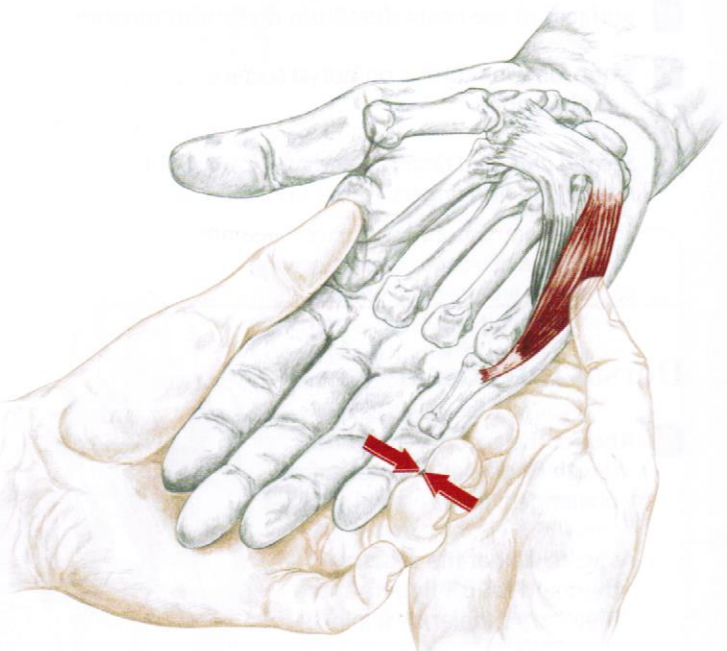
3.134 *Dorsal view of right hand, exploring between the metacarpals for the dorsal interossei*



3.135 *Dorsal/radial view of right hand. Ask your partner to adduct her thumb. "Press the side of your thumb into the side of your index finger." Note how the muscles of the thenar eminence may soften, but the muscles in the hand's webbing (adductor pollicis and first dorsal interosseous) become taut.*



3.136 *Palmar view of right hand, accessing the palmar interossei muscles*

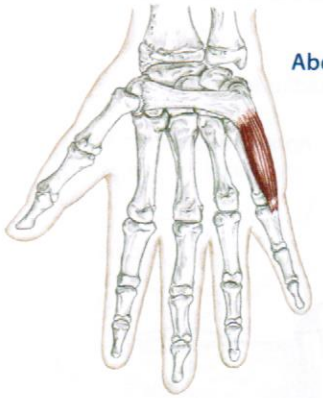


3.137 *Feel the hypothenar muscles contract when your partner abducts her fifth finger against your resistance.*

Hypothenar Eminence

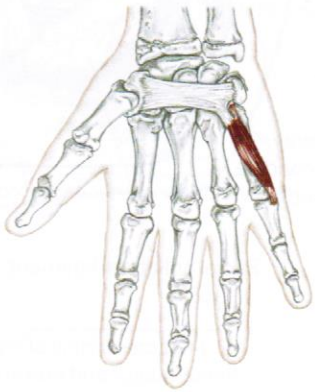
Opposite the thenar eminence, along the ulnar side of the palm, is the hypothenar eminence. This oblong mound of flesh is composed of three short muscles: **abductor digiti minimi**, **flexor digiti minimi brevis** and **opponens digiti minimi** (3.138-3.140).

The abductor digiti minimi is superficial and extends from the pisiform to the base of the fifth finger. To isolate it, ask your partner to abduct her fifth finger as you apply a little resistance. The solid belly of the digiti minimi will become immediately apparent next to the shaft of the fifth metacarpal (3.137).

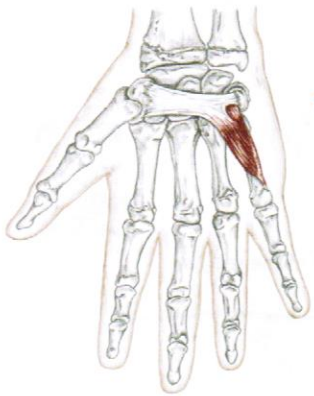


Abductor digiti minimi

3.138, 3.139, 3.140
Palmar views of right hand



Flexor digiti minimi brevis
(deep to abductor digiti minimi)



Opponens digiti minimi
(deep to flexor digiti minimi brevis)

Abductor Digiti Minimi

A **Abduct** the fifth finger (metacarpophalangeal joint)

Assist in **opposition** of the fifth finger toward the thumb (metacarpophalangeal joint)

O Pisiform and tendon of flexor carpi ulnaris

I Base of proximal phalanx of fifth finger, ulnar surface

N Ulnar C(7), **8**, T**1**

Flexor Digiti Minimi Brevis

A **Flex** the fifth finger (metacarpophalangeal joint)

Assist in **opposition** of the fifth finger toward the thumb

O Hook of hamate and flexor retinaculum

I Base of proximal phalanx of fifth finger, palmar surface

N Ulnar C(7), **8**, T**1**

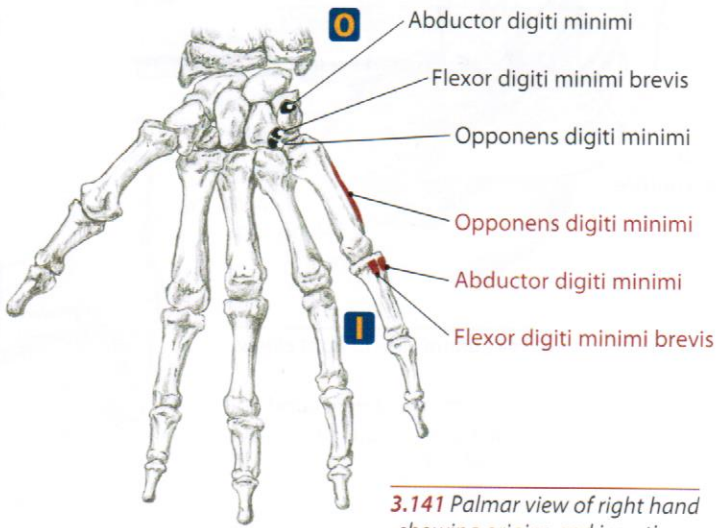
Opponens Digiti Minimi

A **Opposition** of the fifth finger at the carpometacarpal joint

O Hook of hamate and flexor retinaculum

I Shaft of fifth metacarpal, ulnar surface

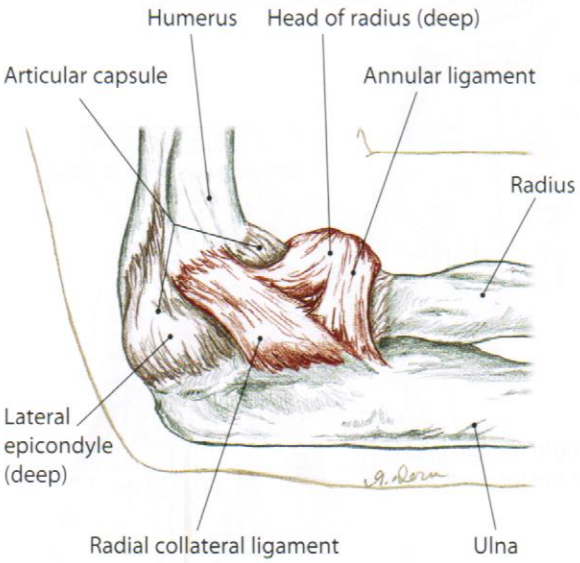
N Ulnar C(7), **8**, T**1**



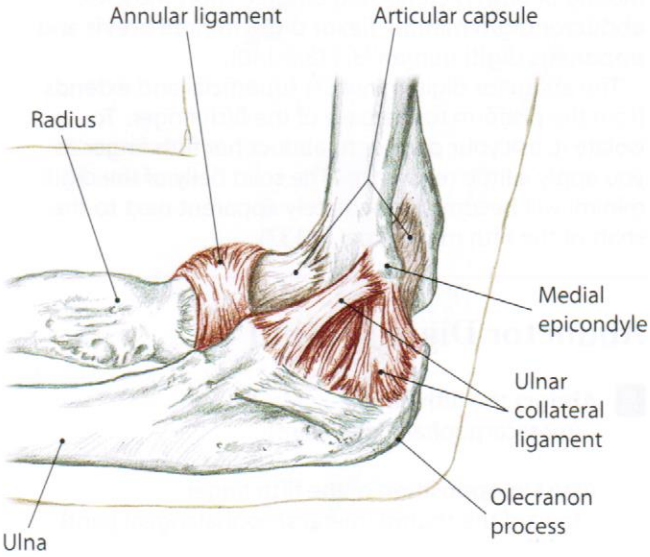
3.141 Palmar view of right hand showing origins and insertions

hypothenar **hi**-po-**thee**-nar Grk. *hypo*, under or below
Grk. *thenar*, palm, flat of the hand

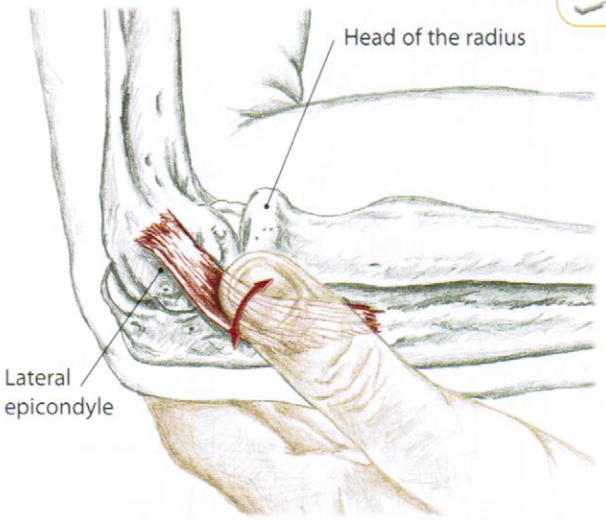
Other Structures of the Forearm and Hand



3.142 Lateral view of right elbow showing humeroulnar and proximal radioulnar joints



3.143 Medial view of right elbow showing humeroulnar and proximal radioulnar joints



3.144 Lateral view of right elbow

Radial Collateral Ligament

The radial collateral ligament is a cordlike band that stretches from the lateral epicondyle of the humerus to the annular ligament and lateral side of the ulna (3.142). The ligament is deep to the supinator and extensors of the forearm.

1) Shaking hands with your partner, locate the lateral epicondyle of the humerus and head of the radius.
2) Between these landmarks will be a slight ditch. Place your fingertip in this space. Visualize the ligament spanning across the ditch and gently roll your finger across the ligament's slender surface. It may feel like a thin strip of duct tape (3.144).

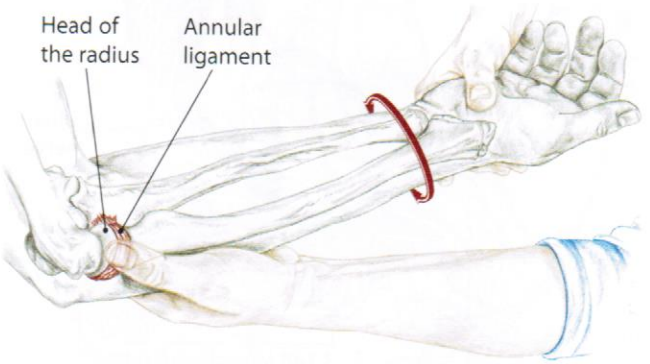
Are you between the head of the radius and the lateral epicondyle? With the elbow flexed, do the fibers of the ligament run parallel with the forearm?

annular	**an**-u-ler	L. ringlike
collateral	ko-**lat**-er-al	L. of both sides

Annular Ligament

The annular ligament wraps around the head and neck of the radius, stabilizing the proximal radius against the ulna during pronation and supination (3.143). It lies deep to the supinator and the extensor muscles of the forearm. Although the annular ligament cannot be palpated separately, its location can be isolated.

1) With your partner's elbow flexed, place your thumbpad on the head of the radius.
2) While passively pronating and supinating the forearm, allow the head and neck of the radius to pivot under your thumb (3.145, 3.146). You may not feel the annular ligament separately, but visualize it stabilizing the head of the radius to the ulna.

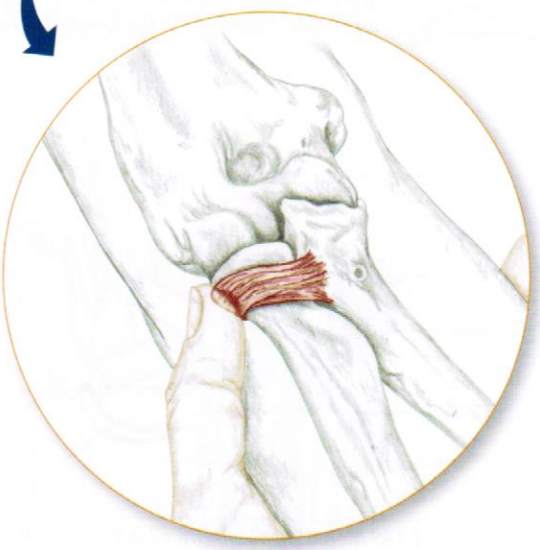


3.145 Posterior/lateral view of right forearm

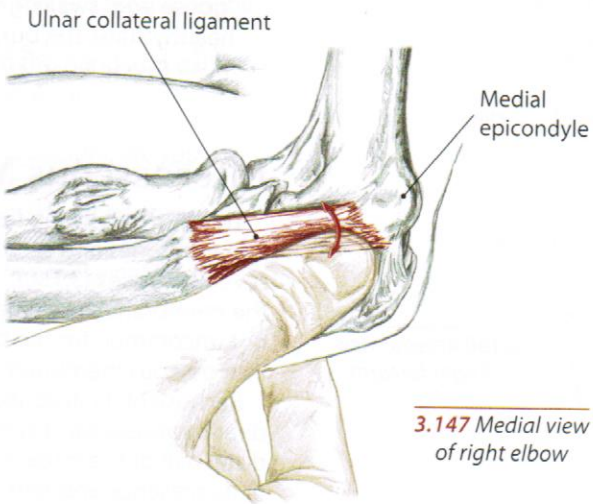
Ulnar Collateral Ligament

The ulnar collateral ligament is a strong, triangular-shaped ligament that originates on the humerus' medial epicondyle (3.143). Its fibers spread out and attach to the coronoid process of the ulna and to the olecranon process. The collateral ligament is deep to the common flexor tendon, but superficial to the ulnar nerve.

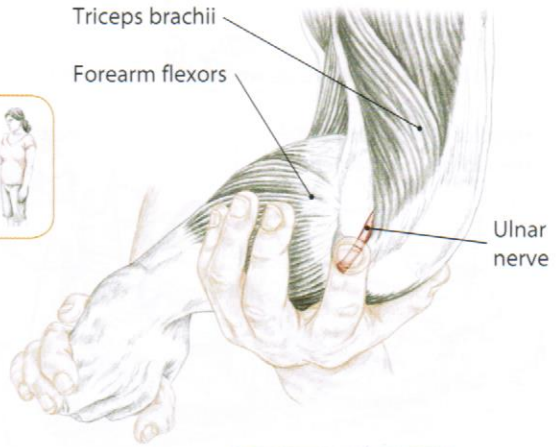
1) With the elbow flexed, locate the medial epicondyle of the humerus and the medial aspect of the olecranon process.
2) Place your thumb between these landmarks.
3) Palpating through the overlying muscle tissue, explore the ligament's thin fibers which run transversely to the fibers of the muscles (3.147). You may not feel something distinct, but if you are between the stated landmarks you are in the right location.



3.146 Anterior/lateral view of right elbow



3.147 Medial view of right elbow



3.148 Medial/posterior view of right elbow

When palpating, be sure not to press too hard and impinge on the ulnar nerve, which can create tingling or numbness in the forearm or hand.

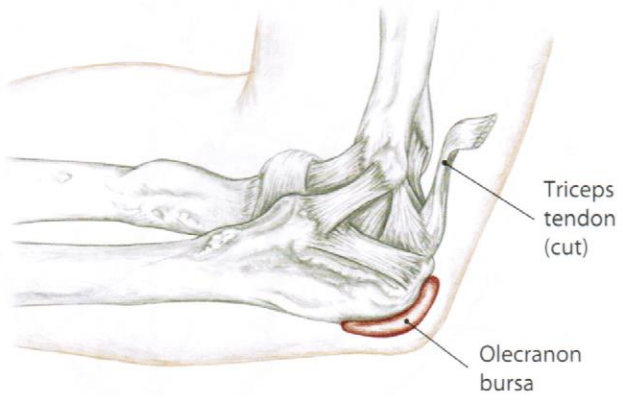
Ulnar Nerve

The ulnar nerve passes between the medial epicondyle and olecranon process as it extends down the forearm. Between these two landmarks the nerve is superficial and easily accessible. Hence, bumping your elbow can irritate the ulnar nerve and create the annoying "funny bone" sensation down the forearm.

Ulnar nerve

1) With the elbow flexed, locate the medial epicondyle and olecranon process. Using gentle pressure, slide your finger into the space between these landmarks and palpate for the tube-shaped nerve (3.148).
2) Explore its location in relation to the triceps brachii tendon and common flexor tendon.

Is the structure you feel soft and movable? Are you palpating the ulnar nerve or the triceps brachii's fibrous tendon? Ask your partner to extend her elbow. Does the tendon tighten and the nerve "disappear" into the tissue?

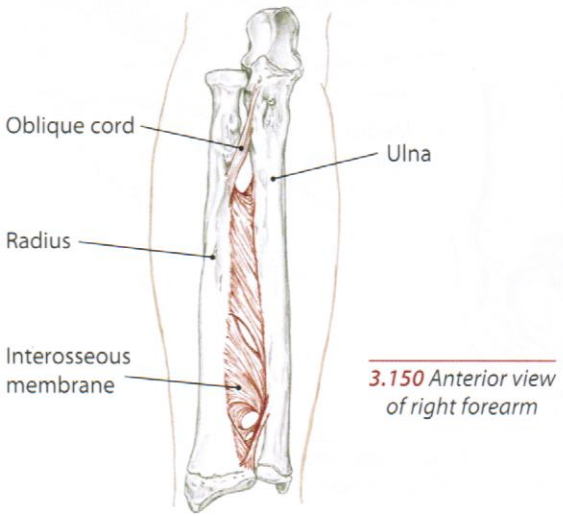


3.149 Medial view of right elbow

Olecranon Bursa

Just distal to the triceps brachii tendon, this small bursa pads the space between the olecranon process and skin of the elbow (3.149). Due to its location, the bursa can become inflamed when the elbow is irritated or struck by an external object. This condition, olecranon bursitis, (or "student's elbow") is readily observable by the distinct, localized ballooning of the elbow.

1) Flex the elbow to 90° and locate the olecranon process.
2) Palpating just distally to the process, gently explore the elbow's thin, malleable tissue. Then let the elbow extend and note how the skin and fascia become even more lax.
3) If the bursa is inflamed, the elbow will present a "goose egg" swelling with localized tenderness. In a healthy state, the bursa is not palpable.



3.150 Anterior view of right forearm

Interosseous Membrane

This thin but strong fibrous sheet binds together the forearm bones and serves as an attachment site for several muscles (3.150). Its oblique cord strengthens the membrane's proximal end. During stress, it is not uncommon for the bones to fracture before the interosseous membrane tears.

Because of its deep location, the membrane is not directly accessible. Exploration between the bones at the distal half of the forearm, however, can give you a sense of its presence and tensile firmness.

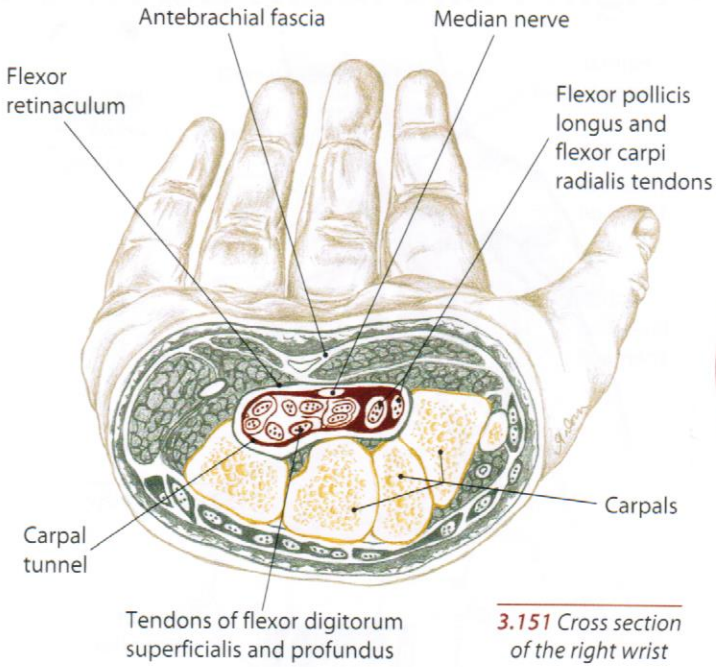
Retinacula of the Wrist and Palmar Aponeurosis

The **flexor retinaculum** is located on the palmar surface of the wrist just distal to the flexor crease. Its transverse fibers lie deep to the palmaris longus tendon and superficial to the other flexor tendons and median nerve. The flexor retinaculum and carpal bones form the carpal tunnel, in which the flexor tendons and median nerve pass (3.151).

Isolating the thin flexor retinaculum can be difficult, but its transverse fibers (which are perpendicular to the deeper tendons) help to distinguish it. Also, if the retinaculum is "tight," the tissue of the anterior wrist might have an inflexible feel.

The thick **palmar aponeurosis** is a continuation of the antebrachial fascia that stretches superficially across the palm of the hand and is an attachment site for the palmaris longus tendon. It is shaped in a similar way to the plantar aponeurosis (p. 404) on the sole of the foot. Although it might not be easy to palpate, nevertheless, like the flexor retinaculum, its tensile quality can be felt.

The **extensor retinaculum** is superficial and located on the posterior wrist. Like the flexor retinaculum, it is a thickening of fascia that has transverse fibers stretching across the wrist to attach to underlying bones. It stabilizes the wrist and thumb extensors. It is roughly three-quarters of an inch wide and located distal to the head of the ulna and the styloid process of the radius.

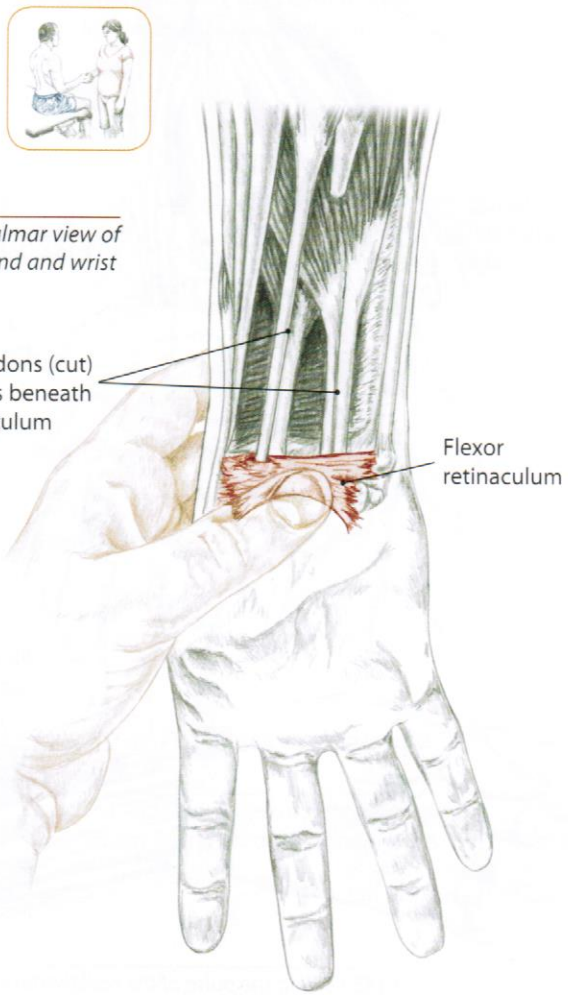


3.151 Cross section of the right wrist

Flexor retinaculum and palmar aponeurosis

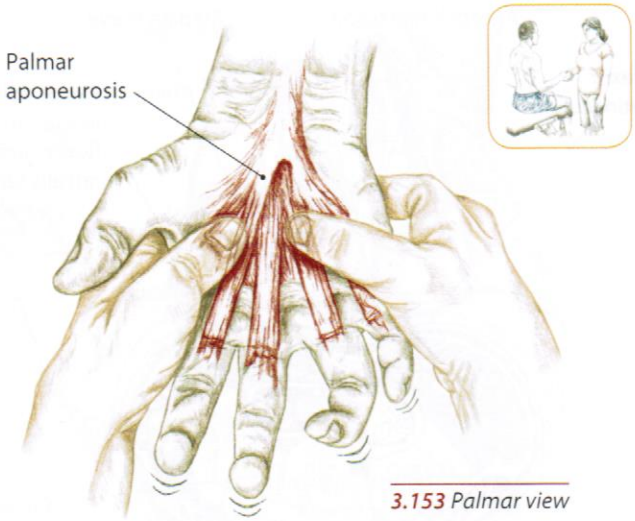
1) Cradle your partner's hand so your thumbpad is on the flexor crease of the wrist. Slide half an inch distally to the crease and sink into the thick tissues of the "heel" of the hand (3.152).
2) As you explore the carpal space, visualize the retinaculum spanning across the carpals. Passively flex and extend the wrist and feel the tension in the retinaculum change.
3) Slide distally onto the palm of the hand and palpate for the thick, superficial palmar aponeurosis.

When palpating the flexor retinaculum, are you distal to the level of the pisiform (p. 121)? To highlight the palmar aponeurosis, ask your partner to tighten his hand as if he were "palming a basketball." (3.153) Note how this action also brings the palmaris longus tendon into view.



3.152 Palmar view of right hand and wrist

retinaculum **ret**-i-**nak**-u-lum L. halter, band, rope
aponeurosis **ap**-o-nu-**ro**-sis Grk. *apo*, from + *neuron*, nerve or tendon

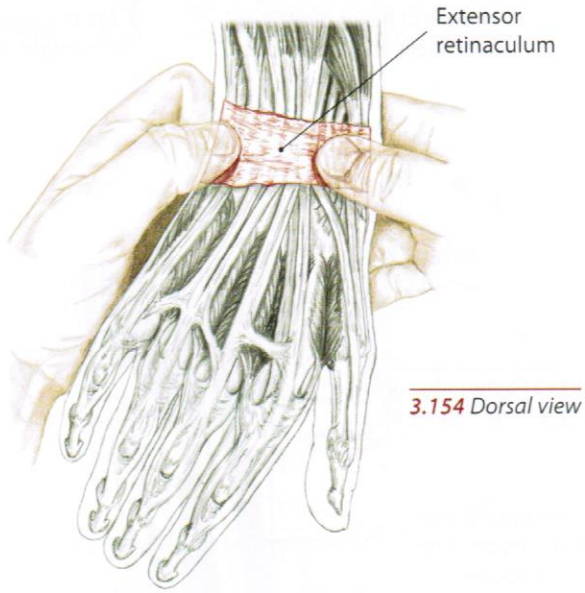


3.153 Palmar view

Extensor retinaculum

1) Ask your partner to extend her fingers and wrist. The pressure from the bulging extensor tendons will make the retinaculum more distinct.
2) Locate the head of the ulna and the styloid process of the radius.
3) Palpate just distal to these landmarks by sliding across the transverse fibers of the thin retinaculum (3.154).

Are you distal to the head of the ulna and the styloid process of the radius? Can you distinguish superficial, transverse fibers?



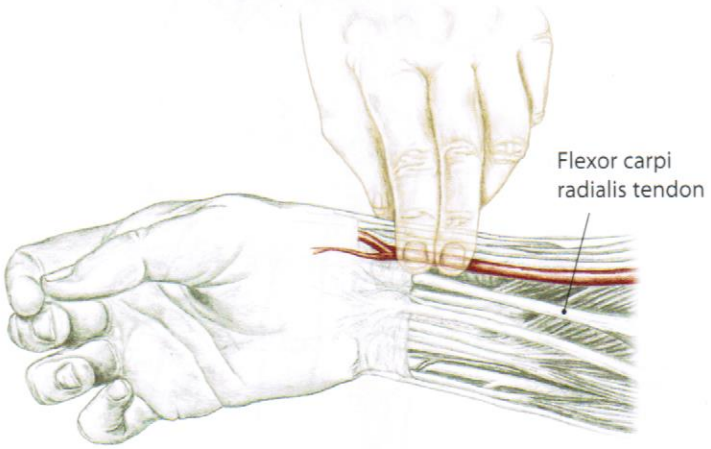
3.154 Dorsal view

Radial and Ulnar Arteries

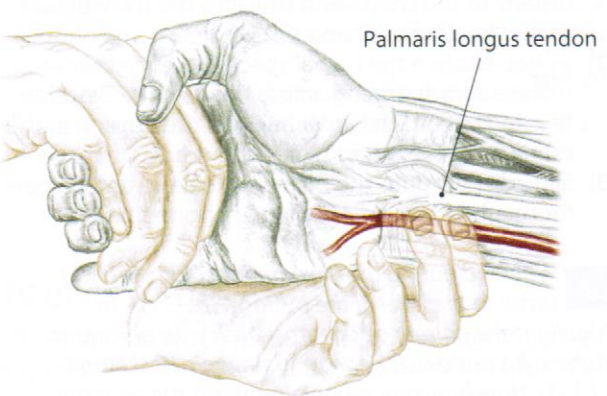
The radial and ulnar arteries branch off the brachial artery and travel down the forearm to the hand. The **radial artery** is often used for taking a pulse. It is detectable on the anterior wrist between the tendon of the flexor carpi radialis and the shaft of the radius.

The **ulnar artery** is found proximal to the pisiform and medial to the palmaris longus tendon. Its pulse may not be as easily accessible as the radial pulse.

1) Locate the radial pulse by placing two fingerpads on the flexor side of the wrist. Move laterally and gently press to feel the pulse (3.155).
2) Locate the ulnar pulse by moving your fingerpads to the medial side of the flexor surface (3.156).

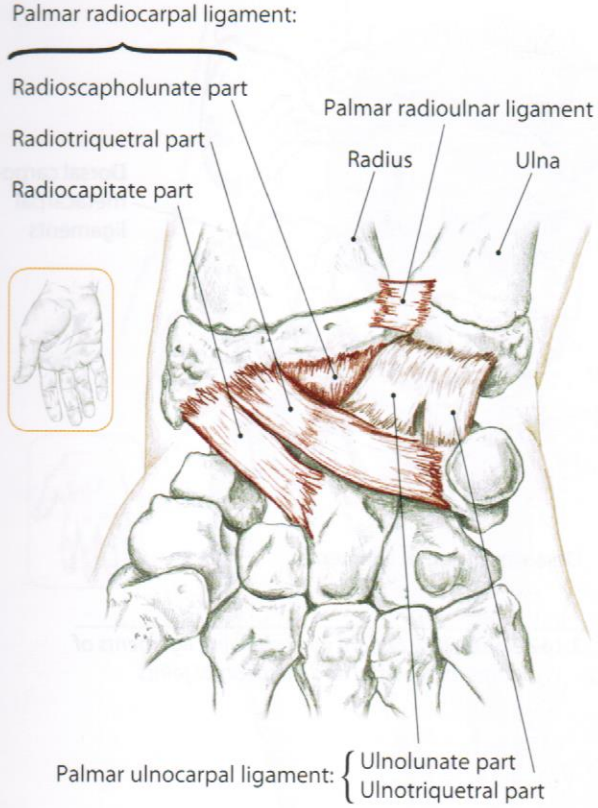


3.155 Feeling the pulse of the radial artery

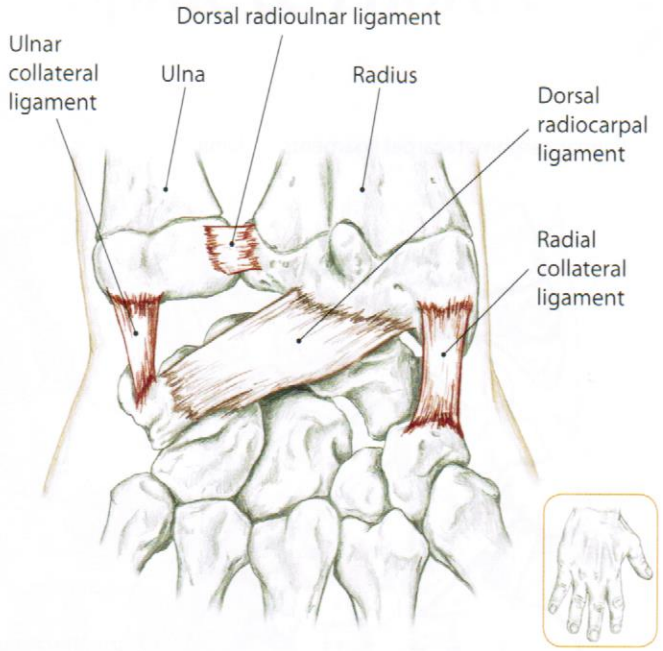


3.156 Feeling the pulse of the ulnar artery

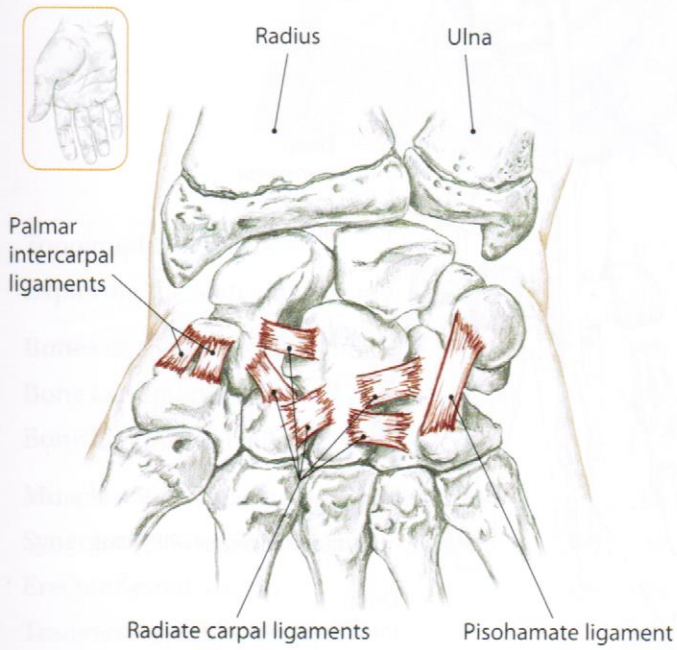
Ligaments of the Wrist, Hand and Fingers



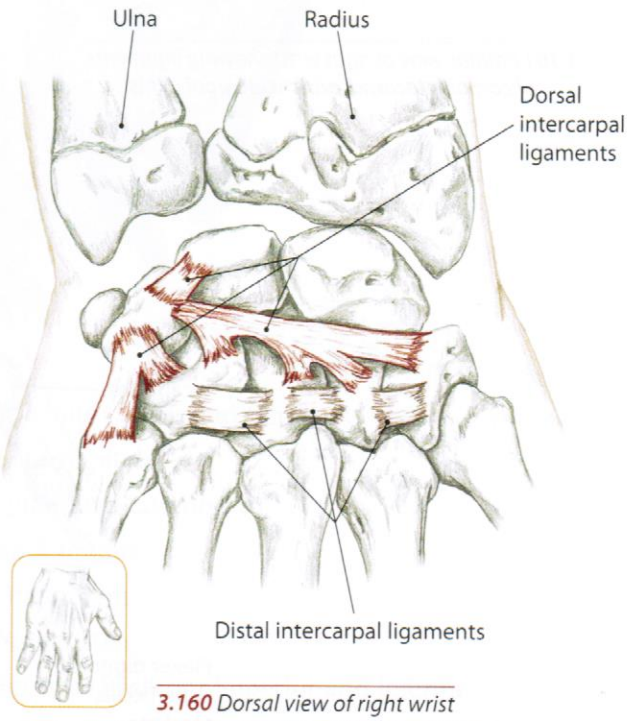
3.157 Palmar view of right wrist showing ligaments of radiocarpal joints



3.158 Dorsal view of right wrist showing ligaments of radiocarpal joints

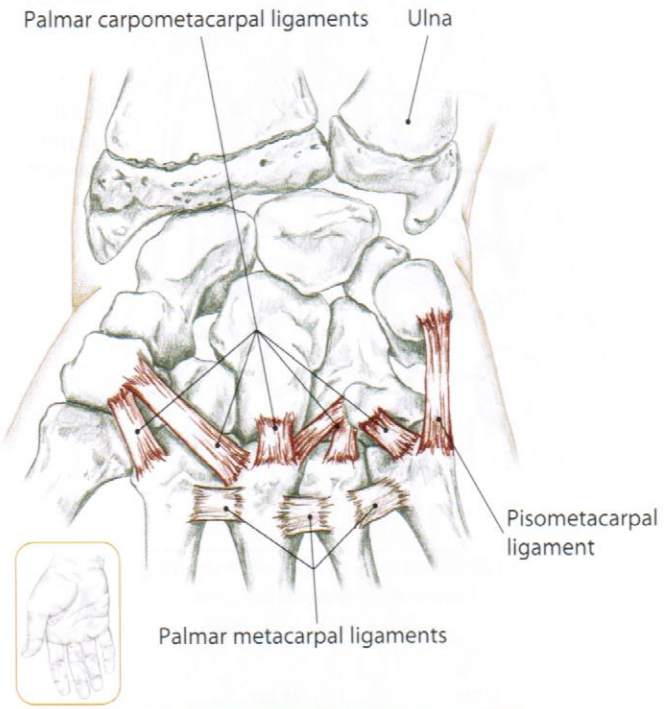


3.159 Palmar view of right wrist showing ligaments of intercarpal joints

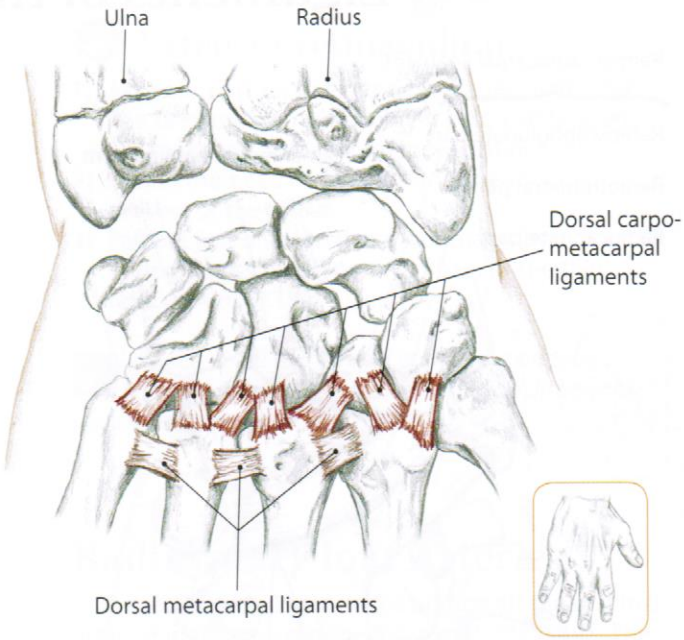


3.160 Dorsal view of right wrist showing ligaments of intercarpal joints

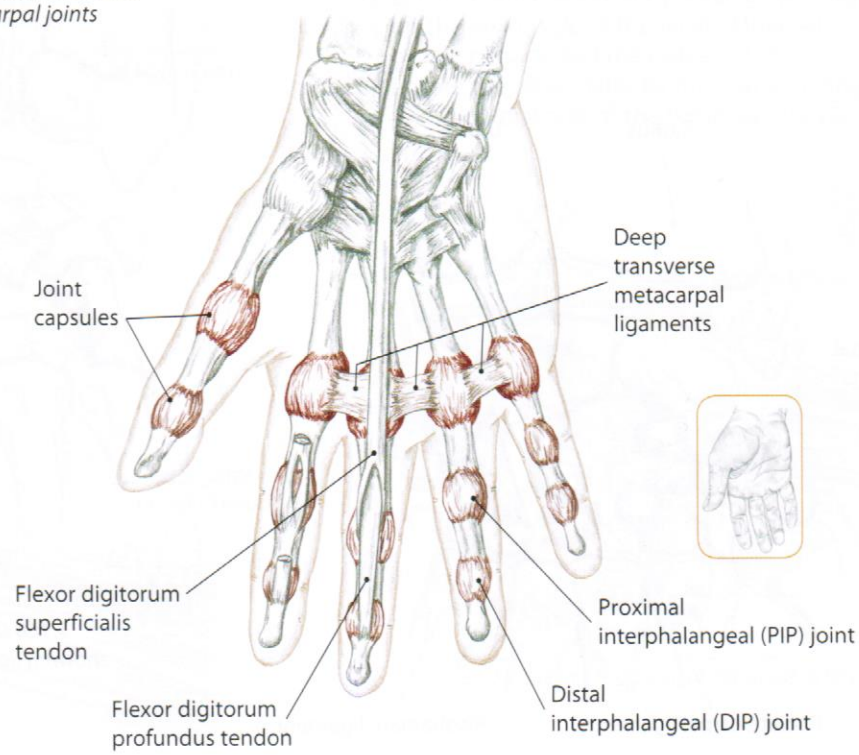
radioscapholunate	**ray**-dee-o-**skaf**-o-**loo**-nate
radiotriquetrum	**ray**-dee-o-tri-**kwe**-trum
radiocapitate	**ray**-dee-o-**kap**-i-tate



3.161 Palmar view of right wrist showing ligaments of carpometacarpal and metacarpal joints



3.162 Dorsal view of right wrist showing ligaments of carpometacarpal and metacarpal joints



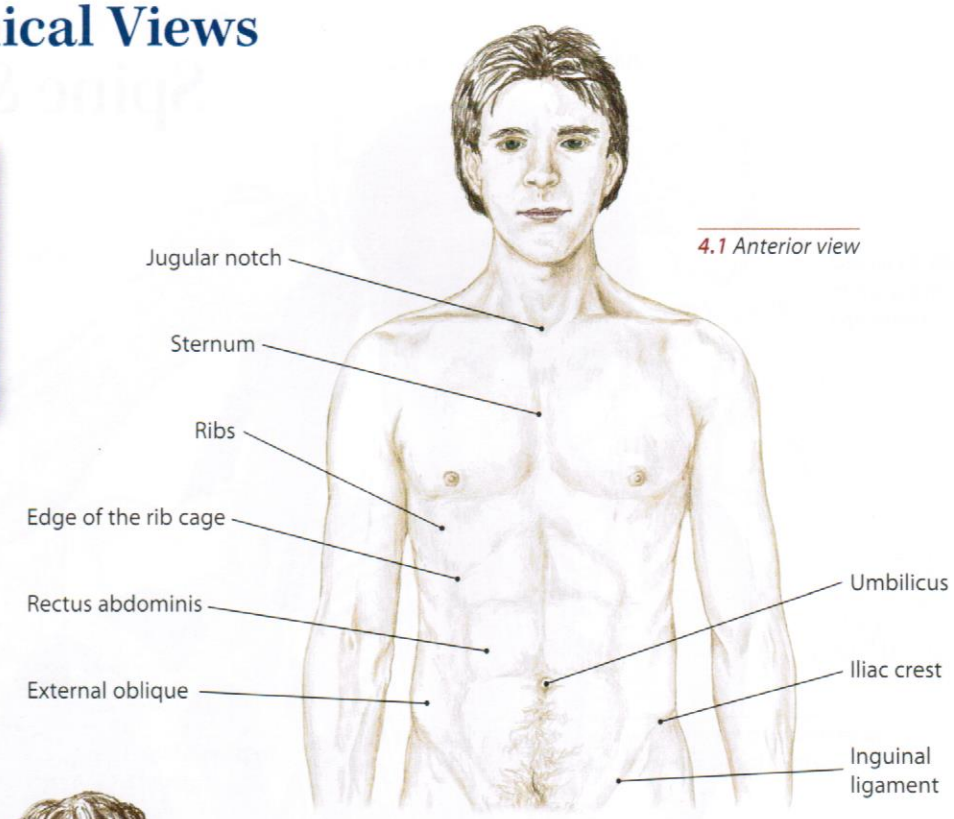
3.163 Palmar view of right wrist and hand showing interphalangeal joints

ulnolunate **ul**-no-**lu**-nate
ulnotriquetrum **ul**-no-tri-**kwe**-trum

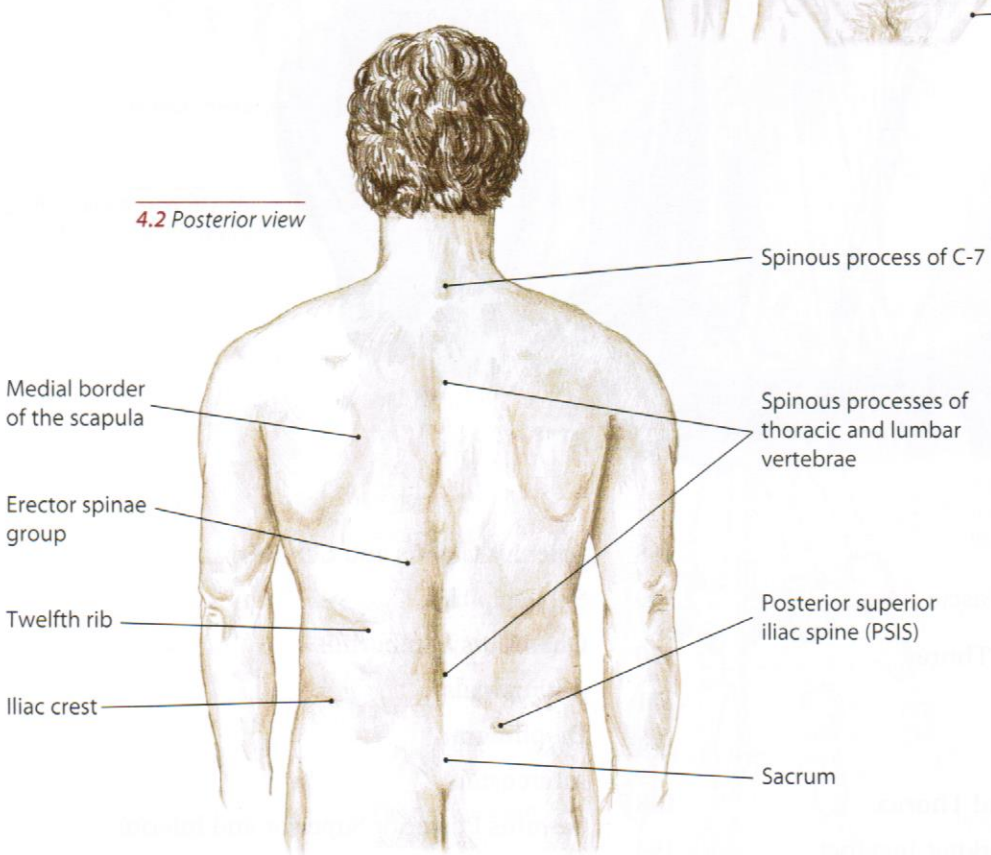
Spine & Thorax 4

Topographical Views

A vertebrate is an animal that has a spinal column. Vertebrates include fishes, amphibians, reptiles, birds, mammals and humans. An insect or a mollusk has no spinal column and is therefore called an invertebrate. Animals that walk on four legs are called quadrupeds whereas humans are bipeds.



4.1 Anterior view



4.2 Posterior view

The vertebrae, sternum and pelvis of a bird are usually air filled or "pneumatized." A bone becomes "pneumatized," it is believed, when its surface comes in contact with an air sac. The bone tissue that rests against the air sac becomes thin before it disappears entirely, leaving behind a cavity that is then penetrated by the air sac. In such a way, the tiny air-filled outgrowths or sacs that extend off the lungs of a bird fill its bones and body cavities, thereby reducing its total body weight.

1) Partner prone. Begin by laying your hands on your partner's middle and lower back and sensing the temperature of the tissue. Explore the sides of the torso as well.
2) Begin to gently lift the skin and fascia superficial to the spinal column in the low back region (4.3). Oftentimes this tissue can be quite dense and impliable. Move a few inches laterally and compare it to the tissue superficial to the large erector muscles.
3) Continue further laterally to the sides of the trunk (between the axilla and pelvis). As you move more laterally, can you detect any differences in the tissue's elasticity or thickness?

4.3 Partner prone

4.4 Partner side lying

The abdomen can be ticklish or sensitive when palpated. Be sure to move slowly and gently, checking in with your partner.

1) Partner supine. Begin with your hands on the sides of the abdomen to sense the temperature of the tissue. Then explore toward the center of the abdomen, up to the edge of the ribs and just below the umbilicus.
2) Begin by gently lifting the skin and fascia of the lateral abdomen and proceed further toward the body's midline (4.5). If some areas may be particularly challenging to grasp, it may be an indication that such action is unwelcome by the body at this time.
3) While grasping a portion of tissue, ask your partner to perform a small "crunch." As the deeper abdominal muscles contract, notice how the tissue may come right out from between your fingers.

When thinking about the thorax (the trunk of the body), most of us consider the "belly and back" surfaces and neglect the sides. Side lying position will allow you to see that the sides of the thorax connect the "belly and back" together and that the thorax is actually one three-dimensional unit.

1) Partner side lying. Lay both hands on the side of the thorax. See and feel how the anterior, lateral and posterior sides of the thorax form one continuous surface.
2) Gently wring your hands in opposite directions (4.4), sensing the tissue's pliability or resistance. Try to move it in all directions.

4.5 Partner supine

Bones of the Spine and Thorax

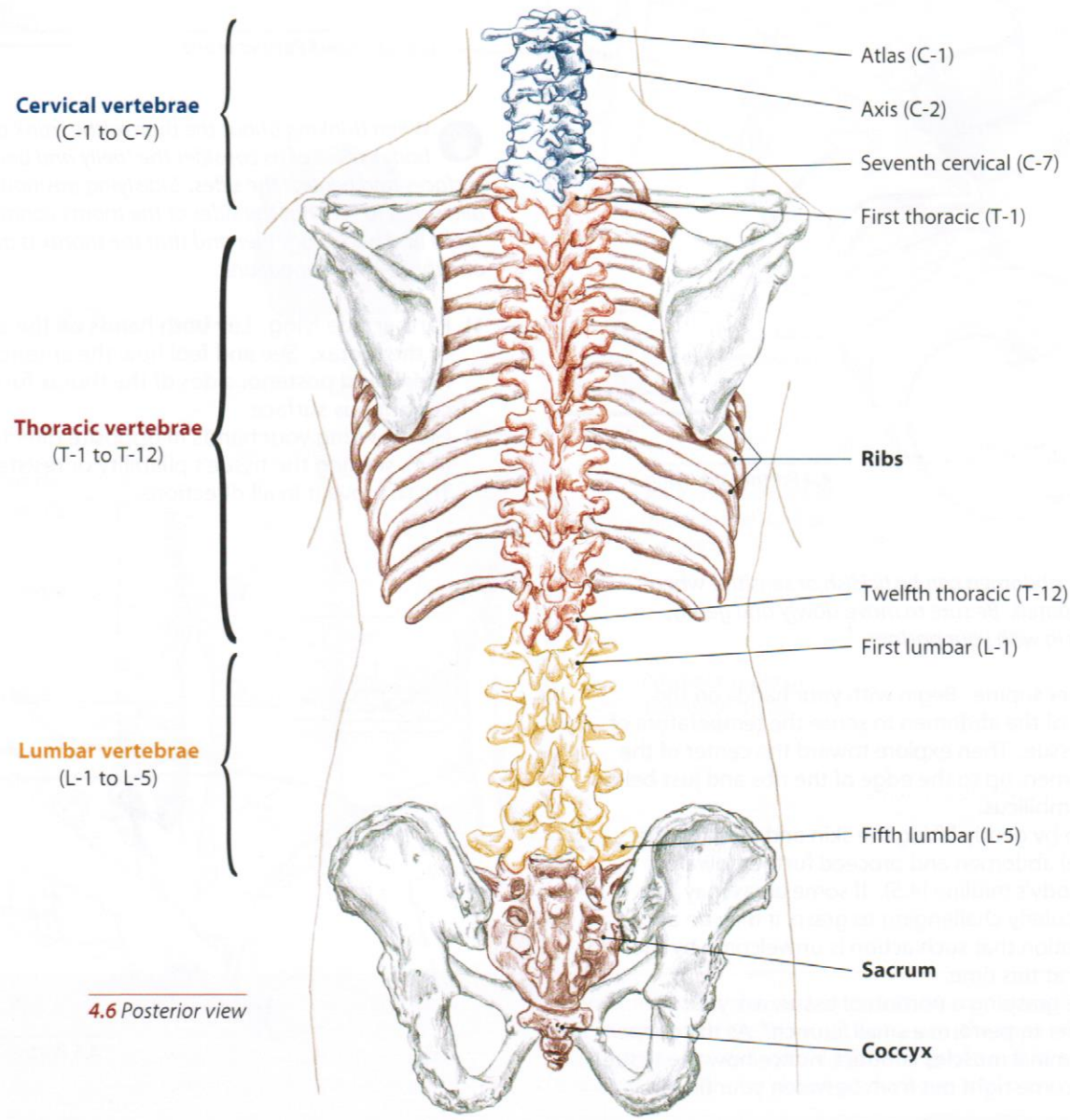
The **vertebral column** (or spine) consists of twenty-four vertebrae: seven **cervical** in the neck, twelve **thoracic** of the thorax and five **lumbar** in the lower back (4.6). The sacrum and coccyx are composed of fused vertebrae and are also considered part of the vertebral column. For the purposes of palpation and clarity, the sacrum and coccyx are included in Chapter Six, *Pelvis and Thigh*.

The **cervical vertebrae** are the most mobile and accessible of the twenty-four spinal bones. The twelve **thoracic vertebrae** articulate with the twelve pairs of ribs. Designed for minimal movement, they help to stabilize the thoracic area and protect the internal organs. In contrast, the larger, stockier **lumbar vertebrae**, located between the twelfth rib and posterior iliac crest, are designed to support the weight of the upper body.

As you palpate along the back, all twenty-four vertebrae will be deep to the layers of muscle tissue. However, the spinous and transverse processes protrude from each vertebra and can be helpful location points.

The **thorax** includes the sternum and rib cage. The superficial **sternum** ("breastbone") is located along the midline of the chest. The **rib cage** consists of costal cartilage and twelve pairs of ribs. The costal cartilage is identical in shape and size to the ribs and serves as a bridge between them and the sternum.

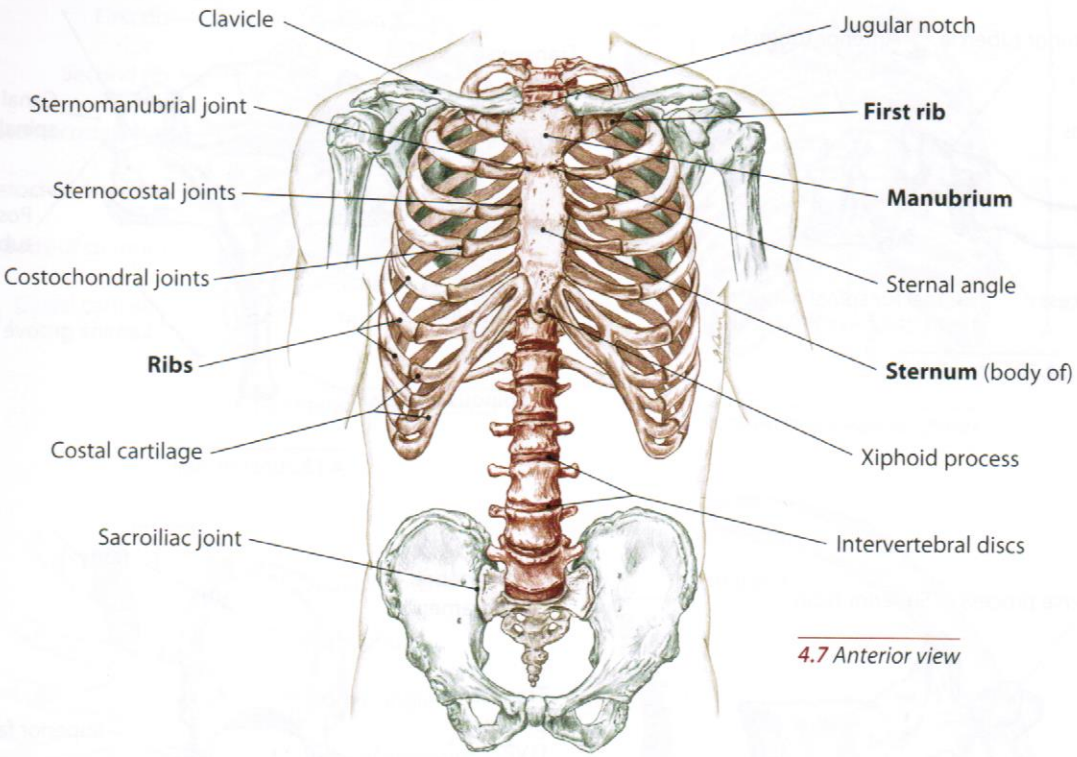
Ribs 1–7 are known as "true ribs" because they attach directly to the sternum. Ribs 8–12 are referred to as "false ribs" because they attach indirectly to the sternum by means of the costal cartilage. Aside from being "false ribs," the eleventh and twelfth ribs are also considered "floating ribs" as they do not attach to the sternum or costal cartilage at all.



4.6 Posterior view

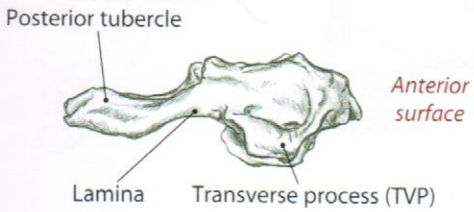
cervical	**ser**-vi-kal	L. referring to the neck
chest		AS. box
lumbar	**lum**-bar	L. loin

Bony Landmarks



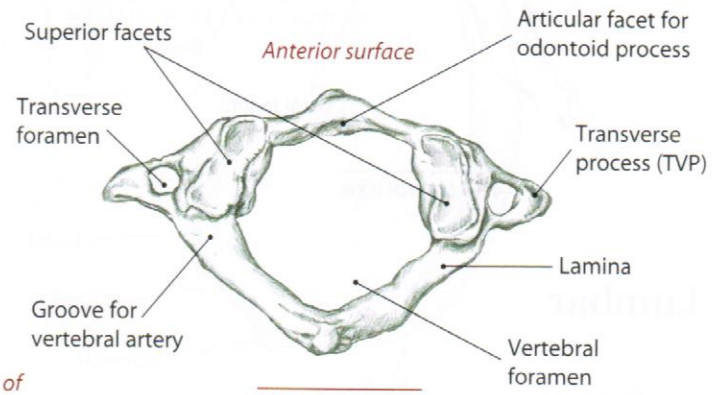
4.7 Anterior view

Atlas (C-1)



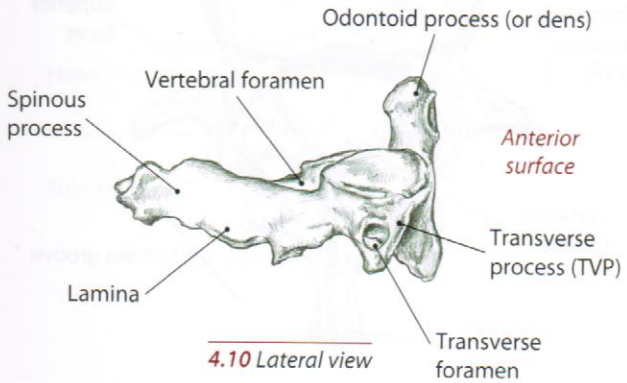
4.8 Lateral view

Lateral view of vertebral column

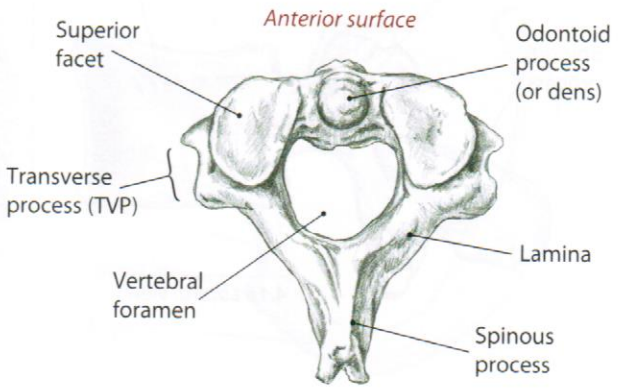


4.9 Superior view

Axis (C-2)



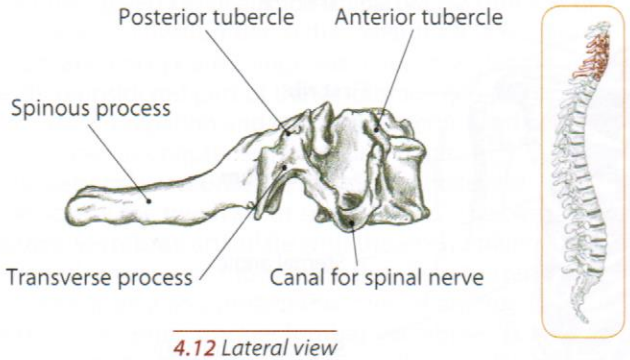
4.10 Lateral view



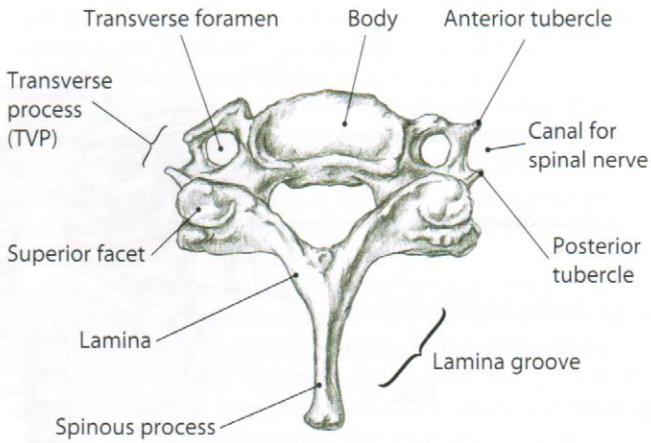
4.11 Superior view

spine
thoracic · tho-**ras**-ik · L. thorn
vertebra **ver**-ta-bra Grk. chest
L. joint

Cervical

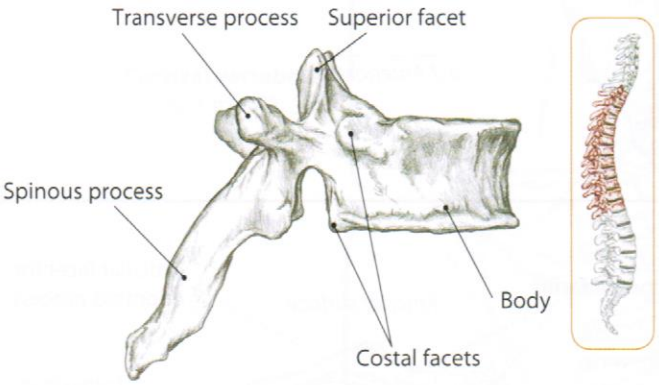


4.12 Lateral view

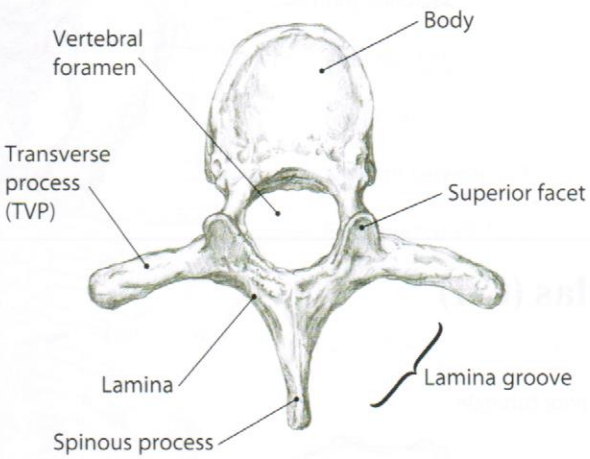


4.13 Superior view

Thoracic

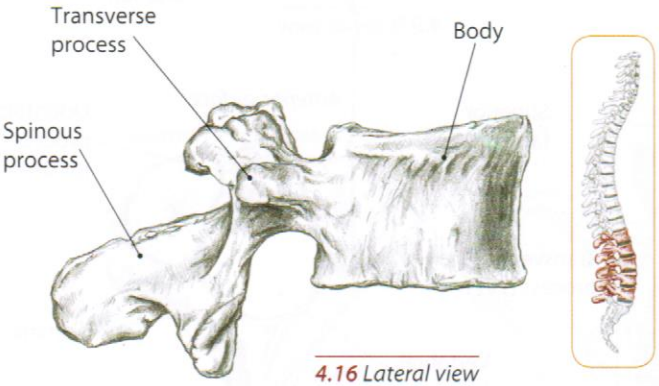


4.14 Lateral view

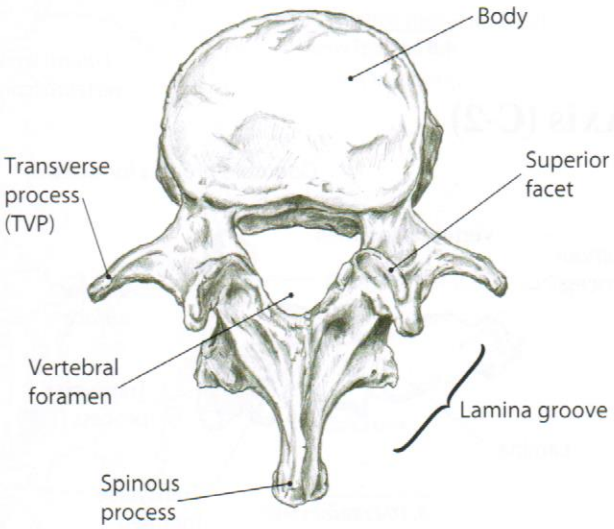


4.15 Superior view

Lumbar



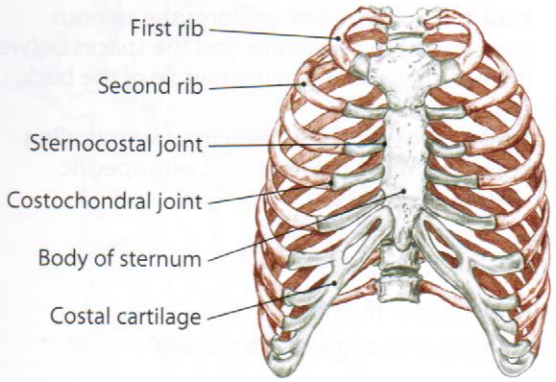
4.16 Lateral view



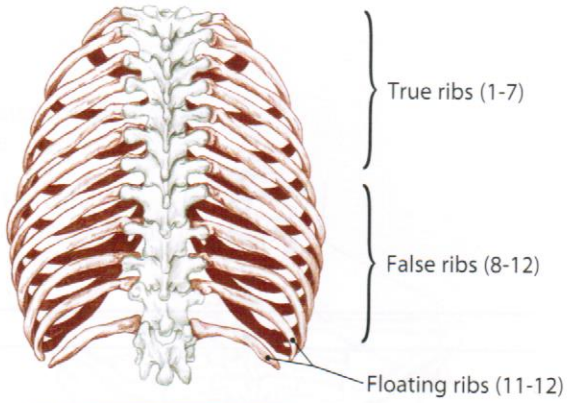
4.17 Superior view

facet	**fas**-et	Fr. small face
foramen	for-**aye**-men	L. a passage or opening
odontoid	o-**don**-toyd	Grk. toothlike

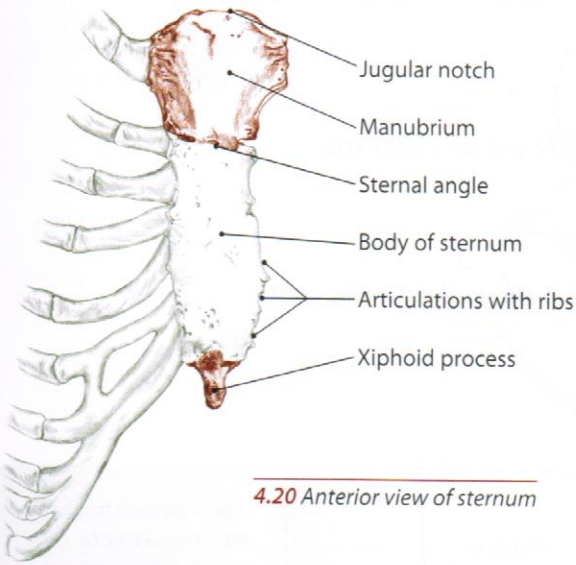
Bony Landmarks



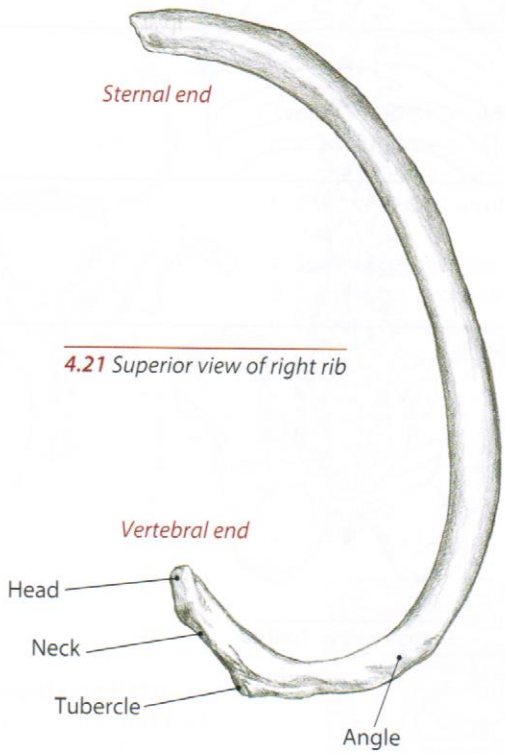
4.18 *Anterior view of thorax*



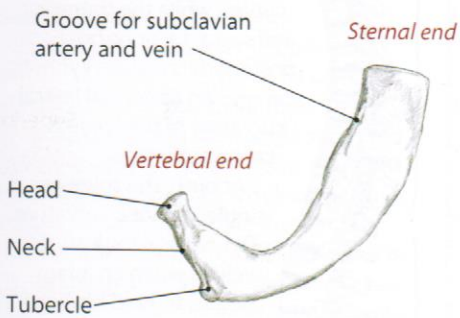
4.19 *Posterior view of thorax*



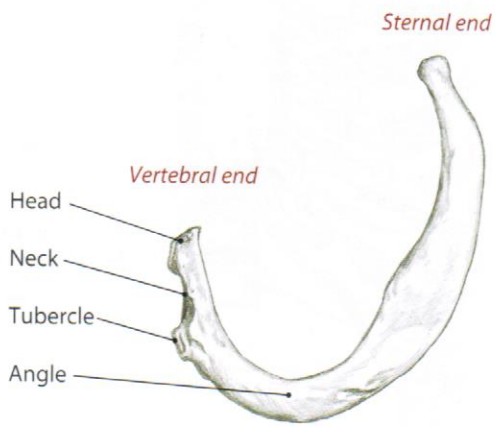
4.20 *Anterior view of sternum*



4.21 *Superior view of right rib*



4.22 *Superior view of right first rib*



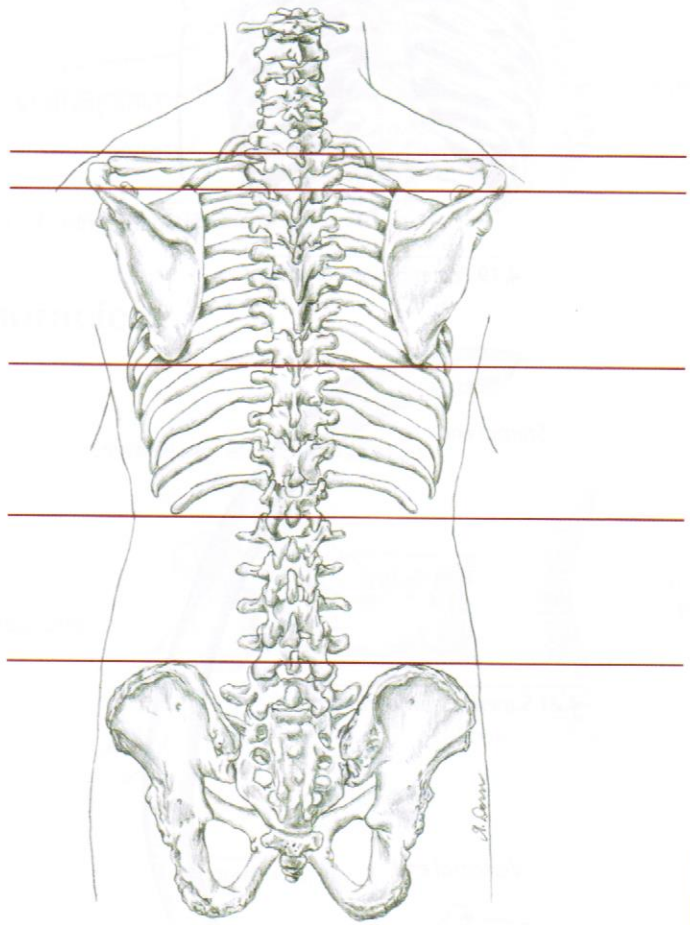
4.23 *Superior view of right second rib*

pedicle **ped**-i-k'l L. a little foot

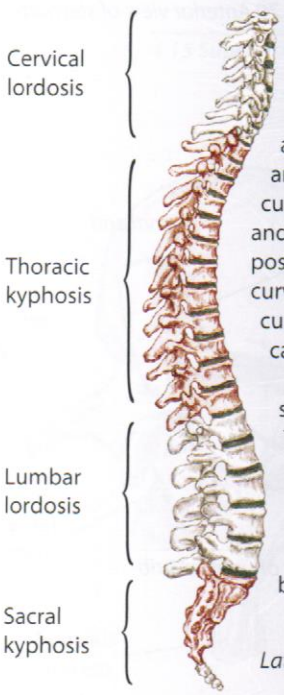
Bony Landmark Trails

Trail 1 "Midline Ridge" explores the spinous processes of the vertebrae and the spaces between them as they run down the middle of the back.

Trail 2 "Crossing Paths" describes surrounding bony landmarks that intersect with specific spinous processes.



Posterior view, Trail #2



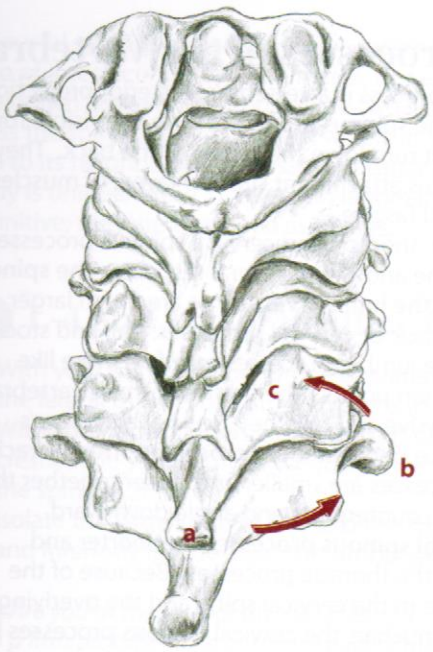
When viewed from the side, the vertebral column has four natural curvatures. The cervical and lumbar regions bend anteriorly to form lordotic curves, while the thoracic and sacral sections bow posteriorly, creating kyphotic curves. An abnormal lateral curvature of the spine is called scoliosis.

At birth, the spine has a single kyphotic curvature. The cervical lordosis develops when an infant begins to hold his head erect. As he begins to stand and walk, the lumbar lordosis evolves.

Lateral view

kyphosis ki-**fo**-sis Grk. bent, curved, or stooped
lordosis lor-**doh**-sis Grk. bent backward

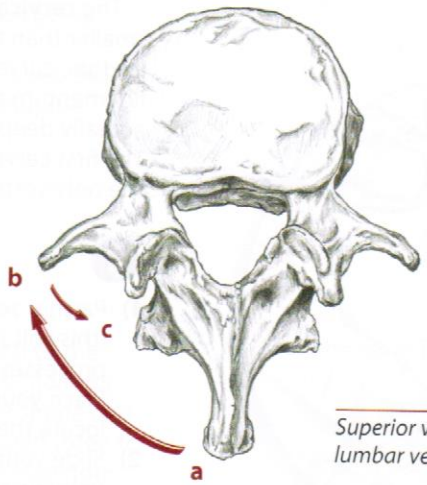
Bony Landmark Trails



Posterior view of cervical vertebrae

Trail 3 "Nape Lane" locates the landmarks of the cervical vertebrae.

a Spinous processes of the cervicals
b Transverse processes of the cervicals
c Lamina groove of the cervicals



Superior view of lumbar vertebra

Trail 4 "Buried Boulevard" delves into the middle and low back regions to locate landmarks of the thoracic and lumbar vertebrae.

a Spinous processes
b Transverse processes
c Lamina grooves

When you are standing, the entire weight of your trunk, head and arms is transferred through the bodies of the vertebrae. The lumbar vertebrae at the base of the spine bear the brunt of this weight.

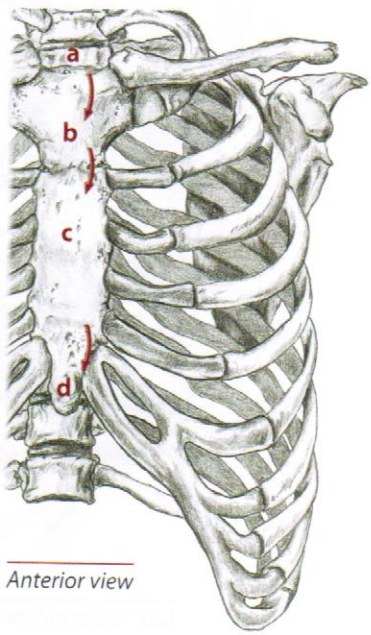
Fortunately, between the bodies of the vertebrae are intervertebral discs that cushion some of this shock. The discs are composed of a tough outer layer, the annulus fibrosus, and a liquid center called the nucleus pulposus. When weight is placed on a disc, the annulus fibrosus supports the nucleus pulposus in compressing and distributing the pressure. The nucleus is mostly water, some of which is squeezed out in the course of the day.

When you are asleep, the pressure is off the spine and the discs are able to fully restore themselves, so that you wake up in the morning half an inch taller than you were the night before.

Trail 5 "Breastbone Ridge" explores the sternum and its landmarks.

a Jugular notch
b Manubrium
c Body of the sternum
d Xiphoid process

Trail 6 "One Bumpy Road" explores the ribs, the rib cage and the costal cartilage.



Anterior view

4.24 *Lateral/posterior view, spine in neutral position*

4.25 *Posterior/lateral view, palpating the lumbar spinous processes*

Spinous Processes of the Vertebrae

A spinous process is a vertebra's posterior projection. As a group, the spinous processes form the visible row of bumps that run down the center of the back. They are designed as attachment sites for layers of muscles, ligaments and fasciae.

The lumbar, thoracic and cervical spinous processes differ from one another in several respects. The **spinous processes of the lumbar vertebrae** are much larger than the thoracic or cervical processes. Tall and stocky, the tips of the lumbar processes may feel more like short strips than points. The bodies of these vertebrae are quite massive and tall; they may have a finger's width of space between their processes. The **thoracic spinous processes** are smaller and closer together than their lumbar counterparts and angle downward.

The **cervical spinous processes** are shorter and smaller than the thoracic processes. Because of the lordotic curve in the cervical spine and the overlying ligamentum nuchae, the cervical spinous processes are actually deeper than the thoracic and lumbar vertebrae. The first cervical vertebra (C-1), or atlas as it is called, is the only vertebra that does not have a spinous process.

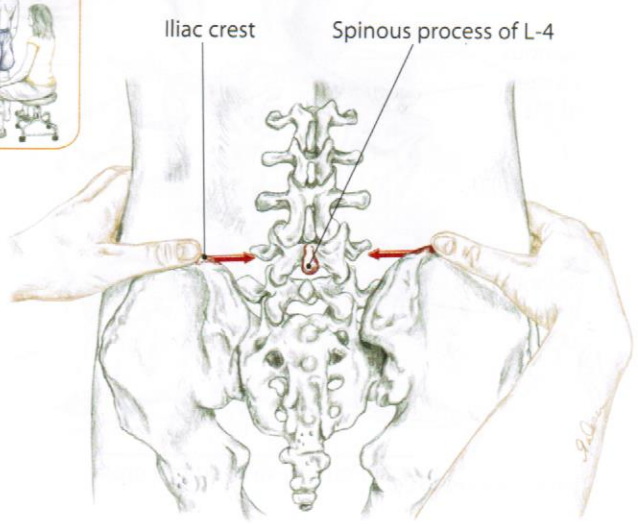
1) Partner seated with trunk and neck slightly flexed (this will stretch the overlying tissues and allow the processes to move posteriorly for easier access). Place your fingers along the midline of the back and locate the long line of processes (4.24, 4.25).
2) Slide your fingers slowly up and down the spine, palpating the different sizes, prominences and spaces between processes. Some processes might present themselves immediately while others might be more difficult to find. Ask your partner to slowly flex and extend his spine, noting the movement of the processes.
3) Try this same method with your partner prone.

Can you sculpt out the sides of the processes as you palpate them? Is there a dip superior and inferior to the point you feel? Can you line up three fingers on a series of processes or in the spaces between the processes?

Partner prone or seated. Palpate the entire spinal column and count the spinous processes. How many can you feel? All the vertebrae (except C-1) have spinous processes, making a total of 23. Use the intersecting spinous processes, such as C-7, T-12 and L-4, to check your accuracy.

Trail 2 "Crossing Paths"

Several spinous processes can be located with the help of intersecting bony landmarks. For example, a line drawn between the tops of the two iliac crests will cross the spinous process of L-4, which, in turn, leads you to its neighboring processes. Because everyone's body is unique, these intersecting landmarks are not definitive; they are best used as guides.



4.26 *Posterior view, partner standing*

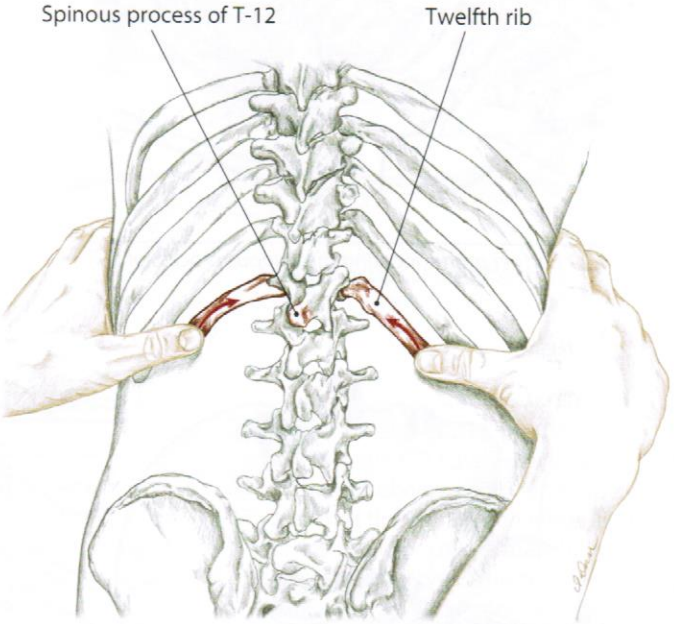
L-4 and Top of the Iliac Crest

1) With your partner either prone or standing, locate the lateral aspects of both iliac crests (p. 285).
2) With your index fingers along the top of the crests, slide your thumbs medially, meeting at the spine (4.26).
3) Isolate the large knob of L-4. Explore superiorly and inferiorly for the adjacent lumbar processes.

Are you at the level of the iliac crests? Can you feel a firm protuberance at the midline of the body?

T-12 and the Twelfth Rib

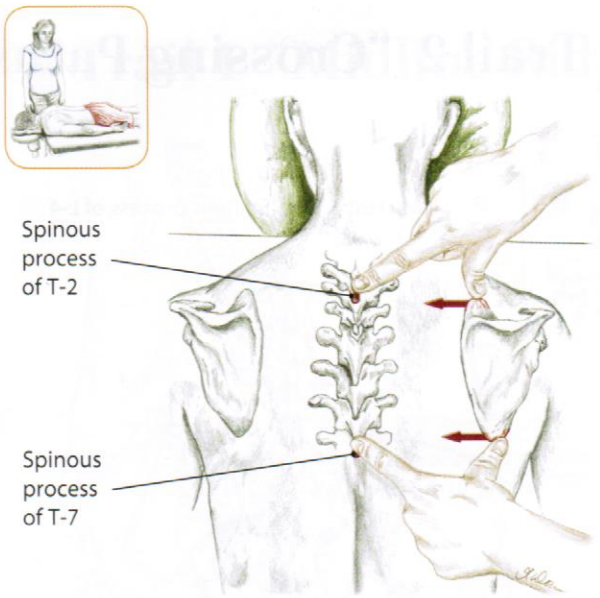
The eleventh and twelfth ribs do not attach to the costal cartilage and are therefore considered "floating ribs." The twelfth rib has a slender, spear-like shape and angles inferiorly. It may vary in length between three to six inches and can be used as a locator for the spinous process of T-12. (See p. 187 for more information about the twelfth rib.)



4.27 *Posterior view, partner standing*

1) Partner prone or standing. The strategy is to locate the tip of the twelfth rib and follow its shaft to the spinous process. Reaching across to the opposite side of the body, place your hand along the lateral edge of the ribs.
2) Slide inferiorly to the bottom of the rib cage and explore for the tip of the twelfth rib (4.27).
3) With the tip isolated, gently follow the shaft of the rib medially, noting how it lies at an angle. As the rib lies deep to the erector spinae muscles, you might lose contact with its most medial portion. Continue to slide your fingers in the direction of the shaft, palpating for the spinous process.

If you have located L-4, can you now count the processes up to T-12?



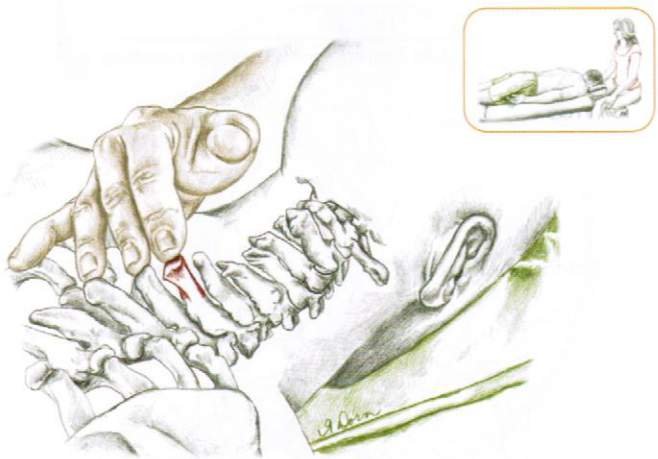
4.28 Posterior view, partner prone

T-7 and Inferior Angle
T-2 and Superior Angle

Body type, muscular contraction and other factors affect the positioning of the scapulae. The inferior angle of the scapula will generally lie at the level of the spinous process of T-7, while the superior angle is at the level of T-2.

1) Partner prone or standing. Locate the inferior angle (p. 53). Keep one hand at the angle while sliding the other medially to the vertebral column.
2) Locate the superior angle. Keep one hand at the angle while sliding the other medially toward the vertebrae (4.28).

From T-7 can you count the processes down to T-12? Can you count them up to T-2? From T-2 can you count down to T-7?



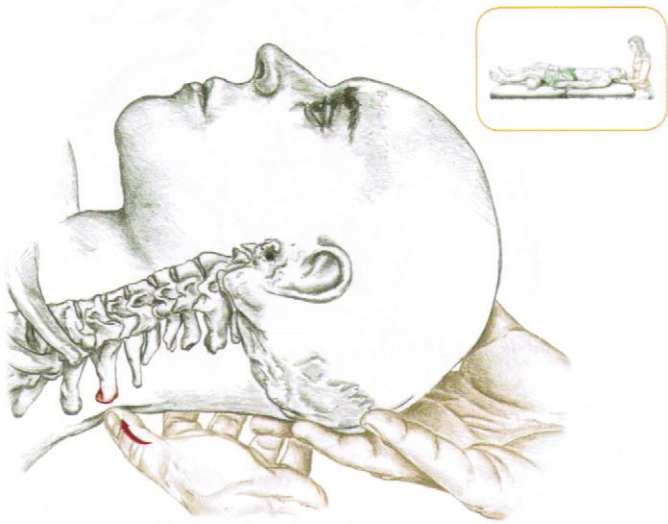
4.29 Partner prone, locating the spinous process of C-7

C-7 and Base of the Neck

The spinous process of C-7 is located at the base of the neck. It protrudes further than C-6, C-5 and C-4—a helpful distinction when locating structures in the upper back and neck.

1) Prone. Place your fingerpad superior to the base of the neck along the midline of the body.
2) Slide inferiorly. At the base of the neck, your thumb will bump into the process of C-7 (4.29).
3) Explore its edges and neighboring processes and then try to locate it from a supine position (4.30).

Are you at the base of the neck? Is the process superior to your finger smaller than the process you are palpating? Is there an equally protruding process (T-1) immediately inferior?



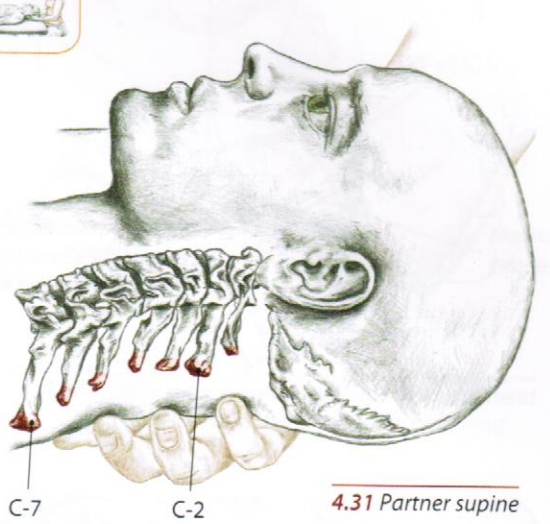
4.30 Partner supine, palpating spinous process of C-7

When the neck is flexed, the spinous process of C-7 shifts superiorly. T-1, however, is buckled in by the first ribs and does not move. With your partner seated, place a finger on the spinous processes of C-7 and T-1. Have your partner slowly flex his neck and observe both processes. Does C-7 tilt superiorly while T-1 is stationary?

Spinous Processes of Cervicals

The spinous processes of C-3 to C-6 protrude posteriorly to approximately the same extent. The process of C-2, however, is larger and more distinct. The tips of the cervical spinous processes are all deep to the ligamentum nuchae (p. 218), a flat ligament attaching to the processes and running superiorly to the occiput (p. 231).

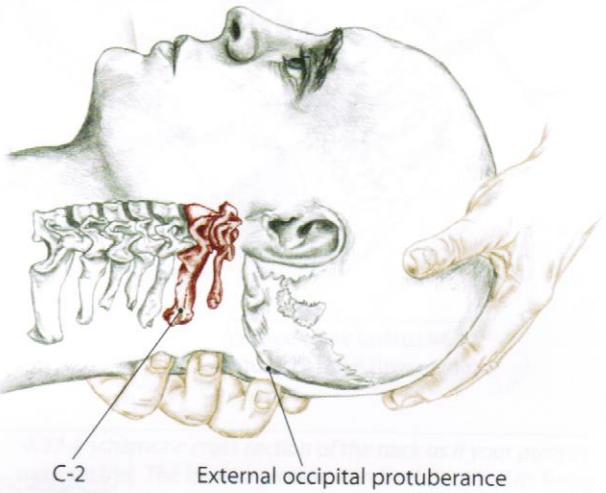
1) Partner supine. Locate the spinous process of C-7.
2) Using gentle pressure, explore the tips and sides of the other cervical processes (4.31). Strum transversely across the dense ligamentum nuchae that spans the tips of the spinous processes.
3) Continue superiorly until you reach the prominence of C-2. As you explore the spinous processes, passively flex, extend and rotate the neck.



4.31 *Partner supine*

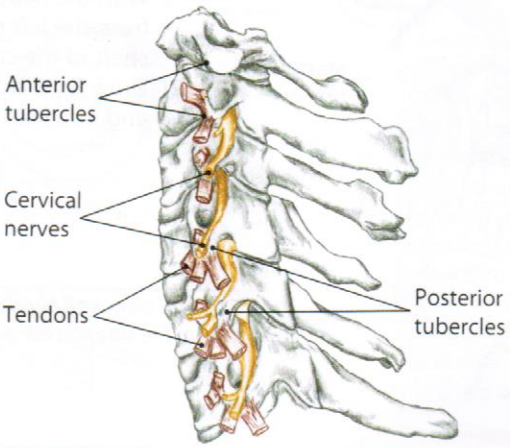
Can you feel the subtle ridge formed by the processes along the back of the neck? When exploring the spinous process of C-2, are you inferior to the level of the ear lobes? Is the process of C-2 larger and more pronounced than that of the other cervicals?

1) Being able to differentiate between the spinous process of C-2 and the external occipital protuberance (p. 232) can be helpful when navigating the posterior neck. Begin by laying your fingers horizontally along the base of your partner's head.
2) Place your ring finger at the external occipital protuberance while locating the spinous process of C-2 with your index finger (4.32). Your middle finger will lie between these two structures at the level of C-1. Explore the distance between these prominent landmarks.



4.32

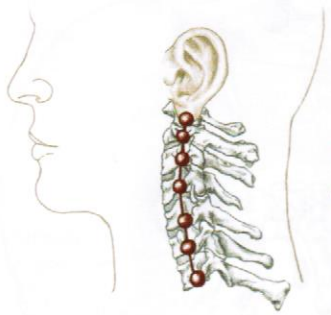
Some bony landmarks serve as attachment sites for multiple tendons and connective tissues. Whether palpating with your fingers or dissecting with a scalpel, these tissues are often difficult to distinguish from one another. The transverse processes of the cervical vertebrae are a case in point. Tendons come from several different directions to attach to their surfaces while nerves pass between the tendons, complicating matters further. To coordinate the tendons and the spinal nerves of the cervical



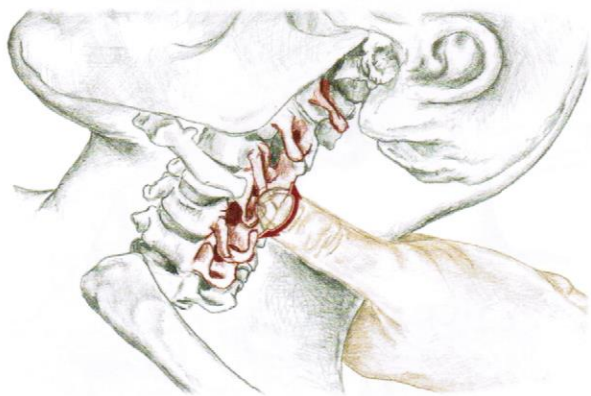
and brachial plexuses, the TVPs of C-2 through C-7 have anterior and posterior tubercles (left). The tubercles are small tips situated on either side of the canal (or sulcus) that channels the cervical nerves. The anterior tubercle is an attachment site for the anterior scalene and other muscles. The middle and posterior scalenes, levator scapula and other posterior muscles attach to the posterior tubercles. It can be difficult initially to palpate individual tubercles, but with experience you will be able to detect them more easily.

nape ME. the back of the neck

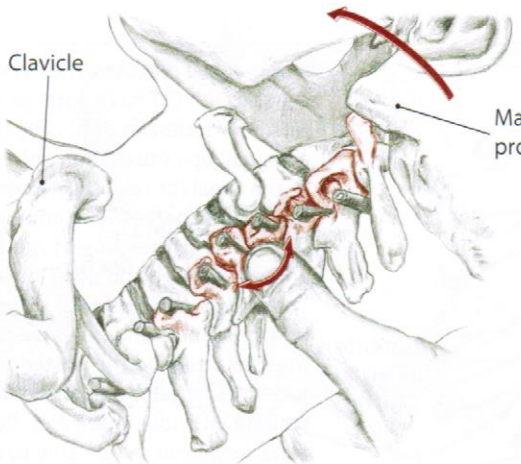
Compression or impingement of the brachial plexus (p. 274) or one of its nerves can create a sharp, shooting sensation down the arm. If this should occur, immediately release and adjust your position posteriorly. As always, ask your partner for feedback.



4.33 The arrangement of the cervical TVPs simulate that of a long, dangling earring



*4.34 Lateral view, partner supine with head **in neutral***



*4.35 Lateral view with head **rotated away** from the side you are palpating*

Transverse Processes of the Cervicals

The transverse processes (TVPs) of the cervical vertebrae are located on the side of the neck. Old Hollywood films put Frankenstein's neck bolts into his TVPs!

The TVPs extend inferiorly from the mastoid process and many are deep to the sternocleidomastoid muscle (p. 244). All of the TVPs are the same width except for the TVPs of C-1, which are much wider.

The TVPs of C-1 are located just distal and anterior to the tip of the mastoid process (p. 233) and are relatively accessible.

All of the TVPs serve as attachment sites for various muscles, including the scalenes and levator scapulae. The brachial plexus, a large group of nerves that innervates the arm, exits between the TVPs. When first accessing the TVPs, use the flat of your thumb or fingerpads. As your palpation skills improve, explore the TVPs' surfaces more specifically.

TVPs of cervicals

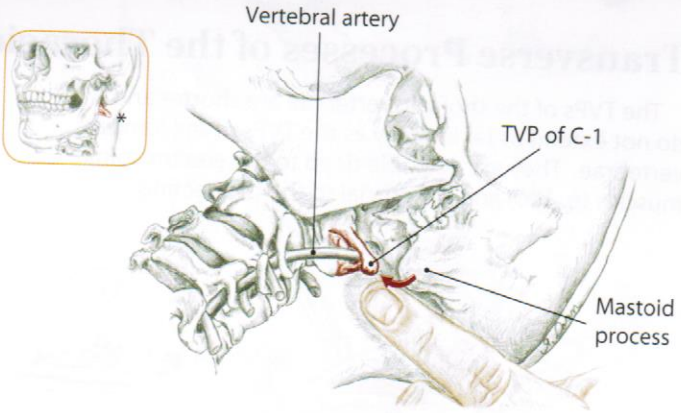
1) Partner supine. Place your fingers on the side of the neck below the earlobes.
2) Using your flat thumbpads, slide anteriorly and posteriorly to feel the ridge of TVPs. Explore the length of the neck (4.34).
3) You might not feel the tips of individual processes, but the ridge formed by the TVPs beneath the overlying tissue instead.

Are you palpating inferior to the earlobe? Do you feel a subtle ridge running down the side of the neck? If you passively flex, laterally flex or rotate the neck, can you feel the TVPs move individually?

1) Partner supine. Rotate the head 45˚ to the right. With the head in this position, the TVPs form a line from the left mastoid process to the center of the shaft of the clavicle (4.35).
2) Draw an imaginary line from these two landmarks and visualize and palpate the TVPs along the path.

Transverse process of C-1

1) Partner supine or seated. Locate the left mastoid process of the temporal bone (p. 233) and rotate the head 45° to the right.
2) Using your broad fingerpad, slide slightly inferior and anterior from the mastoid process. Explore deep to the sternocleidomastoid muscle for the solid bump of the transverse process of C-1 (4.36). Even pressing gently on these points can be uncomfortable for your partner, so use a soft touch.
3) For reference, locate the other transverse process of C-1.

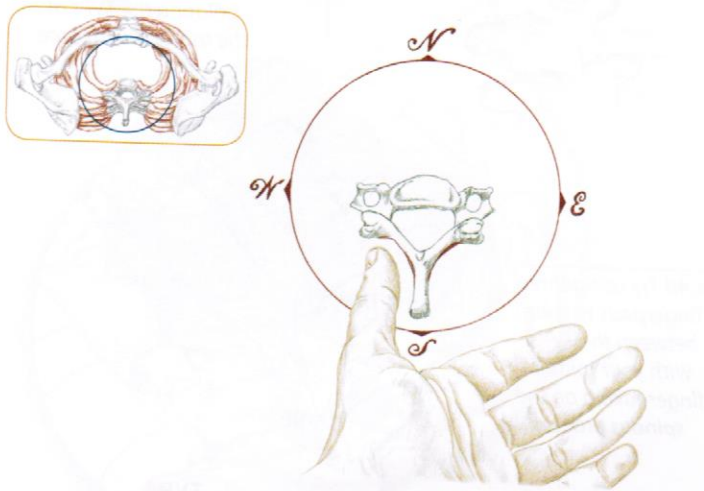


4.36 Partner supine, anterior/lateral view with head rotated away from the side you are palpating

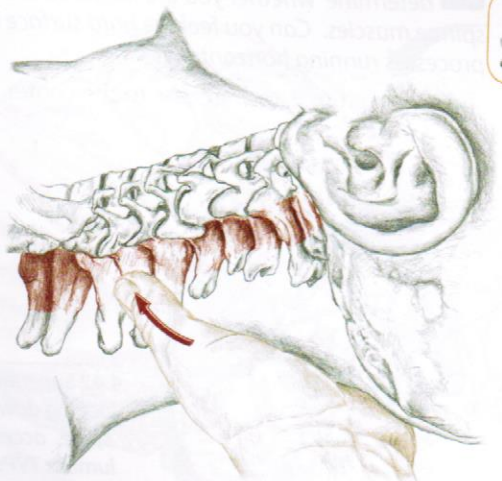
Cervical Lamina Groove

The lamina groove is the troughlike space between the spinous and transverse processes of the vertebrae. Although sizable on a skeleton, the lamina groove of your partner is filled with layers of muscles which render it almost inaccessible. The lamina groove is best thought of as a helpful region for locating muscle bellies.

1) Partner supine. Scoop the head with one hand, and with your other hand, locate the cervical transverse processes.
2) Slide posteriorly off the TVPs. Explore the space between the transverse and spinous processes which constitutes the lamina groove of the cervical vertebrae (4.38). Again, since the groove is filled with muscles, the bone that forms the groove is impalpable.



4.37 A schematic cross section of the neck as if your partner were supine. The lamina grooves can be thought of as being in the neck's southeast and southwest quadrants.



4.38 Lateral view, palpating in the lamina groove

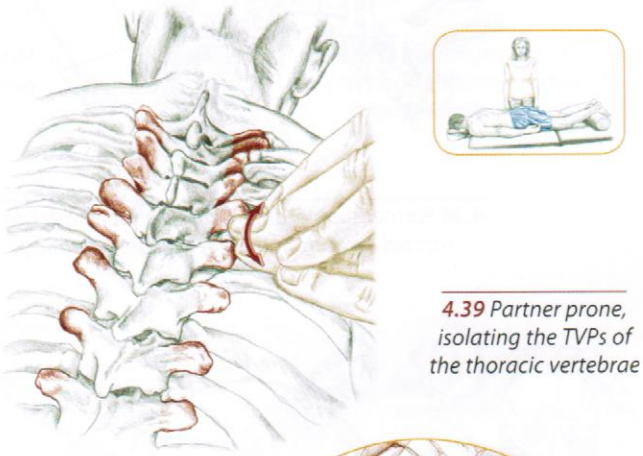
C-6 has a large anterior tubercle called the carotid tubercle. Its name corresponds to the carotid artery (p. 271) that passes immediately lateral to it. Although you would not want to, you can occlude the carotid artery by placing your finger lateral to the cricoid cartilage and pressing in a posterior direction against the carotid tubercle. Long ago this dramatic maneuver was used in emergency rooms as a last-ditch effort to stem hemorrhaging inside the skull.

lamina **lam**-i-na L. thin plate, leaf

Trail 4 "Buried Boulevard"

Transverse Processes of the Thoracic and Lumbar Vertebrae

The TVPs of the thoracic vertebrae are shorter and do not extend as far laterally as the TVPs of the lumbar vertebrae. They are palpable deep to the erector spinae muscles (p. 196) and superficial to the connecting aspect of the ribs. The TVPs of the lumbar vertebrae are also deep to the erector spinae. Extending an inch or two laterally, their solid presence can be felt beneath the overlying muscle tissue.

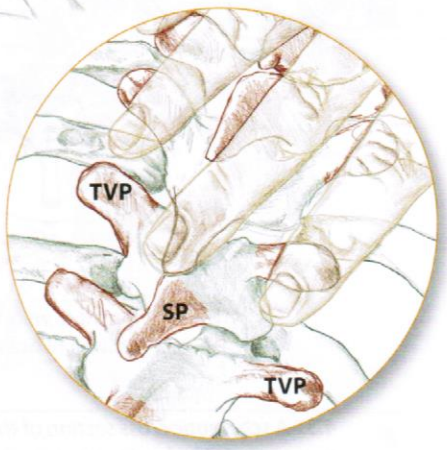


4.39 Partner prone, isolating the TVPs of the thoracic vertebrae

Thoracic transverse processes

1) Partner prone. Locate a portion of the thoracic spinous processes. Move roughly one inch laterally and sink your fingers through the thick erector spinae muscles.
2) Roll your fingers superiorly and inferiorly, palpating for the TVPs' subtle, knobby shape (4.39).

Slide further laterally from the thoracic transverse processes and onto the posterior ribs. Can you determine where the ribs and transverse processes meet? Can you feel the short processes beneath the erector spinae fibers?

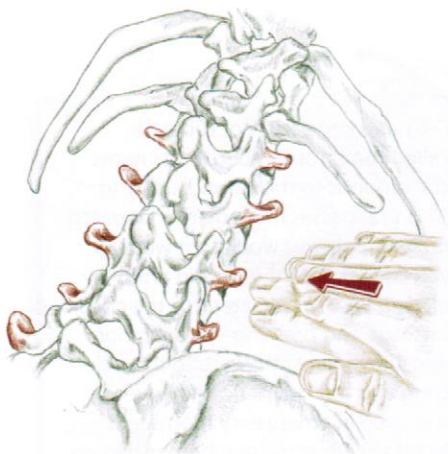


4.40 Try using three fingerpads to span between the TVPs, with your middle finger falling on the spinous process

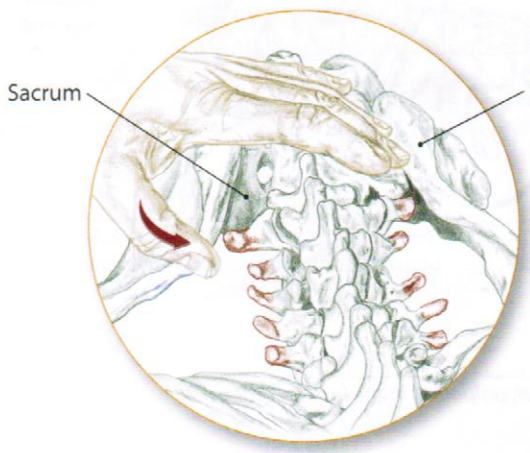
Lumbar transverse processes

1) Partner prone. Locate the lumbar spinous processes. Slide roughly two inches laterally to avoid the thick mound of the erector spinae muscles (p. 196).
2) Slowly sink your fingers through the muscle tissue. Directing your pressure at a medial/anterior angle (as if toward the navel), explore for the tips of the TVPs (4.41). Because of the thick overlying tissue, the individual processes might not be directly palpable, but try to sense the solid ridge they form.

Ask your partner to raise her feet slightly to determine whether you are lateral to the erector spinae muscles. Can you feel the hard surface of the processes running horizontally?



4.41 Partner prone, palpating the TVPs of the lumbar vertebrae



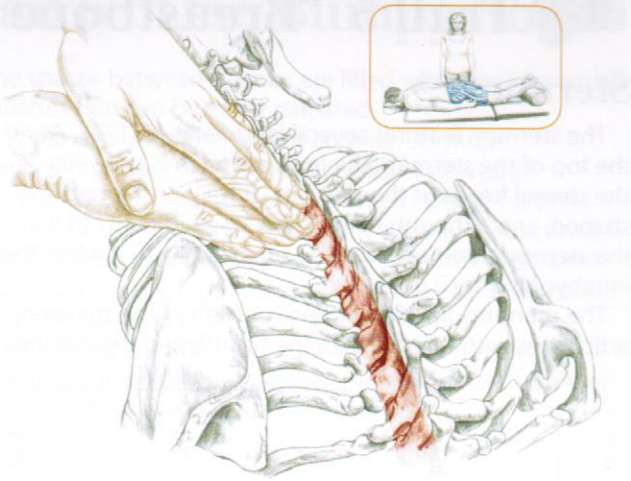
4.42 Superior view looking down the spine, accessing lumbar TVPs with your thumb

Lamina Groove of the Thoracic and Lumbar Vertebrae

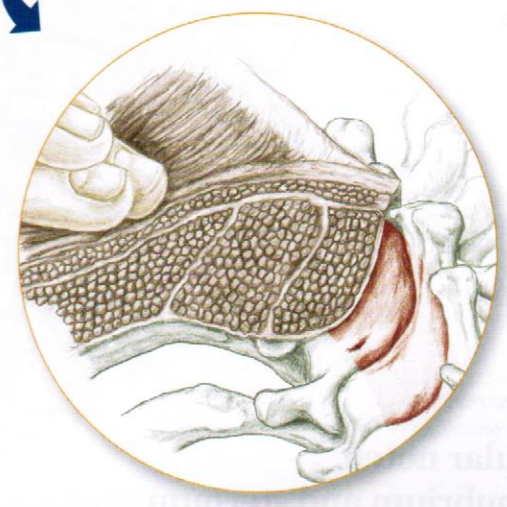
The lamina groove of the thoracic and lumbar vertebrae is located between their spinous and transverse processes. Shaped like a long, vertical trough, the lamina groove expands in depth and width as it progresses down the spine. In the thoracic and lumbar vertebrae, the lamina groove is filled with the layers of the erector spinae and transversospinalis muscles. Because of this overlying tissue, the lamina groove is difficult to access directly, but its borders (the spinous and transverse processes) are palpable.

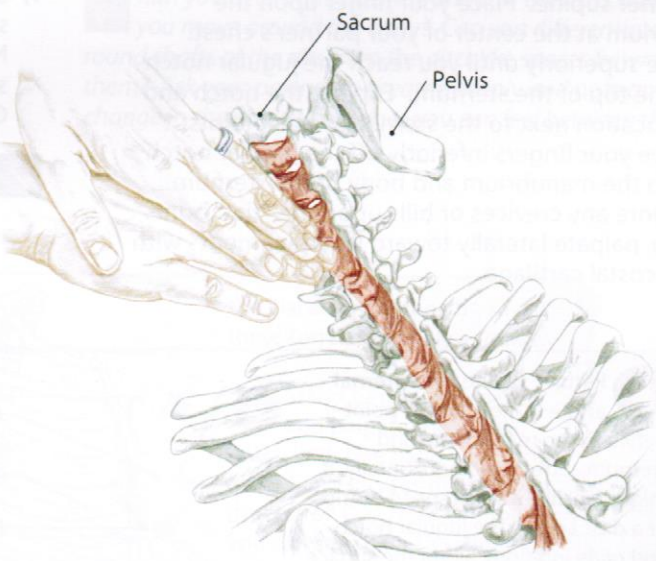
1) Partner prone. Locate the spinous processes of the thoracic vertebrae. With the other hand, locate the TVPs of the thoracic vertebrae.
2) Using firm pressure, explore between these landmarks in the lamina groove (4.43). Note the thick muscle tissue that lies in this groove.
3) Try this same method in the lumbar region (4.44). Observe how the lamina groove widens and deepens and how the muscle tissue is thicker in this region compared with the muscle tissue in the thoracic region.

Are you between the transverse and spinous processes of the vertebrae? Can you slide your fingers between the muscle fibers and sink into the lamina groove?



4.43 Lateral/superior view, accessing the lamina groove of the thoracic vertebrae. Muscles overlying the groove (below).





4.44 Lateral/superior view, accessing the lamina groove of the lumbar vertebrae. Muscles overlying the groove (left).

Trail 5 "Breastbone Ridge"

Sternum

The sternum features several landmarks (p. 173). At the top of the sternum, the **jugular notch** is between the sternal heads of the clavicles. It may be flat or bowl-shaped, and although no muscles attach directly to it, the sternocleidomastoids pass superficially to it while the infrahyoids attach deep to it.

The **manubrium**, the superior portion of the sternum, articulates with the clavicles, the first rib and the second rib. The **body of the sternum** is located inferior to the manubrium and forms the major portion of the sternum. The junction between the manubrium and body of the sternum is called the **sternal angle.**

Extending off the bottom of the sternum, the **xiphoid process** can be an inch in length or completely absent. It is an attachment site for the abdominal aponeurosis. The manubrium, body and xiphoid process of the sternum are superficial, covered only by fasciae and the pectoralis major tendon.

4.45 Partner supine, palpating the sternum, xiphoid process and edge of the rib cage

Jugular notch, manubrium and sternum

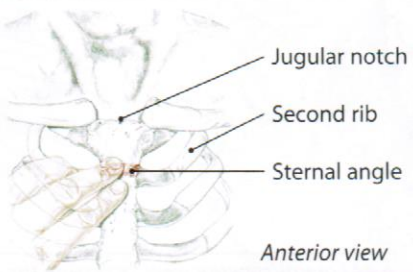
1) Partner supine. Place your finger upon the sternum at the center of your partner's chest.
2) Slide superiorly until you reach the jugular notch at the top of the sternum. Explore the notch and its location next to the sternoclavicular joints.
3) Move your fingers inferiorly off the jugular notch onto the manubrium and body of the sternum. Explore any crevices or hills upon this "flat" bone. Also, palpate laterally toward its attachments with the costal cartilage.

Xiphoid process

1) Slide your fingers inferiorly until they drop off the sternum and fall into the muscles of the abdomen. Now backtrack to the most inferior tip of the sternum, which will be the xiphoid process (4.45). Gently sculpt this tip.

✓ *Are you at the most inferior point of the sternum?*

Partner supine. The **sternal angle** is the junction point between the manubrium and sternum. Stretching horizontally, it might feel like a small speed bump or a dip. Locate the jugular notch and glide inferiorly along the surface of the manubrium. Palpate within an inch or two for a ridge or ditch that stretches horizontally across the sternum.



Anterior view

✓ *The second rib attaches to the sternum at the level of the sternal angle. Slide your fingers laterally off the angle. Can you feel the round surface of this rib?*

abdomen	**ab**-do-men	L. belly
abdominis	ab-**dah**-min-is	
costal	**kos**-tal	L. rib

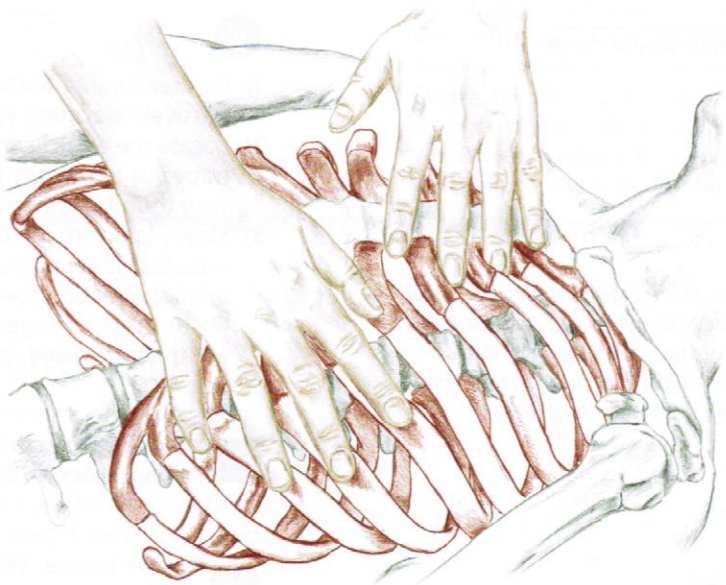
Ribs and Costal Cartilage

The **ribs** articulate posteriorly with the thoracic vertebrae and then curve around the thorax to the anterior chest (p. 173). Extending off the ribs is the **costal cartilage** that attaches them to the sternum. There are six or seven costal branches, all of which are identical in shape and similar in feel to the ribs. The ribs, with their costal cartilage, run at varying angles around the trunk of the body.

The entire rib cage is deep to muscle tissue; however, the ribs along the sides of the trunk are easily accessed. The spaces between the ribs are filled with thin intercostal muscles that can be easily palpated.

When exploring the thorax, consider its three-dimensional quality. Often the thorax is viewed as having only a front and back, leaving its lateral portions neglected. As you explore the body's trunk, try to connect all of its sides together in your mind and with your hands. Note how several muscles, such as the deeper abdominals and intercostals, literally enwrap the thorax.

As you explore the thorax, avoid accessing mammary (breast) tissue. Ask your partner, male or female, whether you may palpate the surrounding areas.

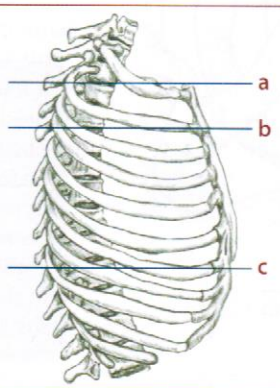


4.46 Partner supine, exploring the ribs

1) Supine. Slide laterally from the sternum onto the costal cartilage. Use your fingertips to locate one costal branch and palpate its rounded surface.
2) Roll off the cartilage into the space between the branches. Explore this groove as it extends laterally. Continue along the length of the sternum, locating and exploring each branch of rib/cartilage and the spaces between them (4.46).

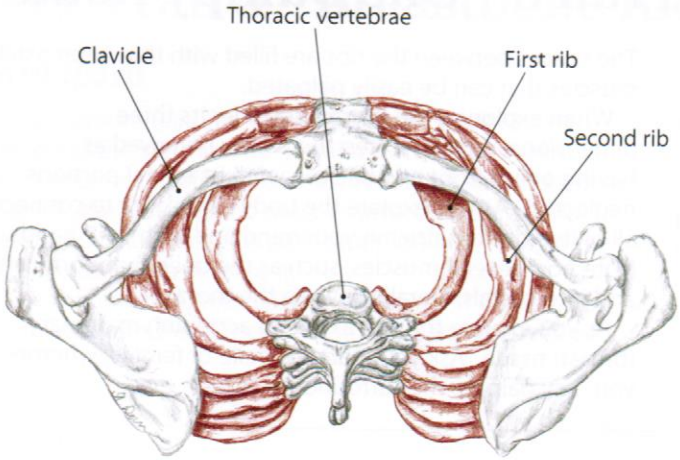
Can you determine how the angle of the ribs changes as you move around the body? Can you differentiate the round shafts of the ribs from the ditchlike spaces between them? Ask your partner to breathe deeply and note any change in the amount of space you can feel between the ribs.

The jugular notch, sternal angle and xiphoid process can be guidemarks along the vertebral column. The jugular notch lies on the same transverse plane as the spinous process of T-2 (a). The sternal angle lines up with the spinous process of T-4 (b), while the xiphoid process is directly across from the body of T-10 (c). Of course, many factors, such as posture and body type, will affect the placement of the ribs, so use these correlations only as guides.



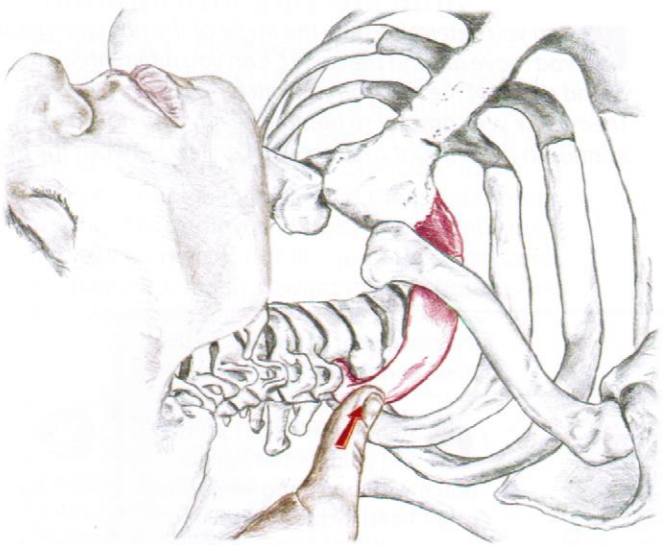
Stand beside your partner and palpate the jugular notch with one hand while your other hand locates the spinous process of T-2. Note whether you can see or feel a difference in the levels of these landmarks. Follow the same procedure for T-4 and T-10.

cricoid	**kri**-koyd	Grk. ring-shaped
jugular	**jug**-u-lar	L. throat
manubrium	ma-**nu**-bree-um	L. handle



4.47 Superior view of thorax

Compression or impingement of the brachial plexus or one of its nerves can create a sharp, shooting sensation down the arm. If this should occur, adjust your position to one side. Also, ask your partner for feedback.



4.48 Partner supine, palpating the first rib

First Rib

Unlike its cohorts, the first rib is difficult to isolate along the anterior thorax. It lies directly beneath the clavicle and then quickly curves toward the back (4.47). It can, however, be accessed in the posterior triangle (p. 226) of the neck, which is formed by the clavicle and the sternocleidomastoid and trapezius muscles.

The scalene muscles (p. 246) fan across the posterior triangle and attach to the first and second ribs. To access the first rib, you must palpate through the scalenes. The brachial plexus (p. 274) and subclavian artery pass between the first rib and the clavicle.

1) Partner supine. Soften the overlying tissue by passively elevating your partner's shoulder.
2) Locate the clavicle and upper flap of the trapezius to identify the posterior triangle. Place your thumbpad between these structures.
3) Slowly sink into the tissue of the scalene muscles, directing your fingers straight in an inferior direction toward your partner's feet (4.48). As your fingers sink into the tissue, you will meet the solid resistance of the shaft of the first rib.

Ask your partner to take a slow, deep breath into the upper chest. Can you feel the rib rise?

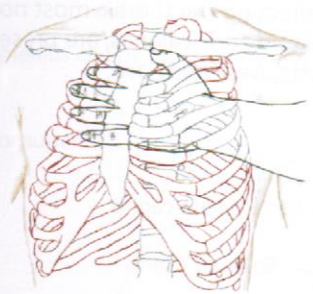
Partner supine. When palpating in the posterior triangle of the neck, the posterior aspect of the first rib can sometimes be confused with the superior angle of the scapula. Distinguish between these structures by palpating in the posterior triangle and locating what you believe to be the first rib. "Check it" by passively elevating and depressing the scapula. The first rib should remain stationary during this movement.

It is not uncommon for the number of ribs to vary from person to person. There are ordinarily twelve pairs of ribs, but on some people eleven or thirteen pairs can be found. If there is an extra rib, it may be bilateral or merely unilateral and will be found either in the cervical or lumbar areas. A cervical rib often articulates with C-7 and can be felt in the posterior triangle region of the neck at the level of the clavicle. An extra rib in the lumbar will extend off L-1.

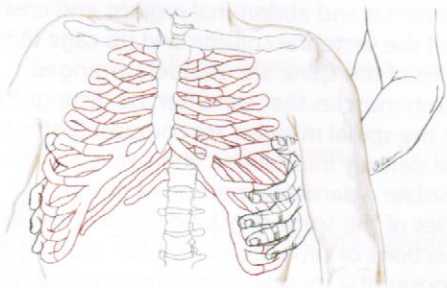
sternum	**ster**-num	Grk. chest
thorax	**tho**-raks	Grk. chest
xiphoid	**zif**-oyd	Grk. sword-shaped

Ideally, the ribs are designed to expand in three directions during inhalation: anterior/posterior, lateral and superior. Yet, for reasons ranging from posture to emotional trauma, few people truly breathe in this manner. Often the breath becomes restricted to a portion of the thorax, and the ribs will move in only one or two directions.

1) With this in mind, ask your partner to stand and breathe normally. Observe any changes in the shape or movement of the thorax, shoulders and abdomen.



Position of the ribs during exhalation



Position of the ribs during inhalation

2) Then lay your hands on all sides of the rib cage and feel for activity in the thorax. Do the ribs move in all three directions? Do some move individually?
3) Ask your partner to inhale deeply and exhale fully. Explore the ribs and anterior neck muscles (scalenes and sternocleidomastoid) during inhalation. These muscles will tighten to elevate the upper ribs. Try these exercises with your partner seated, prone and supine.

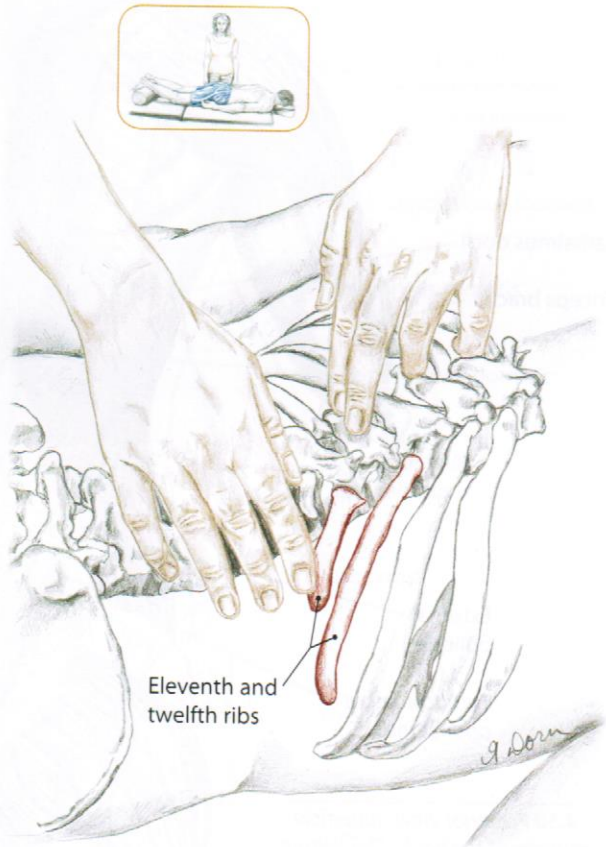
Eleventh and Twelfth Ribs

The eleventh and twelfth ribs are called "floating ribs" because they do not attach to the costal cartilage. Both ribs have a slender, spearlike shape and lie roughly at a 45° angle. Their medial portions lie deep to the thick erector spinae muscles; however, their lateral aspects and tips are palpable.

The eleventh rib is six to eight inches in length and extends halfway around the body. The twelfth rib can vary in length from three to six inches. Since anomalies are common in either the length or number of ribs, your partner's ribs might not match this description. (See p. 177 for more information about finding the twelfth rib.)

1) Prone. Reaching across to the body's opposite side, place your hand along the lateral portion of the ribs.
2) Slide inferiorly to the bottom of the rib cage, allowing your hand to sink into the soft abdominal tissue. Compressing your fingerpads into the side of the thorax, explore this region for the tips of the eleventh and twelfth ribs (4.49).
3) With the tips isolated, gently follow the shafts of the ribs medially, noting how they run at an angle.

Can you feel two tips, one of which is more lateral than the other? Ask your partner to take a slow, deep breath and note whether the tips or the bodies of the ribs press into your hand.



4.49 Partner prone

Muscles of the Spine and Thorax

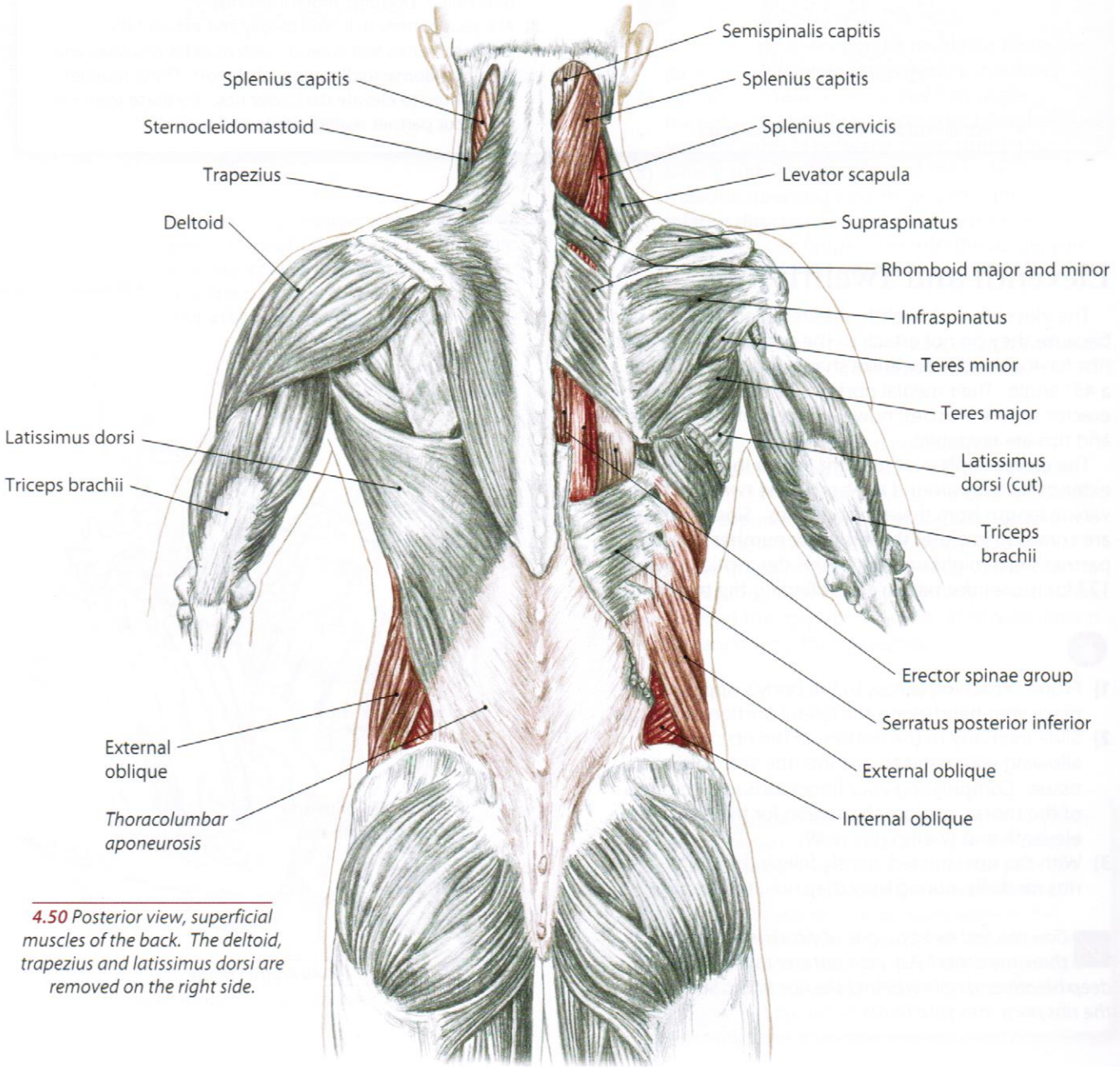
The muscles of the spine and thorax are situated along the posterior and abdominal regions and create movement of the vertebral column and rib cage (4.50).

The muscles of the spine are uniquely arranged. Unlike the limb muscles that can often be distinguished individually, the spinal muscles are composed of numerous bands of densely interwoven fibers that make it difficult to isolate a particular portion of muscle.

The muscles of the spine may be divided into small, individual sections or separated into a few major groups. For our purposes, the muscles of the spine will be divided into four groups:

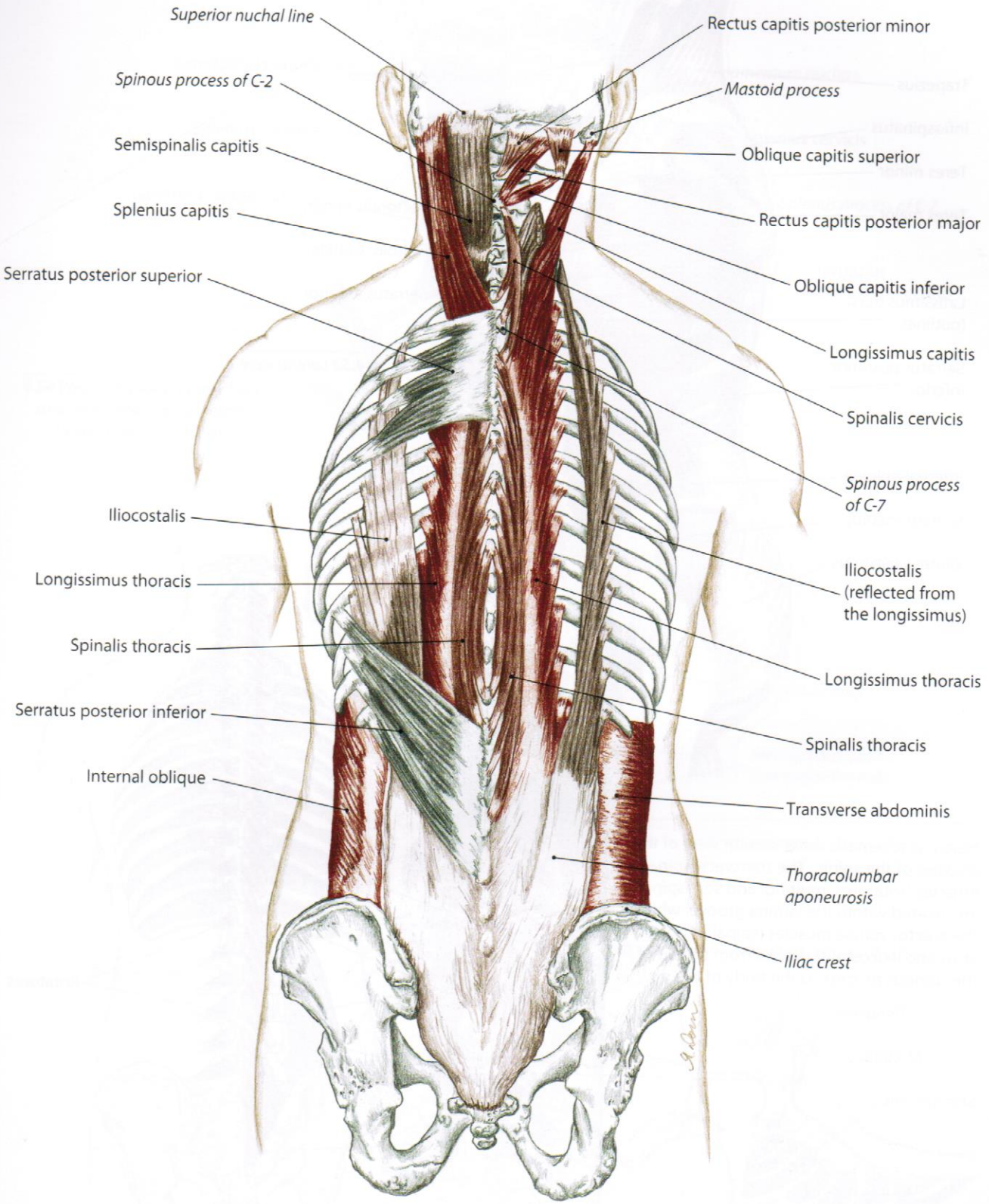
1) The large **erector spinae group** is the most superficial of the spinal muscles and has three major branches.
2) The smaller **transversospinalis group** also has three branches but lies deep to the erectors. Its name refers to its muscle fibers, which extend at varying lengths from the transverse and spinous processes of the vertebrae.
3) The two **splenii** muscles are located along the posterior neck, deep to the trapezius.
4) The eight short **suboccipitals** are the deepest muscles. They are located at the base of the head.

Other muscles affecting the thorax, most notably the sternocleidomastoid and scalenes, are presented in Chapter Five, *Head, Neck and Face.*



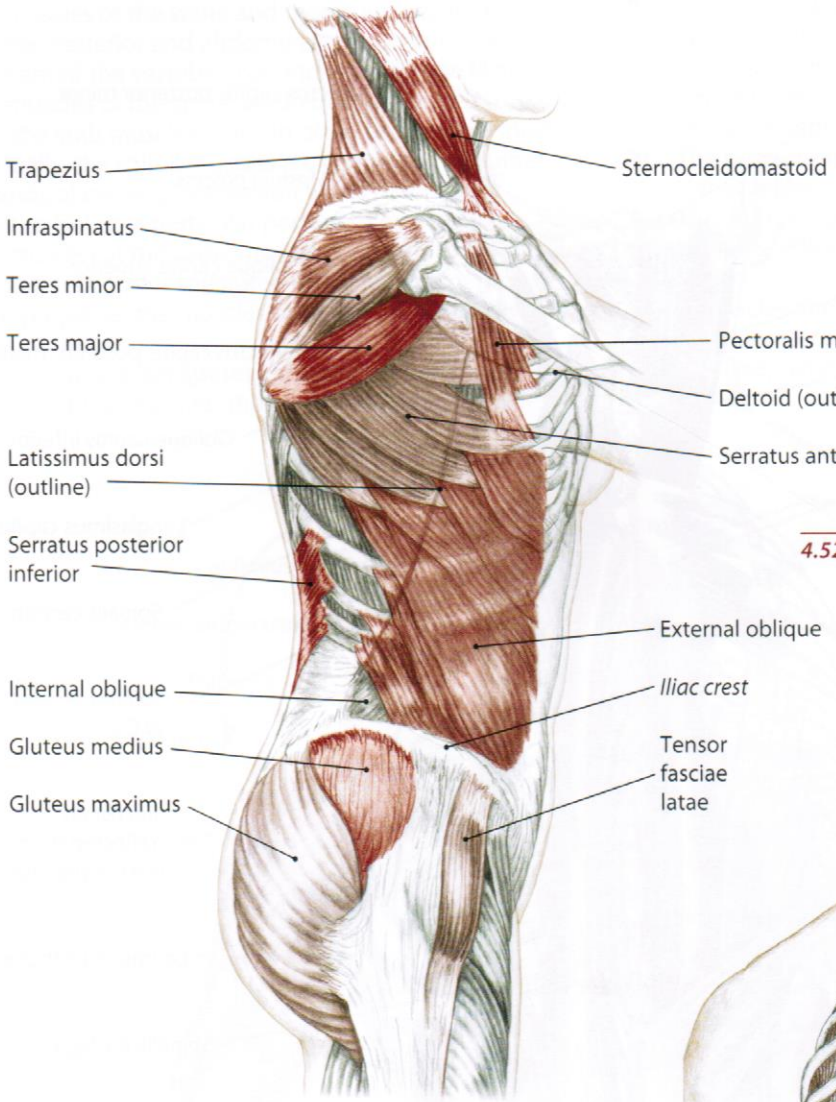
4.50 Posterior view, superficial muscles of the back. The deltoid, trapezius and latissimus dorsi are removed on the right side.

Muscles of the Spine and Thorax



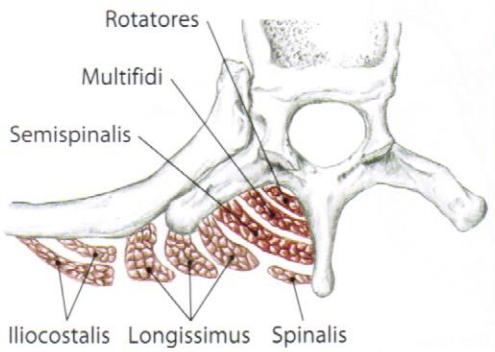
4.51 Posterior view, intermediate muscles of the back

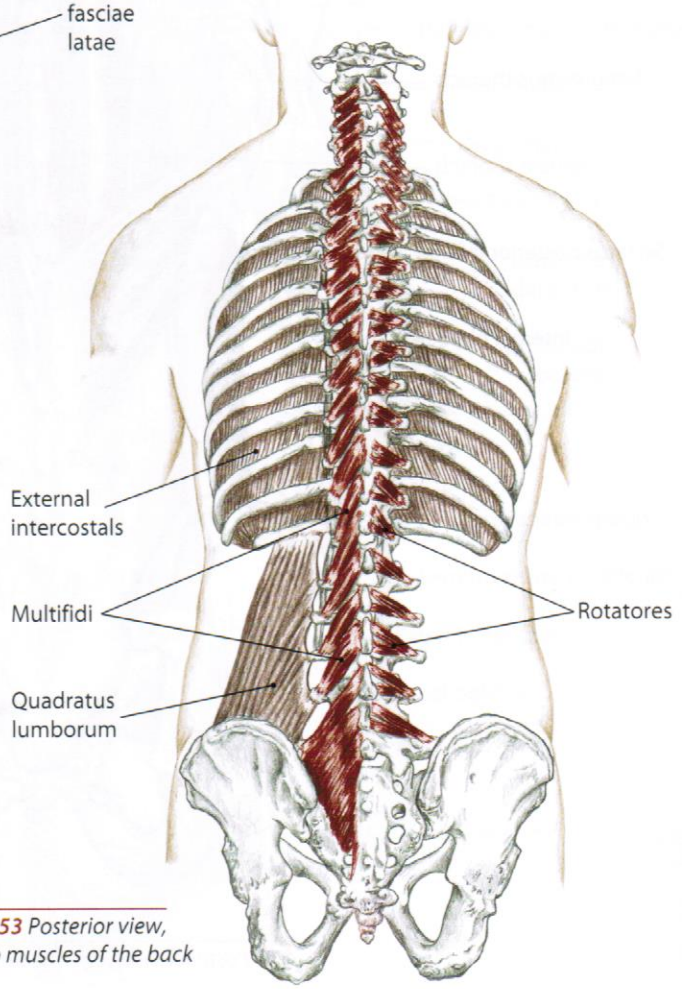
Muscles of the Spine and Thorax



4.52 Lateral view

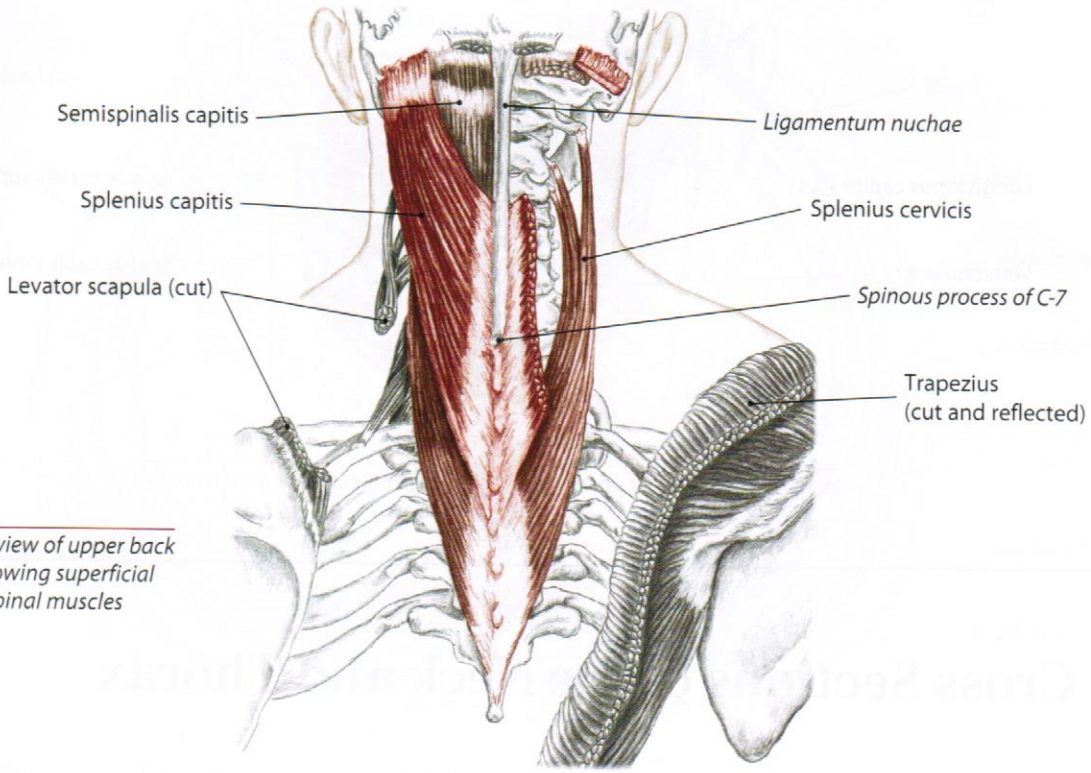
Here is a schematic cross section view of the muscles of the spine. The transversospinalis muscles (rotatores, multifidi and semispinalis) are located within the lamina groove, while the erector spinae muscles (spinalis, longissimus and iliocostalis) extend from the tip of the spinous process to the body of the rib.



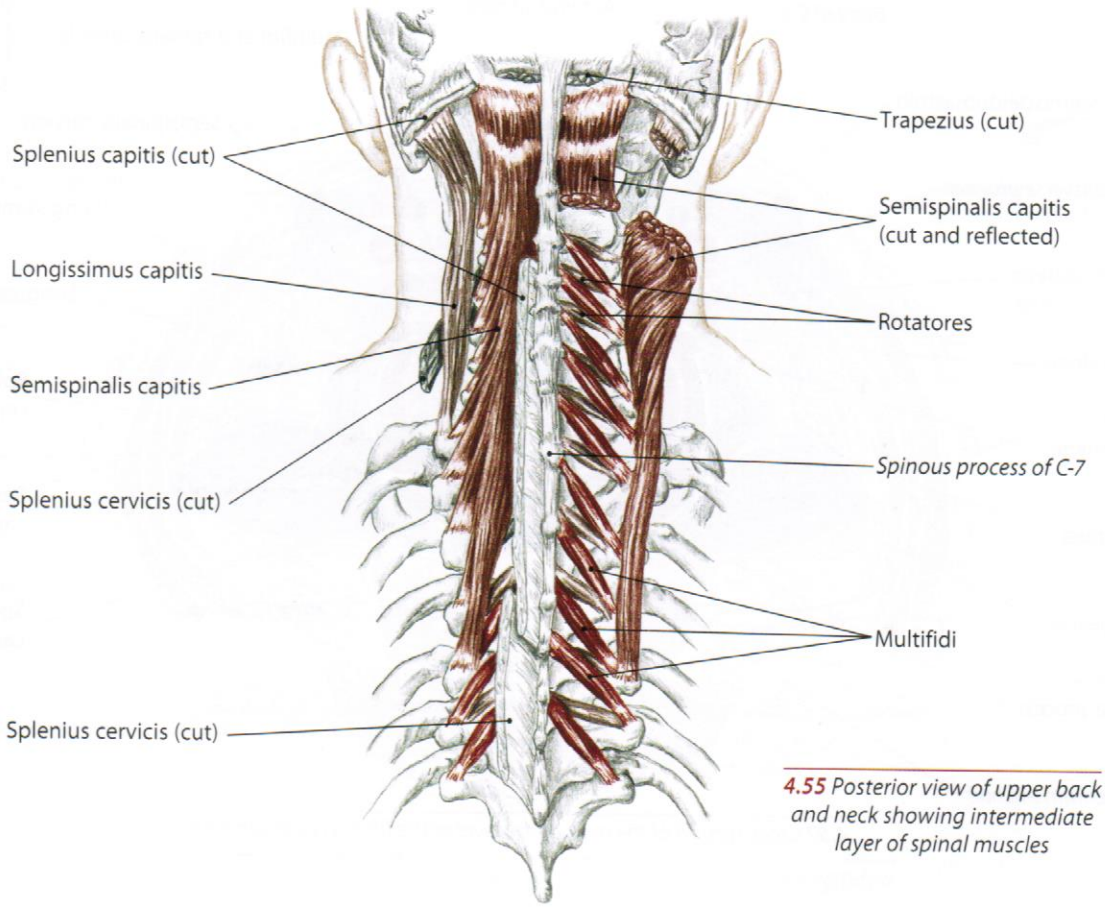


4.53 Posterior view, deep muscles of the back

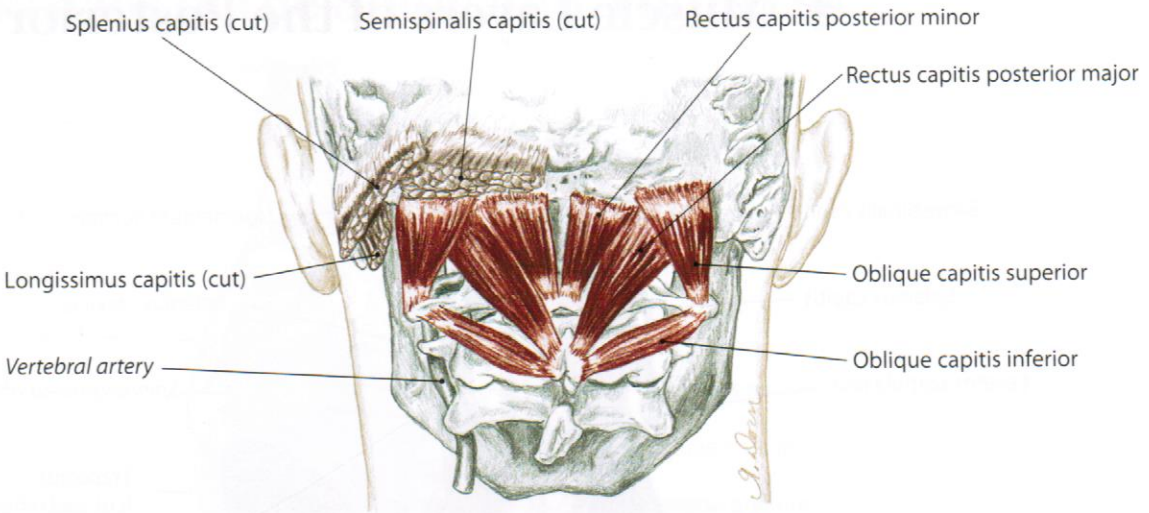
Muscle Layers of the Posterior Neck



4.54 *Posterior view of upper back and neck showing superficial layer of spinal muscles*

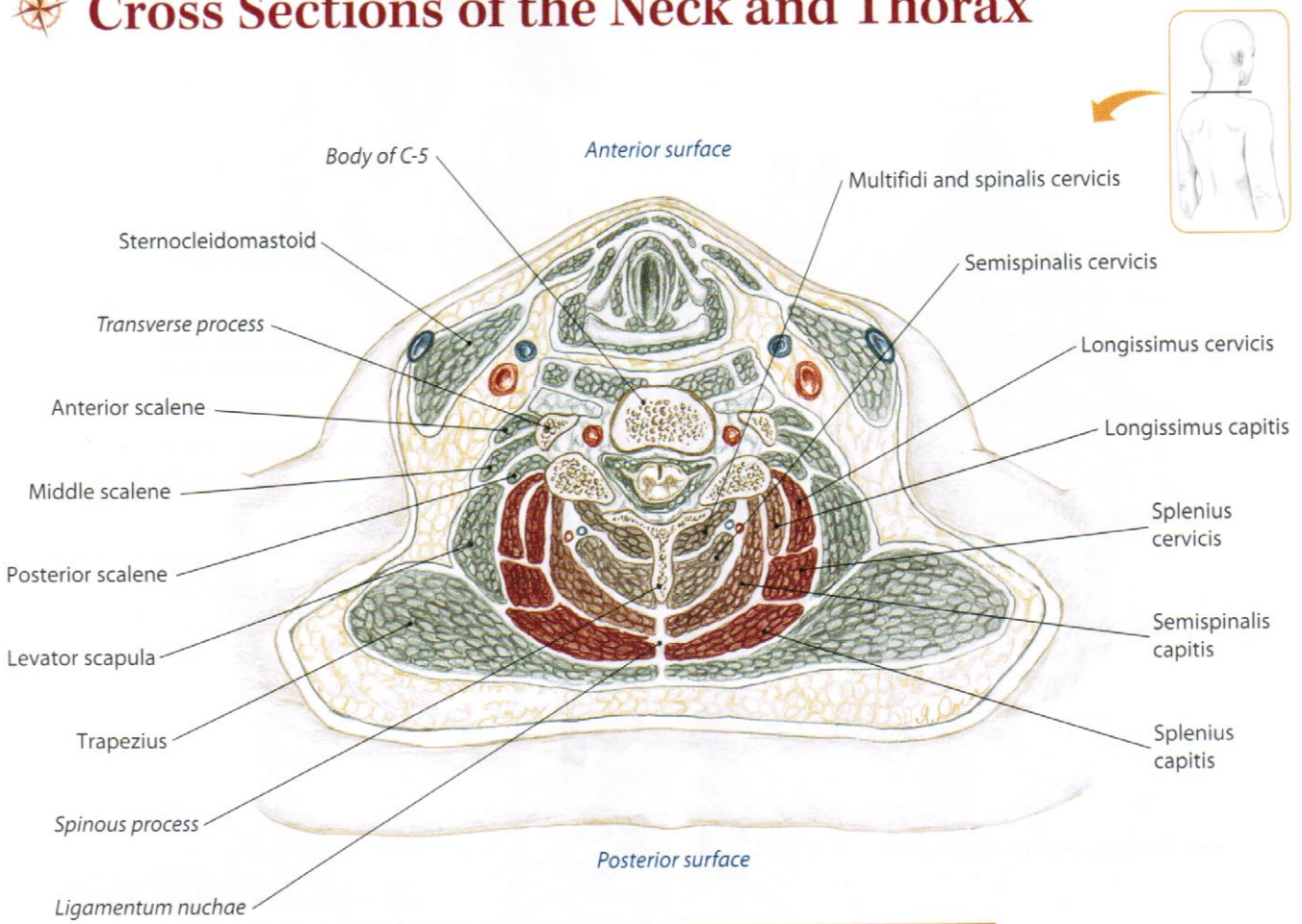


4.55 *Posterior view of upper back and neck showing intermediate layer of spinal muscles*

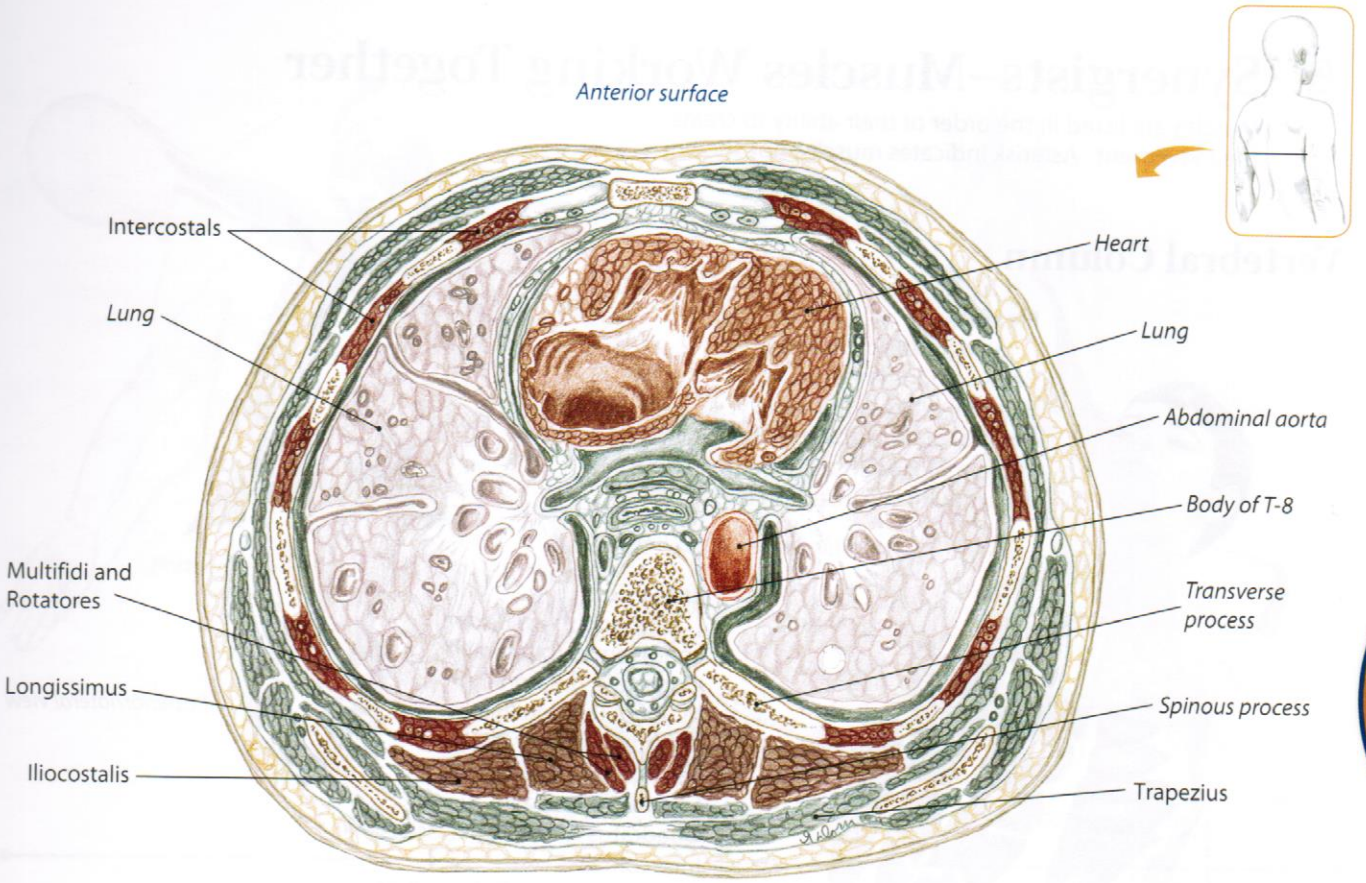


4.56 Posterior view of upper neck showing deepest layer of spinal muscles

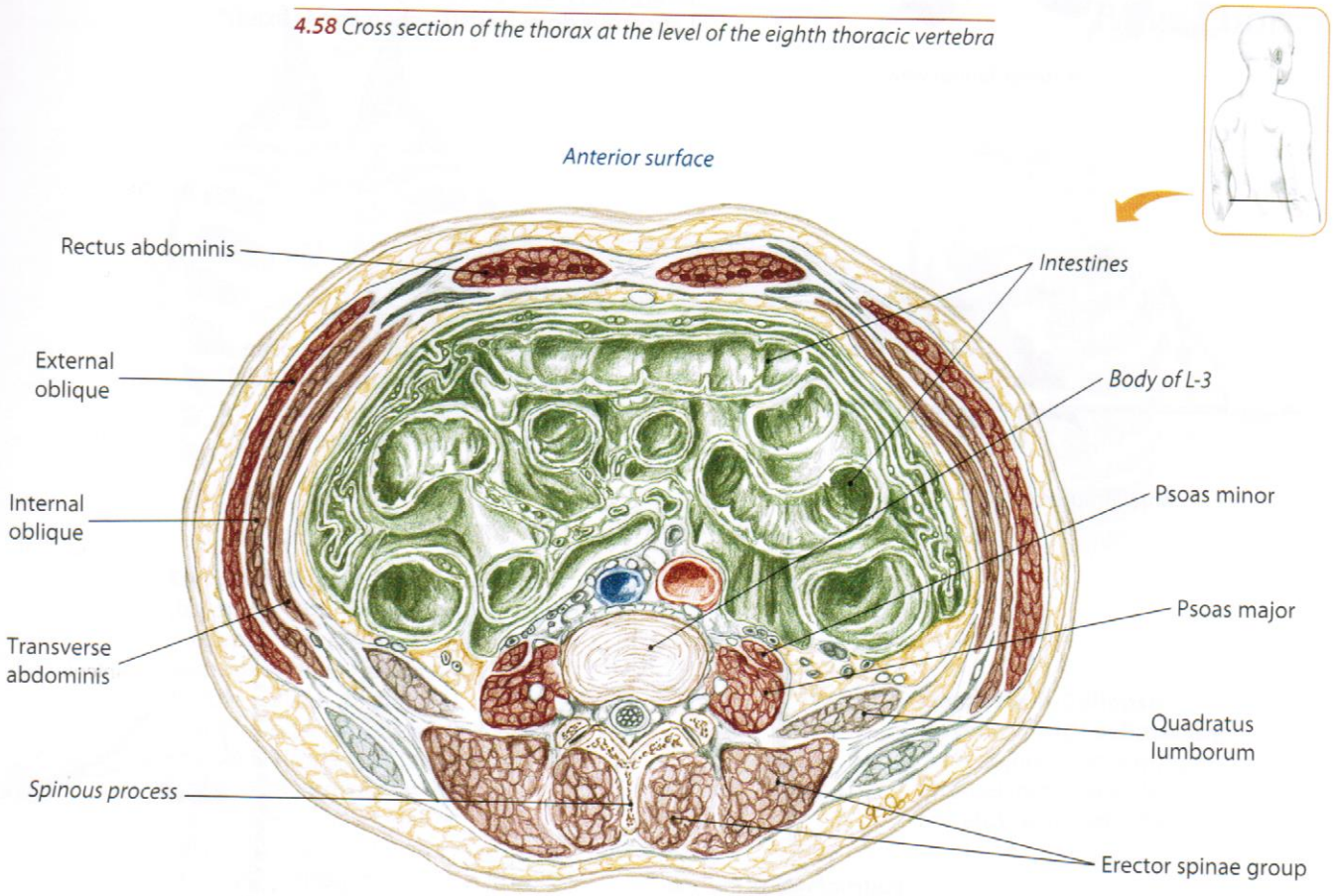
Cross Sections of the Neck and Thorax



4.57 Cross section of the neck at the level of the fifth cervical vertebra



4.58 Cross section of the thorax at the level of the eighth thoracic vertebra



4.59 Cross section of the abdomen at the level of the third lumbar vertebra

Synergists–Muscles Working Together

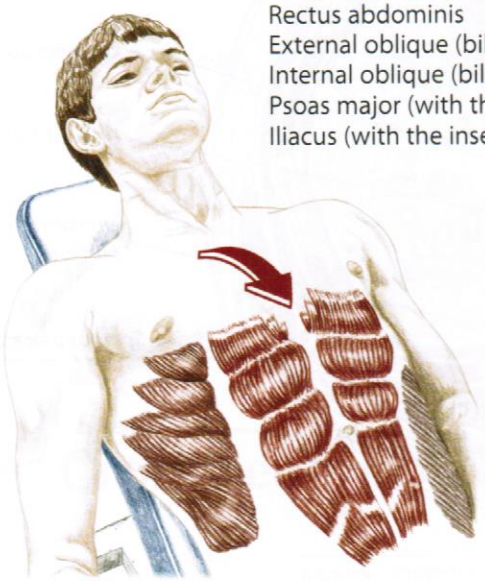
Muscles are listed in the order of their ability to create the movement. Asterisk indicates muscles not shown.

Vertebral Column

Flexion

(antagonists on extension)

Rectus abdominis
External oblique (bilaterally)
Internal oblique (bilaterally)
Psoas major (with the insertion fixed)
Iliacus (with the insertion fixed)



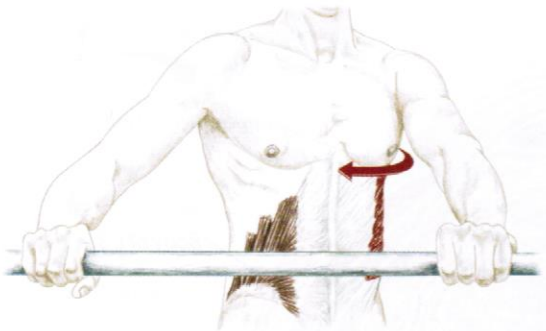
Anterior/lateral view

Extension

(antagonists on flexion)

Longissimus (bilaterally)
Iliocostalis (bilaterally)
Multifidi (bilaterally)
Rotatores (bilaterally)*
Semispinalis capitis
Spinalis (bilaterally)
Quadratus lumborum (assists)
Interspinalis*
Intertransversarii (bilaterally)*
Latissimus dorsi (assists, when arm is fixed)*

Posterior/lateral view

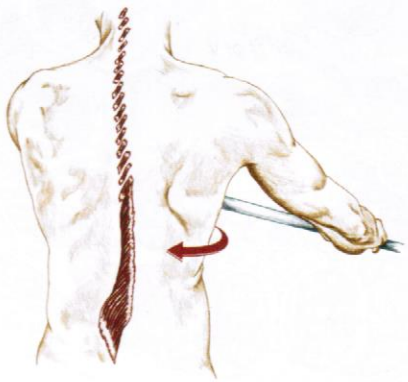


Anterior/lateral view

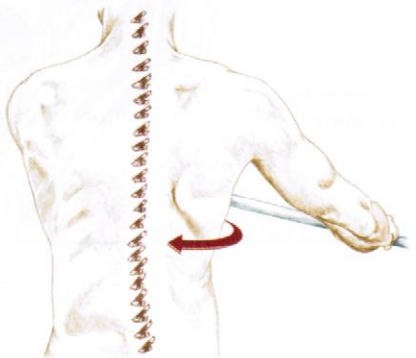
Rotation

(all unilaterally)

External oblique (to the opposite side)
Internal oblique (to the same side)
Multifidi (to the opposite side)
Rotatores (to the opposite side)



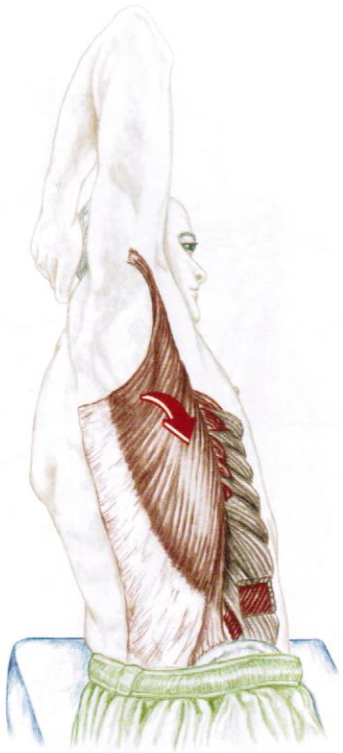
Posterior view of multifidi



Posterior view of rotatores

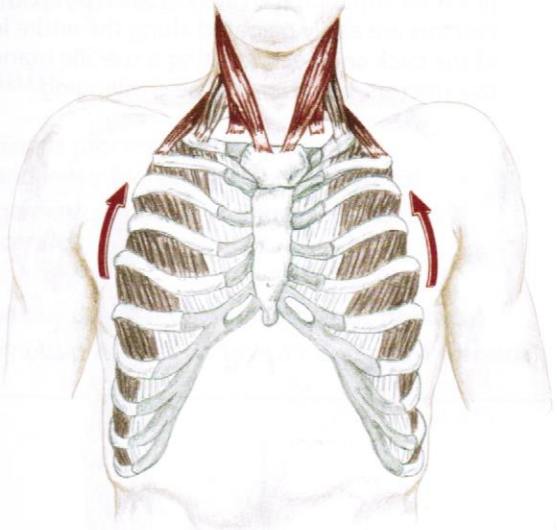
Posterior view

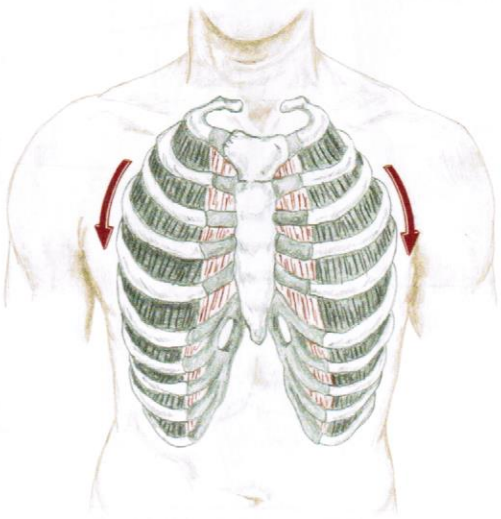
Lateral Flexion
(unilaterally to the same side)
Iliocostalis
External oblique
Internal oblique
Longissimus
Quadratus lumborum
Psoas major (assists)*
Intertransversarii*
Spinalis
Latissimus dorsi (assists)



Posterior/lateral view

Ribs/Thorax

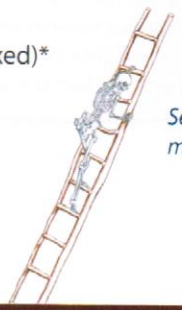




Anterior views

Elevation/Expansion (involved with inhalation)
(antagonists on depression)
Anterior scalene (bilaterally)
Middle scalene (bilaterally)
Posterior scalene (bilaterally)
Sternocleidomastoid (assists)
External intercostals (assists)
Serratus posterior superior*
Pectoralis major (all fibers may assist if arm is fixed)*
Pectoralis minor (if scapula is fixed)*
Serratus anterior (if scapula is fixed)*
Subclavius (first rib)*

Depression/Collapse (involved with exhalation)
(antagonists on elevation)
Internal intercostals (assists)
Serratus posterior inferior*



See p. 409 for a list of the muscles of respiration

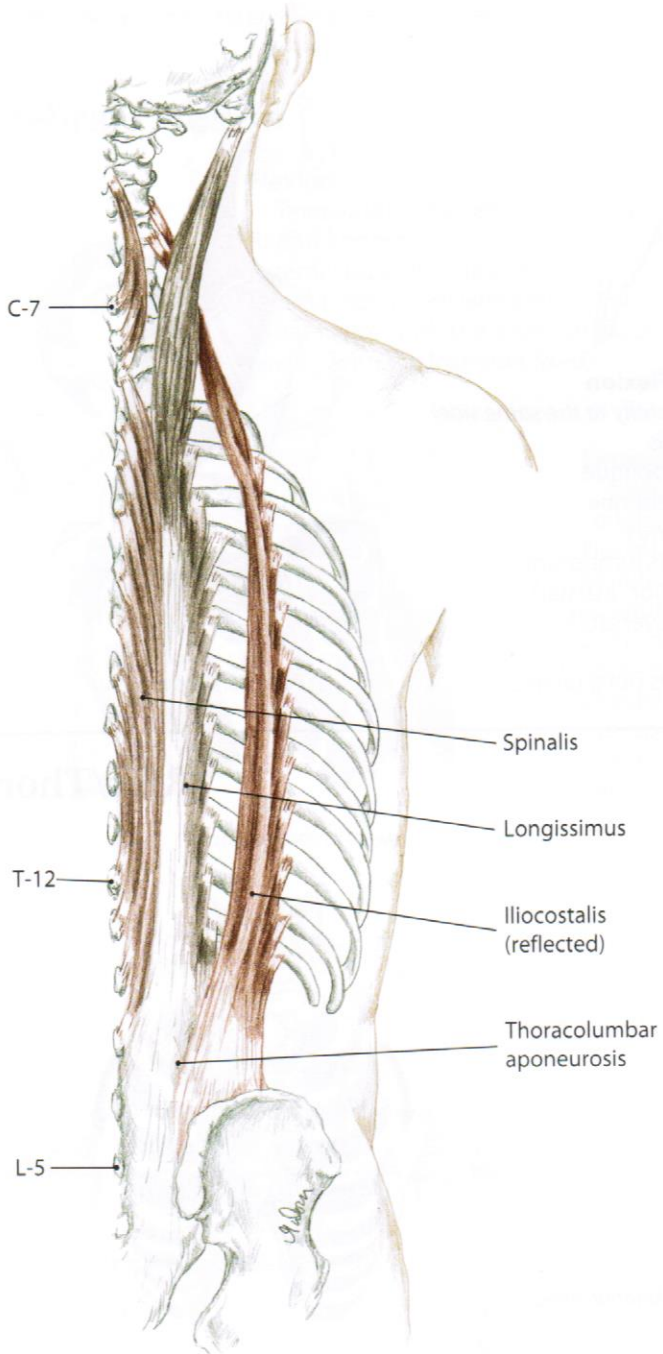
Erector Spinae Group

Spinalis
Longissimus
Iliocostalis

The erector spinae group runs from the sacrum to the occiput along the posterior aspect of the vertebral column. Its musculature has a dense, layered arrangement that can be difficult to visualize. It might simplify matters if you imagine the erector spinae muscles as a tall poplar tree (4.61) with three main branches—the spinalis, longissimus and iliocostalis (4.60). These branches can then be subdivided into numerous, smaller branches such as spinalis thoracis, longissimus capitis, iliocostalis lumborum and more.

The **spinalis** is the smallest of the three muscles and lies closest to the spine in the lamina groove (4.62). The thick **longissimus** and lateral **iliocostalis** form a visible mound alongside the lumbar and thoracic spine (4.64, 4.65). The long tendons of iliocostalis extend laterally beneath the scapula.

In the lumbar region, the erectors lie deep to the thin but dense thoracolumbar aponeurosis (p. 220). In the thoracic and cervical areas, they are deep to the trapezius, the rhomboids and the serratus posterior superior and inferior. As a group, the erectors are easily palpated along the entire length of the back and neck; locating a specific branch of the erectors, however, can be challenging.



4.60 Posterior view of right side showing erector spinae group

4.61 Poplar tree

The upper fibers of longissimus and iliocostalis muscles (longissimus cervicis and capitis, iliocostalis cervicis) assist in extension, lateral flexion and rotation of the head and neck to the same side.

iliocostalis	**il**-ee-o-kos-**ta**-lis	L. from hip to rib
longissimus	lon-**jis**-i-mus	L. longest

Erector Spinae Group

A *Unilaterally:*
Laterally flex vertebral column to the same side

Bilaterally:
Extend the vertebral column

O Common tendon (thoracolumbar aponeurosis) that attaches to the posterior surface of sacrum, iliac crest, spinous processes of the lumbar and last two thoracic vertebrae

I Various attachments at the posterior ribs, spinous and transverse processes of thoracic and cervical vertebrae and mastoid process of temporal bone

N Spinal

Branches of the Erector Spinae Group

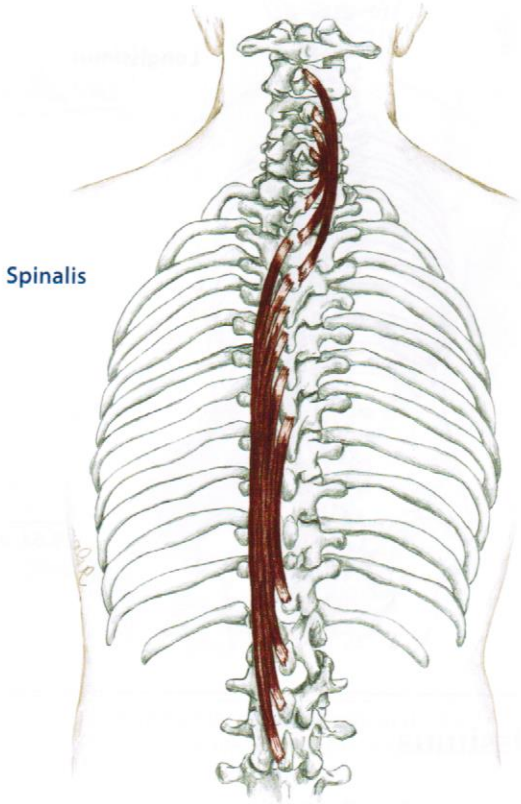
Spinalis

O Spinous processes of the upper lumbar and lower thoracic vertebrae **(thoracis)**
Ligamentum nuchae, spinous process of C-7 **(cervicis)**

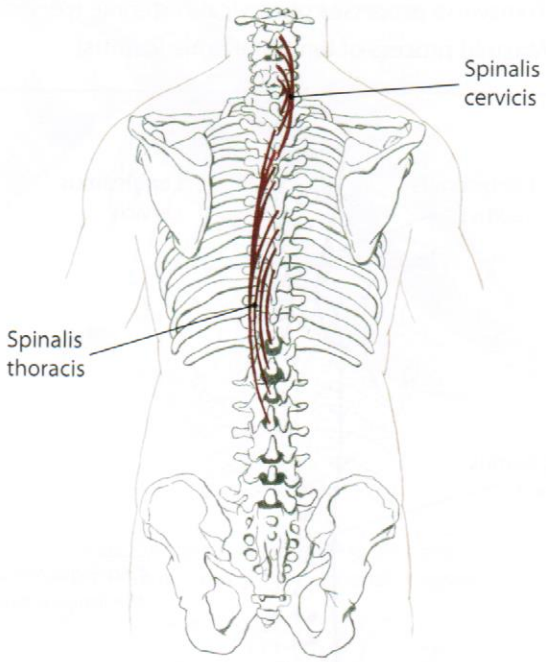
I Spinous processes of upper thoracic **(thoracis)**
Spinous processes of cervicals, except C-1 **(cervicis)**

When Do You Use Your Erectors?

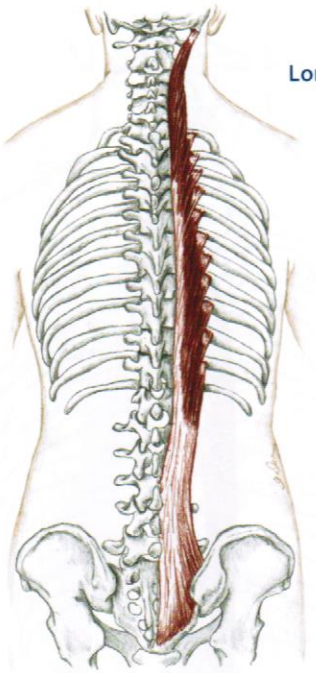
- *Maintaining an upright posture*
- *Returning to anatomical position after tying your shoes*
- *Picking up a heavy suitcase (lateral flexion)*

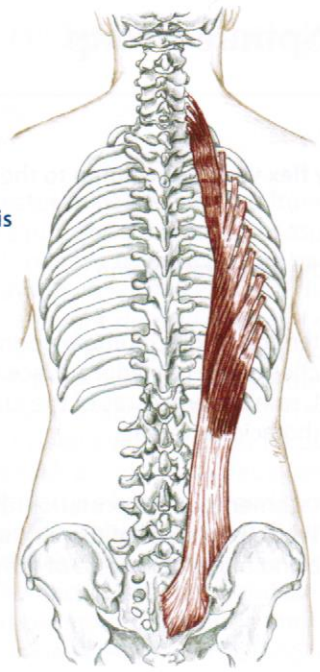


4.62 Posterior view of thorax



4.63 Branches of the spinalis





4.64, 4.65 Posterior views

Longissimus

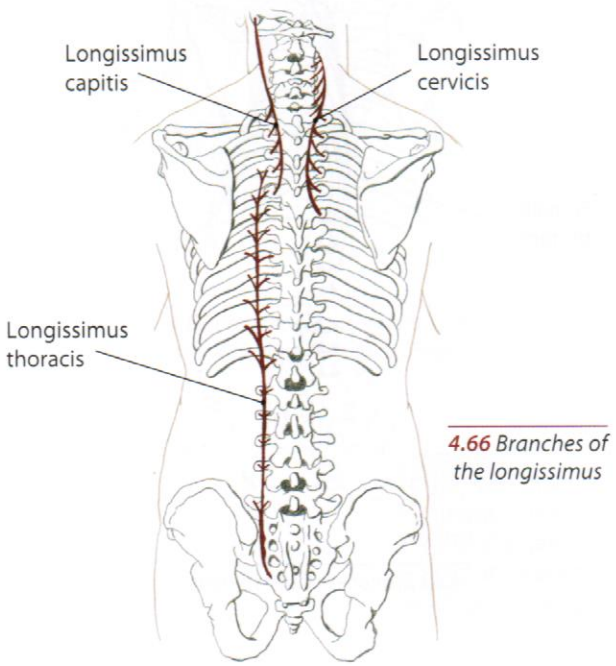
O Common tendon (**thoracis**)
Transverse processes of upper five thoracic vertebrae (**cervicis and capitis**)

I Lower nine ribs and transverse processes of thoracic vertebrae (**thoracis**)
Transverse processes of cervical vertebrae (**cervicis**)
Mastoid process of temporal bone (**capitis**)

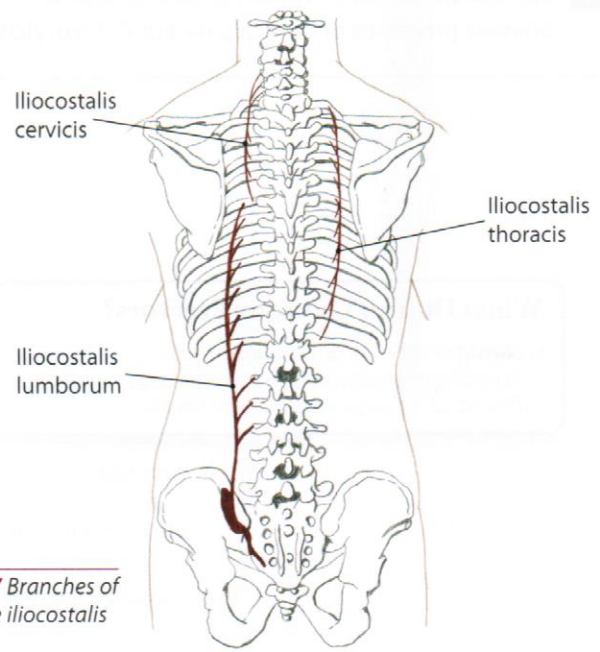
Iliocostalis

O Common tendon (**lumborum**)
Posterior surface of ribs 1-12 (**thoracis and cervicis**)

I Transverse processes of lumbar vertebrae 1-3 and posterior surface of ribs 6-12 (**lumborum**)
Posterior surface of ribs 1-6 (**thoracis**)
Transverse processes of lower cervicals (**cervicis**)



4.66 Branches of the longissimus



4.67 Branches of the iliocostalis