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# Facilitated STRETCHING

Simplified PNF stretching  
and strengthening with

- 64 partner-assisted stretches
- 50 self-stretches
- embedded video of over 90 stretches



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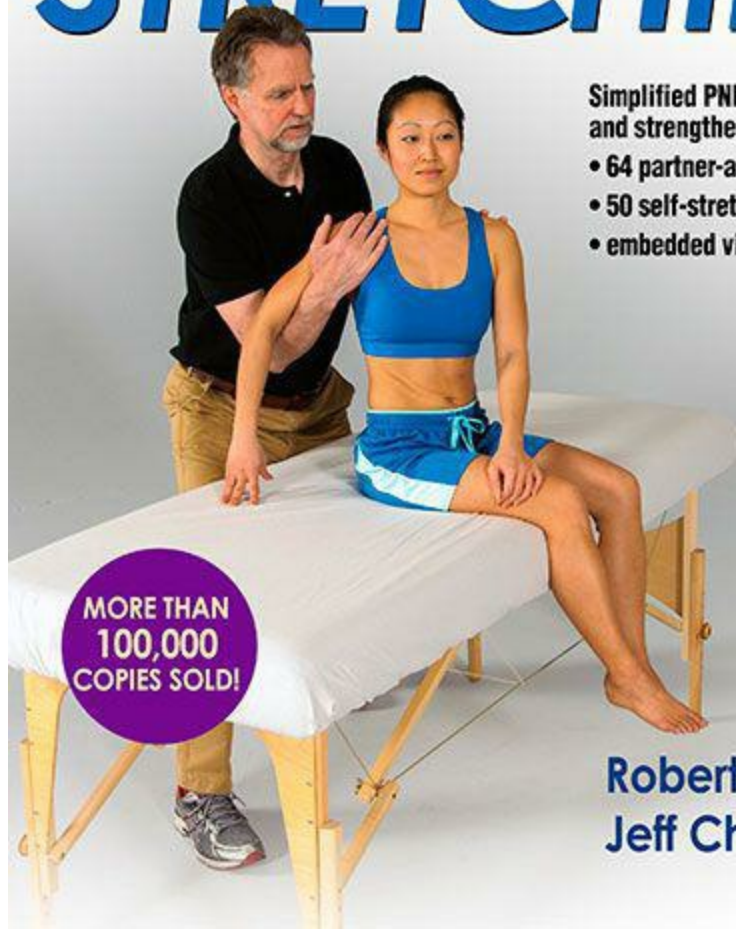
**Robert E. McAtee**  
**Jeff Charland**

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Fourth Edition  
Robert E. McAtee  
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Human Kinetics

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Developmental Editor: Amanda S. Ewing

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Photo Asset Manager: Laura Fitch

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## **Human Kinetics**

Website: [www.HumanKinetics.com](http://www.HumanKinetics.com)

*United States:* Human Kinetics

P.O. Box 5076

Champaign, IL 61825-5076

800-747-4457

e-mail: [humank@hkusa.com](mailto:humank@hkusa.com)

*Canada:* Human Kinetics

475 Devonshire Road Unit 100

Windsor, ON N8Y 2L5

800-465-7301 (in Canada only)

e-mail: [info@hkanada.com](mailto:info@hkanada.com)

*Europe:* Human Kinetics

107 Bradford Road

Stanningley

Leeds LS28 6AT, United Kingdom

+44 (0) 113 255 5665

e-mail: [hk@hkeurope.com](mailto:hk@hkeurope.com)

*Australia:* Human Kinetics

57A Price Avenue

Lower Mitcham, South Australia 5062

08 8372 0999

e-mail: [info@hkaustralia.com](mailto:info@hkaustralia.com)

*New Zealand:* Human Kinetics

P.O. Box 80

Torrens Park, South Australia 5062

0800 222 062

e-mail: [info@hknewzealand.com](mailto:info@hknewzealand.com)

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To my wife, Trina, who lovingly encouraged me to write, even at the expense of time we could have spent together.

# Contents

[Preface](#)

[Acknowledgments](#)

## **[Part I: The Prerequisites](#)**

### **[Chapter 1: Understanding the Basics of Stretching](#)**

[Soft Tissues Affected by Stretching](#)

[Muscle Interactions](#)

[Muscle Contractions](#)

[Reflexes Relevant to Facilitated Stretching](#)

[Types of Stretching](#)

[Guidelines for Stretching](#)

[Chapter Summary](#)

### **[Chapter 2: Focusing on Facilitated Stretching](#)**

[PNF History](#)

[PNF Basis: Spiral–Diagonal Movement](#)

[PNF Stretching Techniques](#)

[Facilitated Stretching Guidelines](#)

[Detailed Sequence for Facilitated Stretching](#)

[Safety Considerations for Facilitated Stretching](#)

[Chapter Summary](#)

### **[Chapter 3: Using the Spiral–Diagonal Patterns of PNF](#)**

[When and Why to Use Spiral-Pattern Stretches](#)

[Learning the Patterns Through Free Motion](#)

[Facilitated Stretching Using the Patterns](#)

[Lower Extremity Stretches Using the Patterns](#)

[Upper Extremity Stretches Using the Patterns](#)

[Strengthening Exercises Using the Patterns](#)

[Chapter Summary](#)

## **[Part II: The Stretches](#)**

### **[Chapter 4: Stretches for the Torso and Neck](#)**

[Oblique Abdominals](#)

[Lower Back](#)

[Upper Trapezius](#)

[Sternocleidomastoid](#)

[Scalenes](#)

[Suboccipitals](#)

[Levator Scapulae](#)

### **[Chapter 5: Stretches for the Lower Extremity](#)**

[Hip Extensors](#)

[Hip Flexors](#)

[Hip Lateral \(External\) Rotators](#)

[Hip Medial \(Internal\) Rotators](#)

[Hip Abductors](#)

[Hip Adductors](#)

[Knee Extensors](#)

[Ankle Plantar Flexors](#)

[Ankle Dorsiflexors](#)

[Toe Flexors](#)

[Toe Extensors](#)

[Ankle Evertors: Peroneal \(Fibularis\) Group](#)

[Ankle Invertors](#)

## **[Chapter 6: Stretches for the Upper Extremity](#)**

[Rotator Cuff](#)

[Scapular Stabilizers](#)

[Additional Muscles That Move the Arm](#)

[Elbow](#)

[Wrist and Hand](#)

[Supinator and Pronators](#)

## **[Chapter 7: Stretching Routines for Specific Activities](#)**

[Everyday Sequence](#)

[Cycling](#)

[Golf](#)

[Ice Hockey](#)

[Running](#)

[Swimming](#)

[Throwing and Racket Sports](#)

[Rusty Hinges](#)

[Appendix](#)

[References](#)

[About the Authors](#)

# Preface

Welcome to the fourth edition of *Facilitated Stretching*, marking its 20th anniversary by converting to full-color photos and illustrations throughout. We appreciate the support of our 100,000-plus readers who have continued to offer feedback about how to make the book more useful for therapists, trainers, coaches, and athletes of every stripe and ability level. Whether you're an accomplished athlete or are just beginning a fitness program, you'll find that the regular use of facilitated stretching will help you improve your flexibility and coordination, which can help improve the overall enjoyment of your chosen sport. If you're a manual therapist, massage therapist, athletic trainer, personal trainer, sport physician, or coach, you'll find valuable information and techniques here for optimizing your athletes' flexibility, coordination, and performance.

After reviewing reader feedback, we've refocused this fourth edition to more fully reflect the continued interest in training to optimize function and to acknowledge the burgeoning research on the role of fascia in transmitting the forces generated during stretching through adjacent muscles and connective tissue. To this end, we've grouped the stretches around each joint, with less emphasis on individual muscles.

You'll find more than 20 tables, 50 illustrations, and 250 full-color photographs illustrating the stretches and strengthening exercises. To enhance your understanding, we've added graphic elements to selected photos that show the muscles under the skin. Additionally, stylized arrows are placed on selected stretch photos to aid in visualizing the direction of the isometric or the hold effort for the stretcher and the partner.

## Organization

This edition is divided into two parts. Part I has three chapters. Chapter 1 lays the groundwork for understanding the basics of stretching. We explain which soft tissues are being stretched, examine the role of reflexes in stretching, discuss the general guidelines for any type of stretching, and describe a variety of stretching techniques. In chapter 2, we focus on facilitated stretching, discussing the historical development of PNF (proprioceptive neuromuscular facilitation), the evolution of facilitated stretching, and our current understanding of the neurophysiology underlying the effectiveness of facilitated stretching, and we give a detailed description of the application of this technique. In chapter 3, we take an in-depth look at the spiral–diagonal patterns of PNF and how they’re used in a variety of movement activities. We discuss using the patterns as part of dynamic warm-up exercises and how to use them in facilitated stretching to improve flexibility by simultaneously engaging synergistic muscle groups. We also discuss and demonstrate how to incorporate the spiral–diagonal patterns into exercise sessions to optimize your functional training.

In part II we show you, step by step, how to stretch the major muscle groups. In this edition, we feature 64 partner-assisted stretches and 50 self-stretches. In previous versions, we’ve primarily demonstrated the partner-assisted stretches as performed on a treatment table. This time we’ve added new photographs and descriptions to demonstrate many of the stretches in nontherapy settings (e.g., on an exercise mat, on a workout bench, or in a chair) to show how the stretches can be done in a variety of locations—at home, in a gym, while traveling, and so on.

Chapter 4 covers the torso and neck; chapter 5 focuses on the lower extremity; and chapter 6 details stretches for the upper extremity. Chapter 7 consists of stretching routines for activity. As in previous editions, these routines are for running, golf, swimming, throwing and racket sports, cycling, everyday stretches, and “rusty hinges.” In response to many requests, we’ve added a stretching routine for ice hockey.

We’ve also added an appendix to the fourth edition that features an overview of the anatomical planes of motion, anatomical terms, and types of joints. This information is useful for readers unfamiliar with these terms and also as a quick review for those who learned it in the past and may feel a bit rusty.

## Enhanced Video Content

Another update is an upgrade from the DVD of the third edition to streaming video for the fourth edition, for which we created all new high-definition videos. The video content is embedded throughout this enhanced e-book and provides you with much more visual information than the text and photo content alone. The new fourth edition video clips also include new demonstrations of selected stretches both on a treatment table and in nontherapy settings (e.g., on an exercise mat, on a bench). The strengthening exercises are demonstrated on a variety of gym equipment, including cable-pulley machines and benches. You'll see that stretches accompanied by video display a video player; simply tap the play button in the video player to view each clip.

Here is a listing of all the stretches accompanied by video:

### Chapter 3

- D1 Pattern for the Arm
- D2 Pattern for the Arm
- D1 Pattern for the Leg
- D2 Pattern for the Leg
- Dynamic Warm-Ups Using the Patterns
- Soccer Kick Partner Stretch (Flexion End of D1)
- Toe-Off Partner Stretch (Extension End of D1)
- Snowplow Partner Stretch (Flexion End of D2)
- Grab Seat Belt Partner Stretch (Flexion End of D1)
- Fasten Seat Belt Partner Stretch (Extension End of D1)
- Draw Sword Partner Stretch (Flexion End of D2)
- Sheathe Sword Partner Stretch (Extension End of D2)
- D1 Flexion: Arms
- D1 Extension: Arms
- D2 Flexion: Arms
- D2 Extension: Arms
- D1 Flexion: Legs
- D1 Extension: Legs
- D2 Flexion: Legs
- D2 Extension: Legs

### Chapter 4

- Oblique Abdominal Muscles Partner Stretch, Seated
- Oblique Abdominal Muscles Self-Stretch, Seated

- Quadratus Lumborum Partner Stretch, Side-Lying
- Quadratus Lumborum Self-Stretch, Sitting With a Side-Bend
- Back Extensors Stretch, Supine, Both Knees to Chest, With a Partner
- Spinal Twist Partner Stretch, Supine
- Upper Trapezius Partner Stretch, Supine on a Table
- Upper Trapezius Self-Stretch, Supine
- Sternocleidomastoid Partner Stretch, Supine
- Scalenes Partner Stretch, Supine
- Scalenes Self-Stretch, Supine
- Levator Scapulae Partner Stretch, Seated

## **Chapter 5**

- Hamstrings Partner Stretch, Supine With Straight Leg (Table)
- Hamstrings Partner Stretch, Supine With Straight Leg (Mat)
- Hamstrings Partner Stretch, Supine With Bent Knee
- Hamstrings Self-Stretch, Supine With Stretching Strap
- Gluteus Maximus Partner Stretch, Supine
- Gluteus Maximus Self-Stretch, Supine
- Psoas Partner Stretch, Prone
- Psoas Self-Stretch, Standing or Kneeling
- Piriformis Partner Stretch, Supine
- Piriformis Partner Stretch, Prone
- Piriformis Self-Stretch, Supine
- Piriformis Self-Stretch, Seated
- Medial Hip Rotators Partner Stretch, Prone
- Hip Abductors Partner Stretch, Side-Lying on a Table
- Hip Abductors Partner Stretch, Supine on a Mat
- Hip Abductors Self-Stretch, Sitting
- Hip Adductors Partner Stretch, Supine on a Table
- Hip Adductors Partner Stretch, Supine on a Mat
- Hip Adductors Self-Stretch, Standing
- Quadriceps Partner Stretch, Prone
- Quadriceps Self-Stretch, Standing
- Gastrocnemius Partner Stretch, Prone
- Gastrocnemius Partner Stretch, Supine
- Gastrocnemius Self-Stretch, Sitting With Stretching Strap
- Soleus Partner Stretch, Prone
- Soleus Self-Stretch, Sitting
- Tibialis Anterior Partner Stretch, Supine

- Tibialis Anterior Self-Stretch, Sitting
- Peroneals (Evertors) Partner Stretch, Supine
- Peroneals (Evertors) Self-Stretch, Sitting
- Tibialis Posterior (Invertor) Partner Stretch, Supine

## Chapter 6

- Subscapularis Partner Stretch, Supine on a Treatment Table
- Subscapularis Partner Stretch, Seated
- Subscapularis Self-Stretch, Standing
- Infraspinatus and Teres Minor Partner Stretch, Prone on a Treatment Table
- Infraspinatus and Teres Minor Partner Stretch, Seated
- Infraspinatus and Teres Minor Self-Stretch, Standing
- Supraspinatus Partner Stretch, Prone
- Supraspinatus Partner Stretch, Seated
- Pectoralis Minor Partner Stretch, Supine
- Rhomboids and Middle Trapezius Partner Stretch, Supine
- Rhomboids and Middle Trapezius Partner Stretch, Side-Lying on a Treatment Table
- Rhomboids and Middle Trapezius Partner Stretch, Seated
- Rhomboids and Middle Trapezius Self-Stretch, Seated
- Serratus Anterior Partner Stretch, Prone
- Serratus Anterior Self-Stretch
- Pectoralis Major Partner Stretch, Prone
- Pectoralis Major Partner Stretch, Seated
- Pectoralis Major Self-Stretch, Standing
- Latissimus Dorsi Partner Stretch, Prone
- Latissimus Dorsi Partner Stretch, Seated
- Latissimus Dorsi Self-Stretch, Standing With Pull-Up Bar
- Biceps Brachii Partner Stretch, Seated
- Triceps Partner Stretch, Prone
- Triceps Partner Stretch, Seated
- Triceps Self-Stretch
- Wrist and Finger Flexors Partner Stretch, Supine
- Wrist and Finger Flexors Self-Stretch, Seated
- Wrist and Finger Extensors Partner Stretch, Supine
- Wrist and Finger Extensors Self-Stretch, Seated
- Forearm Supinator Partner Stretch, Supine
- Forearm Supinator Self-Stretch, Seated
- Forearm Pronators Partner Stretch, Supine

- Forearm Pronators Self-Stretch, Seated

## **Chapter 7**

- Everyday Sequence
- Golf
- Running
- Throwing and Racket Sports

## Instructor Resources

A bonus feature for instructors who adopt the book as a classroom text is free access to an online test package and image bank.

- The test package includes more than 200 questions in multiple choice, true or false, and fill-in-the-blank formats. Instructors can create print versions of their own tests by selecting from the question pool; create, store, and retrieve their own questions; select their own test forms and save them for editing or printing; export the test into a word-processing program; or include the test in a learning management system (LMS).
- The image bank contains all the illustrations, photos, and tables from the book. Instructors can download any of them into their own PowerPoint presentations, use them to create student or client handouts, and so on.

Both instructor ancillaries are available at [www.HumanKinetics.com/FacilitatedStretching](http://www.HumanKinetics.com/FacilitatedStretching).

## Final Notes

We remind you that before starting any exercise or fitness program, prudent readers will consult with their health care providers. We've taken care to ensure that the information given in this text is accurate, but medical knowledge is constantly changing, and as new information becomes available, changes in treatment, equipment, and procedures become necessary.

We hope the collective knowledge and experience we've distilled into these pages will be a valuable addition to your active lifestyle, and we look forward to continuing our interaction with you via every form of communication, including e-mail, snail mail, and social media sites.

# Acknowledgments

The process of writing is a solitary task, often accomplished late at night, early in the morning, or during blocks of time carved out of “leisure time”. On the other hand, turning 50,000 written words into a book takes the effort of many people over an extended period of time.

I owe a debt of gratitude to my clients and students for their support and encouragement over the years, and for keeping the work interesting and challenging every day.

Prior to beginning work on this fourth edition of *Facilitated Stretching*, I requested several colleagues to carefully review the third edition and offer suggestions for improving the book. I sincerely appreciate the feedback from David MacDougall, Charles McGrosky, Laura Allen, John Sharkey, and Patrick Gravel—their comments and suggestions helped shape the draft manuscript.

After the manuscript for this edition was complete, I had the good fortune to recruit two additional colleagues to provide feedback. Patrick Ward and Joe Gallo graciously provided detailed notes, comments, and references that significantly improved the content and the organization of the book.

Many thanks to my acquisitions editorial team: Loarn Robertson, Michelle Maloney, and Amy Tocco. They guided the early stages of the book, helping to delineate our goals for the reader and to then focus the content to meet those goals.

Amanda Ewing served as my developmental editor and was a pleasure to work with. Her sharp eyes, attention to detail, and suggestions for improving the organization, as well as the content, of the book have made a huge impact on the final product. She also was sensitive to both my travel and teaching schedule when setting deadlines, scheduling the photo and video shoots, and handling the myriad production details that go into producing a book like this one.

During a week-long video and photo shoot, I had the good fortune to work with an excellent team that included: Gregg Henness, video director; Doug Fink, script supervisor; Amy Rose, camera operator; Bill Yauch, camera operator; and Roger Francisco, boom operator and sound recorder. Joyce Brumfield, visual production assistant, recruited the models for the shoot and coordinated the props. Neil Bernstein, HK photographer, created a positive and upbeat atmosphere as we shot more than 1,500 photos in the course of two and a half days. Our models for the week (Rebekah Hopkins, Abraham Jones, and Jennifer Rapp) were consummate professionals through long days of shooting and cheerfully agreed to another take or “just one more shot” to be sure we got what we needed.

I also appreciate the dedication and hard work of the entire Human Kinetics’ staff who participated in the development, production, and marketing of the book.

# Part I

## The Prerequisites

In this part, we cover the fundamental information necessary for fully appreciating the stretching work.

In chapter 1 we discuss general guidelines for any kind of stretching, including a review of the soft tissues affected, the muscle types, and the reflexes related to stretching. We also briefly describe a variety of stretching techniques in addition to facilitated stretching.

Chapter 2 reviews the history and development of PNF, its focus on the spiral–diagonal nature of movement, and the expansion of PNF stretching techniques beyond physiotherapy into clinical settings, training rooms, and gyms.

Chapter 3 takes a broad overview of the spiral–diagonal patterns developed in PNF. We follow a natural progression of learning the patterns as free-movement exercises and then incorporating them into dynamic warm-ups. We cover in detail the use of these three-dimensional patterns for facilitated stretching, and we finish up by incorporating them into strength training programs using resistance bands, wall-pulley systems, and cable-based equipment.

# Chapter 1

## Understanding the Basics of Stretching

Our understanding of the physiology of stretching has broadened as a result of advances in research on the subject. Traditionally, explanations of the benefits of stretching have been based on a mechanical model proposing that stretching increases muscle length. Most theories using the mechanical model of stretching are based on the viscoelastic properties of muscle tissue. Viscoelastic deformation (changes in muscle length due to stretch) can be the result of stress relaxation or creep. Stress relaxation refers to the gradual decline in tension observed in a muscle when it's held in a stretched position (as in static stretching). Creep occurs when a muscle lengthens in response to a constant stretching force (Alter 2004). Other theories posit that stretching results in plastic (permanent) deformation of the tissues; an increase in sarcomeres, leading to increased muscle length; and reflex-mediated neuromuscular relaxation (Weppeler and Magnusson 2010).

Research on these proposed mechanical effects of stretching has been overwhelmingly nonsupportive. Currently, the most widely accepted theory for the effects of stretching is the sensory theory, which suggests that increased joint range of motion (ROM) after stretching exercises results from a change in the stretch tolerance of the stretcher, allowing for increased range of motion (Weppeler and Magnusson 2010). As researchers continue to study the effects of various forms of stretching in an attempt to understand what actually happens, we believe it's important to include stretching as a valuable component of an overall health and fitness program.

In this chapter we'll look at some of the elements of stretching, including soft tissues, types of muscle contractions, stretch reflexes, and different stretching techniques.

## Soft Tissues Affected by Stretching

In recent years, there has been an explosion of research on the soft-tissue structures of the body. These findings have significantly broadened and deepened our understanding of both the structure and function of these tissues. This research has also caused a shift in the way we think about the musculoskeletal system, how the various soft tissues interact with one another, and what happens when we perform simple activities such as stretching.

The following sections start with the classic descriptions of each tissue and then expand to include a broad look at new information that increases our overall understanding about their roles in stretching and how they are affected by it.

### Connective Tissue

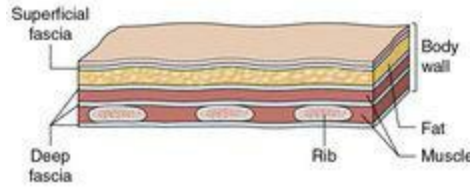
Connective tissue is the building block of all the soft tissues. It's made up of both collagen and elastic fibers embedded in a jelly-like extracellular matrix that usually acts as a lubricant. Connective tissue can be categorized as loose or dense and as regular or irregular, depending on its composition.

Collagen is the most abundant protein in the body and the primary structural component of most soft tissue. It exhibits excellent tensile strength and is relatively inextensible. The elastic fibers in connective tissue coil and recoil like a spring and help return stretched tissue back to its original shape. The ratio of collagen and elastic fibers varies in different tissues, depending on whether they need more strength or more elasticity.

### Fascia

In traditional anatomy books, fascia has been regarded primarily as a wrapper, composed of dense connective tissue that protects and separates the “important” structures, such as muscles, tendons, ligaments, and organs ([figure 1.1](#)).

**Figure 1.1** Superficial fascia lies just below the skin. Deep fascia is a continuous sheet of mostly dense, irregular connective tissue that interpenetrates and surrounds the muscles, bones, nerves, and blood vessels of the body.



According to Langevin and Huijing (2009), “fascia encompasses both loose and dense, superficial and deep, and multiple- and single-layered connective tissues” (p. 1). They describe and define 12 different types of fascia and recommend that when discussing fascia, we specify which type, otherwise we run the risk of equating fascia with connective tissue in general. Langevin and Huijing go on to say that speaking in nonspecific terms about fascia “‘muddies’ the simple definitions of tendons and ligaments that are still helpful to the beginner new to the field. But such caution does not stop us acknowledging that tendons and ligaments can commonly blend with fascia—and in particular, that they can become ‘fascial’ near their attachment sites” (p. 5).

Because of the intense research on fascia in recent years, Myers has referred to it as “the Cinderella of body tissues that is finally getting its due” (Myers 2011, p. 58). Fascia is made up of various types of connective tissue that surround and connect every muscle and every organ, forming continuity throughout the body. Fascia varies in shape, density, and thickness according to its location in the body and the functional stress placed on it. Although traditional anatomists believed that fascia was merely a passive form of connective tissue, we now know that fascia has the ability to contract and relax, that it contains sensory organs such as proprioceptors and mechanoreceptors, and that it is well innervated. When we perform any activity, be it strengthening or stretching, we are affecting and being affected by the fascial tissues and can only artificially separate them from muscles, tendons, and ligaments.

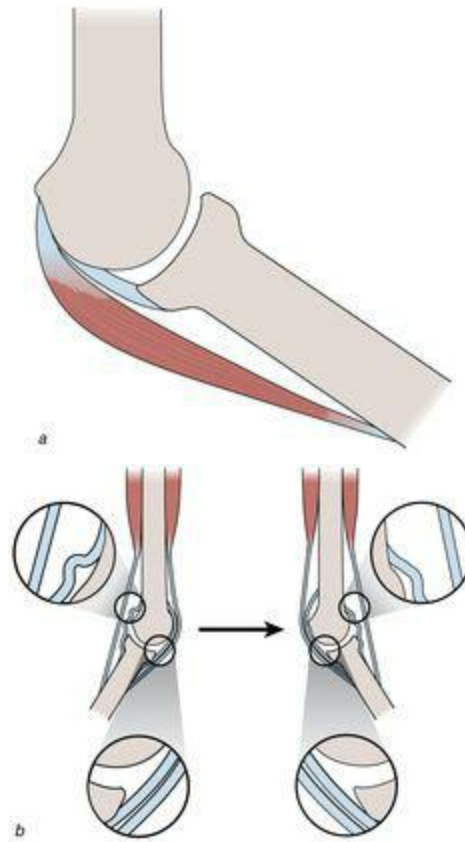
## Ligaments

In classic anatomy, ligaments are defined as fibrous bands of dense connective tissue that attach bones to each other—that is, ligaments hold joints together. Ligaments are composed primarily of collagen bundles in parallel, with a mixture of elastic fibers and fine collagen fibers interwoven. This arrangement creates tissue that is pliable enough to allow freedom of motion at the joint and strong enough to resist stretching forces.

Ligaments are traditionally described as running in parallel to the muscles. Their

function is to provide support to the joint at the ends of its range of motion ([figure 1.2](#)).

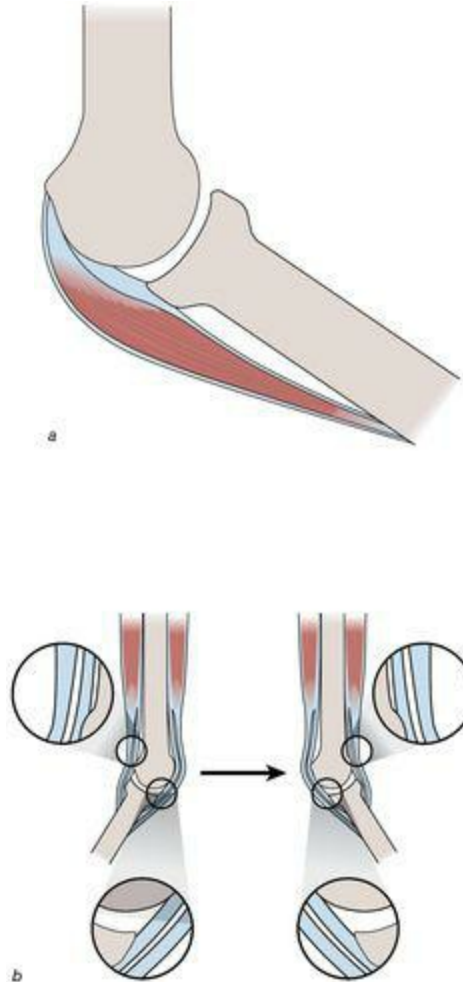
**Figure 1.2** Ligaments are traditionally described as (a) running in parallel to the muscles and (b) functioning primarily when under tension at the end of a joint's range of motion.



Reprinted, by permission, from J. Van der Wal, 2009, "The architecture of the connective tissue in the musculoskeletal system - an often overlooked functional parameter as to proprioception in the locomotor apparatus," *International Journal of Therapeutic Massage & Bodywork* 2(4): 9.23.

As our understanding of the role of fascia throughout the body has deepened in recent years, many of our classic explanations are being challenged. Dutch osteopath and anatomist Jaap van der Wal has published a research paper that looks at the body from an architectural perspective rather than the typical anatomical dissection perspective (2009). He describes ligaments, based on his observations during careful dissections, as being continuous with the fascial sleeve in which muscles run; therefore, they are considered to run in series with muscle tissue and not as parallel, but separate, entities. Ligaments appear to provide support to the joint structure throughout the joint's range of motion. Van der Wal coined the term *dynamant* ("dynamic ligament") to more clearly describe the function of ligaments that form synovial joints ([figure 1.3](#)).

**Figure 1.3** (a) Van der Wal coined the term *dynamment* (“dynamic ligament”) to describe muscles and ligaments that run in series with each other. (b) The dynamment is under tension and provides support in all joint positions.



Reprinted, by permission, from J. Van der Wal, 2009, “The architecture of the connective tissue in the musculoskeletal system - an often overlooked functional parameter as to proprioception in the locomotor apparatus,” *International Journal of Therapeutic Massage & Bodywork* 2(4): 9.23.

Even as our understanding of the structure and function of ligaments broadens to include this architectural viewpoint of the transmission of forces across joints, we must still be cautious with stretching. Ligamentous tissue has a different ratio of collagen to elastic fibers than does tendinous tissue. Ligaments provide the majority of resistance to movement at the end range of a joint. If they are repeatedly overstretched, they lose their ability to return to their normal length and to stabilize the joint. This creates joint laxity and sets the stage for joint injury.

## Tendons

In light of our discussion of fascia in the previous section, we must acknowledge

that this discussion of tendons as separate structures is merely a convenient fiction to help us think about them. Tendons join muscles to bones. Traditional anatomy describes tendons as being formed by closely packed bundles of collagen fibers that run parallel to the muscle and in its direction of pull. The primary function of tendons is to transmit the contraction forces of muscles to the bones, thereby creating movement.

The structure of many tendons shows a wavy configuration (crimp), giving them elastic properties that allow them to act as springs (i.e., they can store energy when stretched and release it when they spring back). Although tendons have these elastic properties, once the crimp has been stretched and the tendon is taut, it is not designed to continue stretching, so we must be cautious not to overstretch tendons.

## Muscles

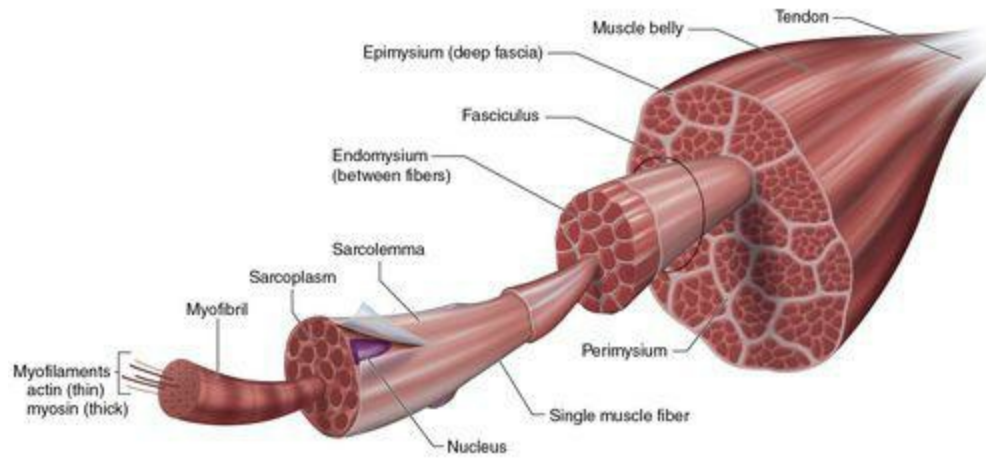
Muscle tissue is made up of closely packed contractile proteins called myofibrils that have the ability to shorten, causing the muscle to contract. This contraction force is transmitted to the muscle tendons, which pull on the bones to cause movement.

Muscles are classified into three main types: smooth, cardiac, and skeletal. Our main interest in the discussion of stretching and strengthening is skeletal muscle.

Skeletal muscles are connected to bones via tendons (and muscle fascia) and act as movers or as stabilizers. Skeletal muscles are under conscious control and are sometimes referred to as voluntary muscles.

Muscle tissue ([figure 1.4](#)) is made up of individual muscle fibers, each wrapped in a connective tissue layer called the endomysium. Groups of these individual fibers, called fascicles, are bundled and held together by a second layer of connective tissue called the perimysium. Finally, bundles of fascicles are bundled and held together by a third layer of connective tissue called the epimysium (part of the overall deep fascia network). This epimysium layer surrounding the entire muscle converges at each end of the muscle belly to form the tendons that attach the muscle to the bones.

**Figure 1.4** Skeletal muscle is made up of bundles of bundles of fibers.

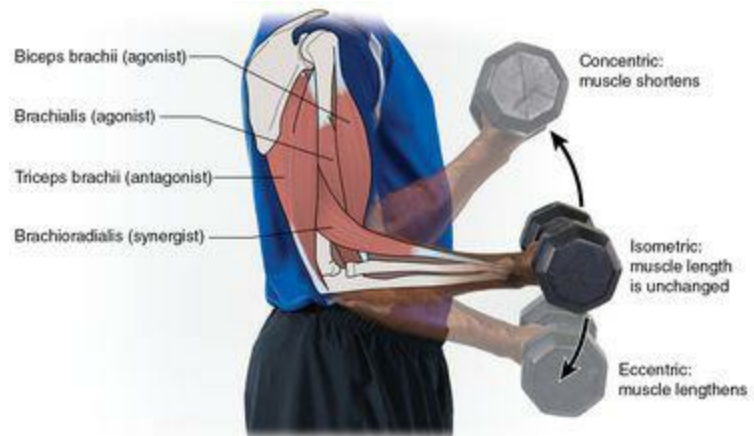


## Muscle Interactions

Muscles work together to create movement or to maintain posture. Muscles can be categorized into groups—agonists, antagonists, and synergists—based on their function in achieving specific results ([figure 1.5](#)). These categories are another artificial construct, since the muscles are all fascially connected and interacting with one another during any movement activities.

- Agonist muscles, also called prime movers, are the main muscles that generate a specific movement at a joint. For example, the biceps flexes the elbow and is considered the agonist for this movement.
- Antagonists are defined only in relation to agonists. Antagonist muscles act in opposition to the movement generated by agonist muscles. Because muscles can generate only a pulling force, once contracted they need an outside force to return them to their resting length. For this reason, agonists and antagonists are typically found in pairs that cause either flexion and extension, adduction and abduction, or internal and external rotation. In the elbow flexion example just used, the triceps is the antagonist to the biceps.
- Synergists are “helper” muscles. They help the agonist (prime mover) achieve a desired movement by stabilizing the joint, steering the movement within the correct plane of motion, or completing the movement initiated by the agonist. In elbow flexion, the brachioradialis acts as a synergist.

**Figure 1.5** Muscle interactions (agonist, antagonist, and synergist) and muscle contractions (concentric, isometric, and eccentric).



## Muscle Contractions

Two types of muscle contractions, isotonic and isometric, are of special interest to us in our discussion of stretching. An isotonic contraction is a voluntary muscle contraction that causes movement. There are two types of isotonic contractions: (1) concentric contraction, in which the muscle shortens as it works, and (2) eccentric contraction, in which the muscle resists while being lengthened by an outside force. For example, when you perform an arm curl with dumbbells, you're concentrically contracting your biceps. As you lower the dumbbells, you're eccentrically contracting the biceps. In this case, the outside force being resisted is a combination of gravity and the weight of the dumbbells. (An eccentric contraction is also called negative work.) An isometric contraction is a voluntary contraction in which no movement occurs. When you hold a dumbbell in midcurl, you're doing an isometric contraction. [Figure 1.5](#) illustrates these three muscle contractions.

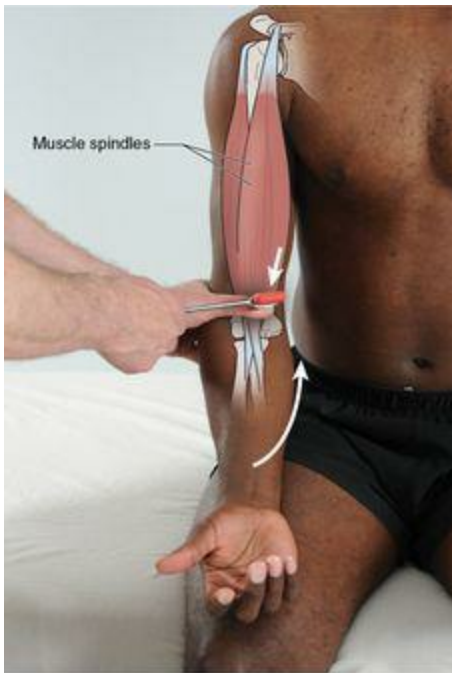
## Reflexes Relevant to Facilitated Stretching

It has been widely believed for many years that a reflex is an automatic, involuntary response to a stimulus. In recent years, the scientific and research communities have reached a broad consensus that reflexes are much more complex and not as automatic as previously believed. In many cases, whether or not a reflex is triggered is task dependent (Hultborn 2001; Zehr 2006). Our current understanding of how reflexes work has had a significant effect on our explanations of why various forms of stretching work, including facilitated stretching. We discuss this more in each section that follows.

### Myotatic Stretch Reflex

In general, the myotatic stretch reflex is thought to prevent a muscle from being overstretched, which helps protect the muscle from tearing and the joint from injury. The myotatic reflex is what you see when a physician tests your reflexes. He strikes your biceps tendon with a small rubber hammer, and your arm automatically bends at the elbow ([figure 1.6](#)). Proprioceptors in the biceps called muscle spindles monitor the length and tension of the muscle. When the muscle lengthens unexpectedly, as happens when the reflex hammer strikes the tendon, the muscle spindles are stimulated and reflexively cause the muscle to contract, which causes the arm to bend. This reflexive contraction—the myotatic stretch reflex—prevents overstretching of the elbow joint and the biceps.

**Figure 1.6** A representation of the muscle spindles, which mediate the myotatic stretch reflex.



As it turns out, the stretch reflex may be strong, weak, or absent, depending on the situation. Whether the reflex is initiated depends on a number of conditions, including the speed and distance the muscle is stretched; whether the stretch is occurring because the opposing muscle is contracting; and whether the opposing muscle is inactive, as in the hammer reflex example just given.

### **Inverse Stretch Reflex**

As described in classic anatomy and physiology textbooks, the inverse stretch reflex (also called autogenic inhibition) is mediated by stretch receptors known as Golgi tendon organs (GTOs), which are located at the musculotendinous junction area and in the muscle tendon. Traditional PNF theory includes discussion of the inverse stretch reflex and its supposed effects after an isometric contraction. The common belief has been that GTOs monitor the load on the tendon. If the load becomes too great, the GTOs are stimulated. In turn, they were thought to cause the muscle to relax through autogenic inhibition.

It seems clear now that although the GTOs do monitor muscle tension, they do not mediate the inverse stretch reflex, if such a reflex even exists (Chalmers 2004). Scientists are still trying to understand GTOs and believe their effect is task dependent; they may inhibit or excite the muscle in which they're located, as well as affect neighboring muscles. As we said earlier, reflexes are much more complex than

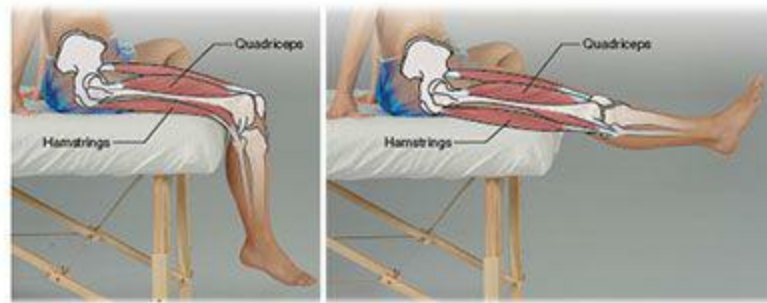
previously explained.

Facilitated stretching techniques were originally developed to take advantage of the muscle inhibition effect of the inverse stretch reflex. Although it appears that this reflex does not occur during facilitated stretching, the research evidence is not yet conclusive. In addition, practical experience has shown that a postisometric effect occurs after an isometric contraction, and this effect allows the muscle to stretch more easily. For this reason, we continue to practice this form of stretching as designed, even if we cannot fully explain why it is effective.

## **Reciprocal Inhibition**

Sir Charles Sherrington's research in the mid-20th century helped develop a model for how the neuromuscular system operates (Sherrington 1947). The textbook explanation of his law of reciprocal innervation (also called reciprocal inhibition) described a reflex loop mediated by the muscle spindles. During a concentric muscle contraction, reciprocal innervation was thought to inhibit the opposing muscle. This inhibition would allow movement to occur around a joint. For instance, when the quadriceps muscle contracts, the hamstrings would be reciprocally inhibited, thereby allowing the knee to straighten ([figure 1.7](#)). If this reflex loop is not functioning well, the muscles could be working against each other, and the movement might become difficult or be compromised.

**Figure 1.7** Reciprocal inhibition. When the quadriceps contract, the hamstrings may be inhibited, allowing the knee to straighten easily.



Although reciprocal inhibition can be seen under experimental conditions, in real life it is much more complex. It is more likely to occur when necessary, as during joint movement, and to not occur when undesirable, as in joint stabilization, when we need to have opposing muscles cocontracting. Reflexes are now seen as task dependent rather than as automatic, involuntary reactions that always occur the same way.

Facilitated stretching techniques were originally developed to take advantage of the effects of reciprocal inhibition on the muscle to be stretched (target muscle). However, we can't be sure it's occurring during facilitated stretching; the research evidence is not yet conclusive. For this reason, we continue to practice this form of stretching as designed, even if we cannot fully explain why it is effective.

## Types of Stretching

A wide variety of stretching techniques are used today, some of which have been developed for specific sports or activities. Stretching can be broadly categorized as passive, active, or assisted. Some of these categories can be further subdivided, based on their movement characteristics, into static, ballistic, and dynamic.

### Passive Stretching

In passive stretching, the stretcher keeps the target muscle relaxed as an outside force applies the stretch. This outside force can be applied by the stretcher assuming a specific position or by a partner moving the limb through the stretch as the stretcher keeps the target muscle relaxed.

### Static Stretching

Static stretching was popularized by Bob Anderson in his classic book *Stretching* (2000). The muscle to be stretched (target muscle) is lengthened slowly (to inhibit firing of the stretch reflex) and held in a comfortable range for 15 to 30 seconds ([figure 1.8](#)). As the position is held, the feeling of stretch diminishes, and the stretcher moves gently into a deeper stretch and holds again.

**Figure 1.8** Hamstrings static stretch. (a) The stretch begins and (b) deepens after 15 to 30 seconds.



## Partner-Assisted Passive Stretching

Passive stretching with a partner is often used to increase flexibility at the extremes of ROM, as in gymnastics, where maximum flexibility is crucial for performance. It may also be used when active movement causes pain. Done carelessly or with poor form, partner-assisted passive stretching can cause muscle injury because the partner cannot feel the sensations of the stretch and may overstretch the muscle. This form of stretching requires proper training and good communication between the stretch and the partner. The directional arrow in [figure 1.9](#) illustrates the partner applying a passive stretch to the stretch's hamstrings.

**Figure 1.9** Partner-assisted passive stretching: The partner stretches the hamstrings without assistance from the stretcher.



## **Active Stretching**

Active stretching means the stretcher is doing the work instead of having a partner do it. Except in the case of ballistic stretching, active forms of stretching are generally considered safer than passive stretching because the chances of overstretching and causing injury are greatly reduced when the stretcher controls the force and duration of the stretch.

## **Ballistic Stretching**

Ballistic stretching is performed using rapid, bouncing movements to force the target muscle to elongate. Ballistic stretching is generally out of favor because it may elicit a strong myotatic stretch reflex and leave the muscle shorter than its prestretch length. Beaulieu (1981) asserts that ballistic stretching creates more than twice the tension in the target muscle than a static stretch does. This increases the likelihood of tearing the muscle because the external force lengthening the muscle opposes the internal shortening force produced by the stretch reflex, resulting in excessive tension in the muscle and tendons.

## **Dynamic Stretching**

Dynamic flexibility refers to the ability to actively move a limb through its full ROM. Dynamic stretching is usually performed as part of a warm-up before exercise and typically includes those muscles involved in the exercise or activity to be performed. Also called dynamic range of motion (DROM), dynamic stretching is

achieved by moving a limb in a slow and controlled manner through its full available ROM ([figure 1.10](#)). As the dynamic motion is repeated, the speed of the movement increases, as does the available ROM (Murphy 1994). Dynamic stretching differs significantly from ballistic stretching because there are no bouncing or jerky movements, only controlled swings of the limb through its comfortable range.

**Figure 1.10** Dynamic stretching is characterized by controlled swings of a limb through its comfortable range of motion.



## Active Assisted Stretching

Active assisted stretching combines active movement by the stretcher with help from a partner, either to add passive stretch or to provide resistance to motion. Techniques in this category that incorporate specific muscular contractions before the stretch are sometimes called precontraction stretching. Facilitated stretching falls into this category, as do a number of other techniques, such as those described next.

## Muscle Energy Technique

Muscle energy technique (MET) developed in osteopathy about the same time that proprioceptive neuromuscular facilitation (PNF) was evolving in physical therapy. According to Chaitow (2006, p. 3), “while muscle energy techniques (MET) target the soft tissues primarily, they can also make major contributions towards joint mobilisation.” Like PNF techniques, MET uses an isometric contraction of the target muscle before the stretch. Muscle energy technique, however, uses only minimal force during the isometric phase. The stretch is most often done passively. Because MET developed in osteopathic medicine, its primary goal is joint mobilization, which is not a goal of PNF techniques.

Some variations or refinements of MET include the following:

- **The Lewit technique (PIR).** Dr. Karel Lewit, a Czech neurologist, refers to his method as PIR, or postisometric relaxation, referring to the decreased resistance of a muscle to stretch after an isometric contraction (Lewit 1999). PIR was thought to

be a form of autogenic inhibition, mediated by the GTOs, but that premise has been abandoned for the same reasons we outlined earlier. Lewit's technique focuses on relaxing hypertonic muscles to reduce pain; any increase in ROM occurs because more slack has been achieved in the tissue, not because of stretching.

- **Reciprocal inhibition (RI) stretching.** Reciprocal inhibition refers to a neurological reflex that may cause one muscle to relax when its opposing muscle contracts. RI stretching is used to stretch a target muscle by first contracting the opposing muscle. This contraction is thought to inhibit the target muscle neurologically and allow it to be stretched farther. Although reciprocal inhibition may not occur every time a muscle is activated, RI stretching can still be effective. Sport massage therapists often use RI stretching as a technique to relieve muscle cramps in athletes after strenuous effort. The therapist has the athlete isometrically contract the muscle opposite the cramping one, reciprocally inhibiting the cramping muscle, which then relaxes.

### **Active Isolated Stretching**

Active isolated stretching (AIS) was developed by Aaron Mattes and is detailed in his book by the same name (Mattes 2000). This method uses active movement and RI, but not isometric work, to achieve greater flexibility. This type of stretching can also be performed with a partner as an active assisted technique. Mattes recommends isolating the muscle to be stretched and then actively lengthening it to a point of light irritation. He suggests holding this position for no more than 2 seconds before returning the limb to the starting position. This sequence is usually repeated 8 to 10 times. This stretching protocol is thought to prevent the stretch reflex while activating RI, thereby allowing the target muscle to lengthen more easily.

### **PNF Stretching**

PNF stretching techniques are a small component of the entire PNF repertoire as used in clinical or sports medicine settings. The stretching work has been expanded and modified over the years to include single-plane stretches as well as the classic spiral-diagonal patterns of PNF. These are described in more detail in chapter 2.

Facilitated stretching is based on the principles of PNF and is one of several variations of PNF stretching. Other versions of PNF stretching are referred to as modified PNF (Moore and Hutton 1980; Cornelius and Craft-Hamm 1988), NF (Surburg 1981), and scientific stretching for sports (3S technique; Holt 1976).

## **Guidelines for Stretching**

Proponents of stretching claim it helps prevent injuries, prevents soreness, improves performance, promotes body awareness, stimulates blood flow, and is mentally relaxing and centering. Opponents argue that stretching is a waste of time, can actually cause injury, and does nothing to improve performance or prevent soreness or injuries. Each side has a multitude of studies, reports, and anecdotal evidence to support its claims. While researchers advance the scientific investigation of stretching, the discussion regarding the benefits versus the risks of stretching continues on the playing field and in gyms, training rooms, and sports clinics.

Supporters of stretching generally agree that in the best of all possible exercise schemes, the athlete warms up, stretches, exercises, stretches again, and then cools down.

### **Stretch After Warm-Up**

The physiological evidence is clear that warm muscles stretch more effectively than cold ones. A warm-up entails 10 to 15 minutes of light activity, similar to what the exercise or sport will be. This light activity increases blood flow to the muscles and gets them ready to work. Warming up also helps reduce stiffness, making the muscles more supple, so they stretch more easily (Bishop 2003a, b). Grant (1997) discusses other benefits of warming up, including increased production of synovial fluid to lubricate joints, increased oxygen exchange in the muscles, increased rate of nerve transmission, and more efficient cooperation of the muscles around a joint. By warming up first, stretching exercises will be more effective and efficient, the athlete will make greater gains than if stretching cold, and the risk of injury from stretching is greatly reduced.

### **Stretch Twice**

In an ideal world, stretching would be included as part of the warm-up before exercise and as part of the cool-down after exercise. The reasoning behind stretching twice goes like this:

- Stretching the muscles before a workout gets them ready to perform at their optimal length. This optimal length allows the muscles to develop the most power as they work. There is a preponderance of evidence that some types of stretching immediately before athletic activity may decrease explosive power and speed (Simic, Sarabon, and Markovic 2013; Behm and Chaouachi 2011). Research on the

effects of preactivity stretching on endurance has not been definitive. Erring on the side of caution, most fitness professionals now recommend that preactivity stretching be confined to dynamic stretching as part of an overall warm-up routine.

- Stretching the muscles after exercise while they're still warm brings them back to their optimal resting length. As muscles work they repeatedly contract and shorten, and they tend to stay short when the workout is over unless they're stretched again to their normal resting length. Postexercise stretching can be incorporated into the cool-down.

## **Stretch Once**

If time is limited, we recommend skipping the preexercise stretching and concentrating on postexercise stretching. When preexercise stretching is eliminated, the warm-up routine before the main workout needs to be thorough. Postexercise stretching will return tight, tired muscles to their normal resting length as you go about the remainder of your daily activities. In postexercise stretching, there is some danger of overstretching the muscles because they may be too pliable. But if postexercise stretching is done with awareness, the risk is minimal and is far outweighed by the benefits.

## **Stretch Without Pain**

We believe that stretching must be completely comfortable to be effective. In our experience, many people stretch incorrectly, believing that if something doesn't hurt a little, it's not working. It's a variation on the "no pain, no gain" mentality of exercise. Stretching until it hurts triggers the nervous system's natural response to pain: The muscle will resist lengthening to prevent possible injury to the tissue being stretched.

We advocate stretching the muscle just to its soft-tissue barrier—that is, the point at which you begin to feel some resistance to further stretching but no discomfort. The soft-tissue barrier is the starting point for the stretch.

"Stretch without pain" also applies to the rest of the body during a specific stretch. Even if you have no pain in the muscle you're stretching, pain or discomfort elsewhere in your body will negatively affect your results. For example, if you're having low back pain while you stretch your quadriceps, you won't be able to relax and fully engage in the stretch. Repositioning to relieve your back pain makes the quadriceps stretch more effective.

## **Remember That Flexibility Varies**

Experienced stretchers are acutely aware that flexibility varies from day to day and

from joint to joint. It's important to take each day as it comes and stretch as best you can. Just as those who change their diets to lose weight are advised not to step on the scale daily, you cannot measure improvement in flexibility daily; you are better off looking at your gains over the long term.

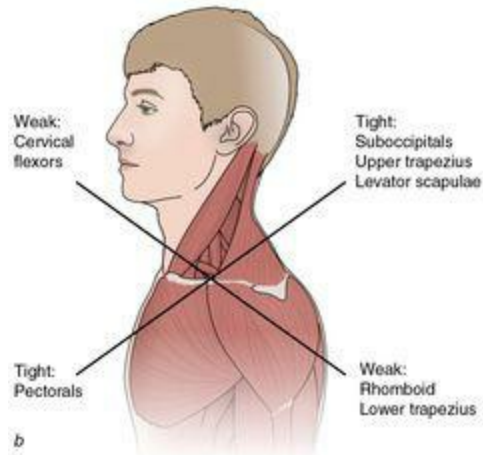
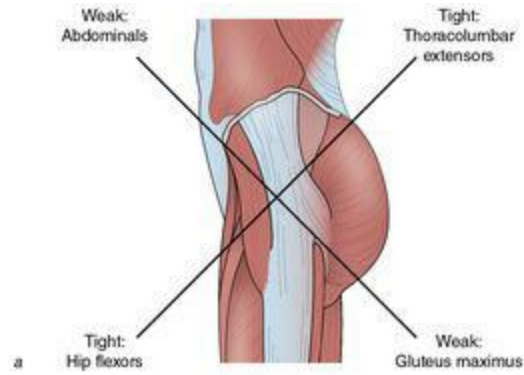
## Recognize When to Stretch and When to Strengthen

Stretching tight muscles is a pleasurable activity when done correctly. But not all tight muscles need to be stretched. Some are already overstretched and need to be strengthened instead. The following paragraphs deal with the differences between hypertonic and eccentrically stressed muscles, called crossed syndrome, and the effects of neurological inhibition on muscle balance. This is a brief discussion of a complex topic, which we urge you to explore more fully in other writings devoted to the subject (Lewit 1999; Chaitow 2006; Liebenson 2006).

- **Hypertonic muscles.** When a muscle is short and tight because of habitual concentric contraction, it's called hypertonic. Myers (2008) refers to this as "locked short." A good example of short and tight can be found in the pectoralis major. Because most of us spend so much time sitting in front of computers, driving, or doing other activities that use our arms in front, the pectoralis muscles can become chronically hypertonic. Hypertonic muscles tend to feel fat or thick and tight to palpation. Stretching these muscles can help restore them to normal tone and length.
- **Eccentrically stressed muscles.** When a muscle is overstretched (usually due to postural stress), it will also feel tight; but instead of being short and tight, it is long and tight, or "locked long" (Myers 2008). It stays in a state of eccentric contraction, in which it constantly works to try to return to its normal length. The rhomboids provide a good example of muscles under eccentric stress. Most of us tend to be a little round shouldered. Hypertonic pectoralis muscles contribute to this posture. As a result, the rhomboids, which attach to the spine and the shoulder blades, are always fighting to counteract the force of the pectoralis muscles and pull the blades back to their normal position. The resulting eccentric stress causes the rhomboids to feel tight and sore to palpation. Muscles under eccentric stress tend to feel thin or stringy and tight. The correction for this condition is not to stretch the rhomboids but to strengthen them and to stretch the pectoralis muscles to restore balance between the chest and the back.
- **Crossed syndrome.** Similar patterns of muscle imbalance can be found elsewhere in the body. Czech researcher Vladimir Janda (1983) describes these patterns of imbalance as upper and lower crossed syndromes ([figure 1.11](#)).
- **Muscle weakness due to inhibition.** Even though Sherrington's law of reciprocal

inhibition does not universally apply as previously believed, our experience with patients has taught us to act as if hypertonic muscles have a reflexive inhibitory effect on their opposing muscles. To use the pectoralis muscles and the rhomboids again as an example, when the pectoralis muscles are locked short, they not only contribute to the eccentric stress on the rhomboids by mechanically pulling against them but also appear to neurologically inhibit the rhomboids, making them less able to exert their normal strength to maintain postural balance. It is common to find that the rhomboids regain much of their normal strength and tone spontaneously after the pectoralis muscles are released through stretching. The same scenario is seen in many areas of the body. Because of this, we believe that stretching work should precede strengthening when one is trying to correct postural imbalances.

**Figure 1.11** Muscle imbalances found in (a) lower and (b) upper crossed syndrome.



## Chapter Summary

It's important to have a clear understanding of the primary elements involved in any stretching technique before proceeding to the specifics of facilitated stretching. These elements include

- the soft tissues affected by stretching including connective tissue, fascia, ligaments, tendons, and muscles;
- muscle interactions (agonist, antagonist, and synergist);
- muscle contraction types (isometric, isotonic concentric, and isotonic eccentric); and
- stretch reflexes (myotatic stretch reflex, autogenic inhibition, and reciprocal inhibition).

The wide variety of stretching styles can be divided into broad categories of passive or active techniques and then further divided based on their specific application.

Certain guidelines apply when using any stretching technique. These include proper warm-up, whether to stretch before and after activity, stretching without pain, and knowing when to stretch and when to strengthen.

# Chapter 2

## Focusing on Facilitated Stretching

Most of us agree that stretching is an important part of training for any sport. Beyond sport, stretching is useful for maintaining general flexibility for daily activities and as preventive maintenance in repetitive-motion activities. As we saw in chapter 1, there are many ways to stretch, from the overall stretches we do naturally to specific techniques found in the many books, DVDs, videos, and online sources available today.

Facilitated stretching is a technique based on the theories and principles of proprioceptive neuromuscular facilitation (PNF), originally developed as a physical therapy modality. Elements of PNF are now widely used in athletic training rooms, in sports medicine clinics, and in personal training.

It's important to remember that PNF stretching techniques are a small component of the entire PNF repertoire used in physical therapy and sports medicine clinics. The stretching work has been expanded and modified over the years in training rooms, fitness facilities, and sports massage clinics to include single-plane stretches as well as the classic spiral–diagonal patterns of PNF. PNF stretching techniques are described in several contemporary texts (Andrews, Harrelson, and Wilk 2004; Baechle and Earle 2008; Kisner and Colby 2002) and in much of the research literature as primarily a passive stretching technique (i.e., the practitioner moves the limb for the stretcher).

Before moving on to facilitated stretching, we'll begin by discussing the history of PNF and reviewing its spiral–diagonal movement patterns.

## PNF History

PNF (proprioceptive neuromuscular facilitation) is a physical therapy technique that seeks to enhance neuromuscular function by activating proprioceptors through targeted muscle contractions. According to Adler, Beckers, and Buck, “the goal of PNF techniques is to promote functional movement through facilitation, inhibition, strengthening, and relaxation of muscle groups” (1993, p. 17).

Herman Kabat, MD, PhD, and two physical therapists, Margaret “Maggie” Knott and Dorothy Voss, developed PNF in the mid-20th century. Kabat, a neurophysiologist, based much of the theoretical structure of PNF on the work of Sir Charles Sherrington, whose research in the early to mid-1900s helped develop a model for how the neuromuscular system operates (Sherrington 1947). Dr. Kabat believed that the principles of neurophysiological development and Sherrington’s laws of irradiation, successive induction, and reciprocal innervation should be applied in the rehabilitation of polio patients with paralysis. Before the development of PNF techniques, paralyzed patients had been rehabilitated using methods that emphasized “one motion, one joint, one muscle at a time” (Voss, Ionta, and Myers 1985).

With backing from industrialist Henry Kaiser, Dr. Kabat founded the Kabat-Kaiser Institute (KKI) in Washington, DC, in 1946 and began working with patients with paralysis to find combinations and patterns of movement that were consistent with neurophysiological theory. By 1951, Kabat and Knott had identified and established nine techniques for rehabilitating muscles.

Physical therapist Dorothy Voss became interested in PNF in 1950 as she learned from and worked with Knott. She was hired as Knott’s assistant in 1952. Voss and Knott realized that PNF was more than a system for the treatment of paralysis; it was a new way of thinking about and using movement and therapeutic exercise.

In 1952 Knott and Voss began presenting workshops to train other physical therapists in PNF methods. By 1954 they were conducting two-week training programs, and in 1956 they published the first edition of *Proprioceptive Neuromuscular Facilitation*.

During the 1960s, PNF courses became available through physical therapy departments at several universities, and their popularity continued to grow. Now PNF techniques are taught in most physical therapy programs in the United States and in many collegiate exercise science and rehabilitation science programs.

## PNF Basis: Spiral–Diagonal Movement

PNF is based on spiral–diagonal movement. Kabat and Knott observed that normal movements seen in sports and physical activities are spiral–diagonal in nature. They defined these “mass movement patterns” as “various combinations of motion . . . [that] require shortening and lengthening reactions of many muscles in varying degrees” (Voss, Ionta, and Myers 1985, p. 1). The spiral–diagonal character of normal movements arises from the design of the skeletal system and the placement of the muscles on it. The muscles spiral around the bones from origin to insertion, and therefore, when they contract, they tend to create that spiral in motion. The motions required when you comb your hair, swing a golf club, or kick a ball all have spiral (rotational) and diagonal components—that is, they occur not in straight lines but through several planes of motion. Consider the golf swing, a complex pattern of motion that requires the ability to move through several planes of motion simultaneously. At any given moment in the swing, we can identify the spiral and diagonal nature of the movement ([figure 2.1](#)). Limitations in range of motion in any aspect of the movement will have a negative effect on the player’s game.

**Figure 2.1** The spiral–diagonal nature of the golf swing requires movement through several planes of motion simultaneously. *(a)* At the height of the backswing of a right-handed golfer, the right shoulder is flexed, abducted, and externally rotated while the left shoulder is flexed, adducted, and internally rotated. *(b)* At follow-through, we see the spiral–diagonal patterns in both the arms and the legs.



# PNF Stretching Techniques

In the years since Knott and Voss developed and published their work, practitioners in a variety of settings have adapted and expanded the techniques. This evolution was inevitable. However, the process has generated significant confusion in the terminology used, the description of the techniques, and the application of the techniques for stretching. There is general agreement that four main stretching techniques have emerged from PNF:

- Agonist contraction (reciprocal inhibition stretching)
- Contract-relax stretching
- Hold-relax stretching
- Hold-relax-agonist-contract stretching

These four are referred to as active inhibition techniques (Gallo 2012) because they're based on the premise that neurological inhibition (from either isotonic or isometric contractions) will relax the contractile elements of the target muscle, and this relaxation will cause the muscle to exert little or no resistance to lengthening during the stretch phase.

In chapter 1, we discuss the interactions of muscles and define agonists and antagonists. It's beneficial at this point to look more closely at these terms as they relate to PNF stretching. The premise of any stretching technique is that tight muscles are limiting range of motion. For instance, if hip flexion is limited, we assume that tight hip extensor muscles (hamstrings and gluteus maximus) are preventing full range in hip flexion, and therefore, stretching the hamstrings and glutes will improve hip flexion. In this example, the hip flexor muscles are the prime movers, or agonists. The tight hip extensors, preventing full hip flexion, are the antagonists.

## **Agonist Contraction (Reciprocal Inhibition Stretching)**

Agonist contraction is usually grouped with other PNF stretching techniques, although it is not described in Voss, Ionta, and Myers' classic textbook on the subject (1985). Agonist contraction (AC) is the least complex of the active inhibition techniques. It's typically performed as a single-plane, single-muscle stretch. There are significant differences in how this technique is named and described in the literature, where it's also called reciprocal inhibition stretching, active stretching, and dynamic range of motion (DROM) stretching.

The practitioner initiates the AC technique by passively moving the limb to its available pain-free end range. Once end range is achieved, the practitioner will back off a few degrees to allow the target muscle to go a little slack. From this position, the

stretcher concentrically contracts the agonist muscle (the muscle opposite the target muscle) to the complete end range (pain free, of course) and holds the contraction for several seconds. This movement to end range is slow and is controlled by the stretcher, with no passive pressure applied by the practitioner.

A variation often seen in practice is for the practitioner to offer mild resistance to the concentric contraction of the agonist, requiring a stronger effort from the stretcher to reach end range. The premise behind this technique is that the concentric contraction of the agonist causes reciprocal inhibition in the target muscle, maximizing its stretch.

## **PNF Contract-Relax**

In a clinical setting, contract-relax (CR) is used with patients who exhibit a marked limitation in range of motion. This technique combines isotonic and isometric work in the spiral patterns of PNF.

Using CR, the clinician moves the limb passively in the spiral–diagonal pattern to the point of limitation and then instructs the patient to try to move the limb into the shortened range of the pattern. The clinician strongly resists but allows the rotational component of the pattern, an isotonic contraction. All other directional effort by the patient is isometric. After the contraction, the clinician moves the limb passively in the spiral–diagonal pattern to a new range of motion. After several rounds of CR, the patient is instructed to move actively through the new range of motion.

## **Contract-Relax Stretching**

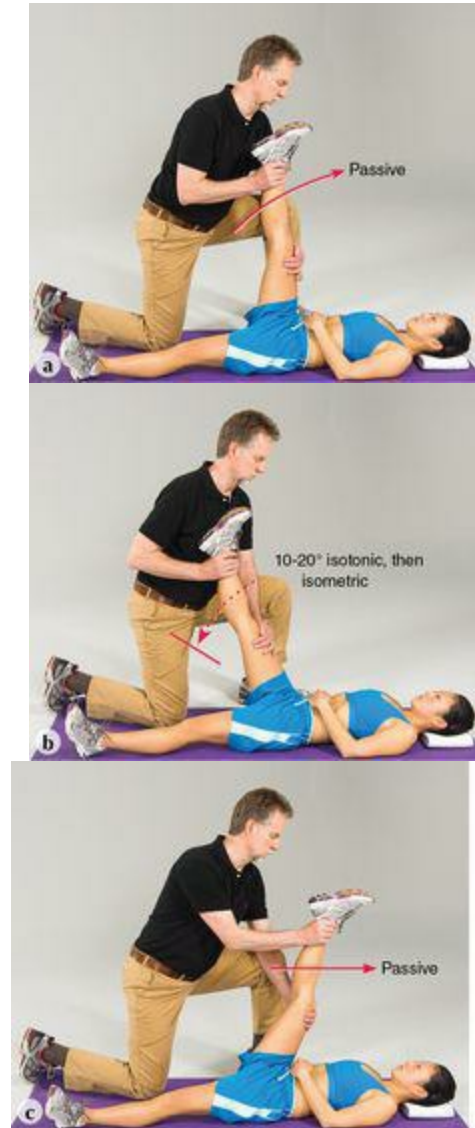
Even though classic PNF makes a distinction between the two, the terms *contract-relax* and *hold-relax* are often used interchangeably in gyms, athletic training rooms, and sports clinics, as well as in much of the research literature. This has led to a variety of descriptions about their application when used outside the physical therapy setting.

Contract-relax stretching (CR) is usually performed as a single-plane stretch, but it can be performed using the spiral patterns of PNF. The main feature of CR stretching is a short-range isotonic contraction of the target muscle, morphing to an isometric contraction before the stretch.

The partner initiates the CR technique by passively moving the limb to its available pain-free end range ([figure 2.2](#)). Baechle and Earle (2008) describe this as a passive prestretch to the point of mild discomfort that is held for 10 seconds. From this starting position, the stretcher initiates an isotonic concentric contraction of the target muscle (or muscle group) as the partner offers moderate resistance. In some descriptions, the partner resists this isotonic contraction strongly enough to allow the limb to move only 10 to 20 degrees into the shortened direction over the course of 5 to 10 seconds. In other descriptions, the partner resists but allows the motion to occur through the same 10 to

20 degrees over a shorter amount of time; the partner then prevents any further motion with an isometric contraction, until 5 to 10 seconds have elapsed. After the contraction phase, the partner moves the limb passively to a new range of motion in the lengthening direction. This sequence can be repeated several times.

**Figure 2.2** The contract-relax stretch for the hamstrings. (a) The partner passively stretches the hamstrings to their pain-free end range. (b) The stretcher initiates an isotonic concentric contraction of the hamstrings as the partner offers moderate resistance through 10 to 20 degrees of motion. The partner then fully resists any additional motion of the leg (an isometric contraction). (c) The partner moves the leg to stretch the hamstrings to a new range of motion.



The premise behind the CR technique is that the sustained contraction of the target muscle, both isotonic and isometric, leads to postcontraction relaxation.

### **PNF Hold-Relax**

In a clinical setting, hold-relax (HR) is generally used if range of motion is extremely limited or if active movement is not available because of weakness or pain.

Using HR, the clinician moves the limb passively in the spiral–diagonal pattern to the point of limitation and then instructs the patient to try to move the limb into the shortened range of the pattern. The clinician strongly resists all three directional efforts by the patient to prevent any movement, generating isometric contractions of the target muscles. After the contraction phase, the clinician moves the limb passively in the spiral–diagonal pattern to a new range of motion. After several rounds of HR, the patient is instructed to move actively through the new range of motion.

## **Hold-Relax Stretching (Postisometric Relaxation)**

As we stated earlier, classic PNF makes a distinction between contract-relax and hold-relax, but the terms are often used interchangeably in gyms, training rooms, and sports clinics, as well as in much of the research literature. This has led to a variety of descriptions about their application outside the physical therapy setting.

Hold-relax stretching (HR; also known as postisometric relaxation) can be performed as single-plane or spiral-pattern stretching. The main feature of HR stretching is an isometric contraction before the stretch. The partner initiates the HR technique by passively moving the limb to its available pain-free end range ([figure 2.3](#)). Baechle and Earle (2008) describe this as a passive prestretch to the point of mild discomfort that is held for 10 seconds. From this starting position, the stretcher initiates a submaximal isometric contraction of the target muscle (or muscle group) as the partner offers appropriate resistance for 5 to 10 seconds. After the contraction phase, the partner passively moves the limb to a new range of motion in the lengthening direction. This sequence can be repeated several times.

The premise behind the HR technique is that the sustained isometric contraction of the target muscle leads to postisometric relaxation.

**Figure 2.3** The hold-relax stretch for the hamstrings. (a) The partner passively stretches the hamstrings to their pain-free end range. (b) The stretcher isometrically contracts her hamstrings to resist the partner's attempt to move her leg farther into flexion. (c) The partner moves the leg to stretch the hamstrings to a new range of motion.



## Hold-Relax-Agonist-Contract Stretching

This technique is a combination of the HR and AC techniques previously described. Although it's not specifically described by Voss, it is similar to the slow-reversal-hold-relax PNF technique. Hold-relax-agonist-contract (HRAC) is the same as the HR technique up to and including the isometric contraction. After the contraction phase, the stretcher is specifically directed to actively move the limb to a new range of motion. At this point, many practitioners also add additional passive stretch to complete the cycle.

The premise underlying the combination of these two techniques is that the combination of inhibitory effects from reciprocal inhibition (from the active motion of the stretcher) and autogenic inhibition (from the isometric contraction) creates the greatest possible increase in range of motion.

## **Facilitated Stretching**

Facilitated stretching is a modified form of the HRAC stretching technique. It specifically promotes the active participation of the stretcher in any movement related to the technique and avoids any passive movement by the partner. In previous editions of this book, we've called facilitated stretching a form of CRAC stretching (contract-relax-agonist-contract) based on our training and understanding of the terminology. In this edition, we've modified our descriptions to align with other authors to more accurately call facilitated stretching a modified form of HRAC stretching.

When using facilitated stretching, the practitioner directs the stretcher to move the limb or body part to the starting position rather than passively moving the stretcher into position. After the isometric contraction, the stretcher actively moves to the newly acquired range of motion without assistance from the practitioner.

Facilitated stretching still relies on the principles and techniques of PNF, including the use of isometric contractions, the isolation of muscles through proper positioning, and the use of the spiral–diagonal patterns. When a partner is involved, the partner's primary responsibility is to monitor and direct the stretcher's activity.

Each of the PNF stretching techniques reviewed in this section have been shown to increase range of motion when used regularly. Throughout this book, we emphasize facilitated stretching because this modified version of HRAC stretching encourages the active participation of the stretcher at each step in the process and discourages passive stretching (at least until all active movement has been achieved).

### **Key Differences in Performing Facilitated Stretching**

- The stretcher actively moves the limb to the beginning position of the stretch. Most PNF stretching techniques are performed passively (i.e., the partner moves the limb to the starting position).
- The stretcher initiates the isometric contraction, and the partner offers only matching resistance. In contrast, in most PNF stretching techniques, the partner will direct the stretcher to “hold” against movement pressure applied by the partner.
- The stretcher actively moves the limb to the new range of motion, and the partner avoids adding any passive stretch until all active motion has been attained.



## Facilitated Stretching Guidelines

Although the basic application of facilitated stretching is easy to learn, there are important, if subtle, factors to understand and master. In this section, we describe an easy-to-remember three-step stretching protocol and then discuss critical elements of the technique that must be applied to achieve optimal results.

### Learn This Three-Step Stretching Sequence

Facilitated stretching incorporates active motion and isometric effort to improve flexibility and enhance motor learning in the process. Simplified, the three steps involved in facilitated stretching are as follows:

1. The stretcher actively moves the limb to lengthen the target muscle (muscle to be stretched, antagonist) to its end range.
2. The stretcher isometrically contracts the target muscle for 6 seconds. The partner offers matching resistance and does not attempt to overcome the stretcher's contraction.
3. After the isometric contraction, the stretcher actively moves the limb again to stretch the target muscle to a new range of motion.

For example, to stretch the hamstrings, the stretcher begins by contracting the quadriceps and psoas (hip flexors) to actively move her leg to the starting position, without assistance ([figure 2.4, a-c](#)). She then isometrically contracts her hamstrings for 6 seconds as the partner provides resistance (see the isometric push arrow in [figure 2.4a](#)). Finally, by contracting the hip flexors again to lift the leg higher, the stretcher actively stretches the hamstrings to a new length (see the active stretch arrow in [figure 2.4c](#)).

**Figure 2.4** Facilitated stretch for the hamstrings. (a) After the stretcher actively moves her leg to stretch the hamstrings to their pain-free end range, the partner supports the leg using proper biomechanics and directs the stretcher to push her leg toward the table or mat. The partner offers resistance only to match the stretcher's isometric contraction of the hamstrings. (b) This photo illustrates an alternative hold position for the partner. (c) The stretcher actively moves into a deeper stretch. The partner does not push the leg.



This three-step sequence of facilitated stretching has been developed over years of clinical practice. It was originally based on the premise that we were activating two neurological effects: reciprocal inhibition and postisometric relaxation.

As discussed in chapter 1, current scientific consensus is that these effects may not consistently occur as previously believed. Unfortunately, we have no firm evidence of the physiological reasons that stretching is so much more effective using facilitated techniques. Research points to several hypotheses: an increased tolerance to stretch or

changes in the viscoelastic properties of the stretched muscle (Chalmers 2002, 2004; Weppeler and Magnusson 2010), or a more complex multifactor interaction that includes some inhibition from Golgi tendon organs, adaptation of the muscle spindle response to stretch, and increased stretch tolerance (Sheard and Paine 2010).

## **Empower the Stretcher to Take an Active Role**

In addition to its effectiveness, there is a deeper philosophical basis for using facilitated stretching over other styles. Passive forms of stretching, in which the partner does the stretching to or for the stretcher, encourage the stretcher to become dependent on a partner. Facilitated stretching is active; and because the stretcher gains flexibility easily using these techniques, she will be more motivated to continue stretching on her own. This helps keep the stretcher from being dependent on someone else. With facilitated stretching, the stretcher learns to do the work for herself and becomes more body aware in the process.

One of the challenges with any stretching technique is maintaining consistent practice. Facilitated stretching is done by the stretcher, and the partner acts only as a facilitator. Self-stretching is emphasized so that the stretcher can do it alone, using a stretching strap, a doorway, or a piece of exercise equipment at the gym to replace the partner. These self-stretching techniques are easy to learn. Also, because the stretcher is motivated when he sees results, and because the techniques engage the mind and the body, he will be much more likely to continue practicing the stretches as part of a home program.

## **Engage Muscles to Improve Neuromuscular Function**

Facilitated stretching is designed to improve the communication between the muscles and the nervous system. The muscles do only what they are told to do by the nervous system. Therefore, this interaction must be clear. When the muscles are actively engaged throughout the routine, learning takes place that allows them to work more efficiently. In passive stretching, this does not occur because the outside force is doing most of the work, with little neurological or muscular involvement required of the stretcher.

## **Use Action Verbs**

In general, during the isometric phase your instruction to the stretcher will be an action verb such as “push,” “pull,” “turn,” “twist,” or “kick.” This communicates clearly what you wish to have happen. If you ask the stretcher to “resist,” you are communicating that you will be doing something to her that she needs to act against. In

fact, you want her to contract the muscle, whose force you, as the facilitator, will resist. The use of action verbs also relates to our discussion of empowering the stretcher to take an active, rather than passive, role in the process.

## **Encourage Normal Breathing**

Muscles need oxygen to work. But we are often in the habit of holding our breath during strong muscular effort. How do we reconcile these two conflicting facts? We think it's more important to breathe, especially because we are not asking for maximal effort on the part of the stretcher during any part of the sequence. Second, holding the breath during the isometric phase is often accompanied by compensatory recruitment of other muscles. And third, there is some risk that holding the breath during muscular contraction may raise the blood pressure. It's easy to monitor the stretcher's breathing and your own throughout the process. We've found that two cycles of normal breathing (in and out) takes about 6 seconds, which is the length of time we want for the isometric contraction.

## **Self-Stretching Principles**

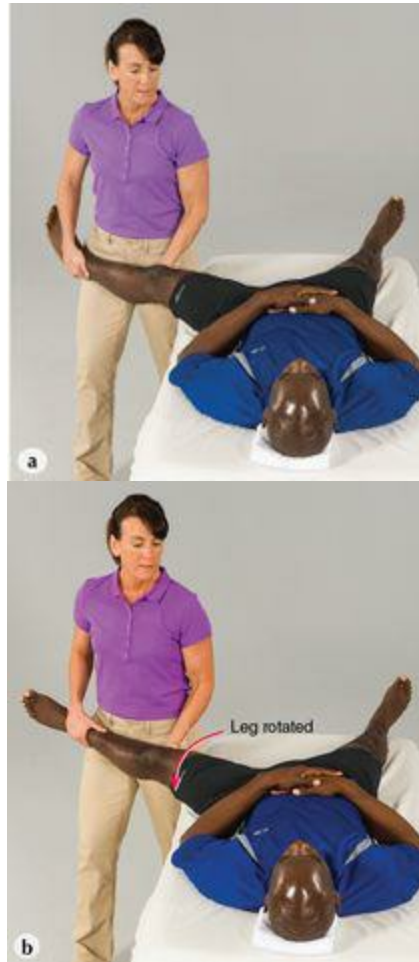
In keeping with the theme of stretcher learning and self-help, our goal is to teach the stretcher to incorporate facilitated stretching into his daily routine without the need to rely on a partner. During partner stretching sessions, the partner can point out compensation patterns, emphasize different aspects of a particular spiral pattern, and fine-tune the technique. In a home program, the learning is reinforced through daily practice, and the stretcher's overall flexibility or rehabilitation (or both) progresses more quickly. For these reasons, most of the stretches presented in this book include a self-stretch version. The principles for self-stretching are identical to the ones for partner work:

- Use proper positioning to isolate the target muscle.
- Use self-stabilization to prevent compensation.
- Breathe correctly.
- Exert appropriate effort during the isometric phase.
- Stretch the target muscle by contracting the opposing muscle.
- Remain pain free throughout the sequence.

## **Recognize the Importance of Positioning**

To achieve the greatest benefit from stretching, the goal is to position the stretcher to isolate the target muscle as much as possible. This isolation ensures that the target muscle is the primary one contracting during the isometric phase and being stretched during the lengthening phase. Although it's impossible to completely isolate and activate only one muscle, careless positioning allows inappropriate muscle recruitment and interferes with achieving optimal results from facilitated stretching ([figure 2.5](#)). Because the stretcher does most of the work in facilitated stretching, it's common to see compensation patterns occurring, especially during the isometric phase. For this reason, we need to pay attention to the stretcher's mechanics and stabilization.

**Figure 2.5** The importance of positioning. (a) Proper position to isolate the target muscles during the supine adductors stretch. (b) Improper position that allows the leg to externally rotate changes the focus to the hamstrings instead of the adductors.



## Be Aware of Compensation Patterns

We all develop compensatory patterns of muscular contraction to make up for muscle weakness or imbalance, postural distortions, structural irregularities, and the like. When performing facilitated stretching, many of these patterns of compensation become obvious. For instance, in facilitating a hamstrings stretch, the stretcher often lifts the hip off the table while isometrically contracting the hamstrings. This unconscious shift engages the gluteus maximus more and is usually the result of a weak hamstring.

By being aware of compensation and working with the stretcher to eliminate it during facilitated stretching, you'll achieve better results on the table or exercise mat, and the stretcher will learn to move more efficiently as she goes about her daily life. Where appropriate, we've indicated the common compensation patterns associated with

a stretch.

It's valuable for the stretcher to take an active role in preventing compensation during the stretching work. This active learning translates into her daily life. If the stretcher can learn to use her gluteus maximus and hamstrings without compensation on the table or mat, then she'll be more likely to carry that new, correct behavior into her everyday activities.

There's another component of greater involvement on the part of the stretcher in stabilizing her motion: the discovery of aspects she has been unaware of. For example, in attempting to stretch the quadratus lumborum, many people are unable to isolate the muscle. They begin recruiting other muscles inappropriately to try to do the simple motion required for the stretch. This discovery enables the partner and stretcher to work together to figure out how to simply contract the quadratus lumborum. The learning that results is extremely useful for the stretcher as she incorporates it into her daily life.

## Detailed Sequence for Facilitated Stretching

As mentioned earlier, facilitated stretching is usually done with a partner, although many of the stretches can be done alone, assisted by accessories. The more detailed steps involved in a partner-assisted facilitated stretch are as follows:

1. The stretcher actively lengthens the muscle to be stretched (the target muscle) to its maximal pain-free end range. This is also called the soft-tissue barrier or stretch barrier. For example, if you wish to stretch the hamstrings, have the stretcher lie on her back and contract her quadriceps and psoas (hip flexors) to actively lift the leg as high as possible, keeping the knee straight. You may need to gently remind the stretcher to hold the knee straight as she lifts her leg. This stretches the hamstrings to their end range (see [figure 2.4a](#)).
2. As the partner, position yourself to offer resistance against the stretcher's isometric contraction of the target muscle. For stretching the hamstrings, support the lower leg against your shoulder (see [figure 2.4a](#)), or hold it with both hands (see [figure 2.4b](#)).
3. Direct the stretcher to begin slowly and “push” or “pull” to isometrically contract the target muscle as you provide matching resistance. Don't allow the stretcher to overpower you. When the stretcher has achieved the proper level of isometric contraction (strong, but not maximum strength), hold it for 6 seconds (two cycles of breathing).
4. After the 6-second contraction, the stretcher relaxes and inhales deeply. During this time, maintain the limb in the starting position.
5. As she exhales, the stretcher contracts the opposing muscles, in this case the quads and psoas, and pulls the target muscle into a deeper stretch (see [figure 2.4c](#)). As the partner, do not push or pull to force the stretch.
6. Now, as the partner, you will move into the new position to once again offer resistance.
7. Repeat the process two or three times.

Facilitated stretches should always be pain free. If the stretcher experiences pain, try repositioning the limb or use less force during the isometric contraction of the target muscle. If pain persists, don't use the technique for that particular muscle until you've determined why it's causing pain.

# Safety Considerations for Facilitated Stretching

Facilitated stretches entail virtually no risk of injury because there is little or no passive movement involved—the stretcher does the work. You act only as a facilitator for the technique and make no attempt to increase the stretch. This factor addresses the concern of some investigators that poorly trained or inattentive partners could cause injury by being too vigorous in moving the limb to a new range of motion (Beaulieu 1981; Surburg 1981).

Stretching safely is of utmost concern for both the stretcher and the partner. Using proper body mechanics is extremely important during all phases of stretching, but especially during the isometric phase. The stretcher and the partner need to plan carefully and communicate freely with each other. The partner may be expending unnecessary energy (because of poor ergonomics) in applying the resistance, or the stretcher may be working too hard. As the partner you can be injured by carelessly using these techniques, and you can develop overuse syndromes unnecessarily.

## Safety for the Partner

When you are acting as the partner during facilitated stretching, you may be at risk for injury if you don't take care of yourself. By paying attention to your posture and body mechanics, you can eliminate the possibility of injury. Remember these points:

- As you work, pay attention to your legs and feet. Use an athletic stance to help you remain balanced and stable, especially as you resist the isometric contraction of the stretcher. Your athletic stance will typically be a modified lunge, with one foot forward and the other back, your pelvis turned toward the line of force. Keep your knees slightly bent, and focus on using your leg muscles. Keep your body weight evenly distributed over both feet, maintain length in your back and neck, and allow your head to sit comfortably over your shoulders ([figure 2.6](#)).
- Be aware of keeping your spine lengthened as you work, instead of collapsing into yourself. This lengthening helps prevent undue stress on your vertebrae.
- Keep your low back area flattened to reduce pressure on your lumbar spine. This will help prevent low back pain. Tighten your abdominal muscles to help keep your back from arching too far.
- Avoid unnecessary twisting or bending. Instead, have the stretcher move to accommodate you.
- Use the large muscles of the trunk and extremities to resist the isometric contraction instead of smaller, weaker muscles. For instance, have the stretcher push against your shoulder rather than your arm during a hamstrings stretch.
- Remember that you control the strength of the stretcher's isometric contraction.

Provide resistance only up to the level that is comfortable for you, and then ask the stretcher to hold at that level of effort. It is not necessary for the stretcher to exert maximal effort for the stretch to be effective.

- To avoid losing your balance when you're acting as the partner, you need to control the session and give the commands so that you're prepared to resist the isometric contraction. Be sure the stretcher begins slowly during the isometric phase.
- Stop immediately if either you or the stretcher has pain, discuss what is happening to determine the cause, and correct the problem before continuing.

**Figure 2.6** Notice the partner's athletic stance, a modified forward lunge with the pelvis turned toward the line of force.



## **Safety for the Stretcher**

When a stretcher is first learning facilitated stretching, it is common for him to work too hard, to lose focus, and to misunderstand the directions for each stretch. To keep the stretcher safe, be sure to proceed slowly, make sure he understands your instructions, and prevent him from overworking.

It's important to be sure that the stretcher is positioned correctly for the stretch, that he is breathing throughout the sequence, and that he is pain free throughout.

## **Reducing Fatigue for Stretcher and Partner**

Because facilitated stretching is an active form of work, it can be fatiguing for both the stretcher and the partner. Preventing fatigue can reduce the chance of injury.

For the stretcher, it's important to remember that maximal effort is not necessary. Only a moderate contraction of the target muscle is needed during the isometric phase. This can be especially important for stretchers who don't participate in a regular exercise program, because they may experience muscle soreness the next day if they work too hard.

For you, the partner, reducing fatigue becomes an issue if you are working with several people throughout the day. Injuries are more likely if you're fatigued. One of the benefits of facilitated stretching is that the stretcher does most of the work. As the partner, your main task is to assist the stretcher, not do the work for her. The stretcher moves the limb into position; you don't have to lift it or support it for her except for brief periods during the sequence. Relax whenever possible during the session, and expend only the effort necessary.

If you're using proper body mechanics, you will usually have a mechanical

advantage when resisting the isometric contraction of the stretcher. This leverage allows you to accomplish your work with minimal physical effort.

## Chapter Summary

In this chapter, we review the history and development of PNF, its focus on the spiral–diagonal nature of movement, and the expansion of PNF stretching techniques beyond physiotherapy into clinical settings, training rooms, and gyms. We discuss the four main types of PNF stretching (AC, CR, HR, and HRAC) and categorize facilitated stretching as a modified form of HRAC stretching. We summarize a three-step process for performing facilitated stretches, offer a more detailed step-by-step protocol, and emphasize the importance of performing the stretches safely and without pain or discomfort. In chapter 3, we take an in-depth look at learning and using the spiral–diagonal patterns of PNF.

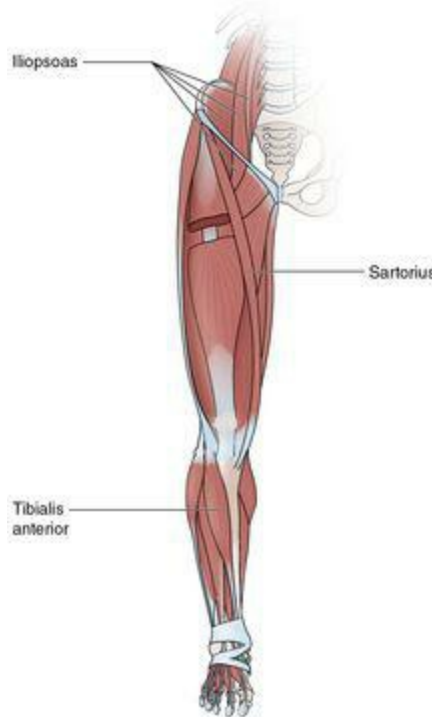
# Chapter 3

## Using the Spiral–Diagonal Patterns of PNF

The PNF modality is based on recognizing and training the spiral–diagonal patterns of movement as identified by the method’s founders. This spiral–diagonal nature of normal movements arises from the design of the skeletal system and the placement of the muscles on it. The muscles spiral around the bones from origin to insertion ([figure 3.1](#)), and therefore, when they contract, they tend to create that spiral in motion. PNF spiral patterns are triplanar, and each pattern includes

- flexion or extension,
- adduction or abduction, and
- medial or lateral rotation.

**Figure 3.1** The attachments of the iliopsoas (psoas major), sartorius, and tibialis anterior muscles facilitate spiral–diagonal motion when the muscles contract.



These spiral components of motion are especially noticeable in the arms, which tend to swing across your body as you walk or run. When the bicep contracts, it not only flexes your elbow but also rotates (supinates) your forearm. Many muscles are actually capable of motion in three planes. For instance, the iliopsoas muscle ([figure 3.1](#)) flexes the hip (the dominant action) but also assists in adduction and external rotation of the femur.

Movement devoid of spiral and diagonal motion looks and feels stiff, awkward, and clumsy. Coordinated, graceful movement can be compromised through outright injury or more insidiously when we limit our movement patterns through habituation.

One of the primary benefits of learning and using the spiral patterns of PNF is to restore or enhance coordinated, graceful movement that incorporates multiple planes and axes of motion.

## When and Why to Use Spiral-Pattern Stretches

The spiral patterns of PNF are used through entire ranges of motion in physiotherapy, occupational therapy, and sports medicine clinics as well as in strength training to increase strength, coordination, and flexibility. Facilitated stretching focuses primarily on improving range of motion at each end of the spiral pattern.

The spiral–diagonal stretches increase the flexibility and coordination of synergistic groups of muscles that act together. Using these three-dimensional patterns lets us stretch groups of muscles simultaneously, thereby gaining greater benefit in a shorter amount of time compared with single-plane stretches.

The patterns can also be used as assessment tools to determine which muscles in a synergistic group are limiting motion, exhibiting weakness, or not firing in the proper sequence. Once these deficiencies are identified, the single-plane stretches can be used along with the patterns to focus on improving the muscular function that needs work.

## Learning the Patterns Through Free Motion

Voss and colleagues (1985) suggest learning the spiral patterns by performing them as free-movement exercises. These give a sense of the natural rhythm of the patterns and let you feel the patterns through a full range of motion. Even though we don't use the full patterns in facilitated stretching, learning them will make it easier to visualize the range of motion you're trying to improve as you incorporate these patterns into stretching.

The patterns can be used to help improve your own coordination and can be made more challenging when you move both arms simultaneously, perform a different pattern with each arm, or add a leg pattern into the mix. Try it and have some fun as you explore the connections between your brain and your muscles.

### Patterns for the Arm

There are two basic PNF patterns for the arm: diagonal one (D1) and diagonal two (D2). Each pattern can be divided into two parts: flexion and extension. The movement sequence for the D1 extension pattern is the exact opposite of the sequence for D1 flexion. The same is true for D2 extension and D2 flexion.

### D1 Pattern for the Arm

Diagonal one (D1) can be divided into D1 flexion and D1 extension. The D1 flexion pattern finishes with the arm in flexion, adduction, and external rotation. When you're sitting in your car and reach your right arm up to grab the seat belt, you're doing a version of D1 flexion ([figure 3.2a](#)). The D1 extension pattern finishes with the arm in extension, abduction, and internal rotation. Continuing with the seat belt example, when you pull the seat belt down and across your lap to click it into place, you're doing a version of D1 extension ([figure 3.2b](#)). The description of D1 makes more sense when you perform the pattern instead of just reading about it. Please take a few minutes now and practice D1 before going on.

**Figure 3.2** The D1 pattern for the arm. (a) The flexion end of D1 (“grab seat belt”) and (b) the extension end of D1 (“fasten seat belt”).



### D1 Practice: Arm

1. While standing, move your right arm up and across your body, with your arm rotated so that the thumb side of your hand points forward, as in [figure 3.2a](#). Specifically, this is flexion, horizontal adduction, and external rotation of the humerus. The right forearm is supinated, and the wrist and fingers are flexed.
2. Go as far in each plane of motion as you can to fully lengthen all the involved muscles. This is the ending position for D1 flexion.
3. From this starting position, slowly rotate and move your arm diagonally down, out, and back to arrive at the same arm and hand position as shown in [figure 3.2b](#). This motion blends internal rotation, abduction, and extension of the humerus; pronation of the forearm; and extension of the wrist and fingers. This is the ending position for D1 extension.

4. From this position, retrace your motion to arrive once again at the flexion end of D1.

### **Practice Makes Perfect**

Repeat these patterns several times with each arm, and then with both together, until you feel the rhythm. What activities use motions like this? Throwing a Frisbee, swinging a golf club or a baseball bat, picking up a hat and putting it on your head, working as a grocery checker, feeding yourself, and using a seatbelt in your car all use patterns of movement that have components of the D1 pattern.

Giving the ends of the two patterns nicknames may help you remember them. Think of D1 flexion, [figure 3.2a](#), as the “grab seat belt” pattern. “Fasten seat belt,” as in [figure 3.2b](#), puts you in D1 extension.

## **D2 Pattern for the Arm**

Diagonal two (D2) uses the diagonal line opposite to that for D1 and is divided into D2 flexion and D2 extension. The D2 flexion pattern finishes with the arm in flexion, abduction, and external rotation. If you were brandishing a sword in the air, you would be doing a version of the D2 flexion pattern ([figure 3.3a](#)). The D2 extension pattern finishes with the arm in extension, adduction, and internal rotation. Continuing with the sword example, if you were placing a sword into its scabbard on your opposite hip, you would be doing a version of the D2 extension pattern (see [figure 3.3b](#)). Once again, the patterns make more sense when you perform them. Please take some time to practice D2 now, before going on.

**Figure 3.3** The D2 pattern for the arm. (a) The flexion end of D2 (“draw sword”) and (b) the extension end of D2 (“sheathe sword”).



### **D2 Practice: Arm**

1. While standing, move your right arm up, out, and slightly behind your body, with your arm rotated so the thumb faces behind you, as in [figure 3.3a](#). This is flexion, abduction, and external rotation of the humerus. The right forearm is supinated, with the wrist and fingers extended.
2. Go as far in each plane of motion as you can to fully lengthen all the involved muscles. This is the ending position for D2 flexion.
3. From this starting position, slowly rotate and move your arm diagonally down and across your body, touching your right thumb to your left hip, ending up in the same position as the model in [figure 3.3b](#). This motion blends internal rotation,

adduction, and extension of the humerus. The forearm pronates, and the wrist and fingers flex. For the sake of practice, you are now at the ending position for D2 extension. (The pattern actually ends with the arm behind and diagonally across the back to ensure that the arm is fully extended and internally rotated.)

4. Now, retrace your motion to arrive back at the flexion end of D2.

### **Practice Makes Perfect**

Repeat these patterns several times with each arm, and then with both together, until they begin to feel natural and easy. What activities use motions like this? Throwing a ball, drawing a sword, using a hockey stick, lifting and stacking, washing windows, and taking a sweater off over your head all use patterns of movement that have components of the D2 pattern.

Again, it may help you remember the ends of the patterns by giving them nicknames. We'll call D2 flexion ([figure 3.3a](#)) "draw sword" and D2 extension ([figure 3.3b](#)) "sheathe sword."

## **Patterns for the Leg**

When you feel competent with the arm patterns, you can move on to the legs. As with the arm, there are two patterns for the leg: D1 and D2. These can also be divided into two parts: flexion and extension. The leg patterns are similar to those for the arms but not identical.

### **D1 Pattern for the Leg**

Diagonal one (D1) can be divided into D1 flexion and D1 extension. The D1 flexion pattern finishes with the leg in flexion, adduction, and external rotation ([figure 3.4a](#)). When you kick a soccer ball, you're likely to end up with your kicking leg in D1 flexion. The D1 extension pattern finishes with the leg in extension, abduction, and internal rotation ([figure 3.4b](#)). During walking and running, as your back leg pushes off the ground, it's likely to be in the D1 extension pattern. Active practice will make this easier to understand. You'll find it easier to do this practice if you hold onto something for balance and support.

**Figure 3.4** The D1 pattern for the leg. (a) The flexion end of D1 (“soccer kick”) and (b) the extension end of D1 (“toe-off”).



### D1 Practice: Leg

1. While standing, move your right leg forward and across your body, rotating the leg so your foot points to the right. This is flexion, adduction, and external rotation of the femur; dorsiflexion and inversion of the foot; and extension of the toes.
2. Go as far in each plane of motion as you can to fully lengthen all the involved muscles. This is the ending position for D1 flexion. Check your position against that shown in [figure 3.4a](#).
3. Slowly swing the leg, beginning with internal rotation, to end up with the leg behind and away from your body, with the foot pointing to the left. This is extension, abduction, and internal rotation of the femur; plantar flexion and eversion of the foot; and flexion of the toes. Compare your position with that of the model in [figure 3.4b](#). This is the ending position for D1 extension.

4. From this position, retrace your motion to return to the flexion end of D1.

### **Practice Makes Perfect**

Swing your leg through this pattern several times to feel the rhythm of it. Many athletic activities require aspects of the D1 pattern. Dancers, skaters, and soccer players, to name a few, all need coordination and flexibility through the D1 pattern. We call D1 flexion ([figure 3.4a](#)) the “soccer kick.” You can remember D1 extension ([figure 3.4b](#)) as “toe-off.”

## **D2 Pattern for the Leg**

Diagonal two (D2) uses the diagonal line opposite to the D1 pattern and is also divided into D2 flexion and D2 extension. The D2 flexion pattern ends in flexion, abduction, and internal rotation of the leg ([figure 3.5a](#)). Skiers will recognize this as the snowplow position. The D2 extension pattern ends in extension, adduction, and external rotation ([figure 3.5b](#)). Ballet dancers will recognize this as being similar to fifth position. Active practice makes it clearer.

**Figure 3.5** The D2 pattern for the leg. (a) The flexion end of D2 (“snowplow”) and (b) the extension end of D2 (“fifth position”).



### D2 Practice: Leg

1. While standing, move your right leg forward and out away from your body, rotating the leg so your foot points to the left. This is flexion, abduction, and internal rotation. The foot is dorsiflexed and everted, and the toes are extended.
2. Go as far in each plane of motion as you can to fully lengthen all the involved muscles. This is the ending position for D2 flexion. Compare your position to that of the model in [figure 3.5a](#).
3. Slowly swing your leg behind and across your body, rotating the leg externally. This is extension of the femur. The foot is plantar flexed and inverted, and the toes are flexed.
4. Go as far in each plane of motion as you can to fully lengthen all the involved muscles. You've achieved the end of D2 extension. Check your position with that shown in [figure 3.5b](#).

### **Practice Makes Perfect**

As you practice this D2 pattern a few times, does it remind you of any activity? If you're a skier, you may recognize components of the snowplow turn in D2 flexion. To help you remember it, we'll call D2 flexion the "snowplow" ([figure 3.5a](#)). D2 extension reminds some people of a ballet position, so we'll call D2 extension "fifth position" ([figure 3.5b](#)).

### **Dynamic Warm-Ups Using the Patterns**

Practicing the patterns as part of a dynamic warm-up ([figure 3.6](#)) is an excellent way to reinforce your memory of what each pattern entails and to thoroughly engage all the muscles of the upper and lower extremity in the warm-up. Using the patterns as part of a warm-up will help improve coordination and can be made more challenging by moving both arms simultaneously, performing a different pattern with each arm, or adding a leg pattern into the mix. Try it and have some fun as you explore the connections between your brain and your muscles.

**Figure 3.6** Mixing patterns during dynamic warm-ups. *(a)* Right arm is in D1 flexion, and left arm is in D2 flexion. *(b)* Right arm is in D1 extension, and left arm is in D2 extension. *(c)* Right leg and left arm are in D1 flexion. *(d)* Right leg and left arm are in D1 extension.





c

▶ VIDEO 3.5



d

## Facilitated Stretching Using the Patterns

The full spiral–diagonal patterns move through three planes of motion: extension or flexion, adduction or abduction, and internal or external rotation. When the goal is to restore or increase strength and coordination, as well as to increase range of motion, moving through the whole diagonal pattern is the most effective strategy. In facilitated stretching, the primary goal is to increase range of motion quickly and effectively rather than to improve strength and coordination.

### Work at the End Range

Because the goal in stretching is to increase range, employ only the end range of the pattern, and keep the limb from going through its full range of motion. The stretcher assumes the ending position of the pattern (the agonist direction), but her attempts to move the limb to the opposite end of the pattern (antagonist direction) are isometric (i.e., she pushes or pulls in all three planes of motion, but no movement occurs). The stretch occurs after the isometric phase, when the stretcher actively moves farther into the end range of the pattern (agonist direction).

### Blend Adduction and Flexion or Abduction and Extension

When using the patterns, the goal is to emphasize the diagonal line of stretch. For instance, in the flexion end of the D1 pattern, the goal is to blend adduction and flexion rather than have too much of either. It may be helpful to visualize a diagonal line through opposite corners of the table or the stretching mat on which the stretcher is lying. Use this diagonal line as a guide for the movement of the arm or leg to be sure there is a balanced blend of adduction and flexion or abduction and extension ([figure 3.7](#)).

**Figure 3.7** Visualize a diagonal line through opposite corners of the table. Use this line as a guide so the movement of the leg has a balanced blend of flexion and adduction.



Although this blend of motion is usually what's desired, there may be times when the goal is to emphasize one direction of movement over another to achieve a specific outcome. For instance, when the stretcher's motion is more limited in adduction than in flexion, improve her range in adduction by deviating from the diagonal to emphasize more adduction and less flexion.

### **Maintain Precise Hand Contacts**

PNF practitioners emphasize the importance of precise hand contacts in PNF ([figure 3.8](#)) because the stretcher is neurologically wired to move into the contact, not away from it. When you place your hands on the medial side of the limb, you should be verbally directing the stretcher to push or pull in that direction. Asking for a lateral push while holding on the medial side may be very confusing to the stretcher because your verbal commands don't match the proprioceptive cues your hands are communicating.

**Figure 3.8** Hand contacts as the stretcher is asked to push “down and out.” (a) Correct hand placement and (b) incorrect hand placement.



## Lower Extremity Stretches Using the Patterns

Not all the spiral patterns for the leg lend themselves to stretching. For instance, the extension end of the D2 pattern is extremely awkward to carry out. Therefore, this section covers the stretches that are the easiest to learn and use. If you have special circumstances with a particular stretcher, feel free to be creative in developing other stretches based on PNF principles and the patterns for the leg.

Compared with the single-plane stretches, using the spiral patterns requires more concentration from both the stretcher and the partner. Accordingly, we recommend passively moving the stretcher through the pattern several times before attempting to perform the stretch sequence. This will make it easier for the stretcher to understand what's expected.

Remember, these stretches are designed to improve range of motion at the end of the pattern. Start with the stretcher at the end of his range in all three planes of motion. In the isometric phase, the stretcher is attempting to move toward the opposite three planes (i.e., toward the shortened direction). After the isometric effort, the stretching occurs as the stretcher moves farther in all three planes of motion toward the lengthened direction.

### Soccer Kick Partner Stretch (Flexion End of D1)

This stretch increases range of motion in flexion, adduction, and external rotation of the hip.

1. The stretcher is supine on a treatment table or a mat on the floor ([figure 3.9](#)), with his left leg in as much flexion, adduction, and external rotation as possible. His foot is dorsiflexed and inverted, and the toes are extended. This is the starting position, which lengthens the target muscles to their end range. These include the hamstrings (especially biceps femoris), gluteals, tensor fasciae latae (TFL), gastrocnemius (especially lateral head), soleus, and peroneals. Demonstrate the pattern passively with the stretcher several times so he knows what you expect him to do during the isometric and the stretching phases.
2. Assume a stable position that allows you to comfortably support and stabilize the leg. Remember, your hand contacts give the stretcher proprioceptive cues about which way to push or pull. Your hand positions should match your verbal commands.
3. Direct the stretcher to begin slowly trying to initiate the D1 extension pattern, first with internal rotation, then abduction, then extension. (“Begin by rotating, then kick down and out.”) Once the stretcher has achieved the appropriate level of effort,

this isometric contraction lasts for 6 seconds. Be sure the stretcher keeps both hips flat on the table or mat and initiates the motion from his hip, not from his foot.

4. After the isometric push, the stretcher relaxes and inhales deeply. As he relaxes, maintain the leg in the starting position.
5. As he exhales, the stretcher moves the hip farther into flexion, then into adduction, and then into external rotation. Remember, the goal is a blend of all three directions in order to keep moving in a diagonal line. He increases dorsiflexion and inversion of the foot and extension of the toes. Support the leg, but do not push to deepen the stretch.
6. Repeat two or three times.

**Figure 3.9** The “soccer kick” stretch (D1 pattern). The stretcher’s left leg is flexed, adducted, and externally rotated. (a) Working on a table. (b) Working on the floor.



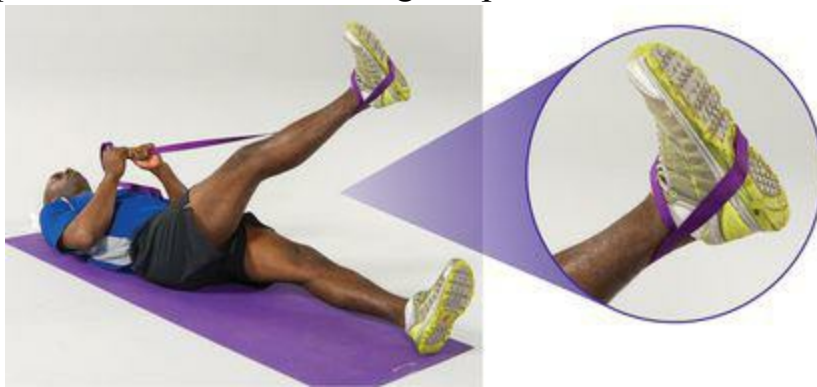
### Soccer Kick Self-Stretch (Flexion End of D1)

1. Loop a stretching strap around the arch of your right foot, and then wrap the stretching strap around the outside of your ankle and behind your Achilles tendon to the inside of the calf. Lie down on your back, with your legs out straight.
2. Hold on to the stretching strap, but use your quads to lift your right leg up as high as you can with the knee straight. Now move your leg across or toward your midline; next, rotate it to the right, so you’re looking at the inside of your knee and foot. Take up the slack on the stretching strap. This is the start of the “soccer kick” stretch ([figure 3.10](#)).
3. Start slowly and try to rotate your leg to the left; next, push it down and out, as if you’re putting it on the floor to your right. Breathe normally. Use the stretching strap to resist this attempt at motion, and hold this isometric contraction for 6 seconds. Now relax and breathe.
4. As you exhale, use your leg muscles, not the stretching strap, to lift your leg higher,

across your midline, and to rotate more to the right. This deepens the stretch on the target muscles.

5. Repeat two or three times.

**Figure 3.10** “Soccer kick” self-stretch. The blow-out photo shows the correct placement of the stretching strap around the ankle.



### **Toe-Off Partner Stretch (Extension End of D1)**

This stretch improves range of motion into extension, abduction, and internal rotation of the hip. Because the stretcher is prone in this stretch, you may be somewhat confused as to internal versus external rotation. It will help to pay attention only to the thigh and ignore the position of the lower leg and foot when determining which is internal and which is external rotation.

1. The stretcher is prone on a treatment table or a mat on the floor, with his left knee flexed ([figure 3.11](#)). Keeping his hips flat on the table or mat, he lifts his thigh into as much extension, abduction, and internal rotation as possible (the lower leg and foot will be pointing out, away from the midline). Keeping the hips flat on the surface helps prevent compensation and muscle substitution. Remember that normal range of hip extension is only 30 degrees. If the stretcher seems more flexible than that, look for hypermobility in the low back area. This starting position lengthens the target muscles to their end range. These include the iliopsoas, rectus femoris, adductors, and lateral hip rotators. For this stretch, the position of the foot and the toes is not important. The knee is in flexion simply to make it easier for the stretcher to lift his leg off the table. If the stretcher experiences any low back discomfort in this position, stop and place a pillow under his hips to make him more comfortable.
2. Support and stabilize the leg, with one hand supporting under the knee and the other at the ankle. At the same time, ask the stretcher to keep both hips on the table or mat.
3. Direct the stretcher to begin slowly trying to initiate the D1 flexion pattern, with

external rotation of the thigh first, then adduction, then flexion. Once the stretcher has achieved the appropriate level of effort, this isometric contraction lasts for 6 seconds. (“Begin with rotation, then try to pull down and in.”) The stretcher does not try to straighten his knee, only to push his thigh toward the table. The gluteal muscles should be relaxed during the isometric phase.

4. After the isometric push, the stretcher relaxes and inhales deeply. As he relaxes, maintain the leg in the starting position.
5. As he exhales, the stretcher moves his leg farther into extension, then abduction, and then internal rotation. Remember, the goal is a blend of all three directions in order to keep moving in a diagonal line. As he lifts, the stretcher must stabilize his pelvis to keep both hips on the table. Support the leg, but do not push to deepen the stretch.
6. Repeat two or three times.

**Figure 3.11** The “toe-off” stretch (D1 pattern). The stretcher’s knee is bent and the thigh is extended, abducted, and internally rotated. Note that this rolls the leg and foot away from the midline. (a) Working on a table. (b) Working on a mat.



## Snowplow Partner Stretch (Flexion End of D2)

This stretch increases range of motion in flexion, abduction, and internal rotation of the hip.

1. The stretcher is supine on a treatment table or a mat on the floor, with his right leg in as much flexion, abduction, and internal rotation as possible ([figure 3.12](#)). His foot is dorsiflexed and everted, and the toes are extended. This starting position lengthens the target muscles to their end range. These include the gluteals, hamstrings (especially medial), gastrocnemius (especially medial head), soleus, gracilis, adductors, and tibialis posterior. Demonstrate the pattern passively with the stretcher several times so he knows what you expect him to do during the isometric and the stretching phases.
2. Support and stabilize the leg. Remember, your hand contacts give the stretcher proprioceptive cues about which way to push or pull. Your hand positions should match your verbal commands.

3. Direct the stretcher to begin slowly trying to initiate the D2 extension pattern, with external rotation first, then adduction, then extension. (“Begin with rotation, then kick down and in.”) Once the stretcher has achieved the appropriate level of effort, this isometric contraction lasts for 6 seconds. Be sure the stretcher keeps both hips flat on the surface and initiates the motion from his hip, not from his foot.
4. After the isometric push, the stretcher relaxes and inhales deeply. As he relaxes, maintain the leg in the starting position.
5. As he exhales, the stretcher moves the hip farther into flexion, then into abduction, and then into internal rotation. Remember, the goal is a blend of all three directions in order to keep moving in a diagonal line. He increases dorsiflexion and eversion of the foot and extension of the toes. Support the leg, but do not push to deepen the stretch.
6. Repeat two or three times.

**Figure 3.12** The “snowplow” stretch (D2 pattern). The stretcher’s right leg is flexed, abducted, and internally rotated. (a) Working on a table. (b) Working on a mat.

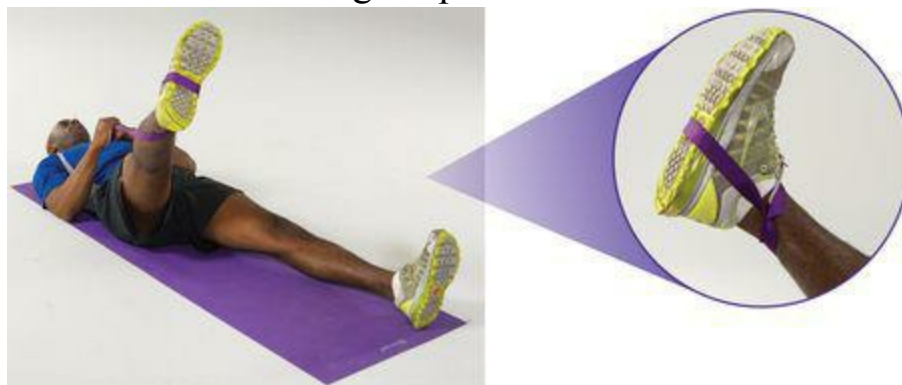


### Snowplow Self-Stretch (Flexion End of D2)

1. Loop a stretching strap around the arch of your right foot, and then wrap the stretching strap around the inside of your ankle and behind your Achilles tendon to the outside of the calf. Lie down on your back, with your legs out straight.
2. Hold on to the stretching strap, but use your quads to lift your right leg up as high as you can with the knee straight. Keep both hips flat on the floor. Move the leg out away from your midline; next, rotate it to the left, so you’re looking at the outside of your knee and foot. Take up the slack on the stretching strap. This is the start of the “snowplow” stretch ([figure 3.13](#)).
3. Start slowly trying to rotate your leg to the right; next, push it down and in, as if you’re putting it on the floor next to your left leg. Use the stretching strap to resist this attempt at motion, and hold this isometric contraction for 6 seconds. Now relax and breathe.

4. As you exhale, use your leg muscles, not the stretching strap, to lift your leg higher, away from your midline, and to rotate more to the left. This deepens the stretch on the target muscles.
5. Repeat two or three times.

**Figure 3.13** “Snowplow” self-stretch. The blow-out photo shows the correct placement of the stretching strap around the ankle.



## Upper Extremity Stretches Using the Patterns

The spiral–diagonal patterns for the arms are extremely useful for increasing range of motion in the shoulder girdle. They're also helpful for determining which muscles in a pattern of motion are weak or not firing properly. These individual muscles can then be isolated for single-plane stretching or strengthening.

Working with the upper extremity can seem complicated because you have the option of working with the elbow bent or straight in the two patterns that involve adduction (flexion end of D1 and extension end of D2). The instructions given here assume the elbow remains straight. As you gain more experience, you can work with the elbow bent and add resisted elbow extension during the isometric phase.

Compared with the single-plane stretches, using the spiral patterns requires more concentration from both the stretcher and the partner. Accordingly, we recommend passively moving the stretcher through the pattern several times before attempting to perform the stretch sequence. This will make it easier for the stretcher to understand what's expected.

Remember, these stretches are designed to improve range of motion at the end of the pattern. Start with the stretcher at the end of his range in all three planes of motion. In the isometric phase, the stretcher is attempting to move toward the opposite three planes (i.e., toward the shortened direction). After the isometric effort, the stretching occurs as the stretcher moves farther in all three planes of motion toward the lengthened direction.

### **Grab Seat Belt Partner Stretch (Flexion End of D1)**

This stretch increases range of motion in flexion, adduction, and external rotation of the shoulder and can be done on a treatment table, a mat on the floor, or a bench.

1. The stretcher can be lying supine on a treatment table or a mat on the floor or seated on a bench, with his feet firmly planted on the floor. Reaching from the shoulder joint, he moves his right arm into as much flexion, adduction, and external rotation as possible, as if reaching for a seat belt. The stretcher keeps his elbow straight and both shoulder blades on the table or mat. His forearm is supinated, and his wrist and fingers are in neutral. To gain as much adduction and flexion as possible, have the stretcher turn his head toward the left shoulder so his chin does not interfere with his arm motion. Ideally, the right upper arm lies across the cheek. This position lengthens the target muscles to their end range. These include the infraspinatus, middle trapezius, rhomboids, teres minor, posterior deltoid, and pronator teres.

2. Assume a stable position that allows you to comfortably support and stabilize the arm and wrist ([figure 3.14](#)). Remember, your hand contacts give the stretcher proprioceptive cues about which way to push or pull. Your hand positions should match your verbal commands. Your grasp spans the wrist and hand and across the elbow to minimize stress on the joints.
3. Direct the stretcher to begin slowly trying to initiate the D1 extension pattern, first with internal rotation, then abduction, then extension. (“Pretend you’re pulling your seat belt.”) Once the stretcher has achieved the appropriate level of effort, this isometric contraction lasts for 6 seconds.
4. After the isometric push, the stretcher relaxes and inhales deeply. As he relaxes, maintain the arm in the starting position.
5. As he exhales, the stretcher moves the arm farther into flexion, then into adduction, and then into external rotation and supination. Remember, the goal is a blend of all three directions in order to keep moving in a diagonal line. Be sure he does not twist his torso but reaches from the shoulder joint to increase the stretch. Support the arm, but do not push to deepen the stretch.
6. Repeat two or three times.

**Figure 3.14** The “grab seat belt” stretch (D1 pattern). The stretcher’s arm is flexed, adducted, and externally rotated. (a) Working on a table. (b) Working on a bench.



### Grab Seat Belt Self-Stretch (Flexion End of D1)

1. Attach a stretching strap to a fixed object above and behind you. To use a cable and pulley machine at the gym, select the maximum weight so that you cannot lift it. While standing (or sitting on a stability ball), reach your right arm up and across and rotate it as if you were reaching for your seat belt. Grab on to the stretching strap or the handle of the machine. Keep your torso from twisting by focusing on stretching from the shoulder joint. This is the start of the “grab seat belt” stretch ([figure 3.15](#)).
2. Start slowly and rotate your arm, then pull down and out, as if you were going to fasten the seat belt. Use the stretching strap to resist this attempt at motion, and hold this isometric contraction for 6 seconds. Now relax and breathe.
3. As you exhale, reach up and across, and then rotate your arm a little more to deepen the stretch on the target muscles. Focus on stretching out of the shoulder

joint, and keep your torso from twisting.

4. Take up any slack on the stretching strap, or reposition yourself at the cable machine, and repeat the sequence two or three times.

**Figure 3.15** “Grab seat belt” self-stretch.



### **Fasten Seat Belt Partner Stretch (Extension End of D1)**

This stretch improves range of motion in extension, abduction, and internal rotation of the shoulder and can be done on a treatment table or bench.

1. The stretcher can lie supine, with the joint line of his right shoulder at the edge of the table; or he can sit on a bench, with his feet firmly planted on the floor. Without twisting the torso, but reaching from the shoulder joint, he moves his right arm into extension, abduction, and internal rotation as far as possible. His forearm is pronated, with his wrist and fingers in neutral. This position lengthens the target muscles to their end range. These include the pectorals (clavicular head), anterior deltoid, coracobrachialis, biceps brachii, infraspinatus, and supinator.
2. Assume a stable position that allows you to comfortably support and stabilize the arm and wrist ([figure 3.16](#)). Your grasp spans the wrist and hand and across the elbow to minimize stress on the joints. Remember, your hand contacts give the stretcher proprioceptive cues about which way to push or pull. Your hand positions should match your verbal commands.
3. Direct the stretcher to begin slowly trying to initiate the D1 flexion pattern, first with external rotation, then adduction, then flexion. (“Begin by rotating, then push up and across toward your left shoulder.”) Once the stretcher has achieved the appropriate level of effort, this isometric contraction lasts for 6 seconds. The

stretcher is not attempting to bend his elbow.

4. After the isometric push, the stretcher relaxes and inhales deeply. As he relaxes, maintain the arm in the starting position.
5. As he exhales, the stretcher moves the arm farther into extension, then into abduction, and then internal rotation and pronation. Remember, the goal is a blend of all three directions in order to keep moving in a diagonal line. Support the arm, but do not push to deepen the stretch.
6. Repeat two or three times.

**Figure 3.16** The “fasten seat belt” stretch (D1 pattern). The stretcher’s arm is extended, abducted, and internally rotated. (a) Working on a table. (b) Working on a bench.



### Fasten Seat Belt Self-Stretch (Extension End of D1)

1. Attach a stretching strap to a fixed object on the floor and behind you. To use a cable and pulley machine at the gym, select the maximum weight so that you cannot lift it. While standing (or sitting on a stability ball or bench), reach your right arm behind and away from you, and rotate it so your thumb faces behind you as if you were putting on a seat belt. Grab on to the stretching strap or the handle of the machine. This is the start of the “fasten seat belt” position ([figure 3.17](#)).
2. Start slowly with rotation, and then pull forward and in as if you were reaching up and across to your opposite shoulder to grab a seat belt. Use the stretching strap to resist this attempt at motion, and hold this isometric contraction for 6 seconds. Now relax and breathe.
3. As you exhale, reach farther behind and away from you, and then turn your arm a little more to deepen the stretch on the target muscles. Focus on stretching out of the shoulder joint, and keep your back flat as you stretch.
4. Take up any slack on the stretching strap, or reposition yourself at the cable

machine, and repeat the sequence two or three times.

**Figure 3.17** “Fasten seat belt” self-stretch.



### **Draw Sword Partner Stretch (Flexion End of D2)**

This stretch improves range of motion in flexion, abduction, and external rotation of the shoulder and can be done on a treatment table or bench.

1. The stretcher can lie supine, with the joint line of his left shoulder just beyond the edge of the table; or he can be seated on a bench, with his feet firmly planted on the floor. He moves his arm as far as possible into the flexion end of the D2 pattern (flexion, abduction, and external rotation). His forearm is supinated, with the wrist and fingers in neutral. This starting position for the flexion end of D2 lengthens the target muscles to their end range. These include the pectorals (sternal head), anterior deltoid, subscapularis, pronator teres, latissimus dorsi, and teres major.
2. Assume a stable position that allows you to comfortably support and stabilize the arm and wrist ([figure 3.18](#)). Remember, your hand contacts give the stretcher proprioceptive cues about which way to push or pull; your hand positions should match your verbal commands. Your grasp spans the wrist and hand and across the elbow to minimize stress on the joints.
3. Direct the stretcher to begin slowly trying to initiate the D2 extension pattern, first with internal rotation, then adduction, then extension. (“Begin by rotating, then try to reach across and down to touch your right hip.”) Once the stretcher has achieved the appropriate level of effort, this isometric contraction lasts for 6 seconds. The stretcher is not trying to bend his elbow.
4. After the isometric push, the stretcher relaxes and inhales deeply. As he relaxes,

maintain the arm in the starting position.

5. As he exhales, the stretcher moves his arm farther into flexion, then into abduction, and then into external rotation and supination. Remember, the goal is a blend of all three directions in order to keep moving in a diagonal line. Support the arm, but do not push to deepen the stretch.
6. Repeat two or three times.

**Figure 3.18** The “draw sword” stretch (D2 pattern). The stretcher’s arm is flexed, abducted, and externally rotated. (a) Working on a table. (b) Working on a bench.



### Draw Sword Self-Stretch (Flexion End of D2)

1. Attach a stretching strap to a fixed object above and behind you. To use a cable and pulley machine at the gym, select the maximum weight so that you cannot lift it. While standing (or sitting on a stability ball), reach your right arm up and out, and rotate it as if you were holding a sword (or an Olympic torch!). Grab on to the stretching strap or the handle of the machine. Keep your torso from twisting by focusing on stretching from the shoulder joint. This is the start of the “draw sword” stretch ([figure 3.19](#)).
2. Start slowly and rotate your arm, and then pull down and across as if you were putting a sword back into its scabbard, or as if to touch your left hip. Use the stretching strap to resist this attempt at motion, and hold this isometric contraction

for 6 seconds. Now relax and breathe.

3. As you exhale, reach up, out, and back; next, turn your arm a little more to deepen the stretch on the target muscles. Focus on stretching out of the shoulder joint, and keep your back flat as you stretch.
4. Take up any slack on the stretching strap, or reposition yourself at the cable machine, and repeat the sequence two or three times.

**Figure 3.19** “Draw sword” self-stretch.



### **Sheathe Sword Partner Stretch (Extension End of D2)**

This stretch improves range of motion in extension, adduction, and internal rotation of the shoulder and can be done on a treatment table, mat on the floor, or bench. The stretch position is different from that in free-exercise practice. During free exercise, we stop at the front of the hip; but remember that the spiral pattern continues through the body to the end of available range in extension, adduction, and internal rotation. So the stretch begins with the arm behind the back.

1. The stretcher lies prone on a treatment table or a mat on the floor or sits on a bench with his feet firmly planted on the floor. Without rotating his torso, and reaching from the shoulder joint, he moves his arm as far as possible into the extension end of the D2 pattern (extension, adduction, internal rotation). The forearm is pronated, with the wrist and fingers in neutral. This starting position is a modified hammerlock. The stretcher keeps his elbow straight while adducting across the back as far as possible, with his thumb pointing away from his back. This position lengthens the target muscles to their end range. These include the anterior deltoid, coracobrachialis, pectorals, and biceps brachii.
2. Assume a stable position that allows you to comfortably support and stabilize the arm and wrist ([figure 3.20](#)). Remember, your hand contacts give the stretcher proprioceptive cues about which way to push or pull; your hand positions should match your verbal commands. Your grasp spans the wrist and hand and across the

elbow to minimize stress on the joints.

3. Direct the stretcher to begin slowly trying to initiate the D2 flexion pattern, first with external rotation, then abduction, then flexion. (“Begin by rotating, then push through and away from your body.”) Once the stretcher has achieved the appropriate level of effort, this isometric contraction lasts for 6 seconds.
4. After the isometric push, the stretcher relaxes and inhales deeply. As he relaxes, maintain the arm in the starting position.
5. On the exhale, the stretcher moves his arm farther into extension, then into adduction, and then into internal rotation and pronation. Remember, the goal is a blend of all three directions in order to keep moving in a diagonal line. Support the arm, but do not push to deepen the stretch.
6. Repeat two or three times.

**Figure 3.20** The “sheathe sword” stretch (D2 pattern). The stretcher’s arm is extended, adducted, and internally rotated. (a) Working on a table. (b) Working on a bench.



### Sheathe Sword Self-Stretch (Extension End of D2)

1. Attach a stretching strap to a fixed object on the floor and behind you. To use a cable and pulley machine at the gym, select the maximum weight so that you cannot lift it. While standing (or sitting on a stability ball), reach your right arm behind and across your back, and rotate it so that the little-finger side of your loose fist is against your buttock. Grab onto the stretching strap or the handle of the machine. This is the start of the “sheathe sword” position ([figure 3.21](#)).
2. Start slowly with rotation and then pull forward and out, as if you were reaching for something in front of you. Use the stretching strap to resist this attempt at motion, and hold this isometric contraction for 6 seconds. Now relax and breathe.
3. As you exhale, reach farther behind and across your back, and then turn your arm a

little more to deepen the stretch on the target muscles. Focus on stretching out of the shoulder joint, and keep your back flat as you stretch.

4. Take up any slack on the stretching strap, or reposition yourself at the cable machine, and repeat the sequence two or three times.

Figure 3.21 “Sheathe sword” self-stretch.



## **Strengthening Exercises Using the Patterns**

Incorporating the spiral–diagonal patterns into an exercise program can provide great benefit. Since the spiral patterns occur in many daily activities, as well as in sports, using the patterns to strengthen synergistic muscle groups is a natural progression from the stretching work.

There are many ways to use the patterns in training, whether at the gym, in a hotel room while traveling, or in a home program. In the gym, wall-mounted pulley systems are easily adaptable to pattern work. Some of the newer free-standing gym equipment is also well suited to training in the spiral patterns. In the absence of gym equipment, elastic bands or surgical tubing can provide adequate resistance to achieve the same benefit. Surgical tubing and elastic bands are generally available through medical supply houses, physical therapy clinics, and stores or catalogs devoted to exercise and fitness equipment. Bands and tubing are usually color coded to indicate the level of resistance they provide. Deciding on the resistance level that's right for you is somewhat a matter of trial and error, but generally, starting with a midlevel band will work for most readers. You can adjust the amount of work you do by changing the length of the band as you exercise.

In this section, we provide some general ideas and suggestions for strengthening exercises, illustrating the use of cable equipment. We recommend that you consult a certified personal trainer, athletic trainer, or strength coach to help design the program appropriate for you.

Instructions are written for the right arm or leg. Be sure to repeat all exercises on the left.

### **Strengthening the Arms**

Once you're sufficiently familiar with the spiral patterns for the arms by practicing them as general warm-ups, you can begin to focus on using them as part of a strength workout. Don't work too hard at the beginning of your program, because you may find that you're too sore the next day. It's best to start slowly and work your way up to a more strenuous routine.

#### **D1 Flexion: Arms**

This exercise improves the strength, endurance, and coordination of the muscles in the D1 flexion pattern (front of the chest and shoulder).

1. Adjust one arm of the cable machine behind you at floor level and load an appropriate amount of weight on the machine. Hold the cable handle in your right hand, and place your arm in extension, abduction, and internal rotation (“fasten seat belt”) ([figure 3.22](#)).
2. Step slightly away from the machine so there is no slack in the cable and assume a comfortable lunge stance, with your left leg forward and your right leg back. Keep your hips facing forward.
3. From this starting position, begin a slow and controlled motion to reach up and across your body toward your left shoulder, ending at the flexion end of D1 (flexion, adduction, external rotation: “grab seat belt”). Your goal is to complete this spiral motion with ease and grace. If you can’t, adjust the amount of weight you’re trying to lift.
4. Once you’ve reached the end of D1 flexion, begin a slow and controlled return to your starting position. You may find this eccentric contraction (or negative work) more difficult than the concentric work, which makes completing the exercise with ease and grace all the more important.
5. The complete motion from extension into flexion and then back to extension makes one repetition. Typically, you’ll do one set of 10 to 12 repetitions to begin your program, adjusting up or down based on your particular level of fitness.

**Figure 3.22** Strengthening exercise, D1 flexion, arm. (a) Starting position (“fasten seat belt”) and (b) ending position (“grab seat belt”).



### **D1 Extension: Arms**

This exercise improves the strength, endurance, and coordination of the muscles in the D1 extension pattern (posterior arm and shoulder).

1. Adjust one arm of the cable machine above your left shoulder and load an appropriate amount of weight on the machine. Hold the cable handle in your right hand, and position your right arm in the flexion end of D1 (flexion, adduction, and

external rotation: “grab seat belt”) ([figure 3.23](#)).

2. Step slightly away from the machine so there is no slack in the cable and assume a comfortable lunge stance, with your left leg forward and your right leg back. Keep your hips facing forward.
3. From this starting position, begin a slow and controlled motion to reach down, out, and behind you, ending at the extension end of D1 (extension, abduction, internal rotation: “fasten seat belt”). Remember, good form is more important than how hard you can pull.
4. Once you’ve reached the end of D1 extension, begin a slow and controlled return to your starting position. You may find this eccentric contraction (or negative work) more difficult than the concentric work, which makes completing the exercise with ease and grace all the more important.
5. The complete motion from flexion into extension and then back to flexion makes one repetition. Typically, you’ll do one set of 10 to 12 repetitions to begin your program, adjusting up or down based on your particular level of fitness.

**Figure 3.23** Strengthening exercise, D1 extension, arm. (a) Starting position (“grab seat belt”) and (b) ending position (“fasten seat belt”).



## D2 Flexion: Arms

This exercise improves the strength, endurance, and coordination of the muscles in the D2 flexion pattern (front of the shoulder and chest).

1. Adjust one arm of the cable machine to your left at floor level and load an appropriate amount of weight on the machine. Hold the cable handle in your right hand, and place your arm at your left hip as if you're sheathing a sword (extension,

adduction, internal rotation) ([figure 3.24](#)).

2. Step slightly away from the machine so there is no slack in the cable and assume a comfortable lunge stance, with your left leg forward and your right leg back. Keep your hips facing forward.
3. From this starting position, begin a slow and controlled motion to reach up and away from your body, as if wielding the sword above your head, ending at the flexion end of D2 (flexion, abduction, external rotation).
4. Once you've reached the end of D2 flexion, begin a slow and controlled return to your starting position. You may find this eccentric contraction (or negative work) more difficult than the concentric work, which makes completing the exercise with ease and grace all the more important.
5. The complete motion from extension into flexion and then back to extension makes one repetition. Typically, you'll do one set of 10 to 12 repetitions to begin your program, adjusting up or down based on your level of fitness.

**Figure 3.24** Strengthening exercise, D2 flexion, arm. (a) Starting position (“sheathe sword”) and (b) ending position (“draw sword”).



## **D2 Extension: Arms**

This exercise improves the strength, endurance, and coordination of the muscles in the D2 extension pattern (front of the chest and shoulder).

1. Adjust one arm of the cable machine above and behind your right shoulder and load the appropriate amount of weight on the machine. Hold the cable handle in your right hand, and position your right arm in the flexion end of D2 (flexion,

abduction, and external rotation: “draw sword”) ([figure 3.25](#)).

2. Step slightly away from the machine so there is no slack in the cable and assume a comfortable lunge stance, with your left leg forward and your right leg back. Keep your hips facing forward.
3. From this starting position, begin a slow and controlled motion to reach down and across to your left hip, turning your arm as you go, ending at the extension end of D2 (extension, adduction, internal rotation: “sheathe sword”). Remember, good form is more important than how hard you can pull.
4. Once you’ve reached the end of D2 extension, begin a slow and controlled return to your starting position. You may find this eccentric contraction (or negative work) more difficult than the concentric work, which makes completing the exercise with ease and grace all the more important.
5. The complete motion from flexion into extension and then back to flexion makes one repetition. Typically, you’ll do one set of 10 to 12 repetitions to begin your program, adjusting up or down based on your particular level of fitness.

**Figure 3.25** Strengthening exercise, D2 extension, arm. (a) Starting position (“draw sword”) and (b) ending position (“sheathe sword”).



## Strengthening the Legs

Once you're sufficiently familiar with the spiral patterns for the legs by practicing them as general warm-ups, you can begin to focus on using them for a strength workout. Don't work too hard at the beginning of your program, because you may be too sore the next day. It's best to start slowly and work your way up to a more strenuous routine.

### D1 Flexion: Legs

This exercise improves the strength, endurance, and coordination of the muscles in the D1 flexion pattern (hip flexors, lateral rotators, and adductors).

1. Adjust one arm of the cable machine behind you at floor level and load an appropriate amount of weight on the machine. Attach the cable to your right ankle with an ankle cuff.
2. Step slightly away from the machine so there is no slack in the cable and assume a stable position that allows you to stand comfortably so you can shift your weight to your left leg. Holding onto something for stability, place your right leg in extension, abduction, and internal rotation (“toe-off”) ([figure 3.26](#)).
3. From this starting position, begin a slow and controlled motion, as if you were performing a soccer kick, ending at the flexion end of D1 (flexion, adduction, external rotation). Your goal is to complete this spiral motion with ease and grace. If you can’t, adjust the amount of weight you’re trying to lift.
4. Once you’ve reached the end of D1 flexion, begin a slow and controlled return to your starting position. You may find this eccentric contraction (or negative work) more difficult than the concentric work, which makes completing the exercise with ease and grace all the more important. Be sure to keep your back from arching by focusing on making the motion happen at your hip joint.
5. The complete motion from extension into flexion and then back to extension makes one repetition. Typically, you’ll do one set of 10 to 12 repetitions to begin your program, adjusting up or down based on your level of fitness.

**Figure 3.26** Strengthening exercise, D1 flexion, leg. (a) Starting position (“toe-off”) and (b) ending position (“soccer kick”).



## D1 Extension: Legs

This exercise improves the strength, endurance, and coordination of the muscles in the D1 extension pattern (hip extensors, medial rotators, and abductors).

1. Adjust one arm of the cable machine in front and to your left at mid-thigh level and load an appropriate amount of weight on the machine. Attach the cable to your right ankle with an ankle cuff.
2. Step slightly away from the machine so there is no slack in the cable and assume a stable position that allows you to stand comfortably so you can shift your weight to

your left leg. Holding on to something for stability, place your right leg in flexion, adduction, and external rotation (“soccer kick”) ([figure 3.27](#)).

3. From this starting position, begin a slow and controlled motion, kicking your leg behind you to the right and ending at D1 extension (extension, abduction, and internal rotation: “toe-off”). Be sure to keep your back from arching by focusing on making the motion happen at your hip joint.
4. Once you’ve reached the end of D1 extension, begin a slow and controlled return to your starting position. You may find this eccentric contraction (or negative work) more difficult than the concentric work, which makes completing the exercise with ease and grace all the more important.
5. The complete motion from flexion into extension and then back to flexion makes one repetition. Typically, you’ll do one set of 10 to 12 repetitions to begin your program, adjusting up or down based on your level of fitness.

**Figure 3.27** Strengthening exercise, D1 extension, leg. (a) Starting position (“soccer kick”) and (b) ending position (“toe-off”).



## D2 Flexion: Legs

This exercise improves the strength, endurance, and coordination of the muscles in the D2 flexion pattern (hip flexors, internal rotators, and abductors).

1. Adjust one arm of the cable machine behind and to your left at floor level and load an appropriate amount of weight on the machine. Attach the cable to your right ankle with an ankle cuff.
2. Assume a stable position that allows you to stand comfortably so you can shift your weight to your left leg. Holding on to something for stability, place your right leg in extension, adduction, and external rotation (“fifth position”) ([figure 3.28](#)). Adjust

your stance to take up the slack on the cable.

3. From this starting position, begin a slow and controlled motion, ending up with the right leg in the “snowplow” position at the flexion end of D2 (flexion, abduction, internal rotation). Your goal is to complete this spiral motion with ease and grace. Swing the leg from the hip joint, and try to keep your pelvis and torso from twisting. If you can’t, adjust the amount of weight you’re trying to lift.
4. Once you’ve reached the end of D2 flexion, begin a slow and controlled return to your starting position. You may find this eccentric contraction (or negative work) more difficult than the concentric work, which makes completing the exercise with ease and grace all the more important. Be sure to keep your back from arching by focusing on making the motion happen at your hip joint.
5. The complete motion from extension into flexion and then back to extension makes one repetition. Typically, you’ll do one set of 10 to 12 repetitions to begin your program, adjusting up or down based on your level of fitness.

**Figure 3.28** Strengthening exercise, D2 flexion, leg. (a) Starting position (“fifth position”) and (b) ending position (“snowplow”).



## D2 Extension: Legs

This exercise improves the strength, endurance, and coordination of the muscles in the D2 extension pattern (hip extensors, external rotators, and adductors).

1. Adjust one arm of the cable machine in front and to your right at hip level and load an appropriate amount of weight on the machine. Attach the cable to your right ankle with an ankle cuff.
2. Assume a stable position that allows you to stand comfortably so you can shift your weight to your left leg. Holding on to something for stability, place your right leg in

flexion, abduction, and internal rotation (“snowplow”) ([figure 3.29](#)). Adjust your stance to take up the slack on the cable.

3. From this starting position, begin a slow and controlled motion, kicking your leg behind and across your midline, turning your leg out and ending at D2 extension (extension, adduction, external rotation: “fifth position”).
4. Once you’ve reached the end of D2 extension, begin a slow and controlled return to your starting position. You may find this eccentric contraction (or negative work) more difficult than the concentric work, which makes completing the exercise with ease and grace all the more important.
5. The complete motion from flexion into extension and then back to flexion makes one repetition. Typically, you’ll do one set of 10 to 12 repetitions to begin your program, adjusting up or down based on your level of fitness.

**Figure 3.29** Strengthening exercise, D2 extension, leg. (a) Starting position (“snowplow”) and (b) ending position (“fifth position”).



## Chapter Summary

This chapter gives a broad overview of the spiral–diagonal patterns developed in PNF. We follow a natural progression by describing the patterns as free-movement exercises and then incorporating them into dynamic warm-ups. We cover in detail the use of these patterns for facilitated stretching and finish up by incorporating these three-dimensional patterns into strength training programs using cable-based equipment.

# Part II

## The Stretches

In part I, we look at the various types of stretching and the importance of using proper biomechanics during stretching. We also discuss the background of facilitated stretching and the details for implementing it. Finally, we explore how to use the spiral patterns for stretching and strengthening.

In part II, we show you, step by step, how to stretch each major muscle in the body, both singly and in groups. Chapter 4 covers the torso and neck, chapter 5 is devoted to the lower extremity (hips and legs), and chapter 6 details stretches for the upper extremity (shoulders and arms). Chapter 7 is a compilation of stretching routines for several different activities, such as running, cycling, hockey, and everyday stretching.

## **Deciding When to Choose Single-Plane Stretches or Spiral Patterns**

Physiotherapists, occupational therapists, athletic trainers, and sports medicine clinics use the spiral patterns of PNF through entire ranges of motion to increase strength and coordination as well as flexibility. Facilitated stretching focuses primarily on improving range of motion. When should you choose pattern work, and when should you employ single-muscle, single-plane stretches?

## Spiral-Pattern Stretching

The spiral–diagonal stretches increase the flexibility and coordination of synergistic groups of muscles that act together. Using these three-dimensional patterns, we stretch groups of muscles simultaneously, thereby gaining greater benefit in a shorter amount of time compared with single-plane stretches.

The patterns can also be used as assessment tools to determine which muscles in a synergistic group are limiting motion, exhibiting weakness, or not firing in the proper sequence. Once these deficiencies are identified, the single-plane stretches can be used along with the patterns to focus on improving the muscular function that needs work.

## Single-Plane Stretching

We use single-plane stretches when we want to develop flexibility or awareness in a specific muscle or muscle group. Single-plane stretches can also be used as an adjunct to soft-tissue therapy. For instance, you can use these stretches for relaxing hypertonic (too tight) muscles to reduce the discomfort of deep massage or trigger point work, or in conjunction with deep friction work to release adhesions within or between muscles.

## Organization of Stretches

Chapters 4, 5, and 6 are organized around the joints and the muscles that act on them. This is not an exact science, and we acknowledge that some muscles could be grouped differently. When in doubt, please consult the index for the muscle group you're looking for.

Each muscle group is presented as follows:

- Anatomy, including the origin, insertion, and action of the muscles, with illustrations
- Functional assessment for normal range of motion, with illustrations
- Detailed stretching instructions, with photos
- Self-stretching instructions, where appropriate, with photos

## Safety Reminders

- An isometric contraction is one in which no movement occurs. The stretcher begins slowly and builds the contraction as you, the partner, provide matching resistance, only to your level of strength. Don't allow the stretcher to overpower you. In some cases, the stretcher may be using only 10 percent of his strength; in other cases, 100 percent. It all depends on how strong you are in relation to the stretcher. Once the stretcher has achieved the proper level of isometric contraction, hold it for 6 seconds.
- Don't push or pull. The partner should rarely push or pull to deepen the stretch.
- Stretch pain free. Facilitated stretches should always be pain free. If the stretcher experiences pain, try repositioning the limb or use less force during the isometric contraction of the target muscle. If pain persists, don't use facilitated stretching for that particular muscle until you've determined why it's causing pain.

# Chapter 4

## Stretches for the Torso and Neck

This chapter addresses the muscles of the torso and neck. The nature of our daily lives places a great deal of stress on our neck muscles as we try to hold our heads up, and the amount of sitting we do requires a great deal of flexion in the torso as we sit at desks, in cars, in front of the computer, and in front of the TV. Our chairs are not really designed to support our bodies well, and the postural muscles are called on to literally take up the slack. Most sports also require a great deal of support and active involvement from these muscles. The following stretches can be used as preventive techniques or to help relieve pain caused by imbalance in these muscles.

## Torso

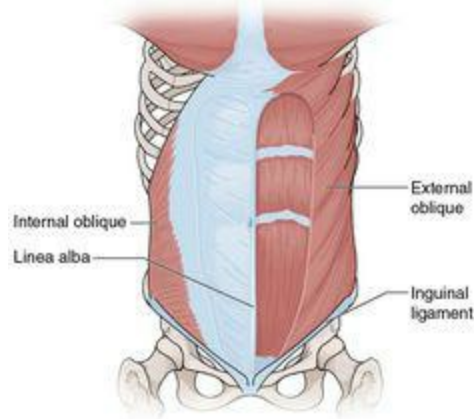
The thoracic and lumbar areas often maintain chronic muscular tension, which can be greatly alleviated through effective stretching. Many people experience pain in these areas from trauma, job-related injury, sports activities, or just plain postural stress.

When performing these stretches, be especially aware that the stretcher is working in the pain-free zone at all times. If you are working with someone who has suffered any type of back injury, work cautiously. Sometimes the stretcher may not realize he is overworking and will have increased pain a day or two after stretching.

## **Anatomy: Oblique Abdominals and Lower Back**

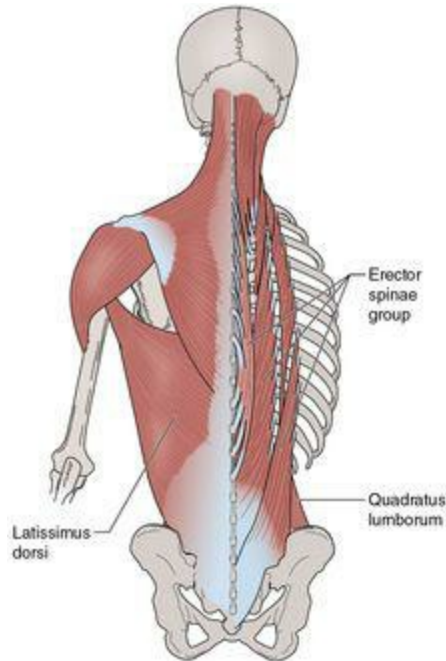
Trunk rotation involves the thoracic and lumbar spines. The major muscles of rotation are the internal and external oblique abdominal muscles ([figure 4.1](#), [table 4.1](#)), assisted by the erector spinae, semispinalis thoracis, multifidus, and rotatores. We list only the oblique abdominal muscles here. The external oblique angles downward and medially from the ribs. The internal oblique angles upward and medially from the lateral and posterior iliac crest.

**Figure 4.1** Oblique abdominal muscles.



In the United States, low back pain ranks second (behind headaches) as the most common medical complaint. Low back pain can be caused by myriad forces, including lumbar or sacral dysfunction, muscle imbalances, repetitive stress, and acute trauma. In the majority of cases of low back pain, stretching of the surrounding musculature will provide significant relief. This includes the back extensors, quadratus lumborum, oblique abdominals, latissimus dorsi, gluteus maximus, quadriceps, and hamstrings ([figure 4.2](#), [table 4.1](#)).

**Figure 4.2** Lower back muscles.



- **Back extensors.** The back extensors consist of the erector spinae group (iliocostalis, longissimus, and spinalis, each with two or three divisions) and the transversospinalis group (semispinalis thoracis, multifidus, rotatores, interspinales, and intertransversarii). We illustrate the erector spinae but do not list the origins and insertions in the table because that information is too complex for this text. These muscles, acting bilaterally, extend the spine. Acting unilaterally, they assist trunk rotation. When these muscles are hypertonic, they can create back pain and limit spinal flexion and rotation. They are also common sites for trigger points.
- **Quadratus lumborum.** The quadratus lumborum (QL) is an important component of a strong and healthy low back. When this muscle is hypertonic, it develops trigger points that refer pain to the hips, to the gluteal area, and down the leg. In our experience, quadratus lumborum hypertonicity and trigger points are nearly always present in low back pain syndromes, even those resulting from disc problems or misalignment of the lumbar vertebrae. The quadratus lumborum is a muscle with many functions. It laterally flexes (side-bends) the trunk and elevates the hip. It also helps stabilize the low back and is therefore usually involved when low back pain is present. The quadratus lumborum has fibers that run vertically and in two diagonals.
- **Latissimus dorsi.** Latissimus dorsi forms part of the posterior axillary border and is used in many activities in which the arm moves from overhead downward, such

as chopping wood, swimming, and rock climbing. It's often overlooked as a source of back pain.

**Table 4.1 Oblique Abdominal and Lower Back Muscles**

Muscle	Origin	Insertion	Action
<b>OBLIQUE ABDOMINAL</b>			
External oblique	Lateral and inferior aspects of the lower eight ribs	Anterior iliac crest and linea alba via the abdominal aponeurosis	Bilaterally: increase intra-abdominal pressure, trunk flexion Unilaterally: lateral flexion of trunk to same side, rotation of trunk to opposite side
Internal oblique	Thoracolumbar fascia Anterior and lateral iliac crest Lateral half of inguinal ligament	Cartilage of the lower three ribs Linea alba via the abdominal aponeurosis	Bilaterally: increase intra-abdominal pressure, trunk flexion Unilaterally: lateral flexion and rotation of trunk to same side
<b>LOWER BACK</b>			
Latissimus dorsi	Spinous processes of T7-L5 Sacrum via the lumbar aponeurosis Crest of ilium	Medial aspect of bicipital groove of humerus	Extension of arm from a flexed position Adduction Shoulder depression Assists internal rotation Provides a "vest pocket" for inferior angle of scapula, holding it against ribs
Quadratus lumborum	Posterior iliac crest and iliolumbar ligament	Inferior border of the 12th rib and transverse processes of L1-L5	Bilaterally: stabilizes the 12th rib during respiration, assists extension of lumbar spine Unilaterally: lateral flexion of trunk or elevation of ilium

## Functional Assessment

Trunk motion is a combination of movement at the lumbar and thoracic spines. Six directions are possible: flexion, extension, rotation to each side, and lateral flexion to each side ([figure 4.3](#)). These movements can also be combined to create a greater variety of motion.

**Figure 4.3** Normal thoracolumbar ranges of motion. (a) Flexion and extension, (b) rotation, and (c) lateral flexion.





Movement in the lumbar and thoracic spines requires a complex combination of motion at each vertebra. Many muscles contribute to every motion, and it is difficult to isolate one muscle at a time. Therefore, even though our focus is on the major muscles of the trunk region, smaller muscles that contribute to the same motion will also be affected.

The thoracolumbar range of motion is as follows:

- Flexion = 90 degrees
- Extension = 30 degrees
- Rotation = 45 degrees
- Lateral flexion = 30 degrees

Stretches: Oblique Abdominals

## **Oblique Abdominal Muscles Partner Stretch, Seated**

This stretch is designed to improve trunk rotation. Twisting to the right stretches the right external oblique and the left internal oblique.

1. The stretcher is seated on a treatment table, with his knees bent and legs hanging over the side, or on a bench with his feet firmly planted on the floor. This position stabilizes the hips. Keeping his spine lengthened and without arching his back, he twists to the right as far as he can, keeping his nose in alignment with his sternum (this neutral position is more comfortable). This position lengthens the left trunk rotators to their pain-free end range.
2. Assume a stable position behind the stretcher, and reach under his right arm to place your right hand on his anterior shoulder. Place your left hand on his left

scapula, near the inferomedial border. Ask him to begin slowly twisting back to the left, keeping his head in neutral ([figure 4.4](#)). Be sure he is twisting from his trunk and not just pushing back with his shoulder. You provide matching resistance for this isometric contraction, being sure the client is breathing normally throughout.

3. After the isometric push, the stretcher relaxes and breathes in. As he relaxes, he maintains his torso in the starting position.
4. As he exhales, ask him to rotate farther to the right, keeping his head in neutral and his spine lengthened. This increases the stretch of the right external oblique and the left internal oblique.
5. Repeat two or three times, and then reposition the client to do the same stretch while turning to the left.

**Figure 4.4** Oblique abdominals stretch (*a*) on a table and (*b*) on a bench.



## **Oblique Abdominal Muscles Self-Stretch, Seated**

1. Sit comfortably in a straight-back chair. Keeping your spine lengthened and your head in neutral, twist to the left as far as you can, and then grab the back of the chair to hold yourself there ([figure 4.5](#)).
2. From this starting position, try to twist back to the right using your trunk, not just your shoulders. Hold this isometric contraction of the obliques for 6 seconds, and keep breathing normally.
3. After this isometric contraction, take a deep breath, and as you exhale, twist farther to the left, using your trunk and not pulling with your arms, to stretch the obliques.

**Figure 4.5** Oblique abdominals self-stretch.



### **Oblique Abdominal Muscles Self-Stretch, Using a Back-Extension Bench**

1. Adjust a back-extension bench to the correct height so you can stand with your right hip against the cushion and your feet firmly placed on the footrest. Side-bend and rotate your trunk to the right, allowing your arms to relax toward the floor (or cross them over your chest if this is more comfortable ([figure 4.6](#))).
2. Slowly begin to rotate back to the left, just enough to engage your muscles against gravity; hold this position, isometrically contracting your obliques for 6 seconds. Keep breathing normally.
3. After this isometric contraction, take a deep breath, and as you exhale, side-bend and twist farther to the right to stretch the obliques.

**Figure 4.6** Oblique abdominals self-stretch using a 45-degree back-extension bench.



*Stretches: Lower Back*

### **Quadratus Lumborum Partner Stretch, Side-Lying**

This stretch is primarily for the vertical fibers, which make up the bulk of the muscle. It works best if the hip abductors are stretched first (see chapter 5).

1. The stretcher is lying on his left side, with his back at the edge of the table and his right leg hyperextended and hanging over the edge of the table. He has his left leg bent and as close to his chest as possible. Be sure he keeps his hips stacked vertically on top of each other. He reaches his right arm up over his head. This lengthens the right QL. If the stretcher experiences any low back pain in this position, he may bend forward from the waist to round his low back while keeping his leg hanging off the edge of the table. If this alternative positioning does not alleviate the stretcher's discomfort, use the supine version of this stretch (see the following stretch).
2. Stand behind the stretcher. Cross your arms and place your left hand against his right iliac crest; your right hand is spread wide and placed on the lateral aspect of his rib cage ([figure 4.7](#)). This crossed-hands position gives you a better mechanical advantage to resist the isometric contraction of QL.
3. Stretcher education begins now. Your goal is to have the stretcher contract the right QL by moving the hip and the ribs toward each other. He is side-bending and hiking his hip at the same time (see the isometric arrows). Many people have difficulty doing this, so you may need to break the motion into separate components and work with him until he can do each motion separately, and then combine them. Be patient and creative.

4. Once the stretcher can perform the motion, ask him to begin slowly trying to move the top of his hip and rib cage toward each other. You apply matching resistance to prevent any motion from occurring. You control the force of his effort.
5. After the isometric push, the stretcher relaxes and inhales deeply. As he relaxes, allow his leg (and his hip) to drop toward the floor.
6. As he exhales, ask the client to actively pull his foot closer to the floor and reach farther up over his head to increase the stretch on the right QL.
7. Repeat two or three times.

**Figure 4.7** Side-lying quadratus lumborum stretch.

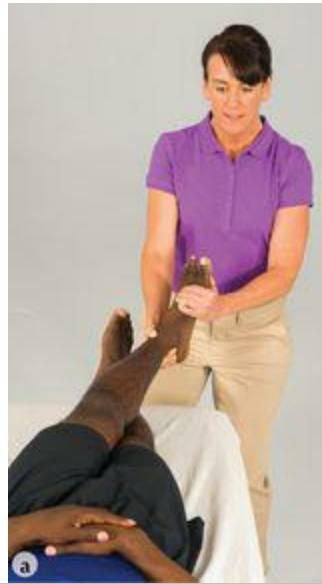


## **Quadratus Lumborum Partner Stretch, Supine With a Leg Pull**

This version of the QL stretch, though slightly less effective, is easier for both the stretcher and the partner.

1. The stretcher is supine on the table or a mat on the floor. Assume a stable position, and firmly grasp the left foot and ankle. Passively stretch the entire leg to pull the hip down, then across the midline, lengthening the QL on the right ([figure 4.8](#)).
2. From this starting position, the stretcher attempts to “hip hike” (pull the hip bone toward the armpit). Be sure he is not lifting the leg toward the ceiling (hip flexion). Hold this isometric contraction of the QL for 6 seconds as the stretcher breathes normally.
3. After the isometric push, the stretcher relaxes and inhales deeply. As he relaxes, maintain the leg in the starting position.
4. As he exhales, passively stretch the leg down and across the midline farther, deepening the stretch on the right QL. You can achieve some additional stretch by having the stretcher move his right arm up over his head to lengthen the entire right side.
5. Repeat two or three times.

**Figure 4.8** Quadratus lumborum stretch, leg-pull variation, (a) on a table and (b) on a mat.



## **Quadratus Lumborum Self-Stretch, Sitting With a Side-Bend**

1. Sit comfortably on a straight-back chair or a bench with your spine lengthened. Place a long towel or stretching strap under your left foot. Move your right arm up behind your head, being careful not to force your chin to your chest. Side-bend to the left as far as you can, grab the stretching strap in your left hand, and take up any slack ([figure 4.9](#)). This position lengthens the right QL.

2. Using the stretching strap to prevent your motion, slowly try to sit up straight, isometrically contracting the right QL for 6 seconds as you keep breathing normally.
3. After the isometric contraction, relax, breathe, and deepen the stretch by bending farther to the left.
4. Repeat two or three times.

**Figure 4.9** Quadratus lumborum self-stretch.



### **Back Extensors Stretch, Supine, Both Knees to Chest, With a Partner**

This is an excellent stretch for the muscles on either side of the lower back.

If the stretcher is already complaining of low back pain, this stretch may be contraindicated because of the risk of causing or exacerbating a possible herniated disc.

1. The stretcher lies on his back on a treatment table or a mat on the floor. He actively pulls both knees as close to his chest as he can. Assume a stable position at his side, place your hands behind his knees, and add just enough passive stretch (knees to chest) so that he feels a slight stretch in his low back ([figure 4.10](#)).
2. Direct the stretcher to begin slowly pushing against you, as if straightening his legs. This will isometrically engage the gluteus maximus and the lower back muscles. Hold this isometric contraction for 6 seconds as the stretcher breathes normally.
3. After the isometric contraction, the stretcher relaxes while you add additional passive stretch (knees to chest) to increase the stretch on the lumbar paraspinal muscles.
4. Repeat two or three times.

**Figure 4.10** Back extensors stretch with a partner (a) on a table and (b) on a mat.



## **Back Extensors Self-Stretch, Supine With Both Knees to Chest**

This is an excellent stretch for the muscles on either side of the lower back.

If you are already experiencing low back pain, this stretch may be contraindicated because of the risk of causing or exacerbating a possible herniated disc. Please consult your doctor before proceeding.

1. Lie on your back on a mat on the floor. Actively pull both knees as close to your chest as you can. Place your hands behind your knees, and add just enough passive stretch (knees to chest) so that you feel a slight stretch in your low back ([figure 4.11](#)).
2. Begin to slowly push against your hands, as if straightening your legs. This will isometrically engage the gluteus maximus and the lower back muscles. Hold this isometric contraction for 6 seconds, breathing normally.

3. After the isometric contraction, relax and breathe, and then add additional passive stretch (knees to chest) to increase the stretch on the lumbar paraspinal muscles.
4. Repeat two or three times.

**Figure 4.11** Back extensors self-stretch.



### **Spinal Twist Partner Stretch, Supine**

This stretch works the lumbar paraspinals, the quadratus lumborum, and the oblique abdominals. The tightest of these muscle groups will feel it the most.

If the stretcher is already complaining of low back pain, this stretch may be contraindicated because of the risk of causing or exacerbating a possible herniated disc. Please consult your doctor before proceeding.

1. The stretcher lies on his back on a treatment table or a mat on the floor. He flexes his hips to about 60 degrees, bends his knees, and places his feet flat. Keeping his shoulders flat against the surface, he drops both knees to the right side as far he can go comfortably. This lengthens the low back muscles on the left.
2. Assume a stable position on the stretcher's right side that allows you to provide resistance as the stretcher attempts to move his legs back up to the starting position ([figure 4.12](#)).
3. Direct the stretcher to start slowly attempting to move his legs back to the starting position while you keep him from moving. Hold this isometric contraction for 6 seconds as the stretcher breathes normally.
4. After the isometric contraction, direct the stretcher to pull his knees closer to the floor on the right, stretching the left lower back.
5. Repeat two or three times.

**Figure 4.12** Spinal twist stretch with a partner.



### **Spinal Twist Self-Stretch, Supine**

If you are already experiencing low back pain, this stretch may be contraindicated because of the risk of causing or exacerbating a possible herniated disc. Please consult your doctor before proceeding.

1. Lie on your back on a mat on the floor. Flex your hips to about 60 degrees, bend your knees, and place your feet flat. Cross your left knee over your right, keep your shoulders on the mat, and drop both knees to the left side as far you can go comfortably. This lengthens the low back muscles on the right ([figure 4.13](#)).
2. Use your left leg to provide resistance as you slowly attempt to move your right leg back up to the starting position. Hold this isometric contraction for 6 seconds and continue to breathe normally.
3. After the isometric contraction, pull your knees closer to the floor on the left, stretching the right lower back.
4. Repeat two or three times.

**Figure 4.13** Spinal twist self-stretch.



## Neck

The cervical, or neck, area is a storehouse of muscular tension. Many people experience discomfort or pain in this region because of postural stress, job-related activities, or trauma. Stretching the neck muscles can provide great relief from tightness and pain but can also create pain if done too aggressively. Two common complaints related to the head and neck area are whiplash and headaches.

- **Whiplash.** Whiplash is the popular name for an injury to the vertebrae and soft tissues of the neck caused by sudden and traumatic flexion–extension of the cervical spine. The medical term for whiplash is cervical acceleration–deceleration injury. Although commonly associated with auto accidents, whiplash can occur in any situation where the neck moves violently, as in being tackled in American football, ice hockey collisions, or falling backward off a ladder. The symptoms of whiplash injuries vary widely from person to person. Depending on the severity of the injury, the vertebrae and vertebral discs can be compromised; ligamentous tissues may be sprained, especially the anterior longitudinal ligament; and a variety of neck muscles may be strained. Symptoms can include limited and painful movement of the neck; severe headaches; muscle spasm around the neck, shoulders, and upper back; radiating pain into the arms; and blurred vision. Stretching is contraindicated in the acute phase of this condition but may offer significant relief in the later stages of recovery as part of an overall treatment program.
- **Headache.** Headaches are the most common medical complaint in the United States, accounting for billions of dollars per year in sales of over-the-counter medications. The International Headache Society has classified more than 200

headache types. Tension headaches are the most common type and generally respond well to a combination of massage and stretching for the muscles of the neck and shoulders. Migraine headaches are more recalcitrant and respond unpredictably to massage and stretching.

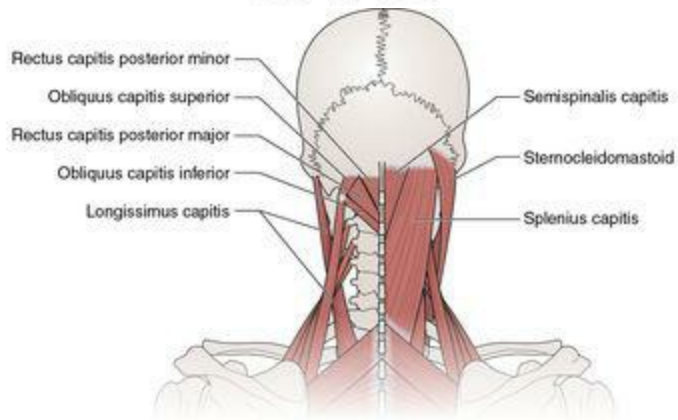
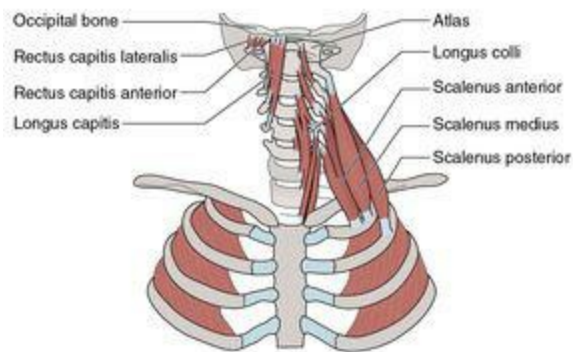
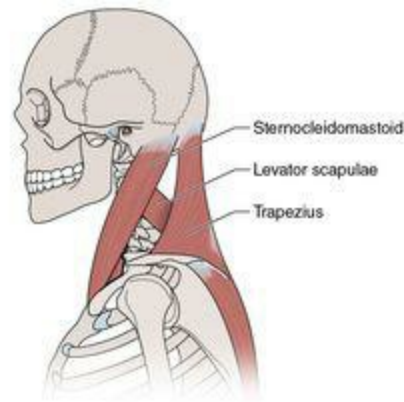
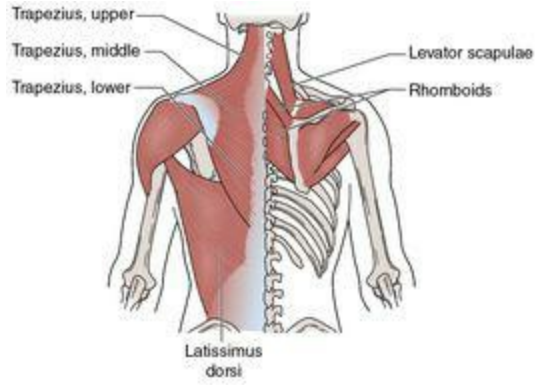
When performing neck stretches, be especially careful that the stretch is pain free at all times. If you are working with someone who has suffered any type of neck injury, work cautiously. Sometimes the stretch may not realize he is overworking and will end up with increased pain a day or two later.

## Anatomy

Muscles of the cervical region include the upper trapezius, sternocleidomastoid (SCM), suboccipitals, scalenes, and levator scapulae ([figure 4.14](#), [table 4.2](#)). We discuss each here, then describe the functional assessment of the cervical spine.

- **Upper trapezius.** Many people have hypertonic upper trapezius muscles. When the upper trapezius muscles are too tight, they can limit range of motion, create neck and shoulder pain, and cause headaches. They also develop significant trigger points.
- **Sternocleidomastoid.** The SCM is a complex muscle with many actions. At its inferior attachments, it has two parts, the sternal and clavicular. These two divisions merge into a common attachment on the skull.
- **Scalenes.** The scalene muscles are divided into three sections: anterior, middle, and posterior. They are strongly implicated in thoracic outlet syndrome, carpal tunnel syndrome, and other painful conditions of the neck, shoulder, and arm. This is because the brachial plexus (a bundle of nerves) and the subclavian artery pass between the anterior and middle scalenes and may become entrapped and compromised if the muscles are hypertonic.
- **Suboccipitals.** The four suboccipital muscles comprise two pairs: the two rectus capitis and the two obliquus muscles. They are the deepest muscles of the posterior upper neck. The rectus capitis posterior major and the obliques form the suboccipital triangle on each side of the spine. The vertebral artery crosses through the triangle, which is filled with dense, fatty connective tissue and is covered by the more superficial semispinalis capitis and longissimus capitis. Even though they are small, these muscles often hold a tremendous amount of tension and benefit greatly from stretching.
- **Levator scapulae.** The levator scapulae is often implicated in complaints of neck stiffness, especially when rotation is limited. Postural stress may cause this muscle to be hypertonic or eccentrically stressed, in which case it may need strengthening rather than stretching.

Figure 4.14 Muscles of the cervical region.



**Table 4.2 Muscles of the Cervical Region**

Muscle	Origin	Insertion	Action
Levator scapulae	Transverse process of C1-C4	Superior angle and medial border of scapula	Bilaterally: extends head and neck, assists shoulder shrugs Unilaterally: assists downward rotation and elevation of scapula, assists lateral flexion and rotation of neck to same side
Obliquus capitis inferior	Spinous process of the axis (C2)	Transverse process of the axis (C1)	Rotates and tilts the head to the same side
Obliquus capitis superior	Transverse process of the atlas (C1)	Lateral aspect of the occiput, between the superior and inferior nuchal lines	Extends the head on the neck Tilts the head to the same side
Rectus capitis posterior (RCP) major	Spinous process of the axis (C2)	Inferior nuchal line of the occiput, lateral to the RCP minor	Extends the head on the neck Rotates and tilts the head to the same side
Rectus capitis posterior (RCP) minor	Tubercle located on the posterior arch of the atlas (C1)	Inferior nuchal line of the occiput, medial to the RCP major	Extends the head on the neck
Scalene, anterior	Anterior aspect of transverse processes of C3-C6	Superior aspect of first rib	Lateral flexion of cervical spine Assists neck flexion Elevates ribs during inspiration
Scalene, middle	Transverse processes of C2-C7	Superior aspect of first rib posterior to middle scalene	Lateral flexion of cervical spine Elevates ribs during inspiration
Scalene, posterior	Transverse processes of C5-C7	Superior aspect of second rib posterior to middle scalene	Lateral flexion of cervical spine Elevates ribs during inspiration
Sternocleidomastoid	Sternal division: anterior aspect of manubrium of sternum Clavicular division: anterior superior aspect of medial one-third of the clavicle	Lateral aspect of mastoid process Lateral half of superior nuchal line on the occipital bone	Bilaterally: flexion of head and neck, especially against resistance of gravity Unilaterally: rotation of head to opposite side, assists lateral flexion to same side
Upper trapezius	Occiput Spinous processes of C7-T12 and the ligamentum nuchae	Posterior aspect of lateral one-third of the clavicle	Unilaterally: elevation of shoulder, lateral flexion of head and neck Bilaterally: extension of head and neck

## Functional Assessment

The cervical spine is capable of motion in six directions: flexion, extension, lateral flexion to each side, and rotation to each side (see [figure 4.15](#)). These motions can also be combined to create a greater variety of movement. In addition to moving with the neck, the head moves independently on the cervical spine in flexion, extension, rotation, and tilting to the side.

**Figure 4.15** Normal range of motion for the head and neck.

**ROM for the Head on the Neck**

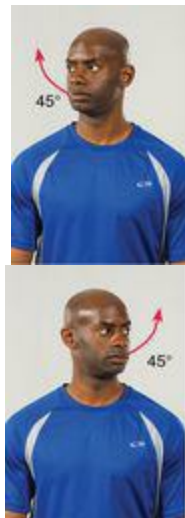
The next two photos show flexion = 10°:



The next two photos show extension = 25°:



The next two photos show rotation = 45°:



**ROM for the Neck**

The next photo shows flexion =  $85^{\circ}$ :



The next photo shows extension =  $70^{\circ}$ :



The next two photos show rotation =  $80^{\circ}$ :



The next two photos show lateral flexion =  $40^{\circ}$ :



Range of motion for the head on the neck is as follows:

- Flexion = 10 degrees (tucking chin to neck)
- Extension = 25 degrees (looking up)
- Rotation = 45 degrees

Range of motion for the neck is as follows (these values include the motion of the head on the neck in the previous list):

- Flexion = 85 degrees (tucking chin to chest)
- Extension = 70 degrees (tilting the head and neck back)
- Rotation = 80 degrees
- Lateral flexion = 40 degrees

Movement of the head and neck is more complex than movements around other joints. Many muscles contribute to each movement, and it is difficult to isolate one muscle at a time. Therefore, even though our focus is on five muscle groups (upper trapezius, SCM, suboccipitals, scalenes, and levator scapulae), synergistic muscles that contribute to the same motion will also be affected.

Stretches: Upper Trapezius

## **Upper Trapezius Partner Stretch, Supine on a Table**

This stretch improves range of motion in cervical rotation and flexion and in shoulder depression. The optimal kinesiological position for stretching the left upper trapezius is neck flexion, right lateral neck flexion, left rotation, and left shoulder depression. This is an extremely difficult position for the stretcher to initiate and maintain while supine, and it is challenging for the practitioner to hold correctly. We decided to feature the stretch as demonstrated because rotating the head to the right, flexing the neck (chin tuck), and depressing the left shoulder lengthens the left upper trap sufficiently to obtain an effective stretch. This positioning is comfortable for the stretcher, since the head rests on the table, and allows the practitioner to comfortably and easily provide resistance to shoulder elevation and neck extension. This positioning does not address the rotational action of the upper trapezius.

1. The stretcher is supine on a treatment table. Help her rotate her head to the right as far as possible without pain and then tuck her chin as far as possible. If the right shoulder interferes with this motion, have the stretcher pull it down, away from the head, and tuck the chin again. The stretcher also pulls her left shoulder down away

from her head. This starting position lengthens the left upper trapezius to its pain-free end range.

2. Place the base of your left hand at the stretcher's occiput, with your fingers resting on the head behind her ear. Place your right hand on her left shoulder ([figure 4.16](#)). Ask the stretcher to begin slowly pushing against both of your hands, as if moving the back of her head and her left shoulder together. You provide matching resistance as she isometrically contracts her left upper trapezius for 6 seconds. She is pushing equally from both ends and breathing normally throughout.
3. After the isometric push, the stretcher relaxes and breathes in. As she relaxes, maintain the head in the starting position.
4. As she exhales, the stretcher rotates her head farther to the right, tucks her chin more (if possible), and pulls her left shoulder farther away from her head. This deepens the upper trapezius stretch.
5. Repeat two or three times.

**Figure 4.16** Left upper trapezius stretch on a table.



## **Upper Trapezius Partner Stretch, Supine With an Arm Pull**

This is an alternative stretch, easier to perform but slightly less effective than the previous supine stretch.

1. The stretcher is supine on the table. Stand at her left side, and ask her to reach her left arm toward her feet to depress the left shoulder. Grasp the left hand and wrist. This starting position lengthens the left upper trapezius ([figure 4.17](#)).
2. Direct the stretcher to slowly attempt to shrug her left shoulder while you prevent the motion. Hold this isometric contraction of the upper trapezius for 6 seconds.
3. The stretcher relaxes and breathes, and as she exhales, ask her to reach toward her feet again, deepening the stretch on her left upper trapezius. The stretcher can achieve additional stretch by rotating her head more to the right.
4. Repeat two or three times.

**Figure 4.17** Left upper trapezius stretch, arm-pull version.



## **Upper Trapezius Partner Stretch, Seated**

This version stretches both sides simultaneously.

1. The stretcher is seated on a chair or bench. She sits tall to keep her spine lengthened and reaches her arms toward the floor to lengthen the upper traps to their comfortable end range.
2. Assume a stable position behind the stretcher, and place your hands on top of and at the edge of her shoulders ([figure 4.18](#)).
3. Direct the stretcher to begin slowly attempting to shrug her shoulders while you resist, isometrically contracting the upper traps for 6 seconds as the stretcher breathes normally.
4. After the isometric push, the stretcher relaxes and breathes in. As she exhales, she keeps her back long while she reaches her arms toward the floor to stretch the upper traps.
5. Repeat two or three times.

**Figure 4.18** Seated upper trapezius stretch with a partner.



### **Upper Trapezius Self-Stretch, Supine**

1. This is an easy stretch to do by yourself. Lie down on your back, keep your neck lengthened, and turn your head to the right as far as possible; tuck your chin as far as possible, and pull your left shoulder toward your feet. Now, place your left arm under your body to anchor your left shoulder. Wrap your right arm around your head so that your right fingers can hold the base of your skull ([figure 4.19](#)).
2. From this starting position, try to move your left shoulder and the back of your head toward each other for 6 seconds while you resist the motion with your hands.
3. After this isometric contraction of the left upper trapezius, increase the stretch by turning farther to the right, tucking your chin, and pulling your left shoulder farther away from your head.

**Figure 4.19** Upper trapezius self-stretch.



Stretches: Sternocleidomastoid

**Sternocleidomastoid Partner Stretch, Supine**

This stretch improves rotation of the head and neck.

1. The stretcher is supine on a treatment table or a mat on the floor. Keeping her neck lengthened, guide her as she rotates her head to the left as far as possible without pain. This starting position lengthens the left SCM to its pain-free end range.
2. Cradle the stretcher's head in your left hand, which rests on the surface; place your right hand just above her right ear ([figure 4.20](#)). Ask the client to begin slowly attempting to rotate her head to the right. She is not trying to lift her head from the table. You provide matching resistance as she isometrically contracts her SCM for 6 seconds. The client is breathing normally throughout.
3. After the isometric push, the stretcher relaxes and breathes in. As she relaxes, maintain the head in the starting position.
4. As she exhales, the stretcher rotates her head farther to the left, deepening the stretch on the left SCM.
5. Repeat two or three times.

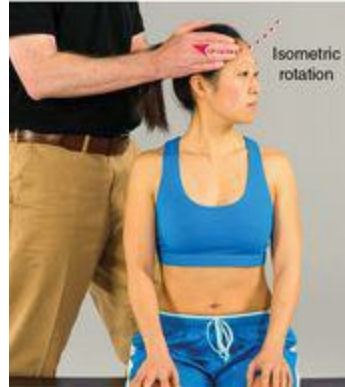
**Figure 4.20** Sternocleidomastoid stretch (*a*) on a table and (*b*) on a mat.



### **Sternocleidomastoid Partner Stretch, Seated**

1. The stretcher is sitting on a chair or bench. Keeping her back and neck lengthened, she rotates her head to the left as far as she can comfortably go. This starting position lengthens the left SCM to its pain-free end range.
2. Assume a stable stance that allows you to place your hands on each side of the stretcher's head, just above her ears ([figure 4.21](#)).
3. Ask the stretcher to begin slowly attempting to rotate her head to the right. You provide matching resistance as she isometrically contracts her SCM for 6 seconds (see the isometric rotation arrow). The stretcher is breathing normally throughout.
4. After the isometric push, the stretcher relaxes and breathes in. As she relaxes and exhales, the stretcher rotates her head farther to the left, deepening the stretch on the left SCM.
5. Repeat two or three times.

**Figure 4.21** Seated SCM stretch.



### **Sternocleidomastoid Self-Stretch, Supine**

1. Lie down on your back, and turn your head to the left as far as possible, keeping your neck lengthened. Place one hand under your head and the other just above your right ear ([figure 4.22](#)).
2. From this starting position, begin slowly attempting to turn your head to the right for 6 seconds while you resist the motion with your hands. Be sure not to try to lift your head from the floor or table; turn only to the right.
3. After this isometric contraction of the SCM, relax, breathe, and increase the stretch by turning farther to the left.

**Figure 4.22** Sternocleidomastoid self-stretch. Keep your head on the mat.



Stretches: Scalenes

**Scalenes Partner Stretch, Supine**

This stretch improves lateral flexion of the head and neck.

1. The stretcher is supine. Guide her as she laterally flexes her head and neck to the right as far as possible without pain. Prevent her from adding rotation to the motion by asking her to keep her nose pointed directly at the ceiling. She also pulls her left shoulder away from her head to anchor the attachments of the scalenes on the ribs. This starting position lengthens the left scalenes to their pain-free end range.
2. Place your right hand on the stretcher's head just above her left ear. Place your left hand against her left shoulder to anchor it in place ([figure 4.23](#)). Direct the stretcher to begin slowly pushing against your right hand as if she is trying to move her left ear directly to her left shoulder. Be sure she does not add rotation to her effort. She does not push up with her shoulder because you're using the shoulder to anchor the ribs, which are the distal attachment of the scalenes (see the isometric push arrow). You provide matching resistance as she isometrically contracts her scalenes for 6 seconds. The stretcher is breathing normally throughout.
3. After the isometric push, the stretcher relaxes and breathes in. As she relaxes, maintain the head in the starting position.
4. As she exhales, ask the stretcher to move her right ear closer to her right shoulder, being sure to keep her nose pointed directly at the ceiling. This deepens the stretch of the left scalenes.
5. Repeat two or three times, then help the stretcher reposition her head to do the same stretch for the right scalenes.

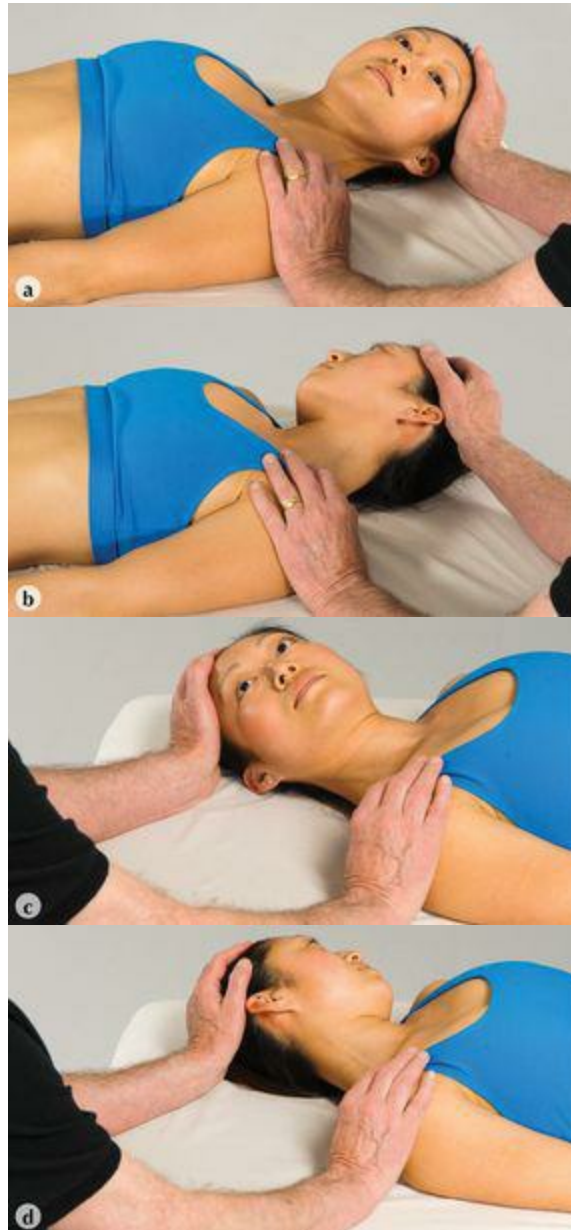
**Figure 4.23** Scalene stretch, with no rotation of the head.



For more specificity, you can isolate the anterior or posterior scalenes by rotating the head as follows:

- Left anterior scalene—Laterally flex the neck to the right, and then rotate the head 45 degrees to the left ([figure 4.24a](#)). From this position, follow the stretching sequence.
- Left posterior scalene—Laterally flex the neck to the right, and then rotate the head 45 degrees to the right ([figure 4.24b](#)). From this position, follow the stretching sequence.
- Right anterior scalene—Laterally flex the neck to the left, and then rotate the head 45 degrees to the right ([figure 4.24c](#)). From this position, follow the stretching sequence.
- Right posterior scalene—Laterally flex the neck to the left, and then rotate the head 45 degrees to the left ([figure 4.24d](#)). From this position, follow the stretching sequence.

**Figure 4.24** Isolating the scalenes. (a) Left anterior scalene, (b) left posterior scalene, (c) right anterior scalene, and (d) right posterior scalene.

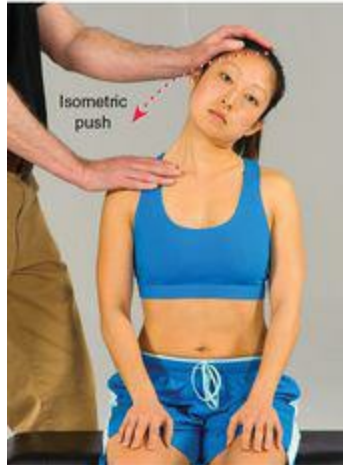


### **Scalenes Partner Stretch, Seated**

1. The stretcher is sitting on a chair or bench. Keeping her back and neck lengthened, she side-bends her head to the left as far as she can comfortably go without adding any rotation. This starting position lengthens the right scalenes to their pain-free end range.

2. Assume a stable stance that allows you to place one hand on her right shoulder and one hand on her head, just above her right ear ([figure 4.25](#)).
3. Ask the stretcher to begin slowly attempting to side-bend her head to the right. You provide matching resistance as she isometrically contracts her right scalenes for 6 seconds (see the isometric push arrow). The stretcher is breathing normally throughout.
4. After the isometric push, the stretcher relaxes and breathes in. As she relaxes and exhales, the stretcher side-bends her head farther to the left, deepening the stretch on the right scalenes.
5. Repeat two or three times.

**Figure 4.25** Seated scalenes stretch.



### **Scalenes Self-Stretch, Supine**

1. Lie down on your back. Pull your left shoulder away from your ear and anchor it by placing your left arm under your body. Keeping your nose pointed toward the ceiling (so you don't rotate your head), side-bend your neck to move your right ear as close to your right shoulder as possible. You may need to lift your head slightly as you move, if it won't slide on the floor. Once you've completed the side bend, let your head rest on the floor again. Move your right arm up around your head, with your fingers holding just above your left ear ([figure 4.26](#)).
2. From this starting position, try to move your left ear toward your left shoulder. Don't try to lift your head from the floor as you push, and keep your nose pointed at the ceiling. After this 6-second isometric contraction of the left scalenes, see if you can move your right ear closer to your right shoulder. Don't pull it with your hand; use your neck muscles. You may need to lift your head slightly as you move, if it won't slide on the floor.

**Figure 4.26** Scalenes self-stretch. Keep your head on the mat as you push.



Stretches: Suboccipitals

### **Suboccipitals Partner Stretch, Supine**

This stretch improves flexion of the head on the neck and helps release the head to balance more freely on the cervical spine.

1. The stretcher is supine on a table or a mat on the floor. Sit at her head and cup your hands under the head so that the pads of your fingers (not the fingertips) can palpate the occiput. Ask the stretcher to tuck her chin toward her throat. She does not try to lift her head toward her chest; rather, she is trying to lengthen the back of her neck. This starting position lengthens the suboccipitals to their end range ([figure 4.27](#)).
2. Direct the stretcher to begin slowly and gently tilting her head back. As she begins, you may feel the occiput slip from your fingers. If this happens, stop and start again, very slowly, so that you can maintain contact with the occiput. This isometric contraction can be done with a minimum of effort by the stretcher. Hold for 6 seconds as the stretcher breathes normally.
3. The stretcher relaxes and breathes, and as she exhales, she tucks her chin again, deepening the stretch on the suboccipitals.
4. Repeat one or two times.

**Figure 4.27** Suboccipitals stretch starting position. The blow-out photo illustrates finger placement.



### **Suboccipitals Self-Stretch, Supine**

1. Lie on your back and wrap your hands around the back of your head so that your thumbs are sitting at the base of your skull. Tuck your chin into your throat, trying not to lift your head off the floor ([figure 4.28](#)).
2. From this starting position, gently try to tilt your head back, using your thumbs to prevent the motion. Hold this isometric contraction of the suboccipitals for 6 seconds. Relax and breathe, and as you exhale, tuck your chin again, deepening the stretch on the suboccipitals.

**Figure 4.28** Suboccipitals self-stretch.



*Stretches: Levator Scapulae*

### **Levator Scapulae Partner Stretch, Seated**

This stretch improves head and neck flexion and helps normalize the position of the shoulder blades on the back.

1. The stretcher sits comfortably on a chair, low stool, or bench, keeping her back lengthened. Ask her to tuck her chin to her chest and then rotate her head to the right about 45 degrees. Stand behind the stretcher, and place one hand on the back of her head and the other at the top of her left scapula. This starting position lengthens the left levator to its end range ([figure 4.29](#)).
2. Direct the stretcher to start slowly lifting her head and neck and her left shoulder simultaneously as you provide resistance to this isometric contraction of the left levator for 6 seconds. Be sure the stretcher is not just trying to extend the head on the neck, but is lifting the head and neck together (see the isometric push arrows).
3. At the end of the isometric push, the stretcher relaxes and breathes, and as she exhales, she tucks her chin closer to her chest to deepen the stretch on the levator.
4. Repeat two or three times.

**Figure 4.29** Levator scapulae stretch.



Figure 4.29 Levator scapulae stretch.

## Levator Scapulae Self-Stretch, Seated

1. Sit comfortably, keeping your spine lengthened. Use your muscles to pull your left shoulder blade down your back and hold it there. Drop your head to your chest, then turn your chin to the right about 45 degrees. Move your right hand up to the top of your head and pull slightly until you feel a stretch of the left levator scapulae. You may need to play with your head position a little to find this place of stretch. Be sure to keep your spine long ([figure 4.30](#)).
2. From this starting position, slowly try to lift your head and neck against your own resistance, isometrically contracting the left levator scapulae for 6 seconds. Relax and breathe, and as you exhale, increase the stretch by tucking your chin more.
3. Repeat two or three times.

**Figure 4.30** Levator scapulae self-stretch.



# Chapter 5

## Stretches for the Lower Extremity

Flexibility in the hips and legs is important for success in most sports. When a muscle is chronically shortened, it cannot develop its full power when called on to contract. In addition, a chronically short muscle limits range of motion. Consider the runner's gait. Short, tight hamstrings will cause the quadriceps to work harder to accomplish a full stride because they are pulling against the internal resistance of the hamstrings. This extra work fatigues both muscle groups, setting the stage for lackluster performance and for injury.

The stretches in this chapter will help develop flexibility in the major muscles of the hips and legs, which will contribute to improved athletic performance and more comfort in daily activities.

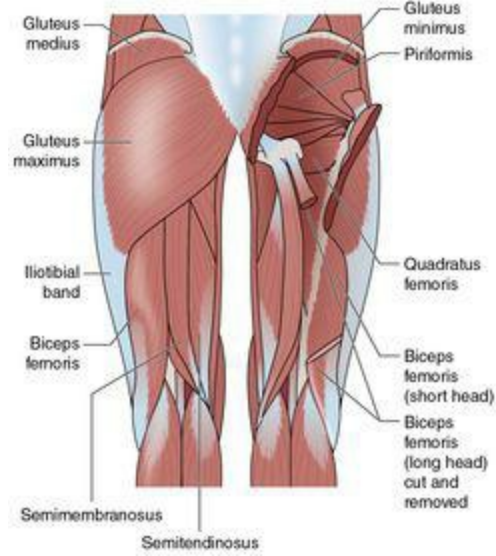
## **Hip Extensors: Hamstrings and Gluteus Maximus**

## Anatomy

Chronically shortened hamstrings can contribute to low back pain, knee pain, and leg-length differences. They can also restrict stride length in walking or running, can cause the quads to overwork, and are more susceptible to injuries such as tendinitis. Hamstring tendinitis is a painful inflammation of the hamstrings attachment on the “sit” bone (ischial tuberosity) at the top of the back of the thigh. It’s commonly a result of overuse and is a common injury for distance runners. Typical symptoms include pain not only at the attachment point but also more generally along the hamstring muscles. Knee flexion and hip extension can both increase the pain. The hip and knee may also feel stiff and sore after periods of inactivity, such as first thing in the morning. As with most overuse injuries, the onset of symptoms occurs gradually, typically over a period of months. Chronic cases of this condition tend to exhibit degenerative changes in the tendon without inflammation and are categorized as hamstring tendinosis. Treatment recommendations include rest, ice, and stretching of the hamstring muscles to reduce tension on the tendon. Additional treatment may include massage therapy, wearing a compression wrap or brace around the thigh during activity, and strengthening exercises for the hamstrings when pain free.

The gluteus maximus is a powerful hip extensor ([figure 5.1](#), [table 5.1](#)). It can be involved in low back pain, especially if it’s hypertonic (too tight) or if it’s weak or dysfunctional as a result of injury, overuse, or lack of exercise. For example, the normal muscle activation sequence for hip extension is initiated by the gluteus maximus, with the assistance of the biceps femoris, and is followed by contraction of the low back muscles (to help stabilize the lumbar spine). If the normal contraction sequence is altered, the erector spinae will contract first, followed by the gluteus maximus and hamstrings. This pattern places excessive stress on the lumbar spine, which may lead to back pain.

**Figure 5.1** Hip extensor muscles.



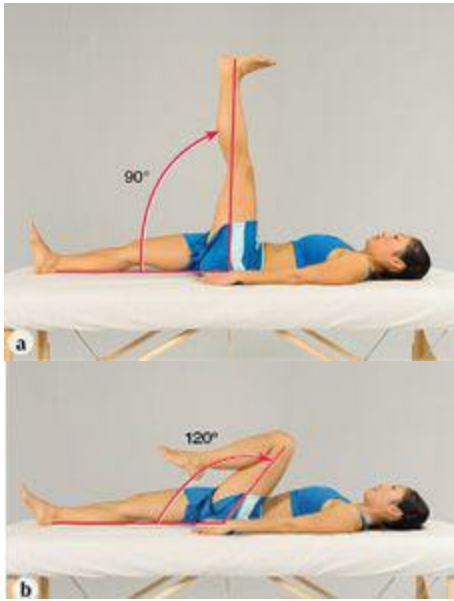
**Table 5.1 Hip Extensor Muscles**

Muscle	Origin	Insertion	Action
Biceps femoris	Long head: Ischial tuberosity Short head: linea aspera of femur	Head of fibula	Long head: hip extension Both heads: knee flexion, lateral rotation of lower leg with knee flexed
Gluteus maximus	Medial one-third of the posterior ilium, just inferior to the posterior iliac crest, lateral sacrum, coccyx, and sacrotuberous ligament	Posterior aspect of the iliotibial band and gluteal tuberosity of the femur	Powerfully extends the hip, especially from a flexed position Lower fibers assist lateral rotation of the femur
Semimembranosus, semitendinosus	Ischial tuberosity	Semimembranosus: posteromedial tibial condyle Semitendinosus: anterior proximal tibial shaft (pes anserine)	Hip extension Knee flexion Medial rotation of lower leg with knee flexed

## Functional Assessment

Check range of motion. Hip flexion to 90 degrees with the leg straight is optimal ([figure 5.2a](#)). If the range is less than 90 degrees, do facilitated stretching for the hamstrings. With the knee bent, hip flexion should increase to approximately 120 degrees ([figure 5.2b](#)). If the hip flexion range is limited when the knee is bent, focus on stretching the gluteus maximus.

**Figure 5.2** (a) Hip flexion to 90 degrees with the knee straight is ideal. (b) With the knee bent, look for 120 degrees of flexion.



Stretches: Hip Extensors

### Hamstrings Partner Stretch, Supine With Straight Leg

This is an effective general stretch for the hamstrings to improve hip flexion. The most common compensation during the hamstrings stretch is for the stretcher to lift the hip off the surface. This is usually an unconscious attempt to recruit the more powerful gluteus maximus to make up for weak hamstrings. By making sure that both hips stay flat on the surface, you can ensure the hamstrings are isolated.

1. The stretcher is supine on a treatment table or a mat on the floor. She lifts her right leg as high as possible, keeping her knee straight. Typically, a stretcher will bend her knee as she lifts her leg because this allows greater hip flexion, but it gives you a false measurement of her real flexion. As the partner, your job is to remind the stretcher to keep her knee straight as she lifts. This lengthens the right hamstrings to their pain-free end range.
2. Assume a stable position that allows you to comfortably offer resistance to the isometric contraction of the hamstrings (see the hold arrow in [figure 5.3](#)). The stretcher must keep her hips flat on the surface during the entire sequence. You may need to work with the stretcher on body awareness until she is able to stabilize her hips properly before performing this stretch. The stretcher may bend her left knee and rest her foot flat on the surface instead of having her left leg outstretched, if

this is a more comfortable position.

3. Direct the stretcher to begin slowly attempting to push her leg toward the surface without bending her knee, isometrically contracting the hamstrings for 6 seconds. (“Allow your knee to lock, and push against me as if you’re trying to put your heel on the table.”) See the isometric push arrow in [figure 5.3](#).
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the leg in the starting position.
5. As she exhales, the stretcher contracts the hip flexors (quads and psoas) to lift the leg higher, keeping her knee straight. This deepens the hamstrings stretch. As the stretcher lifts her leg higher, remind her to keep her knee straight.
6. Now move into the new position to once again offer resistance.
7. Repeat two or three times.

**Figure 5.3** Straight-leg hamstrings stretch (a) on a table and (b) on a mat.



### Hamstrings Partner Stretch, Supine With Bent Knee

This is a better stretch for people with very short hamstrings. Once they've achieved more flexibility, you can use the straight-leg stretch. Since the bent-knee position focuses the isometric effort on the distal hamstrings, it can be used as an adjunct to soft-tissue work in this area.

1. The stretcher lies supine on a treatment table or a mat on the floor and lifts her thigh to flex her hip to 90 degrees, with the knee bent.
2. Stabilize the thigh in this vertical position while the stretcher straightens the lower leg as far as possible, without pain. This lengthens the hamstrings to their pain-free end range ([figure 5.4](#), a and e).
3. Assume a stable position that allows you to comfortably offer resistance to the isometric contraction of the hamstrings, at the same time making sure the stretcher

keeps her hips flat on the surface during the entire sequence. You may need to work with the stretcher on body awareness until she is able to stabilize her hips properly before performing this stretch.

4. Direct the stretcher to begin slowly attempting to bend her knee as if pushing her heel toward her buttock, isometrically contracting the hamstrings for 6 seconds. (“Keep your thigh where it is, and try to bend your knee by pushing your heel toward your buttock.”) See the isometric push arrow in [figure 5.4, a and e](#).
5. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the leg in the starting position.
6. As she exhales, the stretcher contracts her quadriceps to straighten the lower leg farther. This deepens the hamstrings stretch. As the stretcher straightens her leg, gently hold the thigh in the 90-degree position (see the active stretch arrow in [figure 5.4, b and f](#)).
7. Repeat this stretch position again, and then, if you wish, add the next level of difficulty.
8. Direct the stretcher to place her hands behind her bent knee and pull her thigh as close to her chest as she comfortably can and hold it there throughout the exercise.
9. Next, direct the stretcher to straighten the lower leg as far as possible, without pain and without allowing her thigh to come away from her chest. This once again lengthens the hamstrings to their pain-free end range ([figure 5.4, c and g](#)).
10. Position yourself to offer resistance to the isometric contraction of the hamstrings.
11. Direct the stretcher to begin slowly attempting to bend her knee as if pushing her heel toward her buttock, isometrically contracting the hamstrings for 6 seconds. (“Keep your thigh close to your chest, and try to bend your knee by pushing your heel toward your buttock.”) See the arrows in each photo.
12. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the leg in the starting position.
13. As she exhales, the stretcher contracts her quadriceps to straighten the lower leg farther if possible. This deepens the hamstrings stretch ([figure 5.4, d and h](#)).

**Figure 5.4** Bent knee hamstrings stretch (Part I). (a) On a treatment table. (e) On a yoga mat. (b and f) The stretcher actively deepens the stretch with no assistance from the partner. Bent knee hamstrings stretch (Part II). (c) On a treatment table. (g) On a yoga mat. (d and h) The stretcher actively deepens the bent-knee hamstring stretch with no assistance from the partner.





## Hamstrings Self-Stretch, Supine With Stretching Strap

For self-stretching, the sequence of steps is the same as for assisted stretching, but the partner is replaced by a towel, a stretching strap, or an upright object such as a doorjamb.

1. Lie on your back, and lift your left leg as high as possible, keeping your knee straight. Keep both hips flat on the mat during the entire sequence. You may bend your right knee and rest your foot flat on the mat, instead of having your right leg outstretched, if this is a more comfortable position. Use a towel or stretching strap wrapped around the arch of your foot, close to the heel, to provide resistance to the hamstrings contraction ([figure 5.5](#)). The strap simply replaces the partner.
2. Begin slowly attempting to push your left heel toward the floor, isometrically contracting the hamstrings for 6 seconds. After the isometric push, relax and inhale deeply. During this time, maintain the leg in the starting position.
3. As you exhale, contract your hip flexors (quads and psoas) to lift the leg higher, keeping your left knee straight. This deepens the hamstrings stretch. Do not pull on the strap to deepen the stretch.
4. Repeat two or three times.

**Figure 5.5** Hamstrings self-stretch with a stretching strap.



## Hamstrings Self-Stretch, Standing

1. Stand with your right leg and foot stretched out comfortably in front of you, with just your heel on the floor (your toes are up). Lean forward from your hips (no stooping) until you feel a stretch developing in your right hamstrings ([figure 5.6a](#)).
2. From this starting position, the floor provides resistance as you try to drag your right heel back toward you, isometrically contracting your hamstrings for 6 seconds. After the isometric push, relax and inhale deeply. During this time, maintain the leg in the starting position.
3. As you exhale, lean forward until you once again feel a stretch in your right hamstrings ([figure 5.6b](#)).
4. Repeat two or three times.

**Figure 5.6** Hamstrings standing self-stretch. (a) Starting position. (b) Deepening the stretch.



## **Gluteus Maximus Partner Stretch, Supine**

The gluteus maximus is a strong mover of the hip and is often overworked as part of a cocontraction pattern with the iliopsoas. This stretch is useful for normalizing the tone of the gluteus maximus.

1. The stretcher is supine on a treatment table or a mat on the floor. She lifts her right leg, with the knee bent, as close to her chest as possible. Both hips stay flat on the surface to ensure she is stretching the muscle and not just rotating her pelvis. As the partner, assist to passively move her thigh closer to her chest until she feels a stretch in the gluteus maximus or until you reach the end of her comfortable range of motion. Some stretchers will experience a painful pinch in front of the hip when the leg is brought toward the chest. You can usually eliminate this by wrapping your hands around the thigh near the bent knee and tractioning the thigh toward the ceiling before flexing it toward the chest.
2. Assume a stable position to offer resistance to the isometric contraction of the gluteus maximus. To avoid stressing the knee joint, place your right hand behind

the joint, between the thigh and the leg ([figure 5.7](#)).

3. Direct the stretcher to begin slowly pushing against your hand to attempt to move her leg toward the table. (“Push against me as if you’re trying to put your thigh back down on the table.”) She holds this isometric contraction of the gluteus maximus for 6 seconds.
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the leg in the starting position.
5. As she exhales, passively move the stretcher’s thigh closer to her chest to deepen the stretch of the gluteus maximus.
6. Repeat two or three times.

**Figure 5.7** Gluteus maximus stretch (*a*) on a table and (*b*) on a mat.



### **Gluteus Maximus Self-Stretch, Supine**

1. Lie on your back and pull your left knee to your chest as far as is comfortable, keeping both hips flat on the mat. You may need to place your hands behind your knee and pull your thigh toward you before you feel the stretch on the gluteus maximus ([figure 5.8](#)).
2. From this starting position, push against your clasped hands as if you're going to put your thigh back down on the mat. Hold this isometric contraction of the gluteus maximus for 6 seconds. After the isometric push, relax and inhale deeply. During this time, maintain the leg in the starting position.
3. As you exhale, pull your thigh closer to your chest, deepening the stretch on the gluteus maximus.
4. Repeat two or three times.

**Figure 5.8** Gluteus maximus self-stretch.

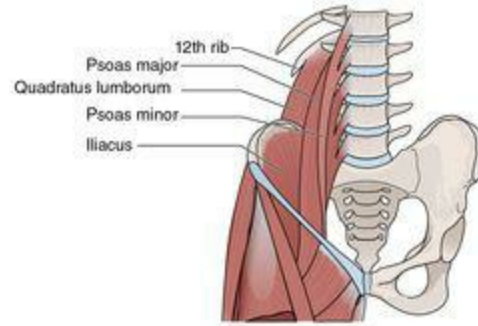


**Hip Flexor: Psoas**

## Anatomy

The psoas is the primary hip flexor ([figure 5.9](#), [table 5.2](#)). Because of its attachment along the lumbar spine, it affects the angle of the lumbar curve. A psoas that is too tight can cause an increase in the curve, which leads to swayback and low back pain. However, sometimes a tight psoas will flatten the lumbar curve, which can also lead to low back pain. For a more detailed discussion of this seeming contradiction, see Tom Myers' article "Poise: Psoas–Piriformis Balance" (1998).

**Figure 5.9** Hip flexor muscles.



**Table 5.2 Hip Flexor Muscles**

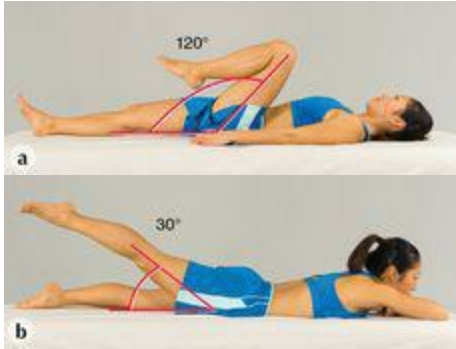
Muscle	Origin	Insertion	Action
Iliopsoas	Psoas: anterior lumbar vertebrae Iliacus: inner surface of ilium	Lesser trochanter of femur	Flexion and lateral rotation of the femur Experts disagree on whether it acts as an abductor or adductor

## Functional Assessment

Check hip range of motion as well as tightness in the psoas and quadriceps.

- **Hip range of motion.** Normal range of flexion (120 degrees) allows the stretcher to pull her flexed knee to her chest ([figure 5.10a](#)). Normal range of motion in extension is approximately 30 degrees ([figure 5.10b](#))

**Figure 5.10** Normal range of (a) hip flexion and (b) hip extension.



- **Modified Thomas test.** To check for tightness in the psoas or quadriceps (or both), the stretcher lies supine with the lower legs dangling off the edge of the table; she then lifts the right leg, knee to chest. Check to see whether the stretcher's left lower leg straightens. This indicates tight quadriceps (especially rectus femoris) and tensor fasciae latae on the left leg ([figure 5.11a](#)). If the stretcher's left thigh lifts off the table ([figure 5.11b](#)), this indicates a tight iliopsoas on the left. Repeat for the other leg. It's common for both the quadriceps and the iliopsoas to be hypertonic on the same leg. If the quadriceps are too tight, do facilitated stretching for the quadriceps. If the iliopsoas is too tight, do facilitated stretching for the iliopsoas.

**Figure 5.11** Modified Thomas test for quadriceps and psoas tightness. (a) The stretcher flexes her right hip and knee, pulling the knee to her chest. The left lower leg extends, indicating a tight quadriceps and possibly a tight TFL on the left. (b) The left thigh lifts off the table, indicating a tight psoas on the left.



### Stretches: Hip Flexors

#### **Psoas Partner Stretch, Prone**

This stretch improves hip extension. The stretcher must keep her hips flat on the table or mat throughout this stretch. There will be a strong tendency for her to lift her hip as she lifts her leg as a way to achieve more range of motion. You may need to work with the stretcher on body awareness until she is able to stabilize her hips properly before performing this stretch.

1. The stretcher lies prone on a treatment table or a mat on the floor. If she has any low back discomfort in this position, place a pillow under her hips to take some of the stress off the low back. You can also teach the stretcher to contract her abdominal muscles (pelvic tilt) to stabilize and flatten her low back. The pelvic tilt position usually eliminates low back discomfort.
2. The stretcher uses her hip extensors (gluteals and hamstrings) to lift her leg off the surface as high as possible, with the knee bent. This lengthens the psoas to its end range. Remember that the normal range of hip extension is only 30 degrees. If the stretcher is not lifting her hip off the surface, yet seems to have more than 30 degrees of hip extension, look for hypermobility in the low back area.
3. Assume a stable position that allows you to support the leg just above the knee to provide resistance to the isometric contraction of the psoas ([figure 5.12a](#)). You may prefer to grasp the stretcher's leg around the ankle ([figure 5.12b](#)).
4. Direct the stretcher to begin slowly pulling her thigh toward the surface, isometrically contracting the psoas for 6 seconds. She is not trying to straighten her

lower leg. As the stretcher contracts her psoas, she should relax her gluteal muscles, but it's often the case that the gluteal muscles are cocontracting with the psoas. This is an inefficient pattern to be discouraged. You can help the stretcher eliminate this pattern by having her briefly drop the weight of her leg into your hand before the isometric contraction of the psoas. After a few times, the stretcher should be able to do this automatically.

5. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the leg in the starting position.
6. As she exhales, the stretcher contracts the hip extensors to lift her thigh higher, deepening the psoas stretch. Be sure the stretcher keeps her hips flat on the surface.
7. Repeat two or three times.

**Figure 5.12** Prone psoas stretch. (a) Supporting the stretcher's thigh. (b) Grasping the stretcher's ankle.



## **Psoas Self-Stretch, Standing or Kneeling**

A widely used standing stretch can easily be modified to become a facilitated stretch for the psoas.

1. Stand with your right leg forward and left leg back, keeping your torso upright and your low back flat.
2. Keeping your left foot flat on the floor, lunge forward with your left hip to lengthen the left psoas. Allow your right knee to bend as you push forward. You should feel the stretch high on the front of the left thigh ([figure 5.13a](#)).
3. Isometrically contract the left psoas by attempting to pull your left leg forward while keeping the foot anchored on the floor. To prevent an unnecessary cocontraction pattern, be sure your gluteal muscles are relaxed. Maintain the isometric contraction for 6 seconds, and then relax.

4. You can now stretch the psoas by pushing the left hip forward again, being sure to maintain an upright posture with your low back flat.
5. If your calf muscles are too tight, you may feel them and not the psoas in this standing stretch position. In this case, you can perform the psoas stretch from a kneeling position ([figure 5.13b](#)).

**Figure 5.13** Psoas self-stretch. (a) Standing. (b) Kneeling. Keep your low back flat, and focus on feeling the stretch high on the front of your left thigh.

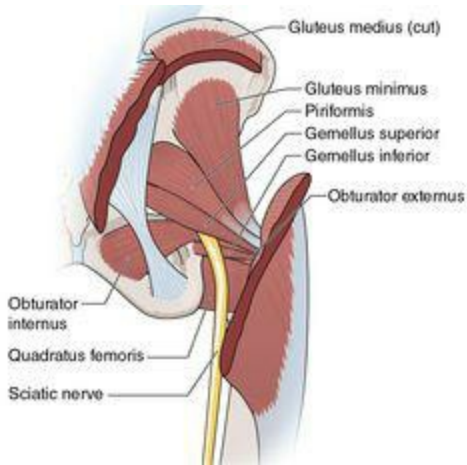


**Hip Lateral (External) Rotator: Piriformis**

## Anatomy

The piriformis is one of six deep lateral hip rotators ([figure 5.14](#), [table 5.3](#)), all of which insert on some portion of the greater trochanter. When these muscles are hypertonic, they contribute to a toe-out gait, commonly seen in dancers, and they restrict internal rotation of the hip. Stretching the piriformis also stretches the other lateral rotators. Although the piriformis is considered to be a lateral rotator of the hip, it may be more important as a postural muscle, acting to stabilize the spine (because of its attachment on the sacrum) and to maintain pelvic balance in conjunction with the psoas (Myers 1998).

**Figure 5.14** Hip lateral rotator muscles and the path of the sciatic nerve through the lateral rotators.



**Table 5.3 Hip Lateral Rotator Muscles**

Muscle	Origin	Insertion	Action
Piriformis	Anterior sacrum	Superior aspect of greater trochanter	Lateral rotation of femur Assists abduction of femur, especially when hip is flexed May act as medial rotator when hip is hyperflexed Helps stabilize hip joint

Tightness in the lateral rotators, including the piriformis, is a common cause of sciatic pain. The sciatic nerve exits the sciatic notch of the ilium and travels through these muscles on its way to the posterior thigh (see [figure 5.14](#)). When the muscles are hypertonic, they can squeeze the nerve, causing irritation and pain. You may be able to differentiate this type of sciatic pain, called piriformis syndrome, from true sciatica by determining where the pain begins. If shooting or burning pain originates at the lumbar spine and travels through the buttock and down the leg, the cause is piriformis syndrome, which responds well to massage and stretching. A leg-length difference can also contribute to piriformis syndrome.

Conditions such as Morton's foot or overpronation can result in excessive medial rotation and adduction of the thigh during running and walking, causing the piriformis to be overworked as it attempts to counteract medial rotation. This may lead to the muscle's being "locked long" in a chronic eccentric contraction.

## Functional Assessment

Because of its importance as a postural muscle, always consider the piriformis when investigating causes of low back pain. With the client standing relaxed, in bare feet, check for level iliac crests, anterior superior iliac spines (ASIS), and posterior superior iliac spines (PSIS). Also note whether one PSIS is anterior compared with the other. Imbalance in these areas is common with piriformis syndrome. With the stretcher supine, compare lateral rotation of the legs. Excessive lateral rotation (45 degrees or more) indicates piriformis shortening on that side ([figure 5.15](#)).

**Figure 5.15** Lateral rotation of the legs. Greater than 45 degrees indicates piriformis shortening on that side.



Stretches: Hip Lateral (External) Rotators

### **Piriformis Partner Stretch, Supine**

This stretch improves medial rotation of the femur. You may have to experiment a little with the starting position of this stretch because each stretcher will feel the muscle stretch in a different position.

1. The stretcher is supine on a treatment table or a mat on the floor. He flexes his left hip and knee to 90 degrees and toward the right shoulder; the right leg rests on the surface. Be sure the stretcher keeps his sacrum flat on the surface to anchor the origin of the piriformis. The stretcher then rotates his left thigh laterally by moving his left foot closer to his right shoulder while maintaining flexion at the hip.
2. Assume a stable position that allows you to place one hand on the stretcher's lateral knee and the other at his lateral ankle to assist him in finding the leg position that begins to stretch the piriformis ([figure 5.16](#)). Be sure the stretcher keeps his sacrum down.
3. From this starting position, direct the stretcher to begin slowly attempting to push his leg toward you diagonally (with equal pressure at both the knee and ankle), isometrically contracting the piriformis for 6 seconds.
4. After the isometric push, the stretcher relaxes and inhales deeply. As he relaxes, maintain the leg in the starting position.
5. As he exhales, he contracts his hip flexors and adductors to deepen the piriformis stretch. You may assist by gently pushing to assist hip flexion and adduction, then by adding more lateral rotation to deepen the stretch.
6. Repeat two or three times.

**Figure 5.16** Supine piriformis stretch (*a*) on a table and (*b*) on a mat.



### **Piriformis Partner Stretch, Prone**

This is an alternative position to increase piriformis length. Some stretchers report feeling more of a stretch in this position; others prefer the supine stretch.

1. The stretcher is prone on a treatment table or a mat on the floor. She bends her left knee to approximately 90 degrees and medially rotates her thigh (rolls her leg away from the midline, toward the floor), being sure to keep both hips flat on the surface. This lengthens the right piriformis to its end range.
2. Assume a stable position at the stretcher's left side that allows you to place your

right hand on her foot or medial ankle; your left hand rests lightly on her sacrum ([figure 5.17](#)).

3. Direct the stretcher to begin slowly pushing against your right hand, attempting to move her leg across her midline (see the isometric push arrow). She holds this isometric contraction of the piriformis for 6 seconds. Make sure there is no pain at the medial knee during the isometric phase. If the stretcher experiences medial knee pain, adjust your hold by moving your left hand to support the medial knee. If this does not eliminate the pain, use a different stretch for the piriformis.
4. After the isometric push, the stretcher relaxes and inhales deeply. As she relaxes, maintain the leg in the starting position.
5. As she exhales, the stretcher once again rolls the leg toward the floor, deepening the stretch on the piriformis.
6. Repeat two or three times.

**Figure 5.17** Prone piriformis stretch (*a*) on a table and (*b*) on a mat.



### Piriformis Self-Stretch, Supine

1. Lie on your back; let your left leg rest on the mat while you bend your right knee to about 90 degrees and move the knee up toward your left shoulder ([figure 5.18a](#)). You want to feel a slight stretch deep in the right buttock, so you may need to play with the position of the leg until you find the “sweet spot.” Try adding a little rotation of the thigh by pulling your ankle closer to you. Keep your hip bones on the mat. Many people experience pain when they try to do this because they are overstretching. Stretch only in the “feels good” range, not into discomfort.
2. From this starting position, hold your right leg at the knee and ankle, and push your leg away from you diagonally, feeling the muscles work deep in the buttock. This is an isometric contraction, so don’t let your leg actually move from your starting position. Breathe normally, hold the push for 6 seconds, and then relax.
3. Stretch by moving your right knee and leg closer to your left shoulder, using your

leg muscles as much as possible to do this and pulling with your arms only at the end. Add a little more rotation by pulling your ankle closer to you. Remember to stay in the comfort zone.

4. As an alternative starting position, you may also cross the right ankle over the left knee and then move the left knee toward the left shoulder, being sure to keep the hip bones in contact with the mat to begin the stretch of the right piriformis. Hold your left leg behind the knee with both hands ([figure 5.18b](#)).
5. Push your right leg away from you, using your left knee to resist the motion. Remember, this is an isometric contraction, so don't actually move your right leg. Hold the push for 6 seconds, and then relax.
6. Stretch by pulling your right knee and leg closer to you, using your leg muscles as much as possible to do this, and pulling with your left leg and arms only at the end. Remember to stay in the comfort zone.

**Figure 5.18** Piriformis self-stretch. (a) Starting position. (b) Alternative starting position.



### **Piriformis Self-Stretch, Seated**

1. Sit at the edge of a bench, and cross your left ankle over your right knee. Keeping your spine lengthened, bend at the hips (no stooping) until you feel a stretch deep in the left buttock ([figure 5.19](#)). Many people experience pain when they try to do this because they are overstretching. Stretch only in the “feels good” range, not into discomfort.
2. From this starting position, push your left ankle into your right thigh, isometrically contracting the piriformis, for 6 seconds. It may also feel good to push against the inside of your left knee with your left hand. After the isometric push, relax and inhale deeply.
3. As you exhale, sit up tall and bend forward to increase the piriformis stretch. Repeat two or three times.

**Figure 5.19** Piriformis self-stretch, sitting.

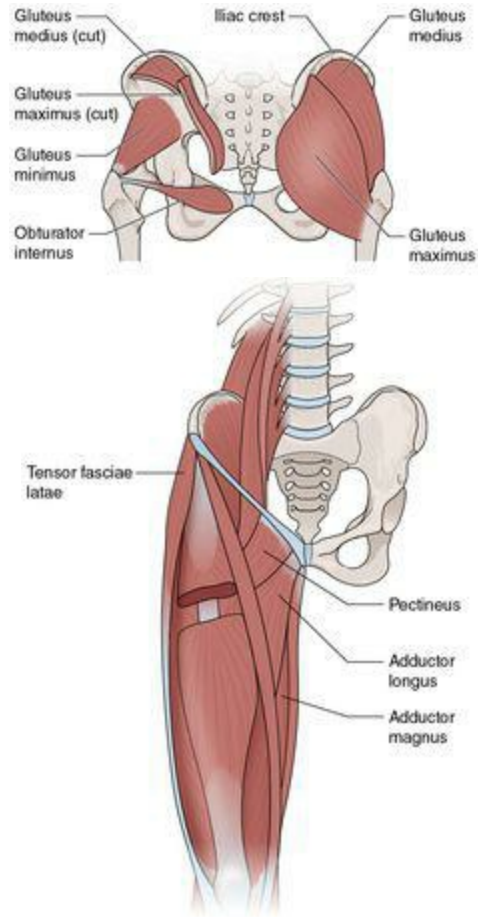


## **Hip Medial Rotators**

## Anatomy

The medial rotators of the hip include the gluteus medius, gluteus minimus, and tensor fasciae latae, possibly assisted by adductors brevis and longus and the superior portion of adductor magnus ([figure 5.20](#), [table 5.4](#)).

Figure 5.20 Hip medial rotator muscles.



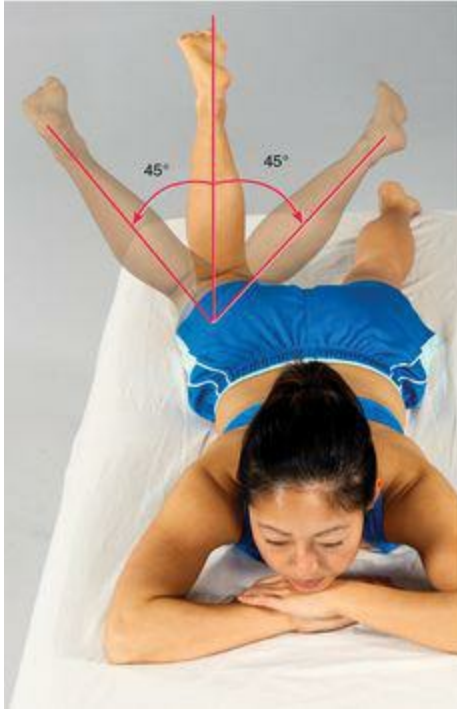
**Table 5.4 Hip Medial Rotator Muscles**

Muscle	Origin	Insertion	Action
Adductors brevis and longus	Anterior pubis	Linea aspera of posterior femur	Adduction of hip Assist flexion of hip May assist medial or lateral rotation of hip
Adductor magnus	Pubic ramus, ischial tuberosity	Vertically along linea aspera of posterior femur and to adductor tubercle of medial femur	Adduction of hip Anterior fibers (origin on pubic ramus) assist hip flexion and may assist medial rotation
Gluteus medius	Just below crest of ilium, between the anterior and posterior gluteal lines Its posterior one-third is covered by the gluteus maximus	Posterior superior aspect of greater trochanter	Primary abductor of hip Anterior fibers assist medial rotation and flexion of hip
Gluteus minimus	Deep to gluteus medius, attaching along lateral surface of ilium, between the anterior superior iliac spine and the greater sciatic notch	Anterior superior greater trochanter	Abduction of hip Anterior fibers assist medial rotation and flexion of hip
Tensor fasciae latae (TFL)	Iliac crest, just posterior to the anterior superior iliac spine	Iliotibial band, which then inserts at the lateral tibial condyle (Gerdy's tubercle)	Abduction of hip Assists medial rotation and flexion of hip

## Functional Assessment

Perform a visual assessment by having the stretcher prone, with one knee bent to 90 degrees. Direct the stretcher to rotate the thigh as far as possible in both directions. The normal range of both lateral and medial rotation is 45 degrees. Tight medial rotators will limit lateral rotation of the hip ([figure 5.21](#)). Compare both sides.

**Figure 5.21** The normal range of both lateral and medial rotation is 45 degrees.



*Stretches: Hip Medial (Internal) Rotators*

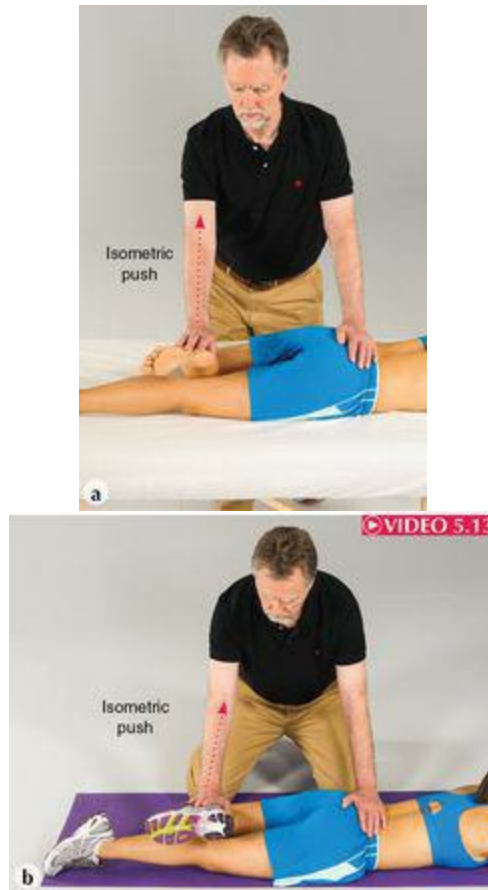
**Medial Hip Rotators Partner Stretch, Prone**

This stretch improves range of motion in lateral (external) rotation at the hip.

1. The stretcher is prone on a treatment table or a mat on the floor. She bends her left knee to approximately 90 degrees and laterally rotates her thigh (moving her leg and foot toward the back of her right knee), being sure to keep both hips flat on the surface. This lengthens the medial rotators to their end range.
2. Assume a stable position at the stretcher's left side that allows you to place your right hand on her foot or lateral ankle; your left hand rests lightly on her sacrum. Direct the stretcher to begin slowly pushing against your right hand, attempting to move her leg toward you, away from her midline (see the isometric push arrow in [figure 5.22](#)). She holds this isometric contraction of the medial rotators for 6 seconds.
3. After the isometric push, the stretcher relaxes and inhales deeply. As she relaxes, maintain the leg in the starting position.
4. As she exhales, the stretcher once again moves her leg and foot toward the back of her right knee, deepening the stretch on the medial rotators.

5. Repeat two or three times.

**Figure 5.22** Prone medial rotators stretch (a) on a table and (b) on a mat.



### Medial Hip Rotators Self-Stretch, Prone

1. Lie on your belly on a mat, and bend your right knee to about 90 degrees. Wrap the loop of a stretching strap around your right ankle, and then drop your right leg toward the back of your left knee, being sure to keep both hips flat on the mat. This lengthens the medial rotators to their end range.
2. Keep your left arm straight against your side, and hold onto the other end of the strap ([figure 5.23](#)).
3. From this starting position, begin slowly pushing your leg against the strap, as if rolling up and away. Hold this isometric contraction of the medial rotators for 6 seconds.
4. After the isometric push, relax and inhale deeply, maintaining the leg in the starting position.

5. As you exhale, move your right leg and foot toward the back of the left knee, deepening the stretch on the medial rotators.
6. Repeat two or three times.

**Figure 5.23** Medial hip rotators self-stretch.

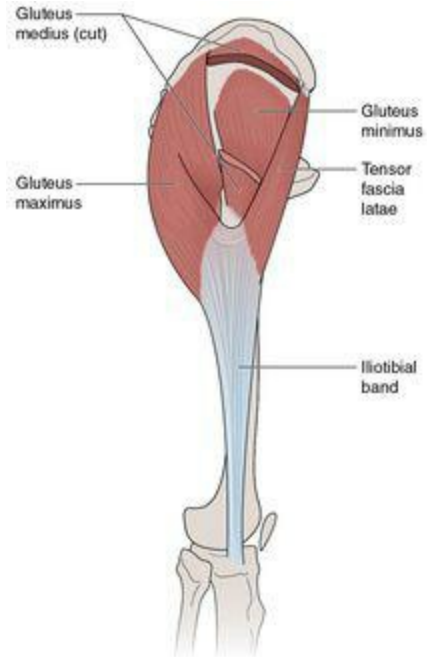


**Hip Abductors: Gluteus Medius, Gluteus Minimus, Tensor Fasciae Latae**

## Anatomy

The primary abductors of the hip are the tensor fasciae latae (TFL) and the gluteus medius and minimus ([figure 5.24](#), [table 5.5](#)). These muscles abduct the hip and also stabilize it during weight-bearing activities. Tightness in these muscles can contribute to pelvic imbalances, which can cause pain not only in the hips but also in the low back and the knee. Gluteus medius and minimus are frequently hypertonic and develop trigger points; these may cause pain that mimics sciatica or sacroiliac joint dysfunction.

Figure 5.24 Hip abductor muscles.



**Table 5.5 Hip Abductor Muscles**

Muscle	Origin	Insertion	Action
Gluteus medius	Just below crest of ilium, between the anterior and posterior gluteal lines Its posterior one-third is covered by the gluteus maximus	Posterior superior aspect of greater trochanter	Primary abductor of hip Anterior fibers assist medial rotation and flexion of hip Stabilizes pelvis during walking or running When left leg is in swing phase (not weight bearing), right gluteus medius contraction prevents pelvis from tilting down on left
Gluteus minimus	Deep to gluteus medius, attaching along lateral surface of ilium, between the anterior superior iliac spine and the greater sciatic notch	Anterior superior greater trochanter	Abduction of hip Anterior fibers assist medial rotation and flexion of hip Assists gluteus medius in stabilizing the pelvis
Tensor fasciae latae (TFL) and iliotibial (IT) band	Iliac crest, just posterior to anterior superior iliac spine	Iliotibial band, which then inserts at lateral tibial condyle (Gerdy's tubercle)	Assists abduction, medial rotation, and flexion of hip Assists knee extension Prevents knee from collapsing during movement

## Functional Assessment

The leg is normally able to swing across the midline of the body about 25 degrees if slight adjustments are made in the position of the legs ([figure 5.25](#)). This motion can be limited by excessive tightness in the hip abductors. Because these muscles also function as knee stabilizers, via the iliotibial (IT) band, knee problems can develop when they are hypertonic (too tight).

**Figure 5.25** Normal range of hip adduction is about 25 degrees.



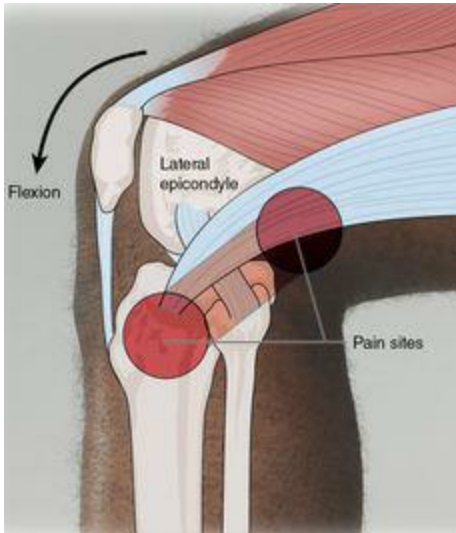
- **Ober's test.** Tight hip abductors can add tension to the IT band and limit hip adduction. To test for this, perform Ober's test. Have the stretcher lie on his side, with the knee of the top leg tucked behind the knee of the other leg ([figure 5.26](#)). Excessive tightness in the hip abductors prevents this position and can lead to problems such as IT band syndrome.

**Figure 5.26** Ober's test. Excessive tightness in the hip abductors will prevent the client from tucking his top knee behind his bottom knee.



- **IT band syndrome.** Iliotibial band syndrome is an overuse injury in which pain is typically reported just proximal to the lateral knee and possibly at the IT band's insertion on the tibia. It's often found in cyclists, rowers, and novice runners who overpronate. This syndrome has long been described as a friction injury that occurs when a tight IT band rubs over the lateral femoral condyle as the knee flexes and extends. Recently, this view has been challenged by Fairclough and colleagues (2007), who assert that the anatomy of the IT band does not allow for movement of the band back and forth over the condyle. Fairclough proposes that the pain of IT band syndrome is the result of compressive forces by the band on underlying tissues. [Figure 5.27](#) shows the areas of pain. Tightness in the band can be caused by a tight TFL or gluteus medius, which pulls on the band, or by a hypertrophied vastus lateralis, which bulges under the band and stretches it.

**Figure 5.27** Typical pain sites for iliotibial band syndrome.



Stretches: Hip Abductors

### **Hip Abductors Partner Stretch, Side-Lying on a Table**

This stretch improves adduction at the hip.

1. The stretcher is side-lying at the edge of the treatment table, top leg hyperextended and hanging over the edge of the table; the bottom leg is bent, with the knee as close to the chest as possible, for comfort and stability in the low back. The hips are stacked vertically on top of each other. The stretcher contracts his adductors to pull the top leg toward the floor, lengthening the abductors to their end range. If the stretcher experiences any low back pain in this position, he may bend forward from the waist to round his low back while keeping his leg hanging off the edge of the table.
2. Stand behind the stretcher to offer support, and stabilize his hip with one hand. Place your other hand across the lateral aspect of the knee joint to offer resistance to the isometric contraction of the abductors.
3. Direct the stretcher to begin slowly pushing his leg toward the ceiling, isometrically contracting the abductors for 6 seconds (see the isometric push arrow in [figure 5.28](#)).
4. After the isometric push, the stretcher relaxes and inhales deeply. As he relaxes, allow the leg to drop toward the floor.
5. As he exhales, the stretcher pulls his leg toward the floor, deepening the abductor stretch even farther.

6. Repeat two or three times.

**Figure 5.28** Side-lying hip abductors stretch.



### **Hip Abductors Partner Stretch, Supine on a Mat**

1. The stretcher is supine on a mat on the floor. Keeping his right leg flat on the mat, he crosses his left leg over his right, knee bent and foot flat on the table. This position allows the stretcher to adduct his right leg across the midline as far as possible, keeping his kneecap pointing toward the ceiling to minimize lateral rotation of the femur. This lengthens the right abductors to their pain-free end range.
2. Place one hand across the lateral knee joint of the right leg, and stabilize the opposite hip with your other hand ([figure 5.29](#)). Direct the stretcher to begin slowly attempting to push his right leg against your hand, isometrically contracting the right abductors for 6 seconds, breathing normally throughout.
3. After the isometric push, the stretcher relaxes and inhales deeply. Maintain the leg in the starting position.
4. As the stretcher exhales, he pulls his right leg farther across his midline, deepening the abductor stretch.
5. Repeat two or three times.

**Figure 5.29** Initiation of the supine hip abductors stretch.



### **Hip Abductors Self-Stretch, Sitting**

This is a modification of a stretch position often used in group exercise classes.

1. Sit comfortably on the floor or a stretching mat, with your left leg straight out in front of you. Cross your right leg over your left, with the right knee bent and the right foot against the outside of your left knee. Sit up tall and twist your torso to the right as far as is comfortable; place your left elbow or upper arm (or both) against the outside of your right knee, and steady yourself with your right hand behind you ([figure 5.30](#)).
2. From this starting position, push your right knee against your left arm, isometrically contracting the hip abductors for 6 seconds. As an added benefit, this will also engage your oblique abdominal muscles.
3. After the isometric push, relax and inhale, and as you exhale, use your leg muscles (adductors) to pull your right leg more toward the left, deepening the stretch on your abductors. Add a gentle push with your left arm as long as it feels good to do so.
4. Repeat two or three times.

**Figure 5.30** Initiation of the hip abductors self-stretch, sitting.



### **Hip Abductors Self-Stretch, Standing**

1. Stand sideways about arm's length from a wall or other vertical object (e.g., post, doorjamb). Place your right hand against the wall, and cross your right leg behind your left as far as you can with your right foot on the floor. Lean your right hip toward the junction of the floor and the wall as far as you can comfortably go so you feel a stretch along your right hip ([figure 5.31](#)).
2. From this starting position, attempt to drag your right leg toward the wall, using the floor to provide resistance to this isometric contraction of your hip abductors. After 6 seconds, relax and inhale deeply. As you exhale, lean your right hip closer toward the floor, stretching the right abductors.
3. Repeat two or three times.

**Figure 5.31** Hip abductors self-stretch, standing.



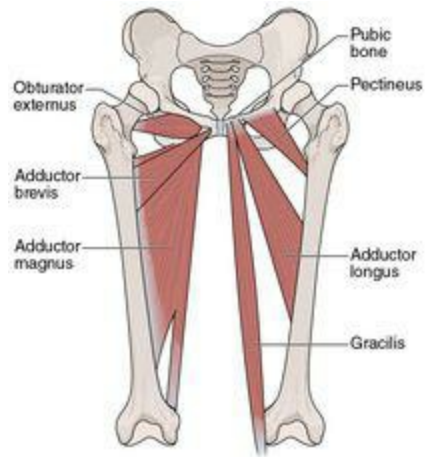
## **Hip Adductors**

## Anatomy

When you move your legs together (toward your midline), you are using your adductor muscles. The adductors also variously assist hip flexion and hip extension, and depending on the position of the femur, they may assist lateral or medial rotation. Importantly, they also help stabilize the legs in running and walking. The adductors are commonly much tighter in men than in women. Groin pulls are often related to fatigue or improper stretching of the adductor longus.

The adductor muscles can be divided into the short adductors (pectineus, adductor brevis, and adductor longus) and the long adductors (adductor magnus and gracilis) ([figure 5.32](#), [table 5.6](#)). We've provided one illustration showing all the adductors.

Figure 5.32 Hip adductor muscles.



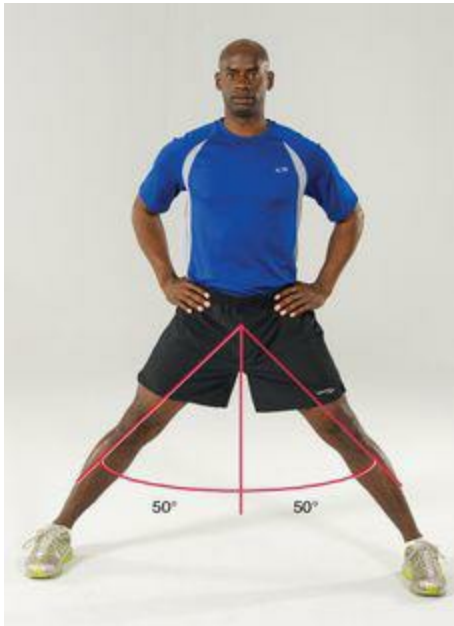
**Table 5.6 Hip Adductor Muscles**

Muscle	Origin	Insertion	Action
Adductors brevis and longus	Anterior pubis	Linea aspera of posterior femur	Adduction of hip Assist flexion of hip May assist medial or lateral rotation of hip
Adductor magnus	Pubic ramus, ischial tuberosity	Vertically along linea aspera of posterior femur and to adductor tubercle of medial femur	Adduction of hip Anterior fibers (origin on pubic ramus) assist hip flexion and may assist medial rotation Posterior fibers (origin on ischial tuberosity) assist hip extension
Gracilis	Anterior pubis	Medial proximal tibia (pes anserine)	Adduction of hip Assists knee flexion and medial rotation of tibia when knee is flexed
Pectineus	Superior pubic ramus	Between lesser trochanter and linea aspera of posterior femur	Hip flexion Assists adduction and lateral rotation of hip

## Functional Assessment

Check the range of motion. Normally, the legs should be able to abduct 45 to 50 degrees from the midline ([figure 5.33](#)). If this range is limited, the reason is often tight adductors. Use facilitated stretching to increase this range.

**Figure 5.33** Normal range of hip abduction is 45 to 50 degrees from the midline. Limited range is usually due to tight adductors.



Stretches: Hip Adductors

### **Hip Adductors Partner Stretch, Supine on a Table**

This stretch increases hip abduction. Occasionally stretchers experience mild abductor cramping during this stretch. If this occurs, stop and stretch the abductors, and then come back to the adductor stretch.

1. The stretcher is supine on a treatment table. Keeping both hips flat on the table, and without arching his back, he abducts his left hip as far as he can, keeping the knee straight and the kneecap pointed toward the ceiling (this prevents rotation of the leg). He may hook his right heel over the edge of the table to keep his right leg from sliding across the table. In this position, the adductors on the left are at the end of their range.
2. Standing at the left side of the table, between the table and the stretcher's leg, support the lower leg with your right hand and place your left hand across the medial aspect of the knee. This position prevents stress on the medial collateral ligament during the isometric phase. Ask the stretcher to begin slowly attempting to move his left leg toward the midline, isometrically contracting the adductors for 6 seconds (see the isometric push arrow in [figure 5.34](#)).
3. After the isometric push, the stretcher relaxes and inhales deeply. During this time,

maintain the leg in the starting position.

4. As he exhales, ask him to abduct his hip farther, deepening the stretch of the adductors. Be sure he keeps his leg from rolling laterally by asking him to keep his kneecap pointing toward the ceiling.
5. Repeat two or three times. After the final stretch, help the stretcher move his leg back to the table. This helps prevent possible groin strain.

**Figure 5.34** Supine hip adductors stretch.



### **Hip Adductors Partner Stretch, Supine on a Mat**

1. The stretcher is supine on a mat on the floor. Keeping both hips flat on the mat, and without arching his back, he abducts both legs as far as he can, keeping the knees straight and the kneecaps pointed toward the ceiling (this prevents rotation of the legs). In this position, the adductors on both sides are at the end of their range.
2. Stand between the stretcher's legs, and place your feet against the inside of the stretcher's knees ([figure 5.35](#)). Supporting the medial knees prevents stress on the medial collateral ligaments during the isometric phase. From this starting position, ask the stretcher to begin slowly attempting to move his legs together, isometrically contracting the adductors for 6 seconds.
3. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the legs in the starting position.
4. As he exhales, ask him to abduct his hips farther, deepening the stretch of the adductors. Be sure he keeps his legs from rolling laterally by asking him to keep his kneecaps pointing toward the ceiling. Also be careful that he does not arch his back as he attempts to stretch farther.
5. Repeat two or three times. After the final stretch, help the stretcher move his legs back to center. This helps prevent possible groin strain.

**Figure 5.35** Supine hip adductors stretch on a mat.



## **Hip Adductors Self-Stretch, Standing**

This stretch is an adaptation of a common adductors stretch.

1. To stretch the right adductors, assume a side-lunge position, being careful not to bend the left knee beyond 90 degrees, keeping the right leg straight, foot flat on the floor. All your weight is on your left leg ([figure 5.36](#)).
2. From this starting position, attempt to pull your right leg toward your midline, using the floor to provide resistance to this movement. After the 6-second isometric contraction, deepen the stretch by sinking lower into your left leg.
3. Repeat two or three times.

**Figure 5.36** Standing adductors self-stretch.



## **Hip Adductors Self-Stretch, Sitting**

This position focuses more on the short adductors.

1. Sit with your back straight, knees bent, and the soles of your feet together. Pull your legs as close to the floor as you can using your leg muscles. This lengthens your short adductors.
2. Place your arms or hands against the inside of your knees. Attempt to move your knees together against your own resistance, isometrically contracting your short adductors ([figure 5.37](#)). Hold the contraction for about 6 seconds, breathing normally.

**Figure 5.37** Sitting adductors self-stretch.



**Knee Extensors: Quadriceps**

## Anatomy

The quadriceps is a four-headed muscle made up of the rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius ([figure 5.38](#), [table 5.7](#)). All four heads converge to cross the knee and insert into the tibial tuberosity. The quads extend (straighten) the knee. Additionally, the rectus femoris assists hip flexion.

**Figure 5.38** Knee extensor muscles.

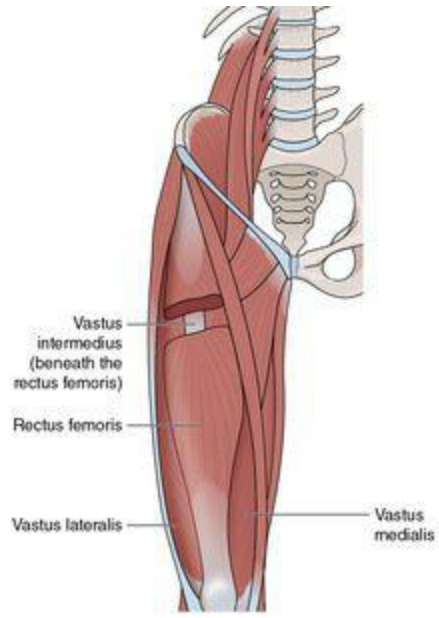


Table 5.7 Knee Extensor Muscles

Muscle	Origin	Insertion	Action
Rectus femoris	Anterior inferior iliac spine and upper margin of acetabulum	Patella and via the patellar ligament to tibial tuberosity	Knee extension Assists hip flexion
Vastus medialis, lateralis, and intermedius	Medialis and lateralis: linea aspera of posterior femur Intermedius: anterior and lateral shaft of femur	Patella and via the patellar ligament to tibial tuberosity	Knee extension

Patellofemoral syndrome is characterized by a nonspecific pain or ache in the area of the patella (kneecap). It's usually attributed to a tight quadriceps and IT band, which causes faulty biomechanics, and is exacerbated by overuse. In some cases, pain can be pinpointed as coming from the underside of the patella (retropatellar) and is then called chondromalacia. Symptoms tend to increase as a result of prolonged sitting (movie theater, airplane seat) or activities that involve forceful contraction of the quadriceps (squats, ascending and descending stairs).

Typical treatment recommendations include rest, stretching and strengthening of the quadriceps, and wearing a soft knee brace or wrap during activity. Additionally, stretching of the hip abductors to reduce tension on the IT band can be helpful. See the discussion of IT band syndrome for more on this.

## Functional Assessment

Check range of motion of the knee in flexion and extension.

- **Knee extension.** The stretcher is seated, with legs dangling over the edge of the table. As the stretcher straightens the lower leg, the arc of motion should be smooth, and the knee should extend to 0 degrees or beyond into a few degrees of hyperextension ([figure 5.39](#)).

**Figure 5.39** Normal range of knee extension. The quadriceps should fully extend the knee.



- **Knee flexion.** While on her abdomen, the stretcher should be able to pull the heel to the buttock, with a little help from a partner ([figure 5.40](#)). If range is limited, the reason may be tight quadriceps, which will feel stretched as you press the heel toward the buttock. Motion may also be limited by the bulk of the hamstrings and calf muscles. If the limitation is due to tight quadriceps, facilitated stretching works quite well here.

**Figure 5.40** The stretcher should be able to pull her heel to her buttock with a little help.



Stretches: Knee Extensors

### **Quadriceps Partner Stretch, Prone**

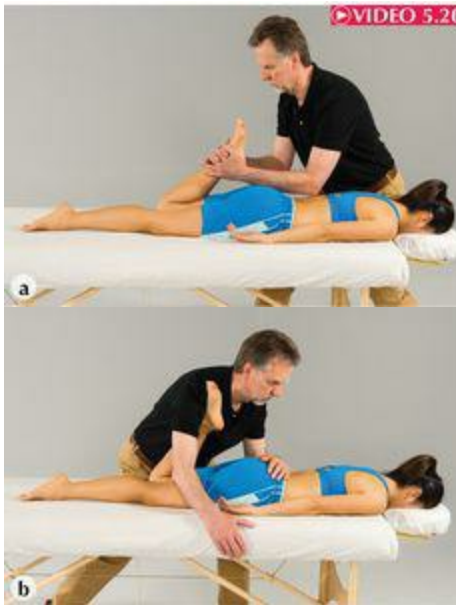
This stretch improves knee flexion.

1. The stretcher lies prone on a treatment table or a mat on the floor, with the knee flexed as far as possible. Because of the bulk of the hamstrings and calf muscles, the stretcher will be unable to stretch the quads to her end range. Gently push against the leg to pull the heel closer to the buttock, but only until the stretcher feels the quads beginning to stretch (stretch barrier). Keep the lower leg aligned with the thigh so as not to stress the knee joint. This is the pain-free end range. If this position causes any low back discomfort, stop and place a pillow under the stretcher's hips to reduce the stress on the low back, and begin again. Or, you may want to have the stretcher contract her abdominal muscles to stabilize and flatten her low back (a pelvic tilt). The pelvic tilt position usually eliminates low back discomfort.
2. Position yourself to offer resistance to the isometric contraction of the quads by placing your hands or shoulder against the stretcher's shin ([figure 5.41](#)). The stretcher must keep her hips flat on the surface (or on the pillow) during the entire sequence. You may need to work with the stretcher on body awareness until she is able to stabilize her hips properly before performing this stretch.
3. Direct the stretcher to begin slowly pushing against you to try to straighten her leg,

isometrically contracting the quads for 6 seconds.

4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the leg in the starting position.
5. As she exhales, the stretcher rests and allows you to offer assistance by pushing on the leg, deepening the quad stretch. Occasionally, the hamstrings will go into spasm at this point, usually because the stretcher is unconsciously contracting them to assist the stretch. You may want to gently rest one hand on the hamstrings to be sure they are not activating.
6. Repeat two or three times.

**Figure 5.41** Quadriceps stretch. Provide resistance with (a) your hands, fingers interlaced, or (b) your shoulder.



## Quadriceps Self-Stretch, Standing

This is a modification of a commonly used quadriceps stretch.

1. While standing comfortably, use a stationary object to help you stabilize as you bend your left knee and lift your heel toward your buttock. Hold your left leg or foot with your left hand, keeping your low back flat and being careful to pull your heel toward the center of your buttock and not toward the outside of your hip, as this may stress your knee ligaments ([figure 5.42a](#)).
2. From this starting position, attempt to straighten your left leg against your own resistance, isometrically contracting your quadriceps for 6 seconds. After the isometric push, relax and inhale, and as you exhale, pull your heel closer to your buttock.
3. As your flexibility improves, you may find that your heel can easily reach your buttock. If this is the case, then your goal with each stretch is to move your thigh to a more vertical position so that the knee points directly to the floor, all the while keeping your low back flattened to prevent hyperextension of the lumbar spine ([figure 5.42b](#)).
4. Repeat two or three times.

**Figure 5.42** Quadriceps standing self-stretch. (a) Heel toward buttock. (b) If your heel can easily reach your buttock, then try to point your knee directly toward the floor.



## **Ankle Plantar Flexors: Gastrocnemius and Soleus**

## Anatomy

The gastrocnemius and soleus muscles (also collectively called the triceps surae) insert into the heel via the Achilles tendon, the strongest tendon in the body ([figure 5.43](#), [table 5.8](#)). The gastrocnemius is a two-headed muscle that gives the calf its shape. The soleus muscle, which lies underneath the gastrocnemius, is more often the reason for calf tightness. Two common overuse injuries involving the calf muscles are plantar fasciitis and Achilles tendinitis.

**Figure 5.43** Ankle plantar flexor muscles.

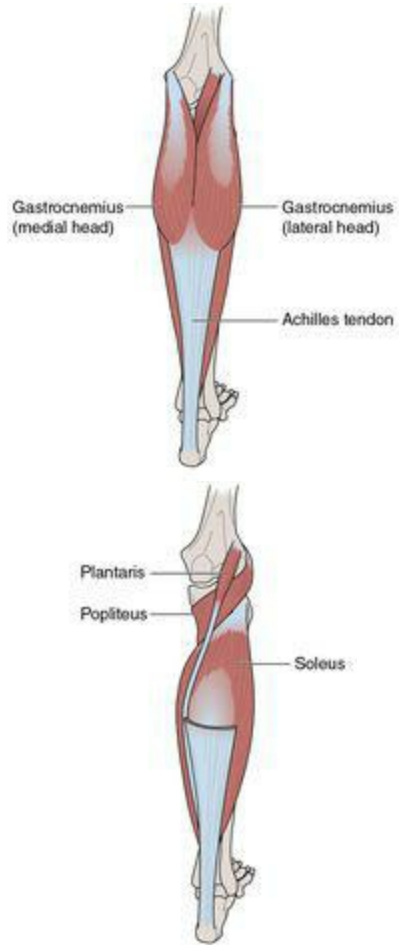


Table 5.8 Ankle Plantar Flexor Muscles

Muscle	Origin	Insertion	Action
Gastrocnemius	Posterior condyles of the femur	Calcaneus via the Achilles tendon (also called the calcaneal tendon)	Plantar flexion of the ankle or assists knee flexion, but cannot do both fully at the same time
Soleus	Posterior proximal third of the fibula and the posterior fibular head, middle third of the medial border of the tibia, and the tendinous arch across the proximal tibia and fibula	Calcaneus via the Achilles tendon (also called the calcaneal tendon)	Plantar flexion of the ankle

## Plantar Fasciitis

Plantar fasciitis is an overuse injury characterized by pain on the sole of the foot, usually near the heel. The plantar fascia is a thick, fibrous band of connective tissue that extends from the bottom surface of the calcaneus (heel bone) along the sole of the foot to attach at the metatarsal arch. The plantar fascia is fascially connected to the calf muscles via the Achilles tendon and should be included in any treatment protocol.

Classic symptoms include pain with the first few steps after being off the foot, such as first thing in the morning, or after prolonged sitting. The pain decreases as the plantar fascia warms up.

The onset of symptoms occurs gradually, typically over a period of months. Chronic cases of this condition tend to exhibit degenerative changes in the plantar fascia without inflammation and are more correctly labeled plantar fasciosis.

Typical treatment recommendations include rest, friction massage, ice, and stretching of the muscles of the calf, foot, and toes. Additional care might include massage of the sole of the foot, orthotics, and wearing a night brace that stretches the plantar fascia during sleep.

## Achilles Tendinitis

The Achilles tendon attaches the calf muscles (gastrocnemius and soleus) to the calcaneus (heel bone). Achilles tendinitis is a painful inflammation of the tendon, sometimes accompanied by mild to moderate swelling.

Typical symptoms include pain at the insertion point on the heel, as well as pain and stiffness along the tendon, especially during activity. Pain may extend into the foot, creating symptoms similar to plantar fasciitis.

As with most overuse injuries, the onset of symptoms occurs gradually, typically over a period of months. Chronic cases of this condition tend to exhibit degenerative changes in the tendon without inflammation and are categorized as Achilles tendinosis.

Treatment recommendations include rest, friction massage, ice, and stretching of the

calf muscles to reduce tension on the tendon. Additional treatment may include orthotics to help correct foot biomechanics, a change in athletic footwear, wearing a compression wrap or brace during activity, and cortisone injections.

## Functional Assessment

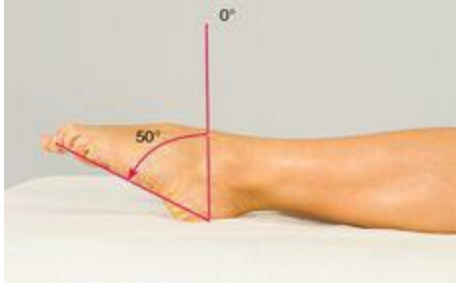
For assessing range of motion at the ankle, zero degrees is when the foot is perpendicular to the leg. Normal range in dorsiflexion is approximately 20 degrees ([figure 5.44](#)), and plantar flexion should be 50 degrees ([figure 5.45](#)). Limited plantar flexion may be due to a tight tibialis anterior.

If dorsiflexion is limited, have the stretcher lie prone and flex the knee to 90 degrees, and then test again. Knee flexion relaxes the gastrocnemius and eliminates it as a limiter of dorsiflexion. So, if limitation is still present after the knee is flexed, focus the stretching on the soleus. If knee flexion improves dorsiflexion, focus the stretching on the gastrocnemius.

**Figure 5.44** Normal range of dorsiflexion at the ankle.



**Figure 5.45** Normal range of ankle plantar flexion is 50 degrees.



Stretches: Ankle Plantar Flexors

### **Gastrocnemius Partner Stretch, Prone**

1. The stretcher lies prone on the table, with her feet hanging over the edge far enough so she can fully dorsiflex without interference from the table.
2. The stretcher dorsiflexes one foot (moves the foot toward the knee) as far as possible. This lengthens the gastrocnemius to its end range.
3. Stand at the end of the table, and place the palm of your hand against the stretcher's foot. Use your thigh to support your hand, being sure to maintain good posture ([figure 5.46](#)). Offer resistance as you direct the stretcher to begin slowly attempting to plantar flex (push the foot toward you), isometrically contracting the gastrocnemius and soleus for 6 seconds.
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the foot in the starting position.
5. As she exhales, the stretcher contracts the tibialis anterior, dorsiflexing the foot and deepening the gastrocnemius stretch.
6. Repeat two or three times.

**Figure 5.46** Gastrocnemius stretch, prone.



### **Gastrocnemius Partner Stretch, Supine**

1. The stretcher is lying on a treatment table or a mat on the floor. She actively lengthens her left gastrocnemius by dorsiflexing her foot (flexing her foot toward her left knee).
2. Assume a stable position that allows you to place both hands across the stretcher's metatarsal arch ([figure 5.47](#)).
3. Offer resistance as you direct the stretcher to begin slowly attempting to plantar flex (push the foot toward you), isometrically contracting the gastrocnemius and soleus for 6 seconds.
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the foot in the starting position.
5. As she exhales, the stretcher contracts the tibialis anterior, dorsiflexing the foot and deepening the gastrocnemius stretch.
6. Repeat two or three times.

**Figure 5.47** Gastrocnemius stretch, supine.



### **Gastrocnemius Self-Stretch, Sitting With Stretching Strap**

1. Sit comfortably with your right leg straight, a stretching strap looped around the ball of your foot ([figure 5.48](#)). If you have enough flexibility, hold the foot in your hands instead of using a stretching strap. Use your leg muscles to move your foot and toes as close to you as possible.
2. From this starting position, try to push your foot away from you, isometrically contracting the gastrocnemius for 6 seconds. After the isometric push, relax and inhale, and as you exhale, use your leg muscles again to move your foot toward you, deepening the stretch on the gastrocnemius.
3. Repeat two or three times.

**Figure 5.48** Gastrocnemius self-stretch using a stretching strap.



### **Soleus Partner Stretch, Prone**

This stretch isolates the soleus and is used to improve dorsiflexion.

1. The stretcher lies prone on a treatment table or a mat on the floor, with one knee flexed to 90 degrees. This position isolates the soleus muscle because it puts the gastrocnemius at a mechanical disadvantage. She then dorsiflexes her foot (moves the foot toward the knee) as far as possible. This lengthens the soleus to its end range.
2. Assume a comfortable and stable position that allows you to support the bent leg with one hand and wrap your other hand around the heel, with your forearm resting against the sole of the foot ([figure 5.49a](#)). As another option, interlace your fingers and place them across the metatarsal arch of the foot ([figure 5.49b](#)).
3. Offer resistance as you direct the stretcher to begin slowly attempting to plantar flex (push the foot toward you), isometrically contracting the soleus for 6 seconds (see the isometric push arrow).
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the foot in the starting position.
5. As she exhales, the stretcher contracts the tibialis anterior, dorsiflexing the foot and deepening the soleus stretch.
6. Repeat two or three times.

**Figure 5.49** Soleus stretch. (a) Support the bent leg with one hand, and wrap your other hand around the heel, with your forearm resting against the sole of the foot. (b) Or interlace your fingers, and place your hands across the metatarsal arch of the foot. (c) Working on a mat.



## Soleus Self-Stretch, Sitting

1. Sit comfortably with your left knee bent, and hold your left foot in your hands. Use your leg muscles to move your foot and toes as close to you as possible ([figure 5.50](#)).
2. From this starting position, try to push your foot away from you, isometrically

contracting the soleus for 6 seconds. After the isometric push, relax, inhale, and as you exhale, use your leg muscles again to move your foot toward you, deepening the stretch on the soleus.

3. Repeat two or three times.

**Figure 5.50** Soleus self-stretch, knee bent.

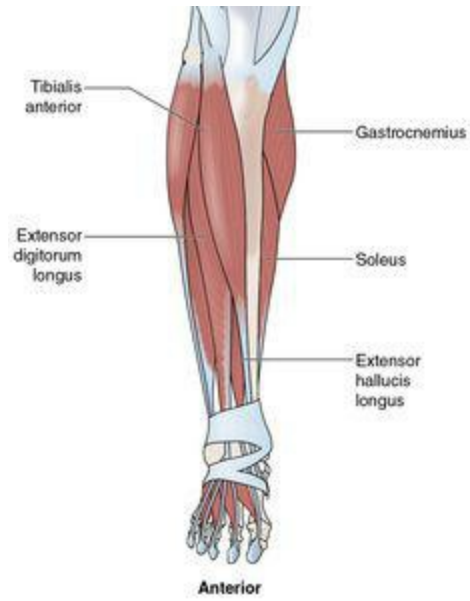


**Ankle Dorsiflexor: Tibialis Anterior**

## Anatomy

When the foot is free to move, the tibialis anterior ([figure 5.51](#), [table 5.9](#)) dorsiflexes and inverts it. When the foot is on the ground, the tibialis anterior assists in maintaining balance. During walking or running, this muscle helps prevent the foot from slapping onto the ground after heel strike (eccentric activation) and lifts the foot to clear the ground as the leg is swinging forward.

**Figure 5.51** Ankle dorsiflexor muscles.



**Table 5.9 Ankle Dorsiflexor Muscles**

Muscle	Origin	Insertion	Action
Tibialis anterior	Lateral shaft of tibia, interosseous membrane	Base of fifth metatarsal, first cuneiform	Ankle dorsiflexion Inversion of foot Supports longitudinal arch

## Functional Assessment

Check range of motion (see [figures 5.44](#) and [5.45](#)). Dorsiflexion of the ankle should be approximately 20 degrees. Plantar flexion of the ankle should be approximately 50 degrees. If range of motion is limited, stretching may be helpful.

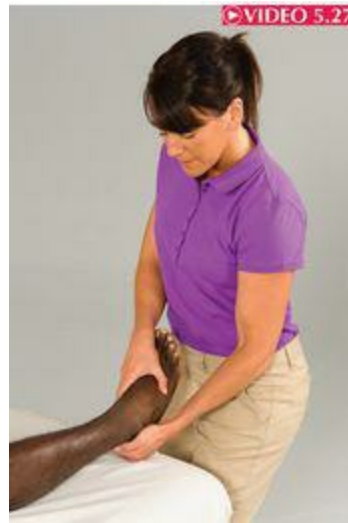
*Stretches: Ankle Dorsiflexors*

### **Tibialis Anterior Partner Stretch, Supine**

This stretch improves plantar flexion.

1. The stretcher lies supine on a treatment table or a mat on the floor and plantar flexes his right ankle (points toes) using the calf muscles. This lengthens the right tibialis anterior to its end range.
2. Assume a stable position that allows you to comfortably cup the right heel with your left hand and hold the top of the right foot with your right hand ([figure 5.52](#)). When stretching the left side, cup the left heel with your right hand, and hold the top of the left foot with your left hand.
3. Direct the stretcher to begin slowly attempting to pull his foot toward his knee (dorsiflexion), isometrically contracting the tibialis anterior for 6 seconds.
4. After the isometric pull, the stretcher relaxes and inhales deeply. During this time, maintain the foot in the starting position.
5. As he exhales, the stretcher contracts the calf muscles to increase plantar flexion, deepening the tibialis anterior stretch.
6. Repeat two or three times.

**Figure 5.52** Tibialis anterior stretch, right foot.



### **Tibialis Anterior Self-Stretch, Sitting**

1. Sit comfortably on a bench, with your right ankle crossed over your left knee. Point your foot and toes, and hold across the top of your foot with your left hand ([figure 5.53](#)).
2. From this starting position, use your leg muscles to try to pull your foot toward your knee, isometrically contracting your tibialis anterior for 6 seconds. After the isometric push, relax, inhale, and as you exhale, use your calf muscles to point your foot and toes again, deepening the stretch on the tibialis anterior.
3. Repeat two or three times.

**Figure 5.53** Tibialis anterior self-stretch.

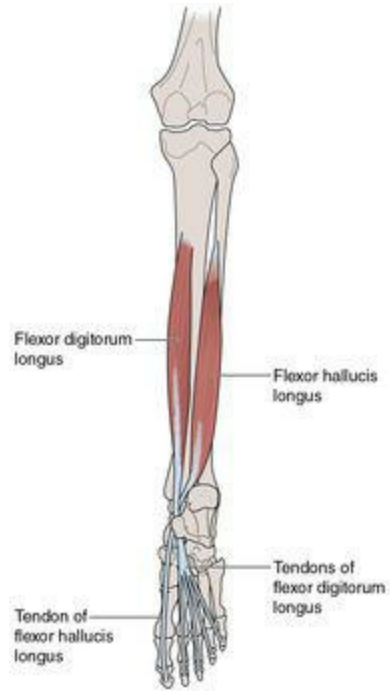


**Toe Flexors: Flexor Hallucis Longus, Flexor Digitorum Longus**

## Anatomy

We illustrate and discuss only two of the six toe flexors (flexor hallucis and flexor digitorum longus; [figure 5.54](#)). [Table 5.10](#) lists all six toe flexors. With the foot on the ground, flexors hallucis and digitorum longus assist in maintaining balance by keeping the toe pads on the ground. Flexor hallucis longus helps support the longitudinal arch and exerts a strong propulsion action during the toe-off phase of gait.

Figure 5.54 Toe flexor muscles.



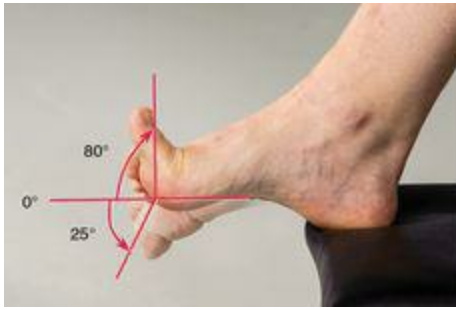
**Table 5.10 Toe Flexor Muscles**

Muscle	Origin	Insertion	Action
Flexor digiti minimi brevis	Base of the fifth metatarsal	Lateral aspect of the base of the proximal phalanx of the fifth toe	Flexes little toe
Flexor digitorum brevis	Medial process of the calcaneal tuberosity and deep surface of the plantar fascia	Splits into four tendons that attach to the plantar aspect of the middle phalanges of toes 2-5	Flexes toes 2-5
Flexor digitorum longus	Posterior surface of the middle third of the tibia, distal to the popliteal line	The tendon passes behind the medial malleolus, crosses the flexor hallucis longus tendon, then splits into four tendon slips and inserts onto the plantar aspect of the distal phalanges of toes 2-5	Flexes toes 2-5 Assists ankle plantar flexion
Flexor hallucis brevis	Medial aspect of the cuboid and the middle and lateral cuneiform bones	The two heads attach to the medial and lateral aspect of the distal phalanx of the great toe Each tendon contains a sesamoid bone	Flexes the great toe
Flexor hallucis longus	Inferior two-thirds of the posterior fibula and interosseous membrane	The tendon passes behind the medial malleolus, passes deep to the tendon of flexor digitorum longus, and attaches to the plantar aspect of the distal phalanx of the great toe	Flexes the great toe Assists ankle supination Weak ankle plantar flexion
Quadratus plantae (also called flexor digitorum accessorius)	Two heads arise from the medial and lateral borders of the inferior aspect of the calcaneus	The muscle spreads out to attach to the tendons of flexor digitorum longus	Assists flexion of toes 2-5

## Functional Assessment

The normal range of motion of the great toe is approximately 80 degrees of extension and 25 degrees of flexion ([figure 5.55](#)). If extension is limited, stretch the flexors.

**Figure 5.55** Normal range of motion of the great toe: 80 degrees of extension, 25 degrees of flexion.



Stretches: Toe Flexors

**Toe Flexors Partner Stretch, Prone**

This stretch improves extension of the toes.

1. The stretcher lies prone on a treatment table or a mat on the floor, with his right knee flexed to 90 degrees and his toes fully extended (pointing toward the table). This lengthens the toe flexors to their end range.
2. Assume a comfortable and stable position that allows you to support the leg with your right hand and cradle the toes lightly with your left ([figure 5.56](#)).
3. Offer resistance as you direct the stretcher to try curling his toes, isometrically contracting the toe flexors for 6 seconds.
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the foot and toes in the starting position.
5. As he exhales, the stretcher uses his muscles to pull the toes farther into extension, deepening the stretch in the toe flexors.
6. Repeat two or three times.

**Figure 5.56** Toe flexors stretch.



### **Toe Flexors Self-Stretch, Sitting**

1. Sit comfortably on a bench, with your right ankle crossed over your left knee. Use your toe muscles to bend your toes toward you, and hold your toes lightly with your hand ([figure 5.57](#)).
2. From this starting position, try to curl your toes against your hand, isometrically contracting the flexors for 6 seconds. After the isometric push, relax, inhale, and as you exhale, use your toe muscles again to move your toes toward you, deepening the stretch in the flexors.
3. Repeat two or three times.

**Figure 5.57** Toe flexors self-stretch.

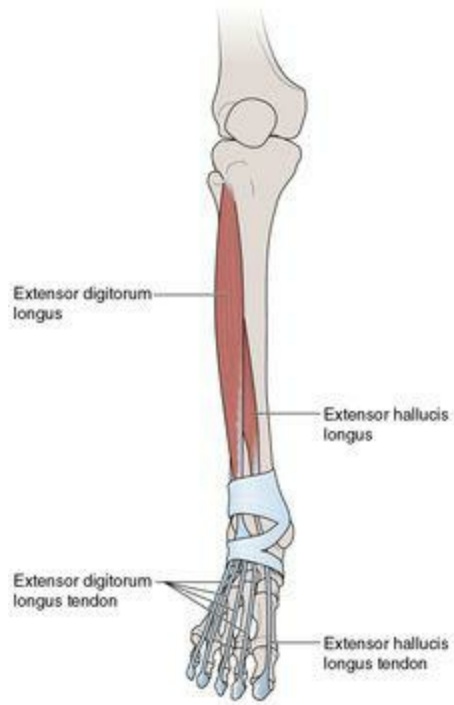


**Toe Extensors: Extensor Hallucis Longus, Extensor Digitorum Longus**

## Anatomy

We illustrate and discuss only two of the four toe extensors (extensor hallucis longus and extensor digitorum longus; [figure 5.58](#)) . [Table 5.11](#) lists all four toe extensors. Extensor hallucis longus and extensor digitorum longus help control the speed of descent of the forefoot to the ground after heel strike, preventing the foot from slapping onto the ground. They also contribute to postural stability by controlling posterior sway. With the foot anchored to the ground, they pull the leg forward at the ankle.

Figure 5.58 Toe extensor muscles.



**Table 5.11 Toe Extensor Muscles**

Muscle	Origin	Insertion	Action
Extensor digitorum longus	Lateral condyle of the fibula; proximal two-thirds of the medial fibula; upper part of the interosseous membrane, fascia cruris, and anterior intermuscular septum	Splits into four tendon slips inferior to the extensor retinaculum and inserts onto the dorsal aspect of the middle and distal phalanges of toes 2-5	Extends toes 2-5 Assists ankle dorsiflexion
Extensor hallucis brevis Extensor digitorum brevis	These muscles have a common attachment to the superior aspect of the calcaneus	The medial tendon attaches to the dorsal aspect of the base of the proximal phalanx of the great toe  The other three tendons fuse with those of extensor digitorum longus to insert on toes 2-4	Assist toe extension
Extensor hallucis longus	Anteromedial surface of the fibula and the adjacent interosseous membrane	Dorsal aspect of the base of the distal phalanx of the great toe	Extends the great toe Assists ankle dorsiflexion

## Functional Assessment

Adequate range of motion in the big toe is essential for normal walking. If extension is limited, then the proper toe-off function will be compromised, and the weight will be shifted to the lateral foot, often with painful results. See [figure 5.55](#) to check flexion and extension range of motion of the great toe. If flexion is limited, stretch the extensors.

*Stretches: Toe Extensors*

### Toe Extensors Partner Stretch, Supine

This stretch improves flexion of the toes.

1. The stretcher lies supine on a treatment table or a mat on the floor with his legs straight or comfortably bolstered under the knees. He curls the toes on his left foot as far as possible. This lengthens the toe extensors to their end range.
2. Assume a comfortable position beside the stretcher's left shin, facing the top of his foot. Support the leg with your right hand, and curl your fingers loosely around the stretcher's flexed toes ([figure 5.59](#)).
3. Offer resistance as you direct the stretcher to try straightening his toes, isometrically contracting the extensors for 6 seconds.
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the foot and toes in the starting position.
5. As he exhales, the stretcher uses his muscles to pull the toes farther into flexion, deepening the stretch on the extensors.
6. Repeat two or three times.

**Figure 5.59** Toe extensors stretch.



### **Toe Extensors Self-Stretch, Sitting**

1. Sit comfortably in a chair or on a bench, with your right ankle crossed over your left knee. Point your foot and curl your toes to stretch the extensors. Use your left hand, wrapped across the toes, to resist as you try to straighten your toes, isometrically contracting the extensors for 6 seconds ([figure 5.60](#)).
2. After the isometric push, relax, inhale, and as you exhale, point your foot and curl your toes again, deepening the stretch on the extensors.
3. Repeat two or three times.

**Figure 5.60** Toe extensors self-stretch.



**Ankle Evertors and Invertors: Peroneal (Fibularis) Group; Tibialis Anterior and Posterior**

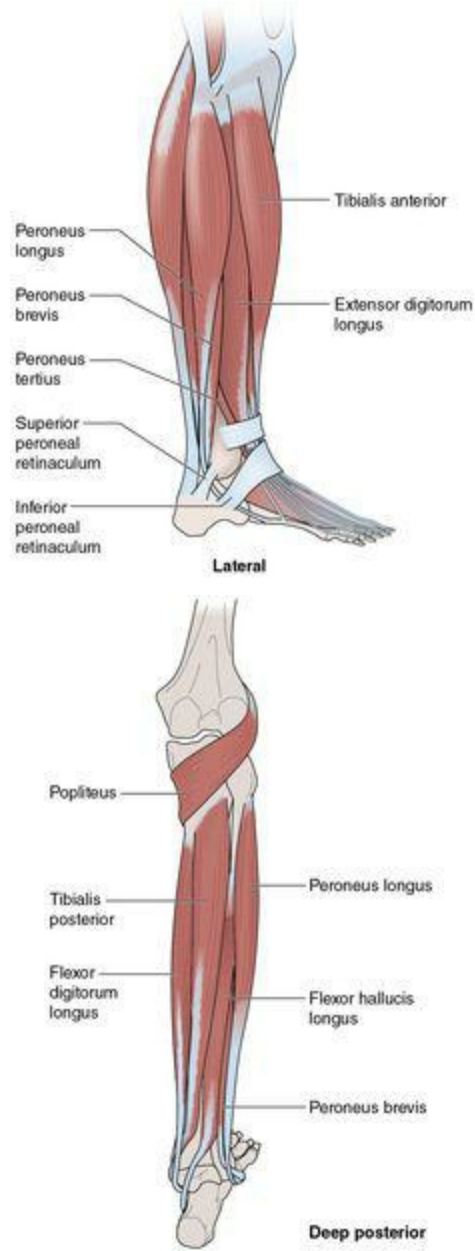
## Anatomy

Eversion (pronation) and inversion (supination) of the foot occur with every step in walking or running. Proper function of the evertors and invertors of the foot is critical for maintaining good biomechanics of the foot and ankle, as well as for stabilizing the leg on the foot. Like many of the lower limb muscles, the invertors and evertors often act to control movement rather than initiate it.

The primary evertors of the foot are two of the three peroneal muscles (also known as the fibularis muscles): the peroneus longus and the peroneus brevis. They make up the lateral compartment of the leg. A third evertor, peroneus tertius, is found in the anterior compartment with the tibialis anterior. Although the peroneals are most often considered evertors of the foot, they also stabilize the foot, ankle, and leg along with the other muscles of the lower limb.

The primary invertors of the foot are tibialis anterior and tibialis posterior (the deepest muscle in the calf). These muscles are shown in [figure 5.61](#) and outlined in [table 5.12](#).

Figure 5.61 Ankle evertor and invertor muscles.



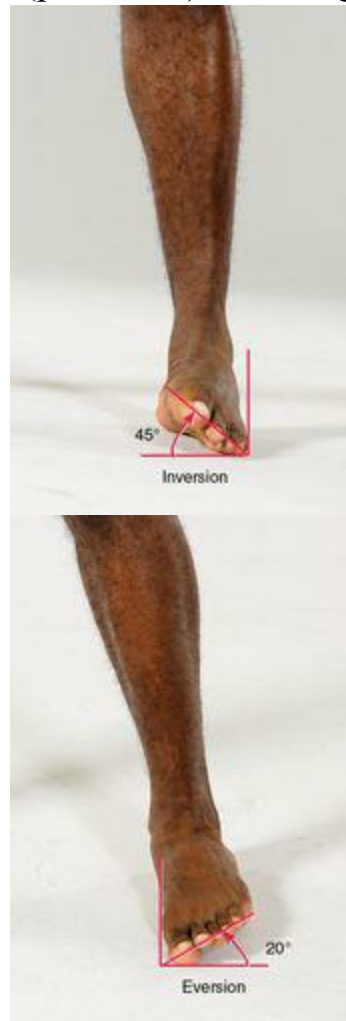
**Table 5.12 Ankle Evertor and Invertor Muscles**

Muscle	Origin	Insertion	Action
<b>EVERTORS</b>			
Peroneus brevis	Distal two-thirds of lateral fibula (lies deep to peroneus longus)	Peroneal tubercle on lateral aspect of fifth metatarsal	Eversion of foot Assists dorsiflexion
Peroneus longus	Proximal two-thirds of lateral fibula	Base of first metatarsal and medial cuneiform	Eversion of foot Assists plantar flexion of foot Stabilizes leg on foot Supports medial arch (in conjunction with tibialis anterior)
Peroneus tertius	Distal half of anterior fibula	Peroneal tubercle on lateral aspect of fifth metatarsal and base of fourth metatarsal	Eversion of foot Assists dorsiflexion
<b>INVERTORS</b>			
Tibialis anterior	Lateral shaft of tibia, interosseous membrane	Base of first metatarsal, first cuneiform	Ankle dorsiflexion Inversion of foot Supports longitudinal arch
Tibialis posterior	Interosseous membrane, medial fibula, and posterolateral tibia	Primarily the navicular and medial cuneiform, and also the cuboid, calcaneus, and bases of the second, third, and fourth metatarsals	Inversion of foot Assists plantar flexion and inversion

## Functional Assessment

Check range of motion. Inversion (supination) should be approximately 45 degrees, and eversion (pronation) should be approximately 20 degrees (see [figure 5.62](#)).

**Figure 5.62** Normal range of motion for inversion (supination) is 45 degrees and for eversion (pronation) is 20 degrees.



*Stretches: Ankle Evertors: Peroneal (Fibularis) Group*

### **Peroneals (Evertors) Partner Stretch, Supine**

This stretch increases inversion of the ankle.

1. The stretcher lies supine on a treatment table or a mat on the floor and inverts his right ankle (turns the sole of his foot toward the midline) by contracting the invertors. The ankle is kept in neutral relative to dorsiflexion and plantar flexion. This lengthens the right peroneals to their end range.
2. Grasp the stretcher's lower leg with your right hand to stabilize it, and place your left hand against the lateral side (little-toe side) of his right foot ([figure 5.63](#)).

3. Direct the stretcher to begin slowly attempting to turn the sole of his foot out against your hand (eversion), isometrically contracting the peroneals for 6 seconds.
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the foot in the starting position.
5. As he exhales, the stretcher contracts the invertors to increase inversion, deepening the peroneal stretch.
6. Repeat two or three times.

**Figure 5.63** Peroneals stretch.



### **Peroneals (Evertors) Self-Stretch, Sitting**

1. Sit comfortably in a chair, with your right ankle crossed over your left knee. Bend at the ankle to move the inside of your foot toward you, as if turning your sole toward your chest. Grasp the outside of your foot with your left hand ([figure 5.64](#)).
2. Try to turn your foot away from you, isometrically contracting your peroneals for 6 seconds. After the isometric push, relax, inhale, and as you exhale, use your leg muscles to turn your foot toward you again, deepening the stretch on the peroneals.
3. Repeat two or three times.

**Figure 5.64** Peroneal self-stretch.



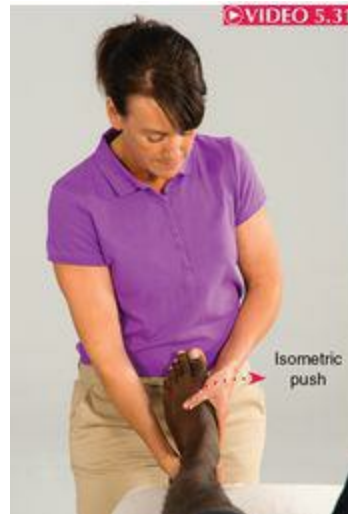
Stretches: Ankle Invertors

**Tibialis Posterior (Invertor) Partner Stretch, Supine**

This stretch increases eversion of the ankle.

1. The stretcher lies supine on a treatment table or a mat on the floor and everts his left ankle (turns the sole of his foot away from the midline) by contracting the peroneal muscles (evertors). The ankle is kept in neutral relative to dorsiflexion and plantar flexion. This lengthens the left posterior tibialis to its end range.
2. Grasp the stretcher's lower leg with your right hand to stabilize it, and place your left hand against the medial side (big-toe side) of his left foot ([figure 5.65](#)).
3. Direct the stretcher to begin slowly attempting to turn the sole of his foot inward against your hand (inversion), isometrically contracting the posterior tibialis for 6 seconds (see the isometric push arrow).
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the foot in the starting position.
5. As he exhales, the stretcher contracts the peroneals to increase eversion, deepening the tibialis posterior stretch.
6. Repeat two or three times.

**Figure 5.65** Tibialis posterior stretch.



### **Tibialis Posterior (Invertor) Self-Stretch, Sitting**

1. Sit comfortably on the floor or a stretching mat, with your left knee bent and the heel resting on the floor. Use your leg muscles to bend at the ankle and turn your foot out, as if you're turning the sole to the left.
2. From this starting position, wrap your hands around your foot, and resist as you try turning your foot inward, isometrically contracting the invertors for 6 seconds ([figure 5.66](#)). After the isometric push, relax, inhale, and as you exhale, use your muscles again to turn the sole of your foot to the left, deepening the stretch on the invertors.
3. Repeat two or three times.

**Figure 5.66** Tibialis posterior self-stretch.



# Chapter 6

## Stretches for the Upper Extremity

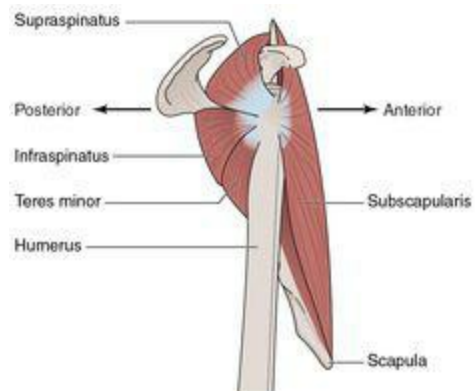
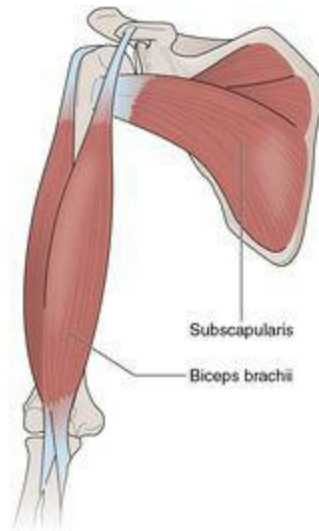
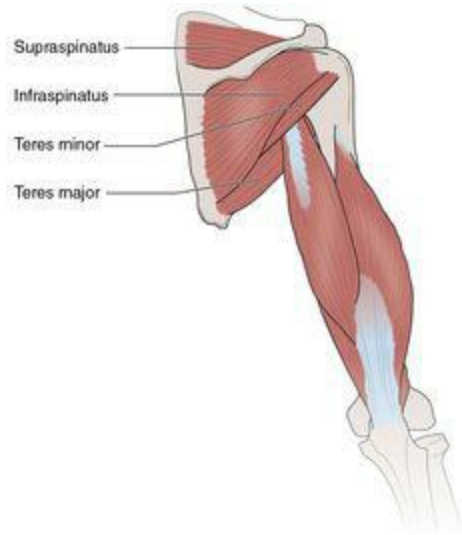
This chapter covers the muscles of the shoulder, arm, and wrist. The shoulder has the greatest range of motion of any joint in the body. We'll look at the four muscles of the rotator cuff, the scapular stabilizers, additional muscles affecting motion about the shoulder, the muscles that move the forearm, and the muscles of the wrist and fingers.

# Rotator Cuff

## Anatomy

The tendons of four muscles form the rotator cuff ([figure 6.1](#), [table 6.1](#)). They are the subscapularis, infraspinatus, teres minor, and supraspinatus. They are also referred to as the SITS muscles, a mnemonic device for remembering their names. These muscles, the prime movers of the arm at the shoulder, also stabilize the humerus in the glenoid fossa of the scapula during movement. The SITS muscles create a variety of movements when acting alone (almost never) and act synergistically to stabilize the humerus on the scapula during activity.

Figure 6.1 Rotator cuff muscles.



**Table 6.1 Rotator Cuff Muscles**

Muscle	Origin	Insertion	Action
Infraspinatus	Infraspinous fossa of scapula	Greater tubercle of humerus (middle facet)	Lateral rotation of humerus
Subscapularis	Subscapularis fossa of scapula	Lesser tubercle of humerus	Medial rotation of humerus
Supraspinatus	Supraspinous fossa of scapula	Greater tubercle of humerus (superior facet)	Stabilizes head of humerus in glenoid fossa Initiates abduction
Teres minor	Upper axillary border of scapula	Greater tubercle of humerus (inferior facet)	Lateral rotation of humerus

Sports injuries to the rotator cuff are very common and tend to fall into two broad categories: rotator cuff tears or impingement syndrome. One or more of the rotator cuff tendons can tear as a result of trauma or overuse. The most common tear occurs in the supraspinatus. Impingement syndrome can occur from trauma or overuse that causes inflammation and swelling of the subacromial bursa (bursitis), inflammation of the rotator cuff (tendinitis), or degradation of the tendinous fibers of the rotator cuff without inflammation (tendinosis). Treatment for any of these conditions varies depending on what structures are involved. In any case, pain-free stretching for the muscles of the rotator cuff is an important component of any therapy program.

## Functional Assessment

Active movements can be used to evaluate the entire shoulder complex (humerus, clavicle, scapula) for freedom of movement and for pain. Restriction in range may be caused by hypertrophy or hypertonicity of the muscles or by pain. Normal ranges of shoulder motion are as follows ([figure 6.2](#)):

- Flexion = 180 degrees
- Extension = 60 degrees
- Adduction = 45 degrees
- Abduction = 180 degrees
- Internal rotation = 90 degrees
- External rotation = 50 degrees
- Horizontal adduction = 130 degrees
- Horizontal abduction = 30 degrees

**Figure 6.2** Normal ranges of motion for the shoulder.





*Stretches: Rotator Cuff*

**Subscapularis Partner Stretch, Supine on a Treatment Table**

This stretch improves external rotation of the humerus.

1. The stretcher is supine on a treatment table with her shoulder abducted to 90 degrees and her elbow flexed to 90 degrees. Her upper arm is resting completely on the table to prevent recruiting extra muscles, and her arm is externally rotated as far as possible. Be sure the forearm is able to clear the edge of the table if she has enough range of motion to do so. This position lengthens the subscapularis to its pain-free end range.
2. Offer resistance to the isometric contraction (no movement) of the subscapularis by placing one hand under the stretcher's elbow and the other hand over her wrist ([figure 6.3](#)).
3. Ask the stretcher to focus just on rotating her arm as you direct her to begin slowly attempting to internally rotate her humerus, isometrically contracting the subscapularis for 6 seconds. ("Try to push your wrist toward the ceiling.")
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the arm in the starting position.
5. As she exhales, the stretcher contracts the infraspinatus to externally rotate the humerus farther, deepening the subscapularis stretch.
6. Repeat two or three times.

**Figure 6.3** Subscapularis stretch. The shoulder and elbow are both at 90 degrees, and the upper arm rests on the table.



### Subscapularis Partner Stretch, Seated

This stretch improves external rotation of the humerus.

1. The stretcher is seated on a bench or stool, with her feet planted firmly on the floor. She abducts her shoulder to 90 degrees, flexes her elbow to 90 degrees, and externally rotates her arm as far as possible. This position lengthens the subscapularis to its pain-free end range. If this position causes pain in the rotator cuff region, consider performing the stretch with the stretcher's arm bent at the elbow and held against her side.
2. Assume a stable position to offer resistance to the isometric contraction (no movement) of the subscapularis by placing one hand under the stretcher's elbow (then asking her to relax her shoulder) and the other hand across the inside of her wrist ([figure 6.4](#)).
3. Ask the stretcher to focus just on rotating her arm as you direct her to begin slowly attempting to internally rotate her humerus, isometrically contracting the subscapularis for 6 seconds. ("Try to rotate your arm by pushing your wrist against my hand.")
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the arm in the starting position.
5. As she exhales, the stretcher contracts the infraspinatus to externally rotate the humerus farther, deepening the subscapularis stretch.
6. Repeat two or three times.

**Figure 6.4** Subscapularis stretch. (a) The shoulder and elbow are both at 90 degrees, and the humerus is externally rotated. (b) The arm held against the side.



### **Subscapularis Self-Stretch, Standing**

1. An easy stretch for the subscapularis can be done at an exercise rack or in a doorway. Stand with your arm at your side, the elbow flexed to 90 degrees, and the humerus externally rotated as far as possible ([figure 6.5](#)). It's helpful to think of the arm as a gate that swings back and forth.
2. Use the doorjamb (or any fixed upright object) to resist your attempt to swing the gate closed (push the arm toward the abdomen). Push for 6 seconds, isometrically contracting the subscapularis.
3. Stretch by “swinging the gate open” more.
4. Repeat two or three times.

**Figure 6.5** Subscapularis self-stretch. Keep your elbow against your side.



### **Infraspinatus and Teres Minor Partner Stretch, Prone on a Treatment Table**

This stretch improves internal rotation of the humerus.

1. The stretcher lies prone on the table with her shoulder abducted to 90 degrees and her elbow flexed to 90 degrees. Her arm is internally rotated as far as possible, and her upper arm is resting completely on the table to help prevent recruiting extra muscles. (The prone position helps keep her shoulder from rolling forward, which would give a false impression of the range of internal rotation.) This position lengthens the infraspinatus to its pain-free end range.
2. Offer resistance to the isometric contraction of the infraspinatus by placing one hand over the stretcher's elbow and the other hand under her wrist ([figure 6.6](#)).
3. Ask the stretcher to focus just on rotating her arm as you direct her to begin slowly attempting to externally rotate her humerus, isometrically contracting the infraspinatus for 6 seconds. ("Try to push your wrist toward the floor.")
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the arm in the starting position.
5. As she exhales, the stretcher contracts the subscapularis to internally rotate the humerus farther, deepening the infraspinatus stretch.
6. Repeat two or three times.

**Figure 6.6** Infraspinatus stretch. The shoulder and elbow are both at 90 degrees, and the upper arm rests on the table.



## Infraspinatus and Teres Minor Partner Stretch, Seated

This stretch improves internal rotation of the humerus.

1. The stretcher is seated on a bench or stool, with her feet planted firmly on the floor. She abducts her shoulder to 90 degrees, flexes her elbow to 90 degrees, and internally rotates her arm as far as possible (scarecrow position). Be sure she sits tall and keeps her shoulder from rolling forward, which would give a false impression of the range of internal rotation. This position lengthens the infraspinatus and teres minor to their pain-free end range.
2. Assume a stable position to offer resistance to the isometric contraction (no movement) of the infraspinatus by placing one hand on the biceps at the stretcher's elbow (then asking her to relax her shoulder) and the other hand across the back of her wrist ([figure 6.7](#)).
3. Ask the stretcher to focus just on rotating her arm as you direct her to begin slowly attempting to externally rotate her humerus, isometrically contracting the infraspinatus for 6 seconds. ("Try to push your wrist toward the ceiling.")
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the arm in the starting position.
5. As she exhales, the stretcher contracts the subscapularis to internally rotate the humerus farther, deepening the infraspinatus stretch.
6. Repeat two or three times.

**Figure 6.7** Infraspinatus stretch. The shoulder and elbow are both at 90 degrees, and the humerus is internally rotated.



### **Infraspinatus and Teres Minor Self-Stretch, Standing**

1. The infraspinatus can be a difficult muscle to self-stretch, but here is one option. Assume a hammerlock position (i.e., with your right arm behind your back and your elbow flexed to approximately 90 degrees). Attach a stretching strap to a fixed piece of exercise equipment, and stand with your back to it ([figure 6.8](#)).
2. Hold the strap taut for resistance, and try to push your forearm against your back, isometrically contracting the infraspinatus for 6 seconds.
3. After the isometric contraction, pull your forearm farther away from your back as you take a step or two away from the piece of equipment, still holding on to the strap. This stretches the infraspinatus.
4. Repeat two or three times.

**Figure 6.8** Infraspinatus self-stretch.



### **Supraspinatus Partner Stretch, Prone**

This stretch improves internal rotation and adduction of the humerus.

1. The stretcher is prone on a treatment table, with her right arm in a hammerlock position (i.e., with her right elbow bent to 90 degrees and her forearm resting across her low back). This position lengthens the supraspinatus to its end range.
2. Assume a stable position that allows you to comfortably stabilize the top of the right shoulder and the right elbow. Direct the stretcher to begin slowly attempting to push her arm away from her side as you provide resistance to this isometric contraction of the supraspinatus (see the isometric push arrow in [figure 6.9](#)).
3. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the arm in the starting position.
4. As she exhales, the stretcher reaches farther across her back, deepening the stretch on the supraspinatus.
5. Repeat two or three times.

**Figure 6.9** Prone supraspinatus stretch.



### **Supraspinatus Partner Stretch, Seated**

1. The stretcher is seated on a bench or stool, with her feet planted firmly on the floor. She sits tall to keep her rib cage from collapsing and reaches her right arm behind her back in the hammerlock position. This position lengthens the supraspinatus to its end range. She allows her left arm to hang relaxed at her left side.
2. Assume a stable position at the stretcher's left side, grasp her right wrist in your right hand, and place your left hand against her left arm at the elbow. Remind the stretcher to sit tall, and direct her to slowly attempt to pull her right arm away from her right side as you provide resistance to this isometric contraction of the supraspinatus ([figure 6.10](#)).
3. After the isometric effort, the stretcher relaxes and inhales deeply. During this time, maintain the arm in the starting position.
4. As she exhales, the stretcher sits tall and reaches farther across her back, deepening the stretch on the supraspinatus.
5. Repeat two or three times.

**Figure 6.10** Seated supraspinatus stretch.



### **Supraspinatus Self-Stretch, Seated**

1. Sit on a bench or stool with your feet on the floor. Sit tall to keep your rib cage from collapsing, and reach your right arm behind your back in a hammerlock position. This position lengthens the supraspinatus to its end range. Be sure this does not cause pain in your right shoulder. Grasp your right wrist with your left hand, and slowly attempt to pull your right arm away from your right side as your left hand resists this isometric contraction of the right supraspinatus ([figure 6.11](#)).
2. After the isometric effort, relax and inhale deeply. During this time, maintain the arm in the starting position.
3. As you exhale, sit tall and reach farther across your back, deepening the stretch on the supraspinatus.
4. Repeat two or three times.

**Figure 6.11** Seated supraspinatus self-stretch.



## **Scapular Stabilizers**

## Anatomy

The ability to move or to stabilize the scapula is critical in daily activity as well as in sport. The scapular muscles ([figure 6.12](#), [table 6.2](#)) work synergistically with their partners to ensure smooth motion or strong stabilization as necessary. The rhomboids and middle traps are responsible for control of scapular retraction, while the serratus anterior and pectoralis minor are responsible for control of scapular protraction. Pectoralis major and minor contribute to rounded and forward shoulders, so they indirectly affect scapular position.

Figure 6.12 Scapular stabilizer muscles.

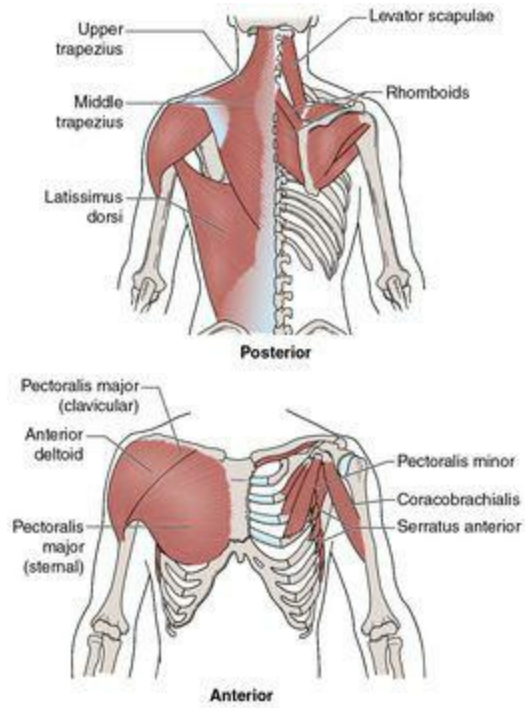


Table 6.2 Scapular Stabilizer Muscles

Muscle	Origin	Insertion	Action
Middle trapezius	Spinous processes of C7-T12 vertebrae	Spine of the scapula	Retracts the scapula
Pectoralis minor	Outer surface of the third, fourth, and fifth ribs, near the costochondral junctions	Medial border and superior surface at the tip of the coracoid process	Protracts, depresses, and downwardly rotates the scapula; tilts scapula anteriorly; accessory respiratory muscle: assists inspiration Stabilizes the scapula by drawing it anteriorly and superiorly against the thoracic wall
Rhomboid major	Spinous processes of T2-T5	Medial border of the scapula, from its spine to its inferior angle	Adducts, elevates, and downwardly rotates the scapula Helps stabilize the scapula during arm movements
Rhomboid minor	Spinous processes of C7-T1	Medial border of the scapula, at the root of the spine	Adducts, elevates, and downwardly rotates the scapula Helps stabilize the scapula during arm movements
Serratus anterior	A series of slips from the lateral aspect of the upper eight ribs and fascia The lower slips interdigitate with the external obliques	The medial aspect of the costal surface of the scapula The upper slip attaches to the superior angle, the second through fourth slips attach along the medial border, and the lower four slips converge at the inferior angle	Protracts and upwardly rotates the scapula

- **Pectoralis minor.** Pectoralis minor stabilizes the scapula when the arm is exerting downward pressure (as in walking with crutches or doing a push-up). When hypertonic, it may cause the inferior border of the scapula to “wing out” and also contributes to forward and rounded shoulders.
- **Rhomboids and middle trapezius.** Although the rhomboids often are tender to palpation, they are commonly overstretched rather than short and tight. This overstretched condition is likely in people with rounded shoulders, in whom the pectoralis muscles draw the shoulders forward. In such a situation, stretching the pectorals and strengthening the rhomboids would be indicated.
- **Serratus anterior.** The serratus anterior stabilizes the scapulae against the rib cage when the arms are bearing weight. It also interacts with the rhomboid muscles to position the scapulae on the back. When hypertonic, it can contribute to rounded shoulders by excessively protracting the scapulae, which also causes eccentric stress on the rhomboids.

## Functional Assessment

With the stretcher standing, observe her active motion through all the movements available at the shoulder (see [figure 6.2](#)). Pay close attention to the bilateral movement of the scapulae, and note any movement restriction, jerkiness, or differences between the two sides that may be the result of dysfunction, especially hypertonicity, in the scapular stabilizers.

*Stretches: Scapular Stabilizers*

### **Pectoralis Minor Partner Stretch, Supine**

This stretch reduces hypertonicity in the pectoralis minor and helps normalize the position of the scapula on the rib cage.

1. The stretcher lies supine on a treatment table or a mat on the floor. Assume a comfortable and stable position at her left side, and hold her left hand in your left hand, allowing her upper arm to rest at her side, on the surface. This position allows the stretcher to relax her shoulder muscles while preventing her arm from bouncing around. Place the fleshy part of your right palm on her anterior shoulder. Direct the stretcher to pull her shoulder toward the surface and her shoulder blade down her back toward her feet. (“Put your shoulder blade in your back pocket.”) You may assist this motion passively. This lengthens the pectoralis minor to its end range ([figure 6.13](#)).
2. Direct the stretcher to start slowly trying to roll her shoulder up into your right hand, isometrically contracting the pectoralis minor for 6 seconds.
3. After the isometric push, the stretcher relaxes and breathes in. As she exhales, ask the stretcher to once again pull her shoulder toward the surface and her shoulder blade down her back as you gently assist. This deepens the stretch on the pectoralis minor.
4. Repeat two or three times.

**Figure 6.13** Pectoralis minor stretch (*a*) on a table and (*b*) on a mat.



### **Pectoralis Minor Self-Stretch, Standing**

1. Stand with your feet about shoulder-width apart or in a lunge stance with your hands clasped behind your back, and pull your shoulder blades down your back. This position puts the pectoralis minor on a stretch.
2. Place the front of your left shoulder against a doorjamb or other fixed upright, and begin slowly trying to roll your shoulder forward ([figure 6.14](#)).
3. Hold this isometric contraction for 6 seconds, and then relax, breathe, and pull your shoulders back and down, stretching the pectoralis minor.
4. Repeat two or three times.

**Figure 6.14** Pectoralis minor self-stretch.



## **Rhomboids and Middle Trapezius Partner Stretch, Supine**

This stretch improves scapular protraction (movement of the scapula away from the midline).

1. The stretcher is supine on a treatment table or a mat on the floor. With her left arm flexed at the elbow, she moves her upper arm across her chest as far as possible. She may assist this motion by pulling with her right hand. She does not roll her torso up to the right, but keeps at least part of her scapula in contact with the table. This lengthens the left rhomboids to their end range.
2. Assume a stable and comfortable position facing her left side. Reach under her back so that your hands are in firm contact with the body of the left scapula and your fingers grasp its medial border ([figure 6.15](#)). Ask the stretcher to begin slowly trying to pull her scapula toward her spine. You provide matching resistance for this 6-second isometric contraction, being sure the client is breathing normally throughout. Be sure she engages her rhomboids and is not just pushing from her arm.
3. After the isometric push, the stretcher relaxes and breathes in. As she relaxes, maintain the scapula and arm in the starting position.
4. As she exhales, ask her to pull her arm farther across her chest, protracting the scapula farther away from the spine and increasing the rhomboid stretch.
5. Repeat two or three times.

**Figure 6.15** Supine rhomboids and middle trapezius stretch.

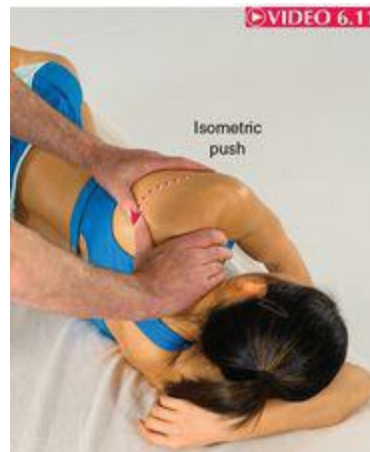


### **Rhomboids and Middle Trapezius Partner Stretch, Side-Lying on a Treatment Table**

This stretch improves scapular protraction (movement of the scapula away from the midline).

1. The stretcher lies on her right side, with her head resting on her right arm to help stabilize her torso. She reaches her left arm over the side of the table, focusing on moving her scapula away from her spine, to lengthen the rhomboids and middle trapezius to their end range.
2. Stand behind the stretcher, and place your hands on her scapula so that your flat thumbs can palpate the medial border ([figure 6.16](#)). Direct the stretcher to begin slowly trying to pull her scapula back toward her spine, isometrically contracting her rhomboids and middle trapezius for 6 seconds (see the isometric push arrow). During this time, the focus is on the scapula. Her left arm should be relaxed.
3. After the isometric push, the stretcher relaxes and inhales. As she exhales, she reaches farther over the edge of the table to deepen the stretch on the rhomboids and middle trapezius.
4. Repeat two or three times.

**Figure 6.16** Side-lying rhomboids and middle trapezius stretch.



### **Rhomboids and Middle Trapezius Partner Stretch, Seated**

1. The stretcher sits comfortably on a bench, flexes her right arm and shoulder to 90 degrees, and moves the arm across her chest.
2. Assume a stable position behind the stretcher that allows you to hold her right elbow with your left hand and to place the flat of your right hand against the medial border of her scapula ([figure 6.17](#)).
3. Direct the stretcher to begin slowly trying to pull her right scapula back toward her spine, isometrically contracting her right rhomboids and middle trapezius for 6 seconds. During this time, the focus is on the scapula as opposed to just pushing with the right arm.
4. After the isometric contraction, the stretcher relaxes, takes a breath in, and stretches as she exhales by moving her right arm farther across her chest. You may add pain-free passive stretch at this point if needed to overcome the muscle mass of the pectoralis major.
5. Repeat two more times, and then stretch the opposite side.

**Figure 6.17** Seated rhomboids and middle trapezius stretch.



### **Rhomboids and Middle Trapezius Self-Stretch, Seated**

1. Sit comfortably on a bench. Flex your arm and shoulder to 90 degrees, and move your arm across your chest. This pulls your scapula away from your spine and stretches your rhomboids. Use your other hand to hold at your elbow, stabilizing your arm.
2. Try to move your scapula toward your spine, isometrically contracting your rhomboids for 6 seconds.
3. After the isometric contraction, stretch the rhomboids by moving your arm farther across your chest ([figure 6.18](#)).

**Figure 6.18** Rhomboids and middle trapezius self-stretch.



### **Serratus Anterior Partner Stretch, Prone**

This stretch helps reduce hypertonicity in the serratus anterior and contributes to normal positioning of the scapula on the rib cage.

1. The stretcher is prone on a treatment table or mat on the floor, with her arms resting at her sides (this makes it easier to move the shoulder blade). Assume a stable and comfortable position near the stretcher's head, and place the pads of your fingers (not the tips) against the lateral border of the right scapula ([figure 6.19](#)). Direct the stretcher to pull her scapula toward her spine (retraction) as you assist. You may need to add some passive stretch to reach the soft-tissue barrier for serratus anterior. This lengthens the serratus anterior to its end range.
2. From this starting position, direct the stretcher to push her shoulder blade into your fingers (protraction), isometrically contracting the serratus anterior for 6 seconds (see the isometric push arrow).
3. After the isometric push, the stretcher relaxes and breathes, and as she exhales, she uses her rhomboids to pull her shoulder blade closer to her spine as you assist. This deepens the stretch on the serratus anterior.
4. Repeat two or three times.

**Figure 6.19** Prone serratus anterior stretch (*a*) on a table and (*b*) on a mat.



## Serratus Anterior Self-Stretch

This version of the serratus anterior stretch requires pain-free internal rotation of the shoulder to assume the hammerlock starting position.

1. Stand or sit with your right arm bent at the elbow and reaching across your low back. Grasp your right wrist with your left hand. Use your upper back muscles to draw your right scapula closer to your spine. This lengthens the right serratus anterior ([figure 6.20](#)).
2. From this starting position, focus on moving your shoulder blade away from your spine (protraction of the scapula), rather than pushing your right arm away from you. Hold this position, isometrically contracting your serratus anterior muscle for 6 seconds. Keep breathing normally.
3. After this isometric contraction, take a deep breath, and as you exhale, use your rhomboids to draw your scapula closer to the spine to increase the stretch of the serratus anterior.
4. Repeat two or three times.

**Figure 6.20** Serratus anterior self-stretch (hammerlock position).



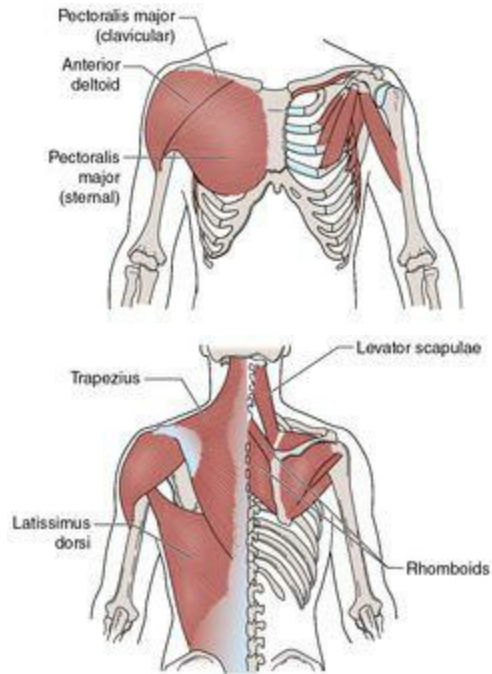
### **Additional Muscles That Move the Arm**

## Anatomy

The pectoralis major ([figure 6.21](#)) is a broad, powerful muscle that gives shape to the chest and is a strong mover of the arm. It is divided into two sections: the clavicular head and the sternal head. Acting together, these help adduct, horizontally adduct, and medially rotate the humerus. The clavicular head, acting alone, assists flexion of the humerus. The sternal head, acting alone, extends the humerus from a flexed position.

Latissimus dorsi ([figure 6.21](#), [table 6.3](#)) forms part of the posterior axillary border and is used in many activities in which the arm moves from overhead downward, such as chopping wood, swimming, and rock climbing. Although we're including latissimus as an upper extremity muscle, it could also be considered a torso muscle because it has a broad myofascial connection to the lumbar spine, sacrum, and iliac crest. It's often overlooked as a source of back pain.

Figure 6.21 Additional muscles that move the arm.



**Table 6.3 Additional Muscles That Move the Arm**

Muscle	Origin	Insertion	Action
Pectoralis major	Clavicular head: medial half of anterior aspect of clavicle Sternal head: sternum and cartilage of the six upper ribs	Lateral lip of bicipital groove of the humerus	Both heads: adduction, horizontal adduction, and medial rotation of the humerus Clavicular head: flexion of humerus Sternal head: extension of humerus from a flexed position
Latissimus dorsi	Spinous processes of T7-L5 Sacrum via the lumbar aponeurosis Crest of ilium	Medial aspect of bicipital groove of humerus	Extension of arm from a flexed position Adduction Shoulder depression Assists internal rotation Provides a "vest pocket" for inferior angle of scapula, holding it against the ribs

## Functional Assessment

With the stretcher standing, observe her active motion through all the movements available at the shoulder (see [figure 6.2](#)). Since this section is focused on the pectoralis major and the latissimus dorsi, pay close attention to the range of motion of the arm in flexion, abduction, and horizontal abduction. Limitations in these movements may be due to one or both of these muscles being hypertonic.

*Stretches: Additional Muscles That Move the Arm*

### Pectoralis Major Partner Stretch, Prone

Stretching the pectoralis major can improve range of motion in horizontal abduction, flexion, extension, and external rotation of the humerus, depending on which fibers of the muscle are emphasized during the stretch. *Note:* By changing the angle of abduction of the arm, you can emphasize different fibers of the pectoralis major. Less abduction (45 degrees) focuses on the clavicular head; more abduction (135 degrees) focuses more on the lower fibers of the sternocostal head.

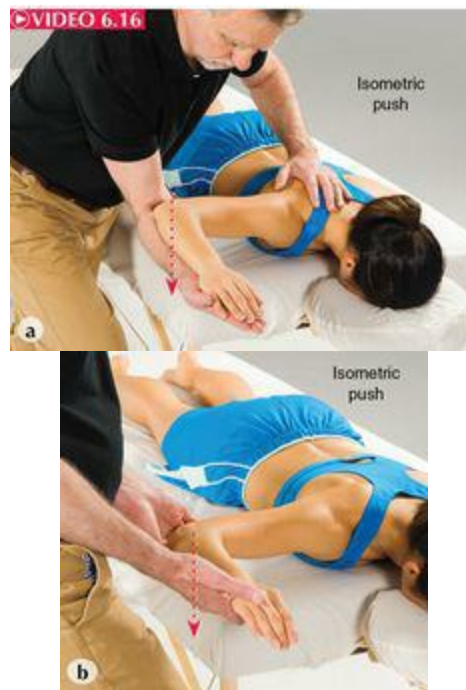
This stretch position is not recommended for a stretcher with an unstable shoulder joint or a history of shoulder dislocation.

1. The stretcher is prone on a treatment table, with her face resting in the face cradle or her head turned to one side if no face cradle is available. Her right arm is abducted to 90 degrees and externally rotated, with the elbow bent to 90 degrees. Her upper arm rests on the table. Stand at the right side of the table, and ask the stretcher to lift her right arm toward the ceiling as high as possible, keeping the forearm horizontal. As she lifts, make sure she does not lift her sternum off the table, which would indicate that she is rotating her trunk. This starting position lengthens the right pectoralis major to its pain-free end range.
2. Support the stretcher's right arm from the elbow to the hand using your right forearm and hand ([figure 6.22a](#)) or position yourself to hold her elbow in your left hand and her wrist in your right hand ([figure 6.22b](#)). Ask the stretcher to begin slowly attempting to move her arm down and across her chest, leading with the elbow, isometrically contracting the pectoralis major for 6 seconds (see the isometric push arrow). During the isometric contraction of the pectoralis major, the rhomboids should be relaxed.
3. After the isometric push, the stretcher relaxes and breathes in. During this time, maintain the arm in the starting position.
4. As she exhales, ask the stretcher to lift her arm higher, keeping the forearm

horizontal and her sternum on the table to prevent trunk rotation.

5. Repeat two or three times. Remember that changing the angle of abduction of the arm emphasizes different fibers of the pectoralis major.

**Figure 6.22** Pectoralis major stretch. (a) Supporting the arm elbow to elbow and wrist to wrist. (b) Two-handed support. Be sure the stretcher does not lift the sternum off the table.



### Pectoralis Major Partner Stretch, Seated

1. The stretcher is seated on a bench or stool. Be sure the stretcher maintains a lengthened spine and allows the head to float over the shoulders. Throughout the stretching procedure, be sure the stretcher avoids jutting her chin forward, which puts unnecessary stress on the neck. The stretcher abducts and externally rotates her arms to 90 degrees, with the elbows bent to 90 degrees (hands-up position). She then actively pulls her shoulder blades together to horizontally abduct her arms, lengthening the pectoralis major muscles to their pain-free end range.
2. Stand behind the stretcher and support her arms at the elbows ([figure 6.23](#)). Ask the stretcher to begin slowly attempting to pull her arms together, leading with the elbow (as in the butterfly strengthening exercise), isometrically contracting the pectoralis major for 6 seconds. During the isometric contraction of the pectoralis major, the rhomboids should be relaxed.
3. After the isometric push, the stretcher relaxes and breathes in. During this time, maintain the arms in the starting position.

## Pthomegroup

4. As she exhales, ask the stretcher to pull her arms back, keeping the forearms vertical. Remind the stretcher to avoid jutting her chin.
5. Repeat two or three times. Remember that changing the angle of abduction of the arm emphasizes different fibers of the pectoralis major.

**Figure 6.23** Seated pectoralis major stretch.



## **Pectoralis Major Self-Stretch, Standing**

You can perform self-stretching of the pectoralis using an exercise rack, a doorway, or any other vertical column to provide resistance during the isometric phase. Raise your arm higher or lower to stretch different parts of the pectoralis. *Note:* Raising your arm higher against the vertical column will emphasize the pectoralis fibers that attach to the sternum. Having your arm lower on the vertical column will emphasize the fibers that attach to the collarbone.

1. Stand at an exercise rack and place your forearm against it. Being aware of your posture, assume a wide front-to-back lunge stance, keeping your back lengthened and not arched. Using your upper back muscles, pull your arm backward, away from the vertical column as far as you can; now take a step or two forward until your forearm is once again placed against the vertical column. This is your starting position ([figure 6.24](#)).
2. Start slowly and push with moderate effort against the column, isometrically contracting the pectoralis major. Your arm is not moving, just pushing. Breathe normally. Hold the push for 6 seconds, and then relax.
3. Take another breath, and as you exhale, use your upper back muscles to pull your arm backward, away from the column, as far as you can. This further stretches the pectoralis major.
4. While your arm is in the stretched position, step forward to contact the post again, and repeat the sequence two or three times.

**Figure 6.24** Pectoralis major self-stretch.



### **Latissimus Dorsi Partner Stretch, Prone**

This stretch, which mimics the lat pull-down used to strengthen the latissimus dorsi, increases range of motion in flexion and external rotation of the humerus.

1. The stretcher is prone on the table, with his arms outstretched (in the “Superman” position) and externally rotated (thumbs up). This position lengthens the latissimus dorsi to the end range.
2. Using a stable front-to-back lunge stance, grasp the stretcher’s arms or wrists securely ([figure 6.25a](#)). If the stretcher experiences discomfort with the wrist grasp, holding at the elbows may be more comfortable ([figure 6.25b](#)). Direct the stretcher to begin slowly trying to pull his elbows toward his sides and rotate his arms internally, isometrically contracting the latissimus dorsi bilaterally for 6 seconds.
3. After the isometric pull, the stretcher relaxes and breathes in.
4. As he exhales, ask the stretcher to reach farther forward (away from his feet), toward the ceiling, and to externally rotate his arms more, deepening the stretch of the latissimus dorsi.
5. Repeat two or three times.

**Figure 6.25** Latissimus dorsi stretch. (a) Holding at the wrists. (b) Holding at the elbows.



### **Latissimus Dorsi Partner Stretch, Seated**

1. This stretch may be done seated or standing, but the seated position stabilizes the stretcher's hips. Direct the stretcher to keep his back and neck lengthened and move his right arm, elbow bent, up behind his head, reaching toward his left shoulder. Ensure that he doesn't force his chin to his chest as he does so ([figure 6.26](#)). This lengthens the right latissimus dorsi.
2. Assume a stable position behind the stretcher. Place your right hand against his right elbow and your left hand against his left shoulder to help stabilize. From this starting position, direct the stretcher to attempt to move his right arm down toward his right side while you resist the motion. Hold this isometric contraction of the right latissimus dorsi for 6 seconds as the stretcher breathes normally.
3. After the isometric contraction, direct the stretcher to reach his right arm farther to the left to increase the stretch on the right latissimus dorsi.

4. Repeat two or three times.
5. To increase the stretch even more, have the stretcher side-bend to the left.

**Figure 6.26** Latissimus dorsi stretch, seated with a partner.



### **Latissimus Dorsi Self-Stretch, Standing With Pull-Up Bar**

This stretch utilizes your own body weight to provide resistance during the isometric phase.

1. With your hands at least shoulder-width apart on a pull-up bar, assume a lunge stance and drop toward the floor until your arms are completely stretched out above you and are holding your weight ([figure 6.27](#)). This position lengthens the latissimus dorsi.
2. Slowly attempt a pull-up from this position. The goal is simply to engage the latissimus dorsi muscles isometrically, not to complete the pull-up. Hold this isometric contraction for 6 seconds, breathing normally.
3. Relax and breathe. As you exhale, let your body weight drop toward the floor, deepening the stretch on the latissimus dorsi.
4. Repeat two or three times.

**Figure 6.27** Latissimus dorsi self-stretch, standing.



### **Latissimus Dorsi Self-Stretch, Seated**

1. This stretch may be done seated or standing, but the seated position stabilizes your hips to help your biomechanics. Keep your back and neck lengthened and move your right arm, elbow bent, up behind your head, trying to reach your left shoulder. Grab your right elbow with your left hand ([figure 6.28](#)).
2. From this starting position, attempt to move your right arm down to your right side, resisting with your left hand. Hold this isometric contraction of the right latissimus dorsi for 6 seconds, breathing normally.
3. Relax and breathe. After the isometric contraction, reach your right arm farther to the left to increase the stretch on the right latissimus dorsi.
4. Repeat two or three times.
5. To increase the stretch even more, side-bend to the left.

**Figure 6.28** Latissimus dorsi self-stretch, sitting.

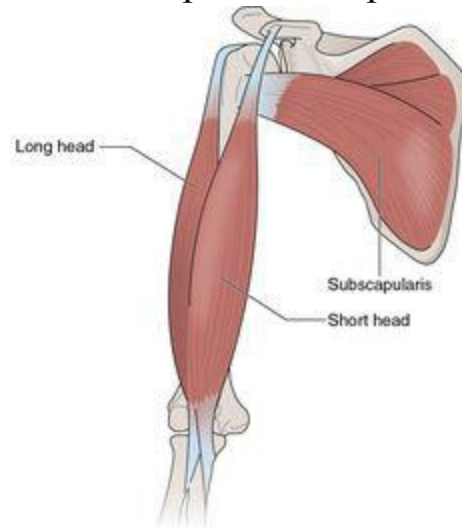


**Elbow: Biceps and Triceps**

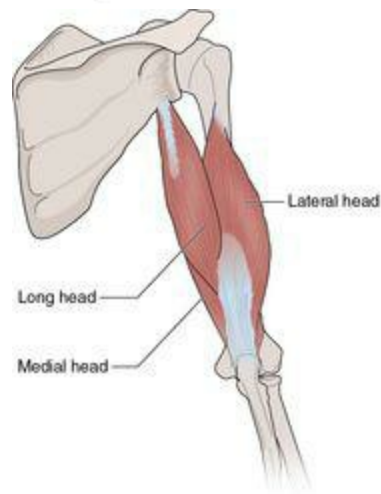
## Anatomy

The biceps brachii is a two-headed, two-joint muscle. It crosses both the shoulder and the elbow and affects both. Primarily, biceps brachii assists flexion of the shoulder, flexion of the elbow, and supination of the forearm. The triceps is a three-headed, two-joint muscle. It crosses both the shoulder and the elbow and acts on both. Its primary action is extension of the elbow. The long head assists extension of the humerus. These are illustrated and discussed in [figure 6.29](#) and [table 6.4](#).

Figure 6.29 Biceps and triceps muscles.



Biceps brachii



Triceps brachii

**Table 6.4 Biceps and Triceps Muscles**

Muscle	Origin	Insertion	Action
Biceps brachii	Long head: tubercle on superior aspect of glenoid cavity Short head: coracoid process	Radial tuberosity and bicipital aponeurosis	Elbow and shoulder flexion Supination of forearm Long head assists abduction Short head assists adduction Helps stabilize humerus in glenoid fossa during heavy lifting or carrying
Triceps brachii	Long head: infraglenoid tubercle of scapula Lateral head: posterolateral surface of proximal humerus Medial head: lower two-thirds of posteromedial humerus	Olecranon process of ulna	Extension of elbow Long head only: extension of humerus

## Functional Assessment

Elbow flexion may be limited by the muscle mass of the anterior arm or by a hypertonic triceps. Generally, the stretcher should be able to bend the elbow far enough to touch the front of her shoulder. Normal range of motion at the elbow ([figure 6.30](#)) is as follows:

- Flexion = 150 degrees
- Extension = 0 degrees

**Figure 6.30** Normal flexion-extension of the elbow.



### Stretches: Elbow

## **Biceps Brachii Partner Stretch, Supine**

This stretch improves the range of elbow and shoulder extension.

1. The stretcher lies supine, with her left shoulder at the edge of the table to ensure full range of motion of the shoulder. Her left elbow is straight, and her shoulder is extended as far as possible. Her forearm is in neutral, neither supinated nor pronated (the palm faces inward). This position lengthens the biceps to its end range.
2. Offer resistance to the isometric contraction of the biceps by placing your right hand against the stretcher's left forearm. Use your left hand to stabilize her shoulder ([figure 6.31](#)).
3. Direct the stretcher to begin slowly attempting to flex her left shoulder and elbow and supinate her forearm, isometrically contracting the biceps brachii for 6 seconds (see the isometric push arrows). ("Try to turn your forearm, bend your elbow, and lift your arm toward the ceiling.")
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, the arm may drop toward the floor or be maintained in the starting position.
5. As she exhales, the stretcher contracts the triceps to extend the arm farther, deepening the biceps stretch.
6. Repeat two or three times.

**Figure 6.31** Supine biceps stretch.

## Biceps Brachii Partner Stretch, Seated

This stretch improves the range of elbow and shoulder extension.

1. The stretcher is seated on a bench or stool, with her feet planted firmly on the floor. She sits tall, and with her left arm straight at the elbow, she reaches behind her as far as possible, without rolling her shoulder forward. She pronates her forearm (the palm faces to the back). This position lengthens the biceps brachii to its end range.
2. Assume a stable position to offer resistance to the isometric contraction of the biceps by placing your right hand across the front stretcher's left elbow and your left hand at her wrist ([figure 6.32](#)).
3. Direct the stretcher to begin slowly attempting to supinate her forearm and flex her left shoulder and elbow, isometrically contracting the biceps brachii for 6 seconds. ("Try to turn your forearm, bend your elbow, and pull your arm to the front.")
4. After the isometric push, the stretcher relaxes and inhales deeply. During this time, maintain the arm in the starting position.
5. As she exhales, the stretcher contracts the triceps to extend the shoulder farther and pronates the forearm more if possible, deepening the biceps stretch. Be sure she does not roll forward at the shoulder.
6. Repeat two or three times.

**Figure 6.32** Seated biceps stretch.



### **Biceps Brachii Self-Stretch**

The biceps brachii can be an awkward muscle to self-stretch, but it can be done.

1. Find a horizontal surface, such as a railing, a dance bar, or the back of a chair. You can also use the doorknob on a closed door. Stand (or kneel) with your arm straight, palm facing inward, and extend your arm behind you as far as you can, keeping your torso upright. Rest your forearm on the horizontal object or grasp the doorknob ([figure 6.33](#)).
2. From this starting position, try to push your hand toward the floor (flexion of the shoulder and elbow), isometrically contracting the biceps for 6 seconds.
3. After the isometric phase, extend your arm back farther. You may need to kneel down to properly position yourself for this stretch.
4. Repeat two or three times.

**Figure 6.33** Biceps brachii self-stretch.



### **Triceps Partner Stretch, Prone**

This stretch improves flexion at the shoulder with the elbow bent.

1. The stretcher is prone, with her head resting in the face cradle or turned to the side. She flexes her right shoulder and elbow and reaches toward her shoulder blade, keeping her upper arm as close to her ear as possible. The flat part of the elbow (posterior humerus) points toward the floor, not out to the side. This lengthens the triceps to their end range.
2. Assume a comfortable and stable lunge position that allows you to place your hand against the stretcher's posterior elbow ([figure 6.34](#)), and ask her to begin pushing slowly against you, attempting to move her elbow toward the floor, isometrically contracting the triceps for 6 seconds.
3. After the isometric push, the stretcher relaxes and breathes in. During this time, maintain the arm in the starting position.
4. As she exhales, ask the stretcher to reach farther down her back, keeping her arm close to her ear, deepening the triceps stretch.
5. Repeat the sequence two or three more times.

**Figure 6.34** Triceps stretch, prone.



### **Triceps Partner Stretch, Seated**

This stretch improves flexion at the shoulder with the elbow bent.

1. The stretcher is seated on a bench or stool, with her feet planted firmly on the floor. She sits tall and flexes her right shoulder and elbow and reaches toward her shoulder blade, keeping her arm as close to her ear as possible. The flat part of the elbow (posterior humerus) points toward the front, not out to the side. This lengthens the triceps to its end range.
2. Assume a stable position. Place your right hand against the stretcher's elbow and your left hand against the posterior shoulder to help stabilize it ([figure 6.35](#)). Direct the stretcher to begin pushing her elbow slowly against your right hand, attempting to move her elbow toward the floor, isometrically contracting the triceps for 6 seconds.
3. After the isometric push, the stretcher relaxes and breathes in. During this time, maintain the arm in the starting position.
4. As she exhales, ask the stretcher to reach farther down her back, keeping her arm close to her ear, deepening the triceps stretch.
5. Repeat the sequence two or three more times.

**Figure 6.35** Seated triceps stretch.



### **Triceps Self-Stretch**

1. Stand tall, keeping your back and neck lengthened. This stretch can also be done sitting.
2. Flex your right shoulder and elbow to try to touch your right shoulder blade. Keep your arm as close to your ear as possible, with the flat part of the elbow pointing toward the front, not out to the side. This lengthens the triceps to its end range.
3. You provide isometric resistance for this stretch by using your other arm and hand as shown in the photo ([figure 6.36](#)). Be sure to keep your neck lengthened as you reach around. Hold the contraction for 6 seconds, breathing normally.
4. After the isometric push, relax, take a deep breath in, and as you exhale, stretch by reaching farther down your back. Be sure to maintain length in the spine (low back and neck) during this stretch to achieve the best results.
5. Repeat two or three times.

**Figure 6.36** Triceps self-stretch. Avoid arching your low back.



## **Wrist and Hand**

Baseball players, racquetball players, musicians, grocery clerks, and typists commonly have hypertonic wrist and forearm muscles. Maintaining good range of motion at the wrist can help reduce the risk of overuse tendinitis or repetitive stress injuries such as carpal tunnel syndrome. Because the wrist muscles are used extensively in daily activity, even “leg sport” athletes will appreciate stretching these muscles.

## Anatomy

Three primary muscles flex the wrist: flexor carpi radialis, flexor carpi ulnaris, and palmaris longus ([figure 6.37](#), [table 6.5](#)). Their common origin on the medial epicondyle is the site of golfer's elbow, a repetitive stress injury. On the other side of the forearm, three primary muscles extend the wrist: extensor carpi radialis longus, extensor carpi radialis brevis, and extensor carpi ulnaris. Their common origin on the lateral epicondyle is the primary site of tennis elbow, a repetitive stress injury common in racket sports.

Figure 6.37 Wrist and hand muscles.

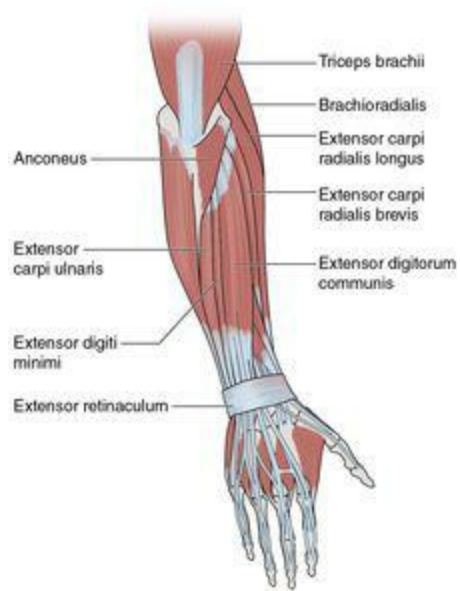
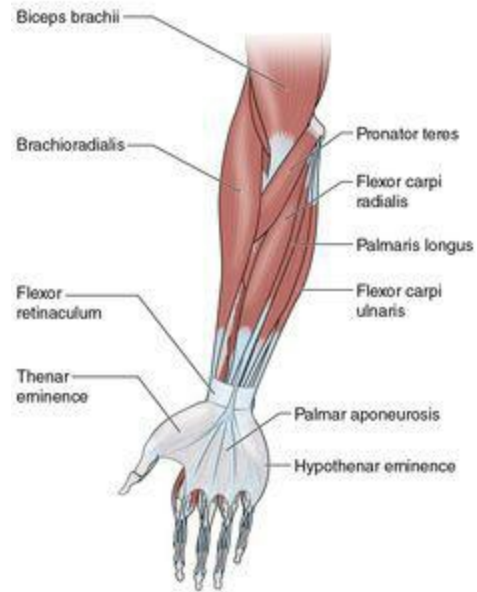


Table 6.5 Wrist and Hand Muscles

Muscle	Origin	Insertion	Action
<b>WRIST FLEXORS</b>			
Flexor carpi radialis	Medial epicondyle of humerus	Base of second and third metacarpals	Flexion and abduction of wrist
Flexor carpi ulnaris	Medial epicondyle of humerus and proximal posterior ulna	Pisiform, hamate, and base of fifth metacarpal	Flexion and adduction of wrist
Palmaris longus (sometimes absent)	Medial epicondyle of humerus	Palmar aponeurosis	Assists flexion of wrist
<b>WRIST EXTENSORS</b>			
Extensor carpi radialis brevis	Lateral epicondyle of humerus	Base of third metacarpal	Extension of wrist
Extensor carpi radialis longus	Lateral epicondyle and lateral supracondylar ridge of humerus	Base of second metacarpal	Extension and abduction of wrist
Extensor carpi ulnaris	Lateral epicondyle of humerus and proximal posterior ulna	Base of fifth metacarpal	Extension and adduction of wrist

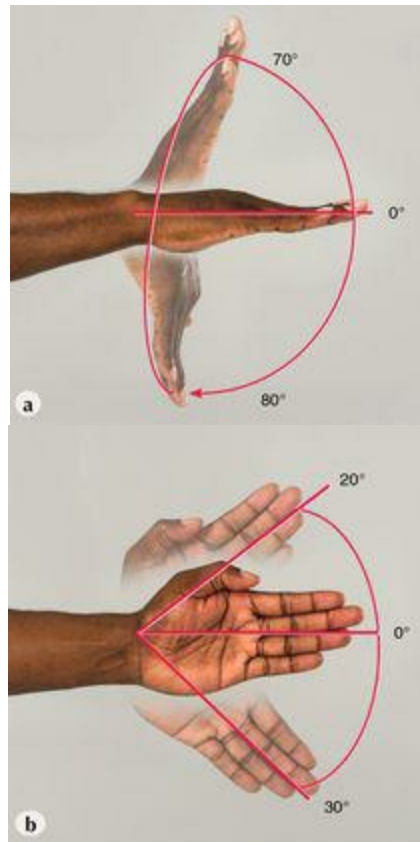
- Tennis elbow and golfer's elbow.** Tennis elbow and golfer's elbow are nicknames for repetitive stress injuries of the wrist flexor and extensor tendons at their common attachments at the elbow. Tennis elbow refers to lateral epicondylitis. Pain is felt on the outside of the elbow. Golfer's elbow refers to medial epicondylitis. Pain is felt on the inside of the elbow. If pain is present but there is no inflammation, this condition is more accurately called epicondylitis. These conditions are usually the result of repetitive stress, but they may occur from acute trauma. Repetitive injury can result from gripping or squeezing something in the hand during elbow movement, such as tennis or golf, or from repetitive finger movements such as typing or piano playing. In addition to physician-prescribed therapy activities, these conditions can improve by adding massage therapy and pain-free stretching of the wrist and finger flexor and extensor muscles.
- Carpal tunnel syndrome.** Carpal tunnel syndrome is a painful condition caused by entrapment of the median nerve at the wrist as it passes through the carpal tunnel. Symptoms may include aching and numbness in the affected hand; difficulty holding or grasping objects; dropping things; and pain in the forearm, palm, or fingers (or more than one of these). The list of possible causes of carpal tunnel syndrome is a long one. These may include repetitive use, especially keyboard use; physical activity that requires tightly gripping an object such as a bat, tennis racket, golf club, or the like; or sleeping with the fist clenched and the wrists curled. This condition can be further complicated by additional factors such as thoracic outlet syndrome, poor postural alignment, or joint instability. In addition to physician-prescribed therapy activities, this condition can improve by adding massage therapy and pain-free stretching of the wrist and finger flexor and extensor muscles.

## Functional Assessment

Limited range of motion at the wrist is uncommon unless the wrist has been immobilized for some reason. Normal range of motion, measured from the wrist in neutral ([figure 6.38](#)), is as follows:

- Flexion = 80 degrees
- Extension = 70 degrees
- Ulnar deviation (adduction) = 30 degrees
- Radial deviation (abduction) = 20 degrees

**Figure 6.38** (a) Normal wrist flexion and extension. (b) Normal ulnar and radial deviation.



Stretches: Wrist and Hand

### Wrist and Finger Flexors Partner Stretch, Supine

This stretch increases extension of the wrist and fingers.

1. The stretcher is supine, with his left elbow straight, arm resting on the table if possible, and his wrist and fingers extended as far as possible. Make sure the table is not blocking full extension of the wrist. This lengthens the left wrist (and finger) flexors to their pain-free end range.
2. Place the palm and fingers of your right hand over the palm and fingers of the stretcher's left hand, matching thumb to thumb and finger to finger. Your other hand stabilizes the stretcher's wrist and forearm ([figure 6.39](#)).
3. Direct the stretcher to start slowly trying to flex his wrist and fingers (including the thumb), isometrically contracting the flexors for 6 seconds.
4. After the isometric push, the stretcher relaxes and breathes in. During this time,

maintain his wrist and fingers in the starting position.

5. As he exhales, the stretcher contracts the wrist and finger extensors, deepening the wrist flexor stretch. You may gently assist in deepening the stretch by pushing on the stretcher's fingers.
6. Repeat two or three times.

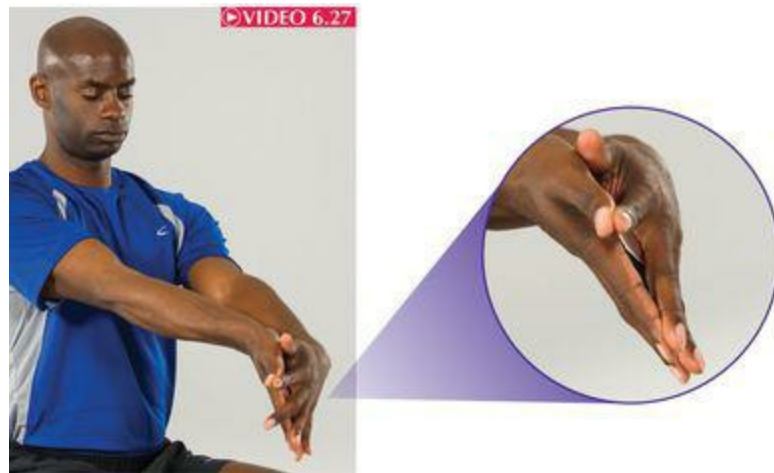
**Figure 6.39** Wrist and finger flexors stretch.



### **Wrist and Finger Flexors Self-Stretch, Seated**

1. To stretch the wrist flexors, sit comfortably with your right arm out in front of you, elbow straight, and wrist and fingers extended as far as possible. This lengthens the right wrist (and finger) flexors to their pain-free end range.
2. Place the palm and fingers of your left hand over the palm, fingers, and thumb of your right hand ([figure 6.40](#)). Start slowly trying to flex the wrist and fingers (including the thumb) against the resistance of your left hand, isometrically contracting the right wrist flexors for 6 seconds.
3. After the isometric push, relax and breathe in, maintaining the wrist and fingers in the starting position. As you exhale, contract the right wrist and finger extensors, deepening the wrist flexor stretch. You may gently assist in deepening the stretch by pushing on your fingers.
4. Repeat two or three times.

**Figure 6.40** Wrist and finger flexors self-stretch.



## Wrist and Finger Extensors Partner Stretch, Supine

This stretch increases wrist and finger flexion.

1. The stretcher is supine, with his right elbow straight, arm resting on the table. He curls his thumb to his palm and then flexes the wrist and fingers to make a loose fist around the thumb. Be sure the table is not blocking the full flexion of his wrist. This will lengthen the right wrist (and finger) extensors to their pain-free end range. The stretcher should fully flex his wrist first and then curl his fingers as far as possible. Curling the fingers first will limit his wrist flexion, and the primary goal is to maximize wrist flexion.
2. Wrap your right hand over the stretcher's fist, matching finger to finger. Your other hand stabilizes the stretcher's wrist and forearm ([figure 6.41](#)).
3. Direct the stretcher to start slowly trying to extend the wrist and fingers (including the thumb), isometrically contracting the extensors for 6 seconds.
4. After the isometric push, the stretcher relaxes and breathes in. During this time, maintain his wrist and fingers in the starting position.
5. As he exhales, the stretcher contracts the wrist and finger flexors to deepen the flexor stretch. You may gently assist in deepening the stretch by pushing on the stretcher's fingers.
6. Repeat two or three times.

**Figure 6.41** Wrist and finger extensors stretch.



### **Wrist and Finger Extensors Self-Stretch, Seated**

1. To stretch the wrist extensors, sit comfortably with your right arm out in front of you, elbow straight, and wrist and fingers flexed as far as possible. This lengthens the right wrist (and finger) extensors to their pain-free end range. Fully flex your wrist first, curl the thumb to the palm, and then curl your fingers around the thumb as far as possible. Curling the fingers first will limit your wrist flexion, and your primary goal is to maximize wrist flexion.
2. Wrap your left hand around your right to provide resistance, and then start slowly trying to extend your wrist and fingers (including the thumb), isometrically contracting the extensors for 6 seconds ([figure 6.42](#)).
3. After the isometric push, relax and breathe in, maintaining your wrist and fingers in the starting position. As you exhale, contract the right wrist and finger flexors, deepening the stretch on the extensors.
4. Repeat two or three times.

**Figure 6.42** Wrist and finger extensors self-stretch.



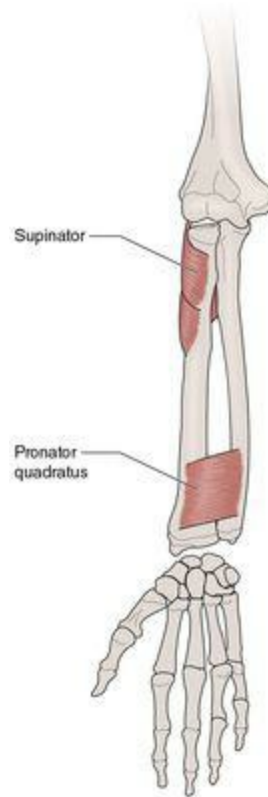
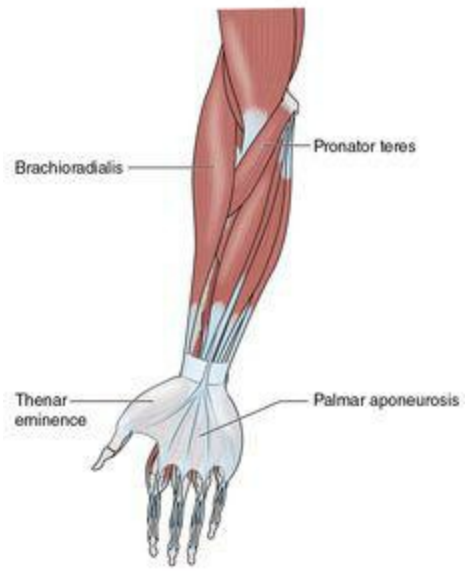
## **Forearm Pronators and Supinator**

## Anatomy

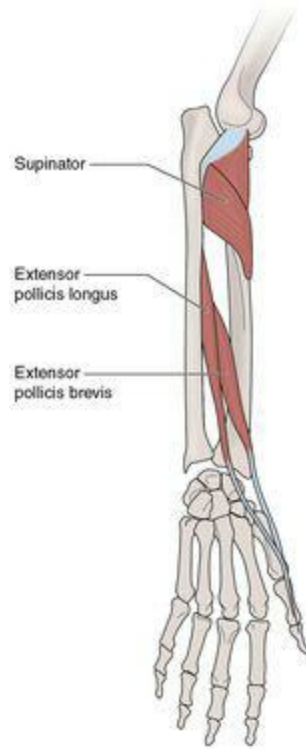
The pronators and supinator ([figure 6.43](#), [table 6.6](#)) are often overlooked as sources of pain.

- **Forearm pronators.** Pronator teres dysfunction can mimic the pain of medial epicondylitis (golfer's elbow) and trigger points in this muscle refer to the radial side of the wrist, prompting some people to self-diagnose carpal tunnel syndrome. Pronator teres syndrome is caused by compression of the median nerve and is characterized by numbness in the median nerve distribution, aching deep in the forearm, and hand weakness. When both pronators are hypertonic, the forearms at rest tend to be pronated.
- **Forearm supinator.** The supinator can mimic the pain of lateral epicondylitis (tennis elbow). The supinator can be injured as a result of excessive eccentric stress placed on it, especially during activities when the elbow is held straight, as in performing the backhand in tennis, carrying a heavy suitcase, or even holding the leash while walking the dog. The radial nerve passes between the deep and superficial parts of the supinator, and nerve entrapment is usually characterized by weakness rather than pain.

Figure 6.43 Forearm muscles.



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**Table 6.6 Forearm Muscles**

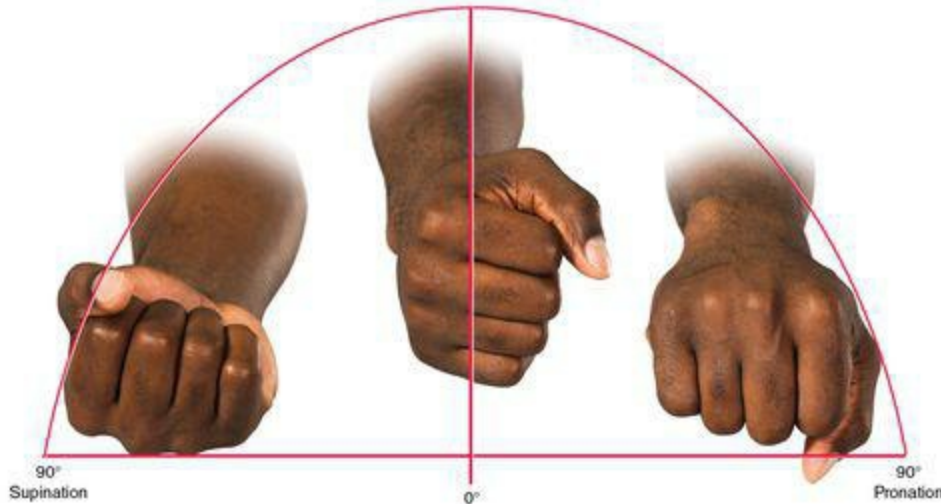
Muscle	Origin	Insertion	Action
Pronator quadratus	Anterior aspect of the distal one-fourth of the ulna	Anterior aspect of the distal one-fourth of the radius	Principal pronator of the forearm
Pronator teres	Medial aspect of the coronoid process of the ulna and the medial epicondyle of the humerus	Halfway along the lateral surface of the radius	Pronation of the forearm (secondary to pronator quadratus) and weak elbow flexion
Supinator	Lateral epicondyle of the humerus, radial collateral and annular ligaments of the elbow, supinator crest and fossa of the ulna	Lateral aspect of the proximal one-third of the radius	Supination of the forearm when the elbow is extended Assists flexion when the elbow is already bent and forearm supinated

## Functional Assessment

Normal range of motion, measured from the wrist in neutral ([figure 6.44](#)), is as follows:

- Pronation = 90 degrees
- Supination = 90 degrees

**Figure 6.44** Normal forearm pronation and supination.



Stretches: Supinator and Pronators

**Forearm Supinator Partner Stretch, Supine**

This stretch increases pronation of the forearm.

1. The stretcher is supine on a treatment table or a mat on the floor with his right upper arm resting at his side, elbow flexed to about 90 degrees, so it's easy for you to stand or kneel at his side and grasp the wrist. The stretcher pronates his right forearm and hand (palm turns down) as far as possible. This lengthens the supinator to its pain-free end range.
2. Assume a stable position that allows you to comfortably support the forearm with one hand and the wrist and hand with the other, being careful to keep the wrist in neutral, neither flexed nor extended, to avoid undue stress on the joint ([figure 6.45](#)). Your grasp should span the wrist from proximal to distal to minimize any twisting stress on the joint.
3. Direct the stretcher to start slowly trying to supinate his forearm (turn his palm up), isometrically contracting the supinator for 6 seconds.
4. After the isometric push, the stretcher relaxes and breathes in. During this time, maintain his forearm in the starting position.
5. As he exhales, the stretcher contracts the pronators to deepen the supinator stretch. You may gently assist in deepening the stretch by adding some passive pronation.
6. Repeat two or three times.

**Figure 6.45** Supinator stretch.



### **Forearm Supinator Self-Stretch, Seated**

1. Sit comfortably, bending at your waist and resting your forearms on your thighs. Bend your left elbow and rotate your left forearm so that your palm faces down (pronation). This position stretches the supinator.
2. Wrap your right hand over your left so that the fingers of your right hand can hold the little-finger side of your left hand and wrist ([figure 6.46](#)).
3. From this starting position, begin slowly trying to rotate your forearm as if turning your palm to face up (supination), isometrically contracting your supinator for 6 seconds. After the contraction, relax and breathe in.
4. As you exhale, rotate your forearm, turning your palm down, to deepen the stretch on the supinator.
5. Repeat two or three times.

**Figure 6.46** Supinator self-stretch.



## Forearm Pronators Partner Stretch, Supine

This stretch improves range of motion in supination.

1. The stretcher is supine on a treatment table or a mat on the floor with his right upper arm resting at his side, elbow flexed to about 90 degrees, so it's easy for you to stand or kneel at his side and grasp the wrist. The stretcher supinates his right forearm and hand (palm turns up) as far as possible, stretching the pronators to their pain-free end range.
2. Assume a stable position that allows you to comfortably face the stretcher. Support his forearm with your right hand, and with your left, grasp his hand and wrist. (Supporting the wrist in neutral helps prevent undue stress on the carpal bones, [figure 6.47](#).) Your grasp should span the wrist from proximal to distal to minimize any twisting stress on the joint.
3. Direct the stretcher to start slowly trying to pronate his forearm (turn his palm down), isometrically contracting his pronators for 6 seconds.
4. After the isometric push, the stretcher relaxes and breathes in. During this time, maintain his forearm in the starting position.
5. As he exhales, the stretcher supinates to deepen the stretch of the pronators. You may gently assist in deepening the stretch by adding some passive supination.
6. Repeat two or three times.

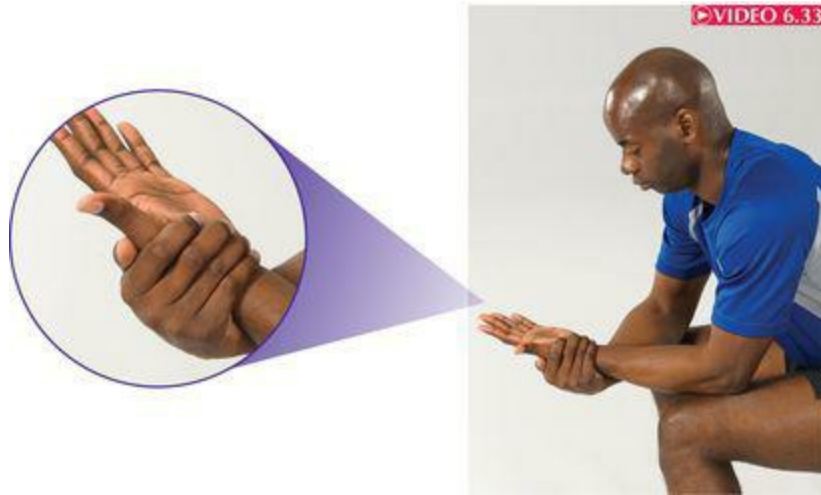
**Figure 6.47** Initiation of the pronator stretch.



### **Forearm Pronators Self-Stretch, Seated**

1. Sit comfortably, bending at your waist and resting your forearms on your thighs. Bend your left elbow and rotate your left forearm to the left so your palm faces up. This position stretches the pronators. Wrap your right hand under your left so that the fingers of your right hand can hold the thumb side of your left hand and wrist ([figure 6.48](#)).
2. From this starting position, begin slowly trying to rotate your forearm back to the left (pronation), isometrically contracting your pronators for 6 seconds. After the contraction, relax and breathe in.
3. As you exhale, contract your supinators by rotating your forearm more to the left to deepen the stretch on the pronators.
4. Repeat two or three times.

**Figure 6.48** Pronators self-stretch.



# Chapter 7

## Stretching Routines for Specific Activities

There is a preponderance of evidence that some types of stretching immediately before athletic activity may decrease explosive power and speed. Research into the effects of preactivity stretching on endurance has not been definitive. Erring on the side of caution, most fitness professionals now recommend that preactivity stretching be confined to dynamic stretching as part of an overall warm-up routine. Postactivity stretching does not have a detrimental effect on future performance and may be helpful in restoring muscles to their optimal length and tone.

Stretching is more effective if your muscles are warmed up first. If you choose to stretch before exercise, we suggest 5 to 15 minutes of light activity to warm up before you stretch.

We have a natural tendency to spend more time stretching the first arm, leg, or area; and because it's natural to stretch the easy side first, the tighter side usually gets less attention. To counteract this, focus on stretching your tighter side first. This will help you gain overall balanced flexibility.

Regular practice is the most important part of any flexibility program.

Perform two or three rounds of stretching for each muscle, which will take 30 to 45 seconds total.

Each sport places differing demands on the body in terms of strength and flexibility. The best approach to enhancing performance and staying injury free is to develop balanced strength and flexibility throughout the body. The following routines cover the primary muscle groups involved in particular activities. To a certain extent, the grouping of stretches is arbitrary, and you may decide you need to add or subtract stretches to fit your particular situation.

## Everyday Sequence

Routine: 14 self-stretches on each side; approximate time to complete: 15-18 minutes

The stretches grouped here are an excellent way to begin and end the day. In the morning, they will help you energize and limber your body. When done in the evening, they will help you unwind and shed the day's tensions.



1 Gluteus Maximus



2 Hamstrings



3 Upper Trapezius



4 Scalenes



5 Gastrocnemius



6 Piriformis



7 Oblique Abdominals



8 Quadratus Lumborum



9 Triceps

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10 Wrist Flexors



11 Quadriceps



12 Hip Flexors



13 Hip Adductors



14 Pectoralis Major

## Cycling

Routine: 14 self-stretches on each side; approximate time to complete: 15-18 minutes



1 Gluteus Maximus



2 Hamstrings



3 Gastrocnemius



4 Soleus



5 Quadratus Lumborum



6 Oblique Abdominals



7 Piriformis



8 Tibialis Anterior



9 Wrist Flexors

# Pthomegroup



**10** Wrist Extensors



**11** Quadriceps



**12** Hip Flexors



**13** Hip Adductors



**14** Hip Abductors

## Golf

Routine: 15 self-stretches on each side; approximate time to complete: 16-20 minutes



1 Gluteus Maximus



2 Hamstrings



3 Gastrocnemius



4 Oblique Abdominals



5 Quadratus Lumborum



6 Piriformis



7 Quadriceps



8 Hip Flexors



9 Hip Adductors



10 Hip Abductors



11 Triceps



12 Latissimus Dorsi



13 Subscapularis



14 Infraspinatus



15 Pectoralis Major

## Ice Hockey

Routine: 10 self-stretches on each side; approximate time to complete: 10-12 minutes



1 Gluteus Maximus



2 Hamstrings



3 Gastrocnemius



4 Soleus



5 Piriformis



6 Oblique Abdominals



7 Hip Flexors



8 Quadriceps



9 Hip Adductors



10 Pectoralis Major

## Running

Routine: 11 self-stretches on each side; approximate time to complete: 10-12 minutes



1 Gluteus Maximus



2 Gastrocnemius



3 Soleus



4 Oblique Abdominals



5 Piriformis



6 Tibialis Anterior

# Pthomegroup



7 Hip Flexors



8 Quadriceps



9 Hamstrings



10 Hip Abductors



11 Hip Adductors

## Swimming

Routine: 16 self-stretches on each side; approximate time to complete: 16-20 minutes



1 Gluteus Maximus



2 Hamstrings



3 Gastrocnemius



4 Soleus



5 Piriformis



6 Oblique Abdominals



7 Quadratus Lumborum



8 Latissimus Dorsi



9 Wrist Flexors

# Pthomegroup



10 Wrist Extensors



11 Quadriceps



12 Hip Flexors



13 Subscapularis



14 Infraspinatus



15 Pectoralis Major



16 Triceps

## Throwing and Racket Sports

Routine: 18 self-stretches on each side; approximate time to complete: 15-18 minutes



1 Gluteus Maximus



2 Hamstrings



3 Gastrocnemius



4 Soleus



5 Hip Flexors



6 Quadriceps



7 Hip Abductors



8 Hip Adductors



9 Latissimus Dorsi



10 Pectoralis Major



11 Subscapularis



12 Infraspinatus



13 Oblique Abdominals



14 Quadratus Lumborum



15 Piriformis



16 Triceps



17 Wrist Flexors



18 Wrist Extensors

## Rusty Hinges

Routine: 14 self-stretches on each side; approximate time to complete: 15-18 minutes

As we age, we tend to lose flexibility, which causes us to move with more difficulty. This begins a vicious downward spiral that can lead to severely restricted range of motion, loss of strength, and poor balance. These stretches are excellent for maintaining or restoring joint mobility, muscular strength, and coordination. They may also help relieve pain.



1 Hip Flexors



2 Quadriceps



3 Hamstrings



4 Hip Adductors



5 Pectoralis Major



6 Oblique Abdominals



7 Quadratus Lumborum



8 Piriformis



9 Rhomboids



10 Triceps



11 Gastrocnemius



12 Gluteus Maximus



13 Upper Trapezius



14 Scalenes

# Appendix

## Anatomical Terms

This appendix is a brief compendium of the common concepts and terms used in the study of human anatomy and kinesiology. It includes information on anatomical position, planes of motion, the varieties of joint movement, comparative anatomical location, and selected joint types relevant to stretching.

## **Anatomical Position**

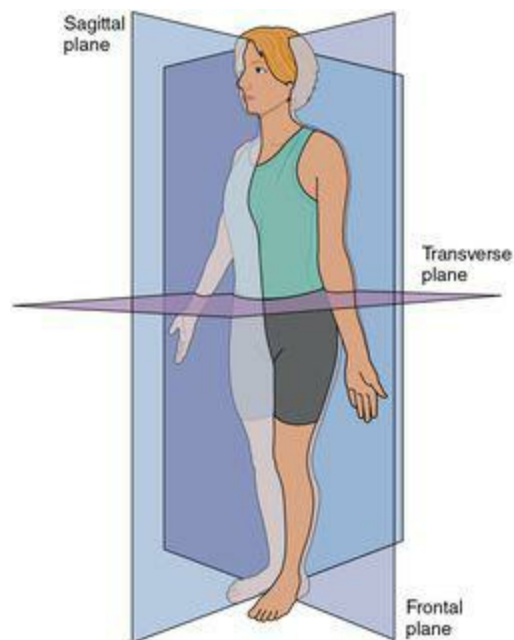
In human anatomy, all descriptions of position and movement are based on the assumption that the body is in the anatomical position. The anatomical position consists of standing with the feet together, the head and eyes facing forward, with the arms at the sides and rotated so the palms are facing forward (see the next figure).

## Planes of Motion

There are three primary planes of motion: sagittal, frontal, and transverse (see the next figure). These planes are imaginary lines passing through the body; they represent the directions through which the human body is capable of moving.

- **Sagittal plane:** Divides the body into right and left sides. Motion through the sagittal plane is flexion or extension.
- **Frontal plane:** Divides the body into anterior and posterior sides (front and back). Motion through the frontal plane is adduction or abduction.
- **Transverse plane:** Divides the body into superior and inferior parts (top and bottom). Movement through the transverse plane is internal or external rotation.

All motion occurs through one (or more) of these three planes. Triplanar motion is any movement that occurs through all three planes (this includes most daily activities). The spiral–diagonal patterns of PNF are triplanar.



## Describing Motion

Descriptions of human movement are based on the anatomical position being the starting point. Any joint motion has an opposite motion, so the terms describing motion are usually paired.

### Adduction and Abduction

Adduction and abduction refer to a change in position relative to the midline of the body. Adduction means moving a limb toward the midline, as in moving the legs together to stand at attention. Abduction is the opposite, as in taking a wide stance with the legs. Adduction and abduction movements occur in the frontal plane.



### Dorsiflexion and Plantar Flexion

Dorsiflexion and plantar flexion refer to movement of the foot and ankle in relation

to the leg. In dorsiflexion, the foot and toes move closer to the front of the shin, as in lifting your foot off the gas pedal in your car. Plantar flexion causes the foot and toes to point away from the shin, as in stepping on the gas.



## **Elevation and Depression**

This motion combination is most commonly seen at the scapula. Elevation is movement of the scapula (shoulder) upward (or superior), and depression is movement of the scapula downward (or inferior).



## Flexion and Extension

Flexion and extension describe a change in the relative angle of a joint. Flexion typically involves closing the joint angle, as in bending the elbow, and extension is the opposite, straightening the elbow. Flexion and extension movements occur in the sagittal plane.





## Inversion and Eversion

Inversion and eversion take place in the forefoot. Inversion turns the sole of the foot toward the midline, causing the little-toe side of the foot to rest on the floor, and eversion turns the sole of the foot away from the midline.



## Lateral (External) Rotation and Medial (Internal) Rotation

Lateral and medial rotation take place in the limbs, primarily at the hips and shoulders. Lateral, or external, rotation is a rotary movement away from the midline. In the anatomical position, the arm position (rotation with the palms facing forward) is lateral rotation. Medial, or internal, rotation is a rotary movement toward the midline. When the arms are rotated so the palms face to the back, they're in medial rotation. Rotation is movement in the transverse plane.



## Pronation and Supination

Pronation and supination refer to rotation of the forearm (independent of rotation of the humerus). With the elbow flexed, pronation rotates the palm downward, and

supination turns the palm upward.



Pronation and supination also describe motion at the foot and ankle. Although often used interchangeably with inversion and eversion, pronation and supination are more complex. Pronation is a combination of eversion, dorsiflexion, and abduction of the foot and ankle, while supination combines inversion, plantar flexion, and adduction.

## **Protraction and Retraction**

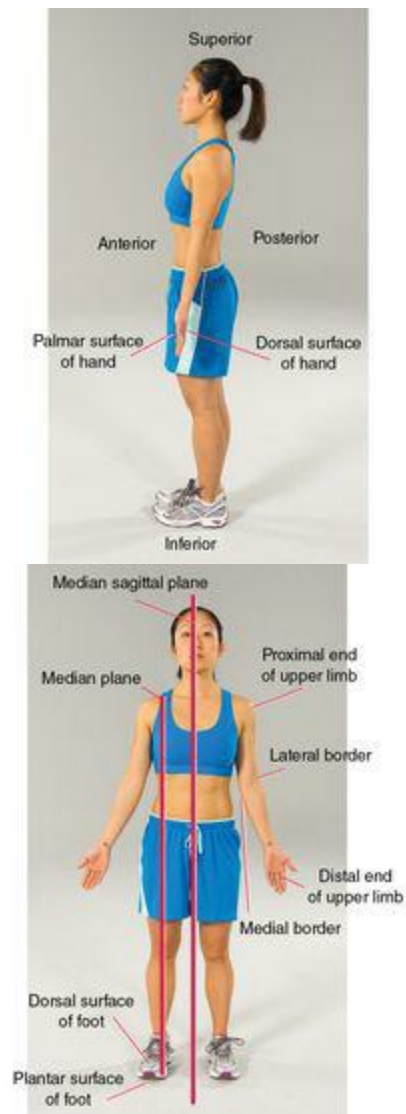
Protraction and retraction usually refer to movement of the scapulae. Protraction can be thought of as movement of the scapulae away from the spine, or as anterior movement in conjunction with the arm reaching forward. Retraction occurs when the scapulae move closer to the spine, as in standing at attention.

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## Describing Relative Location

In describing the relative positional relationship between two anatomical structures, the standard reference point is the anatomical position. This figure shows the anatomical locations, and the following text provides more detail.



### Anterior and Posterior

- Anterior: In front of (e.g., the abdominal muscles are anterior to the spine)
- Posterior: In back of (e.g., the spine is posterior to the abdominals)

### Lateral and Medial

- Lateral: Away from the midline of the body (e.g., the IT band is on the lateral

aspect of the thigh)

- Medial: Toward the midline of the body (e.g., the groin muscles are on the medial aspect of the thigh)

### **Proximal and Distal**

- Proximal: Near the point of reference, usually a point of attachment, or the center of the body (e.g., the proximal attachment of the biceps femoris muscle is on the ischial tuberosity; the femur is proximal to the fibula)
- Distal: Away from the point of reference or the center of the body (e.g., the distal attachment of the biceps femoris muscle is on the fibula; the fibula is distal to the femur)

### **Superior and Inferior**

- Superior: Above (e.g., the eyes are superior to the mouth)
- Inferior: Below (e.g., the mouth is inferior to the eyes)

### **Ipsilateral and Contralateral**

- Ipsilateral: On the same side (e.g., the right arm is ipsilateral to the right leg)
- Contralateral: On the opposite side (e.g., the left arm is contralateral to the right leg)

### **Superficial and Deep**

- Superficial: Close to the surface, or in relation to something else (e.g., the skin is superficial to the gluteus maximus)
- Deep: Not close to the surface, or in relation to something else (e.g., the piriformis is deep to the gluteus maximus)

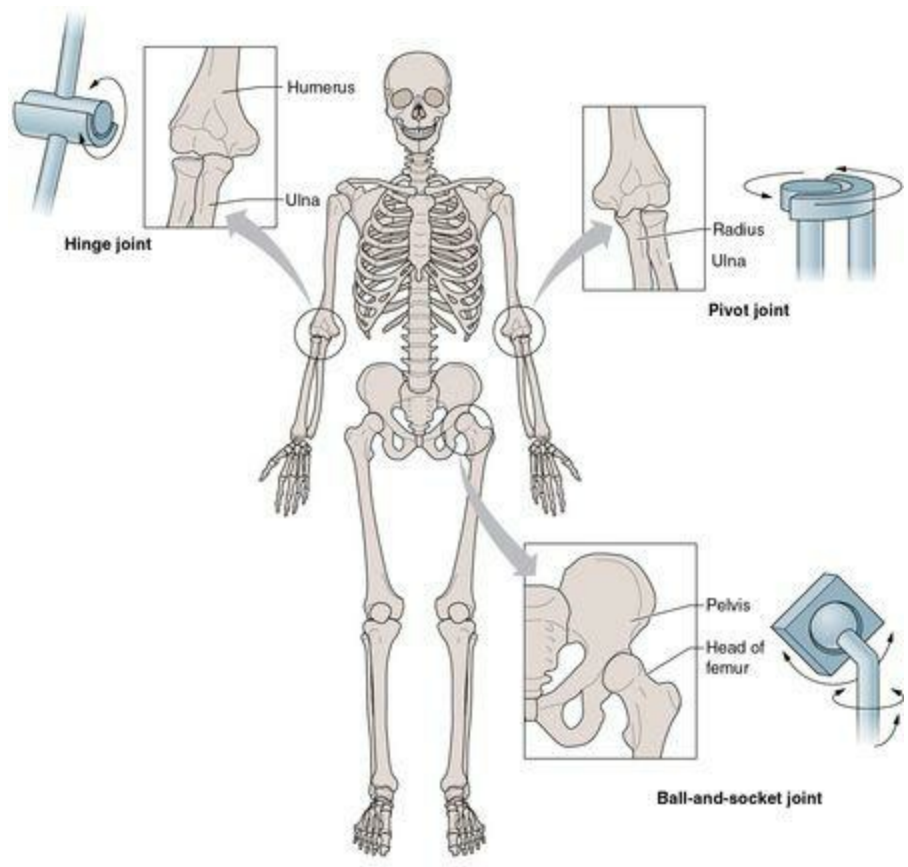
## Joint Types Relevant to Stretching

Wherever two bones attach there is a joint. There are three main categories of joints.

- **Fibrous (fixed) joints.** Fibrous joints connect bones to each other but allow little or no movement. The suture joints where the bones of the skull come together are examples of fibrous joints.
- **Cartilaginous joints.** Cartilaginous joints attach bones to each other with cartilage and allow for very limited movement. The ribs attach to the vertebrae of the spine via cartilaginous joints.
- **Synovial joints.** Synovial joints are the most common type of joints in the body and are built for movement. The articulating surfaces of the bones are wrapped in a joint capsule filled with synovial fluid that acts as a lubricant.

There are seven types of synovial joints, three of which are most relevant in relation to stretching and which are shown in the following figure.

- **Ball-and-socket joints.** Ball-and-socket joints are the most movable joints, allowing for movement in almost any direction. The shoulder and the hip are both ball-and-socket joints.
- **Hinge joints.** Hinge joints allow motion in only one direction. The knee and elbow are hinge joints.
- **Pivot joints.** Pivot joints rotate around an axis as one bone twists around another. The radius and ulna can rotate around each other in the forearm (pronation and supination).



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## About the Authors



**Robert McAtee, BA, LMT, CSCS, C-PT**, has been a sport massage therapist since 1981, specializing in sport and orthopedic massage therapy. Since 1988 he has maintained an active international sport massage practice in Colorado Springs, Colorado.

McAtee has been using facilitated stretching techniques with clients and athletes since 1986. He teaches facilitated stretching and sport massage seminars throughout the United States and internationally to massage therapists, athletic trainers, personal trainers, chiropractors, Olympic-caliber athletes and coaches, and amateur athletes.

McAtee received his massage training at the Institute for Psycho-Structural Balancing (IPSB) in Los Angeles and San Diego (1981-82) and through the Sports Massage Training Institute (SMTI) in Costa Mesa, California (1986). He holds a BA in psychology from California State University (1974), is nationally certified in therapeutic massage and bodywork (1992), and is a certified strength and conditioning specialist (1998) and certified personal trainer. He has been an active member of the American Massage Therapy Association since 1988.

A keynote speaker and featured presenter at numerous national and international conventions, McAtee also regularly presents workshops nationally and internationally on the topics of facilitated stretching, massage, and soft-tissue injury care. For more information, please contact him at

Pro-Active Massage Therapy  
1119 N. Wahsatch Ave., Suite 1  
Colorado Springs, CO 80903  
USA  
Telephone: 719-475-1172  
Website: [www.stretchman.com](http://www.stretchman.com)



**Jeff Charland, PT, ATC, CSCS, GDMT**, was a 1983 graduate of the University of Wisconsin at Madison physical therapy program, where he also competed as a varsity wrestler on a scholarship. Beginning in 1987, Charland lectured in the areas of sports medicine, rehabilitation, and assessment and treatment of neural tissue disorders. He was a team trainer and traveled internationally with the U.S. Judo and U.S. Wrestling Federations' national and Olympic teams.

Charland completed the graduate program in manipulative therapy at Curtin University in Perth, Western Australia, under the direction of Bob Elvey, a world-renowned physiotherapist. He was a certified athletic trainer through the National Athletic Trainers' Association (NATA) and a certified strength and conditioning specialist (CSCS) through the National Strength and Conditioning Association (NSCA). In 1997, he earned a certification in active release techniques. He also served as director of a sport physical therapy clinic in Colorado Springs, Colorado. Charland passed away in December 2004; however, his contributions to previous editions were significant and continue to be appreciated.



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