



Student Handout

Lecture 07 — Nervous System Injuries and Congenital Conditions

Spinal cord injury · Nerve root compression · Stroke · Traumatic brain injury · Congenital conditions

- The lecture with the greatest concentration of emergency recognition content in the course
- Every injury is located anatomically first, then worked through to a treatment plan
- Builds directly on the tract anatomy from RU RMT 16 and the autonomic material from Lecture 4
- Clinical reference: Rattray & Ludwig, Clinical Massage Therapy (Talus, 2000)

How to use this handout

- This handout carries the full content of the lecture in the same order as the slides, so you can follow along without transcribing.
- Headings match the slide titles exactly. Use the wide left margin for your own notes.
- Anything marked MASSAGE THERAPY APPLICATION is the clinical consequence of the material above it — that is what you are being examined on.
- Reference lines give the source. Rattray refers to Rattray & Ludwig, Clinical Massage Therapy (Talus, 2000); CMTA links go to the current Standards of Practice.

THIS LECTURE

Learning Outcomes

By the end of Lecture 7, the student will be able to:

- Localise a nervous system injury from its clinical presentation, using the tract anatomy established in Neurology 2.
- Predict the motor, sensory and autonomic consequences of a spinal cord injury from its level and completeness.
- Distinguish the incomplete cord syndromes from one another by pattern.
- Differentiate mechanical low back pain from radicular pain and from cauda equina syndrome.
- Recognise stroke, transient ischaemic attack, cauda equina syndrome and deteriorating head injury as emergencies and respond correctly.
- Adapt treatment for spasticity, sensory loss, autonomic dysreflexia and impaired thermoregulation.
- Plan treatment for clients with cerebral palsy and spina bifida, including latex precautions.
- Document neurological findings objectively without stating a diagnosis.

FRAMEWORK

Localising the Lesion

Before planning treatment, establish where in the nervous system the problem sits. The pattern tells you.

The four patterns

- Peripheral nerve — deficit follows the territory of one named nerve; both motor and sensory in that distribution only.
- Nerve root (radicular) — deficit follows a dermatome and myotome; a single reflex is diminished; pain is often provoked by neck or trunk position.
- Spinal cord — a level below which everything is affected; bilateral or patterned involvement; upper motor neuron signs below the lesion and lower motor neuron signs at it.
- Brain — deficit is contralateral to the lesion, involves the face, and is often accompanied by speech, vision or cognitive change.

Why this comes first

- It determines urgency. A cord or brain pattern is far more serious than a peripheral one.



- It determines what you can expect from treatment. Massage will not restore a transected tract.
- It determines your safety modifications — sensory loss, spasticity and autonomic instability follow from cord and brain lesions.
- It determines who you refer to and how urgently.
- The RMT localises in order to treat and refer safely. Diagnosing the cause of the lesion is a controlled act and is not within the scope.

Regulated Health Professions Act, 1991 — <https://www.ontario.ca/laws/statute/91r18>

REVIEW

Tract Anatomy — the Three Facts That Decode Every Cord Lesion

Established in Neurology 2. Where each tract crosses is the whole explanation for the patterns in this lecture.

The three crossings

- Corticospinal tract — motor. Crosses in the medulla, at the pyramidal decussation, before entering the cord. Therefore a cord lesion produces weakness on the same side as the lesion, and a brain lesion produces weakness on the opposite side.
- Dorsal columns — vibration, proprioception and fine discriminative touch. Ascend uncrossed on the same side to the medulla, and cross there. Therefore a cord lesion produces loss on the same side.
- Spinothalamic tract — pain and temperature. Crosses within the cord, in the anterior white commissure, one or two segments above the level of entry. Therefore a cord lesion produces loss on the opposite side, beginning a segment or two below.

What follows

- A one-sided cord lesion produces a dissociated picture: motor and dorsal column loss on one side, pain and temperature loss on the other. That is Brown-Séquard syndrome, and it is entirely predictable from the crossings.
- A brain lesion produces everything on the opposite side together, usually including the face — because all three systems have crossed by then.
- Anything at or below the level is affected; anything above it is not. This is what "a level" means.
- The lowest segment with normal function on both sides defines the neurological level of injury.
- Learn the three crossings and the patterns in this lecture require no memorisation at all.

SPINAL CORD INJURY

Spinal Cord Injury — Mechanisms and Classification

Mechanisms

- Traumatic: motor vehicle collision, falls, sport, violence. Falls predominate in older adults, collisions in younger.
- Primary injury is the mechanical damage at impact — compression, contusion, laceration, or distraction.
- Secondary injury follows over hours to days: oedema, ischaemia, inflammation and excitotoxicity extend the damage beyond the original site.
- Non-traumatic causes: tumour, infection, vascular event, disc disease, inflammatory disease.

Classification

- Complete: no motor or sensory function preserved below the level of injury, including the lowest sacral segments.
- Incomplete: some function is preserved below the level, which carries a better prognosis.
- Tetraplegia (quadriplegia): cervical injury affecting all four limbs and the trunk.
- Paraplegia: thoracic, lumbar or sacral injury affecting the trunk and lower limbs.
- The neurological level is the lowest segment with normal function on both sides.
- The ASIA Impairment Scale is the standard grading; the RMT reads it in a chart rather than assigning it.



Cervical Injury

What is lost

- C1 to C3: respiratory function is lost. The phrenic nerve arises from C3, C4 and C5 — the diaphragm depends on these roots. Ventilatory support is generally required.
- C4: diaphragm function is largely preserved; the shoulders and upper limbs are not.
- C5: shoulder abduction and elbow flexion are preserved. The client can bring the hand to the face.
- C6: wrist extension is preserved, which permits a tenodesis grip. This is a major functional threshold.
- C7: elbow extension is preserved, which permits transfers and pressure relief. Another major threshold.
- C8 and T1: finger flexion and intrinsic hand function.

Consequences and treatment

- Tetraplegia with variable upper limb function, upper motor neuron signs below the lesion, and lower motor neuron signs at the level.
- Bowel, bladder and sexual function are affected. Autonomic dysreflexia risk is highest at T6 and above.
- Impaired thermoregulation and impaired sympathetic cardiovascular control.
- Treatment: maintain range and prevent contracture; manage spasticity discomfort; support circulation; protect insensate skin.
- Address the overworked shoulder girdle in wheelchair users, which is a genuine and common source of pain.
- Never apply pressure to insensate tissue without inspecting it before and after.

SPINAL CORD INJURY

Thoracic and Lumbosacral Injury

Thoracic

- Paraplegia with full upper limb function preserved.
- T1 to T6: trunk control is limited and autonomic dysreflexia remains a risk. Sitting balance is poor.
- T6 to T12: progressively better trunk and abdominal control, with improved sitting balance and cough.
- Intercostal involvement reduces respiratory reserve and the effectiveness of cough at higher levels.
- Upper motor neuron pattern below the lesion: spasticity, hyperreflexia, extensor plantar response.

Lumbosacral

- Lumbar injury affects hip and knee function; some ambulation may be possible with bracing and aids.
- The cord itself ends at approximately L1 to L2 as the conus medullaris. Below this the canal contains the cauda equina — peripheral nerve roots, not cord.
- Injury below L1 to L2 therefore produces a lower motor neuron pattern: flaccidity, hypotonia, areflexia and atrophy, not spasticity.
- Conus medullaris and cauda equina injuries produce bowel, bladder and sexual dysfunction with saddle sensory loss.
- Sacral injury may spare the legs while affecting bowel, bladder and sexual function.

SPINAL CORD INJURY

Incomplete Cord Syndromes

Central cord syndrome

- The most common incomplete syndrome. Typically from a hyperextension injury in an older adult with pre-existing cervical spondylosis, often without fracture.
- Damage is concentrated centrally, where the fibres serving the upper limbs run most medially in the corticospinal tract.



- Presentation: upper limb weakness disproportionately greater than lower limb weakness, with variable sensory loss and bladder dysfunction.
- Clients often walk into the clinic with profound hand weakness.
- Prognosis for some recovery is relatively favourable.

Brown-Séquard syndrome

- Hemisection of the cord — classically penetrating trauma, but also tumour or disc.
- Ipsilateral loss of motor function, because the corticospinal tract has already crossed in the medulla.
- Ipsilateral loss of vibration, proprioception and fine touch, because the dorsal columns ascend uncrossed to the medulla.
- Contralateral loss of pain and temperature, because the spinothalamic tract crosses within the cord one or two segments above entry.
- This dissociated pattern is the clearest demonstration in clinical neurology of why tract anatomy matters.
- Treatment must account for a limb that is strong but numb and a limb that is weak but sensate.

SPINAL CORD INJURY

Anterior Cord Syndrome and Tabes Dorsalis

Anterior cord syndrome

- Usually from occlusion of the anterior spinal artery, which supplies the anterior two-thirds of the cord.
- Loss of motor function and of pain and temperature below the lesion.
- Vibration and proprioception are preserved, because the dorsal columns are supplied by the posterior spinal arteries.
- The poorest prognosis of the incomplete syndromes.
- Treatment planning must recognise that the client may retain position sense while having no protective pain sensation.

Tabes dorsalis

- A late manifestation of untreated syphilis, appearing years to decades after the primary infection.
- Degeneration of the dorsal columns and dorsal roots.
- Loss of vibration and proprioception producing sensory ataxia — a wide-based, stamping gait, worse in the dark and with the eyes closed.
- A positive Romberg sign follows directly from the loss of proprioception.
- Lightning pains: sudden severe shooting pains in the limbs or trunk.
- Argyll Robertson pupils, areflexia, and Charcot joints from repeated unfelt injury.
- Rare now, but the sensory ataxia pattern remains diagnostically instructive.

TREATMENT PLANNING

Spinal Cord Injury — Building the Plan

Goals

- Maintain joint range and help prevent contracture in paralysed limbs.
- Reduce the discomfort and pain of spasticity.
- Support circulation and lymphatic return in dependent limbs.
- Treat the overworked, painful shoulder girdle, neck and upper limbs of wheelchair users and transfer-dependent clients — often the client's chief complaint.
- Support skin integrity and reduce pressure injury risk in collaboration with the care team.
- Reduce general stress and support sleep.



Precautions

- Autonomic dysreflexia is a medical emergency at T6 and above — review the response sequence from Lecture 4 before treating this population.
- Insensate skin: inspect before and after, and take full responsibility for pressure and thermal judgment.
- Impaired thermoregulation: no hot or cold applications below the level of injury, and keep the room comfortable.
- Osteoporosis below the level of injury develops rapidly; fracture risk is real, so avoid vigorous passive movement and forceful technique.
- Deep vein thrombosis risk is elevated; screen at every visit and do not treat a limb with suspected DVT.
- Orthostatic hypotension: change positions slowly and stay within reach.
- Transfers: know your limits, use the client's method, and never improvise.

Rattray, F., & Ludwig, L. (2000). Clinical Massage Therapy: Understanding, Assessing and Treating Over 70 Conditions. Talus Inc. ISBN 978-0-9698177-1-0 — condition entry: Spinal Cord Injury.

NERVE ROOT

Intervertebral Disc Herniation

Pathophysiology

- The nucleus pulposus displaces through weakened or torn anulus fibrosus.
- Progression of terminology: bulge, protrusion, extrusion, sequestration.
- Most common at L4-L5 and L5-S1 in the lumbar spine, and C5-C6 and C6-C7 in the cervical spine.
- Herniation is most often posterolateral, because the posterior longitudinal ligament reinforces the midline.
- Symptoms arise from both mechanical compression and chemical irritation of the root by inflammatory mediators.
- Imaging findings correlate poorly with symptoms — many asymptomatic people have disc herniation on MRI.

Presentation

- Radicular pain following a dermatome, often described as sharp, shooting or electric.
- Paraesthesia and numbness in the dermatome; weakness in the myotome; a diminished reflex at that root.
- Aggravated by coughing, sneezing and straining, which raise intrathecal pressure.
- Lumbar herniation: aggravated by sitting and flexion; often relieved by lying down or by extension.
- Cervical herniation: aggravated by extension and rotation toward the side of pain; often relieved by placing the hand on the head.
- Antalgic posture and protective muscle guarding are common findings.

Rattray, F., & Ludwig, L. (2000). Clinical Massage Therapy: Understanding, Assessing and Treating Over 70 Conditions. Talus Inc. ISBN 978-0-9698177-1-0 — condition entry: Disc Herniation.

TREATMENT PLANNING

Disc Herniation — Building the Plan

Approach

- Position for comfort, not for convention. The client's preferred position is clinical information.
- Side-lying with support is frequently the best-tolerated position for acute lumbar herniation.
- Reduce the protective hypertonicity in the paraspinals, quadratus lumborum, gluteals and piriformis that accompanies the presentation.
- Treat the compensatory patterns produced by antalgic posture.
- Avoid positions and techniques that reproduce radicular symptoms — reproduction distally is a signal to stop, not to persist.
- General relaxation to support descending inhibition and reduce guarding.
- Progress by monitoring the response over the following days, not within the session.



Precautions and referral

- Do not attempt to reduce a herniation; that is outside the scope and is not achievable with soft tissue technique.
- Avoid vigorous stretching and end-range passive movement in the acute phase.
- Avoid heavy work directly over the acutely inflamed segment.
- Refer for medical assessment if there is progressive weakness, worsening neurological deficit, or symptoms failing to settle.
- Cauda equina symptoms are an emergency — the next slide covers this in full.
- Document dermatome, myotome and reflex findings objectively at each visit so that change is trackable.

EMERGENCY

Cauda Equina Syndrome

The single most time-critical musculoskeletal presentation an RMT will encounter. Delayed surgical decompression risks permanent loss of bladder, bowel and sexual function.

Recognition

- Compression of the lumbosacral nerve roots below the conus medullaris, most often by a large central disc herniation, and also by tumour, haematoma, fracture or infection.
- Saddle anaesthesia — numbness in the perineum, buttocks and inner thighs. The client may notice it when wiping.
- New urinary retention or incontinence; loss of the sensation of needing to void.
- Faecal incontinence, or loss of anal sphincter tone.
- Bilateral leg pain, weakness or numbness, which may be asymmetrical.
- New sexual dysfunction.
- Severe low back pain is usual but not universal.

Response

- Stop the treatment. Do not continue and do not treat around it.
- Direct the client to emergency care immediately — the same day, not an appointment with their physician next week.
- Do not send them home to see whether it settles.
- Ensure they have a safe means of getting there; call for assistance if needed.
- Document the findings, the advice given and the time it was given.
- Follow up to confirm they attended.
- Ask the bowel and bladder screening questions of every client with low back and leg pain. This is the reason you ask them.

Rattray, F., & Ludwig, L. (2000). Clinical Massage Therapy: Understanding, Assessing and Treating Over 70 Conditions. Talus Inc. ISBN 978-0-9698177-1-0 — condition entry: Disc Herniation.

PAIN

Complex Regional Pain Syndrome — Pathophysiology

The condition

- A chronic pain condition, usually affecting a limb, in which pain is grossly out of proportion to the inciting event.
- Typically follows fracture, sprain, surgery or immobilisation, and occasionally minor injury.
- Type 1 occurs without identifiable nerve injury; type 2 follows a defined nerve injury. The presentation is otherwise similar.
- Mechanisms include peripheral and central sensitisation, abnormal sympathetic activity, neurogenic inflammation and altered cortical representation of the limb.
- Diagnosis is clinical, using the Budapest criteria, and is made medically.



Presentation

- Severe burning or aching pain, with allodynia and hyperalgesia.
- Vasomotor change: asymmetry in skin colour and temperature between the limbs.
- Sudomotor change: altered sweating, and oedema.
- Trophic change over time: altered hair and nail growth, skin thinning and shininess.
- Motor change: reduced range, weakness, tremor and dystonia.
- Disuse leads to stiffness, contracture and osteoporosis — which then worsen the pain.
- Body perception disturbance: the limb may feel foreign or not fully owned.

TREATMENT PLANNING

Complex Regional Pain Syndrome — Building the Plan

Approach

- Begin proximally, or on the contralateral limb, well away from the painful region.
- Very light contact initially. Allodynia means light touch is the painful stimulus.
- Progress by graded desensitisation across sessions, guided by the client's response over the following days.
- The aim is to reduce the threat value of touch, not to force tolerance.
- Address compensatory strain in the trunk, shoulder girdle and opposite limb from guarding and disuse.
- General relaxation to reduce sympathetic drive and support descending inhibition.
- Support the graded motor and desensitisation programmes set by physiotherapy or occupational therapy rather than working against them.

Precautions

- Never work through pain. Provoking pain in a sensitised nervous system reinforces the sensitisation.
- Avoid hot and cold applications; thermal regulation is disturbed and both extremes can flare the condition.
- Avoid firm pressure, deep work and aggressive stretching on the affected limb.
- Early, careful, non-threatening treatment is more valuable than intensive treatment.
- This population is often distressed and frequently disbelieved. Validation of the pain as real is part of the care.
- Coordinate with the pain team; multidisciplinary management is the standard of care.

Rattray, F., & Ludwig, L. (2000). Clinical Massage Therapy: Understanding, Assessing and Treating Over 70 Conditions. Talus Inc. ISBN 978-0-9698177-1-0 — condition entry: Complex Regional Pain Syndrome.

VASCULAR

Stroke — Types and Mechanisms

Ischaemic — approximately four in five

- Thrombotic: a clot forms on an atherosclerotic plaque within a cerebral artery.
- Embolic: a clot forms elsewhere, most often in the heart with atrial fibrillation, and lodges in a cerebral artery.
- Lacunar: occlusion of a small penetrating artery, producing small deep infarcts.
- Watershed: hypoperfusion at the border zones between arterial territories.
- The ischaemic penumbra is tissue that is at risk but still salvageable, which is why time to treatment determines outcome.

Haemorrhagic — approximately one in five

- Intracerebral: bleeding into the brain tissue, most commonly associated with chronic hypertension.
- Subarachnoid: bleeding into the subarachnoid space, most often from a ruptured berry aneurysm.
- Subarachnoid haemorrhage presents as a thunderclap headache — sudden, severe and maximal within moments, classically described as the worst headache of the person's life. This is an emergency.
- Higher early mortality than ischaemic stroke.



- The distinction matters medically because thrombolysis, which treats ischaemic stroke, is catastrophic in haemorrhage.

EMERGENCY

Recognising Stroke — FAST and Beyond

FAST

- Face — is it drooping on one side? Ask the person to smile.
- Arms — can they raise both and hold them there? Does one drift down?
- Speech — is it slurred, jumbled, or absent? Can they repeat a simple sentence?
- Time — call emergency services immediately. Note the time symptoms began, because treatment eligibility depends on it.
- Additional signs: sudden severe headache, sudden vision loss or double vision, sudden dizziness or loss of balance, sudden numbness on one side.

What to do

- Call 911. Do not drive the client, do not ask them to drive, and do not wait to see whether it improves.
- Record the time of onset, or the time the person was last known to be well.
- Keep the person safe, comfortable and supervised. Do not give food, drink or medication.
- Do not treat. Stay with them until help arrives.
- Document everything, including the times.
- A transient ischaemic attack — symptoms resolving within minutes to hours — is not reassurance. It is a warning of high short-term stroke risk and requires urgent medical assessment on the same day.

VASCULAR

Stroke — Presentation by Territory

Vascular territories

- Middle cerebral artery: contralateral hemiparesis and sensory loss affecting the face and arm more than the leg; aphasia if the dominant hemisphere; neglect if the non-dominant.
- Anterior cerebral artery: contralateral weakness affecting the leg more than the arm.
- Posterior cerebral artery: contralateral homonymous visual field loss; memory disturbance.
- Vertebrobasilar and brainstem: cranial nerve signs on one side with limb signs on the other, ataxia, vertigo, dysarthria, dysphagia and diplopia.
- Cerebellar: ataxia, intention tremor, nystagmus and balance disturbance.

Consequences seen in practice

- Hemiparesis with an upper motor neuron pattern: spasticity, hyperreflexia and extensor plantar response, developing after an initial flaccid period.
- The characteristic posture: upper limb flexed and adducted, lower limb extended, with a circumducting gait.
- Sensory loss on the affected side, and neuropathic central post-stroke pain.
- Aphasia — expressive, receptive or mixed — and dysarthria.
- Hemispatial neglect: the client does not attend to one side of space or of their own body.
- Dysphagia; emotional lability; depression; fatigue.
- Shoulder subluxation and hemiplegic shoulder pain from a flaccid, unsupported limb.

Ratray, F., & Ludwig, L. (2000). Clinical Massage Therapy: Understanding, Assessing and Treating Over 70 Conditions. Talus Inc. ISBN 978-0-9698177-1-0 — condition entry: Cerebral Vascular Accident.



Stroke — Building the Plan

Goals and technique

- Reduce spasticity-related discomfort and maintain range of motion on the affected side.
- Help prevent contracture, particularly at the shoulder, elbow, wrist, fingers, hip and ankle.
- Support the subluxed or at-risk shoulder: never pull on, hang from, or forcefully abduct a flaccid arm. Support it fully at all times.
- Treat the unaffected side, which is overworking and frequently painful.
- Support circulation and skin integrity in the affected limbs.
- Slow, sustained, predictable technique; rapid passive movement provokes spasticity.
- General relaxation and stress reduction.

Precautions and communication

- Do not treat in the acute phase; obtain physician clearance and coordinate with rehabilitation.
- Screen for deep vein thrombosis on the affected side at every visit; hemiplegia is a significant risk factor.
- Anticoagulant medication is common — bruising risk means moderating pressure.
- Cardiovascular comorbidity is the rule, not the exception.
- Sensory loss and neglect: check the position of the affected limb yourself, because the client may not know where it is.
- Aphasia is not reduced intelligence. Speak normally, allow time, use yes-or-no questions and gestures, and confirm consent is genuinely understood.
- Where capacity is affected, obtain consent from the substitute decision-maker under the Health Care Consent Act, 1996.

CMTO Standard of Practice: Consent — <https://www.cmta.com/rules/consent/>

TRAUMA

Traumatic Brain Injury — Classification

Mechanisms and types

- Primary injury occurs at impact; secondary injury develops over hours to days from oedema, raised intracranial pressure, ischaemia and inflammation.
- Coup-contrecoup: injury at the site of impact and at the opposite pole as the brain moves within the skull.
- Diffuse axonal injury: shearing of axons from rotational acceleration, a major cause of persistent disability.
- Contusion, laceration and skull fracture.
- Epidural haematoma: usually arterial, classically from a middle meningeal artery tear, with a lucid interval followed by rapid deterioration.
- Subdural haematoma: usually venous, from bridging vein tears; may present slowly, particularly in older adults and those on anticoagulants.

Severity

- Graded using the Glasgow Coma Scale, duration of loss of consciousness, and duration of post-traumatic amnesia.
- Mild injury, including concussion, is the great majority of cases.
- Concussion is a functional disturbance rather than a structural lesion, and imaging is typically normal. This does not mean nothing is wrong.
- Post-traumatic amnesia duration is one of the better predictors of outcome.
- Repeat injury before recovery is complete carries substantially greater risk.



Head Injury — Red Flags for Deterioration

A client who has had a head injury and is deteriorating requires emergency services, not a referral.

- Worsening or severe headache, particularly one that does not respond to simple measures.
- Repeated vomiting.
- Increasing drowsiness, difficulty waking, confusion or agitation.
- Unequal pupils, or a pupil that does not react to light.
- New weakness, numbness or difficulty speaking.
- Seizure activity.
- Clear fluid or blood from the nose or ear, or bruising behind the ear or around both eyes — these suggest skull base fracture.
- Any loss of consciousness, however brief, warrants medical assessment.
- In a client on anticoagulants, the threshold for referral after any head injury is much lower.
- Call 911, keep the person still and supervised, do not leave them alone, and document the times.

TRAUMA

Concussion and Persistent Symptoms

Presentation

- Physical: headache, dizziness, nausea, light and noise sensitivity, blurred vision, fatigue, balance disturbance.
- Cognitive: slowed processing, poor concentration, memory difficulty, feeling in a fog.
- Emotional: irritability, anxiety, low mood, emotional lability.
- Sleep: too much, too little, or difficulty falling asleep.
- Symptoms may not appear immediately and can evolve over the first days.
- Most people recover within weeks; a minority develop persistent symptoms lasting months.

Massage therapy role

- Not in the acute phase and not without medical assessment. Return-to-activity decisions are medical.
- Cervicogenic contribution is common and treatable: the neck is injured by the same forces as the head, and neck dysfunction generates headache and dizziness.
- Treat the suboccipitals, upper trapezius, levator scapulae, scalenes, sternocleidomastoid and the cervical and thoracic paraspinals.
- Address jaw and masticatory muscles where relevant.
- Modify the environment: dim lighting, quiet room, no strong scents, minimal conversation.
- Keep sessions shorter initially and monitor symptom response over the next twenty-four to forty-eight hours.
- Avoid vigorous technique, rapid position changes and end-range cervical movement.
- Refer back to medicine if symptoms worsen or new symptoms appear.

CONGENITAL

Spina Bifida

Types and pathophysiology

- A neural tube defect — failure of the neural tube to close completely during early embryonic development.
- Occulta: a vertebral arch defect without protrusion of neural tissue. Often asymptomatic and discovered incidentally; a tuft of hair or a dimple may overlie it.
- Meningocele: the meninges protrude through the defect, but the cord itself is not in the sac. Neurological deficit may be mild.



- Myelomeningocele: the meninges and neural tissue both protrude. The most severe form, with significant neurological deficit below the lesion.
- Maternal folic acid before and during early pregnancy substantially reduces risk.
- Associated conditions: hydrocephalus, often with a shunt; Arnold-Chiari malformation; tethered cord syndrome.

Consequences

- Motor and sensory loss below the level of the defect, with a lower motor neuron pattern in lumbosacral lesions.
- Bowel and bladder dysfunction; skin insensitivity and pressure injury risk.
- Orthopaedic consequences: scoliosis, hip dysplasia, club foot, contractures.
- Mobility ranges from independent walking to full wheelchair use depending on the level.
- Learning difficulties are more common where hydrocephalus is present.

TREATMENT PLANNING

Spina Bifida — Building the Plan and the Latex Precaution

The latex precaution

- People with spina bifida have a markedly elevated rate of latex allergy, attributed to repeated early exposure through multiple surgeries and catheterisation.
- Reactions range from contact dermatitis to anaphylaxis.
- Use only latex-free gloves and equipment with this population, and check table coverings, bolsters and any supply that may contain latex.
- Ask directly about latex allergy at intake and record the answer prominently.
- This is a required, not optional, precaution.

Treatment plan

- Goals: maintain range of motion, manage the muscular strain of altered posture and gait, support circulation, and provide comfort.
- Treat the overworking upper limbs and shoulder girdle of wheelchair users and crutch users.
- Avoid direct pressure over the defect site, any surgical site, and a shunt or its tubing.
- Insensate areas: inspect skin, take responsibility for pressure and temperature judgment, and no thermal applications.
- Screen for the signs of shunt malfunction — headache, vomiting, drowsiness, vision change — and refer urgently if present.
- Tethered cord may present as new or progressive neurological change; refer rather than treat harder.
- Where the client is a minor, obtain consent from the parent or guardian and follow the requirements for treating minors.

CMTO Standard of Practice: Consent — <https://www.cmta.com/rules/consent/>

CONGENITAL

Cerebral Palsy — Classification

What it is

- A group of permanent disorders of movement and posture arising from a non-progressive injury to the developing brain, before, during or shortly after birth.
- The brain lesion does not progress, but its musculoskeletal consequences do change over a lifetime.
- Causes include prematurity, low birth weight, intrauterine infection, hypoxic-ischaemic injury and neonatal stroke.
- Associated features may include epilepsy, intellectual disability, visual and hearing impairment, and communication difficulty — but need not be present. Motor impairment does not imply cognitive impairment.



Types and distribution

- Spastic — the most common. Upper motor neuron pattern with velocity-dependent hypertonicity, hyperreflexia and contracture over time.
- Dyskinetic — involuntary movements, athetosis or dystonia, from basal nuclei involvement.
- Ataxic — incoordination, tremor and wide-based gait, from cerebellar involvement.
- Mixed types are common.
- Distribution: hemiplegic, diplegic (legs more than arms), or quadriplegic.
- Function is described by the Gross Motor Function Classification System, levels one through five.

TREATMENT PLANNING

Cerebral Palsy — Building the Plan

Goals and technique

- Reduce hypertonicity and the pain that accompanies it.
- Maintain range of motion and help delay or limit contracture — a genuinely valuable long-term contribution.
- Address the compensatory strain of altered gait, asymmetrical loading and mobility aid use.
- Support circulation and skin integrity where mobility is limited.
- Slow, warm, sustained technique. Rapid handling, sudden movement and cold all increase tone.
- Approach within the client's field of vision and announce contact; startle increases tone.
- Work with, not against, the goals set by physiotherapy and occupational therapy.

Adaptation and precautions

- Positioning takes time and generous bolstering; the conventional prone and supine positions may be unusable.
- Consider seated or side-lying treatment.
- Communication: allow time, use the client's own communication method or device, and address the client directly rather than the caregiver.
- Never assume intellectual impairment from motor impairment or from speech difficulty.
- Screen for seizure history and know the client's pattern.
- Ask about hip subluxation and scoliosis, and about surgical history including tendon lengthening and baclofen pumps.
- Avoid direct pressure over a baclofen pump or any implanted device.
- For minors, consent is obtained from the parent or guardian, with assent from the child.

Rattray, F., & Ludwig, L. (2000). Clinical Massage Therapy: Understanding, Assessing and Treating Over 70 Conditions. Talus Inc. ISBN 978-0-9698177-1-0 — condition entry: Cerebral Palsy.

SPINAL CORD INJURY

Spinal Shock and the Evolution of the Presentation

Spinal shock

- A period immediately following acute cord injury in which all reflex activity below the lesion is temporarily abolished.
- Presentation: flaccid paralysis, areflexia, loss of sensation and loss of autonomic reflexes below the level — regardless of whether the lesion is an upper motor neuron one.
- Lasts days to weeks. Reflexes return gradually, often beginning with the bulbocavernosus reflex.
- As spinal cord circuits below the lesion regain excitability without descending inhibition, the picture converts to the expected upper motor neuron pattern.
- Spasticity, hyperreflexia and clonus therefore appear weeks after the injury, not at the time of it.

Neurogenic shock — a different thing

- A cardiovascular emergency, not a reflex phenomenon, occurring with injuries at T6 and above.



- Loss of sympathetic outflow leaves parasympathetic vagal tone unopposed.
- Presentation: hypotension with bradycardia and warm dry skin — the opposite of haemorrhagic shock, where the heart rate rises and the skin is cool and clammy.
- It is a medical emergency in the acute setting.
- The residual consequence seen in practice is chronic low resting blood pressure and marked orthostatic hypotension.
- Do not confuse the two terms; spinal shock is neurological, neurogenic shock is cardiovascular.

SPINAL CORD INJURY

Secondary Complications the RMT Must Screen For

The complications

- Pressure injury: the leading preventable complication. Occurs over bony prominences in insensate, immobile areas — sacrum, ischial tuberosities, greater trochanters, heels, scapulae.
- Deep vein thrombosis and pulmonary embolism: risk is high, particularly in the first months.
- Osteoporosis below the level of injury develops rapidly and produces genuine fragility fracture risk.
- Heterotopic ossification: bone forming in soft tissue around joints, most often the hips and knees.
- Syringomyelia: a fluid-filled cavity developing within the cord, sometimes years later.
- Contracture, spasticity, neuropathic pain, urinary tract infection and respiratory infection.

What you do about each

- Inspect skin over all pressure areas at every visit, and refer any redness that does not blanch or resolve.
- Screen for unilateral limb swelling, warmth and colour change; do not treat a limb with suspected deep vein thrombosis, and refer the same day.
- Avoid forceful passive movement and vigorous technique because of fracture risk.
- A hot, swollen, firm joint region with sudden loss of passive range suggests heterotopic ossification — refer rather than mobilise.
- New or ascending symptoms, new pain, or a change in the level of sensation may indicate syringomyelia — refer.
- Report any change in the established pattern; the client and their team will know what is new.

TREATMENT PLANNING

Spasticity — Mechanism and Management in the Room

Mechanism

- Velocity-dependent increase in muscle tone from loss of descending inhibition to the stretch reflex.
- The faster the passive movement, the greater the resistance — this is what distinguishes spasticity from rigidity, which is uniform regardless of speed.
- Clasp-knife phenomenon: strong initial resistance that suddenly gives way, from Golgi tendon organ inhibition.
- Spasticity is not simply excessive muscle activity; it is a disordered reflex, and it cannot be stretched out.
- Some clients rely on their spasticity for standing, transfers and function — reducing it is not automatically a benefit.

What increases and decreases it

- Increases: rapid passive movement, cold, pain, anxiety, startle, a full bladder, constipation, infection, pressure injury, tight clothing or a poorly fitted brace.
- Decreases: slow sustained stretch, warmth, rhythmic rocking, general relaxation, positioning, and removal of the noxious stimulus.
- A sudden unexplained increase in spasticity is a warning sign — look for a urinary tract infection, pressure injury, fracture or bowel impaction, and refer.
- Technique: slow, warm, sustained, predictable; approach within the client's view and announce contact.



- Ask the client before reducing tone in a limb they use functionally.
- Coordinate with antispasmodic medication and any baclofen pump; avoid pressure over the device.

ASSESSMENT

Radicular, Peripheral and Referred Pain — Telling Them Apart

The three patterns

- Radicular: follows a dermatome; sharp, shooting or electric; accompanied by myotomal weakness and a diminished reflex at that root; provoked by spinal position and by coughing or straining.
- Peripheral entrapment: follows the territory of one named nerve distal to the entrapment; often worse at night; provoked by position or by pressure at the entrapment site; no root-level reflex change.
- Referred somatic: dull, deep, poorly localised, does not follow a dermatome, and is not accompanied by neurological deficit. From joint, muscle or viscus.

Working through it

- Ask for the exact distribution and have the client trace it with a finger; a traced line that follows a dermatome is different information from a vague region.
- Test the dermatome, the myotome and the reflex for the suspected root.
- Test distal to the suspected entrapment, and provoke at the entrapment site.
- Look for a proximal source in referred pain — cervical for shoulder and arm, lumbar and hip for buttock and thigh.
- Consider double crush: a proximal root irritation and a distal entrapment coexisting, which explains an incomplete response to treating either alone.
- Consider visceral referral where the pattern fits no neurological or musculoskeletal explanation, and refer.
- Record the distribution and the tests, so change is trackable.

Lowe, W. (2016). Orthopedic Assessment in Massage Therapy (2nd ed.). Orthopedic Massage Education.

NERVE ROOT

Cervical Radiculopathy

Presentation by level

- C5: pain and altered sensation over the lateral shoulder; weakness of shoulder abduction; diminished biceps reflex.
- C6: lateral forearm, thumb and index finger; weakness of elbow flexion and wrist extension; diminished brachioradialis reflex.
- C7: posterior arm and middle finger; weakness of elbow extension and wrist flexion; diminished triceps reflex.
- C8: medial forearm, ring and little finger; weakness of finger flexion; no standard reflex.
- T1: medial arm; weakness of finger abduction and adduction.
- C6 and C7 account for the large majority of cervical radiculopathy.

Assessment and treatment

- Spurling's test — extension, side flexion and rotation toward the symptomatic side with compression — reproduces radicular symptoms. Use it cautiously and stop at first reproduction.
- Relief of symptoms on placing the hand on top of the head is a supportive finding.
- Treatment targets: scalenes, upper trapezius, levator scapulae, pectoralis minor, subscapularis, and the cervical and thoracic paraspinals.
- Address the thoracic spine and shoulder girdle; a stiff upper thoracic segment loads the cervical spine.
- Position for comfort; a small pillow supporting the head in slight flexion is often better tolerated than flat supine.
- Do not persist with any position or technique that reproduces distal symptoms.
- Refer if there is progressive weakness, bilateral symptoms, gait disturbance, or any sign suggesting cord rather than root involvement.



Lumbar Radiculopathy

Presentation by level

- L3 and L4: anterior thigh and medial leg; weakness of knee extension; diminished patellar reflex.
- L5: lateral leg and dorsum of the foot including the great toe; weakness of great toe extension and ankle dorsiflexion, producing foot drop; no standard reflex, which makes the myotome the key test.
- S1: posterior leg, lateral foot and little toe; weakness of ankle plantarflexion; diminished Achilles reflex.
- L5 and S1 account for the large majority of lumbar radiculopathy.
- Foot drop with an L5 pattern is a significant finding requiring prompt referral.

Assessment and treatment

- Straight leg raise reproducing radicular symptoms between roughly thirty and seventy degrees supports lumbar nerve root irritation.
- The slump test is a further neurodynamic assessment; both are performed gently and stopped at first reproduction.
- Screen the cauda equina questions before treating, every time.
- Treatment targets: lumbar paraspinals, quadratus lumborum, gluteals, piriformis and the deep hip rotators, hamstrings and iliopsoas.
- Side-lying with a pillow between the knees is often the best-tolerated position in the acute phase.
- Address the antalgic pattern and the compensatory loading through the opposite hip and the thoracolumbar junction.
- Refer if weakness is progressive, if there are bilateral symptoms, or if any cauda equina feature appears.

Rattray, F., & Ludwig, L. (2000). Clinical Massage Therapy: Understanding, Assessing and Treating Over 70 Conditions. Talus Inc. ISBN 978-0-9698177-1-0 — condition entry: Disc Herniation.

VASCULAR

Stroke — Risk Factors and Prevention

Modifiable risk

- Hypertension — the single largest modifiable risk factor for both ischaemic and haemorrhagic stroke.
- Atrial fibrillation, which produces cardioembolic stroke and is usually managed with anticoagulation.
- Diabetes; dyslipidaemia; smoking; obesity; physical inactivity; excessive alcohol.
- Carotid atherosclerosis; obstructive sleep apnoea.
- Previous transient ischaemic attack or stroke — the strongest predictor of the next one.

Non-modifiable, and the RMT's part

- Age, sex, family history, and prior cardiovascular disease.
- The RMT does not manage risk factors, but does recognise the risk profile and treat within it.
- A client with several of these factors who reports transient neurological symptoms is referred urgently, not reassured.
- Anticoagulation and antiplatelet therapy are common in this population and require moderated pressure.
- Uncontrolled hypertension is a caution; ask whether it is monitored and managed.
- General relaxation and stress reduction are legitimate supportive contributions, and can be described honestly as such without implying stroke prevention.

TREATMENT PLANNING

Stroke — Rehabilitation Phases and When Massage Fits

The phases

- Acute — the first days in hospital. Medical management. No massage therapy.



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- Subacute — weeks to roughly six months, when the greatest neurological recovery occurs. Intensive rehabilitation. Massage therapy may contribute with clearance and in coordination with the team.
- Chronic — beyond six months. Recovery slows but function continues to improve with practice. This is where most RMTs meet the client.
- Flaccidity typically precedes spasticity; the affected limb passes through a flaccid stage before tone develops.
- Learned non-use develops when the affected limb is not used, and compounds the original deficit.

Fitting in

- Subacute: protect the shoulder, maintain range, manage tone, support positioning, and reinforce rather than duplicate the rehabilitation programme.
- Chronic: manage spasticity discomfort, prevent contracture, treat the overworking unaffected side, and address hemiplegic shoulder pain.
- Ask what the physiotherapist and occupational therapist are working on and support it.
- Do not encourage the client to stop using the affected limb for comfort; that reinforces learned non-use.
- Treatment frequency is usually more valuable than treatment intensity in this population.
- Document objective range and tone findings so that change across months is visible.

Rattray, F., & Ludwig, L. (2000). Clinical Massage Therapy: Understanding, Assessing and Treating Over 70 Conditions. Talus Inc. ISBN 978-0-9698177-1-0 — condition entry: Cerebral Vascular Accident.

TRAUMA

Traumatic Brain Injury — Cognitive and Behavioural Adaptation

What you may encounter

- Impaired attention, slowed processing, and reduced working memory.
- Impaired executive function: planning, initiating, self-monitoring and inhibiting.
- Impaired new learning, so home care and appointment times are forgotten without being written down.
- Disinhibition, impulsivity, irritability and emotional lability.
- Reduced insight into the deficits themselves, which is itself a deficit and not denial.
- Fatigue that is disproportionate and easily triggered by cognitive as well as physical effort.

Adaptation

- Reduce the cognitive load of the appointment: one instruction at a time, written down, with a copy for the client.
- Keep the environment quiet, the lighting low, and conversation minimal.
- Use appointment reminders, and expect to repeat information across visits without comment.
- Confirm that consent is genuinely understood, and re-obtain it at each visit and before each new region.
- Where capacity is affected, involve the substitute decision-maker under the Health Care Consent Act, 1996.
- Manage disinhibited behaviour by maintaining clear, calm, consistent professional boundaries; state the boundary plainly, redirect, and document. Do not take it personally and do not respond in kind.
- Involve family and caregivers with the client's consent, and address them respectfully alongside rather than instead of the client.

Health Care Consent Act, 1996 — <https://www.ontario.ca/laws/statute/96h02>

APPLICATION

Case — C6 Tetraplegia, Four Years Post-Injury

Presentation

- A client in their thirties, four years after a complete C6 spinal cord injury, using a manual wheelchair independently.
- Chief complaint is bilateral shoulder pain, worse with propulsion and transfers, developing over eighteen months.



- Reports lower limb spasticity that has been stable, and a pressure area over the right ischial tuberosity that healed two months ago.
- Reports a pounding headache last month during a blocked catheter, which resolved once the catheter was cleared.

Reasoning and plan

- The headache episode was autonomic dysreflexia. At C6, the client is well above T6 and remains at risk. Review the emergency sequence before the first treatment and confirm the client's own protocol.
- Before every session: ask about bladder and bowel status, and ensure clothing and the leg bag are not constricting.
- The chief complaint is the treatable finding: shoulder overuse is the classic long-term consequence of manual wheelchair use, and it threatens independence.
- Treat the rotator cuff, pectoralis major and minor, subscapularis, upper trapezius and the cervical and thoracic paraspinals.
- Maintain lower limb range and manage spasticity discomfort with slow sustained technique.
- Inspect the previously ulcerated area and all pressure points at every visit; refer any non-blanching redness.
- No thermal applications below the level of injury; osteoporosis below the lesion means no forceful passive movement.
- Transfers: use the client's own method and follow their instruction exactly.

APPLICATION

Case — Chronic Hemiplegia With Shoulder Pain

Presentation

- A client in their seventies, two years after a left middle cerebral artery infarct, with right hemiparesis.
- Right upper limb held flexed and adducted, with increased tone; right lower limb extended with a circumducting gait, using a cane.
- Reports constant right shoulder pain, worse when the arm is moved or when they are helped with dressing.
- Expressive aphasia — comprehension is good, speech is effortful and limited. Takes an anticoagulant for atrial fibrillation.
- Reports left-sided neck and low back pain from cane use and asymmetrical loading.

Reasoning and plan

- Consent: comprehension is intact, so obtain consent directly from the client using yes-or-no questions, gesture and ample time. Do not route consent through the accompanying family member.
- Hemiplegic shoulder pain with subluxation risk: support the arm fully at all times, never pull on it, never abduct it forcefully, and instruct family in safe handling with consent.
- Treat the spastic flexor pattern with slow sustained technique; maintain shoulder, elbow, wrist and finger range within comfort.
- Treat the left side, which is overworking through the cane and doing the work of two limbs — this is often the most changeable source of pain.
- Anticoagulation: moderate pressure, expect bruising, avoid vigorous technique.
- Screen the right lower limb for deep vein thrombosis at every visit.
- Check the position of the right arm yourself before every position change; sensory loss means the client may not know where it is.
- Honest goal-setting: comfort, range, contracture prevention and reduction of compensatory strain — not restoration of the infarcted tissue.



Emergency Recognition Summary

Call 911 immediately

- Stroke or transient ischaemic attack — any FAST sign, sudden severe headache, sudden vision or balance loss.
- Deteriorating head injury — worsening headache, repeated vomiting, increasing drowsiness, unequal pupils, seizure, fluid from nose or ear.
- Autonomic dysreflexia — pounding headache with hypertension in a client with a spinal cord injury at T6 or above.
- Suspected meningitis — fever with headache and neck stiffness, particularly with a non-blanching rash.
- Seizure lasting more than five minutes, or repeated seizures without recovery between them.
- Any sudden loss of consciousness, or rapidly progressive weakness.

Same-day medical assessment

- Cauda equina symptoms — saddle anaesthesia, new bladder or bowel dysfunction, bilateral leg symptoms.
- Progressive neurological deficit — weakness that is getting worse over days.
- New unexplained neurological signs of any kind.
- Suspected first presentation of herpes zoster, and any facial or eye involvement.
- Any wound or ulcer in an insensate area.
- Suspected deep vein thrombosis.
- Suspected shunt malfunction in a client with hydrocephalus.
- In every case: stop treatment, arrange care, ensure safe transport, and document the finding, the advice and the time.

DOCUMENTATION

Recording Neurological Findings

What to record

- The findings themselves, in objective terms: which dermatome, which myotome, which reflex, graded on the standard scales.
- The client's reported symptoms in their own words where relevant.
- What you did, what you did not do, and why.
- Any red flag identified, the advice given, and the time it was given.
- The consent obtained, including consent to communicate with another provider.
- Any change from the previous visit.

How to phrase it

- Write "reduced light touch sensation reported over the lateral forearm and thumb", not "C6 radiculopathy".
- Write "strength graded 4 of 5 in elbow flexion on the right", not "nerve damage".
- Communicating a diagnosis is a controlled act reserved under the Regulated Health Professions Act, 1991, and is outside the RMT scope.
- Objective description is more useful to the receiving clinician than a guess at a label.
- Records must meet the CMTO Record Keeping standard and be legible, contemporaneous and complete.

CMTO Standard of Practice: Record Keeping — <https://www.cmta.com/rules/standard-of-practice-record-keeping/> · Regulated Health Professions Act, 1991 — <https://www.ontario.ca/laws/statute/91r18>

SUMMARY

Key Takeaways

- Localise the lesion first — peripheral, root, cord or brain. The pattern determines urgency, expectation and modification.



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- Spinal cord injury level predicts function: C3 to C5 for the diaphragm, C6 for tenodesis grip, C7 for transfers, T6 and above for autonomic dysreflexia risk.
- Below L1 to L2 the canal contains nerve roots, not cord, so injury there produces a flaccid lower motor neuron pattern.
- Brown-Séquard's dissociated pattern — ipsilateral motor and dorsal column loss with contralateral pain and temperature loss — follows directly from where each tract crosses.
- Cauda equina syndrome is a same-day surgical emergency; ask the bowel and bladder questions of every client with low back and leg pain.
- In complex regional pain syndrome, working through pain reinforces sensitisation. Start away from the limb and desensitise gradually.
- FAST identifies stroke; note the time of onset and call 911. A transient ischaemic attack is a warning, not reassurance.
- Never pull on or hang a flaccid hemiplegic arm — support it fully to protect the shoulder.
- Latex-free supplies are a required precaution for every client with spina bifida.
- In cerebral palsy the brain lesion is static but the musculoskeletal consequences are not, and motor impairment never implies cognitive impairment.

CONSOLIDATION

Review Questions and References

Review questions

- A client has left leg weakness and loss of vibration sense, with loss of pain and temperature sensation in the right leg. Where is the lesion, and explain the pattern from tract anatomy.
- Why does an injury at C6 represent a major functional threshold?
- Why does injury below L1 to L2 produce flaccidity rather than spasticity?
- List the symptoms of cauda equina syndrome and state your exact sequence of actions.
- Explain why hot and cold applications are contraindicated below the level of a spinal cord injury.
- Describe how you would begin treating a client with complex regional pain syndrome of the right hand.
- State the four elements of FAST and what you record alongside them.
- Why is a latex-free environment required for clients with spina bifida?
- How would you phrase a suspected C6 nerve root finding in a chart note without stating a diagnosis?

References

- Rattray, F., & Ludwig, L. (2000). Clinical Massage Therapy. Talus Inc. — Spinal Cord Injury, Cerebral Vascular Accident, Cerebral Palsy, Disc Herniation and Complex Regional Pain Syndrome entries.
- Werner, R. A Massage Therapist's Guide to Pathology (7th ed.). Books of Discovery.
- Lowe, W. Orthopedic Assessment in Massage Therapy (2nd ed.).
- Tortora, G. J., & Derrickson, B. Principles of Anatomy and Physiology (16th ed.). Wiley.
- CMTO Standard of Practice: Record Keeping — <https://www.cmtto.com/rules/standard-of-practice-record-keeping/>
- CMTO Standard of Practice: Consent — <https://www.cmtto.com/rules/consent/>
- Regulated Health Professions Act, 1991 — <https://www.ontario.ca/laws/statute/91r18>