Canadian Physiotherapy Association

Orthopaedic Division
CANADIAN PHYSIOTHERAPY ASSOCIATION
Division d'orthopédie
ASSOCIATION CANADIENNE DE PHYSIOTHÉRAPIE

LEVEL IV/V

Introduction

Welcome to Level IV and V of the Diploma of Advanced Orthopaedic Manual and Manipulative Physiotherapy Courses. This is part of a series of courses sponsored and sanctioned by the Orthopaedic Division of the Canadian Physiotherapy Association. Congratulations on successfully completing the Level I, II, III courses and Intermediate Orthopaedic Manual and Manipulative Physiotherapy examination.

The Level IV and V courses teach students the treatment of spinal, pelvic and costal joint dysfunction safely and effectively by manipulation techniques with emphasis on the indications and contraindications for their use. The integration of clinical reasoning with an understanding of the mechanical and anatomical influences of local and distal tissues forms the final component of these courses.

Please note that because of the critical nature of this material a significant portion of the content of this manual is repeated from previous manuals.

Many students relish the opportunity to spend as much time as possible on practical sessions during scheduled course time. Accordingly, during the Level IV and V courses theoretical material is reviewed briefly and the use of this manual will minimize your need to take notes during course time. The Orthopaedic Division strongly encourages you to read through this manual in order to review, revise and enhance your existing knowledge base.

The Orthopaedic Division expects that students will find this course to be stimulating and challenging, and encourages participants to seek clarification on any topics taught. It is our hope that you come away from this course with an eagerness to put into practice what you learned and a willingness to learn more in the future.

Orthopaedic Division Executive, Education Committee
The Canadian Physiotherapy Association

Acknowledgments

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Special thanks to Jackie Sadi for updating the Effects and Efficacy Section and Clinical Prediction Rules.

Note to Students

Techniques in this manual describe the principles of each specific manipulation (goal of technique, planes of motion, proper body mechanics). The intent is for the participant to reflect on these principles rather than memorize the written text. It is expected that each student will adapt the described methods to individual positioning preferences and patient scenarios. Throughout the practical sessions a significant emphasis will be placed on further development of patient handling skills and sense of touch.

An ability to feel movement is essential for the more specific biomechanical treatment that is taught on this course.

Note Regarding Photocopying

The Orthopaedic Division requests that you do not photocopy these manuals. Significant time and effort has been put into their development. The price of the manuals covers their cost of creation and production. Please contact your local Provincial Orthopaedic Division Course Representative (PODCR) if additional copies are required. Contact information is available in the Orthopaedic Division Review or on the Orthopaedic Division web site www.orthodiv.org.

Manual Therapy Steering Committee

The Manual Therapy Steering Committee (MTSC) oversees the planning and implementation of CPA's strategic initiatives related to the practice of manual therapy and manipulation in Canada. The MTSC also scans the environment with regard to other manual therapy related matters, including pending legislation, legal issues, research implementation and manual therapy education. The MTSC reports directly to the Chief Executive Officer of the CPA and includes representation from the following organizations:

- Orthopaedic Division of CPA
- Sports Physiotherapy Canada
- Canadian Academy of Manipulative Physiotherapists (CAMPT)
- Canadian Council of Physiotherapy University Physiotherapy Programs Academic Council (CCPUP)
- Canadian Alliance of Physiotherapy Regulators (Alliance)
- Canadian Physiotherapy Association staff

The MTSC developed the Selected Resources on the Use of Cervical Manipulation as a Physiotherapy Intervention (Selected Resources) in 2005 to provide references for the safe and effective practice of cervical manipulation for physiotherapists who are actively treating the cervical spine and who may consider including spinal manipulation within their practice
The Selected Resources was revised to provide physiotherapists with additional and current material on the safe and effective practice of cervical manipulation. It has been reformatted and refocused to support clinical reasoning, and to more effectively position cervical manipulation as a tool that may be used as part of overall physiotherapy intervention.

The MTSC has recently embarked on a long term program to examine educators' attitudes towards manual therapy education in entry-level physiotherapy programs in Canada as well as evaluating barriers to increasing manual therapy curriculum content

Level IV Course

Purpose

The Level IV course teaches students the treatment of spinal, pelvic and costal joint dysfunction safely and effectively by manipulation techniques with emphasis on clinical reasoning and the indications and contraindications for their use.

* *Manipulation is defined as a skilful passive high velocity, low amplitude thrust movement of a joint (peripheral or spinal) beyond its physiological limit of motion but inside the limit of its anatomical integrity with the purpose of restoring motion and function.*

Course Objectives

At the completion of the Level IV course, participants will be able to:

1. Analyze examination data to establish the indications and contraindications for the use of high velocity, low amplitude thrust techniques to the spinal column, pelvis, and costal joints.

2. Understand the theories of spinal joint fixation.

3. Understand the theory of high velocity, low amplitude thrust techniques to the spinal, pelvic and costal region.

4. Apply high velocity, low amplitude thrust techniques to specific spinal, pelvic and costal joint dysfunction.

5. Integrate high velocity, low amplitude thrust techniques into the treatment regime for the correction of spinal, pelvic and costal dysfunction.

6. Develop an understanding of evidence based practice with regards to the theory and practical application of discussed diagnostic testing (assessment) and treatment techniques including:

    - generic, condition specific and patient specific outcome measures regarding treatment effectiveness in order to progress or modify treatment
    - knowledge of prognostic indicators
    - a planned prevention program
    - appropriate referral and communication to other members of the health care team in the presence of adverse effects/complications of assessment and/or treatment

Note: A more complete outline of the Level IV course curriculum is available at student@orthodived.ca

Level V Course

Purpose

The Level V course teaches students the treatment of spinal, pelvic and costal joint dysfunction safely and effectively by manipulation techniques with emphasis on the indications and contraindications for their use. The integration of clinical reasoning with an understanding of the mechanical and anatomical influences of local and distal tissues forms the final component of these course.

* *Manipulation is defined as a skilful passive high velocity, low amplitude thrust movement of a joint (peripheral or spinal) beyond its physiological limit of motion but inside the limit of its anatomical integrity with the purpose of restoring motion and function.*

Objectives

At the completion of the Level V course the participants will be able to:

1. Analyze examination data to establish the indications and contraindications for the use of advanced high velocity, low amplitude thrust techniques to the spinal column, pelvis and costal joints.

2. Apply advanced high velocity, low amplitude thrust techniques to specific spinal, pelvic and costal joint dysfunction.

3. Apply advanced high velocity, low amplitude thrust techniques to specific spinal, pelvic and costal joint dysfunction in the presence of proximal or distal hypermobilities, instabilities and / or adverse neuromeningeal tension.

4. Integrate advanced high velocity, low amplitude thrust techniques into the treatment regime for the correction of spinal, pelvic and costal dysfunction.

5. Develop an understanding of evidence based physiotherapy practice with regards to the theory and practical application of discussed diagnostic testing (assessment) and treatment techniques including:
    - generic, condition specific and patient specific outcome measures regarding treatment effectiveness in order to progress or modify treatment
    - knowledge of prognostic indicators
    - a cause and a planned prevention program
    - appropriate referral and communication to other members of the health care team in the presence of adverse effects/complications of assessment and/or treatment

Note: A more compete outline of the Level V course curriculum is available at student@orthodived.ca

Part One: Theory

Part One: Theory

Vascular Supply of the Spinal Cord
Arterial Blood Supply

Anatomy

Major Vessels

- the spinal cord is supplied by three major longitudinal arteries that run the length of the cord
  - single anterior spinal artery
  - two posterior spinal arteries
- usually all three arise from the vertebral arteries in the cranial cavity before passing inferiorly through the foramen magnum at the base of the skull
- occasionally the posterior spinal arteries originate from the posterior inferior cerebellar arteries

Anterior Spinal Artery

- the anterior spinal artery originates from a branch from each vertebral artery which unite in the anterior median fissure

Supplies

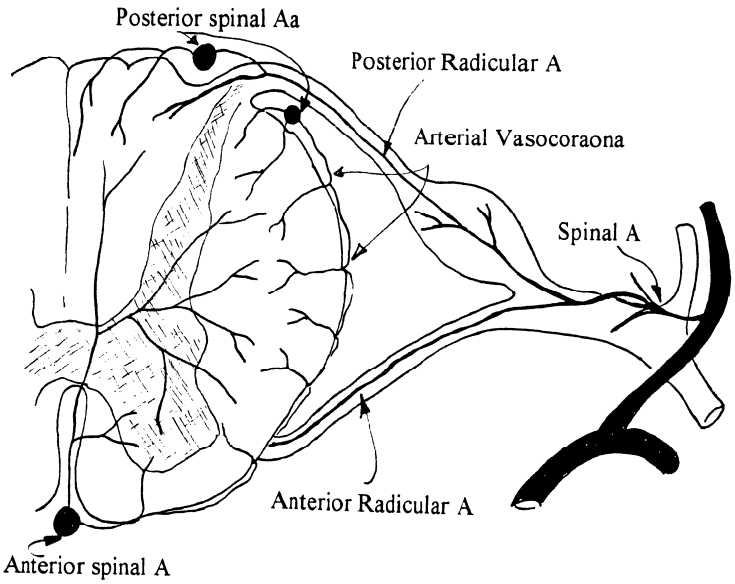
- the anterior spinal artery sends branches to the anterior 2/3 of the cord

Posterior Spinal Artery

- each posterior spinal artery is closely related to the dorsal root entry zones
- in some cases, the posterior spinal artery splits into a pair of descending branches which run distally along the spinal cord, one medial and one lateral to the entry points of the dorsal nerve roots

Supplies

- the posterior spinal arteries supply the posterior 1/3 of the spinal cord



Arterial Supply of the Spinal Cord (modified from Rosse & Gaddam-Rosse)

Segmental Spinal Arteries (Spinal Arteries)

- the amount of blood entering the anterior and posterior spinal arteries from the vertebral arteries is only sufficient to supply the upper cervical segments
- blood supply to the remainder of the cord is supplemented by segmental medullary arteries which arise from segmental spinal arteries
- other spinal cord branches of the segmental spinal arteries are the anterior and posterior radicular arteries
- all spinal nerve roots receive arterial blood via these feeder arteries
- three branches of segmental spinal arteries
  - middle branch: segmental medullary or radicular arteries
  - posterior central branch
  - pre-laminar branch
- segmental spinal arteries enter the vertebral canal via the intervertebral foramina at each level
- segmental spinal arteries accompany the corresponding nerves through the intervertebral foramina, traverse the meningeal layers to provide the anterior and posterior segmental medullary branches

- the corresponding segmental medullary branches enter the dura along with the anterior and posterior roots and anastomosis with the anterior and posterior spinal arteries respectively

Supplies

- segmental medullary or radicular: all spinal nerve roots
- posterior central: posterior aspect of the vertebral body
- pre-laminar: anterior aspect of the neural arch

Radicular Arteries

- most of the segmental spinal arteries give off anterior and a posterior radicular arteries which supply only the anterior and posterior roots respectively
- these radicular arteries end before reaching the anterior or posterior spinal arteries

Supplies

- anterior radicular artery: ventral nerve root
- posterior radicular artery: dorsal nerve root

Segmental Medullary 'Feeder' Arteries

- at various levels an anterior or a posterior radicular artery is replaced by a segmental medullary 'feeder' artery
- unlike the radicular arteries that only supply the roots, the segmental medullary arteries will supply the roots and continue on to anastomose with the anterior or posterior spinal arteries
- therefore, the anterior and posterior spinal arteries are reinforced at the lower cervical intervals by segmental medullary arteries
- these branches from the very short segmental spinal arteries (see above) originate from the vertebral, deep cervical, or ascending cervical arteries
- there are usually six to eight anterior segmental medullary arteries that contribute appreciably to the anterior spinal artery
- there are usually five to eight posterior segmental medullary arteries that contribute to the posterior spinal arteries

- in the thoracic region the anterior and posterior spinal arteries are reinforced by segmental medullary branches from the thoracic aorta and from segmental

spinal arteries coming off of the posterior intercostal arteries
- in the lumbar region, segmental medullary branches of segmental spinal arteries arise from lumbar branches of the abdominal aorta
- in the sacral region, segmental medullary branches of segmental spinal arteries arise from the lateral sacral arteries

Supplies
- with radicular arteries, supplies ventral and dorsal nerve roots
- supplements the anterior and posterior spinal arteries to supply the spinal cord

Artery of Adamkiewicz (Major Segmental Medullar Artery)
- the largest anterior segmental medullary artery is usually found on the left side in the L1 area and is called the major anterior segmental medullary artery or the Artery of Adamkiewicz

Supplies
- this vessel may be the major source of supply to the lower 2/3 of the spinal cord

Arterial Vasocorona (Pial Plexus)
- a plexus of smaller arteries called the arterial vasocorona (pial plexus) lie within the pia
- these vessels interconnect arteries lying in the anterior aspect of the cord with those that lie in the posterior aspect

Supplies
- supplements anterior and posterior vessels

Venous Drainage of the Spinal Cord

Anatomy

Venous Plexus

- veins that drain blood directly from the spinal cord are located in the pia mater, where they form a plexus of ten irregular channels that run longitudinally along the spinal cord

Anterior Spinal Veins

- there are five anterior spinal veins
  - one that runs the anterior median fissure with the anterior spinal artery
  - one on each side
  - two others running longitudinally along the line of attachment of the ventral nerve rootlet

Posterior Spinal Veins

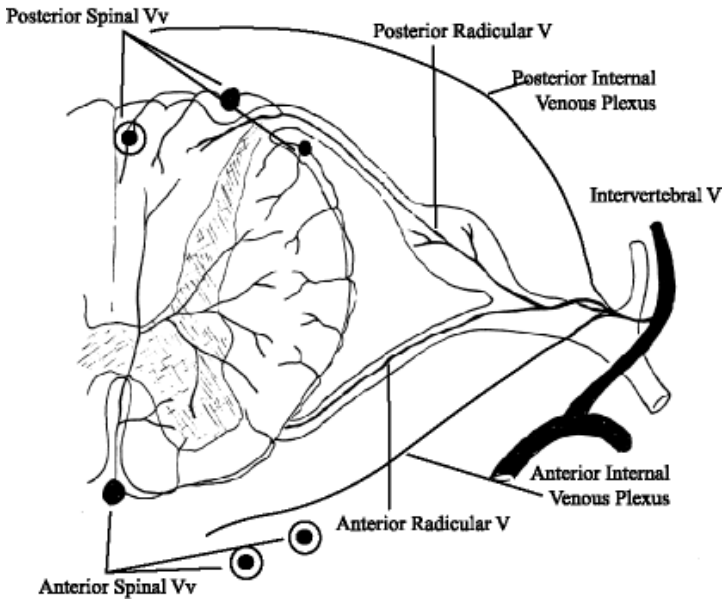
- there are five posterior spinal veins
  - one that runs in the dorsal median sulcus
  - one on each side
  - two others running down along either side of the attachment of the dorsal rootlets

Radicular and Segmental Medullary Veins

- numerous anterior (six to eleven) and posterior (five to ten) radicular (segmental medullary) veins
- drain blood from the anterior and posterior spinal veins as well as receiving tributaries directly from the spinal cord

Anterior and Posterior Vertebral Venous Plexuses

- the radicular (segmental medullary) veins drain into the anterior and posterior internal vertebral venous plexuses (epidural venous plexus)
- the anterior and posterior internal vertebral venous plexuses lie within the vertebral canal between the dura and the vertebrae
- these in turn drain into the intervertebral veins which accompany the spinal nerves through the intervertebral foramina
- the intervertebral veins communicate with the external venous plexus which in turn drains into the caval and azygos systems via dural venous sinuses of the brain, or vertebral, posterior intercostal and lumbar veins



Venous Drainage of the Spinal Cord
(modified from Rosse & Gaddam-Rosse)

Assessment of the Cervical Spine and Cervical Arterial Dysfunction

Background

Guidelines for screening of patients prior to cervical manual therapy have long been in place in the literature (APA guidelines). Several papers have called into question the validity, reliability and evidence base for screening procedures and the uncertainty of quantifying risks of treatment. A broader understanding of the cervical arterial system is advocated (Taylor, Kerry 2010) integrating knowledge of the effects of movement on cervical hemodynamics and recognition of the clinical presentation of cervical arterial dysfunction.

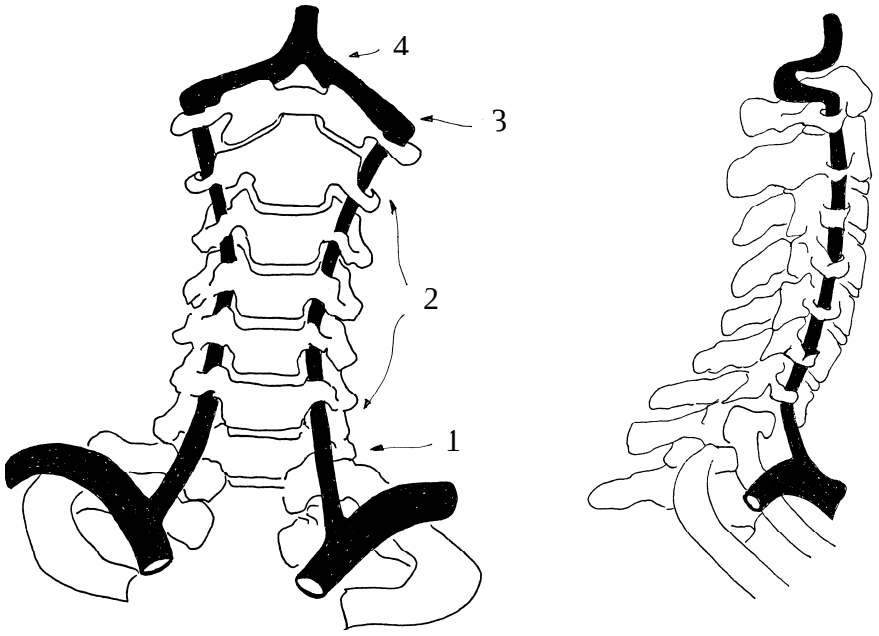
This section will review

1. Anatomy, hemodynamics and pathology of the vertebrobasilar and carotid arterial systems
2. Risk factors associated with cervical arterial dysfunction (CAD)
3. A clinical reasoning algorithm to guide assessment of the cervical spine for possible CAD prior to cervical spine treatment. This is used to enhance understanding of:
   - Differential diagnosis of cervical pain
   - Decision-making in treatment and management of cervical pain and headache
   - Reduction of risk for serious adverse reaction to cervical treatment

Arterial Supply to the Brain Vertebrobasilar System

Four Portions of the Vertebral Artery

1. proximal (ostial)
2. transverse
3. suboccipital
4. intracranial portions



Four parts of the vertebral artery

Proximal (Ostial) Portion

Segment Course

- segment runs from the origin of the artery to its point of entry in the spinal canal
- usual site of origin is from the proximal part of the subclavian artery
- runs vertically, slightly medially, and posteriorly to reach the transverse foramen of the lower cervical spine
- exact direction is dependent on its precise point of origin and any anomalies of origin can result in tortuosity
- typical entry point is at the C6 transverse foramen but other levels of entry between C3 and C7 occur

Transverse Portion

Segment Course

- runs from the point of entry at the spinal column to the transverse foramen of C2
- the beginning of this part of the artery is typically at the C6 level but may vary between individuals and from side to side in the same individual
- the artery runs vertically within the spinal column to reach the transverse foramen of C2

Transverse Canal

- travels in the transverse canal formed by
  - bony transverse foramina at each spinal level
  - overlying anterior and posterior intertransverse muscles

Suboccipital Portion

Segment Course

- extends from its entry into the transverse foramen of C2 to its point of penetration into the foramen magnum
- this section of the vertebral artery is described in four parts

Part 1: Within the Transverse Foramen of C2

- this portion lies in a complete bony canal formed by the two curves of the C2 transverse foramen
- the inferior curve is almost vertical
- the superior curve is more horizontal and oriented laterally

Part 2: Between C2 and C1

- the second part runs vertically upwards to the transverse foramen of C1
- is covered by the levator scapula and the inferior oblique capitus muscles

Part 3: In the Transverse Foramen of C1

- the suboccipital portion of the vertebral artery bends backwards and medially in the transverse foramen of C1 in which it is completely enclosed

Part 4: Between the Posterior Arch of the Atlas and its Entry into the Foramen Magnum

- on exiting from the transverse foramen of C1 the artery winds behind the mass of the superior articular process of the atlas to cross the posterior arch of the atlas in a groove in which it is held by a restraining ligament
- from the medial end of this groove, the artery runs forwards, inwards and upwards to pierce the posterior occipitoatlantal membrane with the nerve of C1 which separates it from the posterior arch of the atlas
- it penetrates the dura mater on the lateral aspect of the foramen magnum about 1.5 centimeters lateral to the midline of the neck

Intracranial Portion

Segment Course

- runs from its penetration of the dura mater at the level of the foramen magnum to the lower border of the pons where the two arteries unite in the midline to form the basilar artery
- after penetration of the cranium, the artery inclines medially towards the medulla oblongata
- then courses up the front of the medulla to reach the lower border of the pons where the artery from each side meets and unites with its partner to form the basilar artery
- the periosteal sheath continues intracranially for about half a centimeter

Branches of the Vertebral Artery

- the vertebral artery is responsible for 20% of the blood supply to the brain (the remaining 80% is from the carotid arteries)
- at the pontomedullary junction the 2 vertebral arteries join to form the basilar artery which lies on the ventral surface of the pons

Extracranial Branches of the Vertebral Artery

Spinal Branch

- leaves the vertebral artery and divides in two
- one branch passes through the intervertebral foramen with the spinal nerve and nerve roots
- anastomoses with other spinal arteries
- supplies
  - dural sleeve of the nerve roots
  - spinal cord
  - meninges of the cord
- other branch divides again into ascending and descending branches to form an anastomotic chain along the posterior aspect of the vertebral bodies
- this anastomotic chain supplies
  - periosteum
  - bone and ligaments of the posterior aspect of the vertebral body

Muscular Branch

- arises from the suboccipital part of the artery as it winds around the superior articular process of the atlas
- supplies
  - deep suboccipital muscles
- anastomoses with the occipital and cervical arteries

Intracranial Branches of the Vertebral Artery

Small Meningeal Branches

- intracranially, the vertebral artery first generates small meningeal branches
- supplies
  - bone and dura mater of the cerebellar fossa
- possible that ischemia of these tissues which occurs with vertebral artery occlusion could be responsible for the suboccipital pain that often accompanies damage of the artery

Anterior Spinal Branches

- the anterior spinal arteries arise near the termination of the artery
- this branch unites with its opposite number in the midline and then descends along the anterior median fissure of the spinal cord
- receives reinforcement from
  - spinal branches of the regional arteries
  - named in descending order, the vertebral, cervical, posterior intercostal and lumbar arteries
- together these arteries supply the spinal cord and cauda equina

Posterior Spinal Branches

- arise from posterior inferior cerebellar artery
- occasionally, arises from the vertebral arteries
- descends the length of the spinal cord and cauda equina on the anterior and posterior aspects of the dorsal spinal root on each side
- reinforced in the same manner as the anterior spinal artery but supplies less of the surface area of the cord

Posterior Inferior Cerebellar Artery

- largest branch of the vertebral artery
- usually formed opposite the medulla oblongata about half an inch below the formation of the basilar artery
- supplies (directly or indirectly)
  - medulla
  - cerebellum
  - dorsal portion of the spinal cord (via the posterior spinal arteries)

Branches of the Basilar Artery

- the formation of the basilar artery at the lower border of the pons marks the termination of the vertebral artery
- formed by the union of the two vertebral arteries
- runs in a fissure on the anterior surface of the pons
- supplies (directly and indirectly)
  - pons
  - visual area of the occipital lobe
  - membranous labyrinth
  - medulla
  - temporal lobe
  - posterior thalamus
  - cerebellum

Anterior Inferior Cerebellar Artery

- arises just after the vertebral arteries unite to form the basilar artery
- travels along the pontomedullary border and goes to the anterior and inferior cerebellum
- side branches go to the lateral pons, superior and middle cerebellar peduncles and the deep cerebellar nuclei
- is a major supplier to the vestibular nuclei

Internal Auditory Artery

- arises from the basilar artery or more frequently from the anterior interior cerebellar artery
- supplies the internal acoustic meatus, the cochlea and the vestibular portion of the inner ear

Pontine Arteries

- a series of small arteries which arise from the basilar artery as it runs along the length of the pons
- penetrate the basilar portion of the pons and ventral part of the pontine tegmentum
- supply the pontine nuclei, corticospinal and corticobulbar tracts and the medial lemniscus

Superior Cerebellar Artery

- penultimate branch of the basilar artery, arising just below the emergence of the root of the oculomotor nerve from the interpeduncular fossa
- passes dorsolaterally around the cerebral peduncles
- supplies the superior surface of the cerebellum
- small branches are also given off to the midbrain, pons and deep cerebellar nuclei, superior cerebellar peduncle and pineal gland and choroid plexus

Posterior Cerebral Artery

- terminal branch of the basilar artery
- slightly distal to the terminal bifurcation of the basilar, the posterior cerebral artery receives an anastomotic branch known as the posterior communicating artery from the internal carotid artery
- supplies the medial and inferior surface of the occipital lobe, posterior part of the lateral surface of the occipital lobe, inferior surface of the temporal lobe and lateral surface of the inferior temporal gyrus
- also supplies the primary visual area of the cerebral cortex, the choroid plexus of the lateral and third ventricles, diencephalon and midbrain

Internal Carotid Arteries

- supply approximately 80% of blood flow to the brain
- also known as the anterior system

Anatomy

- arise bilaterally around C3 level of the spine as they bifurcate from the Common Carotid Artery
- pass through musculature of the neck (sternocleidomastoid, longus capitus, stylohyoid, mylohyoid, digastrics) and along the body of C1, to which they are tethered
- enter the skull through the carotid canal in the temporal bone
- intracranially the Internal Carotid Arteries (ICAs) join the Circle of Willis

Hemodynamics

Neck Motion and the Internal Carotid Arteries

- extracranially, ICA flow is affected by neck extension and less so by rotation (Kerry and Taylor 2006)

Vertebral Artery Blood Flow

- In vivo studies of blood flow velocity in the vertebral artery have been conducted using Doppler ultrasound. Blood flow velocity changes are considered a good indicator of blood flow volume changes (Mitchell 2009).
- Rotation is the most common position studied for motion related changes in blood flow. A few studies have tested rotation combined with extension.
- Differences in study methodology and procedures (measurement in sitting versus supine or prone, measurement of different parts of the vertebral artery, differing instrumentation, heterogenous study populations) may account for contradictory findings amongst Doppler studies (Mitchell 2009)
- Vertebral artery blood flow was found to be higher in supine than in sitting when pooled blood flow data from several studies was compared.
- Mitchell's 2009 review and overall evidence indicates that contralateral cervical rotation is associated with VA flow changes in healthy and patient subjects.
- Temporary blood flow reduction may be a result of stretching or compression of the artery at end of range.

- Reduced blood flow may not provoke symptoms in healthy individuals or in asymptomatic patients, suggesting that collateral circulation is adequate
- Mitchell's (2009) meta-analysis indicated that blood flow is compromised with full or sustained contralateral rotation, especially in the intracranial section of the VA , when measured in sitting moreso than lying, and with patients moreso than with healthy, young subjects.

Supplementary Arteries

- collateral blood flow to the vertebrobasilar system is available through the opposite vertebral artery, occipital artery, ascending and deep cervical arteries and retrograde flow of the internal carotid artery via the circle of Willis

Implications for treatment

- A test of sustained, full range rotation can be used pre-treatment as an indicator of the functional status of a person's vertebrobasilar and collateral circulation and may add evidence (along with the subjective and neurological examination) for additional investigation of the vascular system.
- The sustained rotation test (plus or minus extension) does not provide an indicator of safety for high velocity, low amplitude techniques to the cervical spine. In other words, an absence of VBI signs or symptoms during a premanipulative positional test does not guarantee reduced risk of cervical arterial injury during manual or manipulative therapy (Mitchell 2007)
- Given the differences in blood flow between supine and sitting, it is suggested that the same position (sitting or lying) be adopted for pre –treatment screening as for treatment. (Mitchell 2009)
- Blood flow reduction in contralateral rotation suggests that manipulative treatment at end range of cervical rotation be avoided and that sustained end range rotation procedures (mobilization, sustained hold on exercise) be of shorter duration (less than a minute). (Mitchell 2009)

Pathology

Dissection

- refers to tearing of the intimal wall of the artery

Consequences of dissection

- Luminal stenosis or occlusion may result from subintimal dissection.
- A dissecting aneurysm (with dilatation of the artery) may occur
- Retinal or brain ischemia may result from embolization of a thrombus at the site of dissection
- Local aneurysm may cause local (non-ischemic) signs and symptoms
- A subadvential rupture of a intracranial vertebral artery may cause subarachnoid or intracerebral hemorrhage (Arnold and Bousser 2005)
- Rarely, spinal manifestations of arterial dissection may occur with symptoms and signs of cervical spinal cord or nerve root involvement (Crum et al 2000).

Causes of dissection

Intrinsic

- Dissection is thought to occur due to a combination of underlying blood vessel abnormality and a triggering factor such as trauma or infection
- Arteriopathy and reports of dissection have been linked to conditions such as fibromuscular dysplasia, intracranial aneurysm, aortic root enlargement, Ehlers-Danlos and Marfan's syndrome, osteogenesis imperfecta, autosomal polycystic kidney disease
- Hyperhomocysteinaemia (abnormally high levels of homocysteine in the blood) is associated with venous and arterial disease and may be a risk factor for dissection
- A history of migraine has been reported to be associated with carotid dissection (2 studies cited by Arnold and Bousser 2005)

Environmental Factors

- Recent respiratory infection may be a risk factor (Arnold and Bousser 2005)
- Injury to the intima may result from extreme, repeated or sustained neck motion. eg. whiplash, sports, assault, intubation, some manual therapies

- Dissection may follow an innocuous activity like reversing the car , painting a ceiling or other actions such as coughing, sneezing, vomiting (Arnold and Bousser 2005)

Common Site of Dissection

- the suboccipital (V3) portion of the vertebral artery has been thought to be mechanically more vulnerable to dissection compared to other parts of the artery (factors include tortuosity of its course, large rotation ROM at C1-2, the hard neural arch beneath the artery, its superficiality in this region)
- In an analysis of 2 retrospective studies, Kawchuck et al (2008) concluded that the V3 portion of the artery is the most often dissected in subjects with and without a prior history of cervical manipulation
- With an average age of 43 in their study, Kawchuck et al (2008) noted that age was not predictive of risk of dissection after manipulation.

Atherosclerosis

- Cagnie et al (2006) suggest that atherosclerosis may be stimulated by stretching and compression that occurs at end range of cervical rotation.
- These forces will decrease the cross sectional area of the artery and decrease flow.
- Injury to the tunica intima/endothelium may ensue and repeated microtrauma may lead to atherosclerotic changes in the artery.
- Movement could displace plaque, particularly where the artery is stretched over osteophytes.
- It is not certain whether these changes play a role in the increasing the risk of dissection.
- In this study (average age 81.2 years) plaque formation occured at all levels, was more frequent in the V3 section and least frequent intracranially

Clinical Presentation

- atherosclerosis may produce signs and symptoms of ischaemia in tissues distal to the occlusion
- if the contralateral artery is healthy and of good caliber, the condition may be asymptomatic

Arteriovenous Fistulas

- the abnormal communication between the extra-cranial vertebral artery, or one of its muscular or radicular branches, and an adjacent vein
- variable causes
  - traumatic dissection
  - dissecting aneurysms
  - existing disease such as congenital fibromuscular dysplasia
- traumatic causes of arteriovenous fistulas include
  - accidental arterial puncture during common carotid procedure
  - surgical accident
  - penetrating trauma
  - blunt trauma associated with fracture of the transverse process
  - compression or contusion of the artery
- most spontaneous arteriovenous fistulas occur at the C2/3 level and come directly from the vertebral artery through what is believed to be a tiny rupture in the wall of the artery
- congenital fistulas are rare and generally produce a large pulsating mass in the upper posterior cervical spine

Fibromuscular Dysplasia

- non-atheromatous, non-inflammatory segmental angiopathy of unknown etiology
- incidence is less than 1% of all patients receiving cerebral angiograms
- is the third most frequent structural lesion affecting the vertebral artery following atherosclerosis and dissection
- is believed to be hereditary affecting mainly young and middle-aged female patients
- fibromuscular dysplasia produces multiple areas of stenosis along the artery and gives a "string of beads" appearance on the angiogram due to its serial constriction-dilation effects on the artery

Risk Factors associated with Cervical Arterial Dysfunction (CAD)

- the vertebral and carotid artery systems are inter-related as atherosclerosis may predispose both to dissection
- the hemodynamics of both systems may be affected by mechanical forces and movement of the head and neck

CAD is associated with:

- hypertension
- hypercholesterolemia
- hyperlidemia
- hyperhomocysteinemia
- diabetes mellitus
- genetic clotting disorders or anticoagulant therapy
- infections
- smoking
- free radicals
- direct vessel trauma
- iatrogenic causes (surgery, medical interventions)
- history of migraine
- history of cardiac or vascular disease, TIA or previous stroke
- immediately post-partum
- long term use of steroids

(Kerry, Taylor 2006)

Signs and symptoms of vertebrobasilar insufficiency

The vertebrobasilar system (the posterior system) supplies about 20% of blood flow to the brain. Reduced blood supply to parts of the hind brain may result in signs and symptoms referred to as vertebrobasilar insufficiency (VBI) (Kerry, Taylor, 2006).

The vertebral artery also supplies the upper cervical spinal cord via single branches from each artery which fuse to form the anterior spinal artery. The middle cervical cord is supplied by radicular branches of the VA.

Non-ischaemic symptoms

- VA dissection may present as unilateral neck pain and /or occipital headache which may be described as sharp/severe
- Headache which is described as different than usual, atypical or "unlike any other" should arouse suspicion of a vascular cause
- In the rarer cases of spinal hemorrhage associated with vertebral artery dissection, acute chest or back pain may occur

Ischaemic signs and symptoms

- Unusual for only one sign or symptom to be present and dizziness is not always present
- Includes the 5Ds and 3 Ns of Coman (dizziness, dysarthria, dysphagia, diplopia, drop attacks, nystagmus, numbness, nausea) but may also include
    - facial numbness
    - ataxia
    - vomiting
    - hoarseness
    - loss of short-term memory
    - vagueness
    - hypotonia/limb weakness (arm or leg)
    - anhidrosis (lack of facial sweating)
    - hearing disturbances
    - malaise
    - perioral dysthesia

- photophobia
- papillary changes
- clumsiness and agitation
- cranial nerve palsies

Spinal cord ischemia and cervical cord signs may arise (more rarely) with a vertebral artery dissection if flow to the anterior or posterior spinal arteries is compromised. Radiculopathy (most commonly at C5-6) may occur ipsilateral to a spinal VAD, with pain and weakness more pronounced than sensory loss (Crum et al 2000).

Internal Carotid Artery Dysfunction (ICAD)

- neck pain and /or headache can be a standalone symptom of ICAD and may precede ischaemic signs or symptoms
- headaches are often frontotemporal and may be described as "unlike any other"
- neck pain may be upper or mid cervical
- facial pain or sensitivity may be present

Non-ischaemic signs and symptoms (local)

- neck pain/headache
- Horner's syndrome
- Cranial nerve palsies
- Pulsatile tinnitus

Ischaemic signs and symptoms

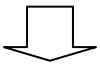
- Transient Ischaemic Attack (TIA)
- Ischaemic stroke (usually Middle Cerebral Artery territory)
- Retinal infarction
- Amaurosis fugax (transient monocular visual loss) (Kerry and Taylor 2006)

Evaluation Framework

Information from the patient history

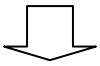
Interpret information

Ascertain potential for symptoms to be arising from CAD and risk factors for CAD.

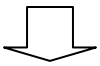


Plan the assessment

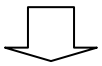
Possible vascular cause or component to symptoms?
Any uncertainties in the patient history?
Any precautions or contraindications?
What tests to choose?
What are the priorities in testing?



Assessment findings



Interpretation



Decision Making

(from Rushton et. al. 2012)

Information from the patient history

If indirect, open ended questions do not elicit responses concerned with the central nervous system, direct questions must be asked.

- Has the patient had any dizziness? If so what type and was it of immediate onset or delayed. Is it still present? If so is it related to head or body position, movements, or medication intake?
- Are there any visual disturbances such as diplopia, field defects (scotoma), and are these related to head position and movements?
- Is there any paresthesia or anaesthesia and if so are these quadrilateral, bilateral, facial, oral, segmental or peripheral nerve?
- Are there any motor disturbances such as drop attacks, ataxia, clumsiness or tendency to fall?
- Has there been recent onset of deafness, speech defects, swallowing difficulties or tinnitus?
- Are there any Red Flags for treatment? (severe or worsening symptoms, night pain, multiple nerve root or spinal cord signs/symptoms,non-mechanical pain, recent significant trauma)
- While the patient has been relating the history, the therapist observes the patient's presentation (slurred speech, ataxic gait)

Interpret information

Ascertain potential for symptoms to be arising from CAD and risk factors for CAD.

- Be aware of ischaemic and non-ischaemic signs and symptoms of CAD
- Maintain an index of suspicion in the presence of neck pain and/or headache

Important Signs and Symptoms

- patient requires immediate referral to a physician if subjective history reveals signs or symptoms including
  - diplopia
  - drop attacks
  - dysarthria
  - dysphagia
  - cord signs and symptoms
  - cranial nerve signs and symptoms
  - ataxia

Caution When Testing

- a careful and graduated examination sequence is demanded by the presence of history of dizziness, vertigo, nausea and vomiting, unusually severe headache , nystagmus and tinnitus or by recent trauma (less than six weeks)
- testing sequence begins with the least stressful of tests (history)
- progresses gradually to the most stressful (full occlusal position of rotation and extension) so the examination can be stopped at the first sign of ischaemia

Plan the Physical assessment

Evaluation of Blood Pressure

- hypertension is a risk factor for CAD and disease and dysfunction of the carotid arteries (Taylor, Kerry 2010). An increase in BP may be associated with acute arterial trauma and, although not routinely evaluated in orthopaedic practice, testing may be indicated if the history suggests CAD.

Neurological Examination

- the neurological examination can be carried out without stressing the spine or the arterial system
- cranial nerves should be examined, and are especially important with a history of head trauma or potential vascular compromise
- long tract signs such as hyper-reflexia, clonus, Babinski response, positive Oppenheimer or Hoffman tests, and reduction or loss of tactile, vibration and position sense should be tested
- multisegmental hypotonia, hypertonia and weakness can also be tested for using palpation, passive movements of the limbs and strength testing
- signs of nerve root deficit (hyporeflexia, fatigable weakness, segmental sensory loss) can also be tested for at this time but they are not helpful in determining the state of the central nervous or vertebrobasilar systems

Examination of Movement

- in the absence of central nervous system signs, one may proceed with examination of motion, monitoring signs and symptoms during and after each movement.
- begin with active cervical movement
- in the presence of dizziness related to head and neck motion, further differentiating tests will be required (see following Differentiating Tests for Dizziness)
- continue to craniovertebral stability tests, then examination of cervical PIVMS, PAVMS and midcervical stability tests. Monitor symptoms produced during or after testing.

Positional Testing

Testing of sustained positions of cervical rotation, extension and extension combined with rotation are of limited diagnostic utility as positive tests, reproduction of dizziness or nystagmus, may not be associated with vascular insufficiency. Conversely, negative tests do not rule out vascular involvement.
(Kerry, Taylor 2006)

To date, existing examination protocols include positional testing and may evoke symptoms in some patients. However, this testing is not predictive of a risk of injury during cervical manual therapy and results should be interpreted carefully in the full context of the patient history and other physical findings.

Current Protocol

- 10 seconds sustained left rotation, 10 seconds rest in neutral
- 10 seconds right rotation, 10 seconds rest in neutral
- 10 seconds combined rotation and extension
- do not progress to the next position if current test produces symptoms
- perform prior to any cervical rotational, extension or traction techniques
- repeat as cervical ROM increases

Supplemental Tests

1. provoking position described by patient
2. pre-mobilization or pre-manipulation hold

Interpretation of Findings and Decision Making

Findings	Risk/Benefit	Action
Ischemic signs or symptoms or high index of suspicion of arterial dissection	No benefit from manual therapy, medical consultation needed	Refer to or discuss with medical practitioner
Severe risk factors	Unlikely benefit from manual therapy	Monitor, delay or avoid manual therapy
Some Risk factors	Moderate likelihood of benefit of manual therapy	Treat with care, reassess
Low or no risk factors	Moderate or high likelihood of benefit of manual therapy	Proceed with treatment in consultation with patient and with consent, monitor effects of treatment

(from Rushton et al, 2012)

Differentiating Tests for Dizziness

If the patient reports a history of dizziness, or dizziness is provoked during the physical examination of the cervical spine, differentiation tests may be undertaken by the therapist. Referral to an appropriate specialist in vertigo and dizziness may be indicated.

Vestibular Tests

Positional Testing

- parts of the vestibular system can be examined without stressing the cervical spine and its arteries
- one way to clinically determine the presence of vestibular vertigo is to move the head and neck as a unit while the patient wears a cervical collar

Test Procedure

- the collar is fitted to the patient with the patient in the seated position
- the head and neck are further supported by the examiner who stands beside the patient
- the patient is then asked to lie down on the bed taking care not to move the head
- if possible, the bed should be of the type where one end can be tilted down so that in the full test position, the patient's head is lower than the trunk
- dropping the patient's head over the end of the bed is not useful as this will result in cervical extension despite the collar and the cervical spine cannot therefore be excluded from any dizziness produced
- if the therapist stabilizes the head and neck sufficiently a collar is not required

Eliminating the Cervical Spine

- if dizziness is produced during this test, the cause is not cervical in origin as the position of the spine has remained constant during the test

Eliminating the Vestibular System

- in the instance of a negative test, amplification of the effect of the test can be achieved by removing the stabilizing effect of the eyes by repeating the test with the patient's eyes closed
- one means to attempt to differentiate the source of dizziness is to stabilize the head (as in a collar) and have the patient log-roll into side-lying
- provides the rotational stimulation to the vestibular system but eliminates vertebral artery stress and minimizes cervical joint stress
- dizziness that is reproduced by cervical rotation in supine may be cervical articular, vascular or vestibular in origin

- cervical stress is difficult to completely eliminate as the patient may continue to activate self-stabilizing musculature thus causing some compression to the joints, but it is unlikely that this level of stimulation would reproduce cervical dizziness

Eliminating the Inner Ear

- the head must be held still while the cervical spine is rotated beneath it
- the patient is seated on the edge of the bed and the therapist holds the patient's head firmly preventing any head motion
- the patient is then asked to twist under the head by turning the body while the head remains stationary
- the labyrinthine system thus remains constant during the test while the cervical articular receptors and the vertebral artery are stressed
- any dizziness produced during the test cannot be vestibular in origin

Rhomberg's Test

- Rhomberg's position is described as standing with both feet together and the arms held by the side
- eyes are closed and the patient is observed to see if balance can be maintained
- if there is perceptible imbalance, the test is positive
- a positive test is considered indicative of cerebellar disease or vestibular dysfunction (Baloh, Jacobson, Beykirch, Honrubia, 1998)
- investigations by Baloh, et al revealed that Rhomberg's position testing causes increased sway with eyes closed versus eyes open in normal 31 to 63 year olds
- considering the great variability of postural sway in normals, the reliability of this qualitative clinical test is questionable

Hautard's Test

- Hautard's (Hautart and Hautarth alternative spellings) may assist with differentiating articular from vascular vertigo
- Hautard's test is a modification of Rhomberg's test
- the principal difference is that in Rhomberg's test, shutting the eyes and removing their stabilizing effect, is sufficient to cause postural disturbance
- Hautard's test produces the disturbance by reducing the blood flow to the cerebellum

Test Procedure

- patient sits on a treatment table and elevates both arms to 90 degrees
- eyes are then closed while the therapist watches for a loss of position of one or both arms
- this initial phase tests for non-vascular cerebellar dysfunction
- if this test is negative, the patient then stresses the vertebral artery either by cervical rotation or rotation with extension
- the minimal head displacement necessary to produce the signs and symptoms should always be used (apparent during the general cervical stress test)
- arms are observed for wavering from the original position, indicating a loss of proprioception and a cerebellar dysfunction
- vasculogenic impairment is implicated as dysfunction did not occur until the head was moved and the artery stressed
- dizziness is not a positive sign for vertebral artery occlusion
- it is already known that the stress position will reproduce dizziness, it is the proprioceptive loss characterized by displacement of the arm that is important

Post-Traumatic Assessment of Dizziness and Vertigo

- a large percentage of patients presenting with cervicogenic dizziness will be post-trauma, usually as the result of a motor vehicle accident
- the cause of dizziness will be difficult to differentiate in a portion of these patients
- differentiation between arterial occlusion and cervical articular dysfunction is difficult

- both causes of dizziness are related to cervical motion and both produce very similar signs and symptoms
- if the above tests do not assist in evaluating the cause, the patient may be put into a soft cervical collar for a short period (1-2 weeks)
- this will promote settling of the apophyseal joint traumatic arthritis and a consequent lessening of the proprioceptive dysfunction
- if the upper cervical joints were at fault, the dizziness may disappear or be reduced

Cervical Articular Dizziness

- cervical joint capsules and ligaments have a profound effect on the ability to maintain balance and ocular position, as seen in studies of the effects of upper cervical denervation either by surgery or injection of local anesthetic and by the reduction in dizziness and nystagmus with treatment of the neck
- cadaver studies revealed a reduction in the number of articular receptors in joints that have undergone degeneration
- subjective complaints may be of unsteadiness, insecurity, lightheadedness but rarely described as strong attacks of dizziness or vertigo (Kristjansson, Treleaven, 2009)
- often worse in the morning with neck stiffness or later in the day with fatigue
- symptoms may be provoked by quick head movement, watching moving objects or walking in the dark

Tests

Cervicogenic dizziness is a diagnosis of exclusion of other possible causes (Kristjansson, Treleaven, 2009). Balance and oculomotor tests are recommended but are not exclusive to cervical disorders as reproduction of symptoms may occur with vestibular or CNS disorders. Kristjansson and Treleaven (2009) note that patients with cervicogenic dizziness have a different, often more subtle response to balance tests than patients with a vestibular disorder.

Balance Tests

- Balance in comfortable and narrow stance (eyes open and closed) on a firm, then soft surface. Abnormal responses are inability to maintain stance for 30 seconds, large increases in sway, slow responses to correct sway or rigidity to correct sway.
- Test tandem and single leg balance on firm surface, eyes open and closed, for up to 30 seconds, although tandem balance can be normally impaired in adults over 45 years of age.
- Dynamic Gait Index (see Kristjansson, Treleaven 2009)

Oculomotor Tests

- "Deficits in oculomotor control, such as decreased smooth pursuit
- velocity gain, altered velocity and latency of saccadic eye movements, and an increased gain of the cervico-ocular reflex have been seen in patients with neck pain." (Kristjansson E, Treleaven J. 2009 p369)
- Smooth pursuit- patient is asked to follow a side to side, slow moving object, keeping the head still. Watch for quick saccadic movements, rather than smooth movements of the eyes. Dizziness may be reproduced.
- Gaze stability- patient is asked to maintain focus on a point directly in front as he/she actively moves head into rotation, flexion and extension, Look for reproduction of dizziness or blurred vision, inability to maintain focus or deviation into lateral flexion
- Saccadic Eye Movement- rapidly moving eyes to fix gaze on different targets. Look for reproduction of symptoms, inability to fixate on a target, taking more than 2 eye movements to reach target
- Eye-head co-ordination - patient moves eyes to focus on target, then moves head to that point. Look for inability to maintain focus or keep head still while moving eyes.

(Kristjansson, Treleaven 2009)

Treatment: "There is evidence that specific treatment programs that have trained cervical joint position sense, eye-neck coordination, and gaze stability have resulted in improvements not only in sensorimotor impairments but also improved neck pain and disability and range of motion. "

(Kristjansson E, Treleaven J. 2009 p371

Manipulation

Manipulation Technique

Manipulation Definition

- a skillful passive high velocity, low amplitude, minimal force thrust
- movement of a joint (peripheral or spinal) beyond its physiological limit of motion but inside the limit of its anatomical integrity
- purpose of restoring motion and function

Types of Manipulation

Articular Glide Manipulations

- direct thrust along the line of the articular glide
- manipulation parallel to the articular surface
- use of the physiological movements to produce that glide

Distraction Manipulations

- gapping techniques
- manipulation perpendicular to the joint surface

Manipulation Technique

Patient

- comfortable, supported position

Therapist

- good body and hand position
- find correct joint plane
- apply thrust at end of range
- use low amplitude with economy of vigour
- don't rebound or backup and charge

Hints for Performing Manipulations

- don't stay too long at barrier
- stay relaxed
- watch body position
- keep head up
- don't stand directly facing plinth
- move from hips and trunk then hands
- contract abdominal muscles slightly at time of thrust

Pre-manipulative Hold

- last safety test prior to thrust
- take up barriers, hold up to 10 seconds
- assess irritability, comfort and willingness to continue

Indications for Spinal Manipulation

- joint fixation
  - the axis of motion is altered and the joint usually exhibits a non-capsular pattern of limitation of its physiological movements
  - the presence of an underlying hypermobility or instability should always be suspected
  - the stability of the joint should be reassessed after manipulation
- treatment plateaued with passive mobilizations
- joint adhesion
  - adhesions limit the mobility of a tissue on adjacent tissue and may be ruptured with a high velocity technique
- inextensible scar
  eg. Mill's manipulation at the elbow
- meniscoid structure entrapment (eg. in zygapophyseal joint of lumbar spine)

Contraindications to Manipulation

Therapist Contraindications

- insufficient subjective assessment of the patient
- inadequate information about co-existing conditions, disease and/or medication
- poor appraisal of the patient as a reliable historian
- failure to discuss the assessment findings and treatment options with patient
- failure to receive patient consent
- poor/insufficient detailed biomechanical examination
- insufficient awareness of contraindications and conditions requiring extra care
- physical limitations size, strength, speed, fatigue
- mental status and confidence
- lack of proper equipment (high/low plinth)
- incompetence

Patient Contraindications

- lack of consent
- impaired mental or emotional status
- inability to communicate/unreliable historian
- unable to relax
- pain in the position of the technique
- non-diagnosed constant or continuous pain
- intoxicated/heavily medicated
- inappropriate findings, end feel, or patient response with
  - scanning examination
  - biomechanical testing
  - stress testing
  - dizziness reproduction testing
  - pre-manipulative hold
- instability findings on testing (cautionary if above or below level treating)
- inappropriate end feel on testing or premanipulative hold (eg. spasm, boney, empty)
- recent or concurrent manipulation by another practitioner

Bony Contraindications

- Relevant recent trauma (fractures, dislocations)
- past or present cancers that metastasize to bone (breast, bronchus, prostate, thyroid, kidney, bowel, lymphoma)
- active infection (cautionary with past bone infections)
  - osteomyelitis, tuberculosis
- congenital anomalies at location of treatment (increased chance of vascular anomaly) caution with anomalies in region of treatment
- gross foraminal or spinal canal encroachment on x-ray or other imaging examination

Neurological Contraindications

Disease of or Injury to the CNS

- extrasegmental pain, increased with passive neck flexion
- bilateral or quadrilateral multisegmental parasthesia, increased with passive neck flexion
- multisegmental paresis or paralysis
- hyper-reflexia
- Babinski/Oppenhiemer/Hoffman present
- clonus present
- ataxia
- neurological spasticity
- bladder and/or bowel dysfunction
- dysphagia/dysphasia
- Wallenberg's syndrome (posterior inferior cerebellar artery)
- other cranial nerve signs/symptoms
- nystagmus (if associated with dizziness/vertigo requires further diagnostic differentiation)

Disease of or Injury to the Spinal Cord

- extrasegmental pain below the level of the lesion which may increase with passive neck flexion
- bilateral or quadrilateral multisegmental parasthesia below the level of the lesion which may increase with passive neck flexion
- bilateral or quadrilateral multisegmental weakness or spastic weakness below the level of the lesion
- hyper-reflexia below the level of the lesion
- hyporeflexia may be present at the level of the level
- Babinski present
- Oppenhiemer present
- Hoffman present if lesion is above C5-6
- clonus below the level of the lesion
- ataxia
- neurological spasticity below the level of the lesion
- reflex bladder (empties when distended)
- reflex bowel
- initial loss of reflex erection (2-3 days) then reflex erection (tactile only as reflex ejaculation often lost)
- vaginal sensation and lubrication lost

Cauda Equina Compression

- hyporeflexia or areflexia (bilateral and/or multisegmental)
- bilateral and/or multisegmental parasthesia/pain
- dural signs positive
- initially bladder hyperactive (increased urgency and frequency) then paralyzed bladder (overflow incontinence)
- faecal retention with impaction and faecal fluid overflow
- loss of genital sensation
- loss of reflex erection or ejaculation

Multiple or Bilateral Nerve Root Involvement

- signs and symptoms of bilateral or multisegmental nerve root lesions (caution, requires further investigation or non-manipulative management)

Vascular Contraindications

- vertebral artery insufficiency
- vascular disease (aneurysm)
- atherosclerosis (caution as intima lining weakened)
- signs of vascular insufficiency in that region
- bleeding disorders (eg hemophilia)
- aortic graft
- suspicion of Cervical Arterial Dissection

Inert Tissue Contraindications

Collagen Disease

- Ehlers-Danlos syndrome
- Marfan's Syndrome
- osteogenesis imperfecta
- achondroplasia
- benign hypermobility syndrome (caution)

Connective Tissue Instability

- collagen disease (see above list)
- trauma
- Grisel's syndrome
- Down's syndrome: congenital laxity transverse ligament
- acute post-traumatic stage (caution 6-8 weeks)
- inappropriate end feel (see patient factor list)

Age Related Contraindications

- children (lack of skeletal maturity, consent issues)
- elderly (Increased risk of osteoporosis, vascular disease, spinal stenosis)

Metabolic Contraindications

- bone disease (eg. osteoporosis, Paget's disease)

Systemic Contraindications

- diabetes (caution)
- asthma (caution secondary to possible corticosteroid medications)
- endocrine disorders (caution) (hypothyroidism, hyperthyroidism, hyperparathyroidism)
- endocrine disorders (contraindication if tagged to collagenous effecting drugs)

- pregnancy, contraindicated in presence of:
  - any history of miscarriage
  - hypermobility/instability
  - recent post-partum (joint instability, risk of post-partum hemorrhage)

Inflammatory Contraindications

active inflammatory disease (eg. rheumatoid arthritis psoriatic arthritis, ankylosing spondylitis,Reiter's syndrome)

inactive inflammatory disease (caution)

Medications

- anticoagulants (Coumadin, heparin) caution with ASA
- any medication that affects collagen
  - corticosteroids, tamoxifen
- any medication linked to osteoporosis (see list below)
- anti-depressants (caution)

Medications Harmful to Bone

Glucocorticoids

Diseases treated with gluccocorticoids.

- rheumatoid arthritis, osteoarthritis, bursitis
- asthma, COPD, allergic rhinitis
- liver disease
- lupus, psoriasis, severe dermatitis
- cancers - leukemia, lymphoma
- ulcerative colitis, Crohn's
- severe allergic reactions and inflammations
- multiple sclerosis
- post-organ transplant
- inflammation and diseases of the eye (glaucoma)

Methotrexate

Diseases treated with methotrexate.

- cancers
- immune disorders
- resistant arthritic conditions

Cyclosporin A

Disease treated with immunosuppressant drugs

- post-transplant
- immune diseases

Gonadotropin Releasing Hormone

- endometriosis

Other Medications

- heparin
- cholestyramine (controls blood cholesterol levels)
- thyroid hormones
- anticonvulsants
- aluminum-containing antacids

Protocol for Serious Adverse Response to Testing or Treatment

Symptoms which occur following testing or treating must be evaluated and appropriate action taken.

Medical Urgency

- requires medical attention as soon as possible but is not immediate life threatening
- involves monitoring the patient's vital signs, level of consciousness, and symptoms
- the referring physician, medical clinic, or hospital physician must be contacted in order to seek guidance on action required
- less extreme patient responses may be adequately addressed by letter or fax and a follow up visit to the physician

Medical Emergency

- requires immediate medical attention and potential life support equipment
- the patient is in a potential life threatening situation or a situation that could rapidly deteriorate
- the emergency response team should be called in order to take patient to the hospital
- in all situations the patient must be monitored (vital signs, level of consciousness and symptoms) until the symptoms abate or until care is transferred to emergency medical personnel
- the patient should be kept calm and reassured continually
- if a cerebral neurological or vascular event is suspected, then the patient should be reassured and placed carefully in the recovery position taking care to support the head and neck
- a patient having an ischemic event may have a panic or a flight response and wish to leave
  - be calm and reassuring
  - if the symptoms do not abate, arrange for immediate transport to the hospital and contact the patient's physician, work, and family
  - the patient must have all their immediate concerns taken care of
- if transport to the hospital is deemed appropriate, document the details of the assessment/treatment, the

- patient's response and your clinical suspicion of diagnosis (vascular insult in an ischemic event)
  - this information is to be sent with the patient
- if the symptoms disappear, contact the referring physician to discuss evaluation and management
- if the patient's signs and symptoms have disappeared and you both feel confident that they may leave the clinic, make sure you contact them later in the day
- the patient should be supervised for the next 24 hours
- inform the patient if they have a reoccurrence of their symptoms, they should go to emergency immediately and report that they have had unusual symptoms following assessment or treatment
- if there are any doubts about management of the situation, arrange for immediate medical evaluation, and appropriate transport

References

Essential References

Specific research tools and position statements have been created to guide the use of manipulation in Canada. It is critical that students review these articles in order to understand the risk to patients and the medical-legal environment before beginning to use manipulation in a clinical setting.

CPA Member Website/Practice
Resources/Clinical/Cervical Manipulation

IFOMPT
Ruston A, Rivett D, Carlesso L, Flynn T, Hing W, Kerry R.(2012) International Framework for the Examination of the Cervical Region for Potential of Cervical Arterial Dysfunction prior to Orthopaedic Manual Therapy Intervention. International Federation of Orthopaedic Manipulative Physical Therapists.

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Biomechanics, Effects, Efficacy and Mechanisms of Spinal Manipulation: A Review of the Literature

- **Biomechanics –** Science that deals with the external and internal forces acting on biological systems

- **Effects** – Benefits of an intervention as tested under "real world" conditions, often using quasi-experimental methods (*Portney and Watkins 3rd edition)*

- **Efficacy** – Benefits of an intervention as tested under controlled experimental conditions, usually with a control group in a randomized clinical trial (RCT) (*Portney and Watkins 3rd edition)*

Biomechanics – External Forces, Internal Forces and Audible Pop

External Forces

The application of a manipulation by a health care practitioner creates a mechanical force of specific magnitude in a controlled direction to a target area, typically on the spine. The external forces applied by a trained practitioner using high velocity, low amplitude (HVLA) manipulations have been studied in the osteopathic and chiropractic literature. (Kawchuk et al,1992; Conway et al, 1993: Herzog et al, 1993a,b; Triano et al 1997, 2000, Forand et al, 2004, Downie et al, 2010) . Based on a summary article on "Biomechanics of spinal manipulation" by Walter Herzog in 2010 the following conclusions on external forces could be made:

- The external forces applied during HVLA treatments *vary dramatically depending on the treatment site* i.e. peak forces for cervical spine 107 N vs. 399 N for the thoracic spine. These total forces are measured over a large contact area including soft tissue between patient and clinician and if the force was calculated without this large area it was estimated to reduce the local forces to 5-10 N (1 – 2 lbs) for a typical thoracic manipulation
- The external forces applied during the HVLA treatments *vary dramatically across clinicians* i.e. forces varied from 200 N (44 lbs) to 1400 N(308 lbs) depending on the clinician but average forces between male and females were about the same.

Relevance: Walter Herzog concludes in his spinal manipulation biomechanics article in 2010 that the detailed force magnitude might not be an important characteristic for the success of a treatment. He hypothesizes that the thrust direction may be more important. Further studies are needed to support this hypothesis.

Internal Forces

The role of internal force transmission on the hard and soft tissues during a HVLA manipulative treatment is poorly studied and the information that is being reported is conflicting. The importance of understanding internal force transmission is around the issue of HVLA spinal manipulation safety, especially with respect to cervical manipulation and

the risk of stroke. Since the measurements of internal stresses on soft tissues caused by manipulation are limited, the literature that has been assessed revolves around ultrasound vertebral artery (VA) blood flow research and the elongation strain of the VA during a cervical manipulation. The following is a summary of the *VA blood flow* literature in regards to various cervical positioning:

Blood flow changes - Stevens 1991, Refshauge 1994, Haynes 2004, Li et al 1999, Rivett et al 1999, Mitchell 2003, Arnold et al 2004, Mitchell et al 2004, Mitchell et al, 2008, Mitchell, 2009

No Blood flow changes - Weingart & Bischoff 1992, Cote et al 1996, Thiel et al 1994, , Licht et al 1998, Licht et al 1999, Haynes & Milne 2001, Licht et al 2000, Zaina et al 2003

Relevance: Janette Mitchell concludes in her meta-analysis article in 2009 that *VA blood flow* velocity was found to be compromised more in patients who are older who may have vascular pathology (arthrosclerosis) than healthy individuals, on contralateral rotation, with the subject sitting, and more in the intracranial compared to the cervical part of the VA. Even with this conclusion the above research articles all demonstrated different methods and procedures such as healthy subjects versus patients, testing in sitting, supine or prone, different parts of the vertebral artery were tested (i.e. sections V1-V4) and Doppler technology varied (continuous, pulsed wave, +/- colour).

The following is a summary of the *elongation strain* (% of arterial lengthening) of the VA in the four cervical VA regions (V1-V4) during cervical manipulation by Herzog and Symons 2002, Symons et al 2002 and Herzog et al 2012:

Strain of VA during Cervical HVLA – results varied from 0.9 to 6.2% for the V1-V4 regions

Strain of VA during Cervical ROM– results varied from 3.2 to 12.2 % for the V1-V4 regions

Relevance: The work of the above authors would suggest that the *elongation strain* of the VA during a cervical HVLA manipulation is lower than end range cervical range of motion (this includes combined extension/rotation). The article by Symons et al 2002 stated that the average failure strain of human VAs was found to be 58% thus

concluding that neither HVLA manipulation nor Cervical ROM testing was close to this threshold. However, these elongation studies had

several limitations. Most importantly, all measurements were performed on old (ages 80 -99) unembalmed cadavers devoid of fluid. Thus, these results must be considered in view of experimental and technical limitations and ultimate proof of the safety regarding stretch of the VA needs to come from human experiments (this is currently not possible).

Audible Pop

The audible "pop" (AP) is a characteristic sound of a HVLA manipulation. It is believed that this "pop" is caused by a cavitation mechanism. Cavitation is the engineering phenomenon that describes the generation and collapse of gas or vapor bubbles in a liquid (Brodeur 1995). Although the AP is associated with HVLA manipulation, a consensus is lacking as to the clinical relevance. The following articles looked at the importance of the "pop" on patient outcomes and the accuracy of the AP:

Audible Pop vs. No Pop – Improvements in pain, disability and ROM were noted in **both** those subjects with an audible pop and those without a pop post- HVLA (Flynn et al 2003, Flynn et al 2005, Cleland et al 2007, Bialosky et al 2010, Sillevis et al 2011).

Accuracy of the AP – The accuracy of the AP was noted only about 50% of the time in the lumbar region and frequently multiple cavitations occurred (Ross et al 2004). In another study (Cramer et al 2011) most cavitations (93.5%) occurred on the upside on subjects receiving a side-lying posture lumbar gap manipulation.

Relevance: Clinicians who use HVLA spinal manipulations should base the significance of the cavitation sounds on their clinical decision making and patient outcomes. The limited number of studies on this topic questions the value of the audible "pop" on patient outcomes and how accurate it is to the level that is being treated.

Effects/Efficacy – Mechanical, Neurophysiological, and Psychological Mechanisms

The **proposed biomechanical effects** of HVLA spinal manipulation are based on a joint assessment of "hypomobility". This loss of joint mobility has been attributed to:

- *joint capsule or ligament adhesions* (Donatelli et al 1981)
- *intra-articular meniscoids* (Mercer et al 1993)
- *entrapment of a disc fragment* (Bogduk et al 1997)
- *hypertonicity of the deep intrinsic musculature* (Norlander et al 1996, Colloca et al 2006).
- *Entrapped synovial folds, capsule*
- *Joint fixation (subluxation)*
- *Mechanical irritation of the nervous system*

Relevance: Although these biomechanical effects of spinal manipulation have been proposed, none have been studied specifically.

Mechanical

The literature surrounding the restoration of joint mobility, stiffness and physiological range of motion (ROM) would suggest that most improvements have been short-term in nature (Colloca et al 2006, Martınez-Segura et al 2006, Bialosky et al 2009, Fritz et al 2011) with a paucity of evidence showing longer term results.

Relevance: Therefore, when explaining the benefits for (bio) mechanical improvements Joel Bialosky et al 2009 presents a model to help better explain the mechanisms associated with manual therapy. He states that the inconsistencies associated with a purported biomechanical mechanism suggest that additional mechanisms may be pertinent. Therefore, a mechanical force is necessary to initiate a chain of neurophysiological responses which produce outcomes associated with manual therapy.

Neurophysiological

Theoretical models and frameworks have been drawn from associated neurophysiological responses which indirectly implicate a complex interaction of both the peripheral and central nervous system (CNS) which comprise the pain experience. It is suggested that manual/manipulative therapy may demonstrate pain reduction through inhibition of nociceptors, dorsal horn, and descending pathways of the spinal cord. Manual therapy may also improve chemical alterations secondary to injury and change CNS thresholds through lessening of temporal summation. (Picker 2002, Bialosky et al 2009, Haavik et al, 2012).

Bialosky et al (2009) categorizes neurophysiological mechanisms as those potentially originating from the spinal cord mechanism, the peripheral mechanism and/or the central mediated/supraspinal mechanisms. Therefore the following evidence supports each of these mechanisms:

Spinal Cord Mechanism

- *Hypoalgesia* (diminished sensitivity to pain) secondary to segmental postsynaptic inhibition on the dorsal horn pathway (George et al 2006, Fernandedez-de-las-Penas et al 2008)
- *Sympathoexcitory response* (change in blood flow, heart rate, skin conductance, and skin temperature) was noted by several authors (Sterling et al 2001, Shacklock et al 2008, Roy et al 2009, Roy et al 2010, Perry et al 2011).
- *Decreased muscle hypertonicity* secondary to reflexogenic inhibition from stimulation to the skin, muscle and articular receptors (Potter et al 2005, Collaca et al 2003, Bulbulian et al 2002)
- *Alterations in EMG muscle activity* (local and distant) and *reduced H reflex* have unknown pain inhibition responses but it is theorized that it may reduce the nociceptive afferent bombardment to the dorsal horn (Dishman et al 2000, Suter et al 2005)

Peripheral Mechanism

- *Reduction of inflammatory mediators* (blood and serum level cytokines, serotonin, B-endorphins) has been found post-manipulation which may impact on pain mediation post injury (Teodorczyk-Injeyan et al 2006, Degenhardt et al 2007)

Central Mediated/Supraspinal Mechanism

- *Hypoalgesia* can be evoked primarily by the dorsal periaqueductal gray (PAG) area and secondarily from the ventral PAG (Wright, 1995). Anthony Wright in a review article in 1995 suggests that hypoalgesia and sympathoexcitation are correlated and those who have the most change in pain perception also have the most change in sympathetic nervous system function (Wright 1995).
- *Alterations in Sensorimotor Integration* (process which coordinates incoming sensory information from different parts of the body and integrates with the motor system to control movement) have been suggested by a couple of authors (Haavik et al 2012, Haavik-Taylor et al 2010).
- *Proprioception improvements* in head positioning and upper limb positioning have been suggested with cervical manipulations and these could also be considered an important component of sensorimotor integration (Palmgren et al 2006, Haavik et al, 2011)
- *Neuromuscular performance improvements* have been suggested by a few articles (Marshall et al 2006 & 2010, Dishman et al 2002). In an early article by Dishman et al (2002) postulates that clinical symptoms such as spasm and hypertonicity may be altered by central mechanisms modulating the gain of the motor neuron pool.

Relevance: While clinical evidence supporting the efficacy and effectiveness of manual therapies has emerged, less scientific evidence has been offered to explain the effects and mechanisms underlying these treatments. Currently, the models that are being proposed for future research are attempting to consider various biomechanical applications (joint, nerve, and soft tissue bias) and how the underlying neurophysiological mechanisms may be playing a role in improving outcomes. (Picker 2002, Bialosky et al 2009, Haavik et al, 2012)

Psychological

Another variable that cannot be overlooked is the various placebo, expectation and psychosocial factors that may be important when considering the underlying mechanisms associated with manual/manipulative therapy.

- *Improved psychological outcomes* (small improvements in mood vs. verbal interventions) were noted in a systematic review by Williams et al, 2007.
- *Improved patient satisfaction and Expectations* was noted for manual therapy techniques (Suter et al 2005, Curtis et al 2000) and one of the most desired aspect of patient expectations is an explanation of the problem.

Relevance: The manual "touch" upon a patient may create a placebo effect which could potentially explain some of the pain reduction benefits, mood improvements and patient satisfaction.

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Systematic Reviews for Spinal Manipulation – Literature Review

Manipulation or Mobilization for neck pain: A Cochrane Review - Gross et al 2010

- Moderate quality evidence showed cervical manipulation and mobilization produced similar effects on pain, function and patient satisfaction at intermediate-term follow-up
- Low quality evidence suggested cervical manipulation may provide greater short-term pain relief than a control
- Low quality evidence also supported thoracic manipulation for pain reduction and increased function in acute pain and immediate pain reduction in chronic neck pain

The Effectiveness of Thoracic Spine Manipulation (TSM) for the Management of Musculoskeletal Conditions: A Systematic Review and Meta-Analysis of
Randomized Clinical Trials – Walser et al 2009

- Seven of the 13 studies were of high quality
- Three studies looked at TSM for treatment of shoulder conditions; however, there is limited evidence to support the use of TSM for shoulder conditions.
- Nine studies used TSM for the management of neck conditions. This analysis suggests there is sufficient evidence to support the use of TSM for specific subgroups of patients with neck conditions but no studies on the efficacy of TSM for thoracic pain.

Spinal Manipulative Therapy (SMT) for Chronic Low-Back Pain: An Update of a Cochrane Review – Rubenstein et al 2011

- High-quality evidence suggests that there is no clinically relevant difference between SMT and other interventions for reducing pain and improving function in patients with chronic low back pain.

Relevance: It is important to appreciate that when the evidence is assessed based on the scientific rigor of a systematic review the overall results are not favorable for spinal manipulation. However, most of these studies are looking at manipulation in isolation and not as part of a multimodal approach. Therefore, be aware of this evidence but put it into context when considering that spinal manipulation when combined with exercise and education improves the overall outcomes of patients with spinal pain (Gross et al 2002)

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Summary of Clinical Prediction Rules

CERVICAL:

Cluster of Tests to help rule in Cervical Radiculopathy

Predictor Variables:

1. Spurling Test reproduces UE symptoms
2. Cervical Distraction Test relieves UE symptoms
3. Ipsilateral cervical spine rotation < 60°
4. + ULNT 1

Conclusion

- 2 positive tests = +LR of 0.88 and post-test probability of 21%
- 3 positive tests = +LR of 6.1 and post-test probability of 65%
- 4 positive tests = +LR of 30.3 and post-test probability of 90

(Wainner et al 2003)

Predicting Short-Term Outcomes with Cervical Radiculopathy

Predictor Variables:

1. Age < 54
2. Dominant arm is not affected
3. Looking down does not worsen symptoms
4. Received multimodal treatment for > 50% of visits
    a. **Manual therapy** (muscle energy, mobilization, or manipulation to the cervical or thoracic spine)
    b. Cervical traction (manual or mechanical)
    c. Deep-neck flexor muscle strengthening

Conclusion: A **successful outcome** is likely if **3 or more** predictor variables are present (+LR=5.2)
(Cleland et al 2007)

Cervical Manipulation for Mechanical Neck Pain

Predictor Variables for favourable response to manipulation:

1. intermittent neck pain
2. neck pain < 30 days
3. work status (not on sick leave or receiving workers compensation at baseline)
4. no prior history of neck pain
5. higher education
6. expectation that the treatment would be helpful

(Rubinstein et al Spine, 2008)
Caution must be considered when interpreting Rubenstein's variables since the only predictor that was consistent with a favorable response was neck pain < 30 days in all 3 of the Outcome measures used in this study.

Cervical Manipulation for Mechanical Neck Pain

Predictor Variables:

1. Initial Neck Disability Index score < 11.5 points
2. Bilateral pattern of involvement
3. Not performing sedentary work > 5 hours/day
4. Feels better while moving the neck
5. Does not feel worse while extending the neck
6. Diagnosis of spondylosis without radiculopathy

Conclusion: Cervical Manipulation is indicated if **4 or more** predictors are present (+LR=5.3)
(Tseng et al 2006)

Patients with Mechanical Neck Pain likely to benefit from Cervical Manipulation

Predictor Variables:

1. Symptom duration < 38 days
2. Positive expectation that manipulation will help
3. Side-to-side difference in cervical rotation ROM of ≥ 10°
4. Pain with spring/PA testing of middle cervical spine

Conclusion: With at least 3 variables present, + LR 13.5 and post-test probability of successful outcome is 90%.
(Puentedura et al. 2012)

Thoracic Manipulation for Mechanical Neck Pain

Predictor Variables:

1. Symptoms < 30 days
2. No symptoms distal to the shoulder
3. Looking up does not aggravate symptoms
4. Fear Avoidance Belief Questionnaire - Physical Activity subscale < 12
5. Diminished upper-thoracic spine (T3-T5) kyphosis
6. Cervical extension range of motion (ROM) < 30°

- With 3 variables present, +LR is 5.5 and post-test probability of success 86%
- With 4 variables present, +LR is 12 and post-test probability of success 93%
- With 5 or 6 variables present, +LR infinite and post-test probability of success 100%.

(Cleland et al, 2005 2007, Lau et al 2011)

LUMBAR:

Diagnosis of Lumbar Fracture in Acute Low Back Pain

Predictor Variables:

1. Female gender
2. Age > 70 years
3. Significant trauma
4. Prolonged use of corticosteroids

Conclusion

a. With at least 2 variables present, +LR 15.5 and post-test probability of # increases from 3% to 32%

b. With at least 3 variables present, +LR 218.3 and post-test probability of # increases from 3% to 87%

(Henschke et al 2009)

Diagnosis of Patients with Lumbar Spinal Stenosis

Predictor Variables:

Score

1. Age 60-70
   2
   > 70
   3
2. Symptoms present> 6 months
   1
3. Symptoms improve when bending forward
   2
4. Symptoms improve when bending backwards
   -2
5. Symptoms exacerbated while standing up
   2
6. Intermittent claudication (+) (symptoms with walking;
   1
   improve with rest)
7. Urinary incontinence (+)
   1

Likelihood of lumbar stenosis if score is **7 or higher** (+LR=3.9)
(Sugioka et al 2008)

Lumbar Manipulation for Acute Low Back Pain (Success)

Predictor Variables:

1. Pain does not travel below the knee
2. Onset ≤ 16 days ago
3. Lumbar hypomobility
4. Either hip has > 35° of internal rotation
5. Fear Avoidance Belief Questionnaire - Work subscale score < 19

Lumbar manipulation is indicated if **4 or more** are present (+LR=24.4) (Flynn et al 2002, Childs et al 2004, Fritz et al 2005, Hancock et al 2007, Hancock et al 2008, Cleland et al 2009)

LBP who will respond to a Stabilization Exercise Program

Predictor Variables:

1. Average SLR > 91°
2. Younger age (< 40 years)
3. "Instability catch" or aberrant movements during lumbar flexion/extension ROM
4. + prone instability test

Conclusion

With at least 3 variables present, +LR 4.0, and the probability of success increases from 50% to 80%
(Hicks et al. 2005)

SACROILIAC JOINT:

Diagnosis of Pain Originating from the Sacroiliac Joint

Predictor Variables:

1. Positive SI] compression test
2. Positive SI] distraction test
3. Positive femoral shear test
4. Positive sacral provocation
5. Positive right Gaenslen's test
6. Positive left Gaenslen's test

Three or more predictor variables indicates a moderate shift in probability that a patient's back, buttock, and leg pain is arising from the SI] when compared to diagnostic injection: **+LR – 4.3**
(Laslett et al 2005)

Overall Relevance: The above Clinical Prediction Rules (CPR) must be considered in context to the level of evidence that has been assigned to the various variables. Many of the above rules have not been validated. Therefore, when making clinical decisions consider the level of evidence

of these CPRs, the client's history, personality, environment, personal preferences and your clinical expertise.

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Cervical Manipulation Risks or Adverse Outcomes Research Historical Perspective

Authors	Reference	Research Findings
Assendelft, WJ et al. (1996)	Complications of spinal manipulation: A comprehensive review of the literature Journal of Family Practice, 42: pp. 475-480	- Reviewed 165 cases of vertebrobasilar accident - Mean age of 38 years - Female predominance - Latency to onset ranged from immediate to 48 hours after manipulation
Dabbs, V., Lauretti, W.J., (1995)	A risk assessment of cervical manipulation versus NSAIDS for the treatment of neck pain Journal Manipulative Physiological Therapy, 18: pp. 530-536	- Incidence of a serious gastrointestinal event with NSAID medication (bleeding or perforation) is estimated at 4 in 1000 - Incidence of death is estimated at 4 in 10,000 cases of patients taking NSAIDs for osteoarthritis
DiFabio, R.P., (1999)	Manipulation of the cervical spine: Risks and benefits. Physical Therapy, 79 (1)	- Review of 177 published cases of injury reported in 116 articles published between 1925 and 1997 - Most frequently reported injuries involve arterial dissection or spasm and lesions of the brain stem - Physical therapists were involved in less than 2% of he cases - No deaths have been attributed to manipulation of the cervical spine provided by a physical therapist
Dvorak, J., et al. (1991)	Consensus and recommendations as to the side-effects and complications of manual therapy of the cervical spine. Manual Medicine, 6: pp. 117-8	- Risk = 1 serious accident per 400,000
Jull, G. et al. (2002)	Physiotherapy, A Responsible Profession to Use Cervical Manipulation. Australian Journal Physiotherapy, 48: pp 180-183	- Response to the article written by Refshauge et al. - Concludes that physiotherapists using spinal manipulation do so selectively with regard for safety and effectiveness of the technique
Haldeman, S. et al. (2002)	Unpredictability of cerebrovascular ischaemia associated with cervical spine manipulation therapy. A review of 64 cases after cervical spine manipulation. Spine, 27: pp. 49-55	- Unable to identify factors from patient's clinical history or physical examination that might identify the at-risk patient - Concluded the incidences appear to be an unpredictable, inherent and a rare complication of cervical manipulation
Hurwitz, E.L., et al. (1996)	Manipulation and mobilization of the cervical spine: A systematic review of the literature. Spine, 21: pp. 1746-60	- Risk of serious complication following manipulation is 1:20,000 - 82% of vascular accidents due to cervical manipulation are due to a thrust technique with rotation - Incidence of serious gastro intestinal event associated with NSAID use was 1 in 1000 patients - Compared to 5 to 10 cases of complication per 10 million cervical manipulations - Incidence of cervical spine surgery complication 15.6 cases per 1000 surgeries
Mann, T. and Refshauge, K.M. (2001)	Causes and complications from cervical manipulation. Australian Journal Physiotherapy,.47 (4)	- Most important risk factors for vertebrobasilar complications appear to be prior trauma to the vertebral arteries and symptoms of vertebrobasilar ischaemia from previous manipulation - Weak evidence that hypoplasia of the vertebral arteries also increase risk of complications - Neither general vascular factors nor pre-existing degenerative conditions of the cervical spine increase risk of vertebrobasilar complications - Negative test results from performance of the current APA guidelines do not preclude vertebral artery injury - Guidelines do test the ability of the vertebrobasilar system to maintain adequate perfusion in the positions of cervical rotation and extension - this may be an indicator of the patient's likelihood of survival if cervical manipulation injures the vertebral artery - Recommended that the procedures described in the APA guidelines be applied prior to every manipulation and that manipulation be avoided in the presence of any signs of vertebrobasilar insufficiency

Part Two: Biomechanics and Assessment

Part Two: Biomechanics and Assessment Manipulation Principles

Vertebral Biomechanics, Assessment and Locking Craniovertebral Region

Biomechanics of the Craniovertebral Region (OA and AA)

Movement	Amount	Osteokinematics	Arthrokinematic	Limiting Factors
OA Flexion	- Approximately 30° total - Extension>flexion	- Anterior sagittal rotation with axis through the mastoid		- Capsules of OA joint suboccipital - Clivus into dens - Posterior OA membrane - Tectorial membrane
OA Extension	- See above - Probably ~20°	- Posterior rotation	- Anterior glide	- Anterior capsule - Anterior OA membrane
OA Sideflex ion/rotation	- 8° - 10° sideflexion in one direction	- Sideflexion with contralateral translation occiput on atlas - Oblique axis through the nose - Contralateral rotation due to banked lateral masses	- Ipsilateral condyle glides anteromedial - Contralateral condyle glides posterolateral	- Contralateral occipital alar - Ipsilateral atlantal alar - Capsule - Tectorial membrane resists rotation
Atlanto axial rotation	- 40° - 45° each direction	- Rotation of the vertebra around axis through dens - Associated with conjunct sideflexion (contralateral or ipsilateral)	- Ipsilateral glides posteroinferior (?) - Contralateral glides anteroinferior (?) - Spin at central joint	- Opposite occipital alar ligament - Capsule
Atlanto axial flexion and extension	- 10° - 15° total	- Sagittal motion around axis through osseoligamentous ring	- Rocking motion mostly superior/inferior motion - Translation up & down dens - Minimal A/P translation - Flexion posterior glide - Extension anterior glide - Superior/inferior translation of 4.1 mm - Anterior/posterior translation of 2.7 mm	- Flexion: tectorial membrane posterior atlanto-axial membrane capsule inferior oblique - Extension: capsule anterior atlanto-axial membrane
AA Sideflexion	- 7° - 11° in one direction	- Controversial - Contralateral conjunct rotation (Penning, Lai, Goel, Mimura) - Ipsilateral conjunct rotation (Worth)	- Minimal translation ipsilateral	- Contralateral occipital alar - Ipsilateral atlantal alar - Capsule

Detailed Biomechanical Assessment of the Craniovertebral Region

Note: Please review the complete Craniovertebral Assessment in Level II Upper manual (pp. 36-45).

Active Mobility Tests

- habitual movement patterns
- isolated craniovertebral motion
- combined movements/quadrants

Directional Stability Tests

- anterior-posterior plane OA joint
- posterior-anterior atlanto-axial joint (transverse ligament)
- lateral atlanto-axial
- transverse plane occipital-atlanto-axial (rotary – alar)
- vertical occiptal-atlanto-axial

Vascular Assessment

- Hautard's test
- vertebral artery

Passive Mobility Tests

PPIVMs

Occipital-Atlantal Joint

- flexion/extension
- sideflexion/rotation

Atlanto-Axial Joint

- flexion/extension
- sideflexion/rotation

To assess for rotation restriction

- ipsilateral posterior glide
- contralateral anterior glide
- in neutral, then toward end range

Muscle Tests

- muscle length, recruitment and strength

Palpation

- muscle tone, capsular/boney thickening

Mid-cervical Spine

Biomechanics of the Mid-cervical Spine

Movement	Amount	Osteokinematics	Arthrokinematics	Limited Factors
Flexion	- Approximately 10° - 20° per level of combined flexion/ extension C4/5=C5/6=20° C3/4=C6/7=17° C2/3=C7/T1-10° - Translation upper>lower and ~2.7mm max	- Anterior sagittal rotation with anterior sagittal translation - Axis of rotation is posteroinferior in upper cervical spine and moves further anterosuperior in lower cervical spine.	- Anterior-superiorlateral glide at zygapophyseal joint - Anterior glide at U-joint	- Facet joint and capsule - IVD - Ligamentum flavum - Ligamentum nuchae
Extension	- See above	- Posterior sagittal rotation with posterior sagittal translation	- Inferior posterior glide at zygapophyseal joint - Posterior glide at U-joint	- Bony impact of arches and facets - ALL - IVD
Rotation with Side Bending	- 4° - 10 sideflexion - 30 - 70 rotation per segment each way (Panjabi) - Approx 1.5 mm translation each way	- Rotations coupled with ipsilateral sideflexion - Lateral translation to side opposite - Oblique axis	- Ipsilateral zygapophyseal joint: inferior-medial-posterior glide - Contralateral: superior-anterior-lateral glide - Ipsilateral U-joint inferoposterior glide - Contralateral U-joint supero-anterior glide	- Ipsilateral U-joint compressed - Contralateral capsules stretched

Detailed Biomechanical Assessment of the Mid-cervical Spine

Note: Please review the complete Mid-cervical Assessment in Level II Upper manual (pp. 51-62).

Active Mobility Tests

- flexion/extension
- sideflexion/rotation
- habitual and combined movement patterns

Position Tests

- neutral, flexion, extension

Directional Stability Tests

- vertical plane – traction, compression
- anterior/posterior plane
- lateral plane
- torsion

Passive Mobility Tests

PPIVMs

- combined movements
- maximum flexion → flexion sideflexion/rotation away from joint being tested
- maximum extension → extension/sideflexion/rotation toward joint being tested
- pure sideflexion in neutral for U joint ?

PAIVMs

Z joint

- superior/anterior glide (flexion)
- posterior/inferior glide (extension)

U joint

- anterior-posterior glide along plane of joint

Lateral glide

Thoracic Spine and Ribs

Movement	Amount	Osteokinematics	Arthrokinematics	Limiting Factors
Flexion	2-6° per joint	- Body translates anteriorly and rotates anteriorly in the sagittal plane; traction - The rib rotates anteriorly	- The IAP of vertebra will glide superior-anteriorly - The rib will glide superior T1-T6; PMS T7-T10 in a mobile thorax - Costovertebral Joint – spins	- Facet impact, capsule, posterior ligaments, POST 1/3 IVD, CT and CV joints and capsules to varying degrees
Extension	2-6° per joint	- Posterior translation and posterior rotation; traction of the body - The rib rotates posteriorly	- The IAP will glide inferior-posteriorly - The rib will glide inferior at T1-T6; ALI T7-T10 - Costovertebral Joint – spins	- Z-joint compression, SP contact and IVD and ALL to a lesser extent
Sideflexion	T1-T10 have ~6°	- Side bend ipsilateral and translates ipsilateral with contralateral rotation. - Ipsilateral rib anterior rotation - Contralateral rib posterior rotates	- Ipsilateral facet of IAP glides inferiorly; contra superior - Ipsilateral rib superior/ant glide - Contralateral rib inferior/post glide - Ipsilateral rib drives vertebra	- Ipsilateral articular facet impact - Contralateral facet capsule - Ligamentum flavum - Intertransverse ligament - ?Rib joints/ligaments?
Rotation	T1 - T10 have 6°	- Ipsilateral body rotation; Contralateral translation; Ipsilateral side bend - Ipsilateral rib posterior roll - Contralateral rib anterior roll - Posterior impact of ipsilateral rib moves ant med relative to ipsilateral transverse process - Contralateral rib moves posterolateral	- Ipsilateral facet of IAP glides inferiorly; contra superior - Ipsilateral rib inferior glide - Contra rib superior glide - CV joint spin	- Ipsilateral facet impaction - Contralateral capsule. - Posterior ligaments - Intertransverse ligaments - IVD; ribs and their ligaments?
Inspiration	Unknown	- Upper ribs (R1-R6/7) are "pump handle"; lower ribs are "bucket handle" to elevate ribs and sternum - Posterior rotation around axis through neck of rib	- R1-R6 or R7 inferior glide - R6/7 – R10 ALI	- Superior. - Costotransverse - Other costal ligaments and capsules intercostals muscles
Expiration	Unknown	- Anterior rotation around axis through neck of rib	- R1-R6 or R7 superior glide - R6/7 – R10 PMS	- Costal ligaments and capsules intercostals muscles

1. The above represents a theoretical model of thoracic biomechanics, not yet verified.
2. Much of the information listed here is derived from studies on cadavers with incomplete rib cages and on clinical observations.

Detailed Biomechanical Assessment of the Thoracic Spine and Ribs

Note: Please review the complete Thoracic Assessment in Level II Upper manual (pp. 79-84).

Observation: Sitting

- architectural design
- muscle recruitment

Active Mobility Tests

- flexion/extension
- sideflexion
- rotation
- arm lift
- neck movements

Respiratory Motion

- note the quantity and direction of relative motion between the vertebra and the rib

Position Tests

- flexion
- extension
- neutral

Directional Stability Tests

Thoracic Joints

- compression/traction
- anterior/posterior translation
- rotation
- lateral

Costal Joints

- posterior joint – posterior-anterior, caudal directed posterior-anterior
- anterior joint anterior-posterior, superior-inferior

Interchondral Joints

- clicking and local pain and swelling may be palpable

Manubrosternal Joint

- A sprain is suspected when local pain is increased as the subject flexes and extends the trunk about an axis through the 2nd rib. Pain may be present on deep breath.

Passive Mobility Tests

PPIVMs

- Flexion/extension in sitting
- Combined sideflexion/rotation (ipsilateral and contralateral coupling)

PAIVMs

- a-joint superior-anterior glide (flexion)
- inferior-posterior glide (extension)
- costal
- lateral glide

Thoracolumbar Junction
Transition Zone Characteristics

Transitional Region (70% Incidence)

- level varies, but most commonly found between T11 and L1
- gradual change from rotational to non-rotational function

Transitional Vertebrae (30% Incidence)

- level varies
  - T11-12: 69%
  - T12- L1: 24%
  - T10-T11: 7% (Davis, 1955)
- forms cranial portion of mortise joint
- site of sudden change from rotational (thoracic) to non-rotational (lumbar) function
- rotation most free at superior joint
- rotation restricted at inferior joint

Biomechanics of Thoracolumbar Junction

Limitations to Movement

- segmental mobility is restricted by the shape of the vertebral bodies, the thickness of the disks, and the orientation of the zygapophyseal joints
- of these factors, the zygapophyseal joints play the largest role in providing torsional and axial loading stability

Arthrokinematics

- CT studies of subjects in end-of-range trunk rotation demonstrated
  - ipsilateral compression
  - contralateral traction of the sagittally oriented z-joints
- coronally oriented joints showed translation of the facets in the direction opposite to active rotation

- subjects with an abrupt transitional mortise joint showed little movement relative to adjacent segments (Singer et al., 1989)

Close Pack Position

- orientation of the inferior zygapophyseal joints of the transitional vertebrae place it in a closed packed position in full extension

Lumbar Spine

Biomechanics of the Lumbar Spine

Movement	Amount	Osteokinematics	Arthrokinematics	Limiting Factors
	8°-13° (mean 10°) and 1-3 mm translation; more in mid-lumbar, less L1-2 and L5-S1	- Anterior sagittal rotation about the coronal axis passing through the IVD - Ant. Sagittal translation. (1-3 mm)	- Superior-anterior glide. (5-7 mm)	- Z-joint capsule, facet, IVD, supraspinous ligament, interspinous ligament, ligamentum flavum
Extension Total 20°-35°	1°-5° and 1 mm translation; more at L1-2 and L5-S1, less at L3-4	- Posterior sagittal rotation with posterior sagittal translation. (1.1-1.7 mm)	- Inferior-posterior glide	- Impaction of SP's, facet into lamina, fatty tissue, ant annulus/ALL
Axial Rotation Total 18°	1°-2° (?up to 3°), past this the facet impacts and IVD shearing occurs	- Rotation of the vertebrae about an axis through the body, coupled with sideflexion, variable contra or ipsilateral tends ipsilateral at L5-S1	- Ipsilateral facet joint distracts - Contralateral facet joint impacts	- Supra and interspinous ligaments - Capsule stretch ipsilateral, joint surface contra IVD
Side Bending Total 15°-30°	0°-2° at L5-S1 3° at L4-5 5° above	- Side bend and ipsilateral translation coupled with rot, variable direction except L5-S1 tends ipsilateral	- Ipsilateral glides inferior. - Contra glides superior	- Ipsilateral facet impact, contra stretch, IVD.

Detailed Biomechanical Assessment of the Lumbar Spine

Note: Please review the complete Lumbar Assessment in Level II Lower manual (pp. 30-37).

Position Testing

- neutral
- hyperflexion
- hyperextension
- Dynamic Position Testing

Stability Tests

- compression
- torsion – general, specific
- translation – anterior
- posterior

Passive Mobility Testing

PPIVMs

- ability of the Z joint to flex or extend
- assess the segment's movement in multiple planes as a whole unit (include ipsilateral and contralateral coupling)
- to determine the appropriate coupling for that segment combine sideflexion/rotation ipsilaterally and contralaterally

PAIVMs

- anterior-superior glide (flexion)
- posterior-inferior glide (extension)

The Pelvis

Biomechanics of the Pelvis

Movement	Amount	Osteokinematics	Arthrokinematics	Limiting Factors
Nutation of the sacrum	2.5° total 0.5-1.6 mm translation	- Sacral promontory rotates anteriorly about axis through interosseous ligament	- (theoretical) Inferior down short arm - Posterior along long arm	- Bony congruency. - Ridged cartilage. - Interosseous ligament - Sacrotuberous ligament
Counternutation of the Sacrum	See above	- Backward motion of the sacral promontory about an axis through interosseous ligament	- Anterior along long arm - Superior up short arm	- Long Dorsal ligament - Multifidus supports ligament
Anterior Rotation of the Innominate	See above	- Superior aspect of the innominate rotates anterior-inferior about axis through interosseous ligament	- Sacrum relative to innominate - Inferior down short arm and post along long arm (relative to sacrum)	- Long Dorsal Ligament - Multifidus
Posterior Rotation of the Innominate	See above	- Superior aspect of the innominate rotates posterior-inferior about axis through interosseous ligament	- Ant along long arm and sup up short arm (relative to the sacrum)	- Shape of joint surfaces - Ridges of cartilage - Interosseous ligament - Sacrotuberous ligament

Detailed Biomechanical Assessment of the Pelvis

Note: Please review the complete Pelvis Assessment in Level II Lower manual (pp. 47-57).

Active Mobility Testing

Functional Tests

- Gillet/Kinetic test
- one leg standing test
- forward and backward bending
- standing sideflexion
- active straight leg raise
- body torque
- prone active straight leg raise

Positional Tests

- innominate
- sacral base and ILA: tested in flexion, extension, and neutral

Passive Mobility Testing

PPIVMs

- nutation/counternutation of sacrum
- anterior /posterior rotation innominate

PAIVMs

Inferoposterior Glide (Innominate on Sacrum)

- anterior rotation of the innominate requires an inferoposterior glide

Superoanterior Glide (Innominate on Sacrum)

- posterior rotation of the innominate requires a superoanterior glide

Neutral Zone Analysis (Lee, 2002)

- examines the ability of the sacroiliac joint to resist vertical and horizontal translation
- apply posterior pressure to ASIS to assess anterior/posterior translation on innominate and sacrum
- apply pressure through femur or ischial tuberosities to assess superior/inferior translation of innominate on the sacrum

Directional Stability Testing

- transverse anterior distraction: posterior compression
- transverse posterior distraction: anterior compression
- long dorsal SI ligament: posterior-anterior pressure on sacral apex - note counternutation of sacrum
- sacrotuberous/interosseous ligaments: posterior-anterior pressure on sacral base - sacrum nutates
- vertical sheer
- public symphysis stability

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Addendum

Case History Exam Objective Booklet

Questions to be completed following the ***Objective*** Examination

Candidate Number:_____

Candidate Name:_____

Exam Date:_____

1. Provide your main hypothesis for this patient's clinical picture. Outline in detail your rationale and justification for this hypothesis with consideration of the evidence from both the subjective and objective examination.
(8 marks)

2. List 2 favourable and 2 unfavourable prognostic indicators for this patient and considering these state your predictive outcome. (.5 for each indicator and 1 mark for predictive outcome - total 3 marks)

3. At this point, with respect to this particular patient, are there any medical diagnostic tests that would be indicated (either now or later) or the need to refer to another health care professional? Give your rationale.
(2 marks)

4.Indicate your PRIMARY FUNCTIONAL GOAL as it relates to the Activity Limitations and Participation Restrictions and select 2 problems that would be the most relevant to address. Include your treatment goal for each problem and the testing criteria you would use to monitor change.
(6 marks)

PRIMARY FUNCTIONAL GOAL:

PROBLEM #1

Treatment goal:

Testing Criteria:

PROBLEM #2

Treatment Goal:

Testing Criteria:

5. Outline in detail the management strategies you would use over the first two treatments under the following headings: manual therapy (3 marks), exercise (3 marks), education and other (2 marks). Include your rationale.
(8 marks total)

6. Outline in detail your progression of subsequent treatments to discharge addressing all the identified problems and provide your rationale. Use the following headings: manual therapy (3 marks), exercise (3 marks), education and other (2 marks).
(8 marks total)

7. Provide evidence to support one of your treatment interventions? Please elaborate.
(2 marks)

Case History Exam
Subjective Booklet

Questions to be completed following the ***Subjective*** Examination

Candidate Number:_____

Candidate Name:_____

Exam Date:_____

1. **Identify three key activity limitations and three key participation restrictions for this patient (based on the International Classification of Function, Disability and Health - WHO - ICF Model).**
   (3 marks)

Activity Limitations:

Participation Restrictions:

2. **The table below describes different mechanisms that may be influencing the patient's pain. Based on the information provided in the subjective examination, list the evidence, if any, that would be most indicative of each pain mechanism. Consider all 3 pain areas.**
   (8 marks)

Nociceptive
Neuropathic or Neurogenic **Peripheral Evoked**
Central Evoked
Psychological Factors
Social/Environmental Factors

3 (a). List 3 of the <u>most likely</u> structures at fault for each of the area of symptoms. (4.5 marks)

P1	P2	P3
1.	1.	1.
2.	2.	2.
3.	3.	3.

3 (b). For P1, explain your rationale for each of the three structures you have chosen based on the subjective data that has been provided.
(3 marks)

Structure	Rationale

4. Circle the one category that best describes the overall irritability of this patient's condition.

Mild Mild - Moderate Moderate Moderate - Severe Severe

Justify your answer with 4 pieces of evidence from the subjective examination.

(2 marks)

What are the implications of this for the physical examination?
(1 mark)

5. Is the disorder inflammatory or mechanical in nature, or both?
(1 mark)

List 6 factors that support your answer.
(3 marks)

6 (a). List 3 subjective examination findings that would indicate caution must be observed during the objective examination. Explain why.
(3 marks)

6 (b). Write one subjective question you would like to have added to this case to help rule in or out any possible red or yellow flags. (1 mark)

7. After reading the subjective data, list the 2 (most likely) clinical hypotheses and provide 3 subjective findings to support each hypothesis. (3 marks)

8. Based on the subjective examination you have developed two clinical hypotheses. Provide 4 key elements of your physical examination and under each element state 2 of the most relevant tests you would perform and explain how these would help you confirm or negate your hypotheses.
(8 marks)

POTENTIAL KEY ELEMENTS:

KEY ELEMENT #1:

RELEVANT TESTS:

RATIONALE:

KEY ELEMENT #2:

RELEVANT TESTS:

RATIONALE:

KEY ELEMENT #3:

RELEVANT TESTS:

RATIONALE:

KEY ELEMENT #4:

RELEVANT TESTS:

RATIONALE:

9. What are 2 outcome measurement or screening tools that you would use to monitor this patient and provide your rationale for choosing them. (2 marks)

Manipulation Technique: Page:

Indications	Key Findings: Subjective & Objective	Problems / Cautions / Contraindications	Potential Modifications

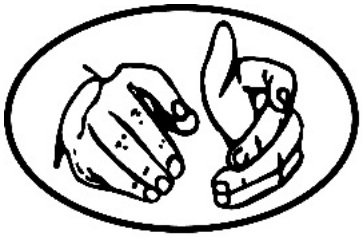
Education (Post- Manip Care, Posture, ADLs, Ergo, Sports):

.

Home exercise program:

Evidence to support choice of manipulation, education, home program:

Part Three: Manipulation Techniques



Orthopaedic Division
Groupe d'orthopédie

Canadian
Physiotherapy
Association

Part Three:

Manipulation Techniques

Level IV/V

Table of Contents - Techniques

CT Junction

Thoracic Spine

Lumbar Spine

TL Junction

SI Joint

Principles of Localization/Locking

Purpose

- reduce stresses through upper and lower levers
- protect joints above and below that segment being treated – important to localize all vectors of the restricted segment
- focus the forces to the segment being treated, reducing the total force required for the thrust
- minimize risk of damage to vascular or neurological structures

Consider

- region
- level
- comfort
- mechanics
- hypermobile joints or dysfunction above and below
- combined movements that produce best motion barrier
- motion to be encouraged at the restricted segment

Ligamentous Lock

- Use flexion to tighten the posterior ligamentous system
- most often used to lock the caudal (lower) lever

Positioning the Segment to be Treated

- position affected segment at its motion barrier
- chose plane dependent on the movement attempting to regain (based on assessment findings)
- may use contract - relax to achieve end range
- be sure not to stay at barrier too long
- must have a firm, ‘crisp’ barrier to be able to manipulate

Creating a Facet Lock

- rotation and side flexion may be coupled ipsilaterally or contralaterally to produce a facet lock
- ipsilateral - side flexion and rotation occurring to the same side
- contralateral - side flexion and rotation are occurring in opposite directions
- can also combine either of these with flexion or extension

Principles of Manipulation

Pre-manipulative Hold

- **a pre-manipulative hold must be performed prior to any manipulation**
- perform a hold in the locked position and assess comfort and end-feel
- may over-press to assess response to loading in the direction of the manipulation
- gives the patient a feel of what to expect, obtain final consent to the manipulation
- helps confirm the appropriate choice of technique and locking procedure

Manipulation Hints

- may use contract-relax to ease any muscle guarding end feel
- don't stay too long at barrier
- stay relaxed
- visualize / keep the objective in mind
- review therapist body position
  - keep head up
  - shoulders down
  - knees slightly bent
  - arms and body follow along the line of the thrust
  - don't stand directly facing plinth, angle feet towards head or foot
- move from hips and trunk $\rightarrow$ then hands
- engage a slight abdominal contraction at time of thrust
- don't lose lock
- DO NOT " back up and charge"

Craniovertebral Localization and Locking

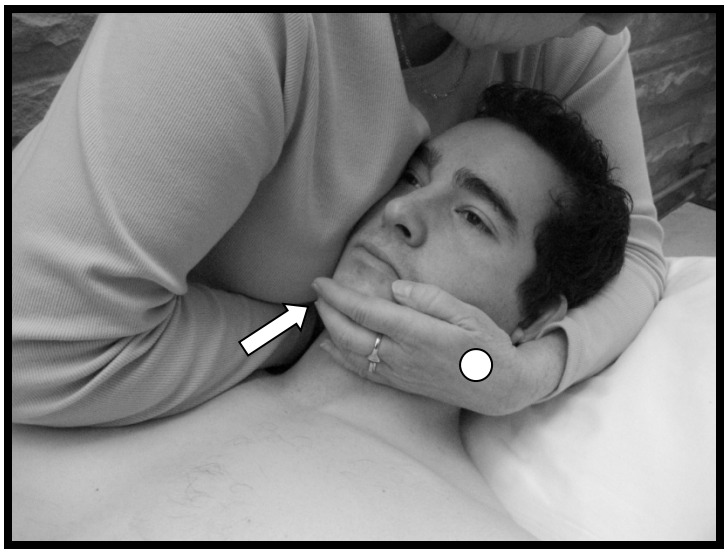
Locking Principles

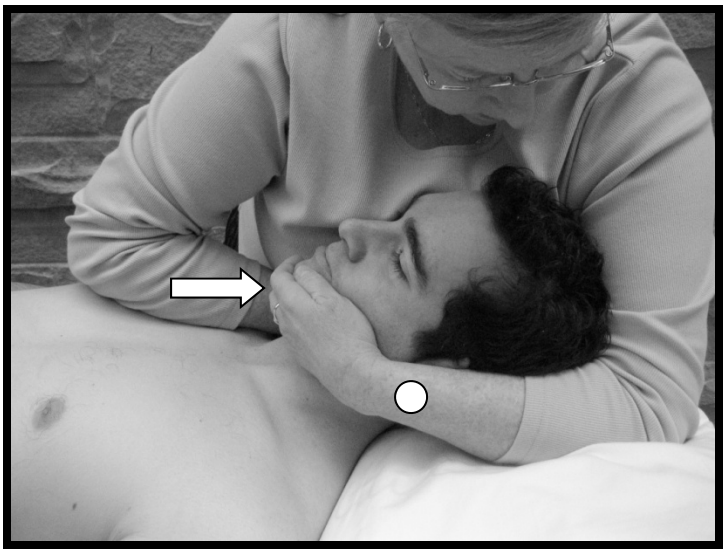
- tend to use contralateral coupling even though these are congruent motions in the CV region
- when locking through craniovertebral region to manipulate C2/3, it is not necessary to take up much atlanto-axial rotation - just snug up side flexion with contralateral rotation
- can apply some compression through the head to further tighten the region

Craniovertebral Locking Technique

- palpate C2 spinous process throughout the locking procedure
- side flex slightly until you feel C2 rotate
- rotate head opposite to bring C2 spinous process back to midline
- increase side flexion slightly
- add rotation to reposition C2 spinous process back to midline
- will feel a firm lock, with the atlanto-axial joint nowhere near its end-range

OA Joint
Unilateral Distraction (Level 4)





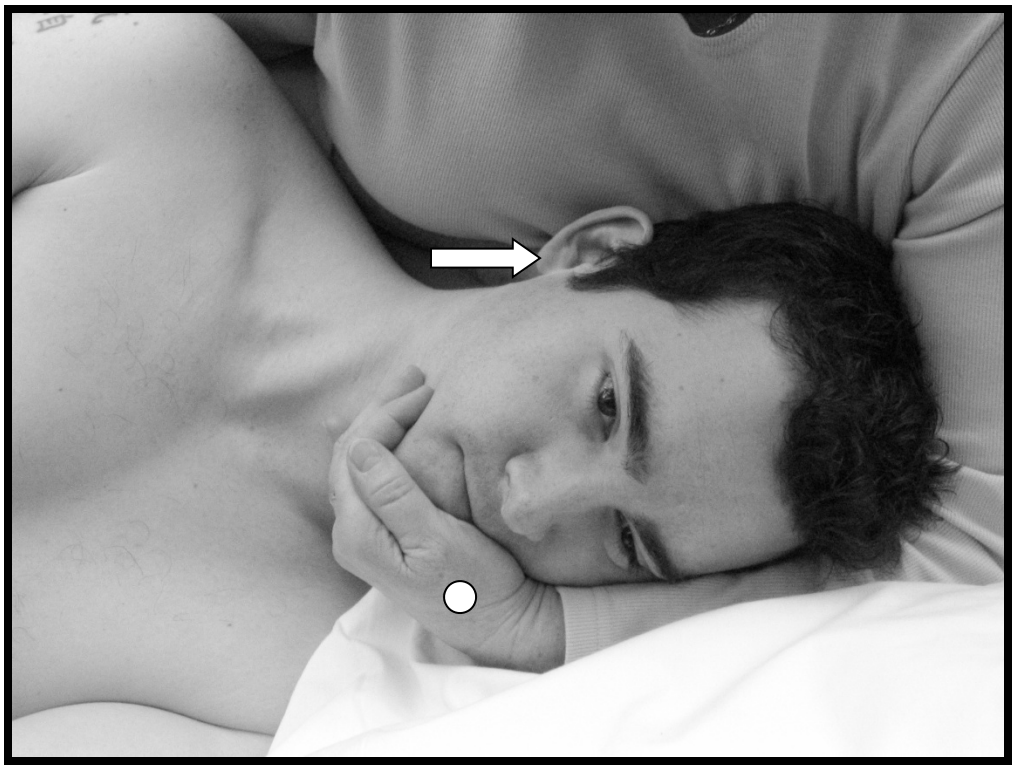
Technique described for the right OA joint

***Patient*:** Supine, head supported on pillow. May flex knees for patient comfort

Therapist: Stands on side in dysfunction. Cradle around the cranium with left hand while palpating the occipital bone with the right hand, just medial to mastoid process. Fix with either the lateral aspect of the MCP of the right index finger, or the thenar eminence.

Technique: Motion barrier is engaged by taking up the slack of distraction at the right OA joint , while maintaining a neutral position. High velocity, low amplitude thrust applied to the occiput in a cranial direction, thus distracting the joint.

OA Joint
Unilateral Distraction
Side-lying technique (Level 4)



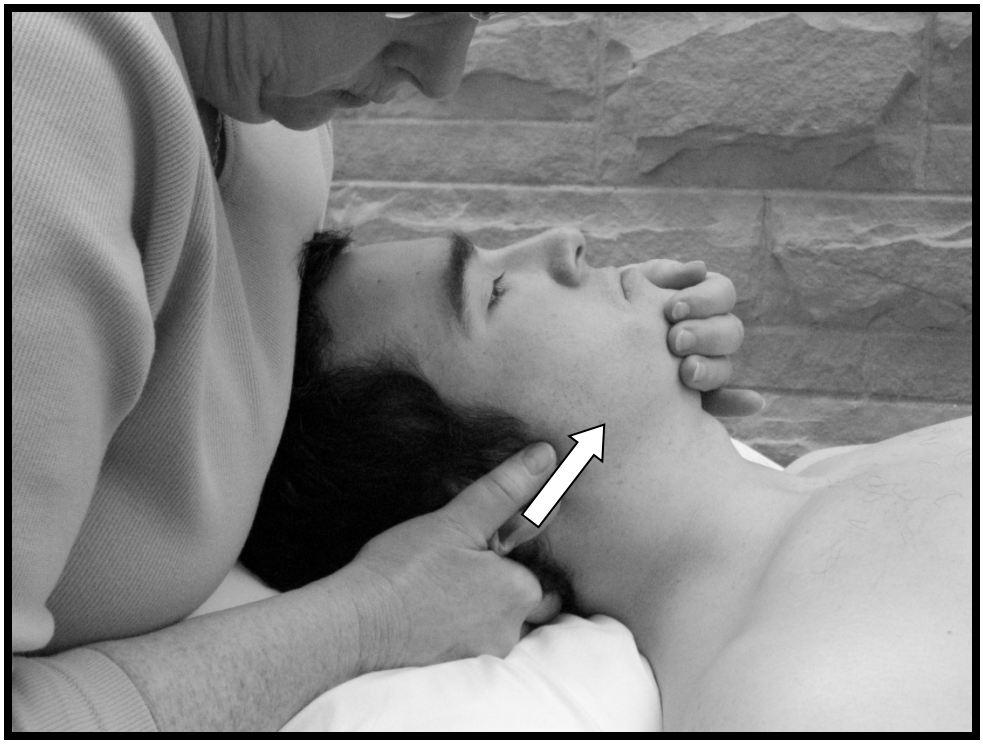
Technique described for the right OA joint

***Patient*:** Side-lying, head supported on pillow. May flex knees for patient comfort

Therapist: Stands behind the patients head. Cradle cranium around to mandible with left hand while palpating the occipital bone with the right hand, just medial to mastoid process. Fix with either the lateral aspect of the MCP of the right index finger, or the thenar eminence. The thrust forearm is on the posterior thorax.

Technique: Motion barrier is engaged by taking up the slack of distraction at the right OA joint , while maintaining a neutral position. High velocity, low amplitude thrust applied to the occiput in a cranial direction, thus distracting the joint.

OA Joint
Unilateral Anterior Glide – Extension (Level 5)



Technique described for the right OA joint

***Patient*:** Supine, head supported on pillow

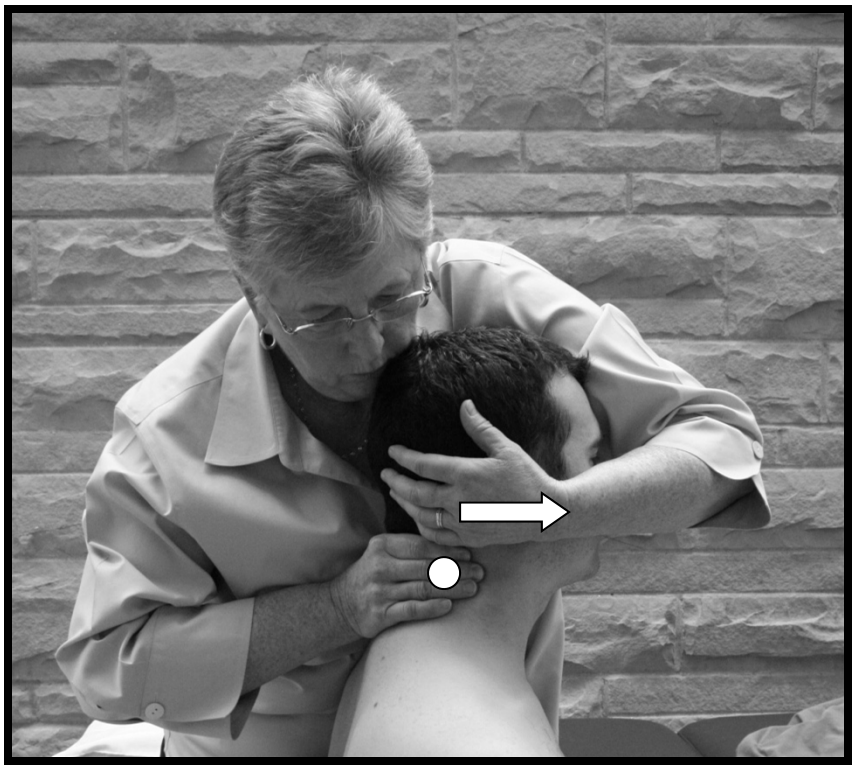
***Therapist*:** Stands at patient's head on the right side, palpate medial to mastoid process with MCP of right index finger. The left hand supports the cranium or cradles the head.

***Technique*:** Motion barrier of extension is engaged by extension, right side bend, left rotation. If necessary, tightening below can be added, using either flexion or lateral translation to the left. High velocity, low amplitude thrust is applied to the posterior aspect of the occiput in an anteromedial direction, thus extending the joint.

OA Joint

Unilateral Anterior Glide – Extension (Level 5)

Alternate Technique



Technique described for the right OA Joint

Patient: Sitting supported in chair

Therapist: Stands on left side of the patient

Right hand fixes atlas from behind with lumbrical grip

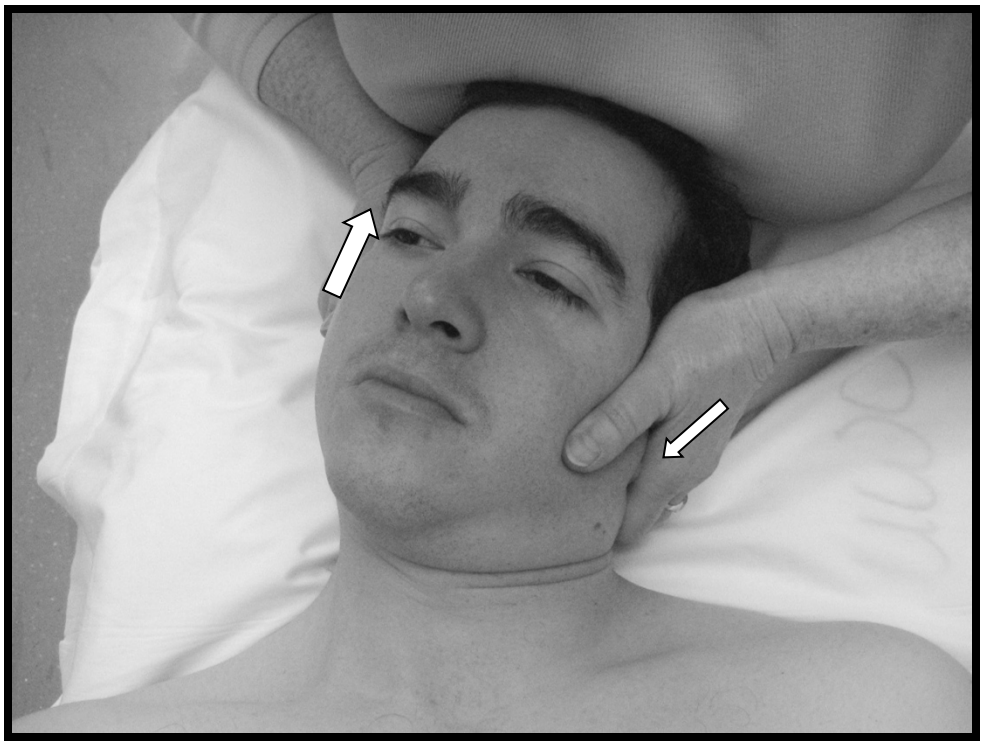
Index finger is positioned to pull back on the C1 transverse process just prior to the thrust

Thumb applies anterior pressure to arch of atlas on opposite side

Left arm is supinated, with little finger cupping behind the mastoid process, on the affected side.

Technique: The motion barrier of anterior glide is engaged by right side flexion and slight left rotation, with the little finger guiding the right facet into an anterior glide. The thrust is a forward pull under the mastoid, counter pressure is given by a backward pull on the C1 transverse process, and anterior pressure on the left arch with thumb. The head can be simultaneously tipped into right side flexion.

OA Joint
Unilateral Posterior Glide – Flexion (Level 5)



Technique described for the right OA joint

Patient: Supine, head supported on pillow

Therapist: Stand at the patients head. Cup around posterior lateral occiput with your right hand. With your left hand support the cranium anteriorly and laterally. Allow head to rotate slightly toward restricted side

Technique: Motion barrier of flexion is engaged by flexion, left side bend and right rotation towards the stiff joint**.** The main thrust is a cranial or traction pull on the right occiput. A guiding inferomedial force is applied with the left hand. High velocity, low amplitude thrust is applied using a two handed technique into left side flexion.

OA Joint

Unilateral Posterior Glide (Flexion)

Alternate Side-lying Technique – Level 5

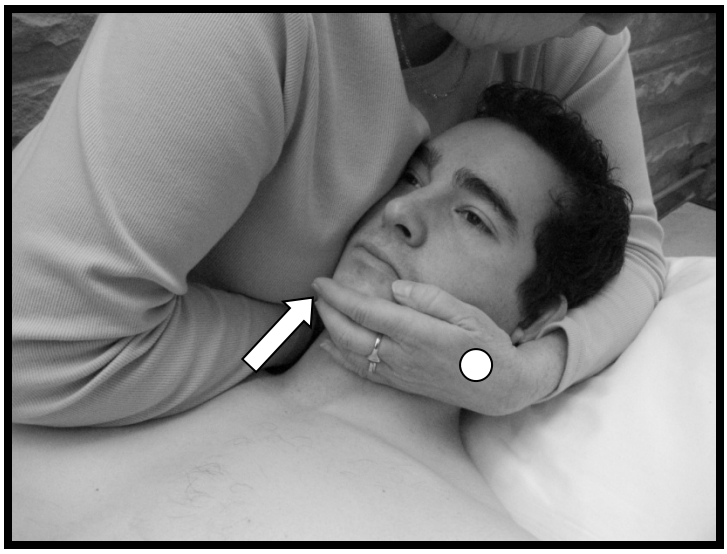
Technique described for the right OA joint

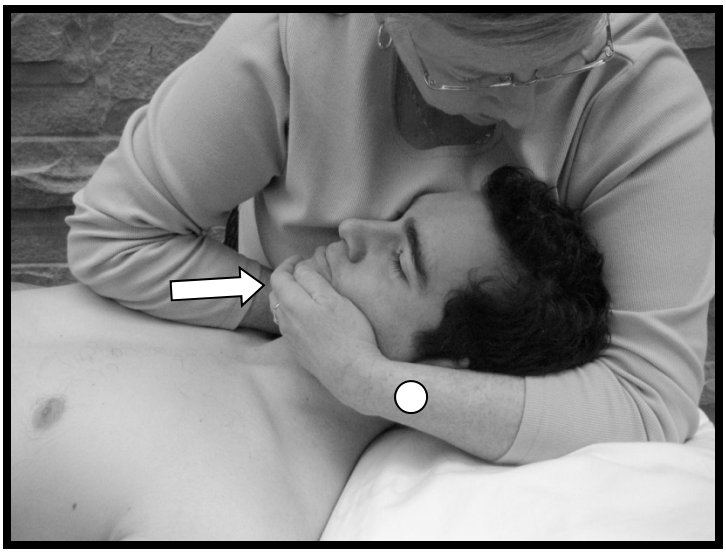
***Patient*:** Side-lying, head supported on pillow. May flex knees for patient comfort

***Therapist*:** Stands behind the patient's head. Cradle cranium around to mandible with left hand while palpating the transverse process of C1 with the MCP of the right index finger.

***Technique*:** Motion barrier is engaged by taking up the slack of flexion, left side bend and right rotation at the right OA joint. High velocity, low amplitude thrust applied to the posterior arch of the atlas in an anterior, slightly medial direction creating a relative posterior glide of the occiput on the atlas. Apply a counter-force to the mandible to maintain occiput fixation.

AA Joint
Unilateral Distraction (Level 4)





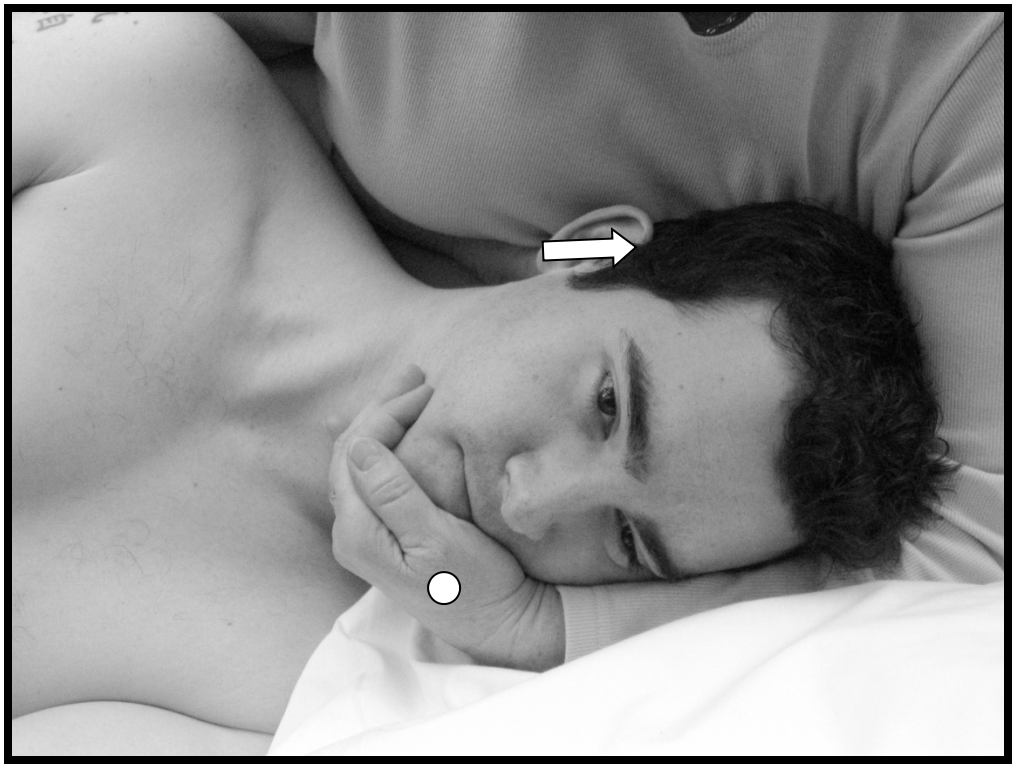
Technique described for the right AA joint

***Patient*:** Supine, head supported on pillow. Patient's knees should be flexed.

***Therapist*:** Stands at patient's side. Left hand cradles cranium around the mandible. The MCP of the right index finger, palpates the inferior aspect of the transverse process of C1

***Technique*:** With the right AA joint in neutral engage the motion barrier by taking up the slack of distraction at the AA joint. High velocity, low amplitude thrust is applied to the inferior aspect of the posterior arch of atlas in a cranial direction.

AA Joint
Unilateral Distraction (Level 4)
Alternate Side-lying Technique



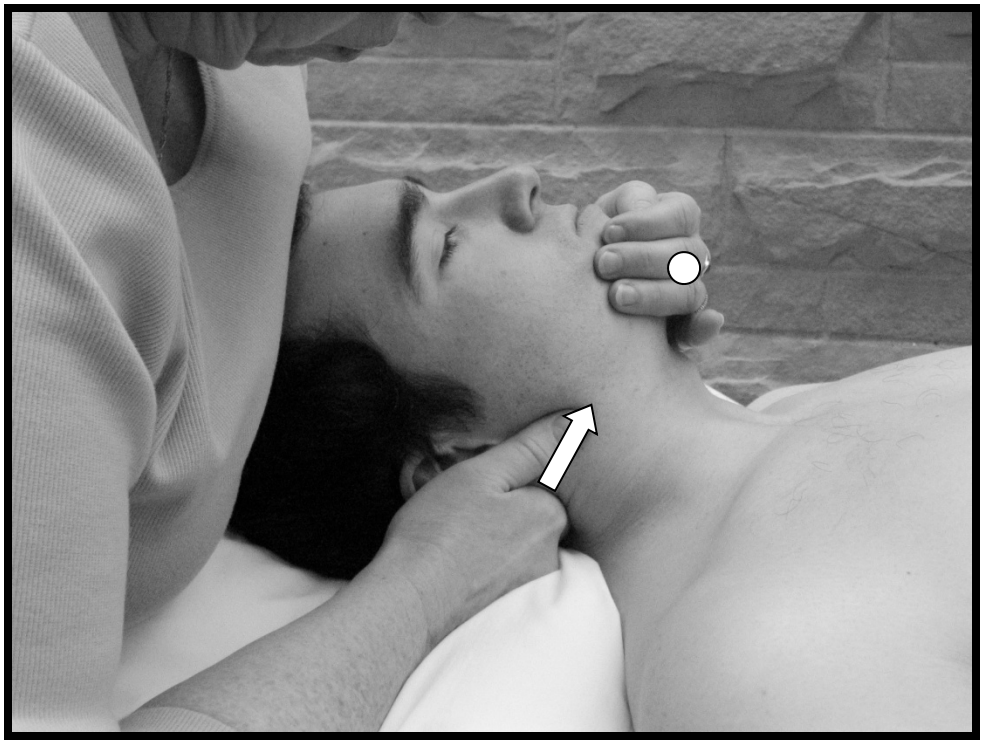
Technique described for the right AA joint

Patient**:** Supine, head supported on pillow

Therapist**:** Stands at patient's side. Left hand cradles the cranium around the mandible. The MCP of the right index finger, palpates the inferior aspect of the transverse process of C1**.** The thrust forearm is on the posterior thorax to support

Technique**:** With the right AA joint in neutral engage the motion barrier by taking up the slack of distraction at the AA joint. High velocity, low amplitude thrust is applied to the inferior aspect of the C1 transverse process in a cranial direction.

AA Joint
Unilateral Anterior Glide (Level 5)



Atlanto-Axial Joint Rotation Restrictions: General Points

•determine if the cause of the rotation restriction is due to an anterior or posterior glide restriction, and manipulate to restore that motion

i.e.. left rotation restriction is either due to right anterior glide restriction or left posterior glide restriction

•avoid extension / rotation manipulations

•emphasize anterior or posterior glide when restoring motion at this joint

Technique described for the right AA joint (restriction of left rotation)

***Patient*:** supine, lying close to right side of bed. Head supported on pillow

***Therapist*:** Stand at patient's head, slightly toward the right side. Place MCP of right hand on the right posterior lateral arch of the atlas (C1). The other hand cradles the other side of the head and the arm on that side can also tuck in around the head to stabilize it.

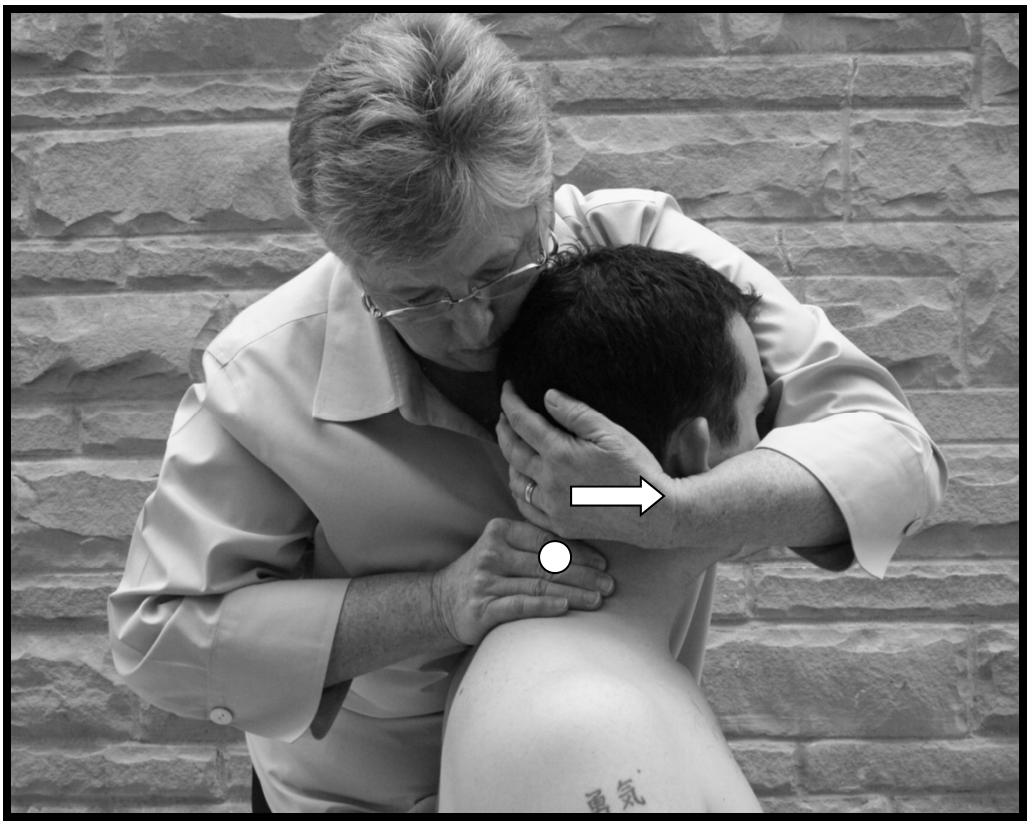
***Technique*:** To lock below, contralateral lock by side bending right, rotating left below C1-2, or laterally translate to the left below C1-2. Maintaining the mid cervical position, rotate the AA joint (pure rotation around the vertical axis) toward the left rotation restriction.
Engage the final motion barrier by taking up the anterior glide of the atlas on the axis at the right lateral joint.

Apply a high velocity, low amplitude thrust to the posterior arch of the atlas in an anterior, slightly medial direction along the line of the jaw.

AA Joint

Unilateral Anterior Glide (level 5)

Alternate Technique



Technique described for the right AA joint

***Patient*:** Sitting supported in a chair

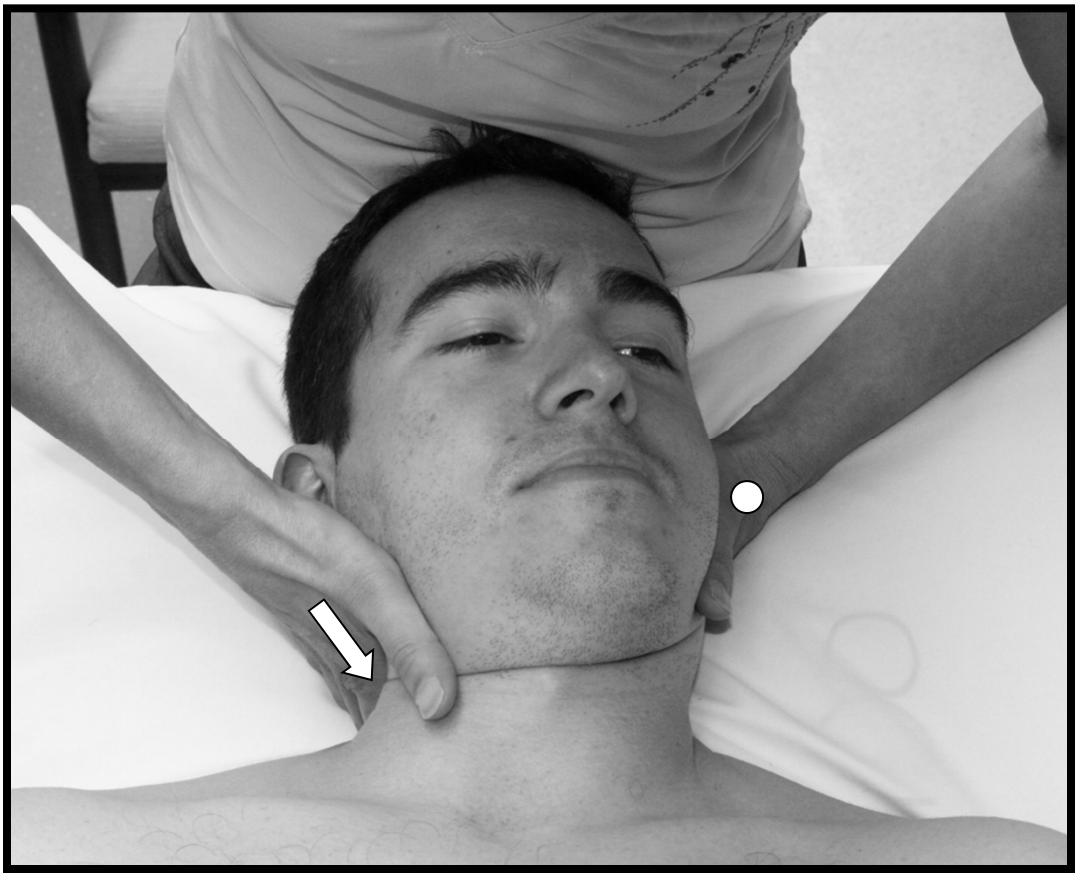
***Therapist*:** Stands on left side. Right hand fixes axis from behind with a lumbrical grip along the lamina. Left hand cups along the atlas and occiput, with the little finger along the posterior arch of the atlas

***Technique*:** Motion barrier is engaged by taking up the anterior glide of the right atlas on axis by right side flexing and left rotating at the AA joint. Joint is kept in neutral flex/ext. The thrust is a forward pull on the posterior arch of the atlas with counter pressure given by a backward force on the lamina of C2.

AA Joint

Unilateral Anterior Glide (level 5)

Alternate Technique



Technique described for the right AA joint

Patient: Supine, head supported on pillow

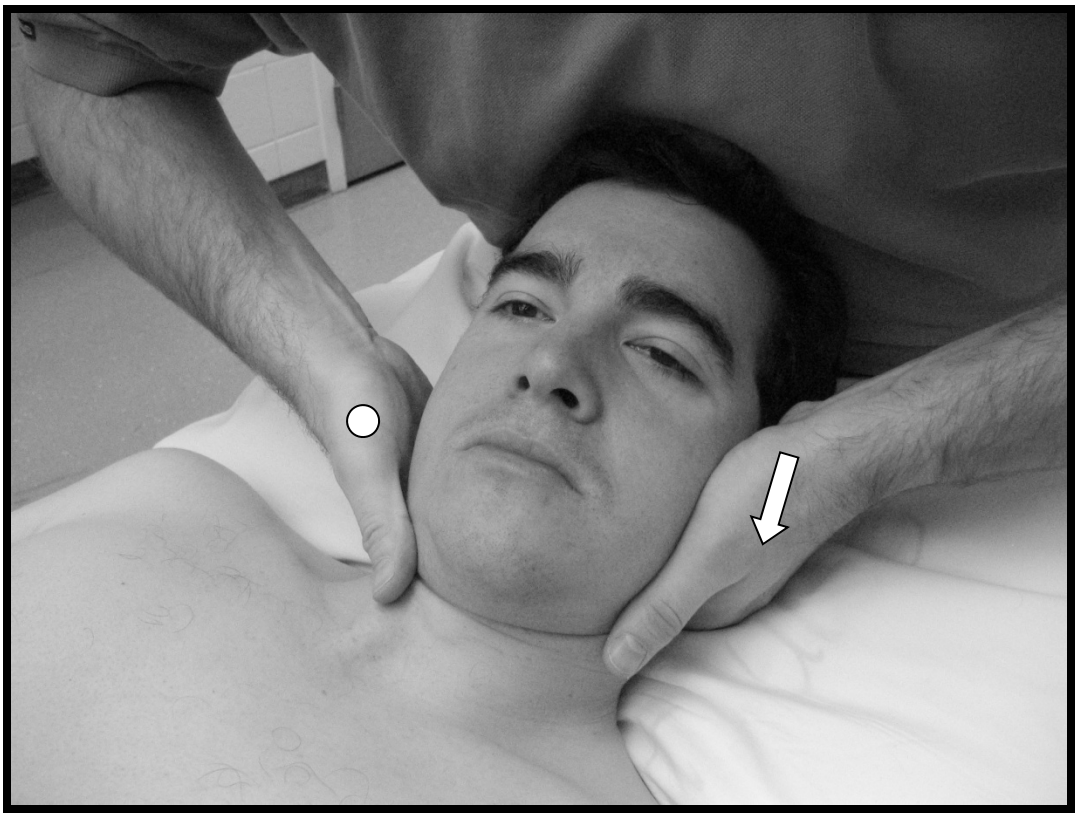
Therapist: Palpate and fix lamina of the axis, with the right index finger. Left hand supports the cranium and atlas.

Technique: Motion barrier is engaged by rotating the cranium and atlas left on the fixed axis, right side bending through the CV axis. High velocity, low amplitude thrust is applied to the right lamina of the axis in a posteromedial direction. This will create a relative anterior glide of the right atlas on the axis.

AA Joint

Unilateral Posterior Glide

(Level 5)



Technique described for the left AA joint

***Patient*:** Supine, head supported on pillow.

***Therapist*:** Palpate, and fix lamina and spinous process of the axis, with the MCP of right index finger. The left hand supports cranium and atlas.

***Technique*:** Motion barrier is engaged by rotating the cranium and atlas left on the fixed axis then tilting the head into right side bend through a CV axis. High velocity, low amplitude thrust is applied to the occiput and C1 in a posteromedial direction.

AA Joint
Unilateral Posterior Glide (Level 5)
Alternate side- lying technique

Technique described for the right AA joint

***Patient*:** Left side lying

***Therapist*:** Stands at patient's side. Left hand cradles around the cranium around to the mandible. This arm is fixed to the bed to maintain fixation of occiput/atlas. The MCP of the right index finger, palpates the posterior lamina of C2**.**

***Technique*:** Motion barrier at the AA joint is engaged by right rotation, and the conjunct side bending. High velocity, low amplitude thrust is applied in an anterior direction to the axis. A counter force is applied to ensure the head remains stationary.

Mid-cervical Localization and Locking

Locking Principles

•Use contralateral coupling because incongruent movements tighten up the cervical spine more quickly

•Locking keeps neck in more midline (less extreme position)

•Can add flexion to ligamentous tighten up mobile necks

•Lateral translation can be used as a method of tightening up the neck below the level being treated

•Lock two or three segments above the level being treated

•For both flexion and extension manipulations it is most common to side flex ipsilateral to the side of the restricted zygapophyseal joint, and rotate to the opposite side

•It is possible to use unlocked techniques if the thrust is directly onto the vertebra requiring manipulation but whenever the thrust is through a lever, the lever must be locked

Locking Technique

•Start with the cranial lock, keep the segment to be treated in neutral

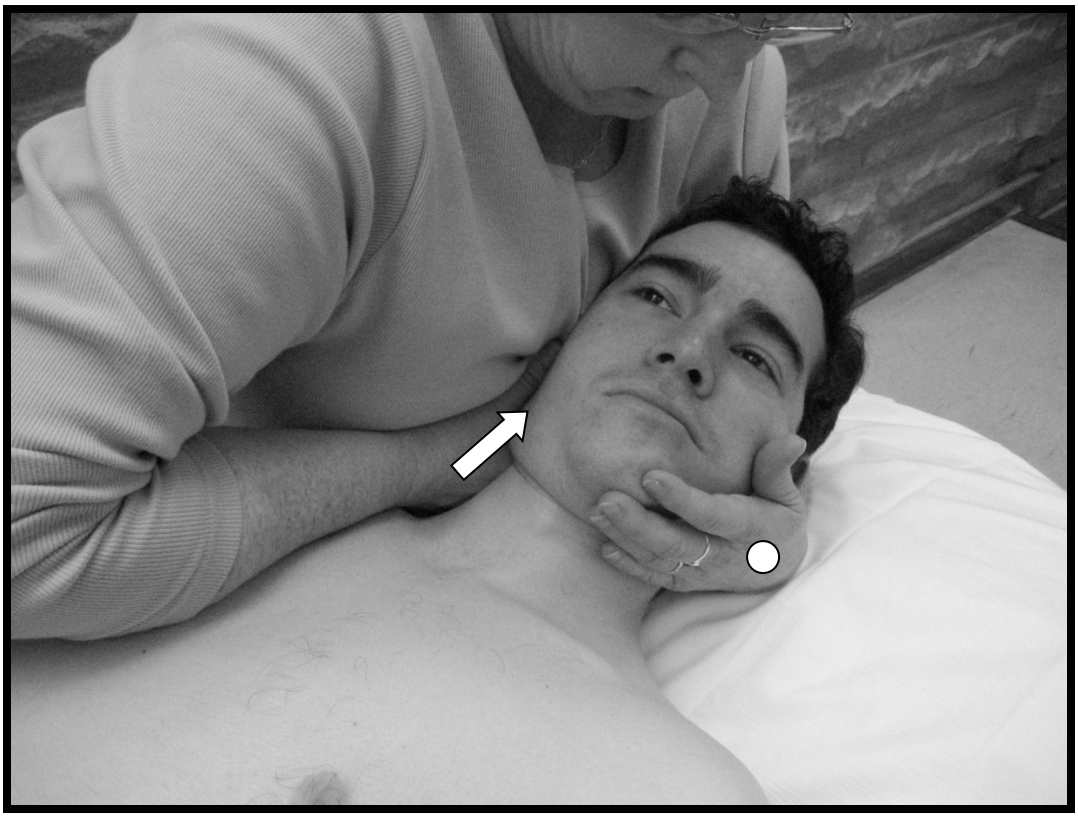
•Accentuate the side flexion component first, as there will be less rotation required

•Maintain the side flexion component as you add the contralateral rotation
- continue to add slight side flexion while adding rotation
- rotate around a vertical axis through the head once side flexion is complete

•Engage the barrier of restriction at the dysfunctional segment

•Then add a lock below, if needed, using lateral translation

Mid-Cervical Spine
Axial traction (Level 4)



Technique described for the C3-4 segment on the right

Axial Traction: Produces an element of Z joint distraction, especially in the upper mid-cervical spine where the joints are more horizontally oriented. To gain flexion or extension on side of thrust

***Patient*:** Supine, lying near right side of bed on side, head resting on pillow

***Therapist*:** Stands at the right side of bed. The left hand and forearm cradles head. Joints above the level to be treated are locked using incongruent movements. Can flex below to get ligamentous tightening. The MCP of the right index finger fixes under the transverse process/lamina of C3.

***Technique*:** As patient exhales take up the slack in vertical traction. High velocity, low amplitude thrust in a vertical direction.

Mid-Cervical Spine
Distraction
Thrust Caudal Vertebrae (Level 5)

Technique described for the right C3-4 Z-Joint

Patient: Supine lying, head resting on pillow

Therapist:

Stands at head of bed

Left hand and forearm cradles head,

Joints above are locked using contralateral coupling

(left side flexion and right rotation will encourage more distraction at the joint, but is more difficult to maintain the lock)

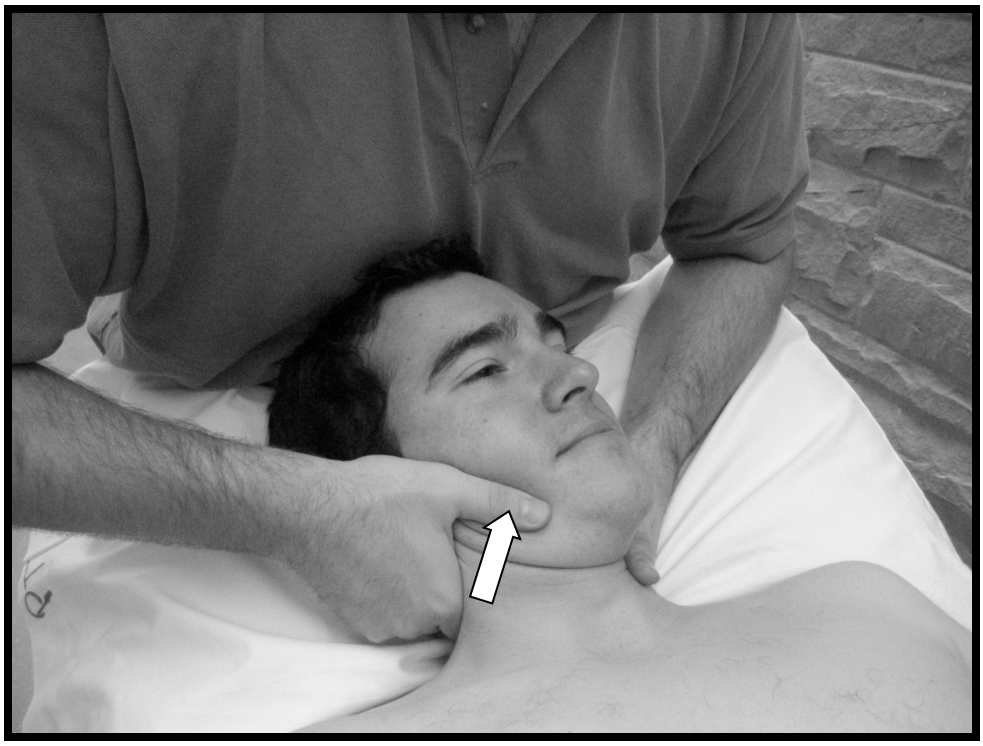
Metacarpal phalangeal joint of the right hand placed on lamina of the C4 vertebra

Technique: High velocity, low amplitude thrust applied to the caudal vertebra in an anterior / inferior direction

Mid-Cervical Spine

Unilateral Flexion Superior Glide (Level 4)

(Osteokinematic Motion)



Technique described for the C3-4 on the right

•to gain anterosuperior glide of Z joint

•combines flexion/rotation/side flexion away from affected side

Patient: Supine, head resting on pillow

Therapist: Stands at head of bed. Radial border and MCP of the right index finger along lamina of C3. The left hand cradles the neck and head at the level of superior vertebra or above.

Technique**:** Lock levels above the restricted level using incongruent movements side bend right, rotate left, keeping the C3-4 joint in neutral.

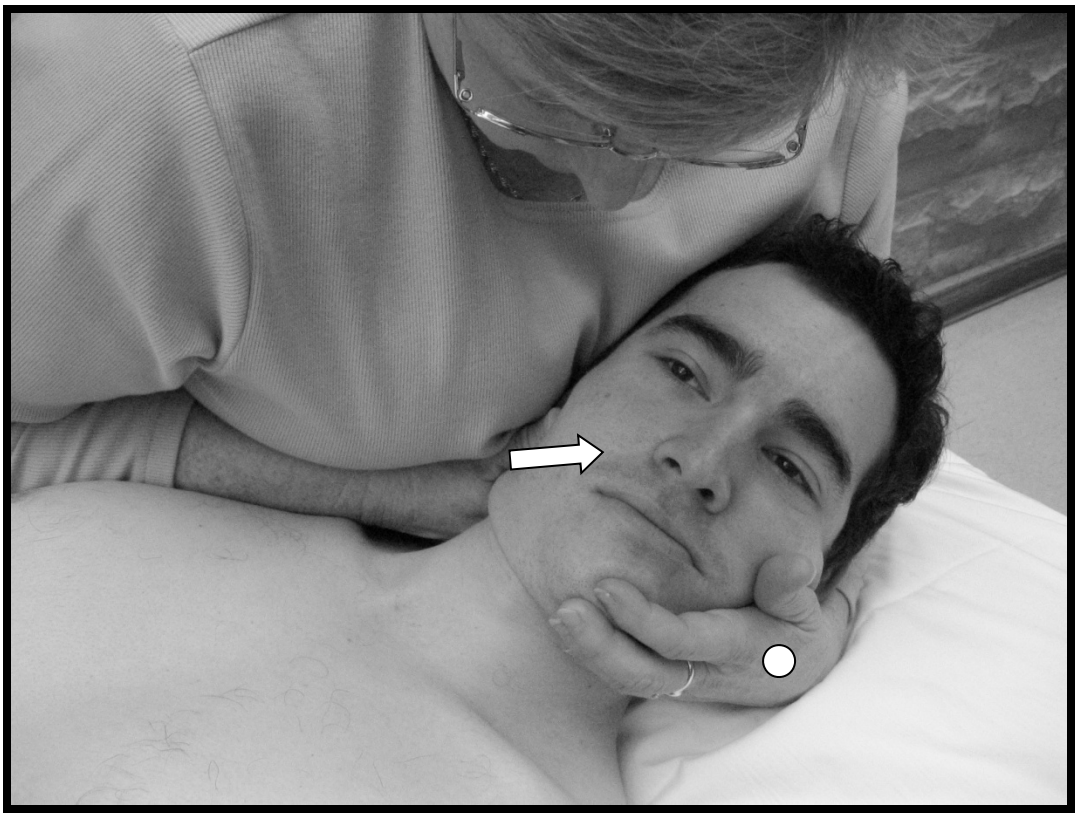
Take up flexion barrier at C3-4 and add a anterosuperior glide, maintaining lock above.

High velocity/low amplitude thrust in a superior/anterior direction toward opposite eye. Accomplished through pro/supination motion of therapist's hands. Emphasis is with hand on side of restricted joint

Mid-Cervical Spine

Unilateral Flexion (Level 4)

Anterior-Superior Facet Glide



Technique described for the C3-4 on the right

Patient: Supine, lying near side of bed, on side of restricted Z joint, head resting on pillow

Therapist: Stands at side of bed. Left hand and forearm cradles head. The MCP joint of the right index finger fixes under the lamina of C3 at the side of neck.

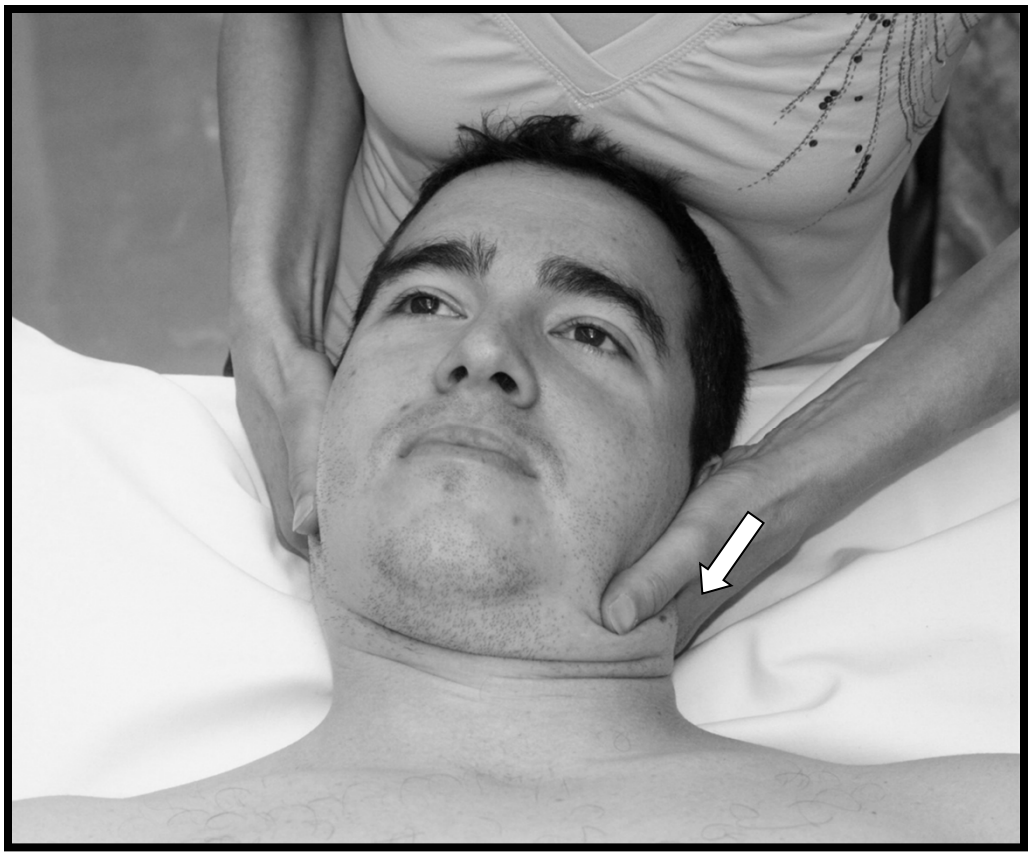
***Technique*:** Joints above the level to be treated are locked using incongruent movements. Can flex below to get ligamentous tightening. The right forearm in the line of the force of anterior-superior glide.

Take up flexion barrier at C3-4 and add a anterior-superior glide, maintaining lock above.

A high velocity/low amplitude thrust is applied in a superior-anterior direction towards the opposite eye.

Mid-Cervical Spine

Unilateral Flexion – Indirect Technique (Level 5)



Technique described for the right C3-4 facet

Patient: Supine, head supported on pillow

Therapist: Radial borders of both index fingers along lamina of C3

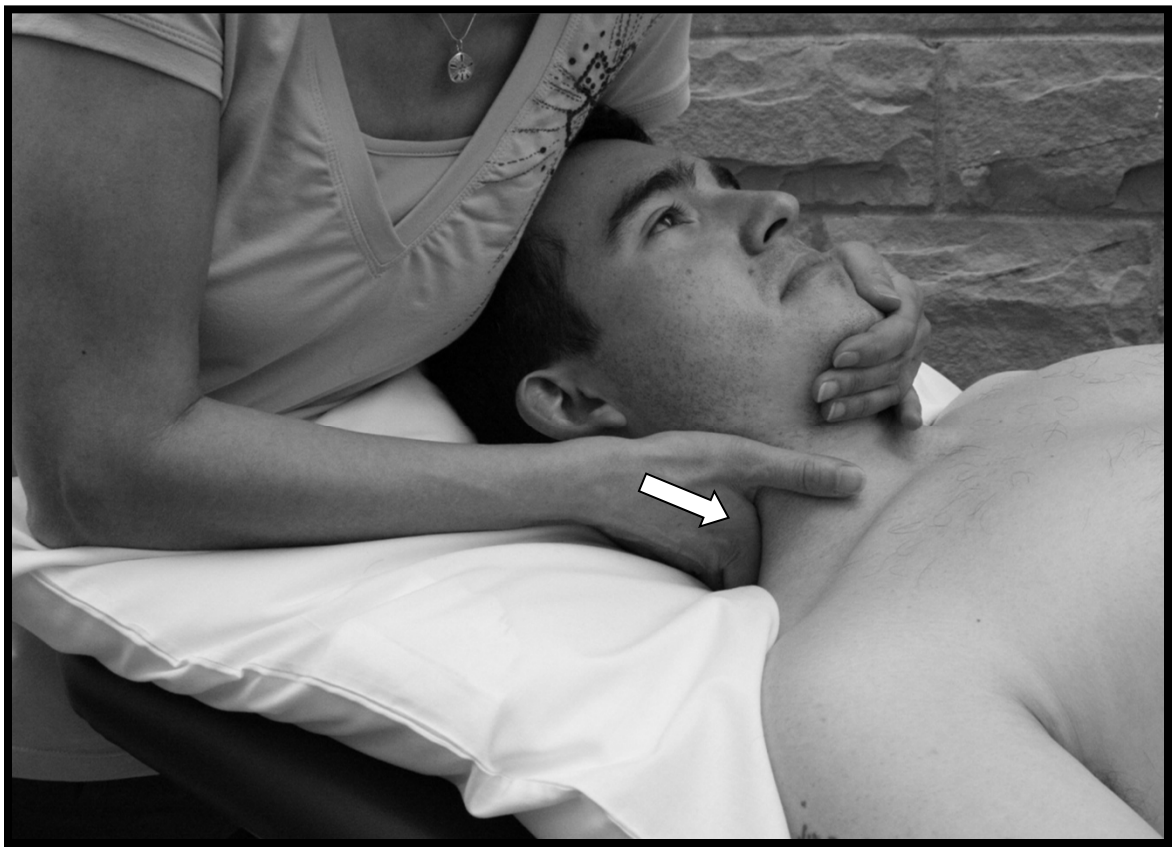
***Technique*:** tighten above with incongruent lock of left side bend and right rotation to C2-3.

Flex C3-4 (to move away from extension of the left C3-4). The motion barrier of the right C3-4 is obtained by further **flexion**, left side flexion and left rotation.

Can laterally translate toward restricted side to tighten up below if needed.

High velocity, low amplitude thrust applied in a inferior-medial-posterior direction on the left lamina of C3. This tilts the vertebra causing flexion (superior glide) on the right side.

Mid-Cervical Spine
Unilateral Flexion
Thrust Caudal Vertebrae (Level 5)



Technique described for the right C3-4 facet joint

Patient: Supine, lying near side of bed, head resting on pillow

Therapist: Left hand and forearm cradles head. Place the metacarpal phalangeal joint of right hand onto the lamina of C4.

Technique: Left side bend and right rotate to C2-3.

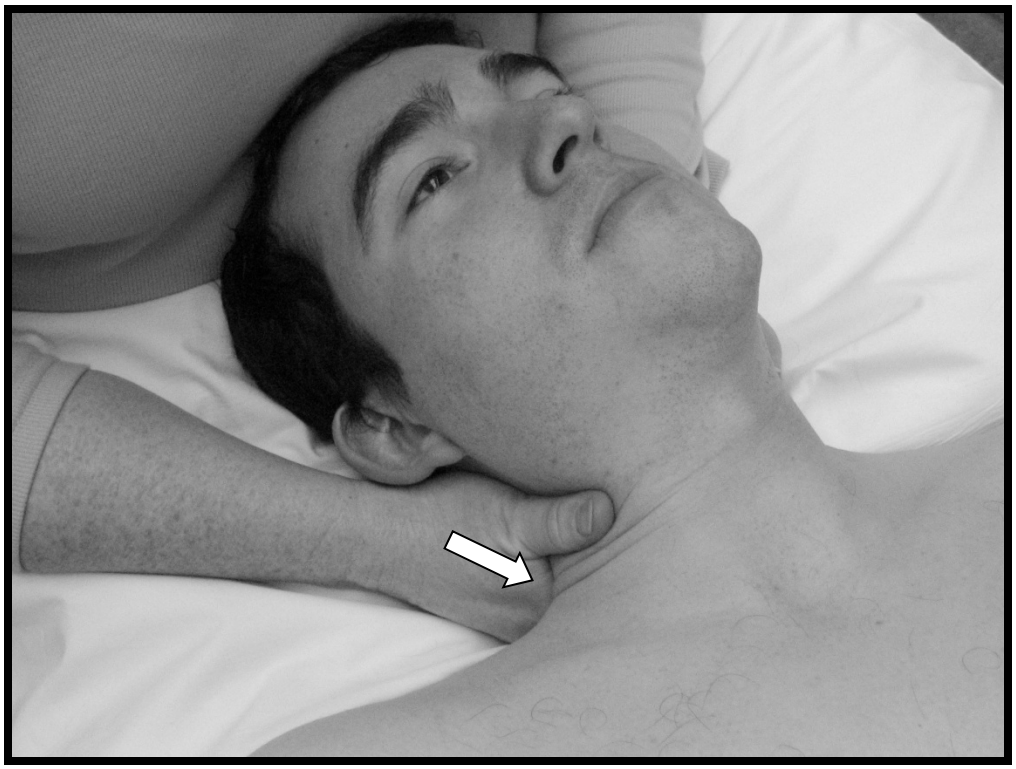
Motion barrier is engaged through flexion, left side flexion and left rotation at C3-4 on the right.

High velocity, low amplitude thrust applied to C4 in an inferior-medial-posterior direction with the right hand.

Mid-Cervical Spine

Unilateral Extension (Level 4)

Posterior-Inferior Glide



Technique described for the right C3-4 segment

•to gain posterior/inferior glide of Z joint

•combines extension/rotation/side flexion toward affected side

***Patient*:** Supine, head resting on a pillow

***Therapist*:** Stands at head of bed. Place the right index finger and MCP joint along the right lamina of C3. The left hand cradles neck and head at level of the superior vertebra or above.

***Technique*:** Joints above the level to be treated are locked using incongruent movements (side flexion towards and rotate away). Can flex below to get ligamentous tightening or can use lateral translation to opposite side

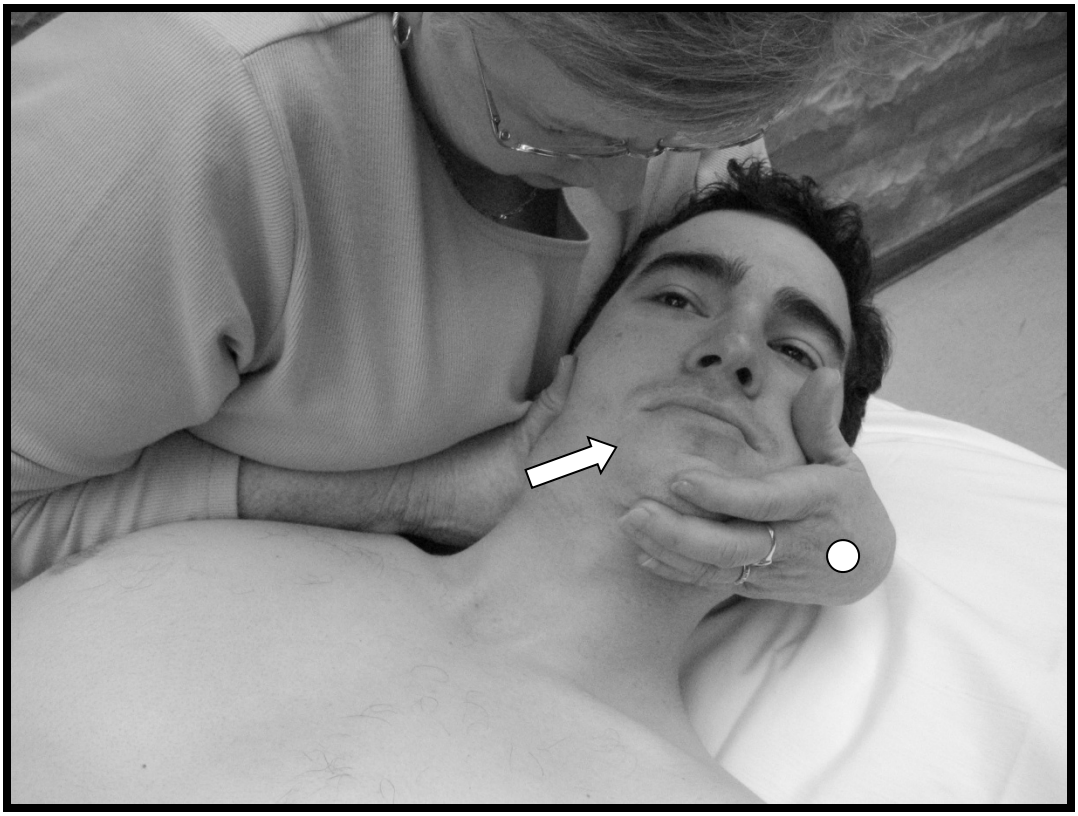
Engage the barrier of extension on the right C3-4 segment by using Inferior-posterior-medial glide, maintaining the lock above

High velocity/low amplitude inferior-posterior-medial thrust on side of lesion.

Mid-Cervical Spine

Unilateral Extension

Superior Thrust Caudal Vertebrae (Level 5)



Technique described for the C3-4 segment on the right

Patient: Supine, head resting on pillow

Therapist: Stands on the right side. Left hand and forearm cradles head and neck, with the arm fixed on bed to avoid traction. The MCP joint of the right hand is placed on the lamina of C4. Arm parallel to the spine.

***Technique*:** Joints above C3-4 are locked using incongruent movements (Side flexion towards and rotation away).

Motion barrier of extension is engaged by further right side bend at the affected joint.

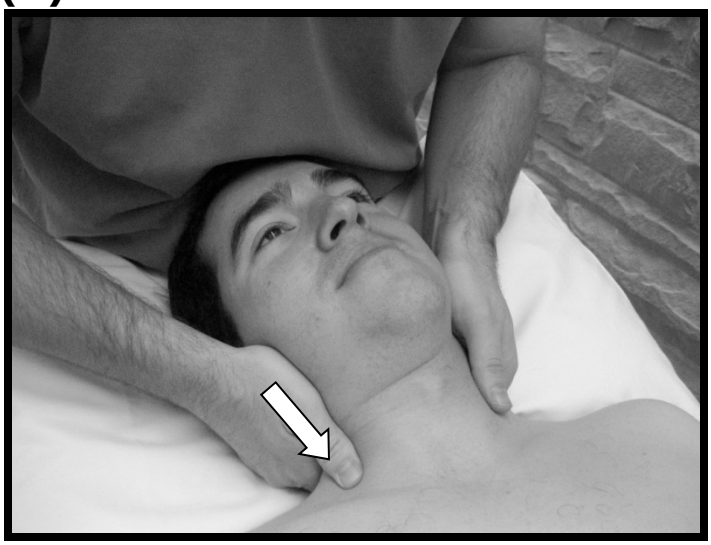
High velocity, low amplitude thrust is applied to C4 in a anterior-superior direction. The arm cradling the head remains stationary

Mid-cervical Spine

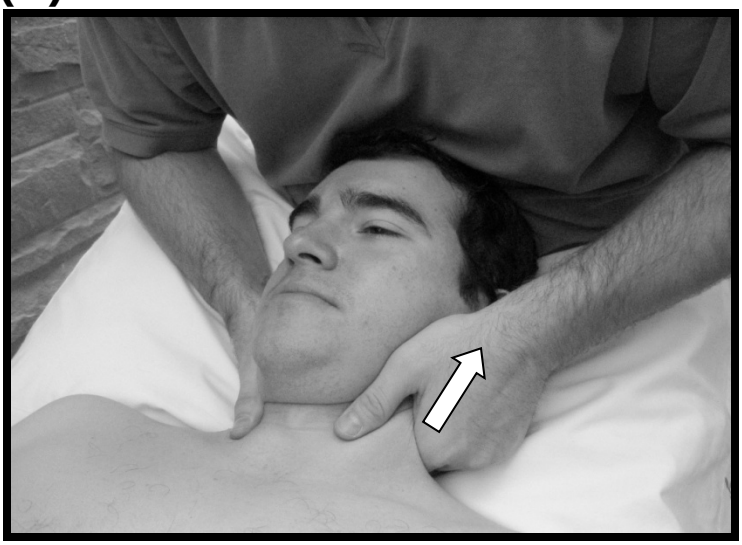
U Joint Manipulation Level 5

Side Flexion Manipulation

(A)



(B)



Side flexion technique to regain right SF at the C3-4 U joint

Patient**:** supine, head resting on pillow

Therapist**:** stands at head of bed. Place both index fingers along the lamina of the C3 vertebra.

Technique**:** tighten above using an incongruent lock, side flexion to the right, rotation to the left.

Engage the motion barrier by right side flexing C3 on C4 while also translating C3 to the left on C4. At this point the caudal joints can be tightened with left lateral translation as needed. An anterior or posterior vector component can be added depending on the plane of the restriction noted in assessment, and the best barrier obtained.

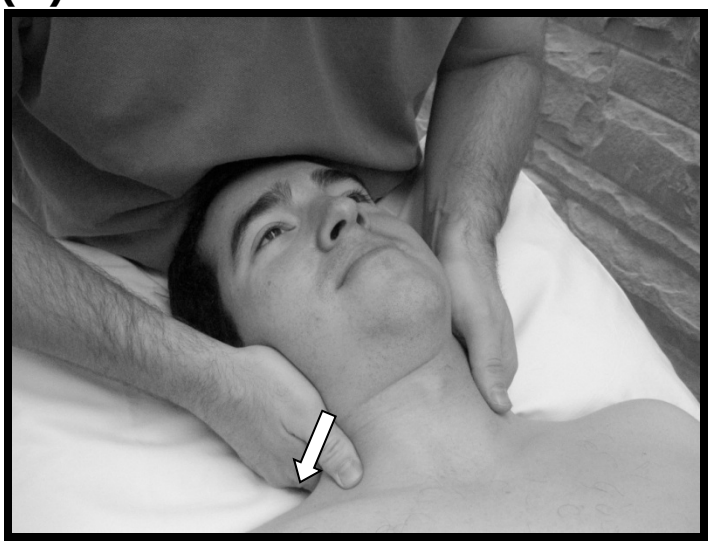
The high velocity, low amplitude thrust is a 2 handed technique into side flexion with a bias toward the side of restriction, incorporating the slight anterior or posterior vector as determined above.

Mid-cervical Spine

U Joint Manipulation (Level 5)

Anterior / Posterior Thrust

(A)



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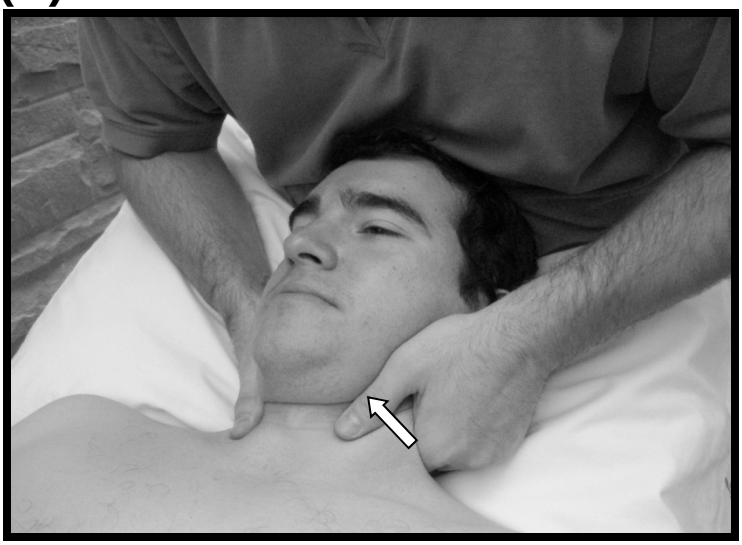


Technique *eg.* to regain right SF at the C3-4 UV joint

Patient**:** supine, head resting on a pillow

Therapis**t:** stands at head of bed. Place both index fingers along the lamina of the cranial vertebra

Technique**:** this technique can be done as an unlocked or locked technique

Engage the motion barrier by laterally translating the cranial vertebra away from the direction of the SF restriction (to the left in this example). The barrier of either posterior glide on one side or anterior glide on the other side is engaged, depending on the side of restriction

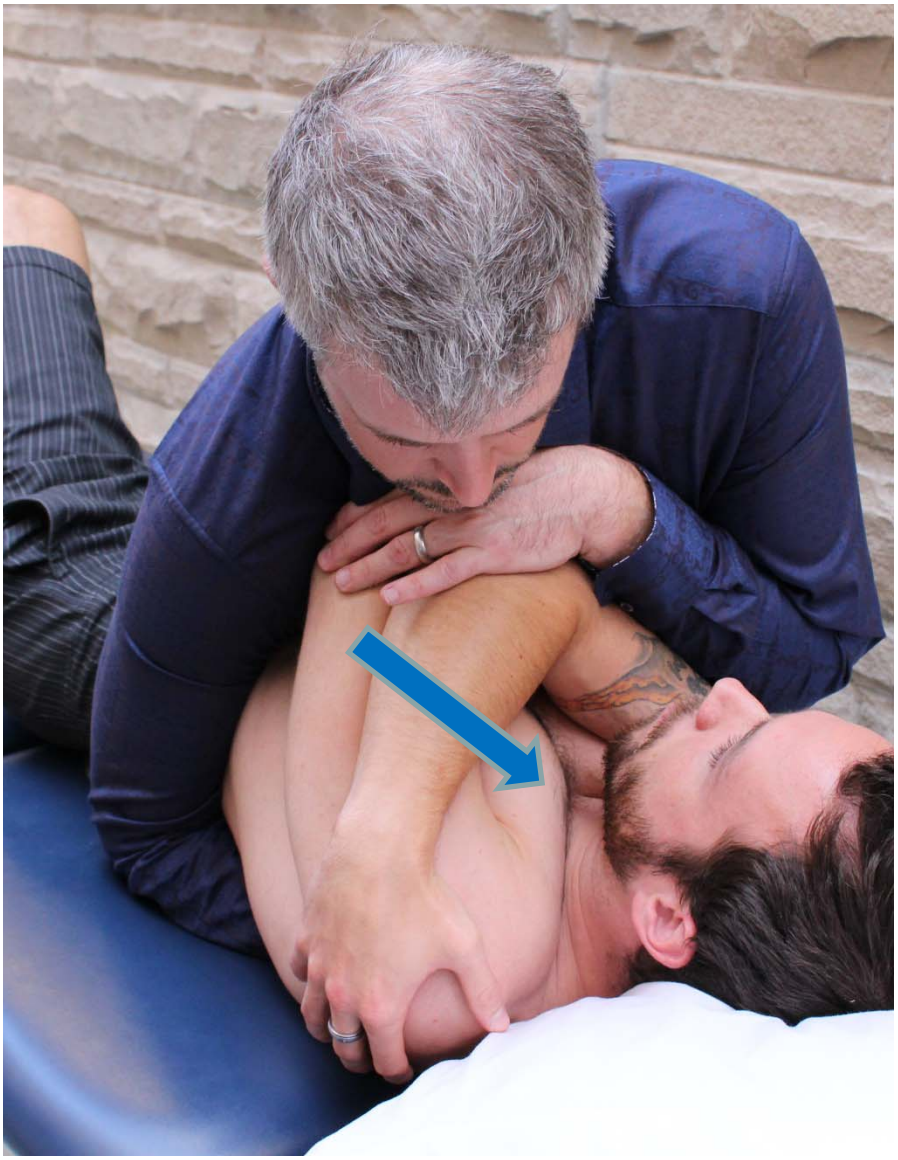
Apply a high velocity, low amplitude thrust in the A/P plane. If the restriction is on the right (A), the thrust is posterior with a slight inferomedial component. If the restriction is on the left (B), the thrust is anterior with a slight superolateral component.

CT Junction
Axial Traction (Level 4)

Patient: Standing or sitting with hands behind neck, fingers interlaced.

Therapist: Stand behind patient, interlock your arms with patient's so that your thumb(s) reach posteriorly to the cranial spinous process of the joint to be treated. Check to make sure patient is not in too much forward head posture. May want to place a rolled towel at the segment below to maintain better contact.

Technique: Apply a vertical traction thrust to the cranial bone. This is assisted by rocking the patient back toward you.



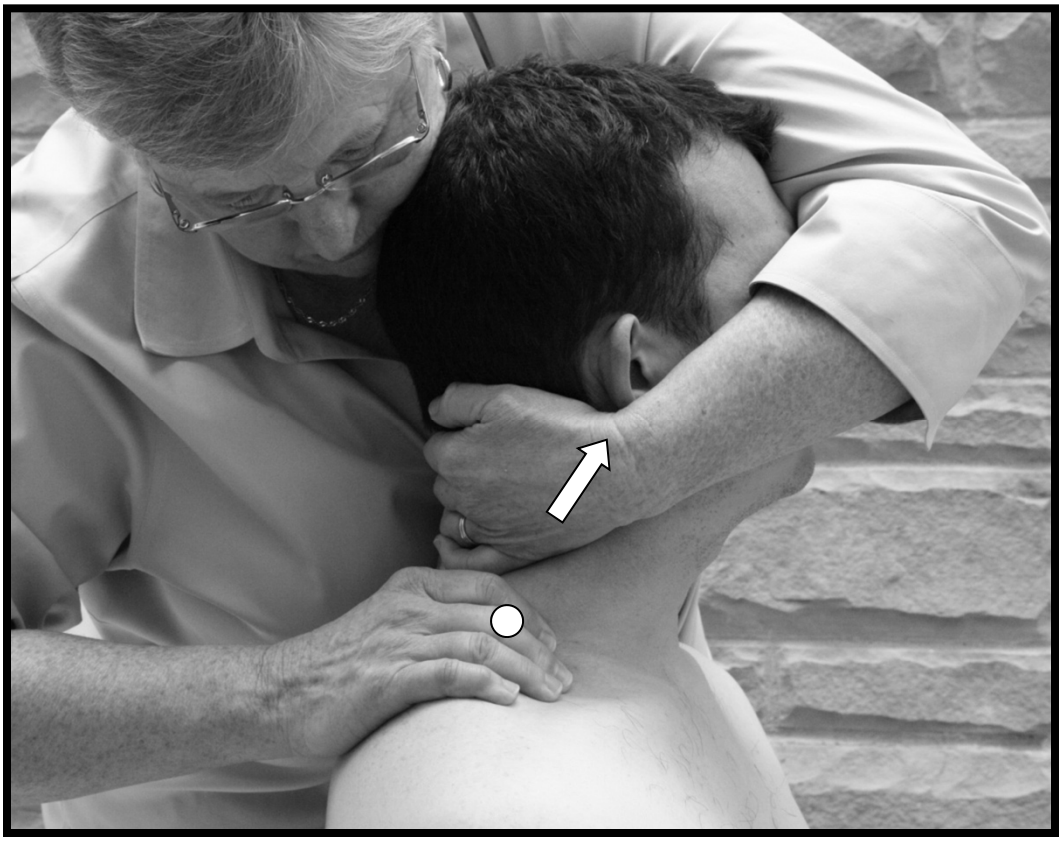
CT Junction Axial Traction
Alternate Technique (T1-2, T2-3)

Patient: Supine, hands interlaced behind neck or head.

Therapist: Stand beside patient. Roll the patient toward you. Cranial arm supports and controls the patient's forearms and the other hand is placed over the transverse processes of the caudal bone. The patient is rolled back into supine. Flex to tighten above.

Technique: A thrust is applied through the patient's forearms in the direction of axial traction (cranial).

CT Junction
Unilateral Z Joint Superior Glide (Level 5)



Technique described for the right T1-2 Z joint

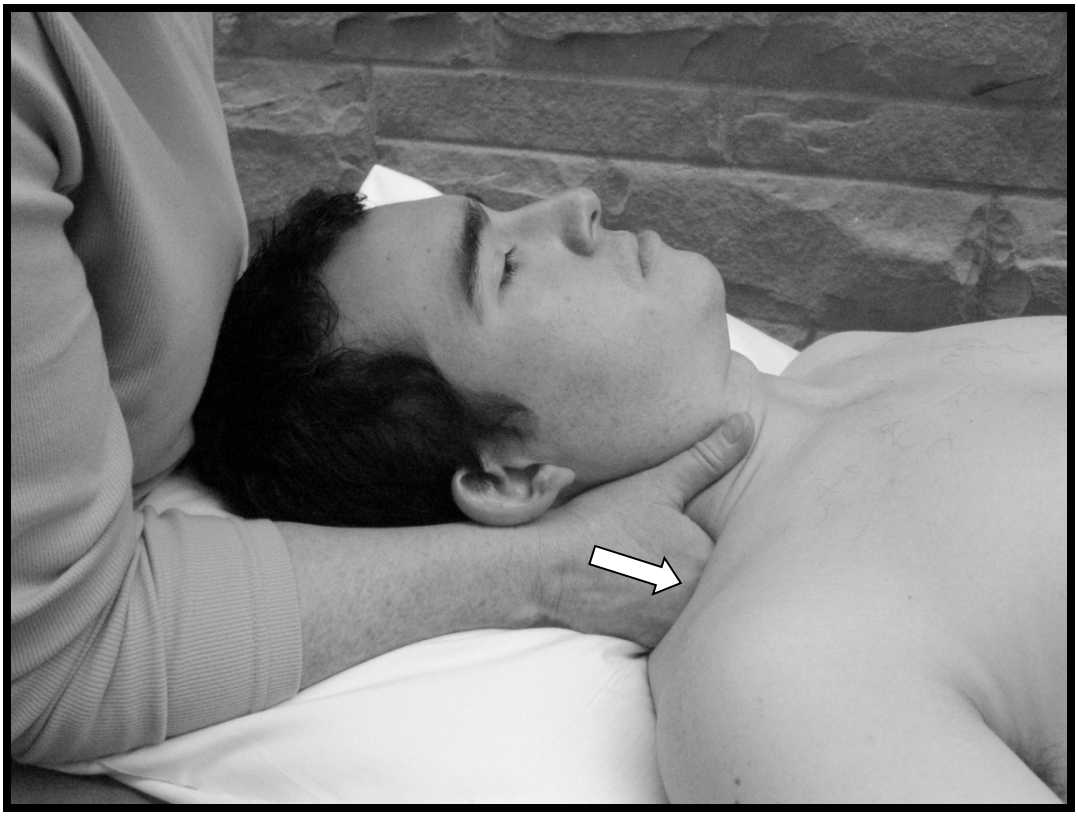
Patient: Sitting

Therapist: Stand on the patient's left side. Reach around with the left hand and place the ulnar border of the little finger over the right transverse process of T1. The right hand stabilizes the spinous process of T2 and can come around to the anterior clavicle to improve stability.

Technique: The cranial chain of bones is locked by side flexing the head/neck to the right and rotating to the left. C7-T1 is locked.

The left hand applies a high velocity low amplitude thrust, "lifting" the transverse process of T1 into slight flexion/left rotation.

CT Junction
Unilateral Z Joint Inferior Glide (Level 5)



Technique described for the right T1-2 Z joint

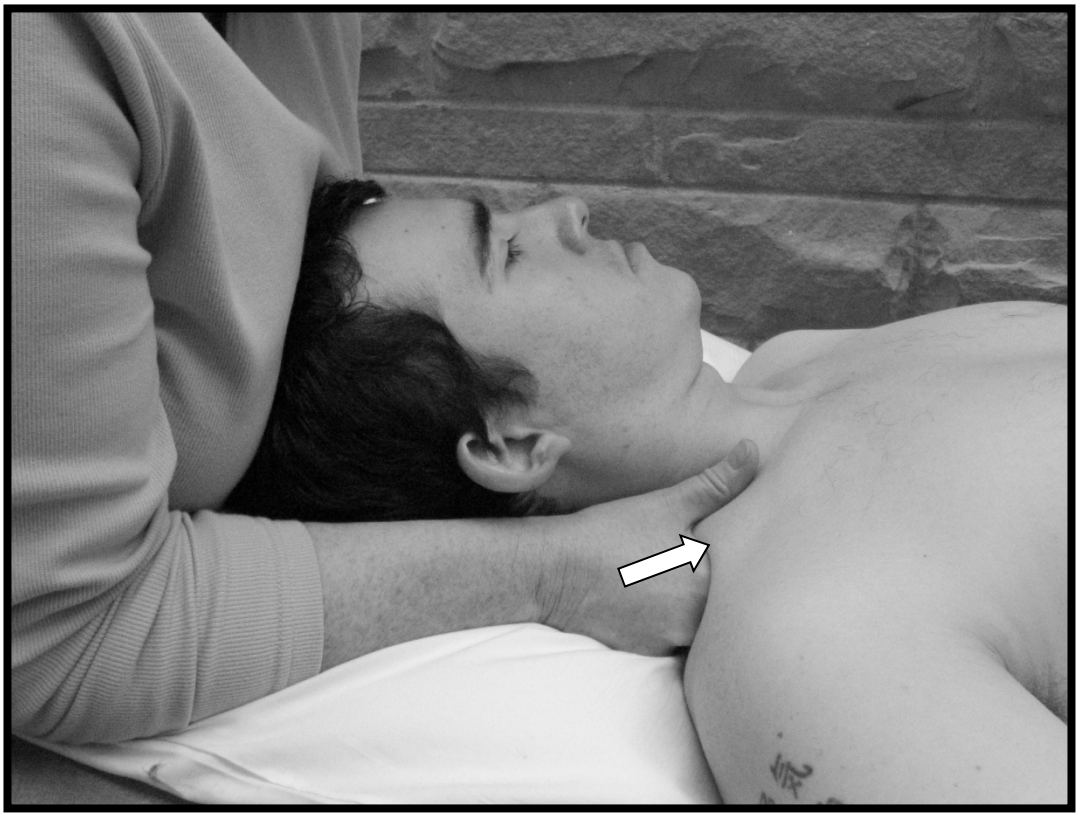
Patient: Supine, head resting on a pillow

Therapist: Stands at head of bed. The radial border of the right index finger palpates the right lamina and transverse process of T1. The left hand cradles the head and neck on the left side.

Technique: The head and neck are side flexed to the right to C7-T1 and rotated to the left.

The barrier of extension, right rotation/side flexion is located at T1-2 and thrust is applied in an inferior-medial-posterior direction with the right hand.

CT Junction
Inferior Glide of the First Costotransverse Joint (Level 4)



Technique described for the right first rib

Patient: Supine, head on a pillow

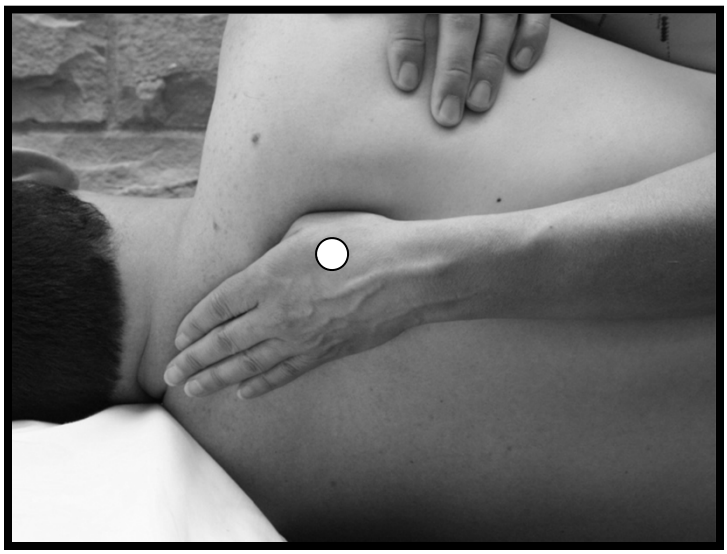
Therapist : Stand at head of bed. Place the radial border of the MCP of the right index finger over the superior portion of the first rib, just lateral to the transverse process of T1

Technique: Lock CT junction including T1-2 with right side flexion and left rotation.

The left hand applies traction to the spine as a high velocity, low amplitude thrust is applied by the right hand to the first rib in an anterior-inferior-medial direction.

CT Junction

Distraction of the First Costotransverse Joint (Level 5)



Technique described for the right first rib

Patient: Supine, arms crossed

Therapist: Place left scaphoid over the right rib angle and the 3rd MCP base on the left transverse process of T1. The right transverse process of T1 should not be blocked.

Technique: Roll patient back over your hand. The thrust is applied through patient's arms in a posterior direction.

Thoracic Localization

Localizing Principles

- Two contact points of therapist's hands are used for fixation
  - pistol grip: scaphoid tubercle and knuckle of 3rd finger
  - flat hand: scaphoid tubercle and 1st metacarpal phalangeal

- Flex the thumb into palm of flat hand (for costal treatment)

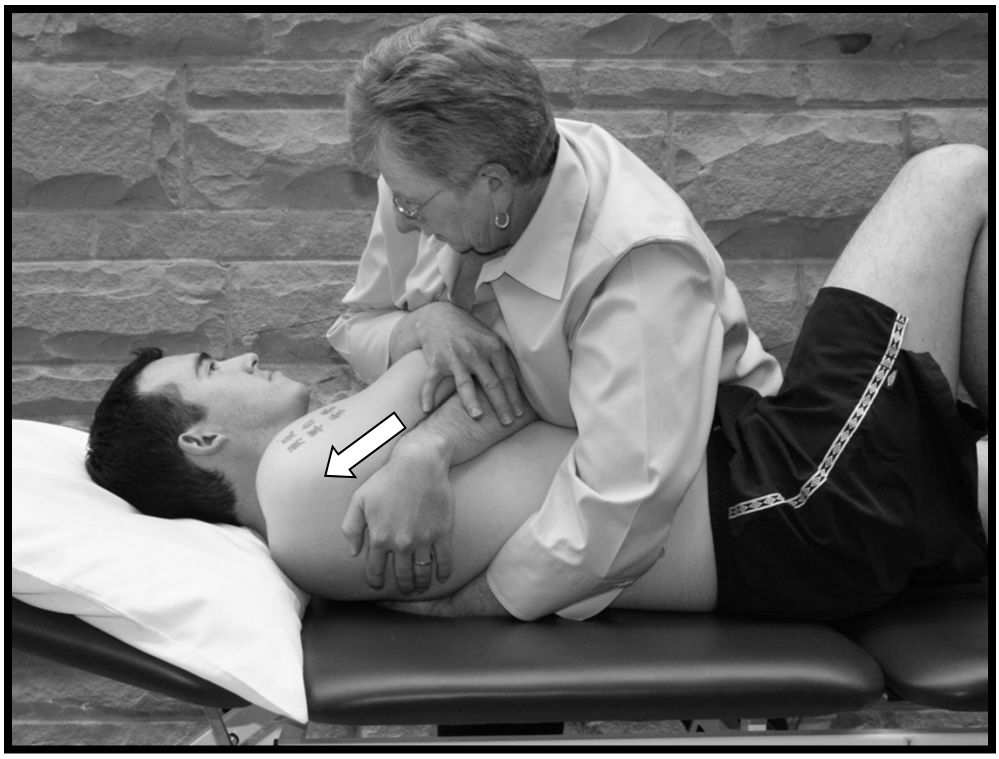
- For supine techniques use flexion to increase ligamentous tension in the cranial lever

Technique

- Thrust on adjacent vertebra using contact points on hand for fixation

- Can also use towel fixation to localize the thrust towards a specific level with sitting techniques

Thoracic Spine
Bilateral Flexion (Level 4)



Technique described for the T4-5 segment

Patient: Supine arms crossed to opposite shoulders

Therapist: Standing facing the patient. Roll patient toward you. With tubercle of left scaphoid bone and PIP of long finger, palpate the transverse processes of the T5 segment. The other hand/ arm lies across the patient's arms to control the thorax

Technique: To isolate the neutral position, flex the joint to the motion barrier and then return the joint to the neutral with the hand controlling the thorax. Maintain this neutral position and roll the patient supine, only until sufficient contact is made between the dorsal hand and the table.

Fix the caudal hand , take up the barrier of motion in a cranial direction and apply a high velocity low amplitude superior thrust through the thorax.

Thoracic Spine

Bilateral Extension (Level 4)

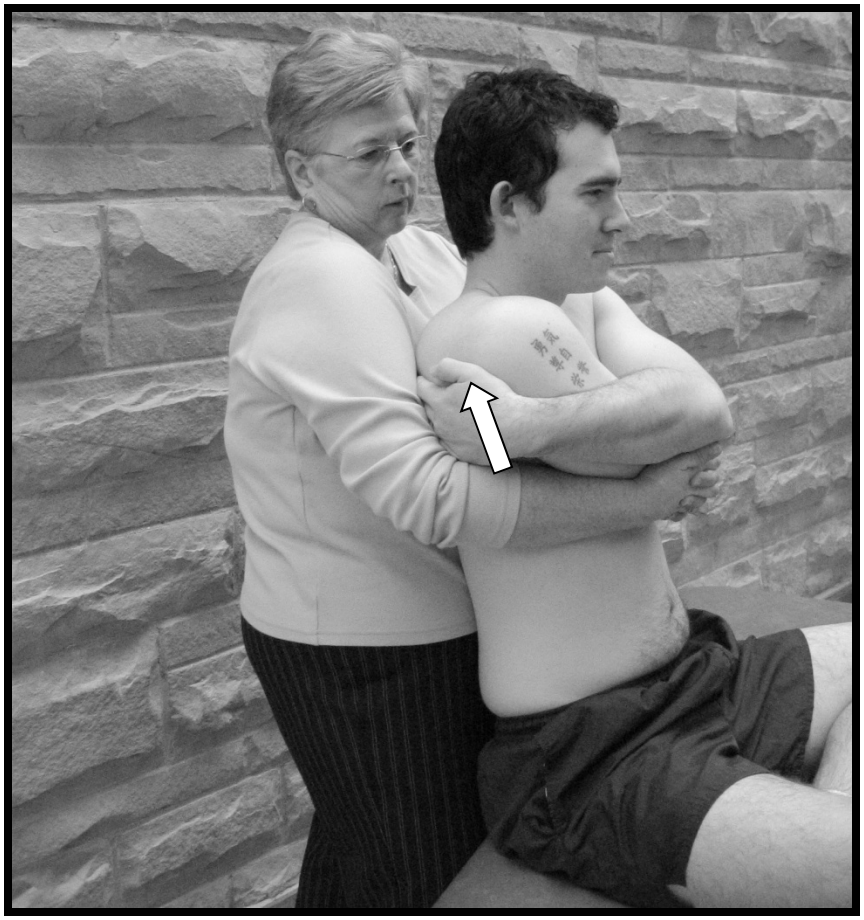
Technique described for the T4-5 Segment

Patient: Supine, arms crossed over shoulders

Therapist: Stand beside patient. Standing facing the patient. Roll patient toward you. With tubercle of left scaphoid bone and knuckle of long finger, palpate the transverse processes of the T5 segment. The other hand/ arm lies across the patient's arms to control the thorax. Flex thorax up to T 3-4 leaving T 4-5 neutral. The barrier of extension is engaged partly by lifting **anteriorly at T5 (**by extending the wrist.)

Technique: A high velocity, low amplitude thrust is delivered in a posterior direction towards the floor.

Thoracic Spine
Sitting Axial Traction (Level 4)



Technique described for the T4-5 segment

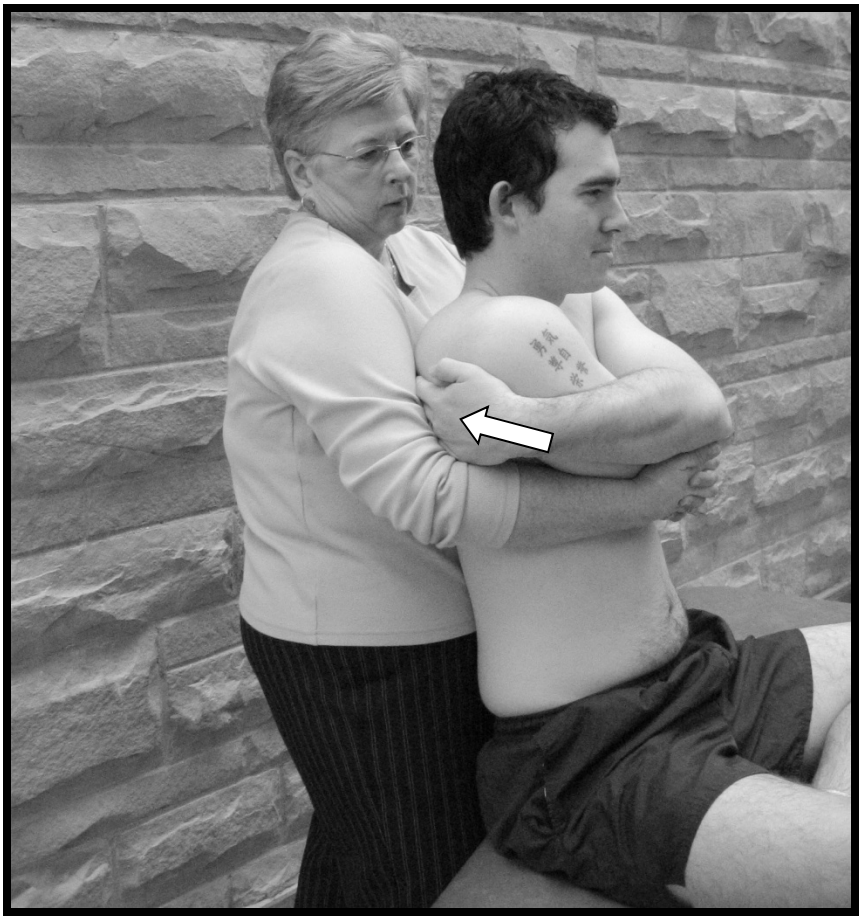
Patient: Seated, arms crossed over shoulders or folded in front of chest. A rolled towel is placed at the level of the spinous process of T5.

Therapist: Stand behind patient and reach around thorax to grasp under forearm or elbow closest to the chest. Therapist to adduct shoulders to ensure a firm hold on patient's thorax.

Technique: Stabilize the towel against patient's back, rock patient back and apply a high velocity vertical thrust through the arms and thorax

Thoracic Spine

Z Joint Distraction (Level 4)



Technique described for the T4-5 segment

Patient: Seated, arms crossed over shoulders or folded in front of chest. A rolled towel is placed at the level of the spinous process of T 5

Therapist: Stand behind patient and reach around thorax to grasp under forearm or elbow closest to chest. Therapist to adduct shoulders to ensure a firm hold on patient's thorax.

Technique: Stabilize the towel against patient's back, rock patient back and apply a high velocity posterior thrust through the arms and thorax

Thoracic Spine
Unilateral Z Joint Flexion (Level 4)

Technique described for the right T4-5 Z joint

Patient: Supine, arms folded over shoulders

Therapist: Stand on the patient's left side. Roll patient towards you and place one fixation point of your left hand over the right transverse process of T5 and the other over the left transverse process of T4. Grasp across patient's folded arms with the right hand. Flex to tighten above. Take up the barrier in left side bending, rotation and flexion.

Technique: A high velocity, low amplitude thrust is delivered in a cranial direction, toward the patient's right shoulder.

Thoracic Spine
Unilateral Z Joint Extension (Level 4)

Technique described for the right T4-5 Z joint

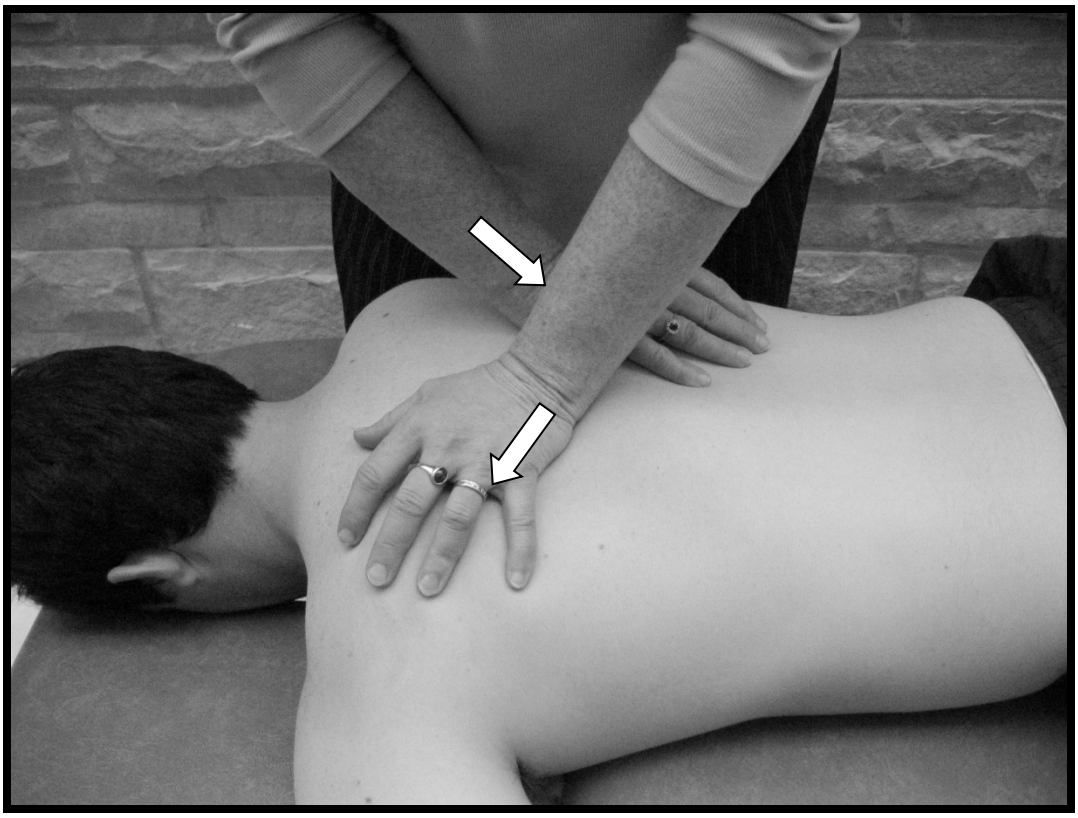
Patient: Supine, arms folded over shoulders

Therapist: Stand on the patient's left side. Roll patient towards you and place one fixation point of your left hand over the right transverse process of T5 and the other over the left transverse process of T4. Grasp across patient's folded arms with the right hand.

Technique: Flex to tighten above. Take up the barrier in right side bending, rotation and extension. A high velocity, low amplitude thrust is delivered in a posterior and slightly inferior direction.

Thoracic Spine

Rotation in Prone (Osteokinematic Technique) (Level 5)



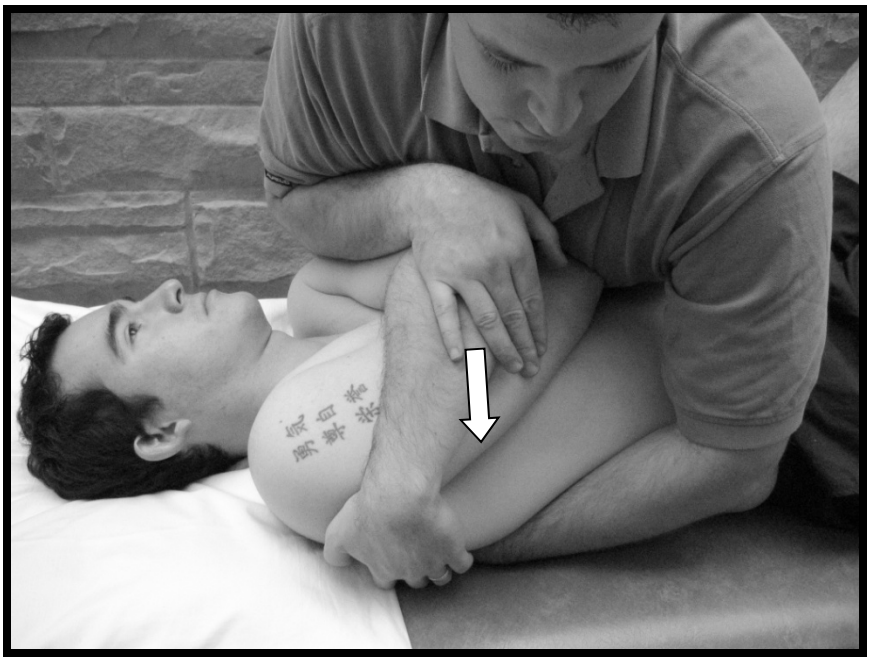
Technique described to induce right rotation the T4-5 segment

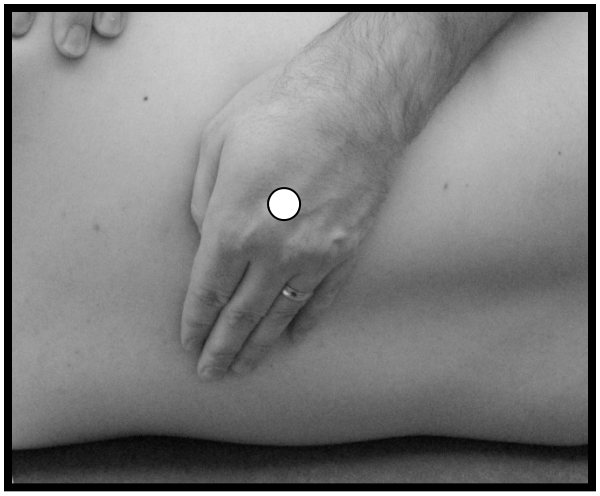
Patient: Prone lying

Therapist: Place the left pisiform on the left transverse process of T4 and the right pisiform on the right transverse process of T5. The slack is taken up with an oblique postero-anterior pressure from both hands.

Technique: An oblique high velocity, low amplitude P/A thrust is applied with the left hand. A counter force is applied with the right hand.

Thoracic Spine
Unilateral Rib Distraction (Level 4)





Technique described for the right fifth rib

Patient: Supine, arms folded

Therapist: *Stand* on the patient's left side. Place one fixation point of your left hand over the left T5 transverse process and the other point over the right 5th rib, just lateral to the right transverse process. (One option is for the therapist to place the radial border of the thumb along the rib, with the tip of the thumb abutting but not covering the ipsilateral transverse process. The fingers are left extended and the index finger is laid across to span the transverse process on the left side. Or, the pistol grip can be widened to span the rib and TP).

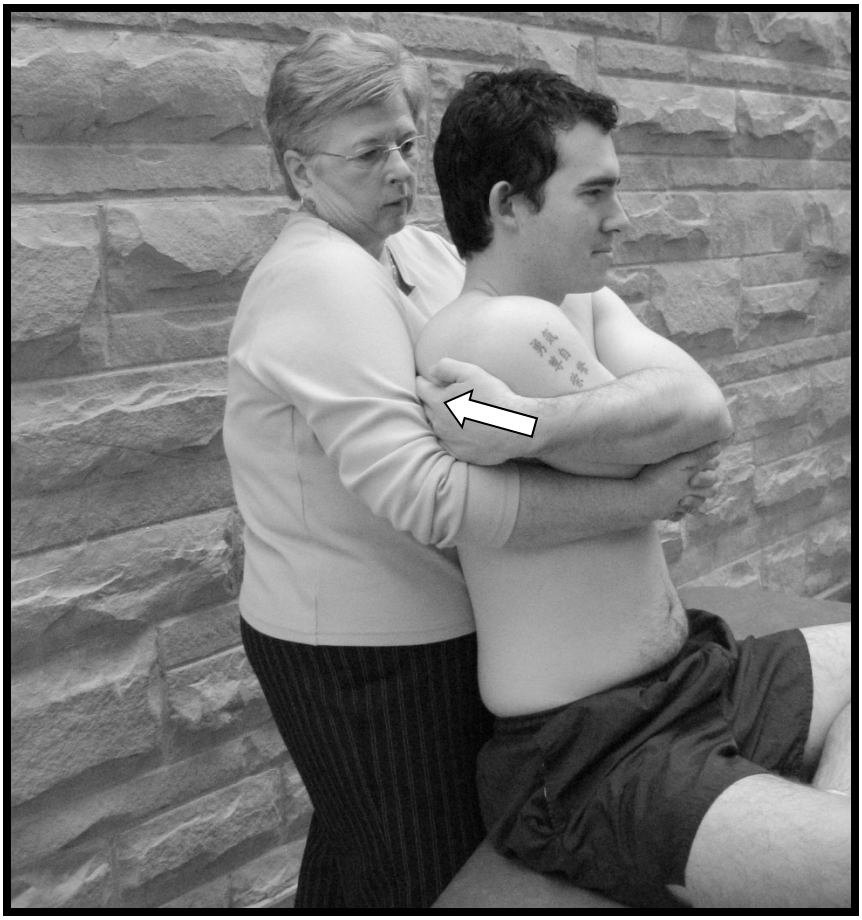
Technique: The manipulation can be facilitated by positioning the thorax in slight side bending toward the affected side to relax the soft tissue on that side.

The thrust is delivered as patient is rolled back into supine and is best timed as therapist's fixating hand contacts the table. The thrust is applied over the affected rib in a posterior direction

Modification: (**Level 5)**

Cranial glide of the CT joint can be facilitated by thrusting in a slightly caudal direction. The thrust glides the vertebra inferiorly on the fixed rib. Caudal glide of the CT joint can be facilitated by thrusting in a slightly cranial direction, gliding the vertebra superiorly on the fixed rib.

Thoracic Spine
Unilateral Rib Distraction (Level 4)



If patient cannot tolerate supine lying, the costotransverse joint can be manipulated using a similar technique to the thoracic traction technique in sitting.

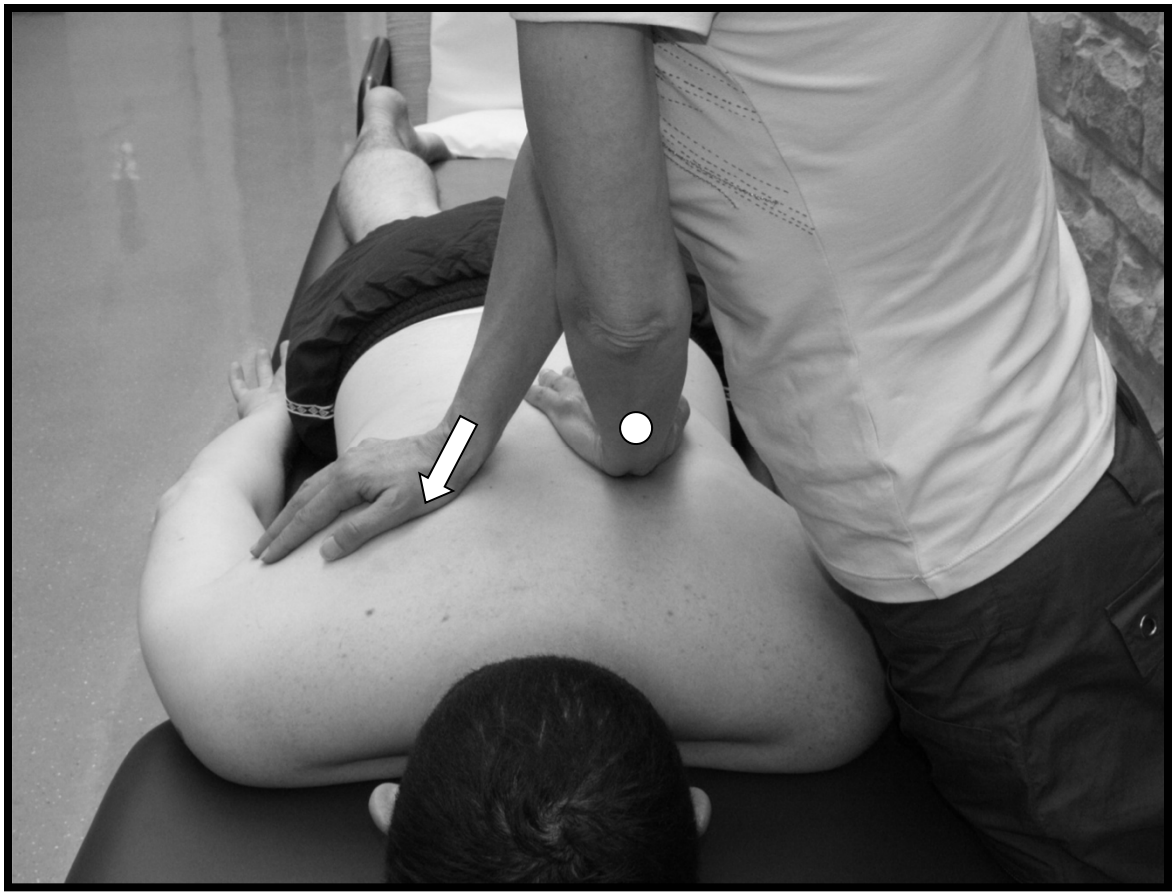
Patient: Seated. Arms folded across chest. The towel is placed over the posterior aspect of the affected rib

Therapist: Stand behind patient and reach around thorax to grasp under forearm or elbow closest to chest.

Technique: A posterior/superior thrust is applied to the thorax.

Thoracic Spine

Distraction Manipulation of the Costotransverse Joint (Level 5)



Technique described for the right 6th rib

Patient: Prone

Therapist: Standing on the left side. With the left hand fix the left TPs of T5 and T6. Place the pisiform of the right hand over the posterior aspect of the right 6th rib medial to the rib angle.

Technique: High velocity, low amplitude thrust is applied in a posterior/anterior/lateral direction mostly with the right hand.

Lumbar Spine Locking and Localization

Locking Principles

- Obtain a tensioned lever by using combined side flexion and rotation
- The cranial (upper) lever is usually locked using a facet lock
- Avoid pure rotation as it creates excessive compression on the downside zygapophyseal joint
- Rotation and side flexion may be coupled ipsilaterally or contralaterally to produce a facet lock and may be combined with either flexion or extension
- In the lumbar spine, rotation always occurs in the direction opposite the side the patient is lying on, therefore the direction of side flexion is the variable factor
- Be careful not to stand where you might block the lever being used to thrust
- "Economy of vigour" is important

- Utilize a compression vector by leaning on the patient's trunk
  - maintains lock and tightens up barrier
- Be sure to use trunk motion (usually a hip and trunk rotation) to thrust
- Use a knee bend motion to incorporate a dropping force into your thrust

Choosing a Locking Technique

Many factors influence the choice of locking technique:

- level of spine being treated
- comfort, both thoracic and lumbar regions
- hypermobilities above and below treated level
- combined movements that produce best barrier to manipulate
- motion to be regained

Locking Technique

Vary angle of pull on patient's bottom arm to encourage desired movement

- Rotation: constant, always opposite to side-lying on
- Extension: pull vertically towards the ceiling
- Flexion: pull horizontally forward, parallel to the floor
- Ipsilateral side flexion: pull cranially, toward the head
- Contralateral side flexion: pull caudally, toward the feet

Biomechanics of Lumbar Manipulation (options)

To Gain Zygapophyseal Joint Motion

- lie patient with stiff zygapophyseal joint “up”
- will incorporate rotation toward the stiff zygapophyseal joint to gap that joint

To Gain Flexion (Superior / Anterior Glide)

- flex
- side flex away
- caudal thrust

To Gain Extension (Inferior / Posterior Glide)

- extend
- side flex toward
- cranial thrust

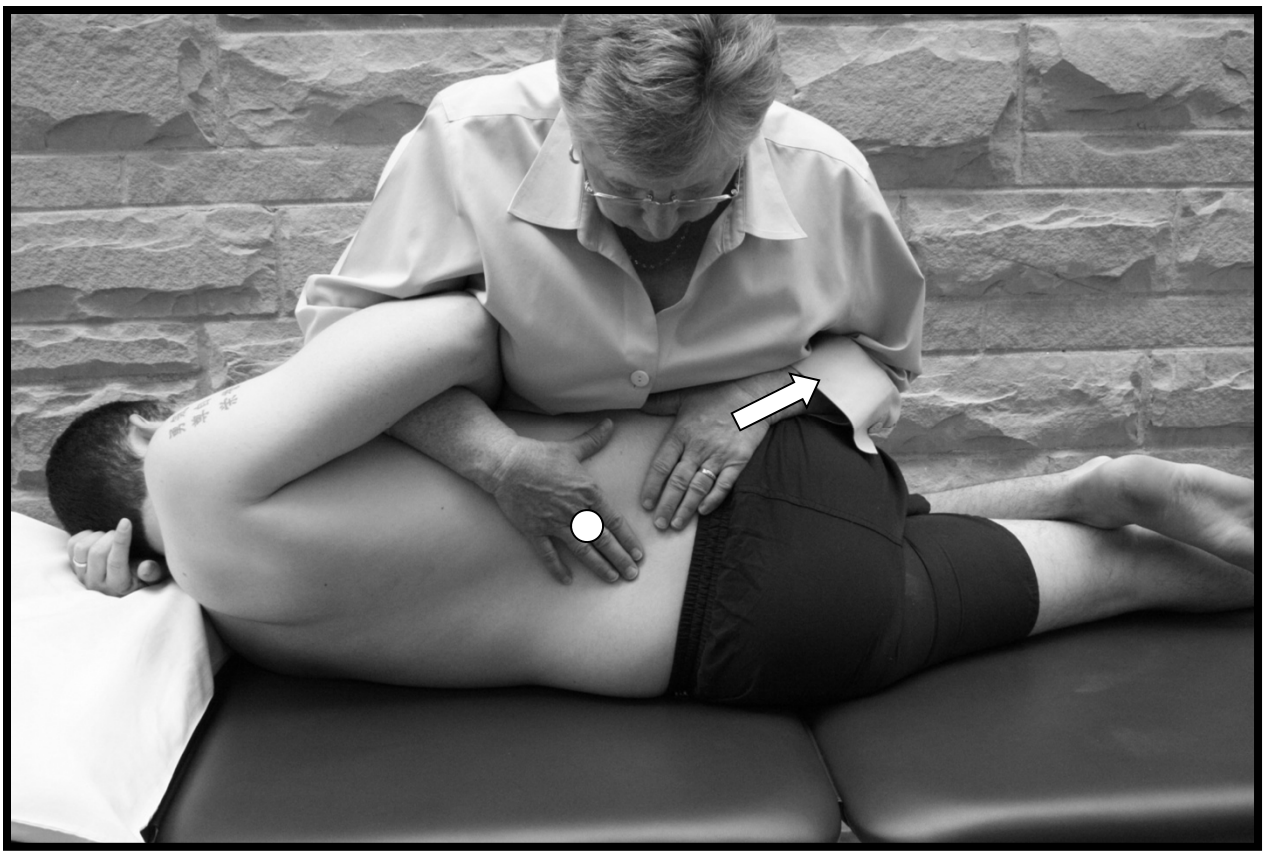
To De-rotate the Segment as a Whole

- Lie patient on same side as rotation restriction so that the rotation used will “unwind” the segment
- Visualize manipulating the entire joint complex (not only the zygapophyseal joint)

To Accommodate Specific Assessment Findings

- Minimize rotation to protect an irritable disc
- Choose the rotation which is stable and pain free on torsion testing

Lumbar Spine (Level 4)
Unilateral Oblique Distraction Manipulation (Gap)



Technique described for the right L3-4 segment

Patient: Side lying on left , restricted Z-joint facing up

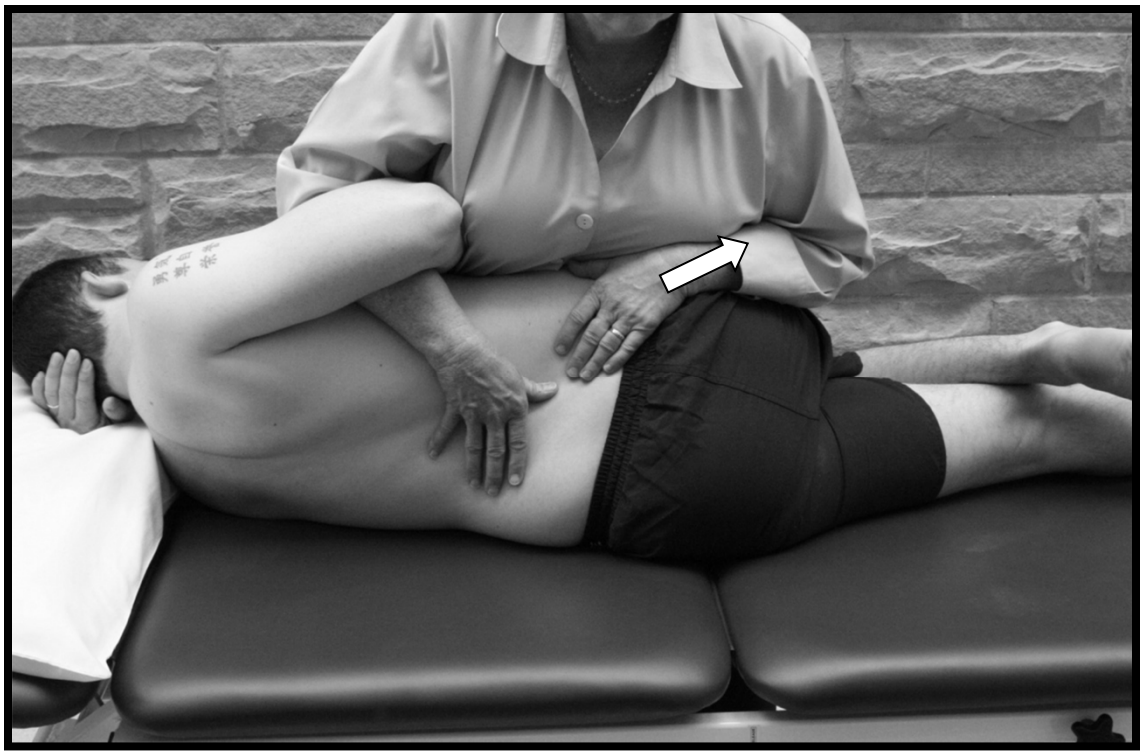
Therapist: Stands facing patient

Technique: Facet lock from above down to, but not including segment to be treated. No need to be specific as to method of locking. Ligamentous lock by flexing from below up to, but not including segment to be treated

Keep the affected segment in neutral. Take up the slack into oblique distraction of the segment by rotating slightly caudally off the line of pure axial rotation

Apply a high velocity, low amplitude thrust along an oblique line, forward and slightly caudal (an angle between pure distraction and flexion). Segment will go into left side flexion and right rotation.

Lumbar Spine
Unilateral Flexion (Level 4)



Technique described for the described for the L3-4 segment on the right

Patient: Side lying on left, restricted Z joint is facing up

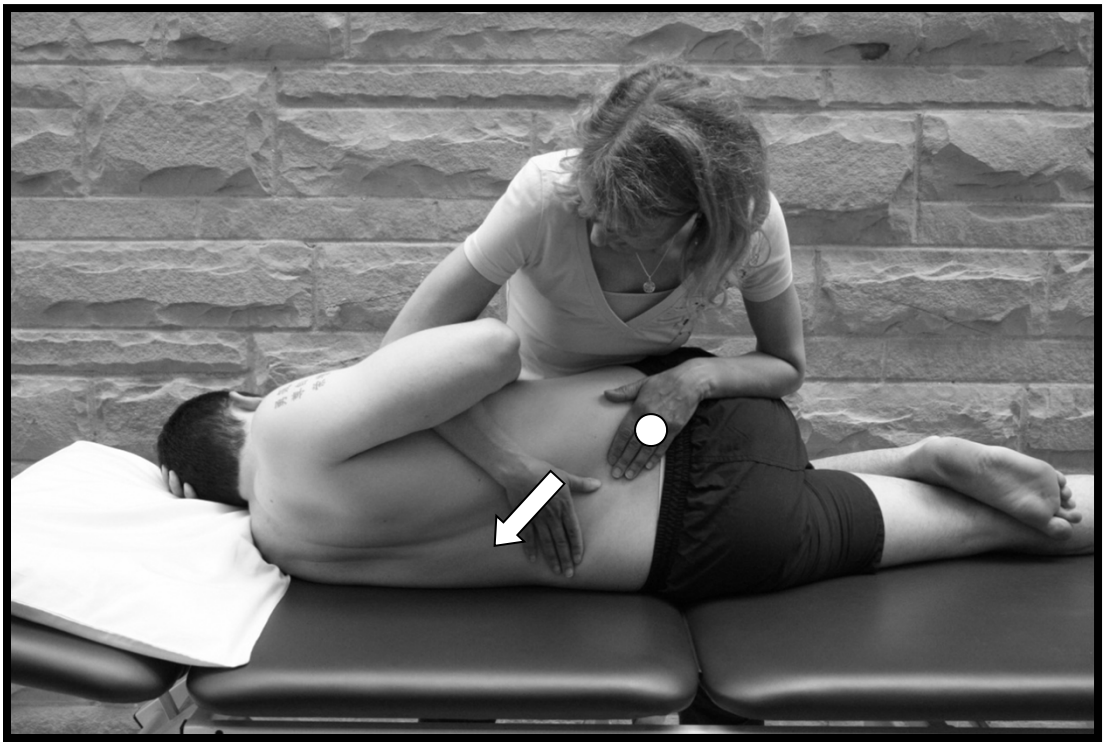
Therapist: Stands facing patient

Technique: Facet lock from above down to, but not including segment to be treated. You may wish to incorporate left side flexion away (pull arm caudally) or flexion (pull arm forward, parallel to the floor). Flex up from below to ligamentous lock the caudal lever.

Position the restricted joint into barriers of: flexion, left side flexion, right rotation

Apply a high velocity, low amplitude thrust Into left side flexion along an oblique axis – caudal and forward through pelvis

Lumbar Spine
Unilateral Flexion – Upper Lever (Level 5)



Technique described for the right L3-4 segment

Patient: Side lying on left , restricted Z-joint facing up

Therapist: Stands facing patient

Technique: Facet lock from above down to, but not including segment to be treated. No need to be specific as to method of locking. Ligamentous lock by flexing from below up to, but not including segment to be treated

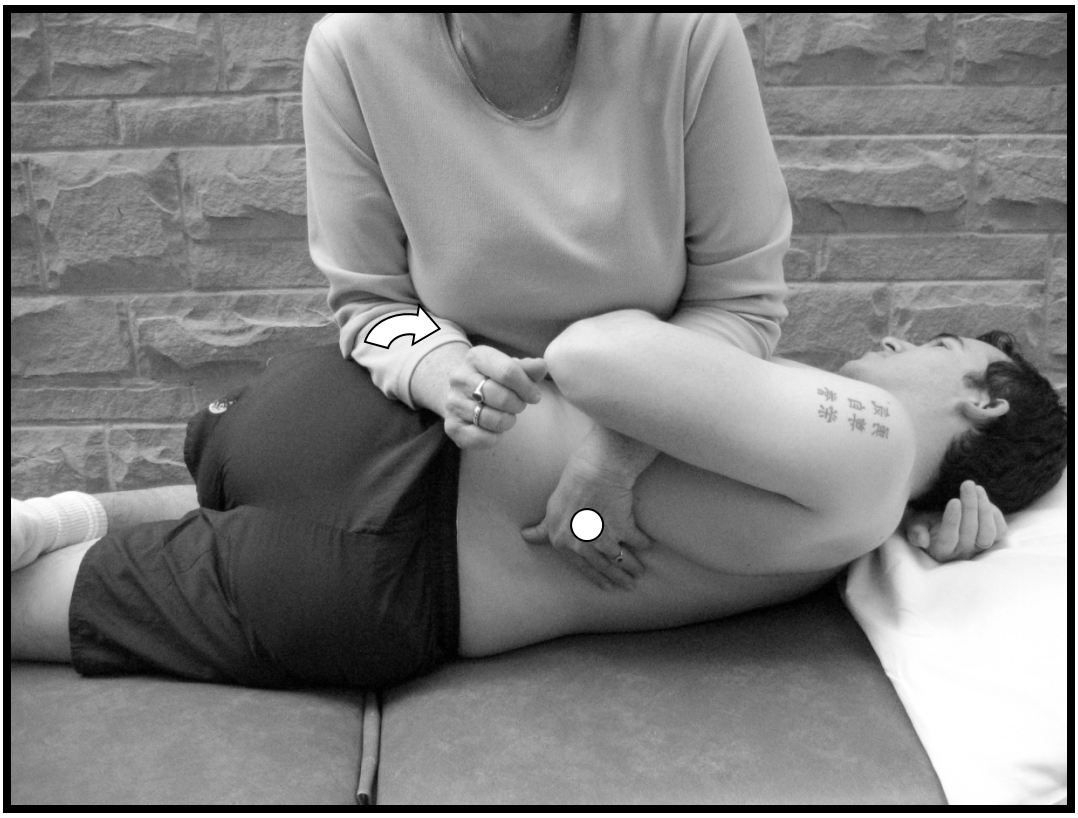
Position the restricted joint into barriers of flexion, left side flexion, right rotation.

Apply a high velocity, low amplitude thrust Into left side flexion along an oblique axis – cranial and backwards through the thorax.

Lumbar Spine

Unilateral Flexion (Stiff Side Down)

Alternate Technique (Level 5)



Technique described for the right L3-4 segment

Patient: Side lying on right with the restricted z-joint down

Therapist: Stands facing the patient

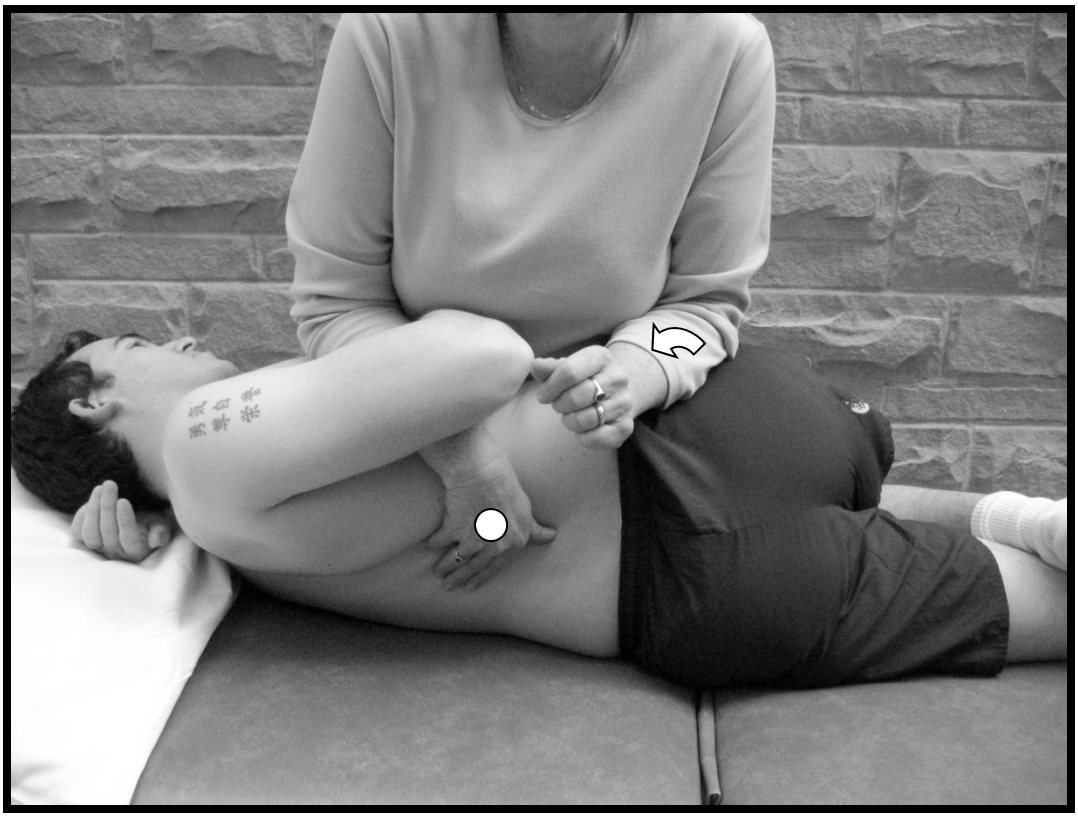
Technique: Facet lock from above. To incorporate left side flexion away pull arm cranially or flexion pull arm forward, parallel to floor.

Flex up from below, start to flex into the segment being treated

Position the restricted joint into barriers of **flexion,** left side flexion, left rotation

Thrust into left side flexion oblique axis – cranial and forward through pelvis to flex bottom joint

Lumbar Spine
Unilateral Extension (Level 4)



Technique described for the right L3-4 segment

Patient: Side lying on left, restricted Z joint is facing up

Therapist: Stands facing the patient

Technique: Facet lock from above down to, but not including segment to be treated, may wish to incorporate right side flexion toward (pull arm cranially), extension (pull arm up towards ceiling)

May use an extension or flexion lock from below

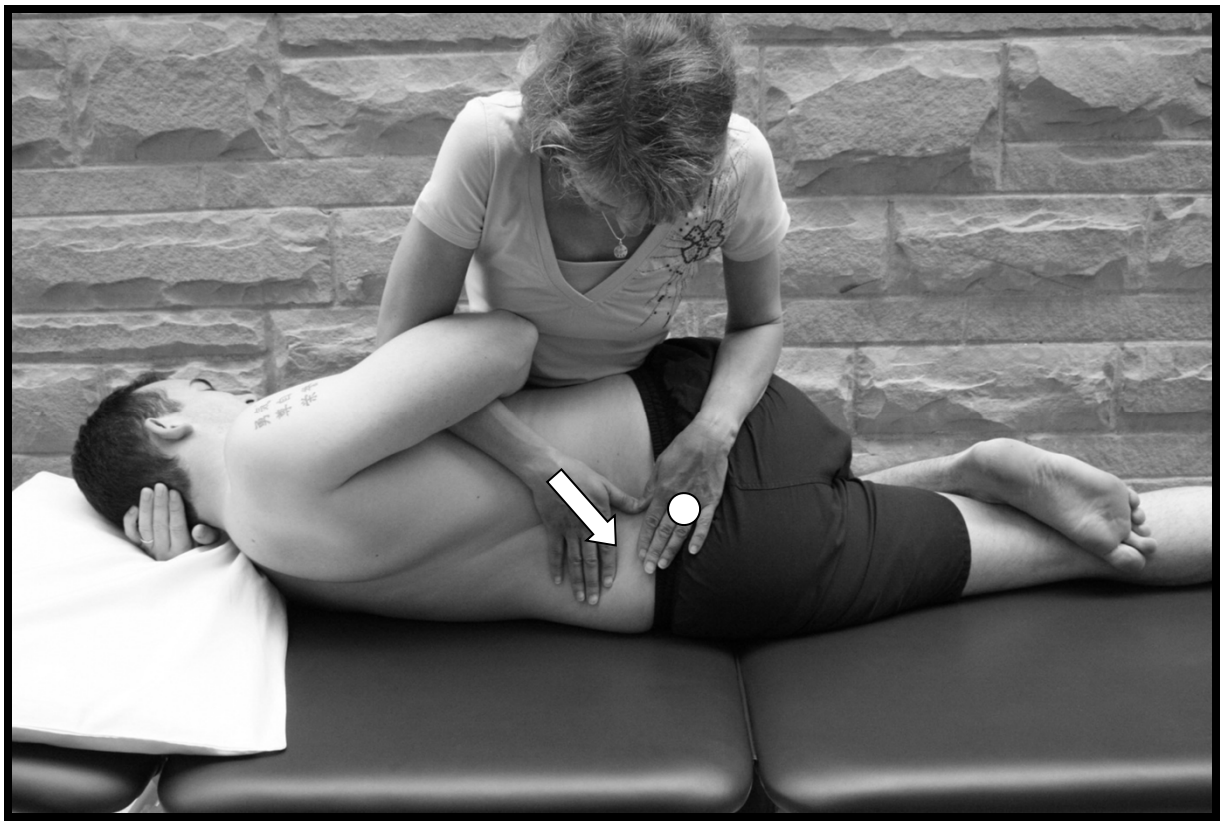
Position the restricted joint into barriers of: extension, right side flexion and right rotation

Apply a thrust into right side flexion /rotation oblique axis – cranial and forward through the pelvis. The right thumb also pushes the spinous process towards the bed.

Alternate technique: As per alternate technique for flexion, can set up to manipulate extension with restricted joint down

Lumbar Spine

Unilateral Extension through cranial lever (Level 5)



Technique described for the right L3-4 segment

Patient: Side lying on left, restricted Z joint is facing up

Therapist: Stands facing the patient

Technique: Facet lock from above down to, but not including segment to be treated, may wish to incorporate right side flexion toward (pull arm cranially), extension (pull arm up towards ceiling)

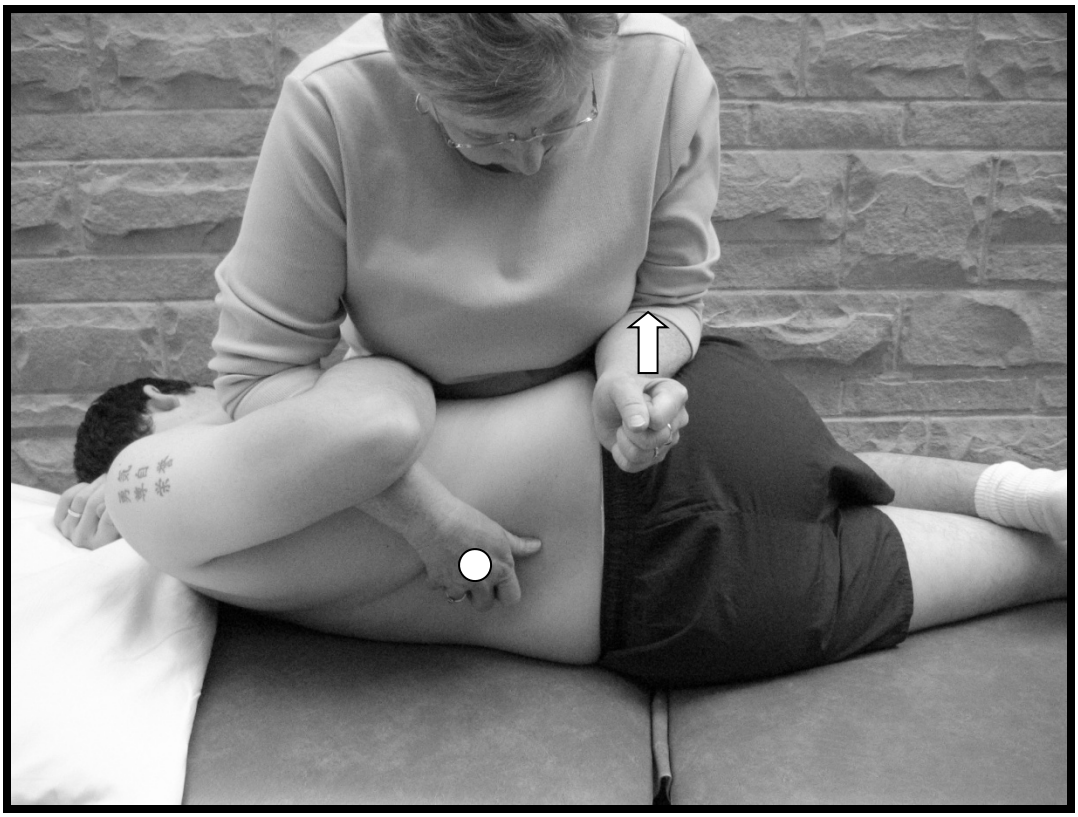
May use an extension or flexion lock from below

Position the restricted joint into barriers of extension, right side flexion and right rotation

Apply a thrust into right side flexion /rotation oblique axis, caudal and back through the thorax. The right thumb pushes towards the bed.

Alternate technique: As per alternate technique for flexion, can set up to manipulate extension with restricted joint down and use the cranial lever to apply the thrust.

Lumbar Spine
Unilateral Sagittal Distraction Z-Joint Level 5



Technique described for the right L3-4 segment
to 'gap' the sagittal portion of the Z-joint eg: right Z-joint block
**** moderate the amount of force used**

Patient: Side lying on left , restricted Z-joint facing up

Therapist: Stand facing patient

Technique: Facet lock from above, no need to be specific as to method of locking. Ligamentous lock by flexing from below.

Keep the affected segment in neutral. Take up the slack into distraction of the top Z joint by rotating about a vertical axis. Force is applied exactly perpendicular to the long axis of the spine.

Thrust: Directly perpendicular to the long axis of the spine. Pure axial rotation

Thoracolumbar Junction Localization and Locking

Principles

•The region from T10 to L1-2 is a common area of dysfunction, but often a more technically difficult area to manipulate

•Side-lying techniques to restore unilateral flexion or extension in a zygapophyseal joint may be performed in a manner similar to the lumbar spine

•During functional movements (twist) side flexion and rotation are coupled in opposite directions

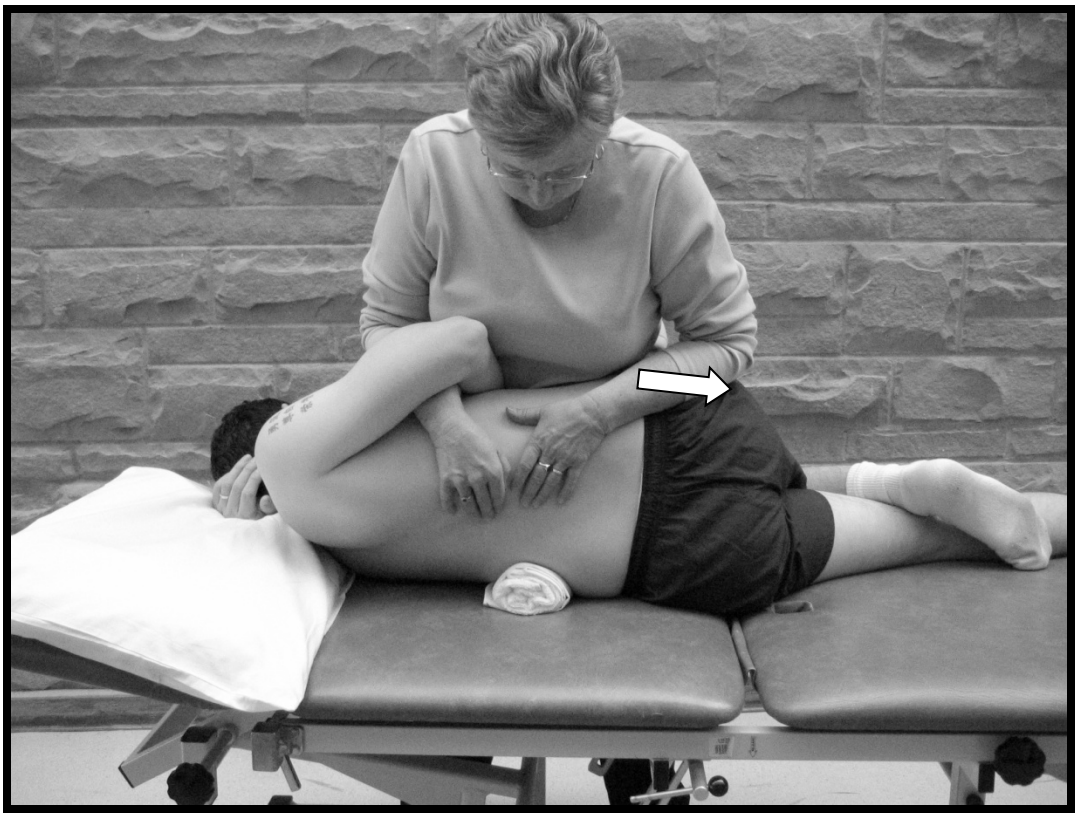
•Coupling rotation and side flexion in opposite directions are effective in achieving the lock

Locking Technique: Thoracolumbar Junction

•A rolled towel can be placed under the affected segment to gain contralateral side flexion or under the pelvis to gain ipsilateral side flexion

•Locking from below can be achieved by flexing the segments (ligamentous lock) or by extending the segments below

Thoracolumbar Junction
Unilateral Flexion (Level 5)



Technique pictured for the T12-L1 segment

Patient: Side lying on left, restricted Z joint is facing up with a rolled towel under the segment being treated

Therapist: Stands facing patient

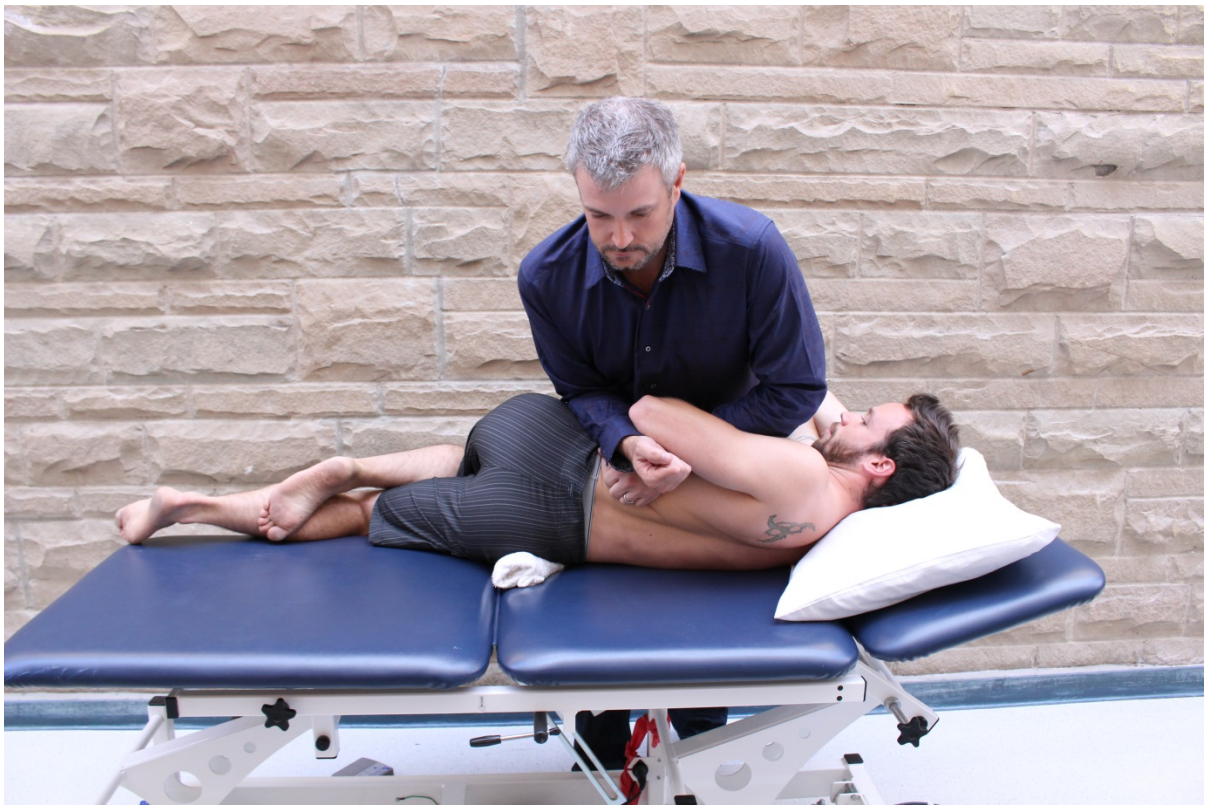
Technique: Facet lock from above down to, using a contralateral flexion into the segment to be treated. Ligamentous lock by flexing from below.

Position the restricted joint into barriers of flexion, left side flexion and right rotation

Apply a thrust into left side flexion and right rotation oblique axis – caudal and forward through pelvis

Thoracolumbar Junction

Unilateral Extension (Level 5)



Technique described for the left T12-L1 segment

Patient: Side lying on right, restricted Z joint is facing up with a towel placed under the pelvis to produce right side flexion

Therapist: Stands facing the patient

Technique: As described previously, lock from above, may wish to incorporate: Left side flexion toward (pull arm cranially) Extension (pull arm up towards ceiling). May use an extension or flexion lock from below

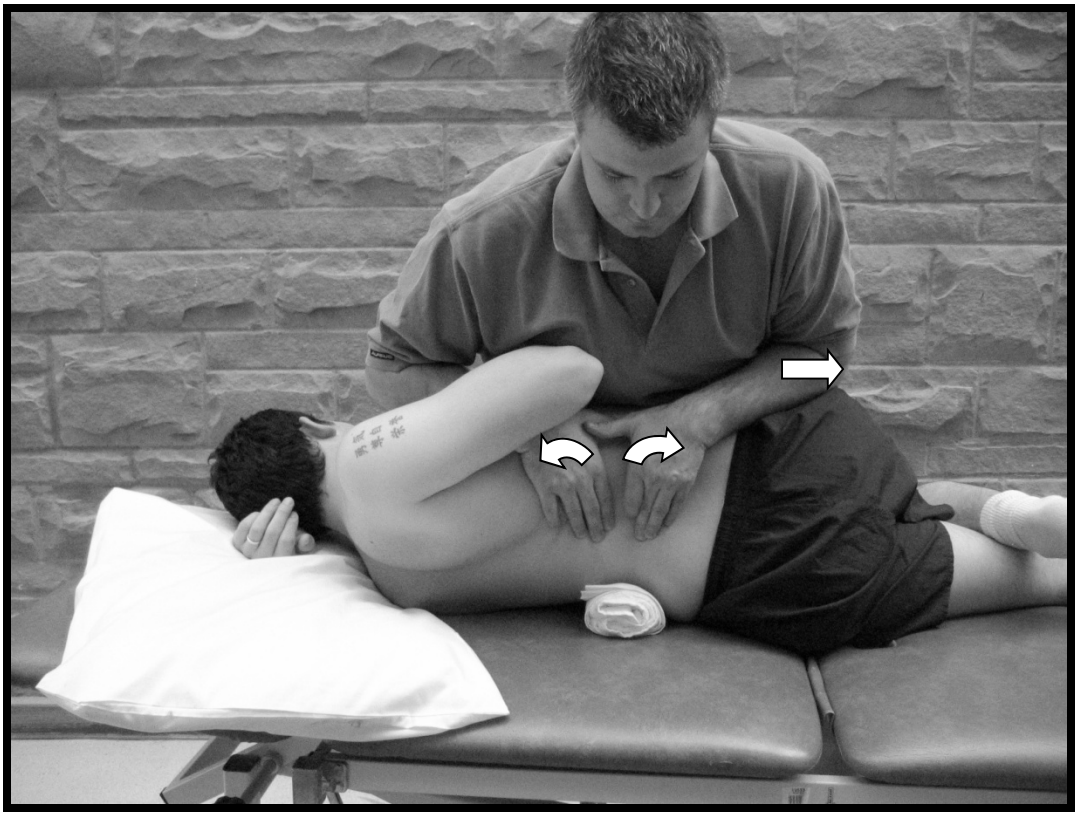
Position the restricted joint into barriers of extension, left side flexion and left rotation

Apply a thrust into **left side flexion** / left rotation oblique axis – **cranial** and forward through the pelvis

Thoracolumbar Junction

Unilateral Extension (Indirect)

Alternate Technique (Level 5)



Technique pictured for the T12-L1 segment

Patient: Side lying on left, restricted Z joint is on the bottom with a rolled towel under the segment being treated

Therapist: Stands facing patient

Technique: Facet lock from above down to, using a contralateral extension into the segment to be treated. Lock by extending or flexing from below.

Position the restricted joint into barriers of **extension**, left side flexion and right rotation

Apply a thrust into **left side flexion** oblique axis – **caudal** and forward through pelvis

SI Joint
Unilateral Gap (Level 4)

Technique described for the right SI Joint

Patient: Supine, small roll or hand on sacrum medial to right PSIS to fix sacrum

Therapist: Stands on right side

Technique: Take up barrier of hip flexion/ adduction

Thrust in direction down towards table along line of femur

Both hands on knee or stabilize pelvis on left side with one hand if the pelvis tends to rotate

* Make sure there is no groin pain and that the hip can tolerate the movement.

SI Joint
Side-lying Unilateral Gap (Level 5)

Manipulation of the right joint

Manipulation of the left joint

Technique described for the right SI Joint

Patient: Lying on right side

Therapist: Stands facing patient

Technique: Thoracolumbar spine is locked down to and including L5 –S1 into left rotation. Right innominate is fixed by the table and by therapist's cranial hand around the PSIS. Lower leg is extended. Top leg is flexed to posteriorly rotate the left innominate and tighten the left SI joint thereby leaving the sacrum free to move at the right SIJ

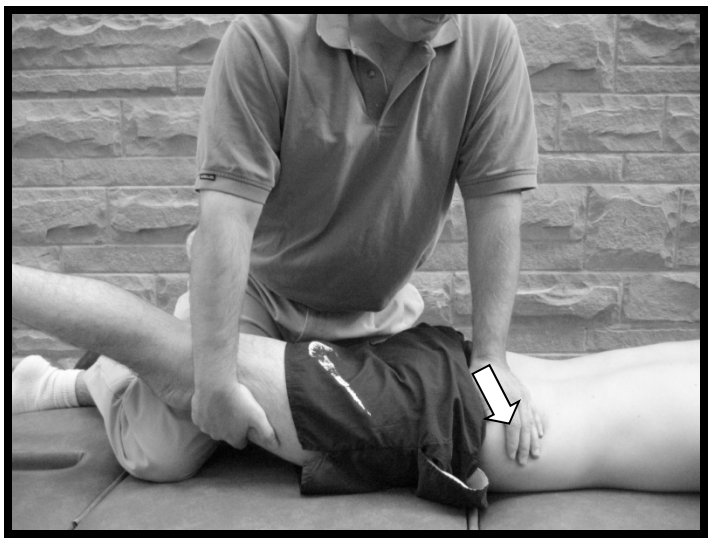
With contact on the right ilium move to the barrier by rotating the left innominate/sacrum unit toward you. Apply a thrust in the direction of axial rotation

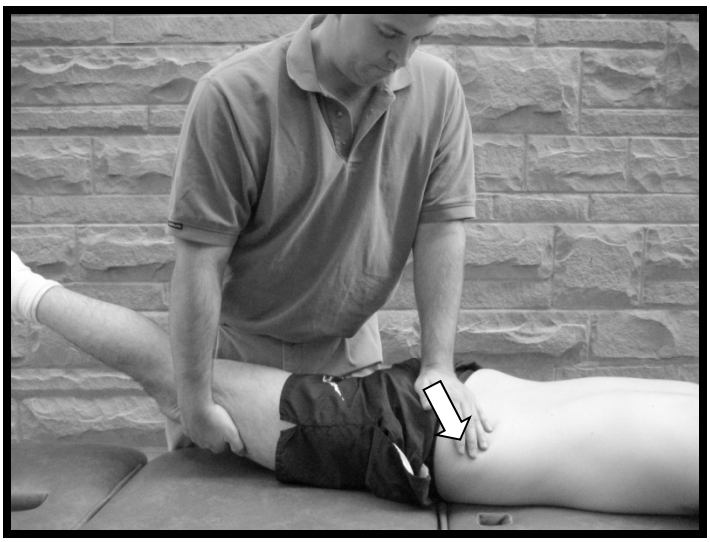
Induces gapping of the right sacral base relative to the right innominate

Alternate Technique (stiff side up) Can gap the Left SIJ in right side lying by fixating the sacrum and bottom innominate and thrusting downward in axial rotation direction on the top innominate

SI Joint

Anterior Rotation of the Innominate (Level 4)





Modified Technique

Technique described for the right SI Joint

Patient: Prone

Therapist: Standing on opposite of lesion

Technique: The heel of the cranial hand palpates the PSIS while the other hand fixes under patient's thigh to extend the femur. The motion barrier is reached by passively extending the femur while simultaneously applying an anterior/superior force to the PSIS in the plane of the joint. A muscle energy technique can be of use to reach the limit of physiological motion.

A high velocity low amplitude thrust is applied to the innominate in an antero-superior direction as the femur is extended.

Modified prone technique

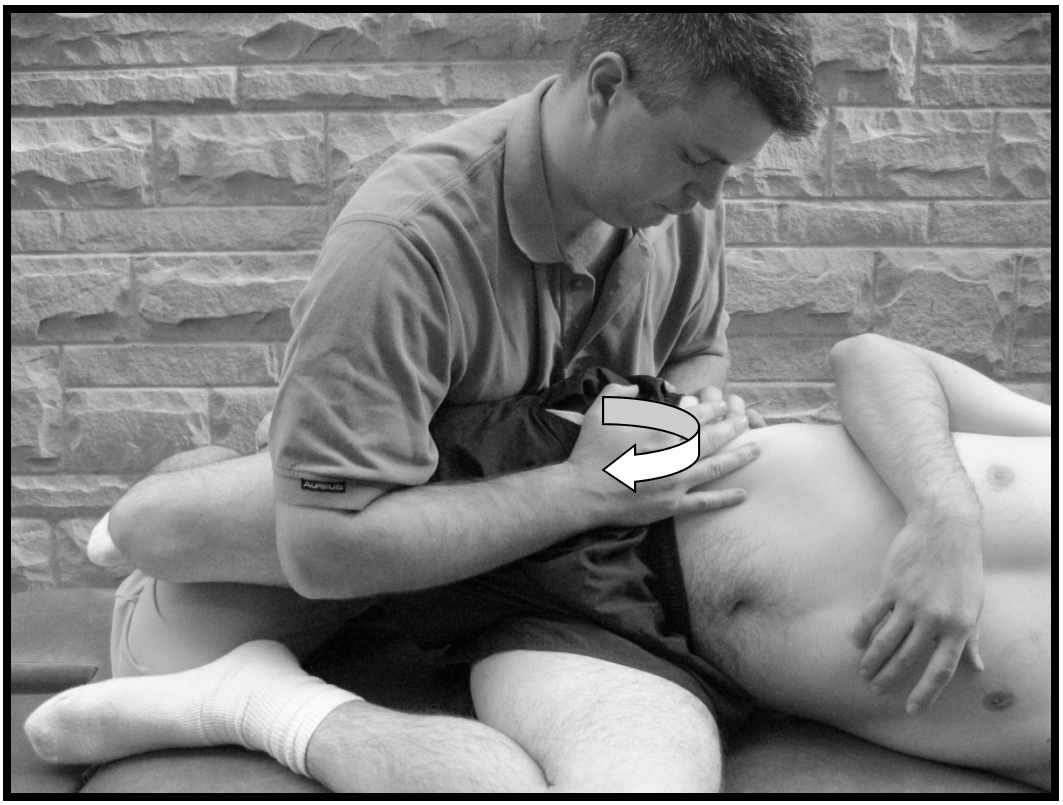
The ***un***affected leg can be flexed over the edge of the bed and supported by the therapist. The thrust is applied in the same fashion.

Standing:

The patient can be positioned in standing, flexed forward with the plinth supporting upper body weight.

SI Joint (Level 5)

Anterior Rotation of the Innominate in Side-lying



Technique described for the right SI joint

Patient: Lying on left side to treat a right restriction

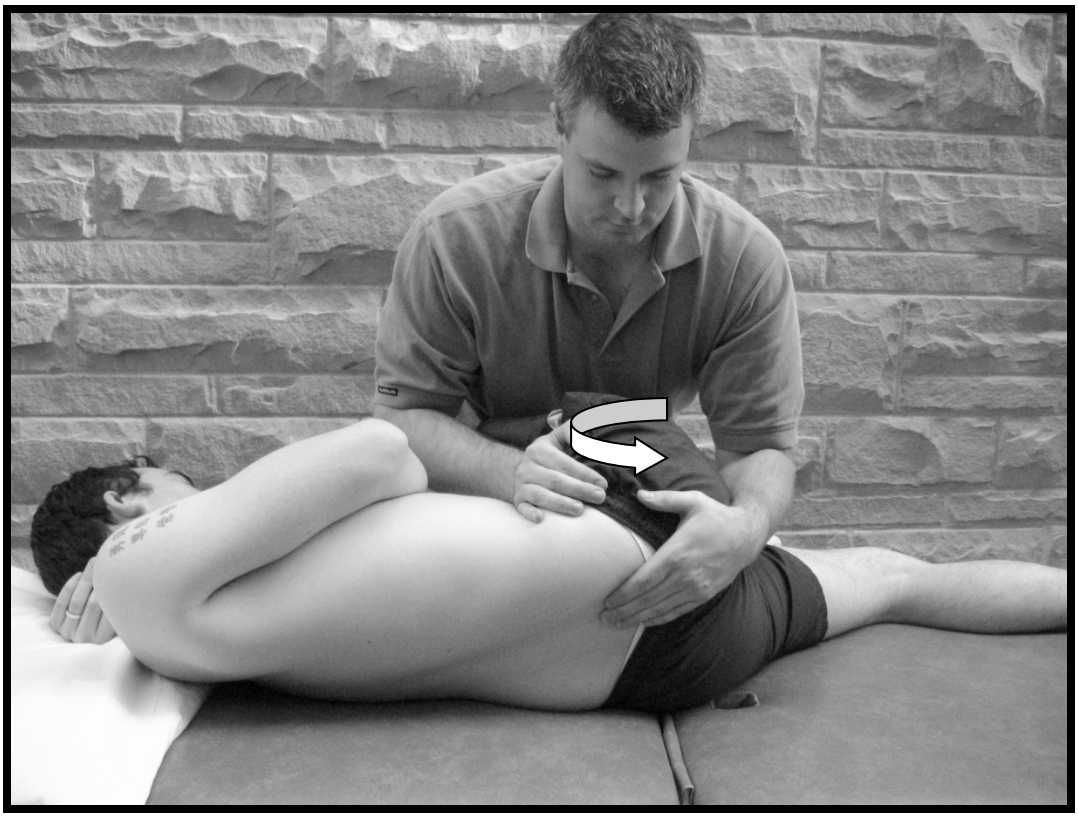
Therapist: Stands facing patient or behind patient:

Technique: Thoracolumbar spine is locked down to and including L5-S1 with right rotation and slight extension. Lower leg is flexed until movement is felt at L5-S1 level (posterior rotation left innominate to tighten left SI joint thereby leaving the right SIJ free to move). To engage barrier of the right innominate anterior rotation the top leg is extended (note thigh can be supported on a pillow) to anteriorly rotate the right innominate until movement is felt at the right SIJ

With contact on the right innominate apply a thrust in the same direction of anterior rotation of the innominate (ensure that thrust is in the plane of the right SIJ and not extending the L5-S1 segment)

SI Joint (Level 4)

Posterior Rotation of the Innominate in Side-Lying



Technique described for the right SI joint

Patient : Side lying with affected side on top. Bottom leg is extended, and can be held back over the edge of the bed to maintain anterior rotation of the bottom innominate.

Therapist: Facing patient

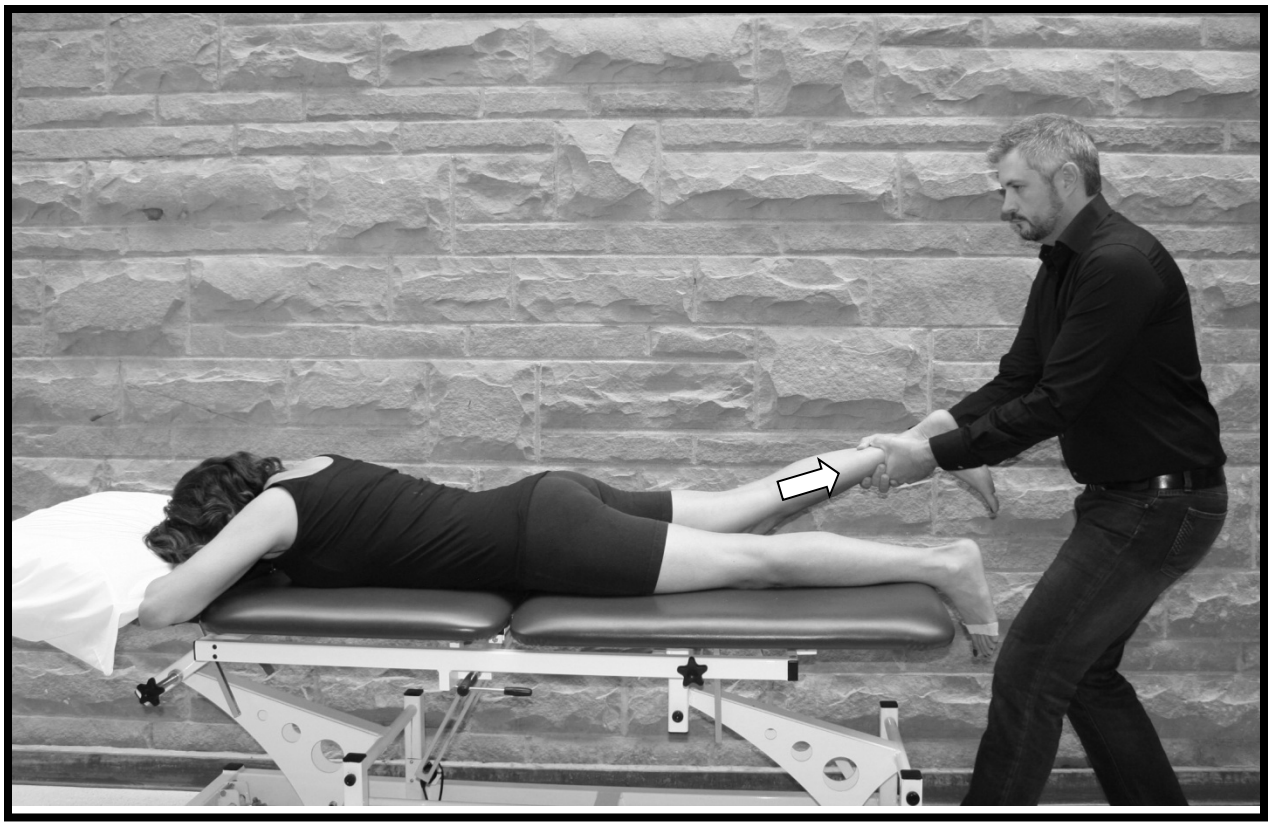
Technique: "Lock" the lumbosacral spine by inducing rotation/contralateral side bending. L5-S1 must be stable and snug. Therapist's cranial hand palpates the PSIS and the other hand flexes the femur to the barrier of posterior innominate rotation. The cranial arm then maintains the lock and the hand cradles the ASIS, the caudal hand cradles the PSIS and ischium

A muscle energy assist is used to get to the end of physiological posterior rotation. The thrust is applied through the ASIS in a direction of posterior rotation of the innominate while the caudal hand simultaneously assists the movement as a two handed technique

SI Joint

Inferior Manipulation

Innominate Fixed Superiorly and in Anterior Rotation (Level 4)



Technique described for the right SI joint

Patient: Prone, head turned

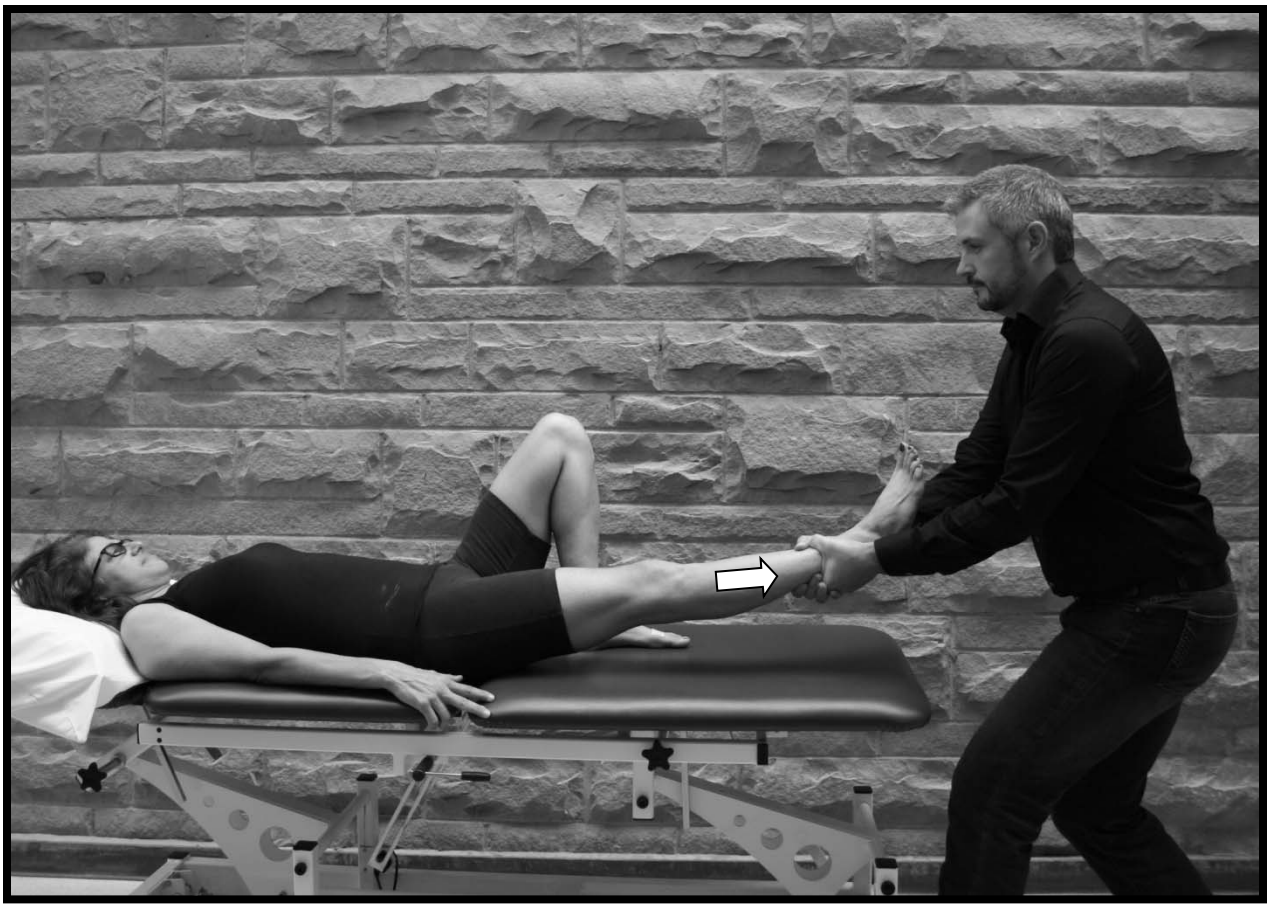
Therapist: Grasp leg of the affected side above the ankle. Slightly extend and IR hip. Amount of extension of hip used depends on degree of anterior rotation of the innominate. Vary position of femoral abduction/ adduction, find line of inferior pull which does not induce side bend of the pelvic girdle under the lumbar spine

Technique: Take up the slack in a longitudinal direction and apply a high velocity low amplitude tug to the leg.

SI Joint

Inferior Manipulation

Innominate Fixed Superiorly and in Posterior Rotation (Level 4)



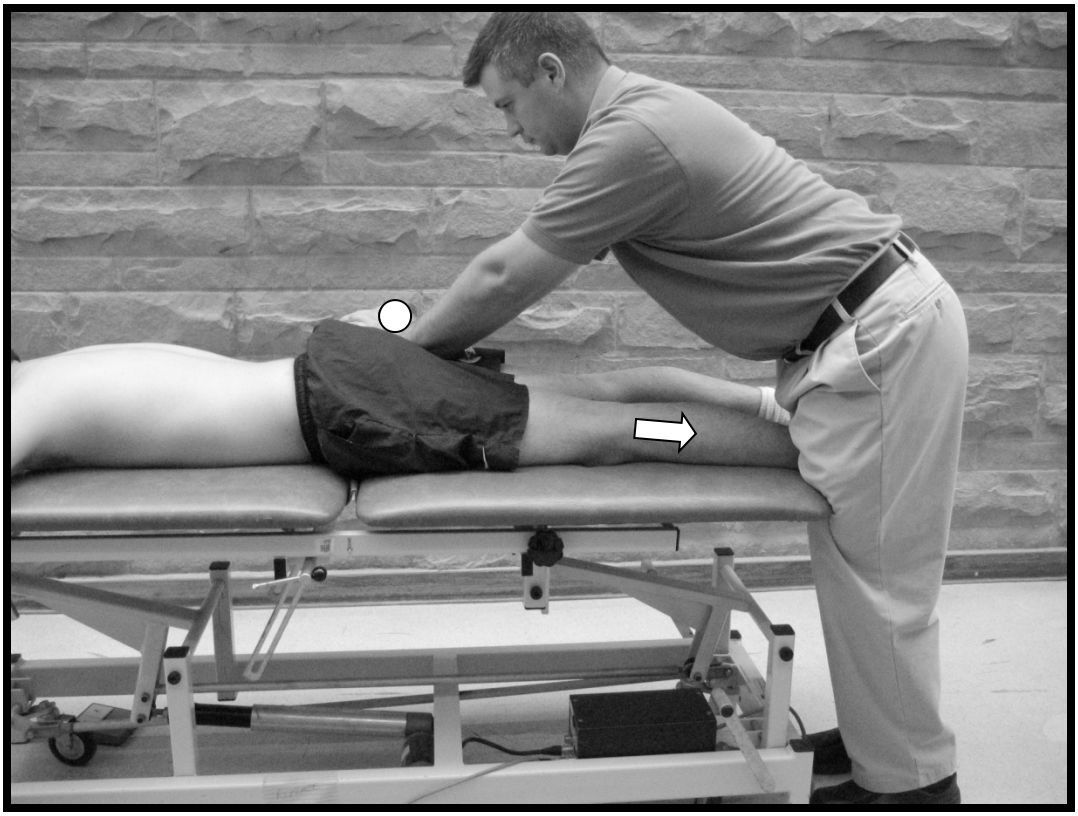
Technique described for the right SI joint

Patient: Supine, arms by side, flexion of the opposite knee

Therapist: Grasp leg of the affected side above the ankle. Slightly flex and IR hip. Amount of flexion of hip used depends on degree of posterior rotation of the innominate. Vary position of femoral abduction/ adduction , find line of inferior pull which does not induce side bend of the pelvic girdle under the lumbar spine

Technique: Take up the slack and apply a high velocity low amplitude tug to the leg.

SI Joint
Superior Glide of Innominate on the Sacrum (Level 5)



Technique described for the right SI joint

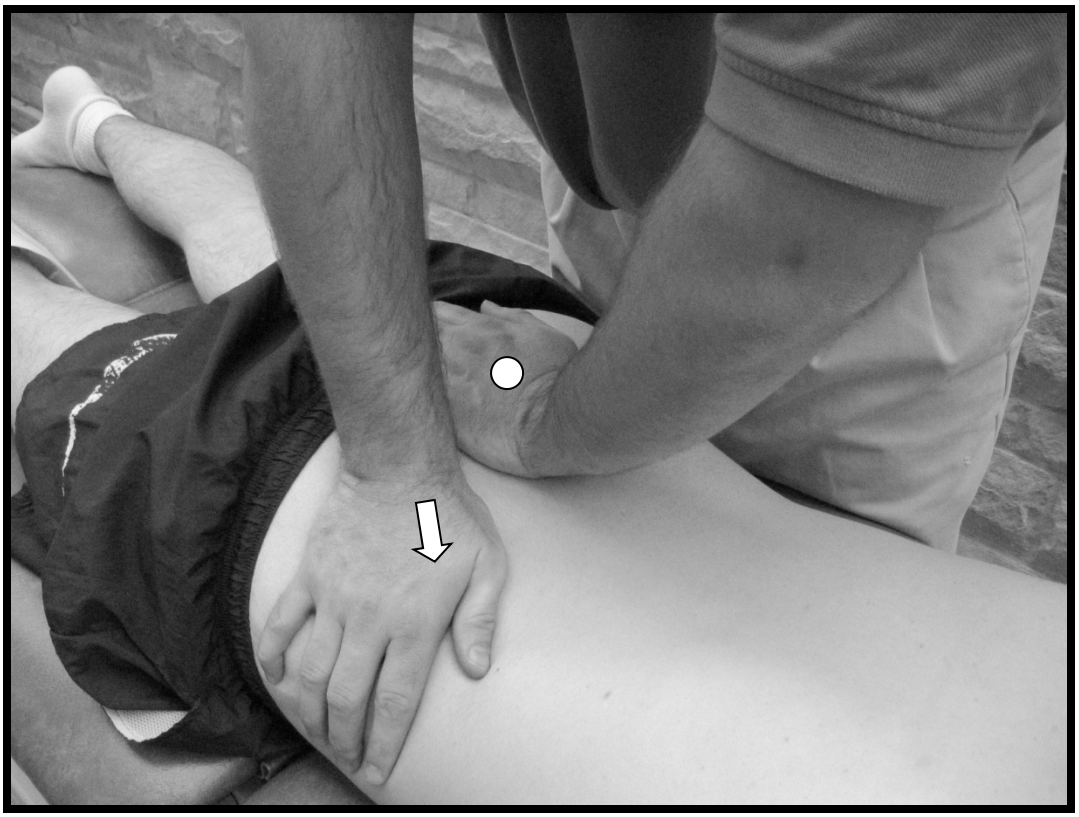
Indications: Innominate fixed inferiorly

Patient: Prone, feet just over end of table
Therapist: At patient's feet

Technique: Apply a cranially directed pressure to patient's affected side ischium. Internally rotate patient's unaffected side hip to tighten the contralateral SI joint. One can apply a tug to the contralateral leg by holding patient's leg between yours and rapidly extending your knees to produce the tug. Apply sufficient counterforce to the affected side innominate

Alternate Technique: This can be performed as a direct technique in prone or side lying. One of the therapist's hands applies a cranial force to the innominate as the other applies a caudal force to the sacrum.

SI Joint
Unilateral Sacral Counternutation (Level 4)



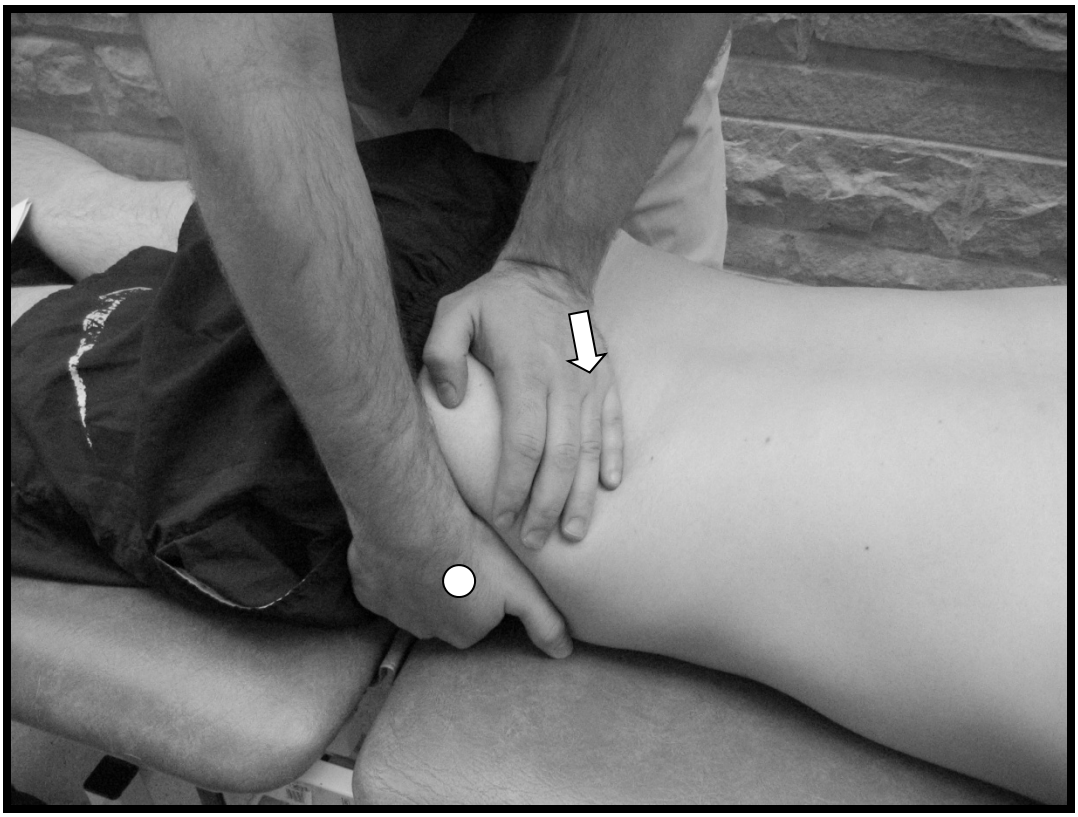
Technique described for right sacral base fixed in nutation

Patient: Prone

Therapist: Stand on left side, place pisiform of left hand over left sacral base or ILA and the right hand over the right PSIS.

***Technique*:** A thrust is applied in an anterior direction to the right innominate while counter pressure is applied to the left sacral base or ILA. This technique is useful when the lumbosacral junction cannot be locked.

SI Joint
Unilateral Sacral Nutation (Level 4)



Technique described for right sacral base fixed in counternutation

Patient: Prone lying

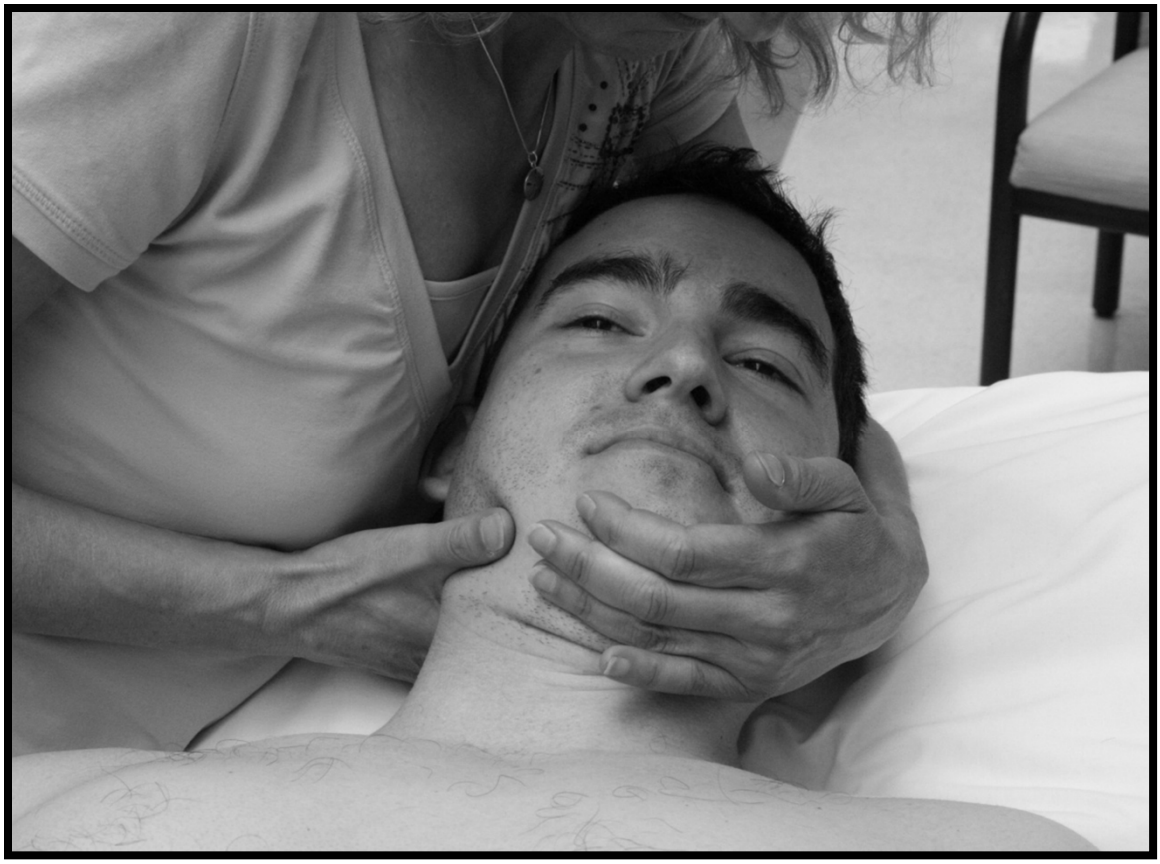
Therapist: Stand on opposite side to the stiff joint. Fix anteriorly under the affected innominate with right hand and place the pisiform of the left hand over the right sacral base.

***Technique*:** A postero-anterior thrust is applied to the sacral base with corresponding counter pressure applied to the innominate.

Modification: Can bring affected leg over edge of bed to posteriorly rotate innominate and protect lumbar spine from hyperextension.

Appendix

Mid-Cervical Spine
Lateral Shift Correction



This technique is described for the C3-4 segment.
Findings: eg right lateral shift C3-4
- C3 resting position is shifted laterally to the right on C4
- Decreased left lateral glide C3-4 & A/P over right U joint
- may be associated with lateral plane instability into right lateral glide (reassess after manipulation)

Patient: supine, head resting on pillow

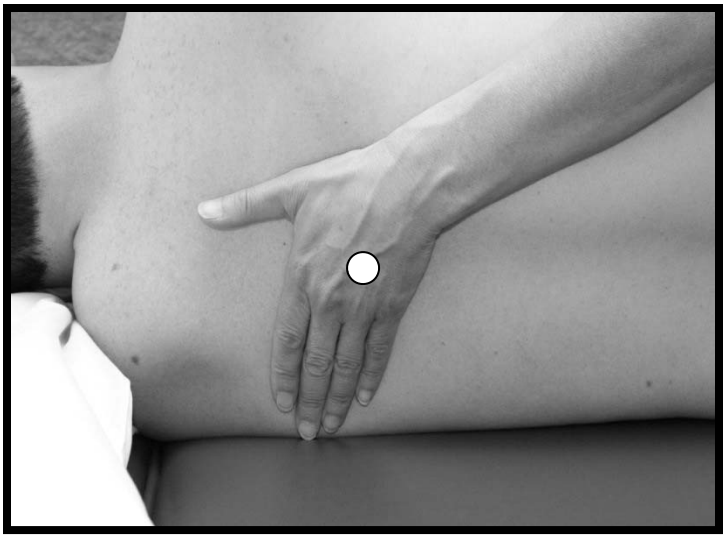
Therapist: stands at head of bed, toward the affected side. Place the radial border index finger and MCP along lamina on side of the lateral shift (right). The other hand cradles neck & head above that level.

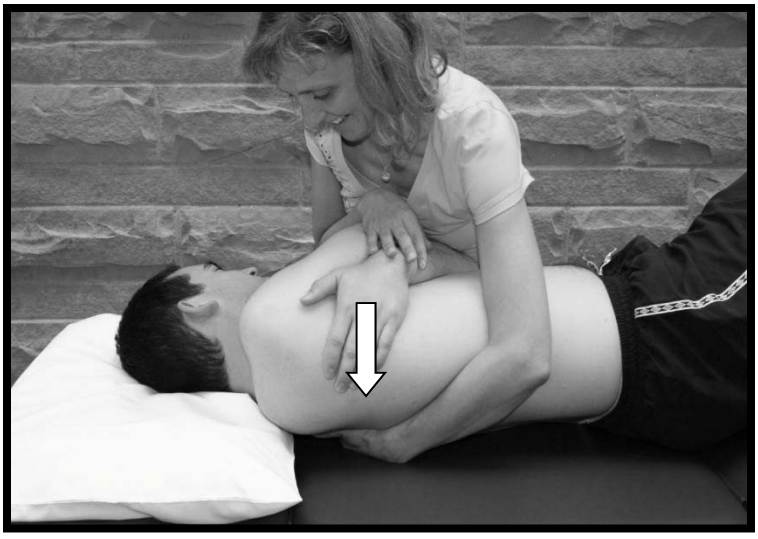
***Technique*:** lock above using contralateral coupling, SF toward/rotate away from the side of the shift (RSF/LR). The level to be being treated remains in neutral.

Apply and maintain strong axial traction with the left hand. Take up restricted barrier of right SF and its opposite left lateral translation with the right hand at C3. There is usually also a slight inferior glide component.
Apply a high velocity, low amplitude left lateral glide thrust to the cranial vertebra (C3), in a slightly inferior direction.

Post Manip: retest lateral plane stability **(**may choose to retest at next visit),
education, stabilization program

Thoracic Spine
Posterolateral Manipulation of the Rib





Technique described for the 6th rib

Purpose: To restore rib motion when the patient does not tolerate direct pressure on the posterior aspect of the rib.

Patient: Supine, arms folded.

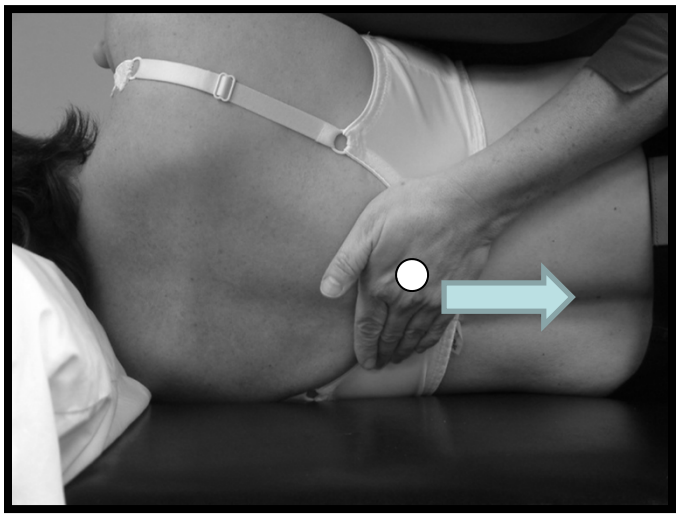
Therapist: Stand on left side. Place the left thenar eminence over the right T6 transverse process. Ensure there is no contact with the right 6th rib.

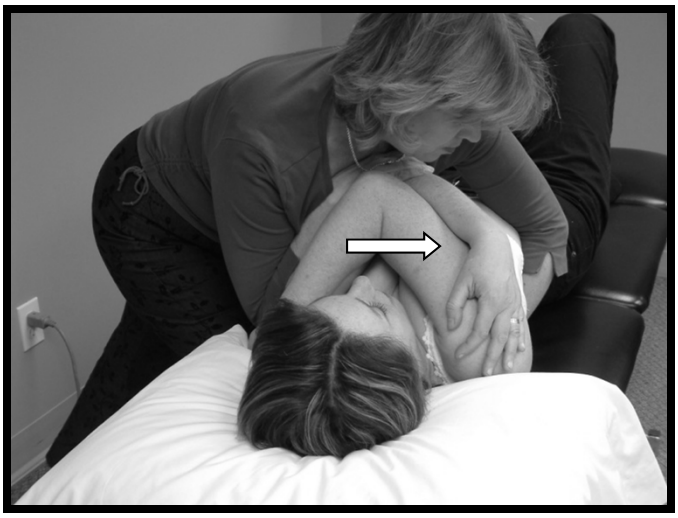
***Technique*:** High velocity, low amplitude thrust is applied in a posterolateral direction through the left side of the thorax as the patient is rolled back into supine and is best timed as therapist's fixating hand contacts the table.

Thoracic Spine

T3-9 Joint Complex Translation Technique

Lateral Shift Fixation





eg. To regain right lateral translation of the 6th ring. The 6th ring include T5, T6 and left and right 6th ribs.

Clinical Findings: For a left lateral shift lesion

- mechanism of injury – thoracic rotation force, seat belt injury
- pain distribution – anterior chest, interscapular, along the rib
- aggravated by deep breath, arm motion, supine lying
- All movements produce a “kink” at T5-6

  -complete block to right lateral translation, decreased in both rotations since it is fixed in left translation/right rotation. T5 will appear right rotated. The L rib 6 will appear posterolateral and the R rib will appear anteromedial. This dysfunction may involve the costovertebral joints and the interbody joint. Underlying instability is common.

Patient: Supine, arms crossed

Therapist: Stand on side the left side of the patient. Roll P toward you. Left hand flat across posterior thorax, compressing the 7th ribs medially to stabilize T7 and the inferior part of T6. The 6th ribs are left free to move.

Technique: Flex to neutral of the Z joints. Strong longitudinal traction is applied and P is rolled toward supine only to the point where T’s hand contacts the table. Maintaining strong longitudinal traction, a high velocity/low amplitude thrust is applied in a right lateral direction.

Post Manipulation: Reassess lateral stability, taping and stabilization exercises as indicated.

11th and 12th Costovertebral Joint
Unilateral Distraction

Technique described is for the left 11th or 12th rib

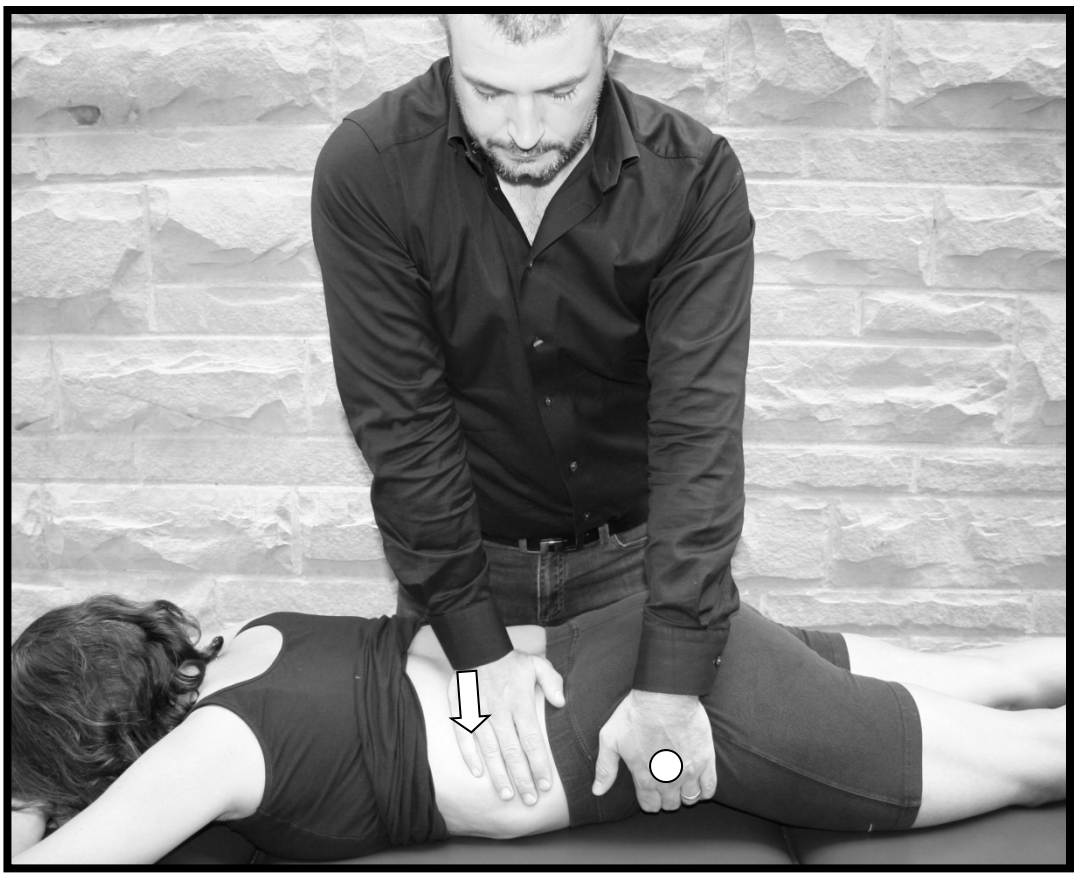
Patient: Side lying on the affected side.

Therapist:
The thoracolumbar junction is locked from above and below.
The therapist's cranial hand is placed over the affected rib to stabilize it onto the bed.
The caudal arm is positioned perpendicular to the spine and the hand rests on the spine at the level of the restriction.

Technique:

The motion barrier is taking up by moving the locked spine in a direction of axial rotation, toward the therapist. A high velocity, low amplitude thrust is applied in this direction with economy of vigour, to gap the costovertebral joint.

11th and 12th Costovertebral Joint
Unilateral Distraction - Alternate Technique



***Patient*:** prone

***Therapist*:** Stands on side opposite the affected rib. The caudal hand fixes under the ASIS and the cranial hand is placed over affected rib.

***Technique*:** The motion barrier is found by lifting the ASIS dorsal and an anterior thrust is applied to the affected rib to gap the costovertebral joint.

Lumbar Spine
Axial Traction

Technique described for the L3-4 segment

***Patient*:** Side lying

Therapist: Stands facing patient. Facet lock from above down to, but not including segment to be treated. No need to be specific as to method of locking. Ligamentous lock by flexing from below up to, but not including segment to be treated.

***Technique*:** High velocity, low amplitude thrust is applied in a caudal direction

Case History Exam
Subjective Booklet

Questions to be completed following the ***Subjective*** Examination

Candidate Number:_____

Candidate Name:_____

Exam Date:_____

1. **Identify three key activity limitations and three key participation restrictions for this patient (based on the International Classification of Function, Disability and Health - WHO - ICF Model).**
   (3 marks)

Activity Limitations:

Participation Restrictions:

2. The table below describes different mechanisms that may be influencing the patient's pain. Based on the information provided in the subjective examination, list the evidence, if any, that would be most indicative of each pain mechanism. Consider all 3 pain areas.
(8 marks)

Nociceptive
Neuropathic or Neurogenic **Peripheral Evoked**
Central Evoked
Psychological Factors
Social/Environmental Factors

3 (a). List 3 of the <u>most likely</u> structures at fault for each of the area of symptoms. (4.5 marks)

P1	P2	P3
1.	1.	1.
2.	2.	2.
3.	3.	3.

3 (b). For P1, explain your rationale for each of the three structures you have chosen based on the subjective data that has been provided.
(3 marks)

Structure	Rationale

4. Circle the one category that best describes the overall irritability of this patient's condition.
(1 mark)

Mild **Mild - Moderate** **Moderate** **Moderate - Severe** **Severe**

Justify your answer with 4 pieces of evidence from the subjective examination.
(2 marks)

What are the implications of this for the physical examination?
(1 mark)

5. Is the disorder inflammatory or mechanical in nature, or both?
(1 mark)

List 6 factors that support your answer.
(3 marks)

6 (a). List 3 subjective examination findings that would indicate caution must be observed during the objective examination. Explain why.
(3 marks)

6 (b). Write one subjective question you would like to have added to this case to help rule in or out any possible red or yellow flags.
(1 mark)

7. After reading the subjective data, list the 2 (most likely) clinical hypotheses and provide 3 subjective findings to support each hypothesis.
(3 marks)

8. Based on the subjective examination you have developed two clinical hypotheses. Provide 4 key elements of your physical examination and under each element state 2 of the most relevant tests you would perform and explain how these would help you confirm or negate your hypotheses.
(8 marks)

POTENTIAL KEY ELEMENTS:

KEY ELEMENT #1:

RELEVANT TESTS:

RATIONALE:

KEY ELEMENT #2:

RELEVANT TESTS:

RATIONALE:

KEY ELEMENT #3:

RELEVANT TESTS:

RATIONALE:

KEY ELEMENT #4:

RELEVANT TESTS:

RATIONALE:

9. What are 2 outcome measurement or screening tools that you would use to monitor this patient and provide your rationale for choosing them.
(2 marks)

Case History Exam
Objective Booklet

Questions to be completed following the ***Objective*** Examination

Candidate Number:_____

Candidate Name:_____

Exam Date:_____

1. Provide your main hypothesis for this patient's clinical picture. Outline in detail your rationale and justification for this hypothesis with consideration of the evidence from both the subjective and objective examination.
(8 marks)

2. List 2 favourable and 2 unfavourable prognostic indicators for this patient and considering these state your predictive outcome.
(.5 for each indicator and 1 mark for predictive outcome - total 3 marks)

3. At this point, with respect to this particular patient, are there any medical diagnostic tests that would be indicated (either now or later) or the need to refer to another health care professional? Give your rationale.
(2 marks)

4. Indicate your PRIMARY FUNCTIONAL GOAL as it relates to the Activity Limitations and Participation Restrictions and select 2 problems that would be the most relevant to address. Include your treatment goal for each problem and the testing criteria you would use to monitor change.
(6 marks)

PRIMARY FUNCTIONAL GOAL:

PROBLEM #1

Treatment goal:

Testing Criteria:

PROBLEM #2

Treatment Goal:

Testing Criteria:

5. Outline in detail the management strategies you would use over the <u>first two treatments</u> under the following headings: manual therapy (3 marks), exercise (3 marks), education and other (2 marks). Include your rationale. (8 marks total)

6. Outline in detail your progression of subsequent treatments to discharge addressing all the identified problems and provide your rationale. Use the following headings: manual therapy (3 marks), exercise (3 marks), education and other (2 marks).
(8 marks total)

7. Provide evidence to support one of your treatment interventions? Please elaborate.
(2 marks)

Manipulation Technique: Page:

Indications	Key Findings: Subjective & Objective	Problems / Cautions / Contraindications	Potential Modifications
-			

Education (Post- Manip Care, Posture, ADLs, Ergo, Sports):

.

Home exercise program:

Evidence to support choice of manipulation, education, home program: