Manual Therapy and the Canine Thoracic Spine

Introduction

• Function = Mobility with Stability

• The Integrated Approach
  – Form Closure
  – Force Closure
  – Motor Control & Timing

• Manual Therapies
  – Mobilization & Traction

Mobilization

■ Form Closure:
  ▪ Mobilization or manipulation aimed at restoring mobility and/or correction of osseous alignment.
  ▪ “If exercise is prescribed first, without firstly restoring joint mobility, the patient’s pain and dysfunction often gets worse.” (Lee & Lee 2004)

■ Mobilization
  ▪ The gentle coaxing of movement by passive rhythmical oscillations
    ▪ To treat stiffness
    ▪ To treat pain (rather than stiffness) (Maitland et al 2005)
Mobilization

- Maitland’s Mobilization Grading Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gentlest. Performed with pressures so light and amplitudes so tiny as may be considered ineffective. Used when pain and more particularly mm spasms are easily evoked by very gentle passive movement.</td>
</tr>
<tr>
<td>2</td>
<td>Large amplitude in painless part of joint’s range. Where in the range is guided by pain and spasm so as to avoid both.</td>
</tr>
<tr>
<td>3</td>
<td>Big amplitude movement and done to ‘knock’ at the limit of range. Used when pain is felt at the limit of range and is moderate and is not associated with spasm.</td>
</tr>
<tr>
<td>4</td>
<td>Tiny amplitude: performed with joint at maximal stretch and used only when examination finds the range to be almost full, not protected by muscle spasm, and when there is very little pain.</td>
</tr>
<tr>
<td>5</td>
<td>Manipulation: An extension of grade 4 – the joint is suddenly moved through a very small amplitude, but at high velocity before patient is aware of it.</td>
</tr>
</tbody>
</table>

Methodology:

- Minimal Symptoms
  - Staccato technique (like plucking a violin)
- Moderate Symptoms
  - Staccato technique (like playing staccato notes with a bow on the violin strings)
- Severe Symptoms
  - Oscillatory movements of smooth and even nature (a movement with unperceivable changes in direction)
Mobilization

• Passive & Active Movements
  – Preservation of full ROM
  – Preservation of strength and flexibility of periarticular tissue

• Physiological Movements
  – Active or passive FUNCTIONAL movements

• Accessory Movements
  – Conjunct movements

• Both are used to mobilize joints

Mobilization

• Passive Accessory vs. Passive Physiological Mov’ts

<table>
<thead>
<tr>
<th>PAIVMs (Passive Accessory Intervertebral Movements)</th>
<th>PPIVMs (Passive Physiological Intervertebral Movements)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usually the first choice for manual treatment</td>
<td>Use if irritable to touch, or if worsened after palpation, or if neurologic signs</td>
</tr>
<tr>
<td>Particularly useful when loss of motion in extension (Canine application or not?)</td>
<td>Particularly useful when loss of motion in flexion (Canine application or not?)</td>
</tr>
<tr>
<td>Eg: Dorso-ventral (PA) pressures, Traction, Transverse pressures.</td>
<td>Eg: Large movements – flexion, extension, side bending, rotation.</td>
</tr>
</tbody>
</table>

Mobilization

• Selection of techniques
  – To OPEN a facet joint
    • Rotate or Side bend AWAY from the side of pain
    • Dorso-Ventral Pressures ON the side of pain
    • Transverse Pressures TOWARDS the side of pain
  – To CLOSE a facet joint
    • Opposite of above
    • And if using a D-V pressure – direct the pressure medially

• Rule of thumb...
  – Try OPENING first!

Mobilization

• Selection of techniques based on PATHOLOGY
  – Acute pain or Nerve root symptoms
    • Static traction – gentle
  – Chronic Nerve root symptoms
    • Central D-V pressure, rotations, traction
  – Discogenic signs
    • Generalized rotation
  – Facet joint signs
    • Localized rotation
  – Osteoarthritis
    • Large movements throughout range (accessory & physiologic)

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Mobilization

• How bloody long do I do the technique(s) for?
  – TIME
  – If Irritable: then 20 – 30 seconds, repeated 1 or 2 times
  – If Non-Irritable: then 1 minute, repeated 4 – 6 times

  – TECHNIQUES PER SESSION
  – Add them in, but reassess before and after each new technique
  – Perform the most effective technique (again) last

Maitland et al 2005

Mobilization

• Mechanical
  – Restoration of voluntary movement
  – Aids in cartilage nutrition
  – Aids in intervertebral disc nutrition
  – Aids in metabolism of soft tissue structures
  – Improved rate and quality of tendon repair

Zusman 1986; Björnsdóttir & Kumar 1997

Mobilization

• Requirements for a Mechanical Effect
  – Repetitive passive joint movements (oscillations) need to be carried out at the limit of the joint’s available range in order to achieve a mechanical effect
  – i.e. Tissues need to be stretched

Zusman 1986

Mobilization

• Neurological Effects
  – Reduction in acute pain
  – Inhibition of reflex muscle contractions

Zusman 1986; Katavic 1998; Björnsdóttir & Kumar 1997; Zelle et al 2005
Mobilization

- Neurological Effects:
  - Repetitive (oscillatory) or sustained manual stimulation results in a hysteresis effect:
    - Inhibitory effect on low threshold mechanoreceptors (group I & II)
    - Inhibitory effect on high threshold nociceptors (group III & IV)
    - THUS reducing intra-articular pressure and peripheral afferent discharge

<table>
<thead>
<tr>
<th>Thicker Myelinated</th>
<th>All = touch</th>
<th>1a = muscle spindle</th>
<th>2b = GTO</th>
<th>1b = muscle spindles</th>
<th>3 = proprioception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinner myelinated</td>
<td>All = nociceptors</td>
<td>3 = nociceptor</td>
<td>3 = nociceptor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmyelinated</td>
<td>4 = nociceptor</td>
<td>4 = nociceptor</td>
<td>4 = nociceptor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mobilization

- Neurological effects
  - ”cheat sheet”

Mobilization

- Postulated Cellular Level Effects
  - Mechanical / Connective tissue remodelling
    - Cellular modulation
    - Release of enzymes to breakdown cross links
    - Simulation of fibroblast synthesis of collagen proteoglycans
    - Realignment of old fibres
    - Increase interfibre distance
    - Increase interfibre lubrication
    - Alignment of new fibres
    - Stretching articular capsule / segmental muscles
    - Breaking intra-articular adhesions
    - Vertebral movement

Mobilization

- Postulated Cellular Level Effects
  - Articular Cartilage Changes
    - Alter joint lubrication
    - Enhance cartilage nutrition
    - Movement of joint inclusions (meniscoids) or loose bodies (cartilage fibrillation)
    - Shift hard fragment of intervertebral disc

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Mobilization

• Postulated Cellular Level Effects
  – Neurological effects *
    • Stimulation of Type I and type II mechanoreceptors
    • Inhibit transmission of nociceptive impulses
    • Decrease pain perception
    • Relieve mechanical irritation of nervous system
    • Activation of articular mechanoreceptors
    • Stimulation of sympathetic nervous system

  * Validated effects

Maffey LL 2007

Mobilization

• Postulated Cellular Level Effects
  – Neuromuscular response *
    • Alter afferent input to efferent output – relax muscle
    • Stimulation of muscle spindle and golgi tendon organ – reflex inhibition of segmental muscles
    • Alter segmental (and more distal) muscle activity
    • Reflex muscle response locally and at a distance
    • Decrease spinal segmental facilitation

  * Validated effects

Maffey LL 2007

Mobilization

• Postulated Cellular Level Effects
  – Alter Circulation
    • Increase supply of materials required for healing
    • Remove chemical irritant (hence decreasing nociceptor stimulation)

Maffey LL 2007

Mobilization

• Postulated Cellular Level Effects
  – Physiological *
    • Increase beta-endorphin levels
    • Immune system effects

  * Validated effects

Maffey LL 2007

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6
Mobilization

- Postulated Cellular Level Effects
  - Joint Tissue Response
    - Increase capsule elasticity
    - Improve articular cartilage nutrition
    - Improve circulation
    - Restoration of joint play / accessory glides
    - Restoration of passive / active movement
    - Decreased pain perception

Mobilization

- Research Examples - Effects of Mobilization
  - Improved pressure pain threshold in pts with rheumatoid arthritis (12 minute P-A pressures) (Dhondt et al 1999)
  - Improved pain (VAS) & immediate neck ROM in pts with mechanical neck pain (Kanlayanaphotoporn et al 2010)
  - A rapid onset analgesic response following joint mobs has been proven in rodent models (Grayson et al 2012)

Mobilization

- Research Examples - Effects of Mobilization
  - Unilateral neck mobs facilitated activation of deep neck flexor muscle firing & reduction in superficial neck flexor activity. (Sterling et al 2001)
  - Improves ROM in the human hip & ankle joints and canine carpus (Hoeksma et al 2004; Collins et al 2004; Olson 1987)
  - Does Not Change vertebral stiffness or have permanent effect on passive cervical ROM (Nilsson et al 1996; Goodsell et al 2000; Lee et al 1993; Allison et al 2001)

Mobilization

- Research Examples - Effects of Mobilization
  - DOES NOT Alter sacrum-ilium joint position (on roentgen stereophotogrammetric analysis)
  - Manipulation might influence soft tissue structures, such as joint capsules, muscles, ligaments, tendons and postures (Tullberg et al 1998)
Mobilization

- Research Examples - Effects of Mobilization
  - Pain is improved & FUNCTIONAL disability is reduced for 6 months following 8 sessions of mobilizations & non-specific back exercises
  (Balthazard et al 2012)
  - Multifidus recruitment is enhanced and sustained after lumbar manipulation which positively impacted FUNCTION
  (Fritz et al 2012)

- THOUGHT:
  - IF, in fact, mobilizations do NOT alter joint position, biomechanics, mobility or long-term stiffness, then perhaps we can choose ANY mobilization technique (within reason...) to result in pain relief, reduction of muscle spasm, improve muscle firing, and enhanced function... followed by neuromuscular retraining.

Mobilization

- Technical Summary of Mobilization Treatment Application:
  - Patient consent received (informed of nature and purpose of mobs, alternate forms of assessment/Rx, associated risks & benefits)
  - Select starting position (relaxed and comfortable)
  - Select starting position of the clinician
  - Select treatment grade
  - Select a sustained oscillatory technique
  - Select duration and speed of oscillatory technique (shorter for acute conditions)
  - Increase the intensity and duration of treatment only when evidence exists that increased dose will not exacerbate pain
  - Select reassessment technique to use before, during and after treatment
  - Select home program to maintain treatment effects

Mobilizations

| Table 3. Cautions to Manual Therapy (choose grades 1 or 2 mobilizations) (from Mapley 2007 & adapted for dogs by L. Edge-Hughes) |
|---|---|
| Gross foraminar or spinal canal encroachment on imaging (Note: this author utilizes techniques that open the foramina on the suspected side of entrapment or side of suspected lateralized disc lesion - L39) | Soft tissue elements
  - Connective tissue instability
  - Acute post-traumatic stage of healing |
| Inflammatory diseases (i.e. polyarthritis) | Medications
  - Anticoagulants
  - Corticosteroids
  - Antidepressants |
Mobilization

- Contraindications for Mobilization or Manipulation specific to the canine patient:
  - Temperament of the dog
    - Highly anxious / fearful
    - Aggressive
  - Owner anxiety or lack of comprehension of the treatment to be administered

Mobilizations

<table>
<thead>
<tr>
<th>Mobilization</th>
<th>Contraindications to Manual Therapy (from Malley 2007 &amp; adapted for dogs by L. Edge-Hughes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Fractures – acute or presently healing</td>
</tr>
<tr>
<td></td>
<td>• Dislocations – acute or presently healing</td>
</tr>
<tr>
<td></td>
<td>• Cancers that metastasize to bone (e.g., breast, bronchus, prostate, thyroid, kidney, bowel, lymphoma) – past or present</td>
</tr>
<tr>
<td></td>
<td>• Active bone infection (i.e., osteomyelitis, tuberculosis)</td>
</tr>
<tr>
<td></td>
<td>• Osteoporosis</td>
</tr>
<tr>
<td>Neurological elements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• CNS disease or signs &amp; symptoms of its injury</td>
</tr>
<tr>
<td></td>
<td>• Spinal cord disease</td>
</tr>
<tr>
<td></td>
<td>• Cauda equina disease or signs &amp; symptoms of its injury</td>
</tr>
<tr>
<td></td>
<td>• Multiple / bilateral level of nerve root involvement</td>
</tr>
<tr>
<td></td>
<td>(Note: for these issues this author utilizes traction techniques – L.E.H.)</td>
</tr>
<tr>
<td>Vascular elements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Vascular disease (aneurysm)</td>
</tr>
<tr>
<td></td>
<td>• Signs of vascular insufficiency in the region</td>
</tr>
<tr>
<td></td>
<td>• Bleeding disorders</td>
</tr>
</tbody>
</table>

Table 2. Contraindications to Manual Therapy (from Malley 2007 & adapted for dogs by L. Edge-Hughes)

<table>
<thead>
<tr>
<th>Mobilization</th>
<th>Caution Regarding the Practitioner (from Malley 2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient scan or biomechanical examination</td>
<td>Inappropriate findings, end feel, or patient response with the scanning exam, biomechanical testing, or stress tests</td>
</tr>
<tr>
<td>Clinician’s insufficient awareness of contraindications &amp; conditions requiring extra care and gentleness</td>
<td>Lack of clinician’s confidence for the technique</td>
</tr>
</tbody>
</table>

Table 4. Contraindications & Caution Regarding the Practitioner (from Malley 2007)
Manual Therapy and the Canine Thoracic Spine

Traction

- Traction may break the “cycle of pain” in radiculopathy caused by herniated discs:
  - Disc herniation
  - Nerve root entrapment in vertebral foramina
  - Nerve root irritation
  - Reflexive response to contract adjacent muscles
  - Further narrowing of foramina
  - Increased pain.

TracNon

- TracNon may break the “cycle of pain” in radiculopathy caused by herniated discs:

TracNon:
- reduce inflammation
- improving circulation
- reducing swelling

Intermident tracNon
- Improves circulation & reduces swelling of surrounding tissues and epidural space
- Relieves the inflammatory reaction of nerve roots
- Contributes to resorption and regression of the herniated disc material
  - Large extruded discs tend to respond more rapidly
- Creates an alternating stretching and relaxation of adjacent soft tissue structures
- Prevents adhesions of the dural sleeve

Traction

- Findings:
  - Human patients with cervical radiculopathy < 12 weeks show less favourable improvement.
  - Early intervention is more successful
  - The response to early therapeutic intervention in large extruded discs is even more favourable.
  - Benefits to lumbar traction with acute radicular pain of less than 6 weeks and concomitant neurological deficits.

Krause et al 2000

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Manual Therapy and the Canine Thoracic Spine

Traction

• Findings
  – Physiotherapy which includes traction for CT scan-proven herniated discs and EMG-proven radiculopathy:
    • 90% good – excellent outcomes and 92% return-to-work rate

Sal & Saal 1985

• Contraindications:
  – Infection
  – Neoplasms
  – Osteoporosis
  – Bilateral pars interarticularis defect
  – Grade 2 or higher spondylolisthesis
  – Fractures
  – Spinal instrumentation

Deen et al 2003

• Traction can also be graded using the Maitland Mobilization Scale
  – Grade 1 & 2 have a neuromodulatory / pain relieving effect
  – Grades 2 & 3 have a vascular effect
  – Grades 3 & 4 have a mobilizing effect
  – Grade 5 is a manipulation (and not recommended with traction)

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The Myofascial System

• THE MYOFASCIAL SYSTEM
  – There is a variance of myofascial states that may accompany a vertebral dysfunction
  – Treatment of the muscle state tends to occur after treatment of the vertebral dysfunction.

<table>
<thead>
<tr>
<th>Muscle Tone</th>
<th>Description</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypotonicity</td>
<td>The presence of pain or stiffness has resulted in a loss of normal mobility. The muscles may feel to have lost bulk, lack normal tone and feel somewhat fibrous.</td>
<td>Treatment is to restore motion, heat, and treatments to encourage circulation, followed by specific exercises.</td>
</tr>
<tr>
<td>Disuse atrophy</td>
<td>Treatment includes muscle elongation by stretching or massage.</td>
<td></td>
</tr>
<tr>
<td>Wasting &amp; fibrosis</td>
<td>The result of neurological or surgical interference with normal nerve conduction. Treatment is to promote circulation and exercises to train the remaining muscles.</td>
<td></td>
</tr>
</tbody>
</table>

Adapted from Paris & Vith 2007
Conclusion

- Manual therapies such as mobilizations / manipulation and traction:
  - Have a proven track record clinically
    - Both in practice and in research
  - Have a limited amount of research to validate their cellular effects
  - Still need further research to elucidate the full potential of manual therapy and/or dispel any falsely propagated myths.
  - The Myofascial system should also be addressed but likely secondarily to the skeletal system

On with the show!
**THE CANINE THORAX**

The Canine Spine: Advanced Assessment & Treatment Techniques

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**The Thorax**

- Thorax = thoracic vertebra, ribs, and sternum + attaching muscles
  - A biomechanical approach to treatment
    - Requires and understanding of normal function
    - Integrates joint mobility and stability
  - The dog is a good research model for the human thoracic vertebra....
    - Hence allowing a transfer of assessment/treatment strategies

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**T/S: Anatomy & Biomechanics**

- Bodies of the thoracic vertebra are shorter than those of the lumbar or cervical spines
- T1 – T7/8 spinous processes are massive
- The spinous processes decline in length from T1 to T9/10 and are caudally inclined.
- T11 is the antclinal vertebra and the transition segment to the thoracolumbar region

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**T/S: Anatomy and Biomechanics**

- The spinous tips of T6 – T9 overlie the bodies of the vertebra caudal to them.
- T12/13 are directly cranial to the bodies.
- The Transverse processes are short, blunt, and irregular

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T/S: Anatomy and Biomechanics

• The Cranial Thoracic Spine (T1 – T9)
  – T1 – T9 facet joints are horizontal and overlap
  – 63% incidence of unilateral or bilateral facet aplasia in small dogs (exclusively)
  – Asymmetry in size of left & right articular surfaces
    • Result of postnatal loading of immature artic. Cartilage
    • Restricted motion may play a role in development (if arches of the adjacent vertebra do not touch)

Breit 2002a

T/S: Anatomy and Biomechanics

• The Cranial Thoracic Spine
  • Weight bearing is suspected to be the main function of the facets in large dogs
  • The disc may compensate for the functional loss of facet joints in small dogs
  • Facet aplasia:
    • Does NOT increase the risk of developing IVDD or spondylitis

Breit 2002a

T/S: Anatomy & Biomechanics

• The Cranial Thoracic Spine
  – In humans: the orientation of the facet joint (of the lower C/S and upper T/S) allow for side bending
  – Clinically, lateral bending is accompanied by rotation to the same side (T1 – T6)
  – Below T7: the conjunct rotation is variable

Breit 2001a; Lee 2003

T/S: Anatomy & Biomechanics

• The Caudal Thoracic Spine (T10 – T13)
  – T10 – T13 facet joints are vertically aligned
  – This orientation allows for flexion and extension
  – Vertebral arches and facets are involved in weight bearing and transmission of loading forces

Breit 2003a,b; Evans 1993

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T/S: Anatomy & Biomechanics

- The Caudal Thoracic Spine (T10 – T13)
  - In Normally positioned vertebra (parallel):
    - The caudal tips of the caudal articular process do not come into contact with the adjoining cranial articular surfaces
    - Lateral bending is restricted by accessory processes
    - Rotation is accomplished only in flexion in this region

Breit 2002b

T/S: Anatomy & Biomechanics

- The Caudal Thoracic Spine (T10 – T13)
  - T10 – L7 is normal kyphotic
  - Lordosis can occur with the loss of elasticity of the bowstring construct
    - The caudal articular surfaces adapt to higher body-weight by the presence of LARGER articular surfaces
    - Thus creating articular surfaces not only laterally but also caudally and/or ventrally

Breit 2002b

T/S: Anatomy & Biomechanics

- The Caudal Thoracic Spine (T10 – T13)
  - Ventrally directed shears cause ventral facets
    - Allows for an increase of loading capacity
    - Excessive extension causes caudal facets
      - Due to loss of elastic stability
    - Ventral and caudal facets (together) create a ball and socket joint
      - Reduces spinal stability & NOTHING resists axial rotation

Breit 2002b

T/S: Anatomy & Biomechanics

- The Caudal Thoracic Spine (T10 – T13)
  - In humans, articular asymmetry is highly prevalent
    - Typically 41%
  - The thoracic spine looks like and responds like the lumbar spine
    - An abrupt decrease in the range of axial rotation

Singer 2004
T/S: Anatomy & Biomechanics

• Rib Articulations
  – Costal fovea (rib articulations) are located at the cranial and caudal sides of each thoracic vertebra.
    • “Cranial or caudal costal fovea”
    • “Demifacets”
  – Rib head 1 articulates with T1 body and sometimes C7 + C7/T1 disc

T/S: Anatomy & Biomechanics

• Rib Articulations
  – The tubercles of the ribs articulate with the TPs of the T/S at the same number as the rib
  – T12 often lacks a demifacet
  – T12 & T13 have ONE complete fovea on each side

T/S: Anatomy & Biomechanics

• Rib Articulations
  – The costovertebral joints & rib cage = STABILITY
  – Ligamentous support: articular capsule, radiate ligament, intercapital ligament, costotransverse ligament and intra-articular ligament
  – RESIST lateral bending and rotations
  – Injury or surgery to the costovertebral joints = LESS stability

T/S: Anatomy & Biomechanics

• Rib Ligaments
  – The Radiating head ligament
    • From ventral aspect of the rib head to the bodies of the 2 adjacent vertebrae
  – Intraarticular head ligament
    • From the dorsal aspect of the rib head to the dorsal surface of the 2 adjacent vertebra and the intervertebral disc
  – Intercapital ligament
    • From the head of one rib over the dorsal part of the intervertebral disc (but ventral to the dorsal longitudinal ligament) absent at Rib 1 & 11-13
  – Ligament of the neck
    • From the neck of the rib to the ventral surface of the transverse process & lateral surface of the vertebral body
  – Costotransverse ligament
    • From the rib tubercle to the transverse process

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**T/S: Anatomy & Biomechanics**

- Costotransverse joint pain
  - (humans report – after injection into CTv jt):
    - Deep, dull ache & pressure sensation.
    - 3.3 / 10 pt scale
    - Pain patterns superficial to the injected point
  - Innervation:
    - Lateral branch of thoracic dorsal rami
    - Sympathetic innervation from neighbouring sympathetic segment & segment cranial to it

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**Table 3.1. Branches of the Spinal Nerves**

<table>
<thead>
<tr>
<th>Branch</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meningeal Branch</td>
<td>Supplies the dura mater, the dorsal longitudinal ligament, the vertebral</td>
</tr>
<tr>
<td></td>
<td>venous sinus and other blood vessels in the canal. Each annulus fibrosis</td>
</tr>
<tr>
<td></td>
<td>of the disc is supplied by meningeal branches from two or more spinal nerves.</td>
</tr>
<tr>
<td>Dorsal Branch</td>
<td>Divided into medial and lateral branches. Supply the epaxial muscles and</td>
</tr>
<tr>
<td></td>
<td>skin over the dorsal aspect of the body wall.</td>
</tr>
<tr>
<td>Ventrail Branch</td>
<td>Also called intercostals nerves. These are also divided into medial and</td>
</tr>
<tr>
<td></td>
<td>lateral branches except in the region of the brachial plexus and lumbar-sac</td>
</tr>
<tr>
<td></td>
<td>rami or the supply to the tail. The intercostal nerves supply the</td>
</tr>
<tr>
<td></td>
<td>hypaxial muscles of the body wall and give off lateral and ventral cutaneous</td>
</tr>
<tr>
<td></td>
<td>branches to supply the skin of the lateral and ventral aspects of the body</td>
</tr>
<tr>
<td>The Visceral Branch</td>
<td>Carries only general visceral sympathetic fibers to and from visceral</td>
</tr>
<tr>
<td></td>
<td>structures.</td>
</tr>
</tbody>
</table>

Cord segments T1 – T7 are displaced cranially with respect to their corresponding vertebrae (Breit 2002c)

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**T/S: Anatomy & Biomechanics**

- Rib Articulations
  - Comparison of bipeds, pseudobipeds & quadrupeds
    - Humans & pseudobipeds have lateral spinal ligaments (i.e. ligs that run from TnP to TnP or rib to TnP of vertebra above.
    - No lateral spinal ligs were found in quadrupeds
    - Query... development in an erect spine & fundamental to stability in an erect posture.

Jiang et al 1995

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**Jiang et al 1995**
Key Muscles of the Thoracic Spine

**Epaxial Muscles**

**Iliocostalis**
The most lateral of the erector spinae muscle group is Iliocostalis, which is divided into the lumbarum and thoracicum portions. Iliocostalis lumbarum originates on the pelvic surface of the wing of the ilium and is joined by fascicles from the ends of all the lumbar transverse processes. It inserts onto lower ribs. The thoracis portion originates from each of the ribs (except ribs 1 and 13), and inserts onto the transverse process of C7 and the costal angles of the ribs. Both portions act to stabilize the vertebral column or for lateral movement when unilaterally contracted. Iliocostalis will also aid in expiration by pulling ribs caudally.

**Longissimus**
The medial portion of the erector spinae consists of overlapping fascicles from the ilium to the head and is the strongest muscle of the trunk. It is also divided into sections by location: the lumbarum, thoracum and cervicis portions. Longissimus thoracis is covered by a dense aponeurosis that is separated from the thoracolumbar fascia by fat. It has attachments to each lumbar, thoracic and cervical vertebra as well as each rib. It will act to extend the vertebral column (from above or below), float the cervicothoracic junction or extend the neck.

**Spinalis et semispinalis thoracis et cervicis**
These arise from the sides of the spinous processes and insert into spinous processes cranial to them and extending up as high as C2. They are capable of floating the thoracic vertebral column and raising the neck.

**Multifidus**
Multifidus is an important muscle for control of intervertebral motion and fixation of the vertebral column. It is reported to have 4 different fascicles (including sacrocaudalis dorsalis medialis), originating as caudally as the sacrum and terminating as cranially as C2. Fascicles cross anywhere from 2 or more vertebral segments from mamilary or articular processes of caudal vertebra to spinous processes of cranial vertebra.

And yes... I acknowledge the Rotatores, Interspinales & Intertransversarii muscles as well! 😊
## Key Muscles of the Thoracic Spine

### Hypaxial Muscles

- **Abdominals**
  - **Rectus Abdominis**
    - Originates via a tendon from the sternum, the first costal cartilage and rib as well as the 9th costal cartilage. It inserts onto the pubis. It acts to compress the abdominal viscera, support the abdominal viscera and bring the pelvis forwards or flex the back.
  - **Transverse Abdominis**
    - Deepest of the abdominals, it originates from the lumbar vertebrae and the thoracolumbar fascia, as well as the medial sides of ribs 12 and 13 and the costal cartilages of ribs 8 and 11. It inserts onto the linea alba and abdominal aponeurosis to the pelvis. Its actions are the same as for the obliques. It has been found in humans to have a significant role in control of intra-abdominal pressure, tensioning of the thoracolumbar fascia, stabilization of intervertebral motion, as well as support for the sacroiliac joint (Hodges 2004).
  - **Ribs**
    - Both muscles arise between the ribs and costal cartilages. The externals run caudoventrally, while the internals run cranioventrally. They act to assist in inspiration and may provide some resistance to twisting movements.

---

**T/S: Anatomy & Biomechanics**

**Key Muscles of the Thoracic Spine**

<table>
<thead>
<tr>
<th>Hypaxial Muscles</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal and external oblique abdominals</strong></td>
<td>Part of the hypaxial muscle group. The external oblique runs caudoventrally from ribs four to twelve and from the thoracolumbar fascia. It inserts into the abdominal aponeurosis and linea alba and caudally to the pubis. The internal oblique runs cranioventrally, and originates from the vertical line crest and fascia and inserts onto rib 13 and 12 as well as the linea alba. Both muscles act to compress the abdominal viscera (which aids in inspiration, urination, defecation and parturition), and also enables flexion of the vertebral column (bilateral action) or lateral bending of the vertebral column (unilateral action).</td>
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</table>
S/S of Thoracic Spine Dysfunctions

- **Human Symptomology:**
  - Pressure headaches,
  - Aching at the back of the shoulders, over the pelvis, in the axilla or medial side of the elbow,
  - Heaviness and tiredness of the arms or legs,
  - A glove distribution of symptoms,
  - Traumatic girdle pain,
  - Scapular / abdominal / kidney pains / chest pain or indigestion,
  - Upper limb/shoulder mobility restriction,
  - Shoulder impingement-type pain.

  Maitland et al 2005; Hengeveld and Banks 2005

S/S of Thoracic Spine Dysfunctions

- **Canine Symptomology:**
  - Exaggerated kyphosis or lordosis of the thoracic region,
  - Discomfort to petting over the thoracic region,
  - Expression of pain with jumping or moving while in a recumbent position, wrestling with other dogs,
  - Forelimb lameness or limb favouring,
  - Head-down posturing,
  - A reduction in athleticism,
  - Excessive stretching (‘down-dog’).

  LEH clinical observations

Palpation Concepts

- **Postural analysis**
  - Reveal nothing OR show a segmental rotation

- **Multisegmental stiffness alters thoracic curve**
  - exaggerated kyphosis, reduced lordosis, or scoliosis

- **Acute zygapophysial joint sprain**
  - produces localized pain over the involved joint

- **Chronic restriction of either the zygapophysial or costovertebral joint**
  - produces symptoms removed from the source
    - (contralateral side of the thorax or at levels above or below).

  Maitland et al 2005; Hengeveld and Banks 2005

Palpation Concepts

- **Posture**
  - Kyphosis, lordosis, scoliosis, body condition

- **Temperature**
  - Non-inflammatory Increase of temp.

- **Thickening**
  - Chronic lesions may be thicker in the interspinous space

- **Abnormal muscle tone**
  - Hypertonic (acute) or hypotonic (chronic)
  - Atrophy

  Maitland et al 2005; Hengeveld and Banks 2005

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Manual Therapy and the Canine Thoracic Spine

General Motion Testing Concepts

• Movement awareness
  – Assess the quality (i.e. sensation throughout motion plus the endfeel)
  – Assess the quantity (i.e. ROM)
  – Assess for symptoms (i.e. pain responses)

• Active Motion Testing
  – Cookie stretches
    • Willingness and/or ability
    • Movement compensations
  – Generally, facet joint movement restrictions may be too subtle for the examiner to notice in this manner

• Joint Play
  – The general sense of the motion within a joint.
  – Used to narrow the examiners search for the lesion
  – Tested in the joint’s neutral position
  – Light pressure & gentle hands

  Limited amount of joint play  Moderate amount of joint play

• ARTHOKINEMATICS
  • Articular function (aka “form closure”)  
    – HYPMOBILITIES
      – An increase in stiffness in the neutral zone and a harder end feel in the elastic zone are noted on passive tests for arthokinematic function.
      – The stiffness has a solid stop.
General Motion Testing Concepts

- **Adjunctive tests**
  - X-rays may be useful to reveal serious bone disease and significant mechanical defects, but rarely provide guidance for manual therapy.

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Clinical Diagnostic Tests & Treatment Techniques

Let's get to the dogs!

T/S Palpation

- Review:
  - Speak now or forever hold your peace....
- Can you:
  - Direct palpation of the spinous processes T1 – T13
  - Palpation of the ribs 1 – 13
  - Palpation of the sternum (including the manubrium and xiphoid process)
  - T10 & T11 are found in the ‘dip’ in the middle of the dogs back
- What techniques have you been practicing?
- Do we need to review anything?
T/S Review – localize the lesion

• Bilateral Transverse Process Posterior – Anterior (Dorso-Ventral) Pressures:
  - Use a thumb and index knuckle to do a P-A on the transverse processes / articular pillars simultaneously.
    • This may give you information as to where along the thoracic spine there is stiffness (hypomobility).
    • Be sure to support under the belly or chest.
  - Assess for quality and quantity of movement, end feel and pain.
    • Angle slightly cranially above T9/10 and straight up and down for T10/11 and below.
    • However, to isolate which facet is problematic, you will need to do a unilateral P-A/(D-V).

Assessment or treatment
T/S Review – localize the lesion

• Individual side bend / rotations:
  – Using the side of the spinous processes and
    a) Push the spine away from one side, while pulling the hips or shoulders in the opposite direction, with the dog in standing or lying
    b) Push the spinous process towards the floor with the dog in side lie (Note: This test is most appropriate for the thoracic spine – above the level of T9/T10 usually)

Assessment or treatment

Passive Physiologic Intervertebral Movements (PPIVMS) & Treatment Techniques

• ARTHOKINEMATICS
  – Ventral translation glide (spinal):
    • Fix one vertebra via the spinous process (pinch it and hold it caudally) and the push the superior vertebrae with a dorsoventral pressure

Assessment or treatment

Feel for stiffness in the neutral zone and the end feel at the anatomical barrier

Passive Physiologic Intervertebral Movements (PPIVMS) & Treatment Techniques

• ARTHOKINEMATICS
  – Dorsal translation glide (spinal):
    • Fix the vertebra below (pinch it and hold it caudally) and then push through the thorax/chest and feel the translation and end feel.

Assessment or treatment

Feel for stiffness in the neutral zone and the end feel at the anatomical barrier
Passive Physiologic Intervertebral Movements (PPIVMS) & Treatment Techniques

- **ARTHOKINEMATICS**
  - Transverse rotation glide (spinal):
    - Fix the spinous process (pinch it and hold it caudally) of one vertebra and push laterally on the spinous process of the vertebra above. Repeat in both directions.

  
  - Feel for stiffness in the neutral zone and the end feel at the anatomical barrier.

Passive Physiologic Intervertebral Movements (PPIVMS) – Assessment only...

- **ARTHOKINEMATICS**
  - Lateral Translation Glide:
    - For segments T3/4 to T10/11 and associated ribs. Compress one rib (i.e. left rib 6) (from the lateral side or dorsolateral side) and shear the contralateral rib just above (right rib 5) PURELY & medially in the transverse plane.
    - NORMALLY, there should be little/if any movement or pain.
    - The primary structure being tested is the disc!

  
  - Lateral translations (stress test for the disc)

T/S: Spinal Treatment Techniques

- **CONCEPT – Regarding Dorsoventral Pressures**
- **To Stabilize above or below? (T1/2 – T9/10)**
  - When performing the D-V pressure you can be more specific as to whether you are ‘opening’ the facet(s) or ‘closing’ the facet(s).
    - If you stabilize the spinous process caudal to the ‘moving’ spinous process, and glide cranially, then you are opening (flexion of) the facet(s) – i.e. Hold T7 caudally while gliding T6 cranially
    - If you stabilize the spinous process cranial to the ‘moving’ spinous process, and glide cranially, then you are closing (extension of) the facet(s) – i.e. Hold T6 caudally while gliding T7 cranially

  
  - Assessment typically... but I use it to treat too!
**T/S: Spinal Treatment Techniques**

- **CONCEPT – Regarding Unilateral Facet Joint Restrictions.**
- **To Block or Assist Side bend/Rotation techniques?**
  - When side bending the dog you can either:
    - Push the spinous process of the segment to be treated AWAY from the side bend motion (ASSISTING movement)
    - BLOCK the spinous process from moving away from the side bend motion (thus stopping further motion down the spine and making the end of motion occur at that specific segment)

**TRY BLOCKING – compare to assisting**

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**T/S: Spinal Treatment Techniques**

- **CONCEPT – Regarding Unilateral Facet Joint Restrictions.**
- **To Block or Assist Side bend/Rotation techniques?**

**TRY in Flexion & Extension**

---

**T/S: Spinal Treatment Techniques**

- **CONCEPT – Regarding ANY Facet Joint Restriction in the Dog.**

  - The problem is usually poor opening of a facet joint. (You can default to flexion techniques if you are unsure of the lesion)
  - If a dog has an increase in pain or exhibits a pain response (i.e. Yelping &/or root signature stance when testing the Cervico-thoracic region or Lumbar region), when you are doing an EXTENSION technique or a BLOCKING technique – you may be dealing with an osteophyte encroaching on the nerve root foramen.

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**TRY in Flexion & Extension**

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T/S: Spinal Treatment Techniques

• **Any zygapophysial restriction**
  – Position the animal standing or sitting.
  – At the site of the lesion (localized with assessment for tenderness), press on the side of the spinous process, one direction at a time. Note the degree of discomfort and mobility of each direction.
  – Work with the direction that is most stiff (and often most uncomfortable)
    • Firstly apply a pressure in the opposite direction to the spinous process of the vertebra cranial and then to the one caudal.
    • One of which will exaggerate the discomfort and one of which will relieve it/be less reactive.
    • Chose to mobilize whichever of these two directional forces that relieves the symptoms/is less reactive.

NEW...
Try it!

T/S: Spinal Treatment Techniques

• **Traction:**
  – This technique restores a bilateral restriction of flexion.
  – Cervical traction with the head and neck positioned in flexion should address the upper thoracic spine
  – Lumbar traction (i.e. a standing traction) will target the mid thoracic spine and all vertebral segments caudally.
With the dog laying on his/her side and the head flat on the floor.

Use one hand just under the dog’s muzzle to prevent the head from being pushed into flexion and the other hand on the back of the skull to create the traction.

Position the animal (and yourself) so that the dog’s neck can be supported over your thigh (standing or lying depending upon size of the dog).

With a wide pinchcr grip, grasp behind the skull and slowly push it away.

The other hand braces the animal’s shoulders or withers.

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The other hand braces the animal’s shoulders or withers.
**T/S: Traction**

- **Traction:**
  - **Small dog hanging traction:** Slowly and gently pick up the dog so that its spine is against your chest. Hold it in a “bear hug” with two arms if necessary (i.e. heavier dog) or with one arm to hold and the other arm to support under the butt or under the legs depending on the comfort of the animal. Straighten up or stand up, so that the animal’s feet come off of the ground and the weight of the lower body is tractioning the spine. You can allow wiggly dogs to touch the ground with their toes or if you want to add extension into your traction.

**T/S: Traction**

- **Traction:**
  - **Specific traction:** Grab one spinous above the site to traction and one spinous process below (if the area is too tender, then raise and/or lower the vertebra used to traction through so as to be further away from the painful area) and pull apart (distract).

---

**T/S: Rib Techniques - Review**

- **Assessing the position of the ribs:** Palpate both dorsally and ventrally and compare the position from side to side and also in comparison to the ribs adjacent cranially and caudally. Palpate for tenderness also. (Best done in standing)
- **Assess ‘general’ mobility of the ribs:** Push downward from the top at the costovertebral junction. Pull up from below at the sternocostal junction or costochondral junction
- **Mobilize:** Dorsal glide & Ventral glide

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T/S: Rib Techniques – New Concept

- **Ventral translation glide** *(with improved specificity):*
  - Stabilize the two associated spinous processes (i.e. T4 + T5) away from the rib to be mobilized
  - With your other hand push ventrally on the rib to be treated (i.e. Rib 5).

- **Dorsal translation** *(with specificity for the sternocostal junction):*
  - NOTE position of the ribs (ventral surface) looking for a step deformity, or a gap in the joint line at the sternocostal junction.
  - Stabilize the sternum and push on the ventral aspect of the costocartilage/rib and push dorsally (upwards).

T/S: Rib Techniques – New Concept

- **Cranial – caudal rib glides:**
  - Fix the corresponding spinous process (pushing it to the contralateral side) and push cranially or caudally on the corresponding rib to assess the glide at the costotransverse joint.

T/S: Rib Techniques - Review

- **Ribs 1 - 4 localization**
  - NOTE:
    - RIB ONE can be accessed adjacent to the sternum and working one’s way inwards towards the cervical spine. (Midpoint between the manubrium and the greater tuberosity of the humerus)
    - RIBS 1 - 3 (and sometimes 4) are located under the scapula but can be accessed (at the rib angle) by maneuvering a finger or thumb under the caudal aspect of the scapula with the shoulder joint in a slight degree of flexion.
• Assessing Rib one:
  – With the dog in sitting: Simultaneously assess both first ribs with either fingers or thumbs lying overtop of these ribs, located by moving dorso-caudo-medially from either side of the manubrium (towards C7).
  – Feel for position and/or push ‘downward’ (caudal) individually on the top of these ribs to assess for discomfort and stiffness.

MOBILIZE:
  Push down on the one that is ‘high’ (caudal glide)

• Rib One
  • Caudal glide with improved specificity
    – Glide rib one caudally (first fixate the T1 spinous process by pushing it to the contralateral side). Feel for end feel and stiffness.
**T/S: Rib Techniques – New Concept**

- **Rib One (for a rib in a cranial position)**
  
  In humans – with elevated rib one issues, the Scalenes are often tight or shortened and can ‘hold’ rib one in a cranial position.

  Stretch Scalenes by pressing caudally (downwards) on rib one while turning the dogs head to the contralateral side.

  You may also want to massage in the same region to release the tension in the Scalenes.

- **Rib One
  - Cranial glide (for a caudally displaced ‘rib one’ that is tender on palpation)**
    
    - From under the axilla place your thumb against the caudal border of rib 1, and then glide the spinous process of T1 caudally.
    - Feel for end feel and stiffness.

**T/S: Rib Techniques – New Concept**

- **Ribs – Generic Treatment Technique**
  
  - **A distraction mobilization or manipulation**
    
    - Localize the angle of the rib and positioning your thumb at this spot.
    - Your other thumb is placed across the ipsilateral side of the spinous processes of the two corresponding vertebra to stabilize.
    - The mobilization / manipulation occurs by creating a lateroventral pressure with the thumb on the corresponding rib at the ‘rib angle’.
T/S – Force Closure

• *Neuromyofascial function (force closure)*
  – In humans, this test would be a prone arm lift, watching for the patient’s method of thorax stabilization.
  – A similar construct could be created in the dog, with a standing unilateral front leg lift (watching for stabilization and control of balance), or a diagonal leg stand.
  – The thorax should not rotate, side bend, flex, extend or translate, and the scapula should not move on the weight bearing side.

T/S – Force Closure

• *Neuromyofascial function (force closure)*
  – The deep small stabilizer muscles of the thorax (such as multifidus and the intercostals) can atrophy subsequent to injury to the thorax.
  • Firmly palpate the ‘gutter’ between the spinous process and the transverse process (multifidus) and feel for firmness and size of the muscles (comparing side to side and above and below).
  • Then palpate between each palpable rib (intercostals) and compare with adjacent and contralateral sites.
**T/S: Neural Conduction & Mobility**

- **Neural conduction and mobility**
  - The adjacent muscles (the epaxials, hypaxials, and intercostals) can be palpated for appropriate muscle bulk and tone. Segmental facilitation leads to hypertonicity (initially) and reduced motor function which causes atrophy (secondarily).
  - *Hypaesthesia* can be one of the first signs of a neurological interference and tend to occur long before sensation becomes reduced.

- **Neural conduction and mobility**
  - In the human, a dural slump test might reveal thoracic pain, which is relieved by head and neck extension.
  - It has been determined that vertebral column flexion in the dog can create a very small gliding distance at the T13 – L1 spinal levels. (Gruenenfelder et al 2006)
  - Other thoracic segments have not been tested, but it is reasonable to hypothesize that the dura at other thoracic levels could be put into tension in a full flexion position.

**T/S: Force Closure and Motor Control**

- **Force Closure and Motor Control:**
  - The four muscles of interest for the stabilization of the lumbopelvic region are the diaphragm, transverses abdominis, deep fibres of multifidus and the pelvic floor.
  - Based on the anatomy of the thoracic region, it is hypothesized that the deep segmental muscles (i.e. multifidus) will have a similar function in the thoracic region. (Lee LJ 2003)
**T/S: Force Closure and Motor Control**

- **Force Closure and Motor Control:**
  - Restoring tonic function of these muscles is essential for regaining segmental stability.
  - Stretching, elongating and/or relaxing larger more dominant global muscles that could be over-actively attempting to stabilize the thorax may need to be addressed for normalization of movement and function.
  - Additionally, the most common component lost in human patients with thoracic dysfunction is lateral costal expansion. (Lee LJ 2003)

**T/S: Force Closure and Motor Control**

- **Stabilization training**
  - 3-leg standing, lifting one front leg off the ground, while cueing the segmental muscles (multifidus) by palpating & rubbing just adjacent to the spinous process in the ‘gutter’ between the spinous process and the erector spinae muscles OR by cueing the abdominals. This exercise can be progressed by having the animal perform it on an uneven surface such as a wobble board or balance disc.

**T/S: Force Closure and Motor Control**

- **Rotations in standing:**
  - In a stable standing position, impart a rotation (twist) to the thorax with your hands spread out wide over the torso (one moves ventrally and the other moves dorsally).
  - The animal must stand and actively resist this force. This can be done as an isometric hold technique in order to activate multifidus and/or the intercostals.
**Stretches:**

- Stretching out of the dominant global muscles in the thoracic spine can help to normalize an overactive stabilizing mechanism.
- Key muscles to evaluate for over-active resting tone or adaptive shortening are the erector spinae, rhomboids, the latissimus dorsi, the rectus and both oblique abdominal muscles.

**Lateral costal expansion:**

- Utilizing a cardiopulmonary therapy technique, position the patient in sitting or standing, and as the patient exhales, gently compress the lateral ribs a bit further.
- The technique occurs either in one compression movement or a succession of two or three compressions that build in compression force.
- Then quickly release your hands, stimulating a greater inhale and lateral costal expansion.
- The practitioner should try to time the technique with the normal breathing pattern.
T/S: Force Closure and Motor Control

The Thoracic Spine

- **Key Points to Return to Activity and Strengthening**
  - Focus first on low loads and control of movement
  - Avoid fast ballistic movements in early stages
  - Progress from stable to unstable surfaces
  - For upper and middle thoracic control, incorporate greater arm movements
  - Work on high load and high speed activities at the end stages.

Want to continue to learn more?
Check out: [www.FourLeg.com](http://www.FourLeg.com)
REFERENCES

MANUAL THERAPY References


THORACIC SPINE References


