Neurodynamics in the Thorax
> mechanical
> electrical
> chemical
Sliders
Tensioners
Image from Dr. Harry Von Piekartz; with permission
Tests are treatments...
Tests are treatments...

- Into s/s or response and then back away
- Reverse the test/treatment
- Focus on single components of the test/treatment
Carpal Tunnel: Median Nerve Glides

1. Place your right fingers on your left palm
2. Gently tip your fingers back
3. Stretch and reach up to the ceiling
4. Gently stretch, hold for 5 seconds and return down to the starting position
5. Remember to breathe
6. Repeat 10 times
7. Repeat 10 times on the other hand
Spinal Manipulation 101

1. Definition
2. Evidence for Spinal Manipulation
3. The audible pop
4. Localization of spinal manipulation
5. Safety
6. Consent
7. Reasons to manipulate
8. Who should manipulate?
1. Definition
2. Evidence

- Thoracic Manipulation
  - Neck Pain
  - Shoulder Pain
  - Thoracic Pain
Development of a Clinical Prediction Rule for Guiding Treatment of a Subgroup of Patients With Neck Pain: Use of Thoracic Spine Manipulation, Exercise, and Patient Education

Joshua A. Clendaniel, John D. Chlebik, Julie M. Fritz, Julie M. Whitman, Sarah L. Eshbold
78 patients with neck pain

Subjective
Objective

Wait 48 hours

GROC
+5 or better

42 YES 54%
36 NO 46%
Examination Items Predicting SUCCESS

• HISTORY
  – Duration of symptoms 30 days or less
  – Symptoms not distal to the shoulder
  – Looking up does not aggravate symptoms
  – FABQPA < 11

• PHYSICAL EXAM
  – Decreased upper thoracic (T3- T5) kyphosis
  – Cervical extension ROM < 30
# Accuracy of Prediction Rule

<table>
<thead>
<tr>
<th>Number of Predictor Variables Present</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive Likelihood Ratio</th>
<th>Probability of Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>All 6 present</td>
<td>0.12</td>
<td>1.00</td>
<td>Infinite</td>
<td>100%</td>
</tr>
<tr>
<td>5 or more present</td>
<td>0.33</td>
<td>1.00</td>
<td>Infinite</td>
<td>100%</td>
</tr>
<tr>
<td>4 or more present</td>
<td>0.33</td>
<td>0.97</td>
<td>12 (2.28 – 70.8)</td>
<td>93% (66 – 99%)</td>
</tr>
<tr>
<td>3 or more present</td>
<td>0.76</td>
<td>0.86</td>
<td>5.49 (2.72 – 12.0)</td>
<td>86% (74 – 94%)</td>
</tr>
<tr>
<td>2 or more present</td>
<td>0.93</td>
<td>0.56</td>
<td>2.09</td>
<td>71%</td>
</tr>
<tr>
<td>1 or more present</td>
<td>1.00</td>
<td>0.14</td>
<td>1.2</td>
<td>58%</td>
</tr>
</tbody>
</table>
• **Objective:** To validate a clinical prediction rule to identify individuals with beck pain most likely to benefit from thoracic manipulation and exercise. **Study Design:** A randomized clinical trial.
3. The audible “pop”
4. Localization
5. Safety
Manipulation is dangerous!

• Reviewed the literature over 77 yr. period

• Ten episodes of cauda equina syndrome following lumbar manipulation reported

• Estimated risk: < 1 per 10,000,000 manipulations

Comparative Analysis: NSAIDs

- 1% to 3% thought to develop GI bleeding as a consequence. ¹
- 7,600 deaths and 76,000 hospitalizations annually in the U.S. may be attributable to NSAIDs. ²
- Standard NSAIDs: 1/1,000 experience GI bleed if used > 4 wks. ³
- COX-2 inhibitors have not established a clinically meaningful safety advantage over NSAIDs. ⁴

Comparative Analysis: Exercise

Risk of sudden death estimated to be 1/1.5 million episodes of vigorous physical exertion

Classification of Complications

1. Serious non-reversible impairment
2. Substantive reversible impairment
3. Transient impairment
1. Serious non-reversible impairment

- Death
- CVA
- Spinal Cord Compression
- Cauda Equina Syndrome
2. Substantive reversible impairment

- Disc herniation
- Disc prolapse
- Nerve root compression
- Fracture
3. Transient impairment

- Local pain or discomfort
- Headache
- Tiredness
- Radiating pain or discomfort
- Paresthesia
- Dizziness
- Nausea
- Hot skin
- Fainting
Causes of Complications

1. Incorrect patient selection
2. Poor technique
1. Incorrect patient selection

- Lack of diagnosis
- Lack of awareness of possible complications
- Inadequate palpation assessment
- Inappropriate/ inadequate progression of forces through mobilization grades
- Lack of patient consent
2. Poor technique

- Excessive force
- Excessive amplitude
- Excessive leverage
- Inappropriate combination of leverage
- Incorrect plane of thrust
- Poor patient positioning
- Poor therapist positioning
- Lack of patient feedback
Contraindications and Precautions

• What’s the difference?

• Contraindication – wouldn’t/ shouldn’t use manipulative technique under any circumstances
Contraindications and Precautions

- Precaution – depending upon the skill, experience and training of the practitioner, the type of technique selected, the amount of leverage and force used, and the age, general health and physical condition of the patient, it may not be the wisest choice
Contraindications

- Bony issues – any pathology that may have led to bone compromise
  - tumor, e.g. metastases
  - infection, e.g. tuberculosis, osteomyelitis
  - metabolic, e.g. osteomalacia, osteoporosis
  - congenital, e.g. dysplasias
  - iatrogenic, e.g. long-term corticosteroid medication
  - inflammatory, e.g. severe rheumatoid arthritis
  - traumatic, e.g. fracture
Contraindications

- Bony issues
- Neurological
  - cervical myelopathy
  - cord compression
  - cauda equine syndrome
  - nerve root compression with increasing neurological deficit
Contraindications

• Bony issues
• Neurological
• Vascular
  - diagnosed vertebrobasilar insufficiency
  - aortic aneurysm
  - bleeding diatheses, e.g. severe hemophilia
Contraindications

- Bony issues
- Neurological
- Vascular
- Lack of diagnosis
Contraindications

- Bony issues
- Neurological
- Vascular
- Lack of diagnosis
- Lack of patient consent
Precautions

• Adverse reaction to previous manual therapy
• Disc herniation or prolapse
• Pregnancy
• Spondylolisthesis
• Psychological dependence upon manipulative techniques
• Ligamentous laxity
Safety in Manipulation

• As a general rule –
safety in manipulation is best provided by gradual progression of the strength of the technique (grades of mobilization) coupled with continual assessment and reassessment (Maitland, 1986)
6. Consent
7. Indications

• Pain
• Stiffness
• Influence adjacent soft tissue
• Remember the 3 functional regions
8. Who Should Manipulate?

- Within the scope of physical therapy
- CAPTE requirement
- Only one state (WA) PT’s not allowed to manipulate
- Check state practice act
- Be sure to check wording needed – manipulation, Grade V mobilization, etc.
Medical Etiologies
Medical Tests & Screening

- T Spine pain not attributed to musculoskeletal causes may be referred pain from visceral pathology
- Need to be on the look out at all times
- Location of pain may or may not overlie the source of the pain
- Pain varying with respiration (pleuritic pain) or not (non-pleuritic).
Assess if pain is **acute** or **not acute**, then if appropriate search for historical or physical examination findings consistent with a diagnosis to be undertaken.
Cardiac Pain

• Pain from myocardium
• From ↓ blood flow build up of metabolites in ischemic segment of heart muscle
• characterized as squeezing sub-sternal sensation, tightness or pressure
Acute MI

• Patients with acute myocardial infarction will classically have an **intolerable gripping or crushing sensation** under their sternum and also have associated diaphoresis (sweating) and **shortness of breath**

• send to emergency room ASAP
Angina Pectoris

• Increased pain with **exertion** (except Variant)

• Regardless of location pain always **worsens with exertion** and is **relieved with rest**

•Patients with suspected angina should be evaluated by their physician ASAP
Aortic Dissection

• Causes marked distention of aortic adventitial coat, which contains pain fibers
• Pain is sudden and rapidly becomes severe
• Pain is unrelenting and not changed by position
• Patient appears in distress and may be pale or cyanotic
• Blood pressure is often normal but distal pulses are frequently decreased or absent
Aortic Dissection
Pericarditis

- Inflammation of the pericardium
- Can be secondary to:
  - infection – bacterial, viral or fungal
  - systemic disease – rheumatoid arthritis, connective tissue diseases, or uremia
  - metastatic tumors
  - drugs – procainamide, hydralazine, phenytoin, anticoagulants
  - idiopathic
Pericarditis

- Patients will have **mild to severe chest pain** that is aggravated by respiration, cough, and thoracic motion
- Pain may be relieved with **sitting and forward bending**
- **Fever, chills, and weakness** are common
- Tachycardia and cough are variable
Pericarditis

- Pain pattern usually within epigastrium & L parasternal region, if the diaphragm irritated, pain referred to L trapezius

- Patients with acute symptoms should be transferred immediately to an ER
Mitral Valve Prolapse

- Results from thickened leaflets that are large and redundant
- Affects 4 – 7% of the population
- More common in women than men
- Chest pain reported in 40 – 50% of affected patients
- Pain is characteristically sharp or sticking in nature
- Some patients report dull pain
Mitral Valve Prolapse

- In 10 – 20% of patients pain is angina-like
- Stethoscope – mid-systolic non-ejection click and late holosystolic murmur
- Pain generally non-exertional and momentarily but occasionally lingers minutes to hours
- Pain episodes more frequent during periods of emotional stress
- Pain typically retro-sternal or left-sided chest - not referred to distal sites
- Patients with suspected mitral valve prolapse should be evaluated by their primary care physician
Esophageal Disorders

- Irritation from foreign bodies or tumors, erosion from acid reflux, and motility problems
- Gastro esophageal reflux leads to a mild-to-severe burning sensation in the epigastric to retro-sternal area
- Pain often worse at night because supine position allows reflux of stomach acid into the esophagus
- Patients may complain of brackish taste and frequent belching
Eat more fish...
Tracheobronchial Pain

- Pain from inflammation of the tracheobronchial tree characteristically is referred to the upper portion of the sternum and lateral to the sternum at points corresponding to the major bronchi.
Pleurisy

- **Parietal pleura** contains pain fibers that are conveyed through the chest wall through the intercostal nerves.

- Irritation of the pleura thereby results in chest wall pain.

- Widening of the intercostal space during **inspiration** stretches the inflamed parietal pleura and accentuates the pain.
Pleurisy

- Pleural inflammation may be caused by:
  - underlying lung insult from pneumonia or pulmonary infarction
  - direct entry of infection to the pleural space (empyema)
  - hematological or lymphatic spread, e.g. TB, uremia, cancer, collagen vascular disease
  - pleural trauma (rib fracture)
Pleurisy

- Pain is generally felt over the site of pleurisy or the chest wall
- If the central diaphragm is irritated, pain may be referred to the neck and shoulder
Pulmonary Embolism

- Caused by a sudden lodging of a blood clot in the pulmonary vascular tree with resultant obstruction of blood flow

- Complete obstruction – pulmonary infarction – consolidation and necrosis of lung tissue

- This is a medical emergency – needs to be diagnosed and treated immediately
Pulmonary Embolism

- Thrombus formation usually occurs at **distant site** such as the deep venous system of the leg or subclavian vein in the arm.

- **Predisposing factors** – recent surgery (< 1 month), trauma, immobilization, cancer, pregnancy, oral contraceptive use, obesity, and advanced age.

- High risk patients – unilateral extremity swelling and chest pain.
Pulmonary Embolism

- Pain from a PE usually secondary to pleurisy from a peripheral infarction
- Presents with the same pain pattern
- Will also be dyspnea (80% of patients), hemoptysis (20 – 30% of patients) and tachypnea (rapid breathing)
Thoracic Pain Referred from Abdominal Pathology

- Pain in the abdomen generally transmitted through T6 – T12.

- Some structures in the chest are innervated as low as T9.
Cholecystitis

• Pain from Cholecystitis (inflamed gallbladder) will typically occur 1 – 2 hours after a heavy meal.

• Sudden or gradual onset of severe pain, which peaks after 2 – 3 hours and resolves in approx. 10 hours.

• Passing gallstones (through the extrahepatic bile ducts) gives the sudden, intense paroxysmal pain of biliary colic – pain is characteristically located in the right upper quadrant of the abdomen, the right subscapular area, or both.
Cholecystitis

- Patients with acute Cholecystitis frequently have moderate fever (100 - 103°F) with occasional chills.
- They are generally in moderate to severe distress and unable to find a comfortable position.
- Tenderness can be elicited in the right upper quadrant that worsens on deep inspiration (Murphy’s sign).
Cholecystitis
Peptic Ulcer Disease

- Increased production of gastric acid or decreased cytoprotection of the stomach lining (e.g. from chronic NSAID use) leads to erosion of the gastric mucosa

- Pain originating from the stomach transmitted through 7th – 9th thoracic nerve roots
Peptic Ulcer Disease

- Pain generally burning and felt in epigastrium below the xiphoid or left upper quadrant of the abdomen
- Significant erosion may cause patient to complain of ‘boring sensation’ through to the back
- **Burning pain** typically begins 1 – 2 hrs after a meal and can be temporarily **relieved with antacids**
- Perforation of the stomach wall can lead to free air accumulation under the diaphragm and cause referred pain to the shoulder
Peptic Ulcer Disease
Renal Disease

- Pain originating from the genitourinary system involves the thorax only at the costovertebral angle.
- Pain can be result of either renal inflammation (from pyelonephritis) or distention (from sudden obstruction).
- Patients with acute pyelonephritis generally will have signs of urinary tract infection which will precede the development of flank pain.
Renal Disease

• Pts may have varying degrees of fever, chills, and sweats, and tenderness can be elicited by percussing the costovertebral angle

• No change in position relieves the pain and patients are usually in marked distress

• Patients with suspected renal disease should be seen immediately by a physician
Take home message

• Be suspicious of thoracic pain that doesn’t appear to behave mechanically and may indicate more serious pathology

• If in doubt – refer to MD
Exercising the Thoracic Spine

- Little known
  - Cervical Spine Stabilization
  - Mid Thoracic Exercises
  - Lumbar Spine Stabilization
Exercising the Thoracic Spine

• Little known
  – Cervical Spine Stabilization
  – Mid Thoracic Exercises
  – Lumbar Spine Stabilization
3 distinct regions

1. Upper T Spine (T1 – T2) – functions as part of lower C Spine
2. Lower T Spine (T10 – T12) – functions as part of upper L Spine
3. Functional T Spine (T3 – T9) – ‘true’ T Spine
Superficial muscles
- greater capacity to exert torque force due to their larger lever arms and cross-sectional areas
- span both cervical regions

Deep muscles
- more localized to either craniocervical or typical cervical regions
- have segmental attachments, larger spindle densities, and muscle fiber compositions that enable them to guide and support motion segments
Upright Postural Tasks

• When devoid of muscles, the C spine will buckle under load of $\frac{1}{5}$ of mass of the head
  (Panjabi et al, 1998)

• “A deep sleeve of muscles envelops both craniocervical and typical cervical regions”
  (Jull et al, 2008)

• These muscles have appropriate morphology and composition for segmental motion control
Changes in strength and endurance

• Decreased isometric strength and endurance in:
  – cervical flexors  (Silverman et al, 1991; Barton et al, 1996)
  – craniocervical flexors  (O’Leary et al, 2007; Watson and Trott, 1993)
  – cervical extensors  (Vernon et al, 1992; Placzek et al, 1999)

• More important finding appears to be loss of craniocervical and cervical flexor endurance at lower contraction levels (25% and 20% MVC)
  – Low intensity contractile deficit detrimental to stability of the C spine
Outcomes
Limited endurance
Greater fatigability
Less strength
Altered proprioception
Reorganization of muscle coordination

PAIN

MUSCLE PROPERTIES
Changes in muscle fiber type proportions
Changes in muscle fiber contractile properties
Changes in muscle fiber membrane properties
Changes in muscle fiber/capillary ratio
Muscle atrophy
Fatty infiltration

CONTROL STRATEGIES
Reduced activation of deep cervical muscles
Augmented superficial muscle activity
Change in feedforward activation
Prolonged muscle activity following voluntary contraction
Reduced relative resting periods
Thoracic ROM

Remember the 3-regions
Lower Thoracic Spine
Two Camps

Queensland: Jull, Hodges, Hides

Canadian: McGill, Fritz

Patient
Stabilization
Also remember: Aerobic Exercise
Scoliosis

• Scoliosis of greater than 25 degrees has been reported in about 1.5/1000 persons in the United States.

• 60% of curvatures in rapidly growing pre-pubertal children will progress.

• Generally, curvatures less than 30 degrees will not progress after the child is skeletally mature.
Classification of scoliosis

- **Nonstructural scoliosis**
  - postural scoliosis
  - compensatory scoliosis

- **Transient structural scoliosis**
  - sciatic scoliosis
  - hysterical scoliosis
  - inflammatory scoliosis
Structural scoliosis

- idiopathic (70 - 80 % of all cases)
- congenital
- neuromuscular
  - poliomyelitis
  - cerebral palsy
  - syringomyelia
  - muscular dystrophy
  - amyotonia congenita
  - Friedreich's ataxia
- neurofibromatosis

- mesenchymal disorders
  - Marfan's syndrome
  - Morquio's syndrome
  - rheumatoid arthritis
  - osteogenesis imperfecta
  - certain dwarves

- trauma
  - fractures
  - irradiation
  - surgery
Idiopathic Scoliosis

- Idiopathic genetic scoliosis accounts for about 80% of all cases of the disorder, and has a strong female predilection (7:1).
- It can be sub-classified into infantile, juvenile and adolescent types, depending upon the age of onset.
- The most common of these is adolescent scoliosis, which by itself is by far the most common type of idiopathic scoliosis in the United States.
Idiopathic Scoliosis

- **Unknown etiology; 4 stages:**
  - **Infant:** Age 3
    - Spontaneous healing / Surgery
  - **Juvenile:** Age 3 - 10
    - Poor prognosis: Growth
  - **Adolescent:** Age 10 - 20
    - Convex to R: Girls > boys
  - **Adult:** 20 +
    - Disc degeneration, increase in pain
partial unilateral failure of formation (wedge vertebrae)

complete unilateral failure of formation (hemivertebra)

unilateral failure of segmentation (congenital bar)

bilateral failure of segmentation (block vertebra)
Scoliosis

• Congenital: Present with birth
  – Method of Cobb
  – Superior and inferior borders: concave side
  – Prognosis = type of curve
  – T-spine = worst
  – Early development = poor prognosis

• Pathology:
  – Vertebral rotation, gibbus, kypho-scoliosis

• Muscles:
  –Weakness, hypertrophy, triggerpoints
Scoliosis: Clinical

- **Observation:**
  - Posterior, anterior, lateral
  - Spinous processes
  - Scapula, pelvis, gluteal folds
  - Arm position

- **Movement:**
  - Flexion: Curve enlarges.
  - Extremity movements

- **Measurements:**
  - Leg length, gibbus, general fitness, lung capacity, R.O.M, muscle strength
Scoliosis: Treatment

- **Medical: Serious medical problems**
  - 20 - 50 degrees: Brace
  - > 50 degrees: ORIF

- **Physical Therapy Goals:**
  - Lung capacity
  - General fitness
  - Posture
  - Kinetic handling/ Back care
  - Joint mobilization : Pain = hypermobility
  - Strengthen back muscles
  - Advice and encouragement
Scoliosis

- The use of the Milwaukee brace or another thoraco-lumbo-sacral orthosis for 23 hours/day, was found to effectively halt progression the curve. Bracing for 8 or 16 hours/day was found to be significantly less effective than bracing for 23 hours/day. The level of patient maturity, and the criteria for failure, were also found to have a significant effect on the outcome of treatment.
Scoliosis

• Results showed that maximal participation in exercise therapy (<=30 min day) for the mean duration of 2 years, as compared to minimal participation (<10 min/day), slowed down and even halted the progression of the deformity (curve and hump).

• Conclusion. If followed rigorously, an accurate exercise program appears to effectively limit the worsening of deformity in mild scoliosis.
Severe Kypho-Scoliosis

Case study:
- Harrington rods
Time to say Goodbye...
Thank you & acknowledgements...

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