Movement System Impairment Syndromes

Concepts Lumbar Spine Syndromes

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Movement Observations

- Relationship to symptoms
- Pattern
  - Consistent with optimal kinesiology
  - Movement of spine itself
  - In total/within motion segments
  - In relation to other adjacent regions
  - Hip/thoracic spine
- Relationship to daily activities
- Implications for treatment

Case Presentation – Low Back Pain

Asymmetry of lumbar spine region

Rotation Movement Impairment

Asymmetric rotation

Asymmetry Side Bending

Spinal Pathology and Movement

- Disc herniation – offending motions
  - Flexion and rotation
- Spondylosis – degenerative osteoarthrosis of the joints between the centra of the spinal vertebrae and/or neural foraminae
- Spondylolysis is a defect of a vertebra. More specifically it is defined as a defect in the pars interarticularis of the vertebral arch
- Spondylolisthesis - anterior or posterior displacement of a vertebra or the vertebral column in relation to the vertebrae below.
- All extension induced
- Spinal stenosis
  - Extension induced
**YOUNG**

- Flexible – each vertebrae
- Good muscles
- Minimal structural change
- Flexion-rotation
- Flexion

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**Scheme for Degenerative Disease of the Spine**

- Theoretical Scheme
  - facet joint synovitis, hypermobility, progressive degeneration
  - “natural” consequences of
    - aging
    - repetitive trauma of "normal" activity

* Ramamurthi’s *Orthopedics in Primary Care*, 1992

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**Scheme for Degeneration**

- facet joint change
- intervertebral disc degeneration
  - circumferential tears of annulus
  - progress to radial tears
  - disc herniation
  - *Hresko, MT, Orthopedics in Primary Care, 1992*

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**Scheme for Degeneration**

- Subluxation of the facet joints with
  - enlargement of articular processes
  - disc resorption
  - spinal osteophytes
  - *Hresko MT, Orthopedics in Primary Care, 1992*

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**Clinical Syndromes of Degeneration**

- Facet joint
- Acute disc herniation with minor trauma

**Implications of theory**

- the facet joint and disc are just two components of the motion segment
- one component cannot be affected in isolation

* Hresko MT, *Orthopedics in Primary Care*, 1992

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**Spinal Changes – Prevention**

Young

Activity and Aging

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DEGENERATIVE CHANGING

Some areas of stiffness – some vertebrae do not move well
Some developing weakness
Early stages of DDD
Extension-rotation
Extension
Rotation
Flexion-rotation: few

General Impressions

- Flexibility
  - Hypermobile
  - Relatively stiff
- Size
  - Overweight – obese
  - Normal weight
  - Slender
- Fitness
  - Muscular – move well – energetic
  - Frail – limited mobility

Sex

Men
- Larger upper body
- Usually Central obesity
- Stiffer lower extremity musculature
- Abdominal weakness not usually a major issue
- Height – tall
- Sports
- Flexion-rotation/flexion; rotation

Women
- Larger lower body
- Apples & pears – equal
- More flexible
- External oblique abdominal muscle weakness
- Height – shorter
- Less active
- Extension-rotation; rotation
Format for Examination

- Patient performs motion (test) in preferred pattern (primary test)
  - Symptoms are noted
  - Movement pattern is assessed
- Patient performance is corrected (secondary test)
  - Effect on symptoms are noted
- Tests of spinal movement
- Tests of limb movements as affect spine

Key Examination Findings

**Standing**
- Lumbar flexion > hip flexion with bend
- Forward bend – sxs ↑
- Modified forward bend – sxs ↓

**Sitting**
- Lumbar flexion with knee extension
- Sitting in flexion – sxs↑; Modified sitting – sxs↓

Key Examination Findings

**Quadruped**
- Lumbar spine flexed
  - Sxs ↑ with quadruped; Modified quadruped sxs ↓
- Rocking back in quadruped
  - Lumbar spine flexion > hip flexion with rocking back – hips not stiff
  - Push back with hands ↓ lumbar flexion
  - Sxs ↑ with rocking back; Modified rocking back sxs ↓

Key Examination Findings

**Abdominal Muscle: shortness - stiffness**

- Short abdominal muscles
- Relaxed standing
- Erect standing

Muscle Active & Passive Tension

Implications of relationship
- Hypertrophy of muscle increases the passive tension
- Passive tension provides "control" of segments
- Reduces demands for active tension for “control”
- Requires optimal length and relative tension
- Can become Excessive
Hamstrings and Low Back Alignment

Before

Limiting lumbar flexion

1 month later

The Compression and Anterior Shear from Psoas Is Major Contributor to Low Back Pain

Nordin & Frankel 1989

Lumbar Extension Syndrome

- Pain with stress or motion toward extension
- Most common problem in
  - those > 55 years of age;
  - chronic pain with repeated episodes
  - short people

Key Examination Findings

- **Standing**
  - Increased extension &/or hypertrophied paraspinals
  - Forward bending: symptoms decrease
    - Lumbar extension > hip extension with return
    - Return from forward bend – sxs ↑
    - Modified return from forward bend – sxs ↓

- **Sitting**
  - Sitting in extension – sxs ↑; Modified sitting – sxs ↓

Case Presentation

Low Back Pain

**Sign:** Increased lumbar extension in standing as evidenced by flexible ruler curve

Note prominent abdomen: diastasis

Not present in all patients with extension syndrome
Bulging disk had been treated with extension exercises.

What are the Contributing Factors to the Lumbar Spine Alignment in These Subjects?

Muscle Stiffness = Passive Tension

- Change in tension/unit change in length
  - Normal property
- Degree of tension during passive stretch
  - Correlated to size of muscle
- Source: Titin (connectin)
  - Large intracellular connective tissue protein

Passive Stiffness of Elbow Flexors: Men & Women

Correlation: Muscle Volume & Stiffness

The relationship between elbow flexor volume and angular stiffness at the elbow
Relative flexibility: abdominals vs hip flexors

Pelvic Tilt Indicated by Right Thumb Moving as Hip Extends

Compensatory lumbar extension
Motion before reaching limit of muscle length

Continued Anterior Pelvic Tilt – Thumb Moves Further Distally

If Pelvis & Spine Were Stable, No Pelvic Tilt, LE Would Remain Suspended

Anterior pelvic tilt & lumbar extension (LS seg)

Relative Stiffness/Flexibility

Sources of Passive Muscle Stiffness

- Structural proteins
  - Titin,
- Extracellular matrix – endomysium, perimysium, epimysium
- collagen – whole muscle
- Weak binding of actin & myosin (thixotropy)
- Tendon
Muscle Active & Passive Tension

Implications of relationship
- Hypertrophy of muscle increases the passive tension
- Passive tension provides “control” of segments
- Reduces demands for active tension for “control”
- Requires optimal length and relative tension
- Immediate delivery of tension to attachment at active contraction

Muscle Length

- Muscles maintained in lengthened position
- Add sarcomeres in series
- Shifts length-tension curve to right
- Test “weak” at short length (at end of range and not through the range)

Tested In Shortened Position

- Lengthened Control

Case Presentation

Post Lumbar Fusion

- Tall Pelvis
  - Lumbar spine should be flat
- Post-spinal fusion
  - Had PT – still pain
- After – alignment change
  - Less extension – no Sxs

Key Examination Findings

- Supine
  - Often lies in lumbar extension
  - Sxs ↓ in supine; Modified supine — sxs ↓
- Prone
  - Sxs ↓ in prone; Modified prone — sxs ↓
- Knee flexion in prone
  - Anterior pelvic tilt
  - Sxs ↓ with knee flexion; Modified knee flexion — sxs ↓
Demographics
20 y/o student
Former gymnast

Sustained:
Alignment
Lumbar extension

Repeated movement:
Lumbar extension

Contributing factors:
Hypertrophy

Patient-Preferred Movement

LBP with knee flexion before 90 degrees. Note degree of lumbopelvic extension.

Modified Movement

Amount of knee flexion without lumbopelvic movement. No LBP associated with knee flexion.

Relative Flexibility/Stiffness

Muscles = Springs in series & in parallel

Passive stretch of stiff & < stiff muscle in series - elongation of least stiff muscle

The Compression and Anterior Shear from Psoas Is Major Contributor to Low Back Pain

Nordin & Frankel 1989

Rotation Classifications: Primary Rotation

- Acute Pain (often)
  - The rotation is causing the symptoms
  - Pt presents as a shift
    - Most often has pain at rest particularly when weight bearing
  - Correction of the rotation reduces the symptoms
  - Dx: flexion-rotation- type primary

Rotation Classifications: Primary

- Has notable asymmetry in lumbar region
- May have symptoms at rest or be on verge of Sx
- Symptoms with side bending and rotation in standing
- Quaduped: rocking back, the rotation in the lumbar spine increases
  - Has symptoms as lumbar region goes from flexion toward neutral (extension)
  - Decreases in flexion and Sx as repeats the rocking backward. (slight manual correction)
  - Asymmetry corrected with repeated rocking
- Remain susceptible to recurrent episodes of rotation of offending joints (rotation-ext/flex)
LBP in standing.
Lumbar side bend to right with shift of trunk to left.

Rotated Spine
Increases when rocking backward
Hip flexion limited – Cam hip impingement
hip flexion limited to 90 deg - structural

Improved lumbopelvic alignment

Treatment Effect
Before
After quadruped rocking

Case Presentation
Low Back Pain with Left Radiculopathy
Initial Visit 5-6 days later
8/23 8/29
6 months post – partum for twins.

Side Flexed Right – Rotated
Left
8/23 8/29 9/5
Rotation to Left When Rocking Back

Right iliopsoas pulling > Left iliopsoas

Natural Standing Right Foot on Stool

Takes stretch off of the iliopsoas

Rotation Classification: Secondary Rotation

- Asymmetry of thoracolumbar regions
- No symptoms at rest even in weight bearing
- The rotated region/joints prevent motion at these joints
- Results in excessive motion at the joints below the rotated regions
- The rotated joints do not cause pain, but cause excessive rotation at the inferiorly situated joints.
  - Disc degeneration at these joints
  - Rotation diagnosis - type Secondary

Alignment

Side-lying Hip Lateral Rotation (L)
Prone Knee Flexion

Prone Hip Rotation

Movement at Iliac Crest
Path of Least Resistance

Changing the Path of Least Resistance

Case Presentation – Low Back
Sitting in Class

Corrected Side Bending

1 Month Later
No Pain
Able to Sit in Class
Has to be Careful
Case Presentation
Abnormal Side Bending

Key Examination Findings
- Standing
  - Asymmetry in lumbar spine region
  - Asymmetric side bending; movement at 1 or a few segments of lumbar spine
- Sitting
  - Lumbar rotation with knee extension (asymmetric)
  - Sxs ↑ with knee extension; Modified knee extension sxs ↓
- Side lying
  - Sxs ↓ in side lying (asymmetric); Modified side lying sxs ↑

Demographics:
62 y/o female
5' 1/2" tall

Complaints:
LBP with sitting at work

Occupation:
Administrative assistant

Prolonged posture:
- Sits on edge of chair in lumbar extension & thoracic flexion

Repeated movements:
- Arm flexion at desk
- Rotates to the right

Lumbar Rotation with Extension Syndrome

Lumbar Rotation with Extension Syndrome - Example

Patient-Preferred Movement - Forward Bend
Thoracic flexion
Lumbar spine straight
Hip flexion 80 degrees

Patient-Preferred Movement
Modified Movement
Lordosis & kyphosis ↑ with arm movement
Less lordosis & kyphosis with arm movement
Key Examination Findings

- Prone position
  - Sxs ↑; Modified prone – sxs ↓
- Knee flexion in prone
  - Anterior tilt &/or lumbopelvic rotation (asymmetric)
  - Sxs ↑ with 1 extremity; Modified knee flexion - sxs ↓
- Hip rotation in prone
  - Lumbopelvic rotation (asymmetric)
  - Sxs ↑ with 1 extremity; Modified hip rotation – sxs ↓

Key Examination Findings

- Quadruped
  - Asymmetry in lumbar region
  - Extended in lumbar region
  - Sxs ↑ with quadruped ↓
  - Modified quadruped sxs

Patient-Preferred Alignment - Quadruped

Lumbar rotation to the right

Modified Alignment - Quadruped

Decreased thoracic kyphosis
Flat lumbar spine without rotation
90 degrees of hip flexion

Key Examination Findings

- Standing
  - Symmetry lumbar region
  - Lumbar flexion > hip flexion with forward bend
  - Forward bend – sxs ↑; Modified forward bend – sxs ↓
- Sitting
  - Sitting in flexion – sxs ↑; Modified sitting – sxs ↓
  - Knee extension – flexion & rotation of lumbar spine (asymmetric)
  - Knee extension – sxs ↑; Modified knee extension sxs ↓

Lumbar Rotation with Flexion

(Washington University in St. Louis School of Medicine)
Primary & Secondary Test
Forward Bend (Primary rotation)

Patient-preferred movement; Increased LBP
Modified movement; No LBP

Sitting Alignment Findings

Patient-preferred sitting alignment
Modified sitting alignment
Symptoms Monitored & Compared

Key Examination Findings

Side lying
- Sxs ↑ in side lying (asymmetric); Modified side lying – sxs ↓

Hip rotation in prone
- Lumbopelvic rotation (asymmetric)
- Sxs ↑ (asymmetric); Modified hip rotation sxs ↓

Key Examination Findings

Quadruped
- Asymmetry in lumbar region
- Flexion in lumbar region
- Sxs ↑ in quadruped; Modified quadruped – sxs ↓

Rocking back in quadruped
- Flexion and rotation in lumbar region
- Sxs ↑ rocking back; Modified rocking – sxs ↓

Hip Rotation Findings

Patient-preferred movement; Increased LBP
Modified movement; No LBP

Quadruped Findings

Asymmetry in lumbar region
Flexion & side bending in lumbar region; Increase LBP
Diagnostic Categories

<table>
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<tr>
<th>Dx</th>
<th>Rotation</th>
<th>Extension</th>
<th>Flexion</th>
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<td>Characteristics</td>
<td>All pts</td>
<td>Old/short/chronic</td>
<td>Young/tall/acute/disc</td>
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<td>Poor obliq</td>
<td>Poor</td>
<td>Good</td>
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<td>Good</td>
<td>Good</td>
<td>Poor</td>
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<td>Stiff/short</td>
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<td>Good/long</td>
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<td>Stiff</td>
<td>Good/long</td>
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<td>activities</td>
<td>sports/job</td>
<td>Sit ext/return fwb</td>
<td>Sit flex</td>
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Treatment Guidelines

- Modify daily work, leisure, and self care activities.
  - Change direction-specific movement & alignment strategies during regular activities.
  - Change regular stimulus that is proposed to be related to LBP & adaptations contributing to LBP.
    - Decreased stress on tissue (short-term effects)
    - Changes stimulus contributing to passive or active adaptations (long-term effects)

- Prescribe exercise/positioning to address contributing factors (changes in movement system elements).
- Motor Control
  - Retrain in appropriate movement strategy
- Redistribute motion
  - Decreasing movement in lumbar spine
  - Increasing movement in other segments

MSI Intervention

- Identify the movement system impairment
- Identify the contributing factors
- Educate the patient about his impairment
- Help identify the way the patient is performing his activities that contributes to the movement impairment
- Instruct the patient in corrective exercises and movement patterns during functional activities