Movement System Impairments of the Lumbar Spine: Why the Hip is Important

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THE HUMAN MOVEMENT SYSTEM

The Body System for which Physical Therapists are Responsible.
The System of our Expertise
Our Identity – APTA 2013

Expertise in a Body System is Important

- Highly respected health professions achieved their status by having expertise in an anatomical or a physiological body system
- Pathophysiology of specified anatomical body system
  - Neurologists, orthopaedists, cardiologists, dentists, podiatrists
- Physiological systems
  - Internists (all physiology), endocrinologists

Movement System Diagnoses
Critical Questions

- Is having precise joint movement important?
  - Are there signs before there are symptoms? (Choi, Blood Sugar, BP)
- Why would the precision of joint movement change – become impaired?
  - From daily activities
  - From sports and fitness
- How should impaired joint motion be corrected?
  - Stretching
  - Strengthening
  - Retraining

Why Does Precise Movement Become Impaired?

- Repeated movements and prolonged postures
- Associated with everyday activities
- Induce adaptive changes in movement system components
- The adaptive changes vary because of intrinsic and extrinsic factors

Kinesiopathologic Model of Movement System

- Musculoskeletal
- Nervous
- Cardio-Pulmonary

INDUCERS
- Personal Characteristics - intrinsic
- Activity Demands - extrinsic

Tissue Adaptations
- Relative stiffness of muscle & connective tissue
- Relative Flexibility Intra-jt + Inter-jt

Path of Least Resistance
- Joint Accessory Hypermobility
- Micro trauma

Working Theory

- Musculoskeletal pain is
  - Related to lifestyle similar to many other health conditions
  - A progressive condition
    - Starting with acute pain – first indication of tissue damage
    - High reoccurrence rate - leading to chronic problem
  - The result of tissue changes associated with
    - Aging related degeneration and
    - Activity induced tissue injury from impaired joint movement

The Challenge: Keeping the Acute Problem From Becoming Chronic

- Acute symptoms subside
  - With time
  - With variety of interventions addressing symptoms
- Recurrence is common
  - Pathoatomic structures considered the cause
  - The impaired movement not considered as cause
  - Therefore has not been identified & addressed.
- To minimize recurrence –
  - Identify the movement cause & contributing factors
- Develop a treatment program that includes
  - Patient specific exercises
  - Correction of performance of basic daily activities
  - Correction of performance of work, recreation, fitness, & sports activities

REPETITION OF IMPAIRED MOVEMENT MAY ACCELERATE THE DEVELOPMENT OF OSTEOARTHRITIS
OA Mechanical Mechanisms

- Cartilage degradation can be correlated with abnormal excessive articular contact stress (Dekeland & Weissman, 1978; Brandt et al., 2008; Radin et al., 1978; Jackson et al., 2004; Fontana et al., 2007).
- This abnormal contact stress may result both from excessive load acting on a normal joint or from normal loading acting on a weakened articulation: ligament laxity, periarticular muscle weakness, or reduced proprioception.
- May all lead to articular instability, exposing the joint to sudden impulsive loads and finally to high peak pressure.
- Brandt et al., 2006; McGonagle et al., 2010; Felson et al., 2000.

Experimentally Induced OA

- Osteoarthritis development in novel experimental mouse models induced by knee joint instability.
- Kamekura et al.
- The surgical destabilization of the medial meniscus (DMM) model of osteoarthritis in the 129/SvEv mouse.
- Glasson et al.

Alterations in Spinal Alignment > Points of High Contact Stress

Movement System Impairment Syndromes – Guiding Theory

- Little things mean a lot!!!
- Underlying problem: micro-instability:
  - The Wobble – Wobble condition
  - Accessory motion (roll, spin, glide) becomes excessive in one or more directions (hypermobility/micro-instability)
  - Micro-trauma from sheer force and points of high contact pressure
  - Becomes macro-trauma

Joint Micro-Instability

- Characterized by moving
  - in range that is more than optimal (joint surfaces not optimal during movement)
  - Points of high contact stress & shear force
  - More often than optimal
  - More readily in specific directions
- Accessory motion micro-instability
- Can progressively increase
- With physiological motion that is
  - Normal
  - Excessive
  - Limited

Key Concepts

- Path of least resistance for motion
- Relative Flexibility
  - Intra-joint: intrinsic accessory motion mobility
  - Inter-joint: physiological motion, e.g. back vs hip
- Relative Stiffness: passive tension of muscle & connective tissue
- Joint (micro-instability) hypermobility causes the pain
  - Accessory motion
  - Range & frequency
  - What moves is what hurts
Key Concepts II
- The way everyday activities are performed is the critical issue
  - Repeated movements and
  - Sustained alignments

Key Concepts III
- You get what you train (many strategies to create moments at a joint or within a limb)
  - Presence of a muscle does not mean appropriate use
  - No magic in an exercise except if the desired motion is evident

Movement System Function Changes With Growth, Activity & Aging
PT needs to be Life Span Practitioner
- Monitoring and Guiding the development of and changes in the Movement System
  - Alignment, movement patterns, strength, endurance
  - Identifying structural variations

Movement System Impairment (MSI) Syndromes
- Named for movement direction that causes symptoms and that is impaired. Correction of the movement usually decreases the symptoms.
- Identify the cause of the dysfunction & contributing factors
  - tissue & neuromuscular impairments
- Organize & cluster specific tissue and movement impairments
- Provide a direction for treatment
  - do not require identification of a specific pathoanatomical structure (source)
  - Based on anatomy and kinesiology

Cause versus Source Operational Definitions
**Cause**
- the mechanical factor (movement) that results in tissue irritation
- e.g. femoral anterior glide, tibiofemoral rotation syndromes

**Source**
- the tissue or pathoanatomical structure that is symptomatic
  - e.g. iliopsoas tendin(tis, osis, opathy); patellar-femoral dysfunction

Low Back Pain: Case Presentation
Observe pattern of bending and returning to standing
Movement System Impairment Syndromes
Determined by the motion direction or alignment that most consistently elicits symptoms, is impaired and when corrected, decreases symptoms
- Low Back
  - Flexion; extension; rotation
  - Flexion-rotation; extension-rotation
- Hip
  - Femoral: accessory movement impairments
    - Joint related symptoms
  - Hip: physiological movement impairments
    - Soft tissue related symptoms

Examination for MSI Syndrome - Diagnosis
- Thorough assessment of movement system components
  - Skeletal – alignment & movement pattern
  - Muscle – performance, length, strength, stiffness
  - Neuromuscular activation patterns
  - Biomechanical influences
  - Patterns of movement of specific joints, limbs, total system for functional movements

Purposes of Diagnosis
- Direct treatment
- Describe the syndrome
- Informs other health professionals of the movement patterns and relationships to pain problems
- Facilitate recognition of the profession
  - Need label to inform others that we can determine the problem
- Enhance communication
  - Intra professional
  - Extra professional
- Group conditions
  - Prognosis, etiology, improve Tx, research

Low Back Pain: Case Presentation
Observe her pelvis while walking, note structural characteristic of hips

Cause and Effect - Vicious Cycle
- Her walking pattern contributes to
  - Excessive rotational flexibility of her low back
- The rotation is the result of
  - Excessive mobility of lumbar spine
  - Stiffness of hip musculature
- The more she walks,
  - the stiffer her hip muscles and
  - the more flexible her lumbar spine

Vicious Cycle: Lumbar flexion
1. Back extensors long
2. Abdominals short/stiff
3. Posterior pelvic tilt, hip extension
4. Hamstrings short
5. Head & shoulders create flexion moment on the lumbar spine
6. Feels natural
**Low Back Pain: Case Presentation**

- Pain with standing worse than sitting
- Age 45
- Height 5’ 3” (160.5 cm)
- Weight 140 lbs (63.5 kg)
- Lordosis with anterior pelvic tilt
- Piano teacher

**Factors Used to Develop a Working MSI Diagnosis**

- Chief Complaint – low back pain
- Age – 60 yo – likely degen change - extension
- Alignment – prominent abdomen – kyphosis – extension
- Height – 5ft – short - extension
- Weight - 190 # - >degen, poor abs – extension
- Body proportions – wide hips - extension
- Activities – standing and rotating - extension

**A Working Diagnosis Improves Efficiency**

- Cluster information from visual appraisal and history with knowledge of syndrome characteristics
- Obese pt, 60 yo with urinary frequency, increased thirst, and increased appetite with weight loss
- Diagnosis? Obese pt 60 yo who is 5ft tall, who is a cook, and has low back pain. Diagnosis? (?) Rotation-Extension not muscle spasm

**Program in Physical Therapy**

Exercise That Contributed to Muscle and Alignment Adaptations

Lumbar spine is flexed: Lumbar spine flexes more than hips when stretch is applied across both joints at same time.

A Working Diagnosis Improves Efficiency
Sitting Posture when Teaching & Playing the Piano

MSI Syndrome: Extension
- Pt’s height, weight, age
- Alignment
- Pattern of bending & returning to standing
- Occupation/recreational activity
- All influence mechanical factors leading to pain with extension
- What are the adaptive tissue changes contributing to this condition?

Possible Contributing Tissue Changes
- Hip flexor muscles: short / stiff
- Abdominals: weak / long / not stiff enough
- Back extensor muscles: hypertrophy

Low Back Pain: Case Presentation
- Age 23
- Weight 175 lbs (80 kg)
- Height 6 ft (183 cm)
- Student
- Competitive cyclist
- Flat lumbar spine
- Tentative MSI diagnosis?

Pts with LBP – Clustering of Potential Findings

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Flexion</th>
<th>Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominals</td>
<td>Strong/stiff</td>
<td>Weak/long</td>
</tr>
<tr>
<td>Back extensors</td>
<td>Weak/long</td>
<td>Strong/stiff</td>
</tr>
<tr>
<td>Hip flex length</td>
<td>Long</td>
<td>Short/stiff</td>
</tr>
<tr>
<td>Hip ext length</td>
<td>Short/stiff</td>
<td>Long</td>
</tr>
<tr>
<td>Activities</td>
<td>Sit flexed</td>
<td>Sit extended</td>
</tr>
</tbody>
</table>
Role as Movement System Experts

- Collaborate with physicians to identify the source of pain: sorting diagnostic dilemmas
  - Pain in knee: from back, hip, or knee?
    - An 84 yo male (knee replacement for spinal stenosis)
    - 3 more recent patients
    - Normal radiological tests, or
    - Positive tests for all three sites
- Collaborate with other exercise providers to direct specificity of programs

Musculoskeletal Pain

- Mechanical in origin
- Produced by way activities of daily living are performed

Spinal Hypermobility/Instability

- Degenerative instability -
  - Back pain exacerbated by movement and associated with inter-segmental movements that are abnormal or excessive at one or more spinal levels.

Relative Fertility

- Intra-joint: accessory motion micro-instability; usually in a specific direction
- Inter-joint: motion occurring at one joint that should occur more readily at another joint (low back vs hip)

Relative Muscle Stiffness

- Hypertrophy of muscle increases the passive stiffness
- Daily activities can induce different degrees of hypertrophy of muscles on either side of a joint

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Relative Stiffness of Muscle

Abdominal muscles stiffer than hip flexors
No pelvic tilt with stretch of hip flexors

Hip flexors stiffer than abdominals
Pelvic tilt with stretch of hip flexors

Inter-joint Relative Flexibility & Relative Stiffness

- Evident when vertebral joint moves readily during motion that should be occurring at another joint
- For example at the hip joint

Starting position of ASIS
Immediate anterior pelvic tilt-lumbar extension with hip extension
Cannot be muscle shortness

Pelvic Anterior Tilt
No Pelvic Tilt

Pull from hip flexors is greater than stiffness of lumbar pelvic region & spinal stability
Abdominal muscles and lumbar spine stiffer than tension from elongation of hip flexors

Relative Stiffness – Relative Flexibility

Muscle Adaptations from Repeated Movements and Sustained Alignments

- Weakness
- Length-Associated Changes: increased and decreased length
- Muscle Stiffness

Case Presentation – Low Back Pain

23 year old student
Why does she stand this way?
- Lordosis with swayed upper back
- Anterior pelvic tilt
- What is her sport?
- What are the tissue impairments?

Muscular/Joint Factors – Affect Low Back

Hip flex/abd
flexor
Hip Extensors short
How Does the Hip Contribute?

**Muscular Factors**
- Hip extensors
- Lumbar flexion
- Hip flexors
- Lumbar extension
- Hip rotators/abductors
- Lumbar rotation

**Structural Factors**
- Femoral ante or retro version
- Lumbar rotation
- Cam – Pincer Impingement (FAI)
- Lumbar flexion
- Degenerative joint
- Lumbar extension
- Lumbar rotation

Restricting motion in a specific direction:
The back has to compensate.

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Case Presentation – Low Back Pain

Pain

Asymmetry of lumbar spine region

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Rotation Movement Impairment

Asymmetrical Side Bending

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Spinal Pathology and Movement

- **Disc herniation** – offending motions
  - Flexion and rotation
- **Spondylolisthesis** – degenerative osteoarthropathy of the joints between the centra of the spinal vertebrae and/or neural foraminae.
- **Spondylolisthesis** 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** – can’t extend

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**YOUNG**

Flexible – each vertebrae

Good muscles

Minimal structural change

Flexion-rotation

Flexion
Scheme for Degenerative Disease of the Spine  
*Hresko MT

- Theoretical Scheme
  - facet joint synovitis, hypermobility, progressive degeneration
  - "natural" consequences of
    - aging
    - repetitive trauma of "normal" activity
  
* Ramamuriti’s Orthopedics in Primary Care, 1992

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

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

Spinal Changes – Prevention

Young Activity and Aging

Examination -General Impressions

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

- Sitting
  - Lumbar flexion with knee extension
  - Sitting in flexion – sx; Modified sitting – sx
**Case Presentation - Low Back Pain**

Demographics:
40 year old male
6 feet tall

Complaint: LBP
sitting > standing

Occupation:
Executive

Leisure-time activity:
ultramarathonist

Prolonged posture:
Sitting

Repeated movement:
Running –
effect on hamstrings and lumbar spine

**Forward Bending & Quadruped**

Thoracic flexion
Insufficient hip
flexion less
flexible than spine

Major issue –
compression from abdominal muscles

Lumbar spine flexed and hip flexion < 90 deg
Note abdominal muscle tautness

**Abdominal Muscle Stiffness**

Flexing Lumbar & Thoracic Spines

Patient-preferred sitting;
Lumbar flexion

Patient-preferred movement
knee extension; Increased lumbar flexion

**Abdominal Muscle: shortness - stiffness**

Short abdominal muscles

Relaxed standing

Erect standing

**Case Presentation – Low Back Pain**

Student - competitive diver

64 years old

Spinal stenosis
DDD
Scoliosis

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Spinal Left Rotation – Flexed Thoracic Spine

DDD of entire lumbar spine: Having chronic pain & acute episodes

Quadruped Alignment

Natural Relaxed Spine

Doing all the wrong exercises

Immediate Change Post Quadruped Rocking

Pre Needed to address sitting and walking patterns

Immediate Post

Case Presentation – Low Back Pain

Pain in Standing & When Driving

Bulging disk had been treated with extension exercises

Pain Relieving Positions

Case Presentation – Low Back Pain

Note alignment of lumbar spine and pelvis

What is strategy for returning from forward bending?

How can that be modified?
Case Presentation- Low Back Pain

Pain in standing relieved by lifting her trunk

What is the Lumbar Spine Alignment? The Pelvic Alignment? Why?

What are the most obvious impairments?
Extremely flexible: Good news: corrected easily
Bad news: returns to previous condition easily

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

Case Presentation-Low Back Pain
Primary Rotation Syndrome

Lumbar side bend to right with shift of trunk to left.

Rotated Spine
Increases when rocking backward
Hip flexion limited to 90 deg Structural Cam Impingement
**Improved Lumbopelvic Alignment**

**Treatment Effect – Quadruped Rocking**

**Before**

**After**

**EVIDENCE FOR CLASSIFICATION AND FOR RELATIVE STIFFNESS/FLEXIBILITY**

**CLINICAL EXAM FOR TESTING CLASSIFICATION ACCORDING TO PAINFUL MOVEMENT DIRECTION OF TRUNK AND LIMBS**

- Reliability – Validity
- Effect of limb movements
- Effect of modifying spine during limb movements

Research: Linda Van Dillen, PT, PhD
Director: Musculoskeletal Analysis Laboratory
Washington University School of Medicine
Associate Professor Physical Therapy / Orthopaedic Surgery

**MSI Syndromes of the Lumbar Region**

- 5 Syndromes
- Named for the direction-specific patterns of movement & alignment proposed to contribute to LBP (signs & symptoms)

**METHODS**

- Sample (N=94) people with LBP all obtained from clinics
- 5 therapists trained in exam: 2 examined pt at same time; randomized pairings

**RELIABILITY: CLASSIFICATION**
Program in Physical Therapy

**RESULTS**
- % Agreement value: 79%
- Kappa value: .58
- Distribution of responses truncated
  - Majority with rotation or extension component, few flexion components
  - Norton et al. 2004

**RELIABILITY: CLASSIFICATION**

**VALIDITY**

**STATISTICAL APPROACH**
- Sample Characteristics (N=188)
  - No differences between Sample 1 & 2.

**Validated Study with additional Subjects**

**Factor Loading Table: Sample 1**

**Factor Loading Table: Sample 2**

**Validity of Classifications Clinical Examination**
- LBP Subgroups (Van Dillen et al., JOSPT, 2003; Trudelle-Jackson et al., JOSPT, 2008; Harris-Hayes et al., PMR, 2009; Henry SM et al., abstract, JOSPT, 2009)
  - Lumbar flexion
  - Lumbar extension
  - Lumbar rotation
  - Lumbar rotation with extension
  - Lumbar rotation with flexion

**Trunk Lateral Bending Movement Testing**
- 3D motion measurement system (EVAR, MAC).
- Retro-reflective markers placed on trunk, pelvis, and extremities.
- Test: Active trunk lateral bending
- Position: Standing, relaxed, feet shoulder width apart
- LBP symptom behavior was recorded.
Pattern of Movement Variable

Percent (%) contribution of the lumbar region (S2-L1) at various increments (25, 50, 75, 100%) of total lateral bending movement.

\[
\text{Lumbar Region Motion} \times 100 \div \text{Total Lateral Bending Motion}
\]

Results: Rot Category

Results: RotExt Category

* \( P \leq 0.01 \)
Trunk Movement Tests

- Lateral Bending in Standing
  - Pattern of early lumbopelvic movement differs among LBP subgroups (Gombatto et al., PTJ, 2007)
  - Parallels findings with the hip lateral rotation test
  - LBP problem
    - Driven by trunk and limb movements

Passive Tissue Characteristics

Passive Movement Device

Passive Tissue Characteristics Measures

End-Range Lumbar Region Motion Group Differences

Trunk Movement Tests

- Lateral Bending in Standing
  - Pattern of early lumbopelvic movement differs among LBP subgroups (Gombatto et al., PTJ, 2007)
  - Parallels findings with the hip lateral rotation test
  - LBP problem
    - Driven by trunk and limb movements
**Passive Elastic Energy - Group Differences**

- Group x side interaction effect

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**Summary of Evidence**

- **Clinical Exam:**
  - Reliability - tests of trunk and limb movements
  - Valid for classifying subgroups of low back patients
  - Modification of trunk & limb movements decrease or eliminate symptoms
- **Relative Stiffness / Flexibility**
  - Knee flexion, hip lateral rotation & trunk lateral bending, passive elastic stiffness of trunk
  - Cause earlier lumbopelvic motion in LBP vs No LBP
  - Have a relationship to subcategories of LBP
  - NOT the length of muscles
  - IS the relative stiffness of the spine

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**Summary Consistent With Evidence**

- Low back pain (musculoskeletal pain syndromes) are from cumulative trauma
  - Progressive changes in tissue from repeated movements and prolonged postures
  - Multifactorial
- Classification according to painful movement direction is consistent with
  - A joint’s directional susceptibility to movement (DSM)
    - Moves more readily in a specific direction than other joints that move in that same direction
- Treatment: should be
  - Based on a movement system diagnosis;
  - Directed toward pre-disposing and contributing factors;
  - Address contributing factors to slow or prevent recurrences (progressive degeneration)
  - Movement patterns associated with all activities
  - Specific exercises
  - Hypermobility of accessory motion underlying cause of degeneration

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**Treatment Strategy**

- Current recommendation
  - During an activity
    - Train to decrease lumbar region motion while increasing movement in other regions
  - Validation – Did the symptoms improve?
- Training which segments are contributing, how much and when they are contributing

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**How?**

- Dependent on contributing factors
  - Neural control
    - Motor Pattern Incoordination
  - Musculoskeletal ↔ Neural control
    - Consideration - are musculoskeletal factors modifiable or not, i.e., increasing risk?
    - Force Production Deficit
  - Priority
    - Decrease lumbar region motion (accessory motion hypermobility)
    - Increase motion of relatively stiffer segments
- Incorporate training into specific everyday movements

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**Key Concepts for Dx and Tx**

- **Path of Least Resistance for Motion**
- Relative Stiffness/Flexibility
- You get what you train (many strategies to create moments at a joint or within a limb; varying motor patterns)
- Presence of a muscle does not mean that it is being appropriately used
- No magic in an exercise except if the desired motion is evident
- The way everyday activities are performed is the critical issue
- **Hypermobility** (accessory/arthrokinematic motion) causes degeneration & pain
EFFECT OF CLASSIFICATION SPECIFIC TREATMENT ON LUMBOPELVIC ROTATION


Classification of Low Back Pain

Rotation-Extension
- Symptoms increase with extension
- Motions of spine & hip that extend the back
- Sx decrease with avoiding spine extension
- Symptoms increase with rotation
- Motions of spine & hip that rotate the back
- Sx decrease with avoiding the rotation

Rotation
- Symptoms increase with rotation motions of the spine & hip
- Both flexion & extension of the spine
- Symptoms decrease with keeping the spine neutral

Classification
- Established reliability of the test items of the exam
  - Van Dillen LR, Sahrmann SA, Norton BJ, Caldwell CA, Fleming DA, McDonnell MK, Woolsey NB.
  - Reliability of physical examination items used for classification of patients with low back pain. Phys Ther. 1998 Sep;78(9):979-88.
- Established validity of the classifications
  - Van Dillen LR, Sahrmann SA, Norton BJ, Caldwell CA, McDonnell MK, Bloom NJ.
Examiner Reliability
- Demonstrated the reliability of examiners appropriately classifying the patients
  - Harris-Hayes M, Van Dillen LR.
  - The inter-tester reliability of physical therapists classifying low back pain problems based on the movement system impairment classification system.
  - Trudelle-Jackson E, Sarvaiya-Shah SA, Wang SS.
  - Interrater reliability of a movement impairment-based classification system for lumbar spine syndromes in patients with chronic low back pain.
  - Henry SM, Van Dillen LR, Trombley AR, Dee JM, Bunn JY.

Index of Relative Flexibility
- Timing difference variable of LPR during HLR
  - Each limb
  - Each LBP subgroup
  - If early lumbopelvic motion occurred
    - Timing difference values small for both LBP subgroups
  - If asymmetry of lumbopelvic motion occurred
    - Right and left timing difference values different

Patterns of Data
Late and Early Lumbopelvic Movement during HLR with Right and Left Lower Extremities

Patterns of Data
Symmetric & Asymmetric Lumbopelvic Movement

Summary of Study
- Patients with LBP can be classified according to
  - Movement directions that cause symptoms
    - Elicited by direct movement of the spine
    - Elicited by indirect movements of the spine by motions of the extremities
  - Pts classified as Rotation
    - Had symmetrical LPR with both right and left HLR
  - Pts classified as Rotation-Extension
    - Had asymmetrical LPR with both right and left HLR
Collaborators

Washington University Faculty
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