Three-step treadmill test and McKenzie mechanical diagnosis and therapy to establish directional preference in a patient with lumbar spinal stenosis: a case report
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Objectives

• Understand the diagnosis and prevalence of lumbar spinal stenosis (LSS)
• Understand current treatment protocols for LSS
• Discuss differential diagnoses
• Discuss the effectiveness of the three step treadmill test in assessing directional preference
• Identify the disparities between radiographic imaging and directional preference in diagnosing LSS
• Discuss why a LSS patient would respond to extension based treatment
Lumbar Spinal Stenosis

- Definition: Narrowing of the spinal canal, neural canal and vertebral foramina.
- 724.02 Spinal Stenosis of Lumbar Region
- Prevalence:
  - 8-14% of the population
  - Most common cause of neurological leg pain in older adults

Signs and Symptoms of LSS

- LBP
- Lower Extremity symptoms
  - pain
  - weakness
  - changes in or loss of sensation
- Symptoms are relieved with sitting, forward bending
- Symptoms are aggravated with prolonged walking, and backward bending- Neurogenic Claudication
Common Treatments

- NSAIDs/prescription pain meds
- Epidurals
- Decompressive/Fusion Surgery
- PHYSICAL THERAPY

Physical Therapy Management

- Four-Fold Approach:
  - Patient Education
  - Manual Therapy
  - Exercise
  - Aerobic Training
Patient Education

- Definition of Lumbar Spinal Stenosis
- Intent of Manual Therapy and Exercise
- Course of Physical Therapy
- Purpose of Home Exercise Program
- Self Management Strategies
- Pain Science Information
- Prognosis

Manual Therapy

- Techniques include:
  - Flexion-Distraction Manipulations
  - Sidelying lumbar Rotation Thrust
  - Posterior-to-Anterior Mobilizations
  - Sidelying Translactoric Side Bending Manipulations
  - Thoracic Thrusts
  - Hip Distraction Manipulations

  - Reiman et al. (2009)
Sidelying Rotational Lumbar Manipulation

Prone Thoracic Manipulation

Therapeutic Exercise

- Spinal Mobility and Lumbar Flexion

- Hip Mobility/Strengthening
  - hip musculature stretching
  - Extensor and abductor strengthening

- Core Strengthening
Single and Double Knee to Chest

Lumbar Rotation Stretch  Thoracic Extension Self Mobilization
Hip Flexor Stretching

Hip Strengthening
Core Strengthening

Aerobic Conditioning

• Un-weighted walking
  - Treadmill
  - Pool Therapy

• Biking

• Inclined Treadmill
PATIENT HISTORY

• 64 Y.O. male diagnosed with LSS based on T2 weighted MRI

• **CC:** 2 year hx of intermittent bilateral pain in gluteal region that radiates to ankles

• Numbness/Tingling in calves and plantar aspects of feet

• Symptoms provoked by walking ~ one block or standing for more than 2 minutes and relieved by sitting or lying down

• Symptoms worsened over 2 previous years despite flexion based PT intervention and core stabilization exercises

PATIENT HISTORY

• **MOI:** No obvious traumatic events as the underlying cause

• **Past Med Hx:** No past medical problems, recent weight loss or night pain

• Received 2 epidural injections but denied significant relief

• Current exercise regimen at the time of visit included:
  • Flexion based exercises
  • Upper and lower body weight training
  • 20-30 min of cardiovascular exercise 4-5 times per week

• **Meds:** N/A
INITIAL EXAM

- Pain levels of 7-9/10 on numerical rating scale
- Oswestry Disability Index (ODI) score=54%
- Posture:
  - Decreased lumbar lordosis
  - Mild upper thoracic kyphosis and a moderate forward head
  - Ambulated with a mild forward trunk lean
- Neuro Screening: Didn’t reveal any focal deficits
- Special Tests: Passive SLR test was limited bilaterally at 70% by hamstring tightness
- Moderate limitation of bilateral rotation and mild restriction of bilateral side glides

INITIAL EXAM

<table>
<thead>
<tr>
<th>PATIENT’S AROM</th>
<th>INITIAL ASSESSMENT</th>
<th>3 WEEK FOLLOW UP</th>
<th>NORMS (McGee, 2008)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumbar Flexion</td>
<td>0-45°</td>
<td>0-50°</td>
<td>40-60°</td>
</tr>
<tr>
<td>Lumbar Extension</td>
<td>0-10°</td>
<td>0-15°</td>
<td>20-35°</td>
</tr>
<tr>
<td>Right-sided Flexion</td>
<td>0-15°</td>
<td>0-20°</td>
<td>15-20°</td>
</tr>
<tr>
<td>Left-sided Flexion</td>
<td>0-10°</td>
<td>0-20°</td>
<td>15-20°</td>
</tr>
</tbody>
</table>

Data from Table 1 Progression of AROM Measured by Dual Inclinometer
INITIAL EXAM

• To establish directional preference tests included:
  1. **McKenzie Mechanical Diagnosis and Therapy (MDT)**
     • Series of repeated movements of Flexion in Standing (RFIS), Extension in Standing (REIS), Flexion in Lying (RFIL), Extension in Lying (REIL)
  2. **Three Step Treadmill Test**
     • Pt walked in spinal flexion, spinal extension and neutral
     • 1 mile/hour with a 15° gradient until onset of pain
     • Test is similar to Two Stage Treadmill Test with addition of the neutral positioning
     • Has not been validated or deemed reliable

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**McKenzie Mechanical Diagnosis (MDT)**

*Table 2 Initial Repeated End Range Movement Testing During Initial Assessment*

<table>
<thead>
<tr>
<th>Direction of Movement</th>
<th>Reps</th>
<th>Pre-Test Symptom</th>
<th>Test Symptom</th>
<th>Post-Test Symptom</th>
<th>Pre-test Walking Tolerance</th>
<th>Post-test Walking Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion in Standing</td>
<td>30</td>
<td>0/10</td>
<td>Buttock/leg pain radiate to calf at 4/10</td>
<td>Not worse</td>
<td>4 min 30 sec</td>
<td>2 min 15 sec</td>
</tr>
<tr>
<td>Extension in Standing</td>
<td>30</td>
<td>0/10</td>
<td>Buttock/back pain at 4/10</td>
<td>Not worse</td>
<td>4 min 45 sec</td>
<td>7 min 10 sec</td>
</tr>
<tr>
<td>Flexion in Lying</td>
<td>30</td>
<td>0/10</td>
<td>No effect</td>
<td>No effect</td>
<td>5 min 23 sec</td>
<td>1 min 47 sec</td>
</tr>
<tr>
<td>Extension in Lying</td>
<td>30</td>
<td>0/10</td>
<td>No effect</td>
<td>No effect</td>
<td>3 min 38 sec</td>
<td>8 min 35 sec</td>
</tr>
</tbody>
</table>
Three Step Treadmill Test

Table 3 Treadmill Test Comparison

<table>
<thead>
<tr>
<th></th>
<th>Time to Initiate Pain in Flexion Posture</th>
<th>Time to Initiate Pain in Neutral Posture</th>
<th>Time to Initiate Pain in Extension Posture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Assessment</td>
<td>1 min 12 sec</td>
<td>3 min 15 sec</td>
<td>8 min 53 sec</td>
</tr>
<tr>
<td>2 Week Follow Up</td>
<td>No Pain After 10 min</td>
<td>No Pain After 10 min</td>
<td>No Pain After 10 min</td>
</tr>
</tbody>
</table>

*Time duration to onset of pain

Summary of 2 tests

**McKenzie MDT:**
- “Repetitive movement testing showed lack of a directional preference and lack of centralization”
- “Demonstrated a change in pre- and post-test walking tolerance”

**Three Step Treadmill Test:**
- “Revealed a previously unrecognized directional preference towards spinal extension”
Classification/ Diagnosis

- Given provisional classification of central symmetrical derrangement
- Symptoms radiating pass the knee
- Possible directional preference in extension

Differential Diagnosis

- Lumbar Spinal Stenosis
- Degenerative Disc Disease
- Spondylolesthesis
- Peripheral Neuropathy
- Vascular Claudication
- Cauda Equina Syndrome
- Tumor
Pertinent Qualities of Pain

1. Flexion exercises failed to improve or exacerbate his symptoms
2. Flexion and extension stretches failed to elicit pain and mechanical responses
3. There was a dramatic functional response to mechanical testing
4. The three-step treadmill test revealed a directional preference toward spinal extension

Treatment Day 1

- Extension based stretches and exercises
- Patient education – use of a lumbar roll while sitting
- Hourly extension exercises and standing or supine position
- Advised to stand every 30 – 45 min.
Treatment Day 2

- 24 hour follow-up
- Reduction of pain
  - Day 1 - 7-8/10
  - Day 2 - 2-3/10 - Primarily on the left side
- Centralization of pain
  - Resolution of right sided leg pain
  - Continued tingling in left leg but no numbness
- Improve gait - avoided flexion posture
- Decreased pain symptoms

Treatment Day 3

- 1- Week post assessment
- Reduction of pain
  - Day 3 - 1-2/10
- Centralization of pain
  - Resolution of bilateral leg pain
  - Continued pain in lower back and buttocks
- Treadmill test
  - Day 1 - 1 min. 23 seconds
  - Day 3 - 23 min.
- Oswestry Disability Index
  - Day 1 - 54%
  - Day 3 - 8%
Treatment Day 4

• 3 – Week post assessment
• Oswestry Disability index
  • Score = 0
• Treadmill Test
  • Stopped after 10 min. because of lack of symptoms
• Reduction of pain
  • Low back and buttock pain had essentially resolved – only sporadic mild lower back stiffness
  • No pain with repeated flexion and extension

Summary

• 64 y/o male Dx with LSS based on T2 weighted MRI
• Pt didn’t respond to typical LSS flexion based exercises in previous PT interventions
• McKenzie MDT did not detect directional preference
• According to Three Step Treadmill Test his functional preference was in extension
• Pt responded to extension based exercises
• ODI-
  • Initial Assessment- 54%       Final- 0%
  • 4 treatment visits over a 3 week span
• Treatment duration was not typical of a normal LSS presentation or central symmetrical derangement
  • 4 total visits VS 8-10 expected visits
Limitations/Discrepancies

- Discrepancies
  - Spondylolisthesis (L3-L4 or L4-L5?)
  - Provocation of Pt symptoms

- Three Step Treadmill Test
  - Lack of validity or reliability
  - Position descriptions
  - Equipment used

- No long term follow up after the final treatment session
- Stage of stable Spondylolisthesis was unreported

Conclusions/Clinical Relevance

- Pt may have been misdiagnosed
- Diagnostic imaging has high false positive rates (Gold Standard)
- Clinicians should not base treatment protocol solely based on diagnostic imaging we must consider their functional or directional preference as well as the following:
  - “A dx of LSS can only be established through a combination of clinical history, physical examination and radiological changes.”
    (Siebert, E. et al. 2009)
  - “Physical Exam must include an in-depth patient history, determination of symptom characteristics, movement examination, gait analysis as often patients present with decreased stride length and increased base of support, balance tests, sensory-motor testing, palpation of peripheral pulses and treadmill testing”
    (Backstrom, M. et al 2011)
Clustering Tests

References