What is Backward Disequilibrium and How Do I Treat It?

Objectives
1. Discuss the clinical findings of a patient with backward disequilibrium (BD) and the related literature
2. Identify clinical characteristics of BD using case examples
3. Develop an evidenced-based intervention plan for someone with BD

Subjective Vertical
- Perception of upright orientation
- Under normal conditions, subjective vertical aligns with physical vertical through implicit representation of verticality
- Internal representation of vertical established through
  - Visual-Vertical
  - Visuovestibular information
  - Haptic (Touch) Vertical
  - Touch and pressure receptors
  - Postural Vertical
  - Graviceptive — somaesthetic information

Psychomotor Disadaptation Syndrome (PDS)
- First described 25 years ago
- Results from decompensation of postural function, gait and psychomotor automatisms linked to posture and motor programming impairment
- Related to fronto-sub-cortical lesions

Psychomotor Disadaptation Syndrome (PDS)
- Considered a Geriatric Syndrome
  - Neurological/Psychological factors
    - Reactive hypertonicity
    - Fear of falling
  - Gait
    - Cautious, retropulsion, fear of falling
  - Postural Impairment
    - Backward Disequilibrium

PDS-Psychological/Neurological Factors
- Fear of falling leading to low self-confidence
- Increased muscle tone that counteracts movement execution
  - "Reational" appears with passive mobilization and with movement but decreases with pt. confidence and relaxation; variable and heterogeneous t/o passive motion
  - Occurs in 95% of PDS cases (Pfitzenmeyer P et al, 2002)
- Abnormal forward protective responses (grabbing with UE’s) and backward (stepping) responses

92% of those with PDS have a high level of dependency (Pfitzenmeyer P et al, 2002)
What Is Backward Disequilibrium and How Do I Treat It?

PDS-Gait Disorder

- Hesitation with initiation, slow/shuffling gait, retropulsion, and knee flexion
- Differentiation from Parkinson’s Disease: patients with PDS have an increased base of support

PDS-Postural Impairment

Backward Disequilibrium

- COM Posterior to BOS – Resists correction
- Posterior Postural Tilt in Standing and Sitting
- Exposes Patients to Backward Falls
- Insufficient Shift of COM Forward During Sit to Stand
- Altered Perception of Postural Vertical Similar to Patients with Contraversive Pushing Behavior
- Successful standing: demon. trunk and knee flex. and toe clenching
- Successful sitting: buttocks on the ant. portion of the seat and trunk on the back of chair

Mechanism

- White Matter Signal Abnormalities
  - Parietal-Occipital area
  - Peri-ventricular frontal
- Redistribution of Functional Reserves
  - Critical threshold
  - Can no longer compensate
- Loss of Postural Reserves
  - Cumulative
  - Similar to acute stress fx

Measurement

- Mini-Motor Test
- Backward Disequilibrium Scale

Mini Motor Test

- 20 items
  - In bed
  - Sitting position
  - Standing position
  - Gait
- Dichotomous scale
- Inter-rater reliability- r =0.956

<table>
<thead>
<tr>
<th>Mini Motor Test</th>
<th>1. Able to roll side to side</th>
<th>2. Able to roll from lying to sitting position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sit</td>
<td>3. No retropulsion of the trunk</td>
<td>4. Able to bend trunk forward</td>
</tr>
<tr>
<td></td>
<td>5. Able to rise from a chair</td>
<td>6. Possible</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standing</th>
<th>7. Possible</th>
<th>8. Without assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9. Able to stand on 2 legs with closed eyes</td>
<td>10. Able to stand on 1 leg</td>
</tr>
<tr>
<td></td>
<td>11. No retropulsion</td>
<td>12. Reactive postural responses</td>
</tr>
<tr>
<td></td>
<td>13. Protective reactions of upper limbs</td>
<td>14. Stepping reactions forward</td>
</tr>
<tr>
<td></td>
<td>15. Stepping reactions backwards</td>
<td>16. Possible</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gait</th>
<th>17. Without assistance</th>
<th>18. Normal heel strike</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>19. No knee flexion</td>
<td>20. No retropulsion</td>
</tr>
<tr>
<td></td>
<td>21. Harmonous turn around</td>
<td></td>
</tr>
</tbody>
</table>
Backward Disequilibrium Scale

- 5 items
  - Maintaining Sitting
  - Maintaining Standing Feet Together – ED
  - Maintaining Standing Feet Together – EC
  - Sit to Stand
  - Stand to Sit
- Each item scored 0-3
  - 0 = No BD
  - 1 = Slight BD; no difficulty with task
  - 2 = Moderate or intermittent BD; difficulty with task but no help needed
  - 3 = Severe BD compromising task

Normal = ≤ 2
Moderate BD = 3-7
Severe BD = ≥ 7

Inter-rater reliability Spearman CC = 0.99
Intra-rater reliability Spearman CC = 0.89

Intervention

- Recommendations in the Literature
  - 45 min/day
  - Rolling
  - Sit to/from Supine
  - Sit to/from Stand
  - Gait

Proposed Intervention Protocol

- Standing Back Against Wall
  - Sit to Stand
  - Stand to Sit
- Continuous Stepping
- Backward Stepping

Standing Back Against Wall

- Heels against wall - no resistance
- Use UE support to assume position if needed
- Increase time standing
- UE movements without changing BOS
- Produce active sway forward
- Practice walking and/or sit to stand after

Sit to Stand

- Without UE support
- If must use UE do so for initiation only
- Provide manual block to posterior displacement of tibia
- Provide assistance with anterior translations of tibia
- Provide encouragement and support related to fear of falling
Continuous Stepping

- Eliminate stopping and starting
- Maintain forward progression
  - Pull rolling walker forward
  - Harness support over a treadmill or over ground
  - Assist with weight shift and limb advancement as needed

Backward Stepping

- Anterior sway prior to stepping
- Controlled – does not have to be continuous
- Practice switching between forward and backward stepping

Patient Example #1

- 87 year old female
- 4 months s/p fall with right hip fracture with hemiarthroplasty
- 14 weeks of PT and OT in SNF
- Discharged to apartment (JNPT 2013;39: 119–126)
- Home Health referral

Examination

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini Motor Test</td>
<td>1/20</td>
</tr>
<tr>
<td>BD Scale</td>
<td>15 (Severe)</td>
</tr>
<tr>
<td>POMA</td>
<td>3/28</td>
</tr>
<tr>
<td>SPPB</td>
<td>0/12</td>
</tr>
<tr>
<td>Gait Speed</td>
<td>0 m/s</td>
</tr>
</tbody>
</table>

Examination

<table>
<thead>
<tr>
<th>Initial movement system examination key findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength (Rat)</td>
</tr>
<tr>
<td>Hip flexion</td>
</tr>
<tr>
<td>Hip abduction</td>
</tr>
<tr>
<td>Knee extension</td>
</tr>
<tr>
<td>Injury Fatigue</td>
</tr>
<tr>
<td>JP2</td>
</tr>
</tbody>
</table>
Examination

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet sitting</td>
<td>Able to sit with full support without UE support once placed, decreased weight bearing on right, resistance needed to shift trunk forward to a vertical position</td>
</tr>
<tr>
<td>Sit to stand</td>
<td>Requires minimal assistance without UE support; pull-up using walker with right foot.</td>
</tr>
<tr>
<td>Right standing</td>
<td>Increased pressure of right hip on table, decreased weight bearing on right, increased posterior displacement of COM relative to IOS, required correction of COM forward</td>
</tr>
</tbody>
</table>

Movement System Diagnoses

- PSD with BD
- Postural Vertical Deficit in Sagittal plane
- Sensory Detection Deficit
- Force Production Deficit

Prognosis for Improvement in Impairments

- Improvement in Impairment Syndromes
  - Poor
  - Fair to Poor
  - Postural Vertical Deficit
  - Force Production Deficit
- Improvement in Activity Limitations
  - Fair
  - 50% of Baseline

Intervention

- Bilateral AFOs
  - Visit 2
  - Casted for custom AFOs week 3
- Standing with Back Against Wall
  - Best initial performance standing heels 2-3 inches from wall holding onto walker 1 min.
  - Improved from max assist to min assist with STS
  - Able to stand with walker without other support 30 sec immediately after
  - Continued throughout course
  - Instructed care givers

- Sit to Stand
  - Initiated visit 2; required UE for initiation
  - End of week 2 – forward translation of tibia during 1st half of execution
  - End of week 4 – consistently SBA standing to walker
  - End of week 6 – consistently min assist with all transfers with facility staff
  - Stand to Sit
    - Initiated visit 2, significant manual and verbal cues
    - Variable performance without cueing; unable to verbalize correct strategy
    - Limited change with practice
  - Visual Guide Line with Ambulation
    - Initiated end of week 1
    - Discontinued during week five because no longer needed
What Is Backward Disequilibrium and How Do I Treat It?

Intervention

- **Continuous Stepping**
  - Initiated during first week
  - Progress slow due to proximal weakness
  - Week 2 – 5 ft with continuous steps; Week 4–5.7 ft; Week 8–40 ft; week 12 50 ft with continuous steps with sustained forward progression

- **Backward Stepping**
  - Initiated at end of week 3; failure
  - Attempted intermittently from week 3 to 11
  - Week 14 – 10 ft without excessive posterior sway or loss of balance; immediate loss of balance on coupled with sitting down

- **Strengthening**
  - Initiated week 4
  - Progressing loading in standing
  - Sitting knee extension
  - Stationary bike

Intervention Time Course

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
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<tbody>
<tr>
<td>Mini Motor Test</td>
<td>7/20</td>
</tr>
<tr>
<td>BD Scale</td>
<td>10 (Severe)</td>
</tr>
<tr>
<td>Berg Balance Scale</td>
<td>22/56</td>
</tr>
<tr>
<td>SPPB</td>
<td>5/12</td>
</tr>
<tr>
<td>Gait Speed</td>
<td>0.3 m/s</td>
</tr>
</tbody>
</table>

Outcome

Patient Example #2

- 94 year old female
- History of repeated falls with injury
- Recently moved from her home to ALF

- PMH: a-fib (coumadin), HTN, multiple fractures, osteoporosis, arthritis

Examination

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Movement System Diagnosis

- Movement Pattern Coordination Deficit with Backward Disequilibrium (Postural Vertical Deficit)
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Intervention

Standing Back Against Wall
- Able to do independently after a few visits
- Home program

Sit to Stand
- Manual guidance for anterior translation of tibia and toe flexion
- Task specific strengthening
- "Bend knees to sit"

Intervention

Continuous Stepping
- Hand hold initially
- Running
- Coupled with bouts of speed training

Backward Stepping
- Over an obstacle
- Opening doors

Outcome

<table>
<thead>
<tr>
<th>Test</th>
<th>Initial</th>
<th>Discharge</th>
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<tbody>
<tr>
<td>Mini Motor Test</td>
<td>7/20</td>
<td>14/20</td>
</tr>
<tr>
<td>BD Scale</td>
<td>10 (Severe)</td>
<td>5 (Moderate)</td>
</tr>
<tr>
<td>Berg Balance Scale</td>
<td>22/56</td>
<td>36/56</td>
</tr>
<tr>
<td>SPPB</td>
<td>2/12</td>
<td>5/12</td>
</tr>
<tr>
<td>Gait Speed</td>
<td>0.3 m/s</td>
<td>0.5 m/s</td>
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Labeling Conditions

- Backward Disequilibrium identified as a condition by clinicians
- Recognition of a pattern
- Understanding of the primary movement system fault is key to planning intervention
- Similar of contraversive pushing behavior
- Deterioration of representation of postural vertical
- Postural alignment with COM outside limits of BOS
- Resistance to correction
- Labeled Postural Vertical Deficit

Clinical Benefits of Describing Common Conditions of the Movement System

- Describing common conditions assists with pattern recognition
- Disseminates knowledge gained from practice
- Describing common faults observed during tasks assists clinicians in movement analysis and recognizing patterns
- Describing and labeling common conditions is a mechanism for organizing knowledge so that it is clinically useful

Educational Benefits of Describing Common Conditions of the Movement System

- Students learn about common patterns seen in practice
- Matching of patient presentation to described conditions reduces need for repeated individual exposure to patient conditions
- Helps fill the knowledge gap between subjects studied in randomized trials and patients seen in clinical practice
- Stimulates clinically meaningful research questions
Research Benefits of Describing Common Conditions of the Movement System

- Focus on the Movement System conditions with which individuals present rather than health conditions only
- Mechanism can be studied
- Intervention studied and refined for conditions seen in practice
- Homogenous groups for study
  - Our complex patient would be an outlier if studying her referring diagnosis – hip fracture

Summary

- Described a condition that physical therapists and assistants see in practice
- Outlined an intervention protocol to guide management of patients with this condition
- Outlined the benefits of describing movement system conditions to
  - Practice
  - Education
  - Research

Questions & Answers