INTRODUCTION

- Age-related musculoskeletal conditions have been associated with decline in locomotor function, increased risk of falls, and a decrease in quality of life.\textsuperscript{1,2}
- Associated age-related changes in local intervertebral segment mobility, descending central nervous system control and muscle strength have a negative influence on spinal mobility, and spinal health.\textsuperscript{3}
- Early detection and consistent tracking of spinal mobility impairment are critical for a physical therapist's clinical reasoning in determining an appropriate intervention.

Clinical assessment of spinal mobility:
- Active thoracolumbar mobility is assessed qualitatively through observation or quantitatively through a forward bend test and a backward bend test.\textsuperscript{4}

Mobile technology:
- Mobile phones (smartphone + accelerometer) have demonstrated promise for the quantitative measurement of joint mobility.\textsuperscript{5} Limited focus on thoracolumbar mobility necessitates further investigation.

OBJECTIVES

Primary Objective: Validity
Secondary Objective: Reliability
- Assess concurrent validity of a body-worn smartphone accelerometer for measuring thoracolumbar mobility, compared to a 3D Motion Capture System.
- Assess intra-rater reliability of a body-worn smartphone accelerometer for measuring thoracolumbar mobility.

METHODS

Study Design:
- Cross sectional prospective repeated measures study
Participants:
- Healthy, able-bodied adults (n=21)
- Ages: 22-60 (mean= 29.1)
Participant preparation:
- Height, weight, age, sex
- Limb length, front, side, ankle, knee width

Figure 1: Tasks Performed

Figure 2: Schematic of Smartphone and VICON Output

Instrumentation:
- Mobile phone: Samsung A5 - smartphone
- Positioned at T10
- Motion Capture: 9-camera VICON motion capture system
- Reflective markers: trunk/external/mobile phone

Thoracolumbar Mobility Task:
- A/P extension (4 – point stance)
- A/P thoracolumbar flexion (seated)
- M/L thoracolumbar flexion (standing)

Thoracolumbar Mobility Measure:
- Peak A/P and M/L angle (degrees)

RESULTS

Concurrent Validity of body-worn accelerometer and 3D Motion Capture (Objective 1)
- Overall we found that the accelerometer had similar accuracy to the VICON when measuring thoracolumbar mobility.
- Our most variable results came from thoracolumbar extension.

Table 1: Concurrent Validity of Smartphone Accelerometer and VICON

<table>
<thead>
<tr>
<th>Task</th>
<th>ICC 95% CI</th>
<th>ICC Interpretation</th>
<th>Excellent correlation</th>
<th>ICC .774</th>
<th>ICC .988</th>
<th>Excellent correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension</td>
<td>0.956</td>
<td>(0.777, 0.993)</td>
<td>Poor to Excellent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>0.956</td>
<td>(0.888, 0.999)</td>
<td>Excellent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left Side Flexion</td>
<td>0.957</td>
<td>(0.860, 0.985)</td>
<td>Excellent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Side Flexion</td>
<td>0.971</td>
<td>(0.916, 0.999)</td>
<td>Excellent</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Bland Altman Data

<table>
<thead>
<tr>
<th>Task</th>
<th>Mean Difference</th>
<th>95% LOA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension</td>
<td>2.0</td>
<td>(0.0, 4.0)</td>
</tr>
<tr>
<td>Flexion</td>
<td>0.3</td>
<td>(-3.8, 4.4)</td>
</tr>
<tr>
<td>Right Side Flexion</td>
<td>0.0</td>
<td>(-6.4, 6.4)</td>
</tr>
</tbody>
</table>

DISCUSSION

- Overall, the present findings are consistent with previous studies that examined the utilization of a mobile application for the measurement of segment mobility.\textsuperscript{6}
- Good – excellent - peripheral segments
- Poorer agreement and reliability for the thoracolumbar extension task may be related to: 1) variability of task performance; 2) angular movement at thoracolumbar region for this movement; 3) efficacy of peak detection algorithm to capture peak angular change.

Limitations:
- Internal validity:
  - Task performance by the participant
  - Secure fixation of phone to the body (i.e., strap method)
- External validity:
  - Able bodied adult population with no known musculoskeletal impairment.

Clinical Relevance:
- We propose that a body worn smartphone accelerometer be utilized as an initial assessment tool for assessing ROM of the thoracolumbar spine, and as an instrument to monitor ROM changes.
- Potential populations of interest to assess include: 1) musculoskeletal aging; aging with or without a spinal pathology (spinal deformity, degenerative joint disease) 2) neurological: Parkinson’s, Duchenne’s muscular dystrophy, amyotrophic lateral sclerosis.

CONCLUSION

- The body-worn smartphone accelerometer demonstrated excellent validity and reliability for the measurement of thoracolumbar anterior-posterior and lateral flexion.
- Thoracolumbar left side flexion showed strong validity when compared to 3D motion capture, however did not show the clinically desired relevance for between-session reliability.
- Thoracolumbar extension showed variable validity when compared to 3D motion capture, and poor-moderate reliability between sessions.

REFERENCES


ACKNOWLEDGMENTS

- Ontario Neurotrauma Foundation