The Challenge

Measuring human movement is clinically important for prescribing devices or guiding treatment decisions.

- One measure of clinical interest is **shank-to-vertical angle (SVA)**, the orientation of the lower leg with respect to the vertical in the global sagittal plane [1].
- Current techniques (e.g., motion capture, video, goniometer) to measure SVA largely require **expensive** equipment, are **time intensive**, or are **isolated to static** measurements with **poor reliability** [2-4].

**Need:** An affordable and widely-available rehabilitation method that dynamically tracks shank orientation in real time.

The application of smartphone sensing has created opportunities to enhance clinical gait analysis [4].

Before integrating smartphone sensing of SVA into clinical practice, research must evaluate:

- **(1) Accuracy** of smartphone sensing compared to gold-standard motion capture
- **(2) Inter- and intra-rater repeatability** for measuring SVA with a smartphone

Methods

**Participants:** Four licensed rehabilitation clinicians (2 physical therapists and 2 orthotists) recruited to use smartphone to measure SVA on two unimpaired, healthy participants during gait analysis.

**Smartphone Sensing:** A custom mobile application was used to measure SVA using phone’s accelerometer. Two different smartphone positions were evaluated, corresponding to anterior and lateral methods for measuring SVA.

**Accuracy**

- Smartphone and Qualisys motion capture concurrently gathered data.
- Anterior SVA was calculated from Qualisys using tibial tuberosity (TT) and distal tibia (DT) markers. Lateral SVA used lateral epicondyle (LE) and lateral malleolus (LM) markers.
- Clinicians were blinded to the passive markers upon phone placement.

**Repeatability**

- Inter-rater repeatability compared SVA measures between clinicians.
- Intra-rater repeatability assessed the clinician’s ability to reposition the smartphone within and between days.

Results

**Anterior placement is accurate and repeatable with deviations less than 2°**

<table>
<thead>
<tr>
<th>SVA Difference (deg)</th>
<th>Smartphone</th>
<th>Qualisys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior Placement</td>
<td>0.67</td>
<td>0.25</td>
</tr>
<tr>
<td>Lateral Placement</td>
<td>0.42</td>
<td>0.28</td>
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</tbody>
</table>

**Clinician Feedback**

- Smartphone sensing would enhance clinical practice.
- SVA is not easy to measure with current tools available in clinic.
- The custom mobile application is intuitive, but requires some practice to use.

**Next Steps**

- Evaluate whether the size and type of smartphone impact accuracy and repeatability.
- Assess accuracy and repeatability of SVA mobile sensing in individuals with clinical populations.
- Further development of custom mobile application.

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References