Reliability and Concurrent Validity of a 2D Observational Gait Analysis Tool

Kevin Yu, SPT
Robert Wayner, PT, DPT
Jennifer Smith, PT, DPT

Reliability and Concurrent Validity of a 2D Observational Gait Analysis Tool

RUNNING

- Stance Phase (Single Limb Support)
  - Initial Contact / Foot contact *
  - Mid-stance / Max Loading *
  - Terminal Stance / Toe off *

- Swing Phase (Limb Advancement)
  - Initial Swing
  - Mid-swing
  - Terminal Swing

Normal Running

- Pelvis/Hip
  - Level pelvis
  - Slight femoral adduction

- Knee
  - Relative femoral and tibial alignment

- Foot/Ankle
  - Contact surface
  - Rearfoot motion
Common Deviations

- **Pelvic/Hip**
  - Excessive contralateral drop
  - Hip adduction
- **Knee**
  - Tibial abduction
  - Excessive flexion
  - Hyperextension
- **Ankle/Foot**
  - Excessive Pronation
  - Foot slap

---

Tool Development

- Consensus of commonly analyzed items with ranges
- 22 items examining spatial characteristics and joint positioning of the trunk, pelvis, hip, knee, foot, and ankle
- Sagittal and frontal plane

---

Gait Recording Methods

- **3D Motion Capture**
  - “Gold Standard” of running gait analysis
- **2D Observational Gait Analysis (OGA)**
  - Cheaper alternative
  - Faster set up
Objectives
1. Determine the inter-rater reliability of the 2D Observational Gait Analysis Tool
2. Determine the validity of 2D observation compared to 3D motion analysis with the tool.

Subject Selection
• 25 recreational runners
  – Males and females between 18-45 years old
  – Running at least 20 km over 3+ days per week
  – Not pregnant
  – Comfortable running on a treadmill
  – No history of lower extremity surgery

Sample Population
– Gender distribution: 9 male, 16 female

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>26.80</td>
<td>5.83</td>
</tr>
<tr>
<td>Pace [m/s]</td>
<td>2.97</td>
<td>0.42</td>
</tr>
<tr>
<td>Running experience (years)</td>
<td>10.03</td>
<td>4.83</td>
</tr>
<tr>
<td>Days/week running</td>
<td>4.76</td>
<td>1.18</td>
</tr>
<tr>
<td>Mileage [miles/week]</td>
<td>26.32</td>
<td>17.32</td>
</tr>
</tbody>
</table>
Methodology

Rating

- 3 raters experienced in running gait analysis
- Standardized education to train raters on use of the tool
- Raters utilized 2D video to score subjects
- Blinded rater scored the 3D data using the same tool

Reliability: Sagittal Plane

<table>
<thead>
<tr>
<th>ITEM</th>
<th>KAPPA SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Contact</td>
<td></td>
</tr>
<tr>
<td>Footstrike to COM</td>
<td>0.75</td>
</tr>
<tr>
<td>Ankle Angle</td>
<td>0.70</td>
</tr>
<tr>
<td>Footstrike Angle</td>
<td>0.32</td>
</tr>
<tr>
<td>Knee Angle</td>
<td>0.72</td>
</tr>
<tr>
<td>Hip Angle</td>
<td>0.64</td>
</tr>
<tr>
<td>Mid-stance</td>
<td></td>
</tr>
<tr>
<td>vertical COM position</td>
<td>0.44</td>
</tr>
<tr>
<td>Ankle Angle</td>
<td>0.52</td>
</tr>
<tr>
<td>Knee Angle</td>
<td>0.60</td>
</tr>
<tr>
<td>Hip Angle</td>
<td>0.50</td>
</tr>
<tr>
<td>Terminal Stance</td>
<td></td>
</tr>
<tr>
<td>Ankle Angle</td>
<td>0.68</td>
</tr>
<tr>
<td>Knee Angle</td>
<td>0.68</td>
</tr>
<tr>
<td>Hip Angle</td>
<td>0.60</td>
</tr>
</tbody>
</table>

- Inter-rater reliability
  - 7 items with moderate to high agreement (K = 0.51-1)
  - 5 items with fair to moderate agreement (K = 0.26-0.50)
  - 1 item with little to no agreement (K = 0.00-0.25)
Objective 1: Reliability

- Is the 2D Observational Gait Analysis Tool a reliable tool for assessing running gait?
  - YES: 12 out of 22 items had moderate to excellent agreement (K>0.51) between raters
  - Scores were reproducible between 3 raters.

2D to 3D Correlation: Sagittal Plane

- All 3 raters had at least 8 out of 13 items with significant (p < 0.05) correlation
2D to 3D Correlation:
Frontal Plane

- All raters had at least 4 out of 9 items with significant (p < 0.05) correlation
- 2 of the 3 raters had 5 of 9 items with significant (p < 0.01) correlation

<table>
<thead>
<tr>
<th>Item</th>
<th>Rater 1 vs 3D</th>
<th>Rater 2 vs 3D</th>
<th>Rater 3 vs 3D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvis Tilt</td>
<td>0.590</td>
<td>0.430</td>
<td>0.101</td>
</tr>
<tr>
<td>Pelvis stance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral Heel/COM</td>
<td>0.340</td>
<td>0.340</td>
<td>0.340</td>
</tr>
<tr>
<td>Footed Angle</td>
<td>0.297</td>
<td>0.297</td>
<td>0.297</td>
</tr>
<tr>
<td>Hip Angle</td>
<td>0.136</td>
<td>0.136</td>
<td>0.136</td>
</tr>
<tr>
<td>Knee Alignment</td>
<td>0.353</td>
<td>0.353</td>
<td>0.353</td>
</tr>
<tr>
<td>Pelvis Tilt</td>
<td>0.590</td>
<td>0.430</td>
<td>0.101</td>
</tr>
</tbody>
</table>

Objective 2

- Do the 2D ratings correlate to the results from 3D data?

Clinical Relevance

- As a whole, the tool demonstrates good inter-rater reliability.
- Comparison of the tool to the gold standard indicates that the majority of items have a significant correlation to 3D
- Bottom line: good promise as a clinical tool for running gait assessment

College of Health Sciences and Professions
Ohio University
Ohio.edu/CHSP
Reliability and Concurrent Validity of a 2D Observational Gait Analysis Tool /
Discussion

• Strengths:
  – Sample size
  – Standardized rater training tool
  – Defined ranges for categorization of each item

• Limitations:
  – Low number of raters
  – Gender distribution

Future Study

• Increase number of experienced and inexperienced raters
• Identify which items from the tool are valid and which items may be correlated
• Adjustments to item ranges
• Examine certain kinematics as precursors to injury (or in context to injury)

References

Special Thanks

- Robert Wayner, PT, DPT
- Ohio University Gait Lab
  - Jackie Swartz
  - Paul Dunn
- Gait Analysis Tool Development Team
  - James Christoffel
  - Denise Boyd
  - Clint Boring
- Betty Sindelar, PT, PhD
- Jennifer Maykut, PT, DPT
- Justin Carr, PT, DPT