VALIDATION OF AN ELECTROGONIOMETRY SYSTEM AS A MEASURE OF KNEE KINEMATICS DURING ACTIVITIES OF DAILY LIVING

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INTRODUCTION

The use of electrogoniometry (ELG) in the monitoring of sagittal knee joint kinematics can provide an opportunity to measure everyday functional activities [1,2]. This can be undertaken in controlled laboratory environments, or away from clinical observation [3]. ELG is being increasingly used to assess clinical populations, as such, there is a requirement to ascertain the validity of different systems. No authors appear to have assessed the validity of the Biometrics SG150 device in humans across a range of functional activities representative of those undertaken during daily living. The objective of this study was to determine the concurrent validity of the Biometrics SG150 electrogoniometer by comparing intersegmental knee angular displacements to a three dimensional motion analysis system (MA) during walking, stair ascent, stair descent, a sit to stand task, and a stand to sit task.

METHODS

Ten asymptomatic male participants were recruited. Participants had a mean age of 23.1yrs±3.69yrs, height of 1.79m±0.07m, mass of 81.57kg±7.79kg, and body mass index (BMI) of 25.42kg/m²±2.21kg/m² and were free from lower extremity injury.

A 12 camera MA system (Vicon MX, Oxford, UK) was calibrated through a standard dynamic protocol. Participants had 16 retroflective markers placed over anatomical landmarks in line with the lower body Plug in Gait model recommendations (Vicon, Oxford, UK).

A Biometrics SG150 electrogoniometer (Biometrics, Gwent, UK) was placed over the lateral border of the right knee on the anatomical line of the greater trochanter, lateral epicondyle, and lateral malleolus. Electronic foot switches were attached to the forefoot and heel to synchronize the ELG and MA system in analysis.

Participants undertook multiple walking trials until three were collected that coincided with a heel strike on a force plate. Three stair ascent and stair descent trails were performed on a stair rig with a force plate built into the first step. Participants then performed three sit to stand and stand to sit trials onto an orthopaedic stool whilst standing bilaterally on two force plates. Stool height was kept at a consistent height of 560mm during the performance of both sit to stand and stand to sit trials.

Analysis of validity by linear regression was undertaken. The typical error and Pearson’s correlation coefficient $r$ were computed for three paired trials between systems for each functional activity.

Figure 1: Set-up of the ELG system and retroflective markers required for MA in one participant.
RESULTS AND DISCUSSION

The mean typical error of estimate, which was the typical magnitude by which the ELG output differed from the MA system output for any given participant over an activity displacement cycle, was found to be 1.87° across walking, stair ascent, stair descent, sit to stand, and stand to sit (Table 1). With 95% statistical confidence, the typical error in this investigation was between 1.74° and 2.04°. Standardisation of this error across all activities produced a 'Trivial' difference of 0.09° between the ELG and MA systems interpreted using a modified Cohen scale.

The mean linear relationship between the ELG and MA system was found to be very high (r = 0.995) across walking, stair ascent, stair descent, sit to stand, and stand to sit (Table 1). This was found to be similar to a previous validation report that described correlations of r ≥ 0.949 between an ELG and MA system when measuring the knee angle in ten dancing movements [4].

CONCLUSION

ELG is a valid method of measuring the knee angle during activities representative of daily activity. The range is within that suggested to be acceptable for the clinical evaluation of patients with musculoskeletal conditions [2].

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REFERENCES


Table 1: Raw typical error of estimate and Pearson’s correlation coefficient r between the ELG and MA systems.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Typical error (°)</th>
<th>95% confidence interval</th>
<th>Pearson’s r</th>
<th>95% confidence interval</th>
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<tbody>
<tr>
<td>Walking</td>
<td>2.65</td>
<td>2.43</td>
<td>2.91</td>
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<td>Stair ascent</td>
<td>2.24</td>
<td>2.09</td>
<td>2.42</td>
<td>0.996</td>
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<tr>
<td>Stair descent</td>
<td>1.93</td>
<td>1.79</td>
<td>2.10</td>
<td>0.996</td>
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<td>Sit to stand</td>
<td>1.30</td>
<td>1.22</td>
<td>1.41</td>
<td>0.998</td>
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<tr>
<td>Stand to sit</td>
<td>1.25</td>
<td>1.17</td>
<td>1.34</td>
<td>0.997</td>
</tr>
<tr>
<td>Mean</td>
<td>1.87</td>
<td>1.74</td>
<td>2.04</td>
<td>0.995</td>
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<tr>
<td>SD</td>
<td>0.60</td>
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<td>0.67</td>
<td>0.004</td>
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