Estimation of In-Vivo Forces During Gait in an Ovine Stifle Joint Requires Motion Reproduction to an Accuracy of Less Than 0.5 mm

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Background

This Study - Force differences between multiple in-vivo gait cycles, perturbed by 0.5 mm in the mediolateral (ML), anterior-posterior (AP) and proximal-distal (PD) directions, test the sensitivity of motion errors on in-vivo joint, meniscal and anterior cruciate ligament loads.

Methods

In-Vivo Kinematics

Motion Analysis (accuracy 0.423±0.4 mm), n=2 Adult Suffolk-Cross Sheep

Motion Reproduction
7 Paths
I. Gait Unchanged
II. 0.5 mm Medial
III. 0.5 mm Lateral
IV. 0.5 mm Posterior
V. 0.5 mm Proximal
VI. 0.5 mm Distal
VII. 0.5 mm Anterior

Results

Table 1. Difference in joint force magnitude between unperturbed and paths perturbed 0.5 mm in three degrees of freedom, animal #1 (a = 1), animal #2 (a = 2) & Average (Avg)

<table>
<thead>
<tr>
<th>Path</th>
<th>Proximal (N)</th>
<th>Distal (N)</th>
<th>Anterior (N)</th>
<th>Posterior (N)</th>
<th>Medial (N)</th>
<th>Lateral (N)</th>
<th>Avg (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gait Uncharged</td>
<td>299±101</td>
<td>484±158</td>
<td>51±18</td>
<td>103±17</td>
<td>118±84</td>
<td>143±38</td>
<td>a = 1</td>
</tr>
<tr>
<td>0.5 mm Medial</td>
<td>234±56</td>
<td>402±90</td>
<td>59±25</td>
<td>87±17</td>
<td>54±29</td>
<td>79±42</td>
<td>a = 2</td>
</tr>
<tr>
<td>0.5 mm Lateral</td>
<td>267±75</td>
<td>345±124</td>
<td>55±21</td>
<td>145±52</td>
<td>88±36</td>
<td>111±40</td>
<td>a = 4</td>
</tr>
<tr>
<td>0.5 mm Posterior</td>
<td>213±45</td>
<td>413±102</td>
<td>45±15</td>
<td>101±45</td>
<td>118±56</td>
<td>140±38</td>
<td>a = 3</td>
</tr>
<tr>
<td>0.5 mm Proximal</td>
<td>252±64</td>
<td>420±108</td>
<td>58±23</td>
<td>106±43</td>
<td>122±53</td>
<td>147±40</td>
<td>a = 2</td>
</tr>
<tr>
<td>0.5 mm Distal</td>
<td>287±78</td>
<td>355±120</td>
<td>53±21</td>
<td>135±52</td>
<td>90±36</td>
<td>116±40</td>
<td>a = 4</td>
</tr>
<tr>
<td>0.5 mm Anterior</td>
<td>239±56</td>
<td>413±102</td>
<td>45±15</td>
<td>101±45</td>
<td>118±56</td>
<td>140±38</td>
<td>a = 3</td>
</tr>
</tbody>
</table>

Conclusions

- The effect of motion reproduction errors on tissue and joint forces is variable, depending on:
  I. Direction
  II. Position of the joint
  III. Structural properties of the joint

- Estimation of in-vivo forces during gait in an ovine stifle joint requires motion reproduction to an accuracy of less than 0.5 mm

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References: