DOES THE ELIMINATION OF THIGH MARKERS INFLUENCE THE BETWEEN-DAY VARIATION IN JOINT ANGLES?

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INTRODUCTION
Tracking the thigh with its adjacent segments (i.e pelvis and shank) may minimize the influence of motion artifact and thus provide a better estimation of any measure referenced in the thigh coordinate system. This study examined the influence of thigh tracking on the between-day variation and magnitude of knee joint motion.

METHODS
Infrared markers (Optotrak® Certus™, NDI, Waterloo, ON, Canada), were secured to one participant’s pelvis and right thigh, shank and foot. Each segment’s endpoints were located with a digitizing probe and used to define a segment-fixed (local) axis system. Motion trials were collected to compute a “functional” hip joint center (HJC) and “functional” knee joint axis (KJA) [1]. This protocol was repeated 20 times so that 20 unique LSMS could be created. On two separate occasions (reference sessions) the participant performed 3 vertical jumps.

The positions of each segment’s endpoints were described relative to a local origin (landmark located with the highest degree of reliability) so that the proximal and distal radius and segment length could be maintained when applied to the reference sessions. As a result, each unique LSM could be used with the same motion data, thus providing an opportunity to contrast two thigh tracking methods: A) using one and two digitized landmarks (DL) defined in the pelvis and shank (PS) coordinate systems, respectively, and B) using a rigid marker cluster fixed to the thigh (TH). In each instance segments endpoints were defined using anatomical landmarks. A third instance (method C) was included for comparative purposes whereby the LSM was created using functional joints (FJ) and tracked with the rigid marker cluster (as in B). Knee joint angles were calculated for each of the 20 LSMS. Between-LSM variation (2 SD) and maximums and minimums were extracted for comparison.

RESULTS
Tracking the thigh segment using landmarks defined in the pelvis and shank coordinate systems did not reduce the between-LSM variation, in comparison to the rigid cluster method (Table 1). In fact, substantial variation was noted in the abduction/adduction and internal/external rotation angles for both tracking methods when anatomical landmarks were used to define the segment endpoints (Figure 1). However, adopting the pelvis/shank tracking did impact the magnitude (Table 1) and direction of the joint angles (Figure 1); substantial differences (~ 9 degrees) were noted in the maximum and minimum joint motion in comparison to the thigh-fixed method.

DISCUSSION & CONCLUSIONS
Tracking the thigh with its adjacent segments minimizes the influence of potential motion artifact and may therefore help to provide a better estimation of the actual knee joint motion. However, this approach has no impact on the between-day variation introduced during the LSM design process, which implies that the interpretation of any between-day changes in a kinematic variable should still be made with caution. To facilitate comparisons of this nature it is recommended that LSMS be created using functionally defined segment endpoints and tracked using landmarks defined in the pelvis and shank coordinate systems.

REFERENCES

Table 1: The between-LSM variation (2 SD), max and min right knee flexion/extension, abduction/adduction and internal/external rotation angles across the 20 LSMS for methods A, B and C. The data are presented as a mean (SD) of the same 6 jump trials.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Flexion/Extension (deg)</th>
<th>Abduction/Adduction (deg)</th>
<th>Internal/External Rotation (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 SD</td>
<td>2.4 (0.1)</td>
<td>2.4 (0.5)</td>
<td>0.0 (0.0)</td>
</tr>
<tr>
<td>Max</td>
<td>5.7 (0.7)</td>
<td>6.0 (0.7)</td>
<td>5.2 (0.7)</td>
</tr>
<tr>
<td>Min</td>
<td>-103.5 (2.7)</td>
<td>-98.9 (3.7)</td>
<td>-99.6 (4.3)</td>
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</tbody>
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