FLUOROSCOPIC VALIDATION OF ELECTROGONIOMETRICALLY MEASURED FEMORAL ROLL-GLIDE MOTION IN THE KNEES OF HEALTHY AND ACL DEFICIENT SUBJECTS

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Introduction: The validity of externally applied electrogoniometers, which measure femorotibial motion indirectly by using a patellar pad, has been questioned and most of its errors are attributed to deformation of soft tissues. Fluoroscopy based analysis can accurately assess the sagittal plane knee kinematics during step ascent. This study compares the subject’s electrogoniometrically measured roll-glide motion of the femoral condyles over tibial plateau, during step ascent, with fluoroscopic techniques.

Materials and methods: Dominant knees of 10 (5 male/5 female) healthy subjects (Controls) and both knees of 10 (5 male/5 female) age, weight and height matched patients with arthroscopically confirmed unilateral ACL deficiency, were investigated. The subjects gave informed consent and the study was approved by the ethical committee. The sagittal plane knee motion was analyzed with fluoroscopy, and with an electrogoniometer system (CA-4000, OSI, USA) during single step ascent of a 21 and 23 cm high step respectively. The data of an ACL deficient subject was eliminated from the analysis due to the history and clinical findings suggestive of injury to the postero-lateral complex of the contralateral knee.

Fluoroscopy: Sagittal images were obtained at 8 frames/sec (Philips Multidagnost DSI) and digitized manually using a tablet (Océ Graphics France SA,) (Fig. 1).

Discussion: The findings indicate that sagittal plane knee translation measurements with the CA-4000 electrogoniometer are reliable. Although a line perpendicular to femoro-tibial articular surfaces at the contact point passes through the flexion axis (2), with increasing flexion, the axis lies posterior to the contact point and contributes to the overestimation in the femoro-tibial measurement. The explanation for smaller anterior movement of the femoral contact point on tibia in the first fluoroscopic image of all knees using a point where the trans epicondylar point method overestimated the movement of the femoral contact point 27%. However, redigitizing the femoral contact point on tibia in the first fluoroscopic image of all knees using a point where the distance between the femoro-tibial articulating surfaces was minimal (described by Wirth et al (1) ) corrected the overestimation.

Statistics: From the slope coefficients of the flexion displacement curve, estimated using a 2 way ANOVA design. Repeated measures ANOVA and post hoc t tests were used at a limit of p < 0.05.

Table 1 Mean ± SD femoral roll forward per degree of knee extension (mm)

<table>
<thead>
<tr>
<th>Measurements (Step ht)</th>
<th>P-T (21 cm)</th>
<th>F-T (21 cm)</th>
<th>P-T (23 cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (N=10)</td>
<td>0.20 ± 0.05</td>
<td>0.28 ± 0.04*</td>
<td>0.16 ± 0.03</td>
</tr>
<tr>
<td>ACL-NI (N=9)</td>
<td>0.18 ± 0.06</td>
<td>0.24 ± 0.04*</td>
<td>0.17 ± 0.03</td>
</tr>
<tr>
<td>ACL-I (N=9)§</td>
<td>0.15 ± 0.06</td>
<td>0.19 ± 0.05*</td>
<td>0.14 ± 0.05</td>
</tr>
<tr>
<td>All Groups</td>
<td>0.18 ± 0.06</td>
<td>0.24 ± 0.05*</td>
<td>0.16 ± 0.04</td>
</tr>
</tbody>
</table>

FLUROSCOPY GONIOMETER

Discussion: The findings indicate that sagittal plane knee translation measurements with the CA-4000 electrogoniometer are reliable. Although a line perpendicular to femoro-tibial articular surfaces at the contact point passes through the flexion axis (2), with increasing flexion, the axis lies posterior to the contact point and contributes to the overestimation in the femoro-tibial measurement. The explanation for smaller anterior movement of the femoral contact point in the injured knees could be that, after an ACL injury, the ACL plays an important role in optimally positioning the tibio-femoral articular surfaces.

Conclusion: Measurements with the CA-4000 electrogoniometer are reliable. Although a line perpendicular to femoro-tibial articular surfaces at the contact point passes through the flexion axis (2), with increasing flexion, the axis lies posterior to the contact point and contributes to the overestimation in the femoro-tibial measurement. The explanation for smaller anterior movement of the femoral contact point in the injured knees could be that, after an ACL injury, the ACL plays an important role in optimally positioning the tibio-femoral articulation.


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