Quantitative Evaluation of the Pivot Shift - Relationship to Clinical Pivot Shift Grade: A Prospective International Multicenter Study

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Objective

- Rotational laxity, or the pivot shift test, is a key to understanding the anterior cruciate ligament (ACL) function after the ACL injury and reconstruction.
- Several quantitative evaluation technologies have been developed1-4 but have not been established as a clinical tool.
- Clinical implication of the measurement results should be properly validated by multiple examiners of different backgrounds, because the pivot shift test is widely varied between examiners.5-7
- Standardized pivot shift testing procedure has been introduced and reported to improve the consistency of the pivot shift test.8

Purpose

To determine the relationship between quantitative measurement and clinical grade of the pivot shift test at four international centers.

Results

There were weak but statistically significant correlations

- Lateral translation vs. clinical pivot shift grade: r = 0.31, p<0.01
- Tibial acceleration vs. clinical pivot shift grade: r = 0.32, p<0.01

- Considering the limited number of individuals with a grade 0 and 3 pivot shift test (right), we used independent t-tests to compare the quantitative measurements between those with a grade 0 or 1 (low grade) pivot shift versus grade 2 or 3 (high grade) pivot shift.

Materials & Methods

- Seventy-three unilateral ACL injured patients at four different institutions were included.
- The standardized pivot shift testing technique was used under anesthesia while evaluating rotational knee laxity by two quantitative technologies; an accelerometer and image analysis system using iPad. (Figures below). The same procedure was performed in four sites.

![Image](image1.png)

Intraoperative quantitative measurement of the pivot shift

- Rotary laxity or pivot shift was assessed with the patient under anesthesia. A matched pair of accelerometers was positioned on the lateral side of the knee, one on the lateral tibial plateau and one on the lateral femoral epicondyle. The movement of these markers was tracked, and the lateral translation was calculated based on the positional relationship between the markers.

Accelerometer (KRA, Orthokey, Italy)

- Measure the lateral translation
- Measure the tibial acceleration

- The tibial acceleration was recorded through a Bluetooth connection to the tablet PC.

![Image](image2.png)

Automatic calculation of the lateral translation by the iPad

1. Markers are detected
2. Calculation of the lateral translation
3. Displaying the lateral translation results
4. Exporting the lateral translation results
5. Measuring the lateral translation results

- The absolute value of tibial acceleration was compared to the clinical pivot shift grade (grade 0, 1, 2 and 3). Spearman correlations were used to determine the relationship between the quantitative measurements and clinical pivot shift grade. The alpha level was set at p<0.05.

![Image](image3.png)

Comparison between high vs. low pivot shift grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>Lateral translation (mm)</th>
<th>Tibial acceleration (m/sec²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.7</td>
<td>3.1</td>
</tr>
<tr>
<td>1</td>
<td>2.4</td>
<td>4.1</td>
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<tr>
<td>2</td>
<td>3.0</td>
<td>6.0</td>
</tr>
<tr>
<td>3</td>
<td>4.0</td>
<td>-</td>
</tr>
</tbody>
</table>

Conclusion

Quantitative pivot shift measurements can consistently provide rotational laxity values in ACL injured knees.

Discussions

- Clinical grading of pivot shift is subjective and therefore is difficult to compare between different surgeons and institutions.
- By contrast, non-invasive, quantitative pivot shift measurements (tibial translation and acceleration) are simple to learn and provide comparable values across four centers around the world.
- However, there were only weak correlations between clinical grading and quantitative tests. Therefore, we propose using side-to-side comparison of quantitative pivot shift test values.
- Further research is needed to determine if the quantitative pivot shift measurements could address additional soft tissue injury in ACL injured knees.

References


Disclosure

The authors have no conflicts of interest to disclose.