

A Standardized Pivot Shift Test and Newly Developed iPad Application Can Quantify ACL Injury in Patients

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Summary:

This study introduces a new iPad application to quantify the pivot shift test. First results of clinical use in patients with ACL deficiency are presented.

Abstract:

Background:

Recently the pivot shift test can be quantified by measuring tibial translation and acceleration. Non-invasive tools include simple image analysis, which relies on tracking of the lateral knee, but is limited by motion artifacts and time-intensive post-hoc analysis. Therefore, a novel iPad application was developed for clinical use, by means of image analysis that quantifies translation in real-time. The purpose of this study was to quantify tibial translation during a standardized pivot shift test using the iPad application in patients with ACL injury. It was hypothesized that knees with a higher-grade pivot shift according to the IKDC, would display greater translation as measured by the iPad application.

Material and Methods:

The standardized pivot shift test was performed as previously described. Skin markers are attached to bony landmarks on the lateral side of the knee joint, i.e. (1) Gerdy's tubercle, (2) fibular head, and (3) lateral epicondyle. The iPad records a video of the pivot shift test and simultaneously tracks the skin markers. Tibial translation, which is the relative movement of the lateral epicondyle marker along the line between the fibular head and Gerdy's tubercle markers, is analyzed by the iPad application. The magnitude of tibial translation and reduction time of the pivot shift is calculated in real time. From May to August 2012, 34 consecutive patients underwent anatomic ACL reconstruction by the two senior surgeons. Examination under anesthesia (EUA) was performed and tibial translation during a standardized pivot shift test was recorded in both the injured and non-injured knee. A t-test was used to analyze differences in tibial translation between pivot shift grades. Significance was set at a p-value of < 0.05.

Results:

Valid data sets were recorded for 20 (59%) patients. For the remaining 14 patients, no reduction could be quantified (n=10) or excessive leg movement was falsely detected as a reduction (n=4). Intraoperative findings revealed a complete ACL rupture in all 34 patients. Standardized pivot shift testing in 20 patients revealed a grade 1 pivot shift in 10 patients with a mean anterior translation of 2.7 ± 0.6 mm and a grade 2 pivot shift in 10 patients with a mean anterior translation of 3.6 ± 1.2 mm ($p < 0.05$). The contralateral knee was clinically graded as a grade 0 in all patients and confirmed by the iPad application.

Discussion:

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This study shows that the newly developed iPad application, using simple image analysis is clinically valid when using a standardized pivot shift maneuver. The iPad application was able to classify clinical pivot shift grade according to the magnitude of tibial translation measured, thus supporting the hypothesis. Future studies will involve further development of the iPad application and a multi-center trial of clinical grading and quantification of ACL injured patients.