Anatomic ACL Reconstruction with or without Lateral Extraarticular Tenodesis Successfully Restores Postoperative Knee Kinematics Independent of Preoperative Quantitative Pivot Shift

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INTRODUCTION:

Following anterior cruciate ligament (ACL) injury, a quantitative pivot shift (QPS) test using the PIVOT technology is able to detect high- and low-grade rotatory instability.[1,2] Previously, preoperative rotatory knee laxity measured using an optical tracking system with manual load application was shown to predict postoperative rotatory knee laxity following ACL reconstruction (ACLR); however, as that study was performed with non-standardized external loads, there is potential for error to be introduced.[3] Knowledge of the effect of preoperative rotatory knee instability as measured by QPS on postoperative *in vivo* kinematics would be beneficial for treatment decision-making. We aimed to determine if preoperative QPS correlates with postoperative knee kinematics in the operative and contralateral, healthy extremity following ACLR with or without lateral extraarticular tenodesis (LET) using a highly precise *in vivo* analysis system. A positive correlation between preoperative QPS and postoperative tibial translation and rotation following ACLR with or without LET in the operative and healthy, contralateral extremity was hypothesized.

METHODS:

Twenty patients with an ACL injury (Age: 20.8 ± 6.8 years; 12 males) were randomized to undergo either isolated anatomic ACLR or anatomic ACLR with LET using either bone-patellar tendon-bone or quadriceps tendon autograft as part of a prospective randomized trial (No. NCT0291340). Under anesthesia preoperatively, lateral compartment translation during the pivot shift test was measured using the PIVOT technology.[2] To be included in this study, high-grade rotatory instability was required; this was defined as a ≥3 mm of lateral compartment translation or a side-to-side difference ≥50% using the PIVOT technology. At 6 and 12 months postoperatively, *in vivo* kinematic data was collected using dynamic biplanar radiography superimposed with high-resolution computed tomography scans of patients' knees during downhill running at 2 m/s (Figure 1). The total anterior-posterior tibial translation and internal-external tibial rotation were calculated as the maximum value subtracted by the minimum value, respectively, over the first 40% of the gait cycle (foot-strike to mid-stance). At 6 and 12 months respectively, both kinematic data and preoperative QPS was available for 16 and 14 patients, respectively. Spearman's rho was calculated to evaluate for correlation between preoperative QPS and postoperative kinematics using SPSS statistics, version 26 (IBM), with $p < 0.05$.

RESULTS:

Preoperatively, all patients were confirmed to have high-grade rotatory knee instability with a QPS of 5.0 ± 1.6 mm (mean ± SD). In the contralateral, healthy extremity, a statistically significant positive correlation was seen between preoperative QPS and total AP tibial translation at 12 months postoperatively ($r_s = 0.59$, $p < 0.05$, Figure 2). No additional statistically significant correlations were observed between preoperative QPS and total AP tibial translation or tibial rotation at 6 months postoperatively as well as tibial rotation at 12 months postoperatively for the contralateral, healthy extremity. No statistically significant correlations were observed between preoperative QPS and total anterior-posterior tibial translation, or between preoperative QPS and total internal-external tibial rotation at 6 and 12 months postoperatively for combined isolated ACLR and ACLR with LET patients as well as isolated ACLR patients or ACLR with LET patients analyzed separately.

DISCUSSION AND CONCLUSION:

The main finding of this study was that there was a statistically significant positive correlation between preoperative QPS and total AP tibial translation at 12 months postoperatively in the contralateral, healthy extremity. There were no significant correlations between preoperative QPS and postoperative in vivo kinematics at 6 and 12 months following ACLR with or without LET. These findings suggest that while PIVOT technology does correlate with *in vivo* knee kinematics, preoperative QPS does not correlate with postoperative rotatory knee instability following anatomic ACLR or anatomic ACLR with concomitant LET as there are likely other patient, injury, and surgical factors which play a role in determining postoperative knee kinematics. Therefore, anatomic ACLR with or without LET successfully restores knee kinematics postoperatively independent of preoperative instability as measured by quantitative pivot shift.

REFERENCES: [1]Musahl et al. AJSM. 2016. [2]Hoshino et al. KSSTA. 2012. [3]Signorelli et al. Scand J Med Sci Sports. 2013. [4]Anderst et al. Med Engl Phys. 2009.

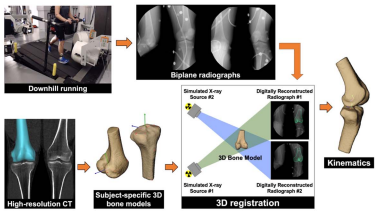

Figure 1. Flowchart of collection of *in vivo* kinematics using dynamic biplanar radiography superimposed with high-resolution computed tomography scans of patients' knees during downhill running.

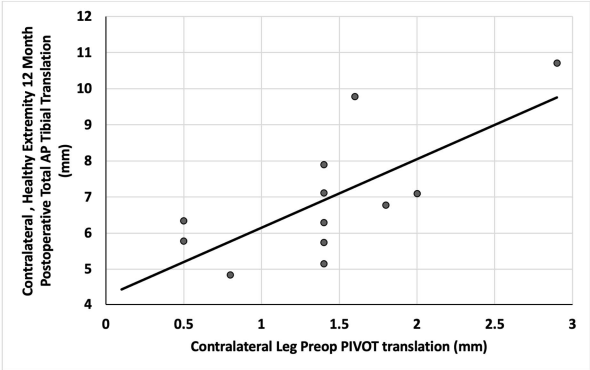

Figure 2. Statistically significant correlation ($r_s = 0.59$, $p < 0.05$) between preoperative quantitative pivot shift as measured using PIVOT technology and total anterior-posterior (AP) tibial translation at 12 months postoperatively in the contralateral, healthy extremity.