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Dynamic Knee Rotation - A Novel Way to Quantify Stability in the Gait Laboratory

Kah Weng Lai, FRCSEd (Ortho), SINGAPORE
Darren Koh, MBBS (S'pore), SINGAPORE
Erica Kholinne, MD, INDONESIA

National University Hospital
Singapore, Singapore, SINGAPORE

Summary:
After an ACL tear or reconstruction, there is no objective method to measure knee stability. Our study attempts to utilise a novel approach to assess the dynamic rotational function of the knee in the gait laboratory.

Abstract:
Background: Reconstruction of the torn ACL aims to restore the antero-posterior and dynamic rotational stability of the knee joint. The KT-1000 is commonly used as an objective measure of antero-posterior translation. However, no objective tools are available to assess dynamic rotational function. The pivot-shift test is commonly used to assess rotational stability, but suffers from low sensitivity and poor reproducibility in clinic. There is currently no quantifiable way to assess the dynamic rotation stability of ACL-reconstructed knees.

Method: This study uses a novel method to quantify the dynamic rotational stability of ACL-deficient and ACL-reconstructed knees compared to normal. Recordings of lower extremity gait patterns were captured using an established motion capture gait analysis program (Vicon Nexus) for three groups of patients - normal (10 patients), ACL-deficient (10 patients, 3-months post-injury) and ACL-reconstructed (10 patients, 1-year post-op). This was done in conjunction with floor-mounted force plates to measure the peak ground reaction force (GRF), over 3 different movement protocols. Data was collected for maximum knee rotation angle when turning, peak GFR on ground impact, knee rotation angle on ground impact and the total range of rotation. This data was compared to the subjects' other (normal) knee, as well as the subjects with intact ACLs.

Results: Preliminary results show that, although ACL-deficient patients have similar maximum knee rotation angles on turning as normal patients, there is a 15 % lower peak GRF and a 5-degree greater knee rotation angle on ground impact. As for the ACL-reconstructed subjects, they continue to demonstrate a small difference in peak GRF (1-2 Newtons lower) on ground impact compared to the normal group. More importantly, there is no increase in the knee rotation angle on impact for the reconstructed knee compared to normal subjects.

Discussion: The data so far shows that even at 1-year post-op, ACL-reconstructed patients could not achieve the same dynamic function as normal subjects. Motion capture analysis coupled with peak GRF can help to quantify the dynamic rotational function of the knee joint and therefore serve as a tool to assess and guide patients' post-op rehabilitation progress, which is especially relevant in high-level athletes. This method could eventually be expanded to be used as an objective tool to compare different ACL reconstruction techniques and graft choices.

Conclusion: Analysis of motion capture with peak GRF measurement in the gait laboratory can serve as a useful and objective tool to quantify the dynamic rotational stability of the knee joint.