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Paper #220

Anterolateral Procedures in Combination with an Anterior Cruciate Ligament Reconstruction: A Biomechanical Analysis of Commonly Used Procedures in a Cadaveric Model

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Summary:
The objective of this study was to compare knee kinematics with different techniques of LET and ALLR in combination with an ACLR.

Abstract:

Introduction

Combined intra-articular ACL reconstruction (ALCR) and anterolateral procedure have been suggested to offer an advantage in controlling anterolateral rotational instability more than an isolated ACLR, with studies displaying a clinical advantage of this combined procedure. Numerous anterolateral procedures are available, such as anterolateral ligament reconstruction (ALLR) or lateral extra-articular tenodesis (LET) using an ilio-tibial band graft. The question of which procedure best controls rotational stability with the least detrimental effect on knee kinematics remains unanswered, and direct comparisons are still lacking, leaving the surgeon to his own judgment and experience. The objective of this study was to compare knee kinematics with different techniques of LET and ALLR in combination with an ACLR. It was hypothesised that LET are more efficient than ALLR, but less physiological.

Method

A controlled laboratory study was performed using 10 fresh-frozen cadaveric knees. Kinematics from 0 to 90° of knee flexion were recorded using a Motion Analysis® 3D optoelectronic system (Vicon, LA, USA). Three conditions of rotation [neutral (NR), external (ER) and internal rotation (IR)] were successively applied to each leg with a dynamometric torque rig. Joint centres and bone landmarks were calculated from 3D bone models obtained from CT scans. Normal intact knees were initially evaluated followed by ACL transection; anterolateral complex (ALL, capsule, Kaplan fibres) transection. After ACLR, four anterolateral reconstruction procedures were performed on the same knee: ALLR; modified Ellison, deep Lemaire; superficial Lemaire and modified Macintosh. The last three procedures were randomised. For each procedure, the graft was fixed in NR at 30° of flexion, and with 20N of applied tension.

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The kinematics motion relating to each procedure was compared to the intact knee.

Results

Full kinematic analysis (0 to 90°) for IR condition demonstrated that isolated ACLR did not restore normal knee kinematic leaving a residual rotational laxity ($p<0.05$). Only the ALLR and modified Ellison procedure restored rotational kinematics to the normal intact state ($p>0.05$). Regardless of the degree of knee flexion, Macintosh, deep and superficial Lemaire overconstrained IR leading to shifted and different kinematics compared to the intact state ($p<0.05$). Further analysis showed that ACLR restored normal kinematics up to 15° of flexion ($p>0.05$). The addition of ALLR to ACLR, restored rotational kinematics to the intact state up to 40° with a divergence of kinematic curves beyond this flexion angle. The additional Ellison procedure had a nonsignificant tendency to decrease IR during 0 to 40° flexion and a lack of rotational control beyond this range. The NR and ER conditions analysis demonstrated that only Macintosh, deep and superficial Lemaire altered the kinematics with a shift in the range of motion towards external rotation.

Conclusions

Isolated ACLR failed to restore intact knee kinematics in a combined ACL plus anterolateral–injured knee, suggesting that unaddressed anterolateral injuries can lead to residual rotational laxity. Addition of either the ALLR or Ellison procedure restored native knee kinematics. MacIntosh, deep and superficial Lemaire achieved excellent rotational control, but overconstrained internal rotation leading to kinematics different to the intact state.