A BIOMECHANICAL COMPARISON OF POSTERIOR CRUCIATE LIGAMENT RECONSTRUCTIONS USING A SINGLE AND DOUBLE BUNDLE TIBIAL INLAY TECHNIQUE

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Introduction: The posterior cruciate ligament (PCL) is the primary restraint to posterior displacement of the tibia relative to the femur. It has been documented that disruption of the PCL results in significant posterior laxity of the knee and may lead to clinical instability and osteoarthritis. Most PCL reconstruction techniques utilize both tibial and femoral bone tunnels for graft placement. An alternative technique for PCL reconstruction involves placement of the bone block from the graft anatomically on the back of the tibia (Inlay technique) thereby preventing formation of an acute angle at the tibial attachment site. A more anatomic PCL reconstruction method utilizing a two-bundle graft through two separate femoral bone tunnels is currently under consideration. The objective of this study was to compare Anterior-Posterior (AP) translation of a Single Bundle (SB) and Double Bundle (DB) tibial Inlay PCL reconstruction. We hypothesized that the technique utilizing a DB graft would be biomechanically superior to the SB graft throughout the range of knee motion with regard to normal posterior tibial translation.

Methods: Four male and four female (8 total) fresh frozen cadaveric knees with an average age of 48.5 years were used (range 37–63 years). Each knee was free from abnormal knee laxity or degenerative joint disease. Specimens were mounted in a custom six-degree of adjustability fixture which did not over constrain the knee (Figure 1) A material testing machine (MTS Systems, Eden Prairie, MN) provided six sequential AP loading cycles of 100N at 1mm/s while AP translation was measured. In all cases the load-deformation curve became reproducible after two loading cycles. The testing was conducted at 90°, 60°, 30° and 10° of flexion in neutral tibial rotation.

40N of anterior Anterior Cruciate Ligament (ACL) loading was used as a reference point which was reproduced at each angle. Each knee served as its own control and was tested with an intact and transected PCL followed by both a SB and DB PCL reconstruction with the tibial Inlay technique.(Figure 2) In order to retain comparable structural and material properties for each graft, Achilles tendons were separated into two equal sections and each half was then prepared into a SB and DB graft (average age = 48 years for grafts, MTF, Edison, NJ). This created two grafts with essentially the same material properties and quantity of collagen, thus testing translational differences stemming from graft geometry and not from adding a second graft. (Figure 3) Both grafts were employed in the same knee and the order of graft reconstruction was randomized throughout the study. The anterolateral and posteromedial grafts were tensioned to 89N at 90° and 30° respectively. SB grafts averaged 9mm in diameter while each arm of the DB grafts averaged 6.5mm. The total cross-sectional area of each graft used for any single knee (SB vs. DB) was within 5%. The total AP translation from the last loading cycle was compared to the original intact knee at each of the flexion angles. The PCL deficient and reconstruction data was then compared to the initial intact knee translation. The data was analyzed using a Neuman-Keuls analysis for grouped comparisons.

Discussion: Under these testing conditions and employing the tibial Inlay technique of PCL reconstruction, no significant improvement in AP translation could be seen with the DB over the SB reconstruction. The differences between each of the graft reconstructions were not statistically different from each other nor from the stability seen in the intact knee at all flexion angles examined.

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Figure 1. Testing apparatus. Figure 2. SB and DB reconstruction.

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