Knee Lateral Extra-articular Tenodesis with Semitendinosus Graft Has Minimal Effect on Tibiofemoral Contact Pressure and Area

ABSTRACT

Background: Rotatory knee instability may persist after anterior cruciate ligament (ACL) reconstruction with concomitant injury to the anterolateral structures being a proposed cause. Several lateral extra-articular tenodesis (LET) procedures in combination with ACL reconstruction have been described in an attempt to address possible residual rotatory laxity. Concern exists that LET procedures may overconstrain the knee, as observed in biomechanical studies, possibly leading to osteoarthritis.

Purpose: To quantify the effects of LET on tibiofemoral compartment contact pressures and area, knee kinematics, as well as in situ forces in the ACL, anterolateral capsule (ALC), and the LET graft.

Methods: Nine fresh-frozen cadaveric knees were tested using a robotic system. Loads (134-N anterior tibial load + 200-N axial compression and 7-Nm internal tibial torque + 200-N axial compression) were applied for each knee state at full extension, 30º, 60º and 90º of knee flexion. Kinematic data was recorded for three knee states: intact, ALC deficiency, and LET. In situ force in the ACL was quantified using the principle of superposition. Tibiofemoral compartments contact pressures and area were measured by replaying kinematics after soft tissues were removed and pressure sensors inserted.

Results: In response to an anterior tibial load, LET reduced mean contact area in the medial compartment compared to the intact knee at 90º of knee flexion (delta 45.6 ± 54.7 kPa, -33.1% variation, P = .042) while no significant differences in the lateral compartment contact pressure or area were observed among knee states (P > .05). In response to both anterior tibial and internal tibial torque loads, no significant difference in kinematics was observed between LET and the intact knee meaning no overconstraint was observed (P > .05). In situ force in the ACL significantly decreased after LET compared to ALC deficiency at 60º (delta 65.7 ± 80.5...
29 N, -43.4% variation, P = .0204) and 90° (delta 69.5 ± 67.5N, -50.0% variation, P = .0063), in response to an anterior tibial load.

31 **Conclusions:** In this in vitro model, LET with a semitendinosus graft did not significantly overconstrain the knee nor increase pressure in the lateral compartment. Additionally, LET reduced in situ force in the ACL in the setting of ALC injury.

34 **Clinical Relevance:** In this cadaveric study, the lack of knee overconstraint without significant increases in lateral compartment pressures indicate that if a LET with semitendinosus graft is not over tensioned, morbidity to the cartilage may be of nominal concern. Additionally, reduction of in situ force in the ACL in the setting of ALC injury possibly indicates a protective effect to the ACL after LET.
INTRODUCTION

Rotatory knee instability may persist after intra-articular anterior cruciate ligament (ACL) reconstruction with some proposing concomitant injury to the anterolateral knee structures as one potential cause.\(^1\) Historically, several lateral extra-articular tenodesis (LET) procedures were described as the procedure of choice for ACL injury prior to the advent of intra-articular ACL reconstruction.\(^2\)\(^-\)\(^6\) There has been a recent resurgence of a LET procedure in combination with ACL reconstruction in an attempt to address possible residual rotatory laxity.\(^7\)\(^-\)\(^9\) However, concern exists that LET procedures may overconstrain the knee which may cause an increase in tibiofemoral contact pressures and possibly leading to accelerated knee osteoarthritis.\(^10\)\(^-\)\(^14\)

One recent biomechanical study investigated LET using a semitendinosus graft and observed overconstraint of the knee when internal rotation and simulated pivot shift loads were applied.\(^12\) However, no tibiofemoral contact pressures were measured to evaluate if the observed overconstraint would lead to an increase in tibiofemoral contact pressures. If increased contact pressures do occur, accelerated degenerative changes may ensue and therefore the addition of LET to ACL reconstructions should be performed with caution.

The purpose of this study was to quantify the effects of LET on tibiofemoral compartment contact pressures and area, knee kinematics, as well as in situ forces in the anterior cruciate ligament (ACL), anterolateral capsule (ALC), and the LET graft. It was hypothesized that LET with semitendinosus graft would overconstrain the knee, leading to an increase in contact pressure and a decrease in contact area in the lateral compartment while no changes in contact pressure or area would be observed in the medial compartment. Further, LET would decrease in situ force in the ACL back to the intact state while in situ force in the LET graft would be higher than in situ force in the native ALC.
METHODS

Nine fresh-frozen cadaveric knees (mean age 66.4; range, 43 to 93 years) were used. These were stored at -20°C and thawed at room temperature for 24 hours before testing. Each specimen was carefully examined manually, radiographically, and arthroscopically before testing to exclude specimens with (1) bony deformities, (2) ligamentous injuries, (3) meniscal injuries, (4) osteoarthritis greater than grade 2 as determined by the Kellgren-Lawrence grading scale, or (5) chondral injuries greater than grade 2 according to the International Cartilage Repair Society grading system. The femur and the tibia were cut 20 cm from the joint line, and the fibula was fixed to the tibia using a bicortical screw to maintain its anatomic position. The femur and the tibia were potted in an epoxy compound (Bondo; 3M) and secured within custom-made aluminum clamps.

The knee was mounted in a robotic testing system (MJT model FRS2010) that consists of a 6-degree-of-freedom (6-DOF) manipulator. The femur clamp was rigidly fixed to the lower plate of the robotic testing system and the tibia clamp was attached to the upper end plate of the robotic manipulator through a universal force/moment sensor (UFS; ATI Delta IP60 model SI-660-60), which is utilized to provide feedback to the controller. The system is controlled by a LABVIEW program (Technology Services Inc) designed for knee biomechanical testing and is operated in hybrid velocity-impedance control. The position and orientation repeatability of the robotic testing system are less than ±0.015 mm and ±0.01°, respectively. The measurement uncertainty of the UFS is approximately 1% of full scale (accuracy). Kinematics were defined based on the Grood-Suntay coordinate system. In short, the line through the femoral insertion sites of the lateral collateral ligament (LCL) and the medial collateral ligament (MCL) defined the flexion-extension rotation axis and medial-lateral translation axis. The long axis of the tibia defined the internal-external rotation axis and proximal-distal translation axis. The cross product of the first two axes created the third varus-valgus rotation axis and the anterior-posterior translation axis. The intact knee was flexed from full extension to 90° of knee flexion to determine the 6-DOF path of passive flexion-extension.
The positions that satisfied the condition of zero-force and zero-moment throughout the range of motion were determined as the path of passive flexion-extension.

Two loading conditions were applied to the intact knee at full extension, 30°, 60°, and 90° of knee flexion, and the resulting kinematics were recorded. The two loading conditions were (1) 134-N of anterior tibial load combined with 200-N of axial compression, (2) 7-Nm internal tibial torque combined with 200-N of axial compression. To remove the viscoelastic effect of the tissue, the specimens were cycled five times and the data of the fifth cycle was used for analysis. After loading the intact knee, the ALC was separated from the surrounding tissue as previously described (Figure 1A). The previously recorded kinematics of the intact knee were replayed while the UFS measured the new forces and moments. Next, ALC deficiency was simulated by removing a 2-cm-wide strip from anterior to the lateral collateral ligament to proximal and lateral to the Gerdy’s tubercle as previously described (Figure 1B). The previously recorded kinematics of the intact knee were once again replayed while the UFS measured the new forces and moments. By the principle of superposition, the change in the force measured before and after the removal of the ALC represented the in-situ force in the ALC. A LET was then performed, as previously published utilizing a 6-mm semitendinosus graft placed according to Kennedy et al’s anatomic description of the anterolateral ligament and fixed at 30° of knee flexion with interference screws (Figure 1C). The graft was tensioned with 20 N as a previous biomechanical study has shown that this amount of tensioning did not lead to overconstraint of the knee after MacIntosh LET. Previously recorded knee kinematics of the knee were replayed while the UFS measured the new forces and moments. The graft was then removed and previously recorded kinematics of the knee with LET were once again replayed while the UFS measured the new forces and moments. By the principle of superposition, the change in the force measured before and after removal of the graft represented the in situ force in the ALC graft (Table 1). Next, the ACL was transected and previously recorded kinematics from all knee states were replayed to calculate in situ force in the ACL at each knee state (Table 1). Lastly, all soft tissue was removed and pressure sensors
(Model 4000, Tekscan Inc.) were inserted and secured to the tibia to measure tibiofemoral medial and lateral contact pressure and area at each knee state by replaying all previously saved kinematics. The ACL was left intact during testing to simulate an ideal anatomic ACL reconstruction and to isolate the effect of the LET procedure with a semitendinosus graft, as performed in previous biomechanical studies.\textsuperscript{10}

**TABLE 1**: The Experimental Protocol and Data Acquired\textsuperscript{a}

<table>
<thead>
<tr>
<th>Step of Injury/ Knee State</th>
<th>Loading Conditions/Replays</th>
<th>Data Acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact</td>
<td>134-N ATL + 200-N AC; 7-Nm ITT + 200-N AC</td>
<td>Kinematics of the intact knee \textsuperscript{(1)}</td>
</tr>
<tr>
<td>ALC Separation</td>
<td>Replay 1</td>
<td>Force transmitted between regions of the capsule</td>
</tr>
<tr>
<td>ALC Deficient</td>
<td>Replay 1. 134-N ATL + 200-N AC; 7-Nm ITT + 200-N AC</td>
<td>In situ force in the ALC Kinematics of the knee ALC deficient \textsuperscript{(2)}</td>
</tr>
<tr>
<td>LET procedure</td>
<td>134-N ATL + 200-N AC; 7-Nm ITT + 200-N AC</td>
<td>Kinematics of the knee after LET \textsuperscript{(3)}</td>
</tr>
<tr>
<td>ALC Deficient</td>
<td>Replay 3</td>
<td>In situ force in the LET graft</td>
</tr>
<tr>
<td>ACL Deficient</td>
<td>Replay 1-3</td>
<td>In situ force in the ACL at each state</td>
</tr>
<tr>
<td>Remove all soft-tissue and insert sensors</td>
<td>Replay 1-3</td>
<td>Tibiofemoral medial and lateral compartment contact pressure and area</td>
</tr>
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</table>

\textsuperscript{a}ACL, anterior cruciate ligament; ALC, anterolateral capsule; ATL, anterior tibial load; AC, axial compression; ITT, internal tibial torque; LET, lateral extra-articular tenodesis.
Figure 1: Surgical procedure; (A) Anterolateral capsule (ALC) is separated from surrounding tissue with three incisions; (B) A 2-cm-wide strip of ALC is removed to simulate ALC deficiency; (C) Lateral extra-articular tenodesis (LET) is performed utilizing a 6-mm semitendinosus graft fixed with interference screws in 30° of flexion and neutral position.

Statistical Analysis

The data distribution was analyzed using the Shapiro-Wilk test of normality. A repeated measures analysis of variance (ANOVA) with a post-hoc Bonferroni correction was used to analyze the variations in kinematics, ALC and ACL forces and tibiofemoral medial and lateral compartments contact pressure and area at 0º, 30º, 60º, and 90º of knee flexion. A Wilcoxon signed rank test was used for non-normally distributed data. All statistical analysis was performed using SAS 9.4 (SAS, Cary, NC, USA). Significance was set at \( P < .05 \).

RESULTS

Tibiofemoral Medial and Lateral Compartment Contact Pressure and Area

In response to an anterior tibial load coupled with axial compression, LET significantly reduced mean contact area in the medial compartment compared to the intact knee at 90º of knee flexion (delta 45.6 ± 54.7 kPa, -33.1% variation, \( P = .042 \)) (Figure 2). No significant
differences in the lateral compartment contact pressure or area were observed among knee states \((P > .05)\) (Figure 3).

In response to an internal tibial torque coupled with axial compression, ALC deficiency reduced mean contact area in the medial compartment compared to the intact knee at 60º of knee flexion \((\text{delta } 26.3.6 \pm 35.1 \text{ kPa}, -13.8\% \text{ variation}, P = .047)\). ALC deficiency significantly reduced mean contact area in the lateral compartment compared to intact knee at 30º \((\text{delta } 21.3 \pm 28.0 \text{ kPa}, -16.0\% \text{ variation}, P = .023)\) and 60º of knee flexion \((\text{delta } 25.6 \pm 25.6 \text{ kPa}, -21.7\% \text{ variation}, P = .023)\) (Figure 4). No significant differences in the lateral or medial compartment contact pressures were observed among knee states \((P > .05)\).

**Figure 2**: Mean contact area in the medial compartment \((\text{mean} \pm \text{standard deviation})\) at full extension, 30º, 60º and 90º degrees of knee flexion in response to 134-N of anterior tibial load + 200-N of axial compression. \(*P < .05\). ALC, anterolateral capsule deficiency; LET, lateral extra-articular tenodesis.
Figure 3: Mean contact pressure in the lateral compartment (mean ± standard deviation) at full extension, 30°, 60° and 90° degrees of knee flexion in response to 134-N of anterior tibial load + 200-N of axial compression. ALCD, anterolateral capsule deficiency; LET, lateral extra-articular tenodesis.

Figure 4: Mean contact area in the lateral compartment (mean ± standard deviation) at full extension, 30°, 60° and 90° degrees of knee flexion in response to 7-Nm of internal tibial torque.
Kinematics

In response to an anterior tibial load coupled with axial compression, no significant difference in kinematics was observed between LET and the intact knee meaning no overconstraint was observed ($P > .05$). Yet, ALC deficiency increased internal rotation of the tibia compared to the intact knee at 90° of knee flexion (delta 5.7 ± 6.8°, 300.0% variation, $P = .0405$) and compared to the LET knee state at 90° of knee flexion (delta 5.6 ± 4.2°, 311.1% variation, $P = .0441$).

In response to an internal tibial torque coupled with axial compression, no significant difference in kinematics was observed between LET and the intact knee meaning no overconstraint was observed ($P > .05$). ALC deficiency increased medial translation of tibia compared to the intact knee at 60° (delta 2.4 ± 2.0 mm, 92.3% variation, $P = .006$) and at 90° of knee flexion (delta 3.1 ± 2.3 mm, 134.8% variation, $P = .0009$) (Figure 5). However, LET did not decrease medial translation of the tibia compared to that of the intact knee at 60° (delta 2.1 ± 2.5 mm, $P = .0147$) and at 90° (delta 2.1 ± 2.5 mm, $P = .0213$) (Figure 5). ALC deficiency increased anterior translation of the tibia compared to the intact knee at 30° (delta 1.21 ± 1.56 mm, 59.1% variation, $P = .0339$), 60° (delta 2.8 ± 3.3 mm, 133.3% variation, $P = .0135$) and 90° (delta 2.8 ± 3.3 mm, 933.3% variation, $P = .012$). LET did not decrease anterior translation of the tibia compared to the intact knee at 30° (delta 0.4 ± 0.8 mm, $P = .0285$). Additionally, ALC deficiency increased internal rotation of the tibia compared to the intact knee at 60° (delta 6.6 ± 5.9, 31.1% variation, $P = .0117$) and at 90° (delta 9.0 ± 7.1°, 45.6% variation, $P = .0117$) and compared to the LET knee state at 90° of knee flexion (delta 3.2 ± 2.1°, 12.7% variation, $P = .0234$). ALC deficiency increased valgus angulation compared to the intact knee at 60° (delta 2.0 ± 2.2°, 47.6% variation, $P = .0291$) and 90° (delta 3.6 ± 3.1°, 87.5% variation, $P = .0027$). However, LET did not decrease valgus angulation when compared to the intact knee at 60° (delta 1.9 ± 2.8, $P = .0393$) and 90° (delta 2.5 ± 3.3, $P = .0351$).
Figure 5: Medial translation of the tibia (mean ± standard deviation) at full extension, 30°, 60° and 90° degrees of knee flexion in response to 7-Nm of internal tibial torque + 200-N of axial compression. LET did not overconstrain the knee, however the procedure did not restore kinematics to the native knee state. *$P < .05$. ALCD, anterolateral capsule deficiency; LET, lateral extra-articular tenodesis.

In Situ Force in the ACL

In response to an anterior tibial load coupled with axial compression, in situ force in the ACL significantly decreased after LET compared to ALC deficiency at 60° (delta 65.7 ± 80.5 N, -43.4% variation, $P = .0204$) and at 90° of knee flexion (delta 69.5 ± 67.5 N, -50.0% variation, $P = .0063$) (Figure 6). In response to an internal tibial torque coupled with axial compression, in situ force in the ACL decreased after LET compared to ALC deficiency at 60° (delta 62.9 ± 84.9 N, -54.4% variation, $P = .0321$). No difference was observed in the in-situ force in the ACL between the intact and LET states ($P > .05$).
**Figure 6:** In situ force in the ACL (mean ± standard deviation) at full extension, 30°, 60° and 90° degrees of knee flexion in response to 134-N of anterior tibial load + 200-N of axial compression. *P < .05. ACL, anterior cruciate ligament; ALCD, anterolateral capsule deficiency; LET, lateral extra-articular tenodesis.

**In Situ Force in the ALC and in the LET graft**

In response to an anterior tibial load coupled with axial compression, no significant difference in the in-situ force in the native ALC and in the LET graft was observed (*P > .05). Yet, in response to an internal tibial torque coupled with axial compression, in situ force in the LET graft was significantly higher than in the native ALC at 30° (delta 17.6 ± 15.4 N, 43.0% variation, *P = .018), 60° (delta 44.9 ± 39.6 N, 122.0% variation, *P = .0164) and 90° (delta 52.1 ± 37.7 N, 170.8% variation, *P = .0064) (Figure 7).
Figure 7: In situ force in the ALC and in the LET graft (mean ± standard deviation) at full extension, 30º, 60º and 90º degrees of knee flexion in response to 7-Nm of internal tibial torque + 200-N of axial compression. *P < .05. ALC, anterolateral capsule; LET, lateral extra-articular tenodesis.

DISCUSSION

The main findings of the present in vitro study were that no overconstraint of the knee and no increase in contact pressure nor decrease in contact area in the tibiofemoral lateral compartment were observed after LET with a semitendinosus graft, contrary to the hypotheses. In agreement with the hypotheses, in situ force in the ACL decreased after LET while in situ force in the LET graft was higher than that of the native ALC. In this cadaveric study, the lack of knee overconstraint without significant increases in lateral compartment pressures indicate that if a LET with semitendinosus graft is not over tensioned, morbidity to the cartilage may be of nominal concern. Additionally, LET reduces in-situ forces in the ACL in the setting of ALC injury possibly providing a protective effect to the ACL. However, when evaluating knee kinematics, LET did not restore all kinematics to the intact state.

Clinical and biomechanical studies that have evaluated LET procedures have raised the concern of overconstraint of the knee, postulating that LET may lead to lateral compartment osteoarthritis (OA). One clinical study in 1990 reported chronic lateral knee pain and significant associated morbidity with extra-articular augmentation of ACL reconstruction.23
A randomized study including 72 patients with ACL injury from 2000 to 2002 had significantly worse subjective, objective, and functional results when ACL reconstruction was combined with LET (sling technique) when compared to isolated ACL reconstruction. In a separate long-term case series, 71% of patients at 24 year follow-up had moderate or severe degenerative changes on radiographs after combined intra- and extra-articular ACL reconstruction with an iliotibial band (ITB) tenodesis technique.

However, in the current study no overconstraint of the knee, based on the kinematics results, nor increase in the lateral compartment pressure was observed after LET. This result is contrary to a previous biomechanical study that evaluated the same LET procedure technique with a semitendinosus graft and compared it with the Lemaire LET (ITB graft technique). These authors observed significant overconstraint of the knee with both techniques. The difference in kinematics between studies may be due to different robotic testing systems and loading conditions applied in the previous study (5-Nm internal rotation torque at 15° increments from 0° to 90° of knee flexion, 5-Nm internal rotation torque and 10-Nm valgus torque at 15° and 30° of knee flexion and an 88-N anterior tibial load at 30° and 90° of knee flexion) compared with the present study (134-N of anterior tibial load combined with 200-N of axial compression and 7-Nm internal tibial torque combined with 200-N of axial compression). The additional axial compression applied in the present study (over twice the amount as previously reported) to simulate partial weight-bearing may generate higher frictional stress in the tibiofemoral compartments when subjected to rotatory loads and thus decreasing knee rotation in all knee states. This increase in load in the current study may prevent a significant decrease in internal rotation (i.e., overconstraint) after LET.

Another previous biomechanical study also did not observe knee overconstraint using the MacIntosh LET (central strip of ITB graft technique) which was performed with 20-N of tensioning. Yet, in the same study, when the LET was tensioned with 80-N, significant overconstraint of the knee and increase in lateral tibiofemoral compartment contact pressures were seen. In the present study, 20-N of tensioning was used based on the results of the aforementioned study. In agreement with the MacIntosh LET study, no overconstraint was
observed in the current study with 20-N tensioning. A separate biomechanical study tested LET with a semitendinosus graft to investigate the effects of different knee flexion angles of graft fixation and observed overconstraint of the knee at all knee flexion angles in which the graft was fixed. Further, a systematic review of biomechanical results of LET procedures reported that 7 of the 8 studies analyzing tibial rotation observed overconstraint of the knee in ACL-deficient knees, supporting the concern of earlier osteoarthritis after LET procedures. Yet, none of these studies in the systematic review that showed overconstraint of the knee utilized a semitendinosus graft using the specific anatomic insertion points performed in the present study.

The in-situ force in the LET graft was significantly higher than in the native ALC in the current study. A previous study has shown that forces in the ALC are minimal, especially in the longitudinal direction that would be expected in a ligament. The significantly higher force in the LET graft in the present study may offload stresses on other structures, such as the ACL. In-situ force in the ACL was found to be significantly lower after LET when compared to the ACL deficient state. This is in agreement with a previous study that also observed decreases in the in-situ force in the ACL after an LET procedure using a single-strand gracilis graft. Further, another study observed an average reduction of the in-situ force in the ACL of 43% after a modified Andrews LET (ITB tenodesis) was added to an intra-articular ACL reconstruction. Thus, LET may provide a protective effect to the ACL when the ALC is damaged. Yet, in the present study, in-situ force in the ACL after LET was not significantly lower than in the intact knee, indicating that LET does not seem to add protection to the ACL when no damage to the ALC is present. Additionally, the significantly higher forces in the LET graft compared to the native ALC could potentially lead to overconstraint of the knee after LET and to an increased pressure in the lateral compartment, although both were not observed in the present study. The addition of a LET procedure to a knee without injury to the ALC may reduce internal rotation to lower values than in the intact knee, leading to overconstraint. Further, LET did not restore knee kinematics to that of the intact knee, exhibiting that the ALC is a three-dimensional sheet of tissue that provides stability in more directions than a graft is
able to. Future studies should compare different LET procedures with different tensioning to evaluate the resultant forces on other knee structures and knee kinematics to determine whether ALC surgery has a protective or deleterious effect.

The findings of the present study and in the literature highlight that the multiple LET procedures may have unique biomechanical behaviors and therefore different results. Different testing systems, loading conditions, fixation locations, type, and tensioning of the graft and fixation angles used in biomechanical studies may all play a role in the conflicting results observed across the literature. Thus, the biomechanical results of one type of LET procedure should not be extrapolated to others. The lack of overconstraint and lack of increase in lateral compartment pressures after LET with a semitendinosus seen in the present study, may indicate that the addition of a LET procedure (when not over tensioned) may play a role. Moreover, the addition of a LET procedure to a knee without injury to the ALC could lead to overconstraint which has been reported but was not studied here. Inherent to biomechanical studies, as a time-zero analysis, the potential overconstraint of LET procedures may only be observed after LET graft is healed to surrounding tissues, which cannot be assessed by the present study. Conversely, if LET graft stretching occurs with time after reconstruction, the potential ACL protective effect may be decreased compared to time zero. LET does not restore knee kinematics to normal levels; the clinical implications of this are not known. It is also not known what implications exist if LET is performed without injury to the ALC; previous cadaveric studies have shown overconstraint may occur. Further clinical studies are needed to evaluate the mid- and long-term outcomes of LET for rotatory knee instability, specifically its effect on ACL graft rupture and other knee structures. This should precede the widespread use of the procedure.

LIMITATIONS

One limitation of the current study is the age of donor specimens (mean age: 66.4 years) was older than the population who typically undergo LET procedures. Yet, a thorough
evaluation of each specimen prior to testing ensured that there were no gross degenerative
changes in the tissue. Inherent to biomechanical studies, a time-zero analysis does not
account for tissue healing and possible effects on knee kinematics and forces. The amount of
axial compression possible in this and all robotic studies is less than in vivo activities such as
walking or running, however the current study used over twice the amount of axial
compression and higher amounts of torque and translation then what has previously been
reported. Therefore, with higher tibiofemoral contact pressures seen in vivo, results may differ.

CONCLUSIONS

In this in vitro model, LET with a semitendinosus graft did not significantly
overconstrain the knee nor increase pressure in the lateral compartment. Additionally, LET
reduced in situ force in the ACL in the setting of ALC injury.
REFERENCES


