The ability of isolated and combined ACL reconstruction and/or ‘monoloop’ lateral extra-articular tenodesis to restore intact knee laxity in the presence of isolated and combined injuries in-vitro.

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Study
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Study

• This controlled laboratory study examined
  • The influence on knee laxity after sequentially sectioning different structures
    • Anterior cruciate ligament (ACL)
    • Anterolateral ligament (ALL)
    • Harvesting a iliotibial band (ITB) midportion strip
    • Releasing the deep fibers of the ITB (Kaplan fibers)
  • The effect of the reconstructions on the laxity
    • ACL reconstruction alone, with hamstring tendon grafts
    • ACL reconstruction in combination with a ‘monoloop’ lateral extra-articular tenodesis
    • Isolated ‘Monoloop’ lateral extra-articular tenodesis without ACL reconstruction
'Monoloop’ lateral extra-aticular tenodesis

During the section phase a midportion ITB strip is harvested. The attachment to Gerdy’s tubercle is preserved (1) and an ITB strip of 10 x 150 mm is taken.

When performing the monoloop procedure, the tibia is locked in the initial neutral rotation at 60° of flexion, the ITB strip is routed deep to the LCL (2) and fixed with a 12 x 23 mm staple on the distal and posterior aspect of the femoral shaft, and proximal to the endobutton ACL fixation device on the lateral cortex of the femoral shaft (3).

Based upon a previous study, this tenodesis was fixed at an applied tension of 20 N ¹ (4)
Methods

• 12 cadaveric left knees
• Installed in a 6 degrees of freedom rig using an optical tracking system to record the kinematics through 0° to 100° of knee flexion with different forces applied
  • No load
  • Anterior drawer (90N)
  • Posterior drawer (90N)
  • External rotation (5Nm)
  • Internal rotation (5Nm)
  • Combined anterior drawer (90N) and internal rotation (5Nm).
• The knees were sequentially tested in intact state and the different states of injury and reconstructions
• Statistics
  • Two-way repeated-measures analyses of variance were used to compare the laxity data across knee states and flexion angles.
  • When differences were found between knee states, paired t tests with Bonferroni correction were performed.
Response to a 90-N anterior drawer force

- Cutting the ACL significantly increased anterior translation laxity by a mean of 4 to 7 mm compared to the intact knee at all flexion angles (p<0.01 from 0-90°, p=0.013 at 100°).

- Further sectioning of the ALL increased anterior translation laxity by <1 mm, significant at 20-30° knee flexion compared to the ACL-deficient knee (p<0.05).

- Harvesting the midportion ITB strip did not affect anterior translation laxity significantly.

- Additional sectioning of the deep ITB significantly increased anterior translation laxity by up to 3 mm, significant at 40° to 100° flexion compared to the ACL and ALL-deficient knee (p<0.05).

- After the cutting stages, the knees with combined soft-tissue damage were significantly more lax in tibial anterior translation than the intact knee, by 7 to 10 mm across 0 to 100° flexion (p<0.004).
Response to a 5-Nm internal torque

- Cutting the **ACL** did **not** increase tibial internal rotation laxity significantly compared to the intact knee at any flexion angle (mean changes 1° to 4°).

- Further sectioning of the **ALL** did **not** increase tibial internal rotation laxity significantly compared to either the intact knee or the ACL-deficient knee at any flexion angle, with mean changes <1°.

- Harvesting the **midportion ITB strip** increased tibial internal rotation laxity significantly when compared to the ACL plus ALL-deficient state at 90° and 100° flexion (mean changes <2°), and the knee was now significantly more lax than when intact across the range 20°-100° flexion.

- Additional *sectioning of the deep ITB* significantly increased internal rotation laxity at 20° to 100° flexion compared to the ACL and ALL-deficient knee (p<0.012), with a maximum mean change of 5° at 70° knee flexion.

- Thus, after the cutting stages, the knees with combined soft-tissue damage were significantly more lax in tibial internal rotation than the intact knee, across 10° – 100°, p<0.017, with mean laxity increases of 4° to 7°.
Response to combined anterior drawer and internal torque

Cutting the ACL significantly increased anterior translation laxity compared to the intact knee from 0-60° flexion (p<0.05), but did not increase internal rotation.

Cutting the ALL did not change either the anterior translation or internal rotation at any angle of knee flexion (p>0.05).

Sectioning the deep ITB significantly increased both anterior translation laxity and internal rotation at 20° to 100° and 30° to 100°, respectively (p<0.05) compared to the ACL and ALL-deficient knee.
Response to a 90-N anterior drawer force

• After isolated ACL reconstruction, anterior translation laxity did not differ significantly from the intact knee at any angle of knee flexion from 0 to 100° (p>0.053), with residual changes from 1 to 3mm.

• Addition of the ‘Monoloop’ lateral extra-articular tenodesis to the ACL reconstruction maintained anterior translation laxity that did not differ significantly (P> 0.085) from the intact values at all angles of knee flexion examined.

=> ACL + MONOLOOP restores normal anterior translation stability
Response to a 5-Nm internal torque

- After the isolated ACL reconstruction, significant differences remained in internal rotation at 30° to 100° knee flexion ($p<0.008$)

- With the combined ACL reconstruction plus Monoloop lateral extra-articular tenodesis, there were no significant differences in internal rotation compared to the intact knee. Thus, there was a significant decrease in internal rotation laxity after monoloop tenodesis compared to isolated ACL reconstruction at 20° to 100° knee flexion ($p<0.01$), and the combined procedure had not overconstrained the internal rotation compared to the intact knee at any angle of knee flexion.

- \[\text{=> ACL + MONOLOOP restores normal rotational stability}\]
Reconstruction states - Graphics

Tibial anterior translation in response to a 5-Nm internal torque combined with a 90-N anterior drawer force

Change of tibial internal rotation in response to a 5-Nm internal torque combined with a 90-N anterior drawer force

- After isolated ACL reconstruction there were still significant differences compared to the intact knee in anterior drawer at 30°-100° flexion (p<0.035) and internal rotation at 20°-100° flexion (p<0.042).

- With combined anterior drawer and internal torque, after additional Monoloop’ tenodesis no significant differences remained in anterior drawer or internal rotation compared to the intact knee.

- There was significant decrease in anterior laxity after adding the ‘Monoloop’ tenodesis compared to the isolated ACL reconstruction at 20°-80° flexion (p<0.027), and internal rotation at 20°-100° flexion (p<0.016).

- Without the ACL graft, the knee with an isolated monoloop lateral tenodesis remained significantly more lax in anterior translation than the native knee throughout 0-100° knee flexion (p<0.009) and in internal rotation from 30-100° (p<0.020).
Conclusion

• This study found that cutting the **deep fibers of the ITB** caused large increases in **tibial internal rotation laxity** across the range of knee flexion, while cutting the ALL did not.

• In case of an ACL deficiency combined with increased rotational laxity caused by cutting both the ALL and deep fibers of the ITB, an **ACL reconstruction alone** was insufficient to restore normal knee laxity.

• However, adding a ‘**Monoloop**’ lateral extra-articular tenodesis procedure restored the **normal knee laxity**.
References


