Fixed-versus Adjustable-Loop Femoral Cortical Suspension Devices for Anterior Cruciate Ligament Reconstruction: A Systematic Review and Meta-Analysis of Biomechanical Studies

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Introduction

- Biomechanical studies simulating ACLR have demonstrated a difference in load to failure and graft displacement between fixed- and adjustable-loop femoral cortical suspensory devices.
- Compared to fixed-loop devices, adjustable-loop devices provide technical advantages, but may be more likely to lengthen during cyclic loading during the early postoperative period.
The purpose of this systematic review and meta-analysis was to compare biomechanical outcomes of fixed- versus adjustable-loop femoral cortical suspensory devices in studies simulating ACLR using an isolated device and/or specimen set-up using porcine femora and bovine flexor tendons.
Methods

- Systematic review and meta-analysis
- Comparing the biomechanical strength of fixed-loop and at least one of two adjustable-loop cortical suspension devices for ACLR using isolated device and/or specimen set-ups using porcine femora and bovine flexor tendons
- Data analyzed: Displacement during cyclic loading, ultimate load to failure, modes of failure
- Meta-analysis: random-effects model used to estimate summary measures for each biomechanical test data and device comparison
Six studies were identified that met the inclusion criteria

- 76 fixed-loop devices (Endobutton CL)
- 120 adjustable-loop devices (ToggleLoc with ZipLoop; TightRope RT).
Results

- Load to failure was significantly different ($P < 0.0001$), with the strongest fixation device being the ToggleLoc with ZipLoop adjustable-loop device ($1443.9 \pm 512.3$ N), compared with the Endobutton CL fixed-loop device ($1312.9 \pm 258.1$ N; $P = 0.04$) and the TightRope RT adjustable-loop device ($863.8 \pm 64.7$ N; $P = 0.01$).
- Mode of failure was statistically different between the 3 groups ($P = 0.01$), with suture failure accounting for 83.8% of TightRope RT devices, 69.4% of ToggleLoc with ZipLoop devices, and 60.3% of Endobutton CL devices.
### Results

Cyclic displacement was significantly different, with Endobutton CL (3.7 ± 3.9 mm) showing the least displacement, followed by ToggleLoc with ZipLoop (4.9 ± 2.3 mm) and TightRope RT (7.7 ± 11.1mm) (P < 0.0001).

<table>
<thead>
<tr>
<th>Study, Year, Model</th>
<th>Displacement: ECL vs TLZ</th>
<th>SMD [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrow, 2014, Isolated Device</td>
<td>-16.42 [-23.09, -9.75]</td>
<td></td>
</tr>
<tr>
<td>Johnson, 2015, Isolated Device</td>
<td>-2.08 [-3.27, -0.84]</td>
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<tr>
<td>Petre, 2013, Isolated Device</td>
<td>-7.45 [-9.91, -4.95]</td>
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<tr>
<td>Nye, 2017, Specimen</td>
<td>-1.86 [-2.91, -0.81]</td>
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<tr>
<td>Petre, 2013, Specimen</td>
<td>-1.87 [-2.92, -0.82]</td>
<td></td>
</tr>
<tr>
<td>RE Model</td>
<td>-5.25 [-9.95, -0.55]</td>
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</tbody>
</table>

ECL vs TLZ p = 0.03

<table>
<thead>
<tr>
<th>Study, Year, Model</th>
<th>Displacement: ECL vs TRT</th>
<th>SMD [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrow, 2014, Isolated Device</td>
<td>-0.31 [-13.21, -5.42]</td>
<td></td>
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<tr>
<td>Chang, 2017, Isolated Device</td>
<td>-2.94 [-4.57, -1.30]</td>
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<tr>
<td>Eguchi, 2014, Isolated Device</td>
<td>-2.28 [-3.49, -1.15]</td>
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<tr>
<td>Johnson, 2015, Isolated Device</td>
<td>-1.98 [-3.18, -0.79]</td>
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<tr>
<td>Petre, 2013, Isolated Device</td>
<td>-4.28 [-5.86, -2.69]</td>
<td></td>
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<tr>
<td>Chang, 2017, Specimen</td>
<td>-0.25 [-1.39, 0.88]</td>
<td></td>
</tr>
<tr>
<td>Eguchi, 2014, Specimen</td>
<td>-0.27 [-1.15, 0.61]</td>
<td></td>
</tr>
<tr>
<td>Nye, 2017, Specimen</td>
<td>-0.03 [-0.90, 0.85]</td>
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<tr>
<td>Petre, 2013, Specimen</td>
<td>-2.12 [-3.21, -1.02]</td>
<td></td>
</tr>
<tr>
<td>RE Model</td>
<td>-2.21 [-3.60, -0.82]</td>
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ECL vs TRT p = 0.002
The most important finding from this study is that the ECL fixed-loop device, on average, displaced significantly less than both the TRT and TLZ adjustable-loop devices.

However, the TLZ adjustable-loop device demonstrated the highest ultimate load to failure.

It is important to note that all devices had failure loads much higher than would be expected on the ACL graft during the early rehabilitation period.
Limitations

- Although biomechanical data is useful, recent studies suggest that fixed-loop and adjustable-loop devices result in similar clinical outcomes. This conclusion may be more important when deciding which fixation device is superior.
- Despite the high level of heterogeneity of the included studies, which limits the ability to draw strong conclusions from these data, this study does provide some insight into the advantages and disadvantages of these different devices and encourages further clinical studies on this topic.
Current biomechanical data suggest that the ToggleLoc with ZipLoop device is the strongest fixation device at “time zero” in terms of ultimate load to mechanical failure. However, the Endobutton CL device demonstrated the least cyclic displacement, which may be a more clinically applicable measure of device superiority.


Thank You

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