Is Blood Flow Restriction Training Superior for the Limitation of Hamstring and Quadriceps Atrophy After Anterior Cruciate Ligament Reconstruction? A Review of Randomized Controlled Trials

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Introduction

- Post operative recovery from Anterior Cruciate Ligament Reconstruction (ACLR) includes extensive rehabilitation of 6-9 months with return to sport/activity at 12 months
- Rehabilitation is initiated shortly following surgery to limit quadriceps and hamstring atrophy, maximizing long term tibiofemoral joint stability and functional outcomes.
- The best way to improve muscle strength and prevent atrophy is progressive overload training, however, these activities cannot be performed post-operatively without risk to the reconstructed knee.
- Blood Flow Restriction Training (BFR) involves impairing the blood supply for short periods through the use of an air-filled blinder or cuff to restrict the venous drainage of the region.
- BFR allows the surgically repaired limb to be safely stressed after ACLR without added reinjury potential of progressive overload training.
- BFR achieves this elevated stress via systemic muscle production, cell swelling, production of reactive oxygen species, and increased fast-twitch fiber recruitment along with stimulation of anabolic and anti-catabolic cell signaling pathways, particularly the mTOR (mammalian target of rapamycin) protein kinase pathway.
- There is inconsistency of methods, outcome measures and results in literature comparing the outcomes of BFR vs Traditional Post-Operative Rehabilitation (TPR).

Objectives

- Determine if BFR limits atrophy of quadriceps & hamstring muscles during early recovery from ACLR better than TPR.
- Discover if BFR is an appropriate alternative or addition to TPR following ACLR.
- Establish recommendations for use of BFR following ACLR.

Methods

- Literature search was completed in December 2021 across multiple journal databases: Cochrane, EMBASE, PubMed, Scopus, Medline, Essential Evidence, and Web of Science.
- Level I & level 2 randomized controlled trials (RCTs) pertaining to BFR training after ACLR were included in the review.
- Only studies which used knee flexion and extension muscle strength as measure of strength and atrophy prevention were included to maximize consistency among included studies.
- Terms included “cruick:at + occlusion”, “cruick:at blood flow restriction”, and “cruick:at + occlusion training”.

Results

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Subjects</th>
<th>Average Age</th>
<th>Results</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>León et al (2003)</td>
<td>22 subjects</td>
<td>18-34 y/o</td>
<td>BFR better than TPR at limiting atrophy &amp; preserving strength</td>
<td>The highest-quality level I RCTs evaluating KE andKF strength via isokinetic torque agree that BFR limits post-operative losses of KE and KF strength while providing similar or improved knee pain and function.</td>
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<tr>
<td>Hughes et al (2019)</td>
<td>24 subjects</td>
<td>22-36 y/o</td>
<td>No difference KE torque between any of the 4 groups</td>
<td>Single level II trial suggests that BFR is similar to TPR for improving KE and KF torque.</td>
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<tr>
<td>Curran et al (2020)</td>
<td>34 subjects</td>
<td>16-30 y/o</td>
<td>No difference KE torque between any of the 4 groups</td>
<td>All included studies agree that BFR is safe for use in the setting of post-operative ACLR.</td>
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References


Conclusions

- Two level 1 studies with training protocols of 8 and 16 weeks and one level 2 study met inclusion criteria.
- Ohta et al (2003) is a level 1 RCT that compared knee flexion (KF) and knee extension (KE) torque in an experimental BFR group versus a load TPR control. Data showed BFR training yielded significantly greater KE and KF than TPR group.
- Hughes et al (2019) is a level 1 RCT that compared KE and KF extension KE torque in an experimental BFR group versus a heavy-load TPR control. Data showed BFR training yielded significantly greater KE and KF than TPR group.
- Curran et al (2020) is a level 2 RCT that compared KE torque between 2 experimental BFR groups and 2 control TPR groups. Each group performed 5 sets of 10 single leg squats. Each group was differentiated by whether they participated in BFR or TPR and whether they performed eccentric or concentric single leg squats. KE torque gathered via isokinetic device showed no significant difference between the BFR and TPR groups.