INTRODUCTION

Knee injuries are one of the most prevalent pathologies in sport. It is estimated that 100,000 – 250,000 ACL injuries occur per year.1 It is common for patients to struggle with quadriceps strength impairment as high as 18% by two years post ACL repair.2,3,4 Quadriceps strength is strongly associated with athletic performance and likelihood of re-injury after ACL repair.4,5,6,7,8,9,10,11. Quadriceps strength deficits are also documented after other arthroscopic procedures and the presence of knee effusion.9,10,11,12,13. Blood flow restriction (BFR) training is an intervention gaining popularity in rehabilitation. BFR can improve strength and hypertrophy measures with loads as low as 20% of 1RM1. This makes BFR an ideal intervention when heavier loads are contraindicated.

OBJECTIVES

The purpose is to determine whether BFR training improves relevant measures of the quadriceps musculature after arthroscopic surgical procedures of the knee.

METHODS

Search Strategy:
Terms Used to Guide Search Strategy:
- Blood flow restriction
- Knee surgery
- Knee arthroscopy
- Anterior cruciate ligament
- Kaatsu training
- Occlusion training

Sources of Evidence Searched:
- EBSCoHost
- MEDLINE
- PubMed
- SPORTDiscus

Inclusion Criteria:
- Study must utilize the blood flow restriction training
- Study must involve arthroscopic knee surgery
- Study must make measurements pre and post BFR intervention
- Study must compare measures pre and post BFR intervention

Exclusion Criteria:
Studies were excluded if they did not utilize blood flow restriction training, utilized other knee surgical interventions (e. Total knee arthroplasty), or did not report on outcomes specific to the quadriceps musculature.

RESULTS

Five of six articles included in this review support the utilization of BFR to improve post-op quadriceps measures. All five articles demonstrated a significant improvement in at least one quadriceps outcome. All studies consisted of small sample sizes, there was inconsistent initiation of BFR, and little consistency in protocols. There was variability among outcomes measured across the studies.

CONCLUSION

The current evidence does support utilizing BFR training to improve quadriceps measures after arthroscopic knee surgery. It is well known that quadriceps are subject to the effects of arthrogenic muscular inhibition post-operatively, resulting in potential long term function and performance deficits. It appears at this point that BFR is more effective compared to controls to improve affected quadriceps.

LEVEL OF RECOMMENDATION

Level B

ANALYSIS

Assessed quality of articles after search criteria were met revealed 6 good articles. 105 subjects were included in the 6 reports. All subjects underwent arthroscopic knee surgery prior to BFR treatment. Documented outcomes included knee torque, thigh cross sectional area, thigh girth, patellar reported outcomes, muscle fiber diameter, and manual muscle testing. Data extraction is presented in the accompanying table.

REFERENCES

1. Erik Arve ATS, PT, DTP CSCS, USAW, Aric Warren EdD, ATC, CSCS, CES

Does Blood Flow Restriction Training Improve Quadriceps Measures After Arthroscopic Knee Surgery? A Critically Appraised Topic

Relevant Measures

<table>
<thead>
<tr>
<th>Ref Citation</th>
<th>Demographics</th>
<th>Methods and intervention</th>
<th>Outcome Measures and Results</th>
<th>Statistical Analysis</th>
<th>Results key findings and validity</th>
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<tbody>
<tr>
<td>1. Otto et al.</td>
<td>46 subjects; age 29 (18-</td>
<td>3R groups performed same rehab exercise for 3 weeks. Intervention: Increase at proximal thigh. 180 mm Hg for rehab. No BFR.</td>
<td>Muscular torque knee ext:</td>
<td>p=0.05</td>
<td>Comparison between groups pre-surgery vs. square root. Comparison of outcome measures vs. Mann-Whitney U-test. Utilization of BFR post ACL repair. Knee flexion and cross sectional size of femoral musculature. It does not appear to significantly affect fiber size for type 1 or 2 fibers. Valid results due to compliance, appropriate study design, and population.</td>
</tr>
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<td>2. Takahashi et al.</td>
<td>16 subjects; 8 RFR group (age 22-4 ( \pm ) 2) &amp; 8 control group (14 ( \pm ) 2). All post ACL repair. Physical characteristics similar between groups.</td>
<td>RCT: Intervention; Increase at proximal thigh. Progression increase in pressure from 180 mm Hg to 220 mm Hg. Increase 5 min. Every 3 min for 5 sets. Performed 2x/day (9am and 2pm). Control: Followed same protocol as RFR group but did not inflate cuff. Experimental period lasted 2 weeks.</td>
<td>Cross sectional area of knee flexors:</td>
<td>p&lt;0.05</td>
<td>Comparison between groups vs. Wilcoxon signed-ranks test. Utilization of BFR reduces the rate of quadriceps atrophy, but no hamstring atrophy. The ACL repair improves knee girth and favors knee extensor function.</td>
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<td>3. Trentham et al.</td>
<td>17 subjects; 18-49 yrs, 12 RFR group and 5 control group. All subjects underwent arthroscopic knee surgery.</td>
<td>RCT; 3R groups performed same rehab protocol for 12 sessions Intervention: Increase at 80% BFR maximum pressure, BFR for 3 additional leg exercises, leg ext, concentric press, 30% 1RM, 60/15/15/15 protocol. Control: went through standard program to intervention group.</td>
<td>Cross sectional area of quadriceps:</td>
<td>-no significant difference after intervention period (p=0.625)</td>
<td>-Descriptive data presented as mean ( \pm ) standard deviations. Comparison between groups made with parametric unpaired t-tests. No p-value reported but no outcomes are of concern. Utilization of BFR improves thigh girth and favors knee extensor function.</td>
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<td>4. Ithurburn et al.</td>
<td>26 subjects; 18-49 yrs, 12 RFR group and 13 control group. All subjects underwent arthroscopic knee surgery.</td>
<td>RCT; Rehab protocol 2x/day for 16 days. Intervention: Increase at 80% BFR maximum pressure, progression increase in pressure from 180 mm Hg to 220 mm Hg. Increase 5 min. Every 3 min for 5 sets. Quadriceps exercises performed during 3 min occlusion. Control: Followed same protocol but no BFR.</td>
<td>Cross sectional area of quadriceps:</td>
<td>-no significant difference after intervention period (p=0.625)</td>
<td>-Descriptive data presented as mean ( \pm ) standard deviations. Comparison between groups made with parametric unpaired t-tests. No p-value reported but no outcomes are of concern. Utilization of BFR improves thigh girth and favors knee extensor function.</td>
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<td>5. Trentham et al.</td>
<td>3 subjects; 1. 21 yo female college athlete, 2. 30 yo active duty female soldier, and 3. 27 yo active duty male soldier. All subjects underwent arthroscopic knee surgery.</td>
<td>Case Series; Various lengths of intervention (2 weeks). Various BFR exercises were used to address specific needs of each pt, though all included a leg press. Case Series utilized 30% BFR and performed 4 sets of each exercise to failure. No exercises were set at BFR limb occlusion pressure.</td>
<td>Peak torque knee ext deficit (17 degrees/cm);</td>
<td>-p&lt;0.05</td>
<td>Comparison between groups post vs. pre. Utilization of BFR improves thigh girth and favors knee extensor function after ACL/ligament surgery.</td>
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<td>6. Loh et al.</td>
<td>10 yo female high school soccer player. Left ACL repair and lateral meniscus repair.</td>
<td>Case Study; 18 sessions were performed over 8 weeks. Thigh BFR set at 80% BFR maximum pressure. 30/15/15/15 protocol utilized for all exercises. BFR was performed in conjunction with的形式。</td>
<td>Muscular torque knee ext:</td>
<td>-p&lt;0.05</td>
<td>Comparison between groups post vs. pre. Utilization of BFR improves thigh girth and favors knee extensor function after ACL/ligament surgery.</td>
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