Oklahoma State University / Athletic Training

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

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## 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[3]. It is common for patients to struggle with quadriceps strength impairment as high as 18% at two years post ACL repair[11]. Quadriceps strength is strongly associated with athletic performance and likelihood of re-injury after ACL repair [4,5,10,12,13,19]. Quadriceps strength deficits are also documented after other arthroscopic procedures and the presence of knee effusion [2,8,14,18]. 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 1RM[1]. 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 involve the utilization of blood flow restriction training
- Study must involve arthroscopic knee surgery
- Study must utilize at least one quadriceps measurement in the outcomes
- Study must compare measurements pre and post BFR intervention

**Exclusion Criteria**

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

| Ref Citation | Demographics | Methods and Intervention | Outcome Measures and Results | Statistical Analysis | Results Key Findings and Validity |
|---|---|---|---|---|---|
| **1. Ohta et. al.** [9] | 44 subjects; avg age 29 (18-52); 22 in BFR group, 22 in control group. Pts were all post ACL repair. No sig difference pre/post op. | RCT;<br>Both groups performed same rehab exercises for 16 weeks<br>Intervention: tourniquet at proximal thigh, ~180 mm Hg for rehab<br>Control: No BFR | -Muscular torque knee ext:<br>concentric at 60 and 180 degrees/s (p<.001 & p=.004) and isometric at 60 degrees (p<.001) all significant<br>-Muscular torque knee flex:<br>concentric at 60 and 180 degrees/s (p<.005 & p=.004) and isometric at 60 degrees (p<.02) all significant<br>-Cross-sectional area of femoral musculature:<br>Significant difference for BFR (p=.04)<br>-Single fiber diameter: No significant difference in type 1 or type 2 fibers, but trend favored BFR group. | -P<.05<br>-Comparison between groups pre-surgery w/ Chi square test.<br>-Comparison of outcome measures w/ Mann-Whitney U-test. | -Utilization of BFR post ACL repair improves knee ext/flex strength and cross sectional size of femoral musculature. It does not appear to significantly affect fiber size for type 1 or 2 fibers.<br>-Valid results due to compliance, appropriate study design, and population. |
| **2. Takarada et. al.** [15] | 16 subjects; 8 in BFR group (age 22.4 +/- 2.1) & 8 in control group (23.0 +/- 2.5). Pts were all post ACL repair. Physical characteristics similar between groups | RCT;<br>Intervention: tourniquet at proximal thigh, progressive increase in pressure from 180 mm Hg. Occlusion 5 min, remove 3 min for 5 sets. Performed 2x/day (9am and 2pm)<br>Control: Followed same protocol as BFR group but did not inflate cuff.<br><br>Experimental period lasted 2 weeks | Cross sectional area of knee extensors:<br>significantly less decrease in CSA favoring BFR group (p=.046)<br>Cross sectional area of knee flexors: No significant difference in decrease in CSA (p=.69)<br><br>*Both groups demonstrated decreases in CSA | -P<.05<br>-Comparison between groups w/ Mann-Whitney U-test<br>-Pre-post study comparisons w/ Wilcoxon signed-ranks test | -Utilization of BFR retards the rate of quadriceps atrophy, but no hamstrings atrophy, after ACL repair.<br><br>-Validity should be questioned due to small sample size and P value was also very close to .05. |
| **3. Tennent et. al.** [16] | 17 subjects; 18-65 yo, 10 BFR group and 7 in control group, 2 wks non-reconstructive knee arthroscopy | RCT;<br>Both groups performed same rehab protocol for 12 sessions<br>Intervention: tourniquet set at 80% limb occlusion pressure, BFR for 3 additional leg press, leg ext, reverse press, 30% 1 RM, 30/15/15/15 protocol<br>Control: work matched program to intervention group. | Thigh girth: Significant improvement w/ BFR vs exercise alone (P=.0069)<br>Performance measures: KOOS and VR-12 not significant between groups<br>Pt-reported measures: Self selected walking v, sit to stand, 4 square step, and timed stair ascent not significant but favored BFR<br>Knee ext and flex torque: no significant difference but favored BFR (removed 1 outlier and BFR sig diff for ext, p=.034) | -P<.05<br>-Descriptive stats, 2-tailed t test, and ANOVA tests used for normally distributed data.<br>-Grubb test used for outliers.<br>-Nonparametric data w/ Wilcoxon signed-rank test | -Utilization of BFR improves thigh girth and favors knee ext strength.<br><br>-Validity should be questioned due to small sample size. |
| **4. Iverson et. al.** [6] | 24 subjects; 18-40 yo, 12 BFR group and 12 control group. Pts post-op ACL repair. No significant difference at baseline. | RCT;<br>Rehab protocol 2x/day for 16 days.<br>Intervention: tourniquet at proximal thigh, progressive increase in pressure from 130 mm Hg. Occlusion 5 min, remove 3 min for 5 sets. Quadriceps exercises performed during 5 min occlusion.<br>Control: Followed same protocol but no BFR. | Cross sectional area of quadriceps: No significant difference after intervention period (p=.6265) | -Descriptive data presented as means +/- standard deviations.<br>-Comparisons between groups made w/ parametric unpaired t-test<br>-No P value reported but no outcomes are <.05 | -Utilization of BFR does not improve quadriceps CSA post ACL repair.<br><br>-Validity should be questioned due to small sample size and lower than expected cuff pressure at start of experiment. |
| **5. Tennent et. al.** [17] | 3 subjects;<br>1. 21 yo female college athlete, 2. 30 yo active duty male soldier, and<br>3. 27 yo active duty male soldier.<br>All subjects underwent arthroscopic knee surgery. | Case Series;<br>-Various lengths of intervention (2-4wks)<br>-Various BFR exercises were used to address specific needs of each pt, though all included a leg press.<br>-Exercises utilized 30% 1RM and performed 4 sets of each exercise to failure<br>-Tourniquets were set at 80% limb occlusion pressure | Peak torque knee ext deficit (90 degrees/s):<br>1.Initial 74.3% Final 49.95%<br>2.Initial 25.4% Final 13.69%<br>3.Initial 63.6% Final -14.36%<br>Peak torque knee flex deficit (90 degrees/s):<br>1.Initial 27%, Final -10.7%<br>2.Initial 42.6% Final -186.18%<br>3.Initial 55.3% Final 1.44%<br><br>*Negative values indicate increased strength measures | Final improvements and deficits were calculated in percentages but no between group comparisons could be made. | -Utilization of BFR may improve knee flexion and extension peak torque in 2-4 weeks after knee arthroscopy.<br><br>-Validity should be questioned as these are single subject studies. |
| **6. Lafont et. al.** [7] | Single Subject;<br>16 yo female high school soccer player. Left ACL repair and lateral meniscus repair | Case Study;<br>-18 sessions were performed over 8 weeks<br>-Tourniquet set at 80% limb occlusion pressure.<br>-30/15/15/15 protocol utilized for all exercises.<br>-BFR was performed in conjunction with NMES as well. | The following improvements are reported after the 8 weeks of interventions:<br>-abolishment of extensor lag<br>-Thigh girth improved from 40cm to 42cm<br>-MMT improved to 4-/5 | No statistical analysis was performed. Only pre and post intervention outcomes were recorded. | -Utilization of BFR may improve thigh girth and knee extensor strength after ACL/lateral meniscus repair.<br><br>-Validity should be questioned as this is a single subject study. |


## 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, patient reported outcomes, muscle fiber diameter, and manual muscle testing. Data extraction is presented in the accompanying table.

## 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

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[Photograph of straight leg raise with occlusion cuff] (2019). Retrieved from https://www.owensrecoveryscience.com/