Effects of Blood Flow Restriction Rehabilitation after Achilles Tendon Rupture Repair – A Randomized Trial

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INTRODUCTION: Patients often experience a significant amount of muscle and bone atrophy following Achilles tendon rupture and surgical repair due to mechanical unloading and an inability to safely perform resistance training at intensities sufficient to preserve mass in the early postoperative period. This potentially increases the risk of reinjury, increases recovery time, and delays return to sport. Low intensity resistance training combined with blood flow restriction (BFR) therapy has been shown to induce muscle hypertrophy similar to high intensity exercise while mitigating the risks during the early postoperative period. We also recently observed that following anterior cruciate ligament reconstruction, the application of BFR around the proximal lower extremity was able to preserve muscle, bone mass, and site-specific bone mineral density (BMD) while also reducing time to return to sport participation (PMID:35762124). However, less is known about how BFR may elicit these effects on tissues that are further distal to the site of the occlusion such as those effected by Achilles tendon rupture. The purpose of this study was to determine if BFR added to the standard postoperative rehabilitation protocol would prevent skeletal muscle and bone atrophy in the lower extremity, improve muscular strength, and improve functional outcomes compared to traditional rehab following Achilles tendon rupture repair.
METHODS: A total of 19 patients undergoing Achilles tendon rupture repair were randomized into two groups, control and BFR, and underwent 15 weeks of postoperative rehabilitation. Both groups performed a standardized protocol. The BFR group performed select exercises under 50% arterial occlusion of the postoperative extremity. Body composition, total lean mass, lower extremity bone mass, thigh lean mass, calf lean mass, and bone mineral density (BMD) of the tibia were measured pre-surgery, prior to physical therapy (week 3), 8 weeks postoperatively, and 16 weeks postoperatively for all subjects. Calf girth, single-leg (SL) squat, single heel raise test, and gastrocnemius and soleus strength were measured in both the operative and contralateral legs at 8 weeks and 16 weeks postoperatively. Data were analyzed using a group (2) by time (3) ANCOVA repeated on timepoint and co-varied on initial measurement values. Significant findings indicated by Type-III tests of fixed effects were followed by a Bonferroni Post-hoc test for individual pairwise comparisons. Significance was set at $P<0.05$ for all analyses.
RESULTS: Thus far, a total of 19 patients have completed the trial (BFR=7, m=4, f=3, | Control=12, m=11, f=1). Only the control group was observed to have lower extremity bone mass loss in the injured limb at the 8 weeks postoperative ($p=0.006$) and 16 weeks postoperative ($p<0.001$) timepoints (Figure 1a). This resulted in similar reductions in symmetry between the operative and contralateral limbs at 8 weeks ($p=0.009$) and 16 weeks ($p<0.001$) within the control group (Figure 1a). The BFR group had preserved symmetry at 16 weeks postoperative compared to the control group ($p=0.038$) (Figure 1a). Compared to the control group, the BFR group was observed to have preserved tibia BMD at 16 weeks postoperative ($p=0.016$) whereas the control group experienced a significant decrease at 16 weeks compared to preoperative ($p=0.003$) (Figure 1b). Both groups were observed to have similar increases in gastrocnemius strength at the 8 weeks (BFR: $p=0.004$; control: $p<0.001$) and 16 weeks postoperative (BFR: $p=0.002$; control: $p<0.001$)(Figure 2a). However, there was a greater improvement toward achieving limb symmetry in the BFR group at 8 weeks postoperative ($p=0.048$)(Figure 2a). Both groups had improvements in soleus strength at 8 weeks (BFR: $p=0.036$; control: $p=0.004$) and 16 weeks (BFR: $p<0.001$; control: $p<0.001$) postoperative compared to 4 weeks postoperative (Figure 2b). However, the BFR group demonstrated greater improvements by 16 weeks ($p=0.043$) postoperative (Figure 2b).
DISCUSSION AND CONCLUSION: Although sample size is limited and data collection is ongoing, preliminary findings suggest that the application of BFR to a standardized rehabilitation protocol following Achilles tendon rupture repair may result in preservation of lower extremity bone mass and tibial BMD, greater recovery of calf muscle strength, and greater preservation of calf muscle mass.

Figure 1a - LOWER EXTREMITY BONE MASS

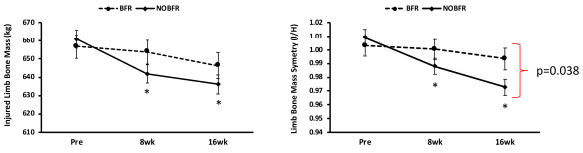
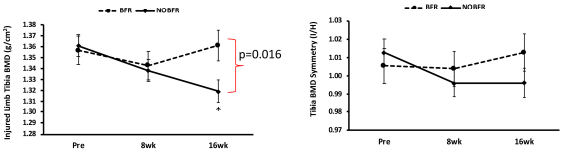


Figure 1b – TIBIA BONE MINERAL DENSITY



Data presented as means ± SEM; * = Significantly different from pre-surgery at *P*<0.05

Figure 2a – GASTROC STRENGTH

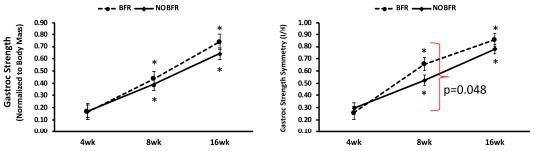
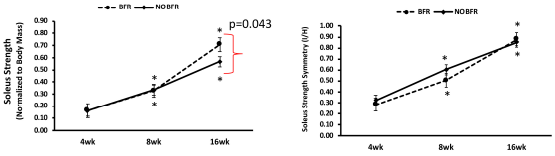


Figure 2b – SOLEUS STRENGTH



Data presented as means ± SEM; * = Significantly different from pre-surgery at *P*<0.05