The Effects of Perioperative Blood Flow Restriction on Patients Undergoing Anterior Cruciate Ligament Reconstruction: A Systematic Review and Meta-Analysis

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INTRODUCTION: Patients undergoing anterior cruciate ligament (ACL) reconstruction commonly exhibit both quadriceps muscle weakness and atrophy. Blood flow restriction (BFR) training involves the application of a specialized tourniquet to restrict blood flow to muscles. It has gained attention for its potential benefits in rehabilitation, particularly in cases like ACL reconstruction where traditional strength training may be initially limited. Several studies have attempted to elucidate the effect of BFR after ACL reconstruction, but this is the first systematic review and meta-analysis to specifically come to a consensus about these effects. This meta-analysis aims to assess the impact of BFR training on quadriceps cross-sectional area and thickness, pain perception, functional capacity, and quality of life in these patients, relative to individuals not undergoing BFR training. We hypothesize that BFR training will enhance muscle morphology and function which will lead to a quicker recovery after ACL reconstruction.

METHODS:

A systematic review and meta-analysis was chosen as the best way to analyze and synthesize the results of the clinical trials. A literature search was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. PubMed, Scopus, Embase, and Cochrane databases were queried using keywords and Boolean operators. Eligibility will look at the study as a whole and determine whether it is a good fit; randomized-controlled trials (RCTs) were the gold standard. All studies examined met the following inclusion criteria: RCT study design; sufficient BFR frequency; at least one week of study duration; and sufficient baseline and final outcome data. For all outcomes, summary estimates of mean differences (MD) and 95% confidence intervals (CI) will be determined using forest plots. A $P < 0.05$ will be considered statistically significant.

RESULTS: From our literature search, 17 articles were chosen for the systematic review. Of these, 8 RCTs, consisting of 198 total patients, were chosen as eligible to be included in the meta-analysis. The most common reported variables were Knee Injury and Osteoarthritis Scores (KOOS) for Pain, Symptoms, Activities of Daily Living (ADL), and Quality of Life (QOL), International Knee Documentation Committee (IKDC) scores, Lysholm Scores, Quadriceps cross-sectional area, and Quadriceps thickness. Random-effects models demonstrated significant improvements in KOOS Pain (MD: -13.51, P<0.00001), KOOS Symptoms (MD: -8.08, P<0.0001), KOOS ADL (MD: -12.38, P<0.0001), IKDC (MD: -12.36, P<0.0001), Lysholm Score (MD: -9.43, P<0.00001), and Quadriceps Thickness (SMD: -1.24, P<0.05). Negative values indicate how much lower the control groups scored in comparison to the BFR groups. Meta-analysis showed no significant improvement in KOOS QOL (MD: -3.03, P<0.79) or Quadriceps CSA (SMD: -0.04, P<0.91).

DISCUSSION AND CONCLUSION: Blood flow restriction training after anterior cruciate ligament reconstruction proves to be a powerful intervention, demonstrating significant improvements in pain, symptoms, and daily activity as measured by KOOS, IKDC, and Lysholm Scores. More research is warranted to determine the effects of BFR training on muscle hypertrophy and long-term prospective trials are encouraged to validate our results.