

**A critical appraisal of “Impact of a Six-Week Prehabilitation With Blood-Flow Restriction Training on Pre- and Postoperative Skeletal Muscle Mass and Strength in Patients Receiving Primary Total Knee Arthroplasty”**

**By**

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## **Abstract**

This term paper is an appraisal of a 2022 research article regarding the use of a prehabilitation program with Blood Flow Restriction (BFR) exercise on patients with end stage gonarthrosis before and after undergoing elective Total Knee Arthroplasties (TKA). The research article chosen was published in *Frontiers of Physiology*. This paper will begin with a brief introduction to the topic of BFR, the formulated clinical question, and why this specific article was chosen for critical appraisal. A summarization of this study will be followed by a critical appraisal of each section including the introduction, methods, results, and discussion. The paper will conclude with a discussion of the findings, clinical relevance, and overall results of the use of BFR.

**Key words: Blood Flow Restriction (BFR), Total Knee Arthroplasty (TKA), prehabilitation, muscle strength**

## **Introduction**

Total Knee Arthroplasty (TKA) is one of the most common surgeries performed, and like many other surgeries, patients experience muscle atrophy and strength loss during the recovery process. Blood Flow Restriction (BFR) training is gaining more popularity because of its known effects on maintaining and increasing muscle mass and strength while keeping mechanical loads low. This is a relevant concept because it could decrease the recovery time for certain musculoskeletal injuries. This is especially beneficial in an outpatient orthopedic setting where athletes or active individuals are treated for musculoskeletal injuries. Furthermore, this information helped formulate the clinical question, “Can Blood Flow Restriction training prevent strength loss in patients with lower extremity injuries?”

## **Methods**

PubMed was the sole source utilized to find research articles to answer the clinical question at hand because it is a reliable search engine with peer-reviewed, primary sources of research. The appraised article was found by searching the phrase “blood flow restriction training athlete,” resulting in a total of 379 articles to review. There were no limitations placed on the search for optimal results. Inclusion criteria included only the intervention of blood flow restriction therapy, involvement of only injuries to the lower extremities, and the general population. The exclusion criteria included any research studies involving upper extremity injuries and other modalities used in conjunction with blood flow restriction therapy. The exclusion and inclusion criteria were chosen to authenticate research results were not influenced by other modalities, and the research question is only concerned with lower extremity injuries.

After narrowing down to three articles, the article chosen was “Impact of a Six-Week Prehabilitation with Blood-Flow Restriction Training on Pre- and Postoperative Skeletal Muscle

Mass and Strength in Patients Receiving Primary Total Knee Arthroplasty,” published June 14, 2022, in *Frontiers in Physiology*. This research was conducted by Alexander Franz and other professionals in the orthopedic, rehabilitation, and sports performance fields respectively, in Germany. This article was chosen for a comprehensive critical appraisal out of the three articles because this research had the longest duration of data collection and uniquely observed the results of blood flow restriction training before and after a major surgical event, like TKA.

## **Results**

### Summary of the study

Total Knee Arthroplasty (TKA) is one of the most common surgeries performed, and like many other surgeries, patients experience muscle atrophy and strength loss during the recovery process. This study utilized Blood Flow Restriction (BFR) therapy which uses specialized tourniquets to restrict venous and reduce arterial blood flow during exercises in the working limb. The goal of the study was to observe the impact of a six-week prehabilitation protocol utilizing BFR training on pre- and post-operative muscle mass, strength, pain perception, and functionality. 30 patients suffering from end-stage gonarthrosis took part in the research study and were randomized into three groups. The first group consisted of a control group (CON) that did not undergo the prehabilitation program with BFR training, an active control group (AC) that did follow the prehabilitation protocol with a placebo BFR application, and a BFR group (BFR) that underwent the prehabilitation protocol with the BFR training. The prehabilitation protocol involved a cycling ergometer-based training protocol performed twice per week for around 50 minutes with intensity based on a calculated exercise heart rate. The BFR was placed on both lower limbs three times per leg progressing from one minute to six minutes throughout the six

weeks prior to TKA. The results showed involvement of BFR in a prehabilitation protocol for Total Knee Arthroplasty can increase muscle mass, increase strength, and reduce perceived pain leading to a better quality of life.

#### Appraisal of the study introduction

The introduction provides enough background information regarding total knee arthroplasty, prehabilitation, and blood flow restriction. It is well written and flows well introducing each component of the research and how they relate to one another. The aim of the research is stated clearly as well. The literature shows knee osteoarthritis and surgery can greatly affect skeletal muscle mass and strength. Previous literature explained the use of rehabilitation as a tool prior to surgery typically caused increased pain. Furthermore, it elaborates on how other studies have shown BFR exercises can have a significant impact on muscle mass and strength while maintaining low mechanical loads.

The only critique for the introduction is regarding the reference listed for the opening sentence of the introduction where TKA, gonarthrosis, pain, and quality of life are introduced (Vos et al. 2022). Upon looking up the research article referenced, there was no information found throughout the article regarding any of those topics.

#### Appraisal of the study methods

The research design is an accurate portrayal of a randomized controlled trial because patients were randomly assigned into one of three groups. This study design is also correctly assigned as a prospective, single blinded, parallel study because the patients are unaware of their group assignments, contrarily the clinical assessors were not blinded. This is also a longitudinal study because the patients are being studied before and after undergoing elective TKA surgeries. All patients participating in the study were suffering from end-stage gonarthrosis and would be

undergoing elective TKA. A benefit of this research study was that of the 30 patients who participated in the study, there was a documented dropout rate of 0% and no exercise or BFR-related adverse events noted.

There were several negative features noted in the methods section. First, not all patient groups were managed in the same way. The control-group followed a clinical treatment but did not get a specialized prehabilitation protocol like the other two groups that either received placebo BFR or full BFR. Lastly, this research can't be easily replicated because the occlusion caused by the tourniquet in BFR is different for every individual. The limitation would be a trained individual in BFR would need to assist someone trying to replicate this for safety purposes.

#### Appraisal of the study results

Each section of results was written clearly and separated into different sections with headings making it easily navigable. Each aim regarding muscle mass, strength, functionality, and subjective pain perception were addressed in detail as well. The outcome measures were muscular strength of the thigh muscles, thigh circumference, and quality of life and functional activity examined by a 6-minute walk test and chair rising test. The results corresponding to each individual outcome measure had its own section making results easy to interpret as well. The tables and figures were well organized with the results separated into the different phases of the research corresponding to each experimental group. This organization helped to avoid confusion on what group and phase of the research the results were corresponding to.

Although the results were presented in an organized manner, there are some improvements that could be made. The researchers failed to document study participants' prior level of function and activity level before participating in the study. This could skew the results

if a patient had more or less muscle mass prior to use of BFR. Furthermore, the researchers could have improved on data collection post TKA. There are many variables such as compliance, diet, activity level etc. that could influence results that were not observed before the final measurements taken.

### Appraisal of the study discussion

The authors did not repeat the results and indicated the meanings of the findings. The authors compared several studies that supported preoperative well-being and postoperative rehabilitation through prehabilitation. They also compared the results of their 6-week cycling ergometer protocol with literature that illustrated a 6-week knee extensor-based prehabilitation protocol with BFR prior to receiving ACL reconstruction. They also gave reasoning for the duration of their research based on the results of another study by Grapar Zargi and colleagues. The improvements in muscle mass and strength were in line with previous literature on subjective pain perception and QoL.

Regarding the literature cited for improvements in muscle mass and strength decreasing subjective pain perception and QoL (Davison et al. 2017; Kemnitz et al., 2017) there is no mention of quality of life in either article. There were quite a few limitations listed for this study as well. The circumference measurements for muscle mass taken are only an estimation of the muscle mass. The results could be caused by a missed matching of groups to baseline characteristics such as previous level of physical activity, preoperative muscular deficits, or leg-dominance. There was possible risk of attention bias as well due to more visitations to supervisors by the prehabilitation groups through the weekly training than the controlled group that didn't receive BFR. This could have influenced the results preoperatively.

## **Discussion**

BFR is known for its effects on maintaining and increasing muscle mass and strength while keeping mechanical loads low. This is a relevant concept because it could decrease the recovery time for certain musculoskeletal injuries. This would be especially beneficial in an outpatient orthopedic setting where athletes or active individuals are treated for musculoskeletal injuries and could have a quicker return to their usual routines. This research study is relevant to clinical question because it observes the effects of BFR on the large quadricep muscle group.

BFR is a great rehabilitation tool because it could decrease the amount of time needed for a patient to fully recover from an injury, whether that be a muscle strain or post-surgical repair. This would be financially advantageous for the patient as well due to spending less time in the clinic for rehabilitation. The only drawback of this intervention is the need for a trained individual and constant supervision to perform the modality due to the occlusion from the tourniquet. I believe the benefits outweigh the drawback. If possible, I would include a financial analysis within the statistics portion of the research to further emphasize the impact of decreased time in the clinic for rehabilitation using BFR.

I do not have enough confidence in the research validity of this paper alone, but I would include it with other research articles to support my decision to use this intervention. The reason I cannot use this article alone is due to the inclusion criteria for this research study. All patients had end-stage gonarthrosis and were undergoing elective TKA surgery. There could be different protocols and results for those that have different injuries for different body parts or undergoing different surgical repairs. There are too many scenarios that would benefit from BFR, this research article just covers one. I believe BFR is an intervention I could safely perform in the



clinical setting during my career because training courses and equipment for this modality are becoming more widely available.

Overall, this is a well-thought-out research article, and the information is presented in an organized manor. The organization makes it easier for the reader to navigate through the article and find information when needed. Additional research should be completed to analyze the effects of BFR on other types of musculoskeletal injuries to better answer the clinical question. Despite the limitations placed on the research due to the type of injury and rehabilitation protocols, it does answer the clinical question, BFR does in fact prevent strength loss in lower extremity injuries.