Introduction

Knee osteoarthritis (KOA) is a chronic disorder with more prevalence in females compared to males, caused by articular cartilage destruction, and affects the knee joint's surface and bones, and ultimately causes pain, reduces activities of daily life (ADLs) and affects quality of life (QOL) by restricting the movements. Pathophysiologically, the cartilage generation and destruction enzymes are not present in a balanced ratio. KOA grade 1 means minor bone spurs, grade 2 means certain number of spurs and narrowing of joint space, grade 3 means multiple medium-sized bone spurs and further narrowing of space, and grade 4 indicates a large no of bone spurs, reduced joint space, sclerosis and bone deformity.

KOA prevalence in Pakistan is high compared to other Asian countries as 25% rural and 28% non-rural areas are affected; northern region being much more affected than the southern region. Key risk factors are gender, age >50 years, obesity, history of trauma, overuse or occupational injury and smoking etc. Common symptoms include pain due to long-duration activity and weight-bearing, stiffness due to inactivity and difficulty during climbing stairs and walking.

In addition to pharmacotherapy and activity modification, multiple non-pharmacological options are available, which include the use of therapeutic modalities, assistive devices and strengthening exercises to different groups of muscles. Resistance training with blood flow restriction (BFR) has been found to decrease pain and disability and to improve strength and physical working.

Resistance exercise with BFR or vascular occlusion is also an option for the management of KOA. It is done with a pneumatic cuff or tourniquet that lessens the blood flow and restricts the venous return, thereby raising the metabolic stimulus in working muscles. BFR exercise results in favourable adjustments to muscle strength, mass and endurance. It incorporates a collection of metabolites, cell swelling, enhanced motor unit recruitment, decreased protein breakdown and the multiplication of satellite cells, most likely expanding the muscle hypertrophic reaction.

Various studies from Pakistan are available on KOA using different treatment options, but BFR has not been tried as

Impact of strengthening exercises with and without blood flow restriction on quadriceps of knee osteoarthritis patients

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Abstract

Objective: To determine the effect of blood flow restriction with strengthening exercises on knee osteoarthritis patients.

Method: The case-control study was conducted at the Department of Physical Medicine and Rehabilitation, Combined Military Hospital, Okara, Pakistan, from June to December 2018, and comprised knee osteoarthritis patients who were assigned to two equal groups. The cases in Group A received strengthening exercises with blood flow restriction, while the controls in Group B received strengthening exercises without blood flow restriction. Both groups were given 4 sessions of treatment per week with 5-minute warm-up on a stationary bike for 4 weeks. Outcome was measured using visual analogue scale, Kujala scoring questionnaire and muscle girth measurement. Data was analysed using SPSS 20.

Result: Of the 30 patients, 15(50%) were in each of the two groups. There were 20(66.7%) females and 10(33.3%) men with an overall mean age of 66.5±6.5 years. Also, 18(60%) subjects were overweight on the basis of body mass index. There were significant improvement in terms of pain and disability in both the groups (p<0.05), but only Group A showed significant improvement in muscle girth (p<0.05). Overall there was no significant difference between the groups (p>0.05).

Conclusion: Strengthening exercises reduced pain and disability, but the addition of blood flow restriction had no significant impact except in terms of muscle size.

Keywords: Knee osteoarthritis, Muscle strength, Strengthening programmes, Tourniquet, Vascular occlusion.

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The current study was planned to determine the effect of BFR with strengthening exercises on KOA patients.

 Patients and Methods

The case-control study was conducted at the Department of Physical Medicine and Rehabilitation, Combined Military Hospital (CMH), Okara, Pakistan, from June to December 2018. After approval from the institutional ethics review committee, the sample size was calculated using 95% confidence level and 5% margin of error on the basis if an earlier study. The sample was raised using non-purposive consecutive sampling technique. Those included were grade 2 KOA patients of either gender aged 50-75 years with complaint of pain at the knee joint or inability to perform ADLs. Those with history of recent/old trauma, knee replacement surgeries, movements restricted at the knee joint, other co-morbidities, like stroke and rheumatoid arthritis, pain due to other knee problems, like tendonitis, bursitis, anterior cruciate ligament (ACL) tear etc., were excluded. After taking informed consent from the participants, they were assigned to two equal groups. The cases in Group A received strengthening exercises of quadriceps, hamstrings and calf muscles with BFR, while the controls in Group B received strengthening exercises alone without BFR.

On the first visit, muscle bulk, pain intensity and knee joint activity of all participants were determined. Demographical data was noted using a proforma and body mass index (BMI) was calculated. BMI 18-24.9kg/m² was considered normal weight and >25kg/m² as overweight. Both groups received a total of 16 physiotherapy sessions; 4 sessions per week for 4 weeks. During each session, 5-minute warm-up was performed by each participant on a stationary bicycle followed by strengthening exercises in the lying position at moderate speed with 5-second rest between each contraction and a total 3 sets of 10 repetitions per session. The participants were told to discontinue routine exercises apart from the treatment exercises.

Group A participants performed strengthening exercises with BFR using a tourniquet on the most proximal portion of the involved muscle and on arterial supply for each muscle, as on femoral artery for thigh muscles and on tibial artery for calf muscles. The BFR pressure was high enough for venous return occlusion, but was not too high to completely block the arterial flow. The control Group B performed strengthening exercises without tourniquet application.

Pain was measured using visual analogue scale (VAS) scores, while Kujala Scoring Questionnaire (for assessment of pain at knee joint) was used for assessing knee joint activity. Muscle girth measurement was taken with the help of flexible inches tape by measuring the respective muscle bulk. The assessments and measurement was done by the therapist at baseline and post-intervention on the last day of the 4th week.

Data was analysed using SPSS 20. Paired-t and independent-t tests were used. P<0.05 was considered significant.

Results

Of the 30 patients, 15(50%) were in each of the two groups. There were 20(66.7%) females and 10(33.3%) males with an overall mean age of 66.5±6.5 years. Also, 18(60%) subjects were overweight on the basis of BMI value (Table-1).

There were significant improvement in terms of pain and disability in both the groups (p<0.05), but only Group A showed significant improvement in muscle girth (Table-1).

Table-1: Descriptive data.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Frequency Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 30 (%)</td>
<td>BFR group (N=15)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>20(66.7%)</td>
</tr>
<tr>
<td>Male</td>
<td>10(33.3%)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>50-62 years</td>
<td>11(36.7%)</td>
</tr>
<tr>
<td>63-75 years</td>
<td>19(63.3%)</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>12(40%)</td>
</tr>
<tr>
<td>Overweight</td>
<td>18(60%)</td>
</tr>
</tbody>
</table>

BFR: Blood flow restriction.

Table-2: Pain, disability and muscle girth assessment in participants with and without blood flow restriction (BFR).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Initial Mean</th>
<th>Final Mean</th>
<th>Mean Difference</th>
<th>P value</th>
<th>Initial Mean</th>
<th>Final Mean</th>
<th>Mean Difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain Assessment</td>
<td>2.67±0.48</td>
<td>2.00±0.53</td>
<td>0.67±0.61</td>
<td>0.001</td>
<td>2.46±5.16</td>
<td>2.13±5.16</td>
<td>0.33±0.48</td>
<td>0.019</td>
</tr>
<tr>
<td>Knee Disability Index</td>
<td>4.47±1.50</td>
<td>5.67±1.91</td>
<td>-1.20±0.08</td>
<td>0.001</td>
<td>4.53±1.59</td>
<td>5.07±1.62</td>
<td>-0.53±0.51</td>
<td>0.001</td>
</tr>
<tr>
<td>Muscle Girth</td>
<td>1.47±0.51</td>
<td>1.80±0.67</td>
<td>-0.33±0.48</td>
<td>0.019</td>
<td>1.40±0.63</td>
<td>1.47±0.63</td>
<td>-0.06±0.25</td>
<td>0.334</td>
</tr>
</tbody>
</table>
The current study verified that muscle action was improved by BFR exercises and they also enhanced the level of daily activities. One study observed that BFR increased muscle fatigue though it lasted for a short period of time. Overall, most studies are in favour of BFR exercises regarding muscle strength, size and cross-sectional area.

In the current study the muscle girth, or cross-sectional area, was only significant in subjects with BFR training and not in subjects with strengthening exercises alone. One study showed that strength training, or conditioning, also increased the cross-sectional area of quadriceps muscle. In another study, however, it was mentioned and the regime was performed according to the participants had many concerns about this technique, like muscle soreness, bruising, pain etc.

As the sample size was small in the current study, no long-term follow-up was done and BFR was applied mostly on the quadriceps, the findings cannot be generalised to overall population. Further studies regarding long-term follow up, a large sample size and muscles other than quadriceps are highly recommended. In the current study, no indications and contraindications were mentioned and the regime was performed according to subject’s tolerance level. In another study, however, it was highlighted that proper BFR modality would be needed and identification of indications, contraindications, modality procedure, cuff tolerance, intensities would have to be determined for this regimen to be safe for subjects and there will be a need to modify the relatable risk factors.
In terms of limitations, there is a lack of prior research in this area locally which means no comparable literature regarding BFR was available. Also, data might be indicative of some cultural or other types of biases.

**Conclusion**

KOA patients were found to have significant improvement in pain and disability through strengthening exercises along with BFR, but muscle size only increased with BFR exercises due to its metabolite-accumulation mechanism.

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**Conflict of Interest:** None.

**Source of Funding:** None.

**References**


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