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Original Article

EFFICACY OF INTERMITTENT VACUUM THERAPY AS AN ADJUNCT TO CONVENTIONAL PHYSIOTHERAPY TREATMENT IN PATIENTS WITH KNEE OSTEOARTHRITIS

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ABSTRACT

Objective: Osteoarthritis (OA) is a severe joint disease that affects more than 60 percent of the elderly. It is highly prevalent and a leading cause of pain and disability worldwide. Symptoms can become increasingly debilitating over time and can greatly affect the quality of life, contributing to feelings of dependence and loss of autonomy in older people. Intermittent vacuum therapy (IVT) is a new technology which is now being used to treat vascular diseases of the legs, to accelerate rehabilitation, to reduce oedema in the lower extremities, to treat cellulite as well as other indications. The majority of the examinations of physiological effects of intermittent vacuum therapy is based on reactions to stable negative pressure in the lower body.

Methods: A total of 30 patients, 15 in group A (Conventional) and 15 in group B, were randomly selected based on inclusion and exclusion criteria. Outcome measures-VAS, WOMAC and Knee flexion ROM were assessed pre and post-intervention. The treatment was performed for 10 sessions.

Results: There was statistical significance seen in Group A (Conventional) and Group B (Interventional) in all outcome measures. However, treatment with Intermittent Vacuum therapy showed better results in comparison to conventional therapy. Data analysis was done using Paired T test.

Conclusion: Intermittent Vacuum Therapy along with conventional protocol showed significant improvement in the above outcome measures in O. A Knee patients. Therefore, Intermittent Vacuum Therapy can be incorporated as a part of rehabilitation in O. A Knee patients.

Keywords: Osteoarthritis, Indications, Intermittent vacuum therapy

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INTRODUCTION

Osteoarthritis of the Knee joint is the most common cause of joint dysfunction and is far more common in India than in Western countries. Knee osteoarthritis (OA), is typically the result of wear and tear and progressive loss of articular cartilage. Knee osteoarthritis can be divided into two types, primary and secondary. Primary osteoarthritis is articular degeneration without any apparent underlying reason. Secondary osteoarthritis is the consequence of either an abnormal concentration of force across the joint as with post-traumatic causes or abnormal articular cartilage, such as rheumatoid arthritis (RA) [1, 2].

Clinical recommendations support non-surgical treatment for knee OA, including exercise, weight loss (for those who are overweight or obese), and self-management education. Physiotherapists are more frequently referred to by general practitioners for non-surgical treatment of osteoarthritis (OA) than other allied health professionals. Furthermore, most patients believe that physiotherapists are crucial in helping them manage their osteoarthritis and in prescribing activities [3].

Physiotherapy management is part of the primary treatment for osteoarthritis in the knee, aimed at symptom control and function improvement. Physiotherapy involves educating patients on self-management skills related to fatigue, pain management, and weight control. Utilizing pain management techniques such as TENS, ultrasound, laser, and shockwave therapy, Exercises to strengthen the muscles surrounding the knee are prescribed in order to increase stability and reduce strain on the knee joint, stretches to release tension on the shortened muscles surrounding the knee that could be causing pain. Knee braces can reduce pain during movement and offer stability. Exercises in the pool enable a range of motion and strengthening while utilizing bouncy surfaces to assist reduce stress on the knee joint. Manual therapy methods are used to improve function and range of motion [4, 5].

Intermittent vacuum therapy-IVT-was developed by NASA, USA for the astronauts on the basis of the LBNPD procedure (lower body negative pressure device). A significant improvement on this technology has been done by Parveen Singh of IVT technologies, Patiala, and this advanced IVT has been used in this study. This kind of therapy is used to treat the entire body of a patient, including vascular diseases of the legs, rehabilitation of athletes, reduce oedema in the lower extremities, and to treat cellulite as well as other indications. The device for intermittent vacuum therapy consists of a cylindrical chamber into which the legs or arms of a patient are inserted one by one. The patient is lying on his back; his leg is placed inside the chamber. In the area at the upper end of thigh, the chamber enclosing the leg of the patient is sealed using a diaphragm. A vacuum pump generates negative pressure in the chamber. The device generates intermittently negative and normal pressure. Under the effect of the vacuum, blood from the area with relatively high pressure (upper body being outside the chamber) flows into the area of lower pressure (lower body inside the chamber), thus improving blood circulation in the lower extremities. Due to the blood flow towards the lower extremities, the mean blood pressure falls. Normally, the body compensates for the re-distribution of blood by increasing the pulse rate and peripheral vascular constriction. Due to the blood flow towards the lower extremities, the mean blood pressure falls [6, 7].

Due to the negative pressure in the chamber, the negative pressure in the lower body triggers the movement of the circulating blood volume into lower extremities. This blood movement results in lowering the blood pressure in the central vein, heartbeat volume, cardiac output and, finally, in lowering the arterial blood pressure, which must be met by compensation mechanisms. All in all, the short-term reaction is a changed total resistance of bloodstream, venous tone, frequency and width of heart contractions. Directly proportional to the effective negative pressure in the lower body, the amounts of deoxygenized and overall hemoglobin in the muscles of the lower extremities are increased [8, 9].

The aim of this study is to compare the effect of intermittent vacuum therapy in combination with conventional physical therapy and conventional physical therapy on pain intensity, knee range of motion and functional disability in patients with knee osteoarthritis.

Objectives 1. To assess the effect of conventional exercise in Knee OA on pain, WOMAC score and Knee flexion ROM 2. To assess the effect of IVT in Knee OA on pain, WOMAC score and Knee flexion ROM 3. To compare the effect of above 2 group

METHODS AND MATERIALS

This study was conducted in Nanavati Max Super Specialty Hospital, Mumbai, after the approval from Ethics committee board. Patients were assessed for inclusion and exclusion criteria and divided into Group A and Group B. The study was also registered under CTRI with trial number 2024/01/061646.

Inclusion criteria

Patient Diagnosed with Knee Osteoarthritis

-Age above 40.

Exclusion criteria

-Recent known lower limb injuries

-Known circulatory disorders in lower extremities

-Associated any known neurological impairment and cardiovascular conditions.

Group a received conventional physiotherapy treatment, which include the following:

Session 1 and 2-Ankle toe movements (ATMs), Ankle toe rotations (ATRs), Static Quadriceps (SQ), Static Hamstring (SH), Static Gluteal (SG), Straight leg Raise (SLR), and Heel Slides.

Session 3 and 4-All exercises of session 1 and 2, Abduction in Side lying, Clam Shells, VMO activation, and Dynamic quadriceps

Session 5 and 6-All exercises of session 3rd and 4th, Sit to Stand, Strengthening exercises of Knee flexors, Knee and Hip extensors, Step ups

Session 7 and 8-All exercises of session 5th and 6th, Clamshells with band, Wall Squats, Balance exercises on foam bed.

Session 9 and 10-All exercises of session 7th and 8th, Cycling, Balance exercises on ground.

GROUP B was given Intermittent Vacuum Therapy for 15 min for each leg along with above conventional protocol treatment.

Outcome measures-

1. VAS (Visual Analogue Score)
2. Knee range of motion
3. WOMAC (Western ontario and mcmaster universities arthritis index)

Statistical data analysis

Data was analyzed using IBM SPSS software version 29. Assuming that the data was following normal distribution (n=30) Independent Sample t-test was performed between the groups and paired t-test for within the group analysis. A p-value of<0.05 was taken as significant.

RESULTS

The mean age of the patients in both groups was 57.73±9.58. Both the groups were similar with no confounding factor. Demographic data of all the patients is given in table 1

Table 1: Demographic data of all the patients

Demographic data	Mean±SD
Age	57.73±9.58
Height	165.13±7.13
Weight	68.33±12.19
Gender (M: F)	20:10

Visual Analogue Scale shows improvement in both the groups; however, the improvement in Group B was significantly more as compare to group a (table 2).

Table 2: Visual analogue scale measurements in both the group

Outcome measure			
VAS	**Pre-Intervention**	**Post Intervention**	**P Value***
Group A	6.00±0.85	4.47±1.06	<0.05
Group B	6.47±1.13	3.73±1.10	<0.05

(*-p value<0.05 is significant), WOMAC score shows improvement in both the groups; however, the improvement in Group B was more as compare to Group A.

Table 3: WOMAC score measurements in both the groups

Outcome measure			
WOMAC	**Pre-Intervention**	**Post Intervention**	**P Value***
Group A	55.80±11.16	49.13±10.66	<0.05
Group B	54.20±9.44	42.40±9.44	<0.05

Knee Range of Motion shows improvement in both the groups; however, the improvement in Group B was significantly more as compare to Group A. (table 4)

Table 4: Knee ROM measurements in both the groups

Outcome measure			
Knee range of motion	**Pre-intervention**	**Post-intervention**	**P value***
Group A	81.33±13.69	92.33±13.87	<0.05
Group B	85.33±13.69	108.33±12.19	<0.05

DISCUSSION

The primary goal of this study was to see the effect of IVT as an adjunct to conventional physiotherapy treatment in patients with knee osteoarthritis. As seen in table 1 total 30 patients were recruited, out of which 20 (66.33%) were females and 10 (33.33%) were males. The age of these participants ranges from 40 y to 80 y. The mean age and standard deviation of these patients were 57.73±9.58. The mean

height and standard deviation were 165.13±7.13. The mean weight and standard deviation were 68.33±12.19.

Table 2 represents VAS score pre and post-intervention and a clinically and statistically significant difference was seen from 6.00±0.85 to 4.47±1.06. Exercises such as isometric muscle strengthening play a crucial role in stabilizing and supporting the knee joint. The activation of quadriceps stimulates blood flow to muscles, whereas it triggers release of endorphins, which are natural pain-relieving chemicals produced by the body which may alleviate pain by reducing muscle tension. Table 4 represents Knee flexion ROM pre and post and clinically and statistically significant difference was seen from 81.33 to 13.69±92.33±13.87. Range of motion exercises, such as knee and hip ROM, help maintain or improve joint flexibility reduces stiffness. Moving joint during mobility exercises can help distribute synovial fluid, which act as a lubricant and nourishes the cartilage surfaces of the joint. Better lubrication will reduce the friction and wear on the joint, potentially decreasing pain and stiffness. Weight-bearing exercises, such as squats, tandem walking, sideway walking, one leg standing, heel raises provide support and stability. Stimulate bone remodeling and increases bone density, which is important for maintaining bone strength and reducing the risk of osteoporosis related fractures. Sinaki *et al.* concluded in the study that strengthening of back muscles in osteoporotic women significantly reduces the risk of vertebral fractures. Table 3 represents WOMAC score pre and post has clinically and statistically significant difference from 55.80±11.16 to 49.13±10.66. Hence, improvement in joint lubrication, range of motion has enhanced neuromuscular control and improve their overall functional abilities to perform daily tasks.

On the other hand, in intermittent vacuum therapy as shown in table 2, the VAS score is reduced from 6.47±1.13 to 3.73±1.10 and p value<0.001 at the end of session, which was statistically significant. KNEE FLEXION score is increased from 85.33±13.69 to 108.33±12.19 and p value<0.001 at the end of session, which was statistically significant. WOMAC score is reduced from 54.20±9.44 to 42.40±9.44 and p value<0.001 at the end of session, which was statistically significant.

IVT creates negative pressure and atmospheric pressure intermittently, which is alternatingly applied to the lower extremities, it is speculated that a rhythmic vascular dilation and compression causes the obliteration of visceral vessels, as compared to the physiology of upright and bent body position. Thus, the negative pressure is created by the vacuum in the lower body, the visceral vessels circulation is improved and venous constriction is maintained, which promotes exsanguinations causing an increase in the amount of oxygenated blood, increasing the total hemoglobin, which causes improving the circulation in lower limb muscles. This increased blood flow helps reducing inflammation, promoting tissue repair, reducing swelling at the knee joint, therefore having analgesic effects by modulating pain [5]. Model-controlled hypovolemia can be achieved by controlling venous reflux by the use of negative pressure in the lower body. Due to similarities in the neuro-vascular physiology between bent and upright body positions, low pressure in the lower body is employed to promote exsanguinations. Applying an intermittent negative pressure, the vasoconstrictor effect causes venoarterial reflex, which may be circumvented. For instance, arterial blood flow velocity, skin blood flow, and skin temperature decreases. In a study conducted by Vitor Pimenta *et al.*, stated that application of IVT showed improvement in muscle generation in athletes with torn muscle of dominant leg. The transfer of the circulating blood volume into the lower extremities is caused by the negative pressure in the lower body, which is a result of the negative pressure in the chamber. This blood flow lowers cardiac output, central vein blood pressure, heartbeat volume, and arterial blood pressure, all of which need to be made up for by compensation procedures. The amount of deoxygenated and total hemoglobin in the lower limb muscles increases in direct proportion to the effective negative pressure in the lower body. The amount of oxygenized hemoglobin is increased considerably at-10 mmHg, and the curve of the amount of oxygenized hemoglobin in relation to the effective negative pressure becomes constant when the pressure is increased further. This may be the reason for increased muscle activity, which in turn improves functional activities.

A study done by Hageman D *et al.* showed that the effects of IVT caused improved walking distances thus improving the functionality of patients with lower limb claudication [10]. Therefore, ROM exercises, strengthening exercises of the hip and knee given along with IVT have caused to improve the circulation, reducing inflammation and swelling in the knee joint, thereby improving the pain scores, ROM and functional activities, improving the quality of life.

CONCLUSION

The study concluded that exercise with Intermittent Vacuum Therapy had a significant effect on VAS, WOMAC and Knee Flexion ROM. Hence Intermittent Vacuum Therapy showed clinically and statistically significant improvement in patients with knee osteoarthritis. Therefore, Intermittent Vacuum Therapy can be incorporated as a part of rehabilitation in O. A Knee patients.

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AUTHORS CONTRIBUTIONS

All the authors have contributed equally

CONFLICT OF INTERESTS

Declared none

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