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ISOMETRIC EXERCISE VERSUS COMBINED CONCENTRIC-ECCENTRIC EXERCISE TRAINING IN PATIENTS WITH OSTEOARTHRITIS KNEE

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ABSTRACT

Background: Osteoarthritis is a slowly evolving articular disease, which appears to originate in the cartilage and affects the underlying bone and soft tissues. OA results in pain and functional disability. The purpose of this study was to determine the effect of isometric exercises and combined concentric-eccentric exercises in reducing pain and functional disability in patients with osteoarthritis of knee.

Methods: Forty individuals who were diagnosed as osteoarthritis by qualified orthopaedics and orthopaedic surgeons were chosen and were randomly divided into 2 groups Group A (N=20) and Group B (N=20). Group A was treated with isometric exercises and Group B was treated with combined concentric-eccentric exercises. The intervention lasted eight weeks and the physical activity was carried out for 3 days a week. Both the groups were assessed for pain and functional disability of knee joint by using WOMAC osteoarthritis index and VAS.

Results: Between group analysis of pre and post study data reveals that VAS and WOMAC osteoarthritis index revealed significant findings (P=0.00). Group B performs significantly better on both the scales after the treatment.

Conclusion: Both the groups showed significant improvement in decreasing pain and functional disability. But mean scores of Group B showed greater improvement in reducing pain and functional disability as compared to Group A in patients with knee osteoarthritis. Thus the results suggest that a combined concentric-eccentric exercise is more effective than isometric exercises in reducing pain and functional disability in knee osteoarthritis.

Keywords: Osteoarthritis, Isometric Exercises, Combined Concentric-Eccentric Exercises, VAS, WOMAC Osteoarthritis Index.

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INTRODUCTION

Osteoarthritis is a slowly evolving articular disease. Osteoarthritis appears to originate in the cartilage and it affects the underlying bones and soft tissues.¹ Osteoarthritis commonly occurs in the later part of life and mostly affects the large weight bearing joints such as the knee and hip. In elder people osteoarthritis is predicted to become the 4th most important cause of disability in the world.² Osteoarthritis results in pain and physical disability.³

Osteoarthritis of knee is the most common of all the arthritis and one of the major causes of chronic musculoskeletal pain and disability in the elderly. It thus represents a significant burden on healthcare provision.⁴ Osteoarthritis is second only to ischemic heart disease as a cause of work disability in man over age 50 Lawrence et.al, 1998.

Osteoarthritis is a major cause of disability in people aged 65 and older. In some people, evidence of osteoarthritis changes may exist by the second or third decade of life usually without associated symptoms. By age 40, almost everyone has some osteoarthritic changes in weight bearing joints example hip and knee joints. And by age 75 virtually everyone has changes in at least one joint.⁵ The prevalence in developing countries is variable; some studies show lower prevalence rates while others show similar levels to those in developed countries. It is estimated that OA knee has prevalence of 22% to 39% in India.⁶ The clinical features of knee osteoarthritis includes chronic pain accompanied by muscle weakness and joint instability which results in physical dependence and decreased quality of life leading to depression, physical inactivity obesity and social isolation.^{7,8}

Physiotherapy is concerned with maximizing mobility and quality of life by using clinical reasoning to select and apply the appropriate treatment. However, now-a-days, Physical therapists attempt to treat the patient with knee osteoarthritis by using a wide variety of interventions, such as manual therapy techniques, balance, co-ordination, strengthening, functional retraining techniques, knee taping techniques, electrotherapy, knee foot orthotics and ADL modification etc., to assist in overcoming the barriers which results in easy participation in physical activities.⁹ At the initial stages of osteoarthritis, physical therapy and education can improve the functional outcome and the participation of patients in daily activities. In the case of osteoarthritis of knee progression and when an operation is the only effective treatment,

physiotherapy is very useful in enhancing self-esteem and minimizing depression and anxiety for the forthcoming surgery. Post-operative intense physical therapy application offer remarkable benefits in terms of faster recovery, shorter hospital stay and increase of range of motion. Furthermore, home-based exercises following discharge from the hospital should be encouraged in order to optimize the final result. Due to above beneficial effects of physiotherapy, it is a must in both conservative and surgical management of osteoarthritis of knee.

Isometric exercises can improve muscle strength and static endurance. Isometric exercises prepare the joint for more dynamic movements and are, therefore, typical starting points for most strengthening programs. Studies have indicated that strength increases when isometric contractions are performed at the muscles' resting length.^{10,11}

In daily activities, such as ascending and descending stairs or standing up from or sitting down into a chair, the knee muscles contract concentrically or eccentrically to control the movement of the limb and to prevent joint overloading.

Although concentric and eccentric contractions are frequently used in daily activities, muscle strength, pain and disability have been investigated in patients with knee osteoarthritis. There is lack of study on the effects of combined concentric-eccentric exercises on improvement of pain and on functional activities.

So the purpose of this study is to analyze the effect of isometric exercises and combined concentric-eccentric exercises in reducing pain and on functional disability in patients with OA knee.

METHODOLOGY

40 subjects with bilateral knee osteoarthritis were taken for the study. Ages between 45 to 65 years with unilateral knee osteoarthritis with Knee pain for the past 3 months were included. Patients with Radiographic evidence of knee osteoarthritis by using Kellegren-Lawrence scale (Grade 0, I and II) were included. Prior to start the study the concern letters were taken.

Patients with Rheumatoid arthritis, recent fractures, malignancy, lower limb deformities, diseases of knee, and acute infection/inflammation of knee joint were excluded. Subjects with Osteoporosis, Chondromalacia patellae or patellofemoral pain syndrome, cardiovascular diseases, Patients with sensory, cognitive and psychiatric disorders were also excluded.

PROCEDURE

After checking inclusion and exclusion criteria, 40 subjects with bilateral knee osteoarthritis were selected and assigned into 2 groups with 20 subjects each. A brief introduction about the treatment procedure is given to all the subjects. Before starting the treatment both groups are to be evaluated for pain and functional disability of knee joint by using WOMAC osteoarthritis index¹² and VAS.¹³

Group A, Isometric Exercise: Exercises includes muscles of both extensor and flexor groups of knee joint.^{14,15}

Short-arc quadriceps set: Patient in supine lying, a rolled towel is placed under the knee so that knee is bent. Slowly foot is lifted until leg is straight and towel is pressed and hold for 6 seconds and 3 seconds rest between motions. 3 sets with 10 repetitions for each set were performed.

Long-arc quadriceps set: Patient in sitting position and patient is asked to squeeze the muscles on top of thigh and foot is lifted and leg must also be straightened. Hold for 6 seconds and patient is asked to slowly lower the leg. 3 seconds rest was given between motions. 3 sets with 10 repetitions for each set were performed.

Isometric Hamstring Exercise: Patient in supine lying, the muscles behind the knee are to be tightened, as if the knee is to be bent. Heel must be dig down but the knee must not bend. Hold for 6 secs then relax and 3 secs rest given between motions. Repeat for 10 repetitions for 3 sets.

Straight leg rise: Patient in supine lying with opposite knee bent. Patient is asked to lift straight opposite leg with toe flexed back to about 45°. Hold for 6 secs and then slowly lower the leg back to couch. 3 sets of 10 repetitions were given.



Figure1: Short-arc quadriceps set



Figure 2: Long-arc quadriceps set

Group B, Combined Concentric-Eccentric Exercises: Exercises includes muscles of both extensor and flexor groups of knee joint.^{16,17,18}

Eccentric Squat: Patient is asked to stand with the feet hip width apart next to a wall or table for balance. The weight of the body is shifted to the right leg and slowly lowered until the thighs are parallel to the floor. It should take a count of four or five to reach this position. Take care not to let the knees extend over the toes. Shift the weight back to both feet and rise to standing. Repeat five to ten times each leg.

Step Down: Patient is asked to stand on a step with feet hip width apart. Step down in a slow, controlled motion with the right leg. When the right foot hits the floor, bring the other foot down. Repeat five to ten times each leg. Increase difficulty by increasing the height of the step.

Unilateral and bilateral leg extensions on quadriceps table: Patient is asked to sit straight on the quadriceps table with the knees bent. By holding the thigh still, patient is asked to extend the legs against the resistance until the legs are straight. Then the knees are to be bending to come to the starting position. 15 to 20 repetitions of leg extensions were done and in between every repetitions 3 seconds rest was advised.

Seated hamstring curls (concentric strengthening): Patient is asked to sit straight on the quadriceps table and by holding the thigh still, patient is asked to bend the legs against the resistance until the legs are bending. Then the knees are to be straightening to come to the starting position. 15 to 20 repetitions of leg extensions were done and in between every repetitions 3 secs rest was advised.

Prone hamstring exercises (eccentric component): Patient in prone lying with ankle weights of 250gm was given. Patient is asked to bend the knee against the back of the thigh and then straighten to original position. 3 sets of 10 repetitions were given and in between every repetitions 3 seconds rest was advised.



Figure 3: Leg extension on quadriceps table



Figure 4: Seated hamstring curl on quadriceps table



Figure 5: Prone hamstring exercise



Figure 6: Eccentric squat

STATISTICAL INTERPRETATION

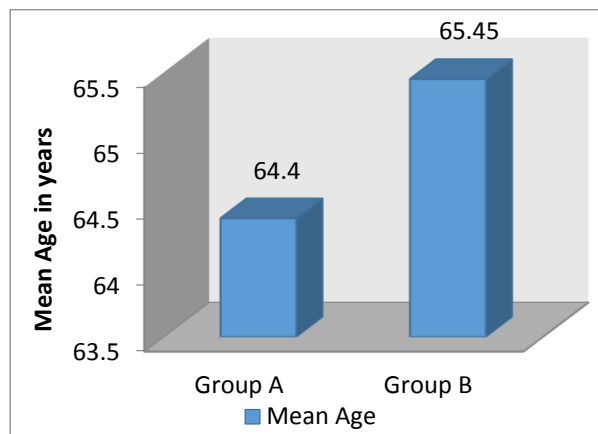
All analysis was carried out in SPSS windows Version 20.0. An alpha-level of 0.05 was used to determine statistical significance. Paired t-test was performed to find effectiveness of isometric exercise and combined concentric-eccentric exercise. Independent sample t-test was carried out to compare isometric exercise and combined concentric-eccentric exercise.

Demographic Representation of Data:

Demographic information of the study population is outlined in the table below.

Group A	Age (Mean \pm SD)	64.40 \pm 5.78
	Gender (Male : Female)	7 : 13
Group B	Age (Mean \pm SD)	65.45 \pm 6.69
	Gender (Male : Female)	2 : 3

Table 1: Demographic information

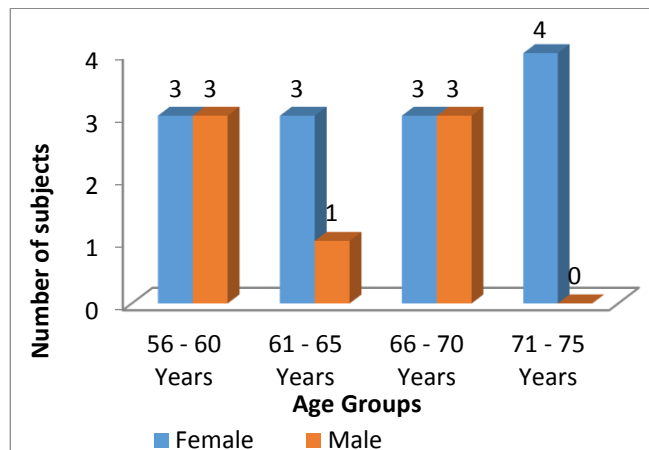


Graph 1: Mean age of subjects of Group A and Group B

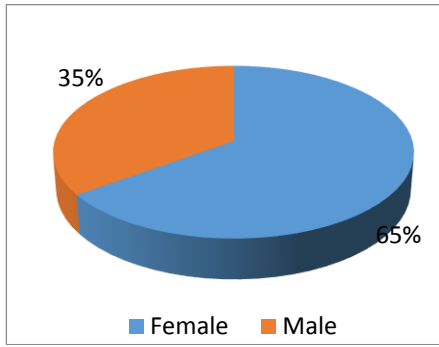
Age Group	Gender of Group A		Total
	Female	Male	
56 - 60 Years	3	3	6
61 - 65 Years	3	1	4
66 - 70 Years	3	3	6
71 - 75 Years	4	0	4
Total	13	7	20

Table 2: Age and Gender Distribution of the subjects of Group A

Out of 20 subjects in Group A, there were 7 males and 13 females with mean age of 64.4 years ranging from 56 years to 75 years.



Graph 2.a: Distribution of Gender with respect to age in Group A

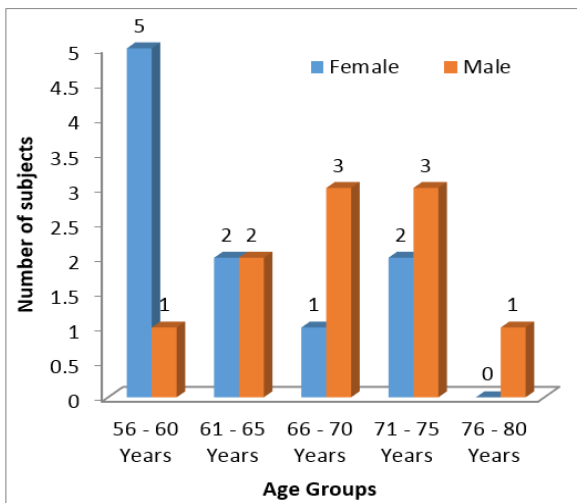


Graph 2.b: Male female ratio of Group A

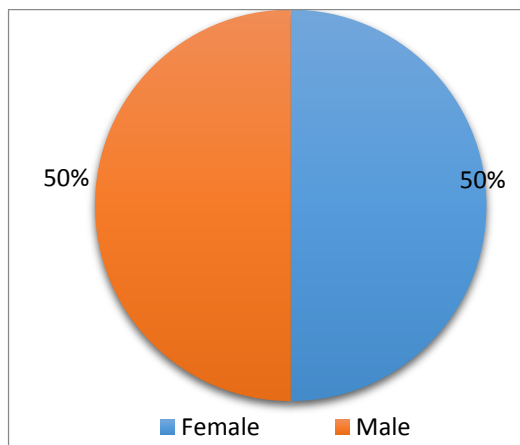
Age Group	Gender of Group B		Total
	Female	Male	
56 - 60 Years	5	1	6
61 - 65 Years	2	2	4
66 - 70 Years	1	3	4
71 - 75 Years	2	3	5
76 - 80 Years	0	1	1
Total	10	10	20

Table 3: Age and Gender Distribution of the subjects of Group B

Out of 20 subjects in Group A, there were 10 males and 10 females with mean age of 65.45 years ranging from 56 years to 76 years.



Graph 3.a: Distribution of Gender with respect to age in Group B



Graph 3.b: Male female ratio of Group B

Analysis and interpretation of data:

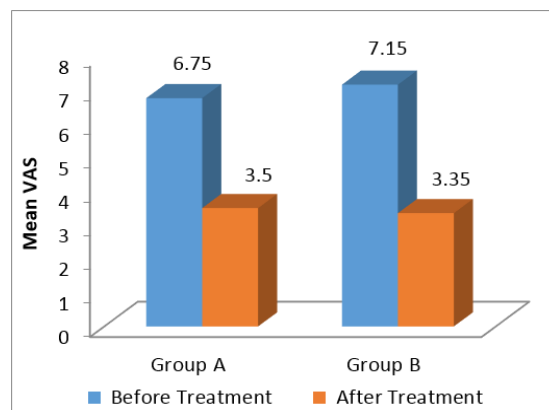
VAS		Mean \pm SD	N	t	df	p
Group A	Before Treatment	6.75 \pm 3.75	20	32.716	19	0.00
	After Treatment	3.50 \pm 2.15	20			
Group B	Before Treatment	7.15 \pm 5.15	20	32.484	19	0.00
	After Treatment	3.35 \pm 2.44	20			

Table 4: Group analysis within groups of Group A and Group B of VAS

The above table is constructed to see whether isometric exercise and combined concentric-eccentric exercise are effective in reducing pain and functional disability in knee osteoarthritis.

In Group A VAS decreased after application of isometric exercise. Paired t-test was performed to see the significance difference in VAS before and after treatment. It was found that in Group A, $t = 32.716$ which is highly significant ($p = 0.00$). We can say that there has been remarkable decrease in VAS after applying isometric exercise.

The value of t to find the difference in VAS before and after treatment in Group B was 32.484. This value is highly significant ($p = 0.00$). It has been found that VAS decreased significantly after applying combined concentric-eccentric exercise to the patients. In other words, combined concentric-eccentric exercise is highly effective in reducing pain and functional disability in knee osteoarthritis.



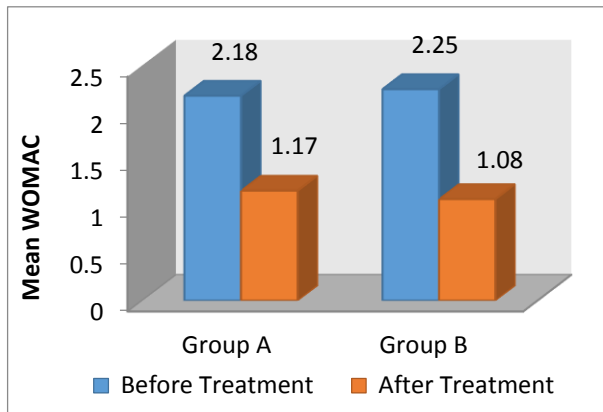
Graph 4: Mean VAS of Group A and Group B

WOMAC		Mean \pm SD	N	t	df	p
Group A	Before Treatment	2.18 \pm 0.35	20	15.499	19	0.00
	After Treatment	1.17 \pm 1.17	20			
Group B	Before Treatment	2.25 \pm 0.341	20	14.187	19	0.00
	After Treatment	1.08 \pm 0.06	20			

Table 5: Group analysis within groups of Group A and Group B of WOMAC

To see the difference in WOMAC before and after application of isometric exercise and combined concentric-eccentric exercise, paired t-test was performed. In Group A, value of t has come out to be 15.449. This value of t is highly significant ($p = 0.00$). We can thereby say that WOMAC decreased significantly after applying isometric exercise.

The table above shows that WOMAC decreased significantly in Group B after applying combined concentric-eccentric exercise. The value of $t = 14.187$ and it is highly significant ($p = 0.00$).



Graph 5: Mean WOMAC of Group A and Group B

RESULTS AND DISCUSSION:

The assumption of difference in the effects of Isometric Exercises (Group A) and Combined Concentric-Eccentric Exercises (Group B) in reducing pain and functional disability in patients with knee osteoarthritis were tested by comparing VAS and WOMAC values between the groups. It was observed that there was a significant decrease in both Group A and Group B with means (6.75 ± 3.75 and 7.15 ± 5.15) for VAS and (2.18 ± 0.35 and 2.25 ± 0.341) for WOMAC. The mean age of the sample for both Group A and Group B was 64.40 ± 5.78 and 65.45 ± 6.69 (years). There was no significant difference in the mean age between the two treatment groups. After the intervention considerable change was observed in the mean values of Group A and Group B from that of baseline values (VAS and WOMAC).

Statistical analysis revealed a significant decreased in pain in both groups. In Group A, VAS decreased after application of isometric exercise. Paired t-test was performed to see the significance difference in VAS before and after treatment. It was found that in Group A, $t = 32.716$ which is highly significant ($p = 0.00$). We can say that there has been remarkable decrease in VAS after applying isometric exercise. The value of t to find the difference in VAS before and after treatment in Group B was 32.484. This value is highly significant ($p = 0.00$). It has been found that VAS decreased

significantly after applying combined concentric-eccentric exercise to the patients.

Statistical analysis revealed a significant decreased in functional disability in both groups. In Group A, value of t has come out to be 15.449. This value of t is highly significant ($p = 0.00$). We can thereby say that WOMAC decreased significantly after applying isometric exercise. For Group B after applying combined concentric-eccentric exercise, the value of $t = 14.187$ and it is highly significant ($p = 0.00$). It also shows that WOMAC also decreases significantly after applying combined concentric-eccentric exercises.

Results of the study revealed that there was a significant difference in reducing pain and functional disability who were treated with Combined Concentric-Eccentric Exercises (Group B) with mean being 3.35 ± 2.44 and 1.08 ± 0.06 on 8th week as compared to patients treated with Isometric exercises (Group A) with mean being 3.50 ± 2.15 and 1.17 ± 1.17 on 8th week.

Both the groups showed significant improvement in decreasing pain and functional disability. But mean scores of Group B showed greater improvement in reducing pain and functional disability as compared to Group A in patients with knee osteoarthritis.

Hakan Gur et al, done a study to compare the effects of concentric versus combined concentric-eccentric isokinetic resistance training on functional capacity and symptoms of patients with osteoarthritis of both knees. The results suggest that with the isokinetic resistance training used in this study, it was possible to improve functional capacity and decrease pain in patients with Osteoarthritis of the knee.¹⁹

Paula R.M.S.Serrao et al. In their study, 21 men with knee osteoarthritis grades I or II (according to Kellgren and Lawrence criteria) were participated. Concentric and eccentric knee extensor torque were assessed using a Biodex System 3 Pro isokinetic dynamometer, at a speed of $90^{\circ}/s$. Self reported symptoms and disability were assessed using WOMAC questionnaire. They found out that concentric and eccentric knee extensor torque is significantly correlated with self report symptoms of patients in initial stages of knee osteoarthritis. Therefore, the strengthening of the quadriceps muscles, through concentric and eccentric exercise is indicated for patients in order to minimize the symptoms of pain, stiffness and function.²⁰

CONCLUSION

Both the groups showed significant improvement in decreasing pain and functional disability. But

mean scores of Group B showed greater improvement in reducing pain and functional disability as compared to Group A in patients with knee osteoarthritis.

Thus the results suggest that a combined concentric-eccentric exercise is more effective than isometric exercises in reducing pain and functional disability in knee osteoarthritis.

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