



“EFFECT OF QUADRICEPS AND HIP ABDUCTOR STRENGTHENING VERSUS QUADRICEPS AND HIP ABDUCTOR WITH HIP EXTENSOR STRENGTHENING ON PAIN AND FUNCTION IN OSTEOARTHRITIS OF KNEE: A COMPARATIVE STUDY”

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ABSTRACT

Background: Osteoarthritis (OA) is a degenerative joint disease that leads to a reduction in joint space between two articulating surfaces, mainly due to wear and tear. The knee is the most commonly affected joint with osteoarthritis, with its prevalence increasing with age. The most common signs and symptoms of osteoarthritis are pain and difficulties in activities of daily living (ADL). Current physical therapy management for knee OA aims to reduce pain and improve functional ability. Decreasing joint space leads to pain, stiffness, swelling, and activity limitations. Thus, prevention and treatment of osteoarthritis are the specific goals of rehabilitation in patients with osteoarthritis.

Objective: The main objective of this interventional study was to compare and determine the effects of quadriceps and hip abductor strengthening versus quadriceps and hip abductor strengthening with hip extensor strengthening on pain and function in osteoarthritis patients.

Method: Twenty patients from the population of 40–80 years of age with knee OA have been recruited and randomly allocated into 2 groups. Then subjects in Group A (n = 10) received quadriceps and hip abductor strengthening exercises, and Group B (n = 10) received quadriceps and hip abductor strengthening exercises. Both groups were given hot packs before the exercises for 20 minutes. The treatment period was 4 weeks for both groups. The outcome measures taken for this study were the Numerical Pain Rating Scale (rest and activity), the XI Pain Pressure Threshold of the knee joint, and the WOMAC scale. They were taken before and after the completion of the intervention, that is, from the 1st day to the 24th day.

Results: There was a significant effect found in the within-group analysis comparison, and there was no significant difference found in the between-group analysis of NPRS at rest, NPRS at activity, pain pressure threshold, and WOMAC scale.

Conclusion: Both groups showed a significant effect with intervention. There was no statistically significant additional effect observed in reducing pain and functional performance in patients with knee osteoarthritis.

Key Words: Knee osteoarthritis, hip muscle strengthening, hip muscle weakness, Numerical Pain Rating Scale (NPRS), pain pressure threshold (PPT), WOMAC Scale.

INTRODUCTION

The word "osteoarthritis" originated from the Greek words "osteo" meaning "bone", "arthro" meaning "joint", and "itis" meaning inflammation. Osteoarthritis is a chronic joint disease with a multifactorial aetiology involving changes in bone alignment, cartilage, and structures necessary for joint stability.^[1] Osteoarthritis (OA), also called degenerative joint disease, is the most common form of chronic disorder of the synovial joints.^[2]

Most cases of osteoarthritis have (age-related) unknown causes and are referred to as primary osteoarthritis. Primary osteoarthritis is mostly related to aging. It can be present as localized, generalized, or erosive OA. Primary osteoarthritis occurs in the elderly, more commonly in women than in men.^[2] When a cause of osteoarthritis is known, the condition is referred to as secondary osteoarthritis. Secondary osteoarthritis is caused by another underlying disease or pathology.^[3] The exact etiology is still unknown, but multiple factors like age, sex, obesity, genetics, bone density, cigarette smoking, local factors, and joint location have a major effect on osteoarthritis.^[4] OA is characterised by involvement of the whole joint, cartilage degradation, bone remodeling, osteophyte formation, and synovial inflammation. Pathological changes in the late stage of OA include softening, ulceration, and focal disintegration of the articular cartilage. It may lead to pain, stiffness, swelling, and loss of normal function.^[5] Typical clinical symptoms are pain, particularly after prolonged activity and weight-bearing, whereas stiffness is experienced after inactivity.^[3] Osteoarthritis is the second most common rheumatologic problem and it is the most frequent joint disease, with a prevalence of 22% to 39% in India. In India, the crude prevalence of clinically diagnosed knee OA was higher in the urban

(5.5%) than in the rural community (3.3%). The joint most commonly affected by osteoarthritis is the knee joint. Knee OA is defined as a clinical syndrome of joint pain accompanied by varying degrees of functional limitation and a reduced quality of life. OA of the knee is a major cause of mobility impairment, particularly among females. The overall prevalence of knee OA was found to be 28.7%.^[6] KOA patients mostly suffer from progressive stiffness and knee pain. Gradually, they experience difficulties in performing daily activities, such as walking, squatting, climbing, and doing housework, to varying degrees.^[7] Radiological findings remain the mainstay of the diagnosis of OA knee. An X-ray shows the reduction in the medial joint space and osteophyte formation more commonly.^[1] The most widely used classification scheme for OA is based on the radiological appearance of the joint, as given by Kellgren and Lawrence, using an ordinal scale of five levels.^[8] In previous studies, alignment was associated with tibiofemoral osteoarthritis progression. This study tested whether alignment influences the risk of incident and progression of radiographic features in tibiofemoral osteoarthritis. Varus and valgus alignment increase medial and lateral tibiofemoral load.^[9]

Conservative treatment is advocated in patients with mild to moderate OA of the knee. Since pain, muscle weakness, and physical dysfunction form a vicious circle in OA of the knee, and since muscle weakness is also associated with pain and physical dysfunction and influences the progression of the disease, muscle strengthening exercise may be of primary importance in the prevention and treatment of OA of the knee.^[10] For the rehabilitation of OA patients, exercise, modification of activities of daily living, pharmacotherapy, alternative medicine, and surgery are all treatment modalities that should be considered. Pain is the primary symptom of arthritis, and multiple medications are available to relieve pain and improve function.^[11-12-13-14-15] Management of chronic knee OA symptoms primarily includes pharmacological, physiotherapeutic, and surgical interventions. Considerable evidence in the literature confirms that strengthening exercises should be employed in the treatment of knee OA. However, there is some disagreement about which exercises are the most appropriate and beneficial in meeting the needs of the OA patient. Traditional exercises tend to focus on the isolation of one or more muscle groups (e.g., quadriceps) in an attempt to address the impairment. Alternately, functional task training focuses on the activity level by strengthening and adapting postural strategies to environmental demands through functional task performance.^[6]

As OA spans decades of a patient's life, patients with OA are likely to be treated with a number of different pharmaceutical and non-pharmaceutical interventions, often in combination. Exercise is strongly recommended for OA knee patients.^[16] Hip abductor strengthening is found to relieve pain and improve function in KOA patients.^[7] Exercises specifically aimed at muscle strengthening have been used as the cornerstone of most exercise rehabilitation programs, and the American College of Rheumatology (ACR) recommends strengthening exercise for the management of knee OA symptoms.^[17] Strength training is presumed to protect the joints from pathologic stress and loading. Programs to strengthen knee extension and flexion have resulted in significant strength gains and appear to reduce pain and improve function. The beneficial effects of resistive exercise for individuals with OA may be attributed to several associated factors, such as: facilitation of endogenous opiates, which create an analgesic effect to improve a person's tolerance to pain; a decrease in depression coupled with a perceived level of disability, through associated weight loss; or mechanically, through alteration of the biomechanics of the joint.^[18] There is ample evidence demonstrating that muscle-strengthening exercises result in improvements in pain, physical function, and quality of life in people with knee OA.^[19] Some researchers

have suggested that there is hip muscle weakness in OA knee patients. Subjects with knee OA have significant muscle impairments. These muscle impairments affect physical function and should be targeted in therapy.^[19] Patients with knee OA typically present with reduced force-generating ability in the quadriceps that can be attributed to muscular atrophy as well as muscular inhibition, which results in an inability to fully and volitionally activate the muscle.^[20] There is some evidence to suggest that quadriceps weakness precedes the onset of knee OA and hence could increase the risk of disease development, particularly in women.^[19] Assessment of quadriceps function remains the gold standard of muscle assessments in knee OA research. Subjects with knee OA also have well-documented hamstring strength deficits; isometric deficits range from 4% to 35%. During concentric isokinetic tests, deficits ranged from 7% to 38%. Hip muscle strength in subjects with knee OA shows isometric deficits ranging from 16% in extension to 27% in external rotation.^[19-20-21] Concentric isokinetic deficits range from 22% in hip abductors to 64% in hip extensors.^[20]

AIMS OF THE STUDY

To find the effectiveness of quadriceps and hip abductors muscle strengthening versus quadriceps and hip abductors with hip extensor muscle strengthening on pain and functional performance in patients with knee osteoarthritis.

NEED OF THE STUDY

There is huge amount of research available on hip muscle weakness in OA knee patients.^[20-22] Large scale research available on strengthening exercise, improving pain and functional activity.^[7] Based on the various evidence, it is concluded that quadriceps and hip abductor muscle strengthening are effective in OA knee, however very few studies analyzed the additional effect of extensor muscle strengthening exercise in OA knee patients. Hence, the purpose of this research was to compare the effects of quadriceps and hip abductor muscle strengthening versus quadriceps and hip abductor along with hip extensor muscle strengthening on pain and function in OA knee patients.

RESEARCH METHODOLOGY

- ❖ **SOURCE OF DATA** : Govt. Physiotherapy college & G.G. Hospital, Jamnagar
- ❖ **STUDY DESIGN** : A Comparative Interventional Study
- ❖ **SAMPLING TECHNIQUE**: Simple Random sampling
- ❖ **SAMPLE SIZE** : 20
- ❖ **STUDY POPULATION** : OA knee patients
- ❖ **STUDY SETTING** : Government Physiotherapy College, Jamnagar
- ❖ **DURATION OF STUDY** : 1 year

Inclusion Criteria

- ❖ Patient willing to take part in the research
- ❖ People who have been diagnosed with OA knee by their doctor or an orthopaedic surgeon
- ❖ Both male and female.
- ❖ Age range: 40–80 years

Exclusion Criteria

- ❖ Knee joint diseases other than OA or any other musculoskeletal problems associated with the knee joint, such as fractures, tendon or ligament tears, meniscus injury, rheumatoid arthritis, etc.
- ❖ During the physical examination, severe varus or valgus deformity, ankylosis, intense synovitis, and other knee joint abnormalities were discovered.
- ❖ OA of the hip joint or the foot joints
- ❖ Intra-articular corticosteroid or hyaluronic acid injections during the last six months.
- ❖ Previously undergone knee surgery.
- ❖ Central or peripheral neuropathy.
- ❖ Uncooperative patients.

Method and material

- ❖ Consent form
- ❖ Pen
- ❖ Plinth
- ❖ Pillow
- ❖ Towel
- ❖ Hot packs
- ❖ Stepper Numerical Pain Rating Scale (NPRS)
- ❖ Sand bags (weight cuffs)
- ❖ Threshold of Pain Pressure
- ❖ Western Ontario and McMaster Universities' Osteoarthritis Index (WOMAC) Scale
- ❖ Case Record Form

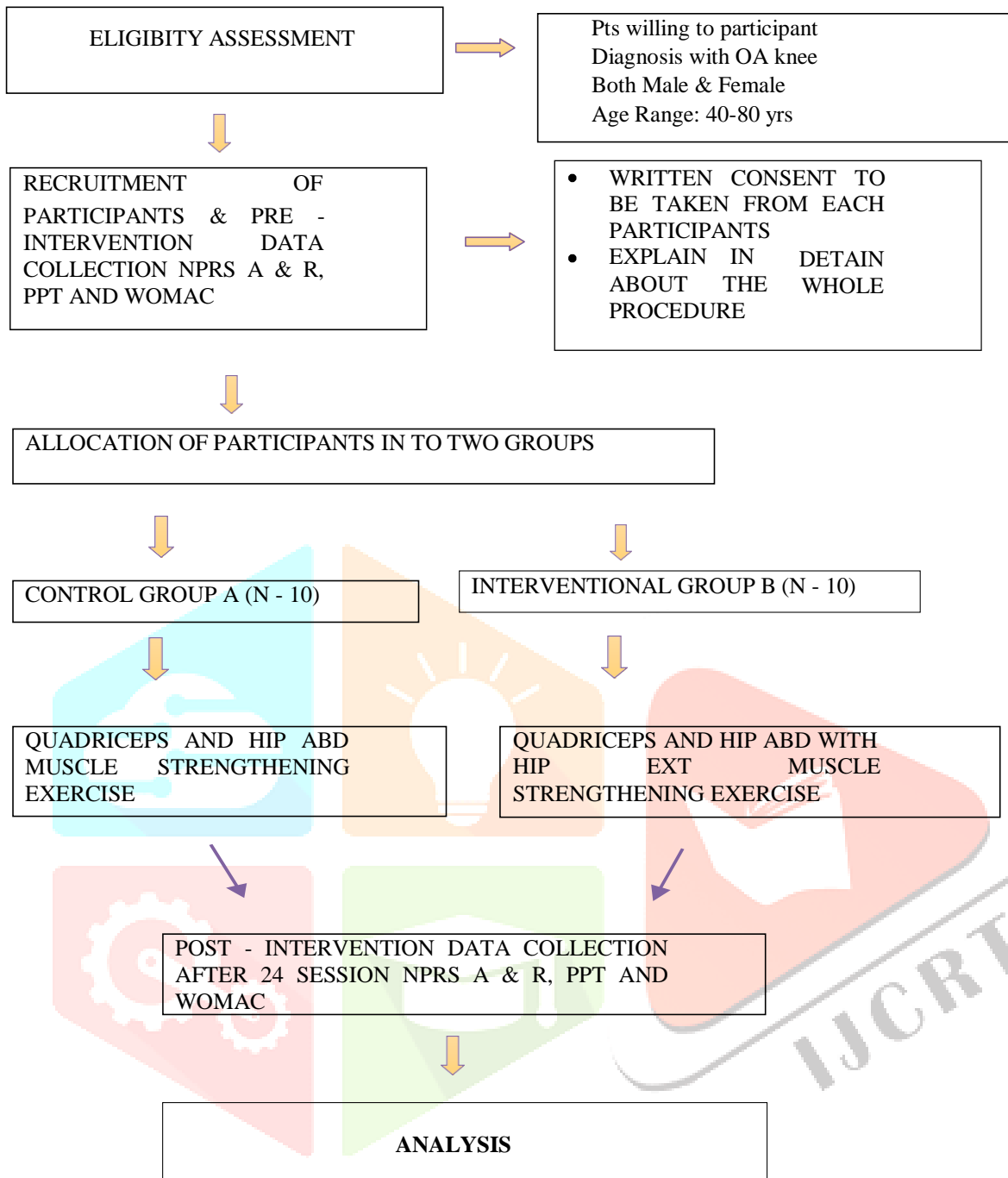
METHODOLOGY

Ethical clearance was obtained from the ethical committee of M P Shah medical College, Jamnagar (Ref. No. IEC/Certi/126/04/2019).

Twenty patients falling under the inclusion criteria were selected with informed consent, and then the patients were divided into two groups, A and B, with group A: quadriceps and hip abductor muscle strengthening exercises and group B: quadriceps and hip abductor with hip extensor muscle strengthening exercises given. Patients were treated with one session per day for four weeks (24 sessions). A Numerical Pain Rating Scale (rest and activity) was taken to measure pain intensity, a pain intensity check of the knee joint was measured by PPT, and the WOMAC scale was taken to measure functional activity.

Strengthening exercises for both groups were based on the 10 RM. To measure the 10RM, he first told the subjects to perform active exercise for warm up and then explained the whole procedure. The initial weight, which was within 50%–70% of the subject's perceived capacity, was selected to start the testing. The weight was progressively increased by 500 grammes until the subject could perform 10 repetitions with it in their available active range and could not perform the 11th repetition, or if they could perform the 11th repetition, the range decreased. This is how the 10RM was determined for each and every shoulder movement within four trials, with 3-5 minutes of rest in between trials to prevent fatigue.^[50]

For the knee extensor, I instructed the patient to sit on a plinth with their backs against the wall and perform 10 repetitions of knee extension in the available range with weights while avoiding trick movements. I told the patient to lie down on his/her unaffected side and asked to do 10 repetitions of hip abduction in the available range with weights, avoiding trick movements. For hip extensors, I instructed the patient to lie down in a prone position and perform 10 repetitions of hip extension with weights in the available range, avoiding trick movements. On the first day, each patient was assessed using the WOMAC scale, PPT, and NPRS scale.

CLINICAL INTERVENTION**fig – 1 trial protocol**

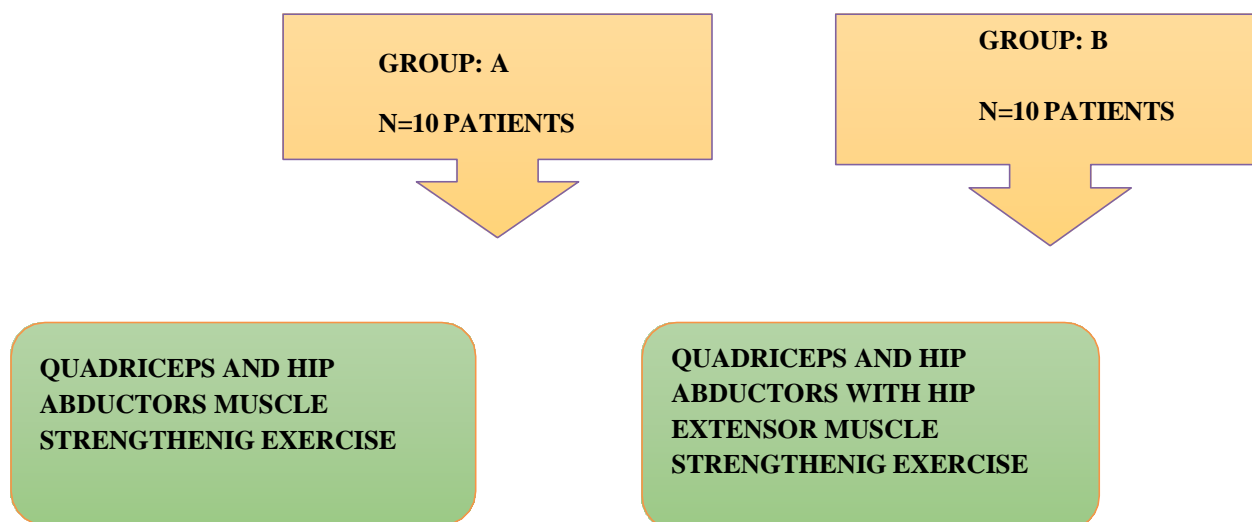


fig : 2 group a and group b therapeutic protocol

GROUP- A:

Quadriceps and hip abductors muscle strengthening exercise.^{[7][23]}

Quadriceps Setting Exercise :- Patients position and procedure: The patient was positioned in supine lying with knee extended. A rolled towel was placed under the knee and patient was asked to contract the quadriceps isometrically, causing the patella to glide proximally; then hold for a count of 10 for 10 repetition.

Short-Arc Terminal Knee Extension :- Patients position and procedure: The patient was positioned in supine lying. A pillow was placed under the knee to support it in flexion. The patient was asked to do terminal knee extension and then hold for a count of 10 for 10 repetitions.

Quadriceps muscle strengthening Exercise :- Patients position and procedure: The patient was positioned in high sitting. The patient was asked to extend the knee from 90 °flexion to full extension and then hold for a count of 10 for 10 repetitions. Weight cuff was tied around the ankle joint.

Hip Abductor muscle strengthening Exercise^[7] :-Patients position and procedure: The patient was positioned in side lying. The patients lie down on the unaffected side on plinth, with the weight cuff positioned around the ankle joint of the affected limb. Patients raise the affected lower limb for about 30 degrees, and then hold for a count of 10 for 10 repetitions.

Each exercise was repeated 3 sets of 10 repetitions. The patient rested 1-2 minute after the completion of each set. Hot packs were used for symptomatic relieve and given 20 minutes before the exercises.



fig.: 3 quadriceps setting exercise



fig.: 4 short-arc terminal knee extension



fig.: 5 hip abductor muscle exercise



fig.: 6 quadriceps muscle exercise

GROUP -B :

Quadriceps and hip abductors with hip extensor muscle strengthening exercise.

Same exercise group A and additional exercise is hip extensors muscle exercise.

Position and procedure of the patient: The patient was positioned prone lying. In the prone position, subjects were asked to lie prone on a height-adjustable table; the therapist adjusted the height of the table prior to testing to allow the therapist to produce the best exertion. The initial testing position of the leg was with the hip in hyperextension at 20° and the knee in full extension^[52] and then held for a count of 10 for 10 repetitions. A weight cuff was tied around the ankle joint.



fig.: 7 hip extensor muscle strengthening exercise.

Both the Group in Each exercise was repeated 3 sets of 10 repetitions. The patient rested 1-2 minute after the completion of each set. Hot packs were used for symptomatic relieve and given 20 minutes before the exercises.

OUTCOME MEASURES

- ❖ The Numerical Pain Rating Scale^[24]
- ❖ Pain Pressure Threshold^[25]
- ❖ WOMAC Scale: [26-27-28-29]

RESULTS AND ANALYSIS

- ❖ Statistical analysis was done using SPSS version 20, Microsoft Excel (2013) and SPSS were used to generate tables and graphs.
- ❖ The mean was calculated as a measure of central tendency for NPRS-R, NPRS-A, PPT, and WOMAC. The standard deviation was calculated as a measure of dispersion. The level of significance was kept at 5% with a confidence interval (CI) of 95% (P value = 0.05).

- ❖ The Shapiro test was performed, taking the pre-outcome measure, and the P value was > 0.05 for NPRS-R, NPRS-A, PPT, and WOMAC. This showed that the following outcome measure in both groups was normally distributed.
- ❖ So, NPRS-R, NPRS-A, PPT, and WOMAC, parametric test T-test were used.
- ❖ In both group within group comparison and group analysis after 24 sessions of intervention for NPRS-R, NPRS-A, PPT, and WOMAC, the paired T-test was used.
- ❖ In between-group comparison of data, an unpaired T-test was applied.

Table: 1 age, height, weight and bmi distribution in two groups

	Group	N	Mean	SD	P value
AGE (years)	1	10	56.60	12.22	0.432
	2	10	60.90	11.68	
HEIGHT (meter)	1	10	1.47	0.062	0.04
	2	10	1.56	0.11	
WEIGHT (kg)	1	10	68.40	15.55	0.30
	2	10	75.70	15.01	
BMI (kg/m ²)	1	10	31.30	5.63	0.8
	2	10	30.79	4.85	
Gender	1	10	1.00	0.00	0.00
	2	10	1.70	0.483	

The above table shows the mean \pm SD of age, Weight, BMI shows $p > 0.05$ for all data so baseline data was comparable. But gender and height shows $p < 0.05$ so the baseline data was not same baseline distributed.

Table: 2 group: a within group comparison

Parameter	Pre (mean \pm SD)	Post (mean \pm SD)	t value	P value	Significance
NPRS-R	5.40 \pm 1.77	2.30 \pm 2.45	5.47	0.00	Significant
NPRS-A	6.60 \pm 1.35	4.30 \pm 1.82	6.86	0.00	Significant
PPT	1.85 \pm 0.73	2.49 \pm 0.81	3.32	0.009	Significant
WOMAC	44.80 \pm 17.35	24.10 \pm 13.84	5.65	0.00	Significant

The above shows results show significant difference for pre and postparameter ($p < 0.05$).

Hence, the null hypothesis was rejected and alternate hypothesis was accepted for the withingroup-A comparison.

Table: 3 group: b within group comparison

Parameter	Pre (mean \pm SD)	Post (mean \pm SD)	t value	P value	Significance
NPRS-R	5.60 \pm 1.07	3.10 \pm 2.02	3.92	0.003	Significant
NPRS-A	5.90 \pm 0.99	3.90 \pm 1.37	9.487	0.00	Significant
PPT	1.86 \pm 0.56	2.41 \pm 0.59	-2.55	0.031	Significant
WOMAC	27.40 \pm 11.62	15.30 \pm 6.21	5.96	0.00	Significant

The above table shows results show significant difference for pre andpost parameter ($p < 0.05$).

Hence, the null hypothesis was rejected and alternate hypothesis was accepted for the withingroup-B comparison.

Table: 4 between group comparison of group: a and group: b

PARAMETERS	MEAN DIFFERENCE ± SD		t value	P value	Diffrence
	GROUP:1	GROUP:2			
NPRS-R	-3.10±1.79	- 3.10±0.87	0.00	1.000	non- significant
NPRS-A	-2.30±1.05	- 2.00±0.66	0.75	0.458	non- significant
PPT	0.63±0.6	0.55±0.67	0.30	0.767	non- significant
WOMAC	-20.70±11.58	- 12.10±6.42	-2.05	0.055	non-significant

The above table shows all parameter of both group: 1 &2 showed that $p > 0.05$. Hence, the null hypothesis was accepted for the between group comparison.

GROUP - A: The above findings suggest that there was significant improvement in post-intervention findings in NPRS-R, NPRS-A, PPT, and WOMAC in patients with OA knee.

GROUP - B: The above findings suggest that there was significant improvement in post-intervention findings in NPRS-R, NPRS-A, PPT, and WOMAC in patients with OA knee.

BETWEEN

GROUP : According to the findings, there was no significant improvement between groups.

DISCUSSION

The intent of the present study was to find out the effect of quadriceps and hip abductor strengthening versus quadriceps and hip abductor with hip extensor strengthening on pain and function in OA knee patients.

The results of this study suggest that there was a significant improvement in both the within groups. But there was no significant difference between the groups.

The quadriceps and hip abductor strengthen the pain and improve function in knee osteoarthritis patients.^[9] During walking, weak hip abductors of the stance limb produce a pelvic drop on the swing limb and stance knee varus angulation that shifts the line of gravity (LOG) away from the stance knee. This LOG shift increases the knee adduction moment and the medial joint compressive forces, leading to progressive degeneration. Besides, hip adductor muscles may eccentrically counteract the varus angulation of the knee and, consequently, might unload the medial tibiofemoral joint.

The hip extensor muscles create a hip extension moment, which improves the metabolic efficiency during walking. Hip extension, by virtue of the posteriorly placed LOG, maintains the knee joint in extension. The position of knee extension lessens the demand on the knee musculature and thereby reduces the muscle-induced compressive forces on the knee joint. Also, strong hip external rotators produce less transverse plane excursion of the knee joint and attenuate the vertical ground reaction forces in female athletes. The reasons mentioned earlier suggest that hip muscle strength can affect knee joint loading and disease progression in people with knee OA. Considering the strength deficits in the hip muscles, a targeted exercise program for hip muscle strengthening might reduce the medial compartment loading and improve knee symptoms.^[30]

Yujie Xie, Chi Zhang, Wei Jiang, Juan Huang, Lili Xu et al. (2018)^[7] have studied quadriceps combined with hip abductor strengthening versus quadriceps strengthening in treating knee osteoarthritis: a study protocol for a randomised controlled trial. In 80 patients with knee OA, they concluded that hip abductor strengthening relieved pain and improved function in KOA. The main difference between the two studies is the method of treatment. In the first, they gave strengthening by the elastic band, and in the present study, treatment based on the PRE protocol was given by sand bags. Therefore, this difference in the method of the treatment could affect the result of the present study. In both the studies, The sample size and duration are also different, so that could affect the result of the present study.

Thiago Yukio Fukuda, William Pagotti Melo et al. (2012)^[31] have studied Hip Posterolateral Musculature Strengthening in Sedentary Women With Patellofemoral Pain Syndrome: A Randomized Controlled Clinical Trial With 1-Year Follow-up. They concluded that hip posterolateral musculature–strengthening exercises were more effective than knee exercises alone in improving long-term function and reducing pain in sedentary women

with PFPS. The main difference between the two studies is that the former was done in PFPS and the present study was done on KOA, so the study population could be the reason for the difference in the results contrasted with the present study. The method, age, and treatment duration were also different as compared to the present study. So, that could affect the result of the present study.

Victor Lun, Andrew Marsh, et al. (2015) [32] have studied the efficacy of hip strengthening exercises compared with leg strengthening exercises on knee pain, function, and quality of life in 72 patients with knee osteoarthritis. They concluded that both types of treatment exercise programmed similarly improve knee pain, function, and QOL. They gave generalized hip muscle strengthening and, in the present study, focused on hip extensor muscle strengthening exercise, but there was no additional effect on pain and function. As a result, this finding supports and justifies the findings of the current study. In both the studies, the sample size and duration are also different, so that could affect the result of the present study. Hence, hip extensor muscle strengthening exercise shows no additional effect on pain and function in OA knee patients.

CONCLUSION

In this current research Group A received quadriceps with hip abductor strengthening exercises along with conventional exercises, and Group B received quadriceps with hip extensor strengthening exercises along with conventional exercises, and both groups showed a reduction in pain and improved functional activity of the patients with knee osteoarthritis. As a result, it was determined that hip extensor muscle strengthening exercise had no additional effect on pain and functional activity in patients with knee osteoarthritis.

CLINICAL IMPLICATION

Quadriceps and hip abductor strengthening in Group A; quadriceps and hip abductor strengthening in Group B. In the present study, the effect was found in both groups. So, hip extensor muscle strengthening does not have additional beneficial effects.

LIMITATION OF THE STUDY

- Male-Female ratio was unequal
- Small sample size
- Study duration was short
- Onset and severity of the disease was not taken into account in the study.

FUTURE RECOMMENDATIONS

- Comparison with a large sample size
- Studying can be done by considering different grades of knee osteoarthritis.
- A study can be conducted to determine the long-term effects of these exercises.

RESEARCH IMPACT / POTENTIAL CONTRIBUTION OF KNOWLEDGE

- A new paradigm for improving the physical function and pain at personal, societal, and global level
- Reduce the burden of disease globally as rate of disability may reduce by reducing the pain and improving the physical function and increasing the physical activity level.
- This research will strengthen the science of integrating evidence-based interventions into regular rehabilitation practice.

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