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## Effectiveness of Mckenzie exercise versus VMO strengthening exercise on physical function in subjects with knee osteoarthritis

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### Abstract

**Background:** Osteoarthritis (OA) is a slowly progressive joint disease that is typically seen in middle aged to elderly people. Due to the high physical and economic burden of knee OA, the effectiveness of conservative interventions and determining those patients who will respond to them should be investigated

**Objective:** To compare the effectiveness of Mckenzie exercise versus VMO exercise with ultrasound on pain and physical function in subjects with knee OA.

**Method:** 30 participants with OA knee were allocated into two groups (15 participants in each group). Group A were given Mckenzie exercise and Group B was given Vastus medialis obliques muscle exercise. The outcome measures used were Western Ontario Mc University Osteoarthritis Index (WOMAC). The treatment was given for 3 weeks.

**Result:** In group A WOMAC score improved from 54.40 to 39.23 ( $p < .001$ ) which were statistically significant. In Group B the pre WOMAC score improved from 56.73 to 47.20 ( $p < .001$ ). When compared between the groups, the WOMAC total scores showed statistically significant difference. However, the stiffness sub score of WOMAC did not show significant difference between the groups ( $p \text{ value} > .525$ )

**Conclusion:** Mckenzie exercise is better than VMO strengthening exercise on physical function in subjects with knee osteoarthritis.

**Keywords:** Osteoarthritis of knee, Mckenzie exercise, VMO exercise, Ultrasound, WOMAC

### Introduction

Osteoarthritis stands for "Arthritis of the joint". Osteoarthritis is a chronic degenerative disorder of multifactorial etiology characterized by loss of articular cartilage, hypertrophy of bone at the margins, subchondral sclerosis and range of biochemical and morphological alterations of the synovial membrane and joint capsule<sup>[1]</sup>.

Pathological changes in the late stage of OA include softening, ulceration and focal disintegration of the articular cartilage; synovial inflammation also may occur<sup>[2]</sup>.

Several studies has shown Knee arthritis usually progress with aging population. Higher rate of knee arthritis is most common among the elderly population of age in between 60s and 70s<sup>[1, 2]</sup>.

Knee Osteoarthritis is the second most common rheumatologic problem and is most frequent joint disease with prevalence of 22% to 39% in India. According to the Johnston county project, a long term study from University of North Carolina, the lifetime risk of developing OA knee is about 46% and the lifetime risk of developing OA of the hip is 25%<sup>[3]</sup>. Arthritis may be caused by a variety of factors, including older age, female sex, obesity, osteoporosis, occupation, sports activities, previous trauma, muscle weakness or dysfunction, proprioceptive deficit and genetic factors<sup>[4]</sup>. And other factors like the popular squatting position in India, obesity, sedentary lifestyle and poor diet<sup>[5]</sup>.

Typical clinical symptoms are pain, particularly after prolonged activity and weight bearing; whereas stiffness is experienced after inactivity<sup>[2]</sup>. It is probably not a single disease but represents the final end result of various disorders as joint failure. It is also known as degenerative arthritis, which commonly affects the hands, feet, spine, and large Weight-bearing joints, such as the hips and knees<sup>[1-3]</sup>.

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Most cases of osteoarthritis have no known cause and are referred to as primary osteoarthritis.

Primary osteoarthritis is mostly related to aging. It can present as localized, generalized or as erosive osteoarthritis. Secondary osteoarthritis is caused by another disease or condition [5]. In addition, individuals with knee OA often exhibit poor neuromuscular control, slower walking speed, decreased functional ability, and an increased susceptibility to falling [1, 2].

Conventional management includes pharmacological management such as NSAIDs, corticosteroids etc.; surgical management such as Arthroscopy, Joint Replacement (Arthroplasty), Joint fusion, Osteotomy, however it is indicated in later stage and physiotherapy management includes exercise therapy like Range of Motion exercises, Muscle Strengthening exercise, Manual Therapy, Bracing, and electrotherapy involves ultrasound, transcutaneous electrical nerve stimulation, and interferential therapy [6].

According to Carolyn Kisner and Lynn Allen Colby; Vastus Medialis muscle which is in itself one of the 4 components of the quadriceps muscle at the front of the thigh. The fibres of VMO have a more oblique alignment than the other fibres of Vastus Medialis, and are particularly important in patello-femoral (kneecap) problems. VMO is an active and dynamic stabiliser of the patella. In healthy, pain free individuals the fibres of VMO are active throughout the range of movement. In patients with patella (kneecap) problems the fibres contract in phases, out of time, weakly and fatigue easily. The specific role of VMO is to stabilize the patella within its groove and to control of the, tracking "of the patella when the knee is bent and straightened. Mis-firing and weaknesses in the VMO cause mal-tracking of the patella and subsequent damage to surrounding structures and aching pain. The key to solving this problem is both getting the timing of VMO right, and the relative strength compared with the rest of the quadriceps group.<sup>7</sup> Exercise is important in osteoarthritis management. It helps pain relief, maintaining stability of joint controls the effusion and improves the blood supply to the joint structures. During exercise there is release of endogenous opiates and thus relieves pain and improves muscle power. In osteoarthritis of knee the person complaints of pain in the joint and hence there is restriction of movements in the knee joint thus leading to atrophy of muscles. The first muscle to go for atrophy is vastus medialis oblique is muscle (VMO) [8]. Mode of exercise delivery has cost implications and may influence overall outcome.

A acronym for the Mckenzie method is mechanical diagnosis and therapy (MDT). The Mckenzie method was developed in 1981 by Robin Mckenzie. A basic philosophy of Mckenzie theory is that the reverse force can probably abolish the pain and restore the function. The Mckenzie method consists of 3steps: assessment, treatment and prevention. The assessment is received using repeated movements and sustained positions with the aim to elicit a pattern of pain responses, called centralization, the symptoms of the lower limbs and lower back are classified into 3 subgroups-: derangement syndrome, dysfunction syndrome and postural syndrome. The choice of exercises of Mckenzie method is based upon the direction. The aims of therapy are reducing pain, centralization of symptoms and the complete recovery of pain. The prevention step consists of educating and encouraging the patient to exercise regularly and self-care [9].

Murtezani A, Govori V, Meka VS, Ibraimi Z, Rrecaj, Gashi S conducted the study to compare Mckenzie therapy electrophysical agents for the treatment of work related low

back pain. Patients were randomized into 2 groups: the mckenzie group and electrophysical agents group. The treatment period of both groups was 4 weeks at an outpatient clinic. Mckenzie therapy reduces pain and disability among subjects with chronic low back pain [10].

Ultrasound (US) is a deep heating agent that has been widely used to reduce pain in patients with knee OA. US transforms electrical energy into an acoustic waveform, which is then converted into heat as it passes through tissues of varying resistances Biological responses to US therapy (UT), through thermal and non-thermal mechanisms, include elevation of the pain threshold, alteration of neuromuscular activity leading to muscle relaxation, induction of tissue regeneration, and reduction of inflammation [11].

In the spine, MDT type of treatment based classification has demonstrated effects superior to those of guideline based treatment and non-specific exercise therapy. The MDT assessment and management process in the spine has been shown to reduce the incidence of surgery in those with sciatica. Similarly patients with knee OA who were awaiting potential TKR benefited from exercise intervention. Pain decreased and physical function improved in the short and medium term to a greater extent than those of a control group given no exercise [12].

Richard Rosedale *et al* conducted the study to examine the effectiveness of MDT in knee OA. The intervention group, in which patients classified as having knee derangement received MDT directional exercise and patients classified as non-responders received Evidence - based exercise. Result concluded the patients with knee OA who were prescribed exercise based on MDT assessment had superior outcomes compared to those of waitlist.

Laprade J, Culham E, Brouwer B conducted the study advocated the effect of strengthening of the vastus medialis oblique (VMO) as a treatment patellofemoral pain syndrome. It compared the recruitment of vastus medialis oblique in persons with or without patello femoral pain in isometric exercise and found vastus medialis oblique recruitment in the former [13].

It is proved from the past studies that the traditionally VMO and ultrasound has shown its effectiveness on osteoarthritis knee. Similarly Mckenzie's MDT has been found effective in improving physical function and decreasing impairment in various knee conditions. However, there are no studies that show the superiority of one technique with respect to the other is still a question of interest. Due this lack of research, the need of this study is to compare the effect of Mckenzie exercise versus VMO strengthening with ultrasound in knee osteoarthritis.

## 2. Materials and Methods

The study was conducted at Acharya physiotherapy clinic, Bangalore. Ethical clearance was obtained from institutional ethical committee, as per ethical guidelines for biomedical research on Human subjects, 2000 ICMR, New Delhi. The study design was a pre-post experimental study. 30 participants with age ranging 40-55 years, both genders and subjects diagnosed with osteoarthritis by Orthopedician, onset of duration greater than 3 months and subjects with unilateral knee pain were included in the study. Subjects with cardiovascular, neurological disease, fever or tumor's, other knee pathology like tendinitis, bursitis etc. Surgery or arthroscopy within 3month prior to inclusion. Severe burns or joints deformities making the patient unable to walk. Intra articular steroids therapy within last 6 month. Any valgus or

varus deformity at knee joint were excluded from the study. Prior to participation, a written informed consent was taken from all subjects and subjects were informed about study protocol.

WOMAC questionnaire, chair, pen, paper, stop watch, ultrasound machine with 3 MHz, ultrasound gel, treatment couch, towel to perform VMO exercise were used for the study.

Outcome measures used were- Western Ontario McMaster University Osteoarthritis Index (WOMAC) for assessing the functional outcomes.

30 patients with OA knee subjects fulfilling inclusion criteria were taken. Informed consent was obtained from each of the subjects. Subjects were divided into two groups. GROUP A (MDT) consisted of 15 participants and were given McKenzie exercise and ultrasound. GROUP B (VMO) consisted of 15 participants and were given Vastus medialis obliques strengthening exercise and ultrasound. Pre-test values on WOMAC (Western Ontario University Osteoarthritis Index) test were taken for both the groups. Respective exercises on each group, as mentioned below were given for 4-6 physiotherapy session over a 2week period, for duration of 1 hour and follow up session for 20 minutes. Apart from the exercises, both the groups were given ultrasound therapy in continuous mode (1:4) with an intensity of 1.5w/cm<sup>2</sup> for duration of 8 minutes for 5 days. Post test value for each group was taken. Outcome values (WOMAC) obtained on each group were completed.

### In group A

During the MDT assessment process, both knee flexion and extension were assessed in the patient history and examination to determine the presence of a potential directional preference. The initial direction explored was determined by the therapist, based on the most painful direction, the most limited direction, the direction reported to bring relief. While giving exercise for the first time least load was given. So, for example, with flexion, flexion in sitting would be explored first. If the patient felt or functioned better following flexion, this were the exercise prescribed. If the patient was worse, then flexion was abandoned and extension explored. If the patient's symptoms were changed following the exercise, then more repetitions or more loading were been tried, and, in this case, the therapist could progress to knee flexion in standing or kneeling. When the patient reported improvement in pain or function, the examination was stopped and the specific exercise that generated the effect

were prescribed. The repetitions and frequency were typically 10 times every 2 to 3 hours. However, this varied depending on the patient's capabilities or the amount needed to obtain the desired effect. The exercises were supervised for the 2 weeks of physiotherapy sessions. The patients then continued these exercises unsupervised at home.

### In group B

US therapy were given for five days in continuous mode with intensity of 1.5 watts/cm<sup>2</sup> around the patella for a period of 8 minutes. After 5days subject were taught VMO strengthening exercise. Mainly three VMO exercise were taught to the patient. SLR with adduction of hip, SLR with external rotation of the hip, end range knee extension with towel roll under the knee. The patients were typically prescribed the strengthening exercises in 3 sets of 10 repetitions. The frequency varied between 3 to 4 times per week and 1 to 2 times per day; these were dependent on the patient's exercise tolerance, pain response, and preference. All of the following exercises were prescribed and monitored during the 2 weeks of physiotherapy sessions, after which they were continued unsupervised at home.

Data analysis was performed by SPSS (version 17) for windows.  $\alpha$  value was set as 0.05. Descriptive statistics was performed to find out mean, range, standard deviation for demographic variable and outcome variable. Chi-square test was performed to find out the gender difference among both groups and side involved. Unpaired t-test was used to find out the significant difference among demographic variables such as age, duration. Mann Whitney U test was used to find out significant differences at baseline between groups and to compare for WOMAC and its components. Wilcoxon signed rank sum test was used to find out significant difference within groups for WOMAC. Microsoft excel and word was used to generate groups and tables.

## 3. Results & Discussion

### 3.1 Results

Base line characteristics of 30 subjects for both groups are shown in Table 1. The Chi-square test was used for distribution of subjects according to gender and dominance in both groups. There was no significant difference in the proportion of subjects with knee osteoarthritis in both the groups i.e.  $p > 0.05$ . The difference in mean age of group A and group B was not significant difference. Thus the demographic variables were homogeneous in both the groups.

Table 1: Baseline data

Variable	Group A McKenzie exercise	Group B VMO exercise	p- value
Age	50.93±3.71	50.27±2.49	0.56
Gender (M/F)	8/7	7/8	0.774
Onset & duration	10.27±4.43	11.33±5.52	0.564

In table 2 group A for WOMAC the non-parametric Wilcoxon test was carried to compare the pre and post value and it showed significant improvement with P value <0.05.

In group B for WOMAC the non-parametric test was carried to compare the pre and post value and it was showed no significant improvement with P value >0.05.

Table 2: Pre and post difference within the group

Variables	Group-A			GROUP-B		
	Pre	Post	P-Value	Pre	Post	P-Value
WOMAC	54.40±5.70	39.23±5.87	0.001	56.73±8.63	47.20±7.83	0.001

The mean difference in WOMAC total score in group A and group B was statistically significant between the groups.

**Table 3:** WOMAC difference between the groups

Variable	Group-A	Group-B	P-value
WOMAC	39.23±5.87	47.20±7.38	0.003

### 3.2 Discussion

The objective of the study was to compare the effectiveness of Mckenzie exercises Vs VMO strengthening exercise in physical function in OA of knee.

The baseline demographic variables were homogeneous in nature in both the groups. The mean age in Mckenzie group was 50.93 and the mean age in VMO group was 50.27. 8 males and 7 females were taken in Mckenzie group and 7 males and 8 females were taken in VMO group. And the mean duration of symptoms in Mckenzie group was 10.27 months and VMO group was 11.33 months. The baseline data for outcome variables in both the groups were also homogeneous in nature.

The WOMAC sub score of pain in group A and group B have improved significantly than the respective pre-score which could be explained due to the therapeutic effect of ultrasound in both the groups. According to Loyola-Sanchez A and colleagues found that Ultrasound therapy is often effectively used in conjugation with exercise to treat chronic musculoskeletal programs such as Knee Osteoarthritis [14]. Ultrasound therapy is known to reduce pain and improving physical function, patient-perception of disease severity, and cartilage repair in people with knee osteoarthritis (OA). Ultrasound is a non-pharmacological management approach that involves application of deep heat which exhibits like an increase in tissue temperature and local metabolism, softening of tissue, increase in local circulation and decrease in pain [15].

Also, it produces non thermal effects such as stimulate the rate of chemical activity in the tissue, accelerates the inflammatory process by increasing nutrition and oxygen supply and removes waste products [16]. The significantly greater improvement in WOMAC sub score of pain in group A when compared between the groups could be because of directional preference exercises which activates the joint mechanoreceptors more efficiently that would overlap the pain receptors.

The stiffness sub score of WOMAC also showed significant improvement in both the groups. Both the Groups exhibits movement of the joint which facilitates joint nourishment, improve flexibility and reduce stiffness. And the heating as well as thermal effect of the Ultrasound could also have positive effect on reducing stiffness which is in accordance to study done by Dyson M, Pond [17]. However, when compared between the groups; there was no significant difference between the groups. Possible reason for this could be that the amount of joint loading in both the groups was relatively same. Also, the BMI for the groups were not considered. According to A Powell and colleagues found that obese patients will have more biomechanical loading to the joint resulting in pain and stiffness [18].

The physical function sub score of WOMAC showed the significant improvement in group A. This is in accordance to the study by Richard Rosedale and colleagues found that patient with knee OA who were prescribed exercises based on a Mechanical diagnosis and therapy assessment had superior outcomes compared to those of control group [12]. MDT improves joint position sense, postural control as well as shows some improvement in isometric quadriceps strength which relates to the improvement in physical function. Therefore, the technique may be beneficial in OA knee to improve the physical function. According to Long A and

colleagues found that specific directional preference exercises for patient with low back pain has demonstrated effects superior to those of guideline-based treatment and non-specific exercise therapy [19]. Similarly, the physical function of WOMAC in group B also showed significant improvement in post scores. According to the study done by R.R Neptune and colleagues found that the musculoskeletal model and simulation of running had examined the two commonly prescribed treatments for (vastus medialis oblique strengthening and orthosis) for patellofemoral pain. It revealed that increasing of vastus medialis oblique strength yielded more consistent results across subjects than orthosis in reducing patellofemoral joint loads during running. These finding indicates that a reduction in patellofemoral pain may be achieved through techniques that selectively increase the vastus medialis strength. According to Bengtson and colleagues found that the result of the study shows that strengthening exercise increase the functional capacities of osteoarthritis patients [20].

When compared to both the groups, group A showed significantly greater improvement than group B in WOMAC sub score of physical function. One possible reason for this could be use of Mckenzie exercise, i.e. directional preference exercises. The use of directional preference included extension direction preference and flexion preference. If the patient felt better following flexion, this exercise was prescribed and similarly, if the patient was worse than flexion were abandoned and extension explored. When patient reported improvement in pain and function, the examination was stopped and specific exercise that generated the effect was prescribed. According to Grey and colleagues conducted study on directional preference exercise at the knee using mechanical diagnosis and therapy along with McMurry's test as a part of an assessment. On performing a structured MDT assessment, the pain and obstruction to movement improved and McMurry's test became negative.

Other possible reason for this may be inclusion of exercise that mimic the common functional activities of daily life like getting up from chair, sitting on chair, resting on stool or floor etc. the repetitive movement that are used in daily life exercises might have contributed to this improvement. M.F Pisters and colleagues found the long term effect of exercise therapy in OA patients. The authors concluded that integrating more functional and task oriented exercises and strategies are in particularly important for patients with hip and knee OA [21].

Few limitations of the study are that the study was done with small sample size, subject blinding and researcher blinding were not implemented in this study, BMI of the individual was not taken in consideration, Outcome measures used were more subjective assessment than the objective assessment.

### 4. Conclusion

The objective of the study was to compare the effectiveness of Mckenzie exercise Vs VMO strengthening exercise on physical function in subjects with knee OA. The study concludes that Mckenzie exercises are more effective than VMO Strengthening exercise to improve physical function in patients with OA knee. Hence, the alternate hypothesis is accepted and null hypothesis is rejected. Thus the exercise in Mckenzie can be implicated clinically as it is simple,

directional preference and cost effective program to improve the physical function on subjects with knee OA.

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