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Effectiveness of Mulligan Mobilization Versus Mckenzie Exercises in Knee Osteoarthritis: A Single Blind Randomized Controlled Trial

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Abstract

Background: Knee Osteoarthritis is a prevalent musculoskeletal condition affecting older people. Physiotherapy treatment options include conventional physiotherapy which comprised of strengthening and stretching exercises and other is manual techniques. The purpose of this study was to compare the effectiveness of Mulligan Mobilization with Movement along with Conventional Physiotherapy and McKenzie exercises with Conventional Physiotherapy in knee osteoarthritis.

Method: Subjects were screened using inclusion and exclusion criteria and a written informed consent was obtained from the participants. 60 eligible subjects were divided into 2 groups using simple random sampling method. In Mulligan Group, subjects received Mulligan mobilization with movement along with conventional physiotherapy and McKenzie Group received McKenzie exercises along with conventional physiotherapy. The subjects were assessed for outcome measures with the help of Knee Osteoarthritis and outcome score (KOOS) Index, Time up and go test (TUG), Range of motion of knee joint & Manual muscle testing (Modified Research Council Scale) at baseline, 4th week and after 3 months.

Results: Repeated measure ANOVA with post hoc Tukey- Kramer multiple comparison tests were used to find out the significant difference within the group. While unpaired t test was used to find out the difference between two groups. Within group analysis showed significant improvement in all outcome measures in Mulligan group and McKenzie group ($p>0.05$). After comparing two different methods we found that there was no significant difference between two groups ($p<0.05$).

Conclusion: McKenzie exercises and Mobilization with movement technique are equally effective in improving functional outcome and knee range of motion In other hands McKenzie exercises are more effective in improving knee extensor strength.

Keywords: Knee osteoarthritis; Mulligan mobilization; McKenzie exercises

Introduction

Osteoarthritis (OA) is the most prevalent of the chronic rheumatic diseases and is a leading cause of pain and disability in most countries worldwide [1] The reported prevalence for knee OA was 1.18 and 2.8 per 1000 per year in men and women respectively [2]. In India the crude prevalence of clinically diagnosed knee OA was higher in the urban (5.5%) than the rural community (3.3%) [3]. Knee osteoarthritis is a prevalent musculoskeletal condition affecting older people [4], considerable evidence indicates that the menisci, ligaments, peri-articular muscles and the joint capsule are also involved in the OA process. Common signs and symptoms of knee OA include knee pain, joint stiffness, decreased muscle strength, and proprioceptive deficits [5-7]. In addition; individuals with knee OA often exhibit poor neuromuscular control, slower walking speed, decreased functional ability, and an increased susceptibility to falling [8,9]. Reduced quadriceps strength has been shown to be associated with the presence of OA in the knee [10,11]. An evidence based approach to management should include patient education about OA and its management, including pain management, options to improve function, decrease disability, and prevent or retard progression of the disease [12]. Treatments available for OA include pharmacological therapies, intra-articular injections, surgical procedures, and conservative interventions, such as physical therapy, braces and devices, and exercise [13-19]. Five guidelines (ACR20, AAOS21, OARS22, EULAR23 and NICE24) have evaluated treatment effects on key outcomes of knee osteoarthritis (including pain, function, and disability). All recommend treatment with muscle-strengthening and aerobic exercise, education, weight loss (if required), and where necessary, paracetamol and/or topical NSAIDs; when these are ineffective, a choice of one or more options from a range of pharmacological and non-pharmacological treatments is sometimes recommended, including transcutaneous electrical nerve stimulation (TENS), thermal (heat/cooling) treatments, insoles, and braces [20-24]. A growing body of evidence shows that exercise improves knee joint function and decreases symptoms [25,26]. Furthermore, the findings of a recent study suggest that physical therapy intervention including exercise may reduce the need for knee Arthroplasty and intra-articular injections [27]. Physiotherapy is one of the professions that provide effective non-pharmacological interventions for people with knee OA [28] and procedures prescribed by physiotherapists are considered important and play a fundamental role in patient treatment. Brian Mulligan has developed a most ingenious compilation of manual techniques [29]. Mulligan's Movement with Mobilization (MWM) is a manual therapy technique in which a manual force usually in the

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form of a therapist-applied pain-free accessory joint glides applied with active movement of the gilding segment and sustained while a previously impaired action (e.g. painful reduced movement, painful muscle contraction) is performed [30,31]. MWM found more effective in improving pain, joint stiffness, range of motion, and walking distance in patients with osteoarthritis of the knee [32,33]. In 1981, Robin McKenzie proposed a classification system and a classification-based treatment for LBP labelled Mechanical Diagnosis and Therapy, or simply the McKenzie method [34]. The McKenzie method of mechanical diagnosis and therapy is one clinical approach which uses the DP system [35,36]. The system of mechanical diagnosis and therapy (MDT), well known for use with patients with spinal problems, also has been applied to patients with extremity problems [37]. The classification categories in the MDT system are non-pathoanatomical and are based on the patient's response to repeated end-range movements. The most prevalent and well-studied MDT subgroup is the "derangement" classification. This classification has been described in all joints and has been as¬sociated with a rapid response to specific end-range exercises, which corresponds to "directional preference" [38, 39]. A directional preference occurs when a posture or repeated movement in one direction, usually to end range, makes a rapid and lasting positive change in symptoms, function, and/or range.

Hence this study was undertaken to find out the effectiveness of Mulligan mobilization with movement and McKenzie exercises with a usual conventional Physiotherapy in knee osteoarthritis and also to see the comparative effectiveness of Mulligan Mobilization with movement and McKenzie exercises in knee Osteoarthritis.

Methods

This Single blind randomized control trial was conducted at Dr. Vitthalrao Vikhe Patil Foundation's, Physiotherapy OPD, Ahmednagar. This trial was registered on clinical trial registry of India (**CTRI Regi. No- REF/2015/03/008638**). The Ethical clearance was obtained from the institutional ethical committee of COPT. Subjects were screened using inclusion and exclusion criteria. Marathi written informed consent was obtained from each participant.

Patients Screened: 84

Sample Size: N=60 (Confidence interval=95%, Proportion=0.5)

Total 60 eligible subjects were divided into two groups viz, Mulligan Group and McKenzie Group using simple random sampling method. Each group consisted of 30 subjects. After allocation subjects were assessed for outcome measures with the help of Knee osteoarthritis and outcome score (KOOS) Index, Time up and go test, Range of motion of knee joint& Manual muscle testing (Medical Research Council Scale) of knee joint. In Mulligan Group, subjects received Mulligan Mobilization with movement along with Conventional Physiotherapy & McKenzie Group received McKenzie exercises along with conventional physiotherapy.

Mulligan group

Mulligan mobilization with movement along with conventional physiotherapy was given for knee joint osteoarthritis.

Mulligan mobilization with movement: Medial, Rotation and Lateral glides were given, at the rate of 2 sets and repetitions [40, 41].

Conventional physiotherapy [28]:

Stretching exercises:

- Gastrocnemius and Soleus stretching
- Hamstring stretching: (Position was maintained for 30 sec. and repeated for 3 times)

Quadriceps strengthening exercise

Closed-kinetic chain exercise:

- Seated leg press
- Partial squat
- Step-up

McKenzie group

McKenzie exercises were given along with conventional physiotherapy.

McKenzie exercises [42-44]

During the Mechanical Diagnosis and Therapy (MDT) assessment process, both knee flexion and extension was assessed. The history and examination was done with the help of McKenzie institute of lower extremity assessment. This will determine the presence of a potential directional preference using repeated movement assessment depending on loading strategy and retesting of baseline activities. The directional preference and mechanical diagnosis of knee derangement was established for a particular subject on the basis of positive and lasting effect on symptom. Functional baseline activities and knee range of motion on repetitive knee movement in a certain direction. These subjects were given McKenzie exercises. If there was no lasting positive change from these repeated movements, it was deemed not to be a derangement and those non-responder subjects were excluded. The initial direction explored was determine based on the most painful direction, the most limited direction, the direction reported to bring relief or the direction most avoided. When assessing for directional preference, the exercise with the least loading was tested in the beginning. The investigator tested the next loading strategy if the subject responded with no symptoms. Each exercise was repeated 10 times, once in the physiotherapy department of a hospital and twice at home.

Flexion directional preference given in sitting, standing and kneeling position (Figures 1-3).

Extension directional preference given in lying, sitting and standing position (Figures 4-7).

These exercises were supervised for 4 weeks. The subjects were then asked to continue these exercises twice in a day at home. Conventional physiotherapy exercises were given which were similar as explained to Mulligan group.

Figure 1: Knee flexion in sitting.

Figure 2: Knee flexion in standing.

Figure 3: Knee flexion in kneeling.

Figure 4: Active Knee extension in lying.

Figure 5: Knee extension in sitting.

Figure 6: Active Knee extension in sitting.

Figure 7: Knee extension in standing.

The total duration of treatment lasted for 30-45 minutes, 1 session/day, 3 sessions/week, for 4 weeks. At the end of 4th week, reassessment was done. Subjects were asked to maintain daily exercises diary at home during follow up period. At the end of 3 months subjects were re-assessed for all outcome measures as well as exercise diary for adherence.

Results

Statistical analysis performed by using Graph pad instat software version 3 & Microsoft excel 2007. Repeated measure ANOVA with post hoc Turkey- Kramer multiple comparison tests were used to find out the significant difference within the group. While unpaired t test was used to find out the difference between two groups. For all the tests level of significance was set at p equal to or less than 0.05 considered significant and p value less than 0.0001 were considered extremely significant.

Demographic data

Demographic data showed there was no significant difference in both the groups.

Within group comparison

Within group comparison showed significant difference in both the groups at baseline compared to 4th weeks and at 3 months assessments of the subjects.

Between Group Comparison

Koos index

Pain (Table 1)

Symptoms (Table 2)

Activities of daily living (Table 3)

Sports and recreational activities (Table 4)

Quality of life (Table 5)

Time up and go test (Table 6)

Between group comparisons-Mean of active range of motion (Table 7)

Right-Active ROM (Table 8)

Left-Active ROM (Table 9)

(Figure 8)

Between group comparisons-Mean of passive range of motion

Right-Passive ROM (Table 10)

Left-Passive ROM (Table 11)

	Group	Mean	± SD	p value	t value	Result
At Baseline	Mulligan	47.5	14.61	0.3697	0.904	Not significant
	McKenzie	50.73	12.56			
At 4th Week	Mulligan	75.7	12.9	0.2584	1.141	Not significant
	McKenzie	72.4	8.95			
At 3 Months	Mulligan	79.6	8.88	0.2124	1.261	Not significant
	McKenzie	76.85	7.86			

Unpaired t test was used to find out the difference between groups.
At Baseline, there was no significant difference (p=0.3697, t=0.9040)
At 4th week there was no significant difference (p=0.2584, t=1.141)
While at 3 Months, there was no significant difference (p=0.2124, t=1.261)

Table 1: Pain.

	Group	Mean	± SD	P value	t value	Result
At Baseline	Mulligan	59.76	21.91	0.1922	1.32	Not Significant
	McKenzie	65.94	12.53			
At 4th Week	Mulligan	78.45	13.96	0.2176	1.246	Not Significant
	McKenzie	82.85	12.92			
At 3 Months	Mulligan	82.97	9.96	0.8056	0.2473	Not significant
	McKenzie	82.38	8.29			

Unpaired t test was used to find out the difference between groups.
At Baseline, there was no significant difference (p=0.1922, t=1.320)
At 4th week there was no significant difference (p=0.2176, t=1.246)
While at 3 Months, there was no significant difference (p=0.8056, t=0.2473)

Table 2: Symptoms.

	Group	Mean	± SD	P value	t value	Result
At Baseline	Mulligan	48.57	14.47	0.1647	1.407	Not Significant
	McKenzie	53.08	9.40			
At 4th Week	Mulligan	73.87	8.73	0.5931	0.5373	Not Significant
	McKenzie	75.19	9.97			
At 3 Months	Mulligan	79	7.6	0.8899	0.1391	Not significant
	McKenzie	79.12	5.65			

Unpaired t test was used to find out the difference between groups.
At Baseline, there was no significant difference (p=0.1647, t=1.407)
At 4th week there was no significant difference (p=0.5931, t=0.5373)
While at 3 Months, there was no significant difference (p=0.8899, t=0.1391)

Table 3: Activities of daily living.

	Group	Mean	± SD	P value	t value	Result
At Baseline	Mulligan	48.57	14.47	0.1647	1.407	Not Significant
	McKenzie	53.08	9.4			
At 4th Week	Mulligan	73.87	8.73	0.5931	0.5373	Not Significant
At 3 Months	Mulligan	79	7.6	0.8899	0.1391	Not significant
	McKenzie	79.12	5.65			
	McKenzie	79.12	5.65			

Unpaired t test was used to find out the difference between groups.
At Baseline, there was no significant difference (p=0.4167, t=0.8181)
At 4th week there was no significant difference (p=0.3425, t=0.9571)
While at 3 Months, there was no significant difference (p=0.2166, t=1.249)

Table 4: Sports and recreational activities.

	Group	Mean	± SD	P value	t value	Result
At Baseline	Mulligan	24.58	18.1	0.2612	1.135	Not Significant
	McKenzie	29.79	16.82			
At 4th Week	Mulligan	57.9	12	0.4886	0.697	Not Significant
At 3 Months	Mulligan	60.41	15.16	0.6009	0.526	Not significant
	McKenzie	60.8	14			
	McKenzie	58.54	18.85			

Unpaired t test was used to find out the difference between groups.
At Baseline, there was no significant difference (p=0.2612, t=1.135)
At 4th week there was no significant difference (p=0.4886, t=0.6970)
While at 3 Months, there was no significant difference (p=0.6009, t=0.5260)

Table 5: Quality of life.

	Group	Mean	± SD	P value	t value	Result
At Baseline	Mulligan	15.5	6.17	0.5468	0.6061	Not significant
	McKenzie	14.7	3.52			
At 4th Week	Mulligan	13.33	4.64	0.6569	0.4466	Not significant
	McKenzie	12.86	3.16			
At 3 Months	Mulligan	12.76	3.91	0.9435	0.07116	Not significant
	McKenzie	12.7	3.18			

Unpaired t test was used to find out the difference between groups.
At Baseline, there was no significant difference (p=0.5468, t=0.6061)
At 4th week there was no significant difference (p=0.6569, t=0.4466)
While at 3 Months, there was no significant difference (p=0.9435, t=0.07116)

Table 6: Time up and go test.

	Group	Mean	±SD	p value	t value	Result
AT Baseline	Mulligan	114.07	15.95	0.1064	1.64	Not significant
	McKenzie	120.07	11.55			
At 4th Week	Mulligan	120.4	13.23	0.4209	0.8106	Not significant
	McKenzie	123.06	11.78			
At 3 Months	Mulligan	122.5	12.14	0.6148	0.5059	Not significant
	McKenzie	124.1	11.94			

It showed comparison of active flexion ROM on right and left side. For that Unpaired t test was used to find out the difference between groups.
At Baseline, there was no significant difference (p=0.1064, t=1.640)
At 4th week there was no significant difference (p=0.4209, t=0.8106)
While at 3 Months, there was no significant difference (p=0.6148, t=0.5059)

Table 7: Between group comparisons: Mean of active range of motion.

	Group	Mean	±SD	p value	t value	Result
AT Baseline	Mulligan	114.07	15.95	0.1064	1.640	Not significant
	McKenzie	120.07	11.55			
At 4th Week	Mulligan	120.4	13.23	0.4209	0.8106	Not significant
	McKenzie	123.06	11.78			
At 3 Months	Mulligan	122.5	12.14	0.6148	0.5059	Not significant
	McKenzie	124.1	11.94			

It showed comparison of active flexion ROM on right and left side. For that Unpaired t test was used to find out the difference between groups.
At Baseline, there was no significant difference (p=0.1064, t=1.640)
At 4th week there was no significant difference (p=0.4209, t=0.8106)
While at 3 Months, there was no significant difference (p=0.6148, t=0.5059)

Table 8: Right-Active ROM.

	Group	Mean	±SD	P value	t value	Result
AT Baseline	Mulligan	114.1	14.22	0.1985	1.301	Not significant
	McKenzie	118.4	10.71			
At 4th Week	Mulligan	119.26	13.39	0.2134	1.258	Not significant
	McKenzie	123.2	10.2			
At 3 Months	Mulligan	122.7	12.16	0.6265	0.4892	Not significant
	McKenzie	124.16	10.6			

At Baseline, there was no significant difference (p=0.1985, t=1.301)
At 4th week there was no significant difference (p=0.2134, t=1.258)
While at 3 Months, there was no significant difference (p=0.6265, t=0.4892)

Table 9: Left –Active ROM.

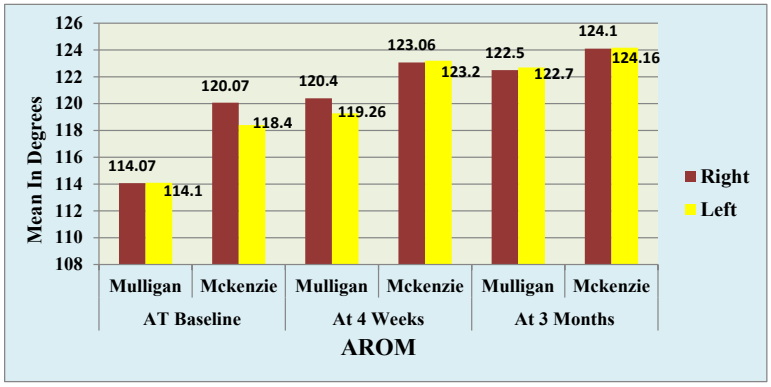

Figure 8: Between group comparisons-Mean of active range of motion..

	Group	Mean	±SD	P value	t value	Result
At Baseline	Mulligan	122	15.06	0.1075	1.635	Not significant
	McKenzie	127.5	9.86			
At 4th Week	Mulligan	127.03	11.95	0.1025	1.659	Not significant
	McKenzie	131.53	8.39			
At 3 Months	Mulligan	128.16	11.49	0.0791	1.788	Not quite significant
	McKenzie	132.86	8.26			

It showed comparison of passive flexion ROM on right and left side. For that Unpaired t test was used to find out the difference between groups.

At Baseline, there was no significant difference (p=0.1075, t=1.635)

At 4th week there was no significant difference (p=0.1025, t=1.659)

While at 3 Months, there was no significant difference (p=0.0791, t=1.788)

Table 10: Between group comparisons- Mean of passive range of motion: Right-Passive ROM

	Group	Mean	±SD	P value	t value	Result
AT Baseline	Mulligan	123	13.44	0.1611	1.420	Not significant
	McKenzie	127.23	8.78			
At 4th Week	Mulligan	127.63	11.30	0.3441	0.9540	Not significant
	McKenzie	130.2	9.06			
At 3 Months	Mulligan	130.2	9.91	0.8562	0.1820	Not significant
	McKenzie	130.66	9.617			

At Baseline, there was no significant difference (p=0.1611, t=1.420)

At 4th week there was no significant difference (p=0.3441, t=0.9540)

While at 3 Months, there was no significant difference (p=0.8562, t=0.1820)

Table 11: Left- Passive ROM.

(Figure 9)

Between group comparisons-Mean of manual muscle testing

Right (Table 12)

Left- Flexor-MMT (Table 13)

(Figure 10)

Between group comparison-mean of manual muscle testing (Extensor)

Right (Table 14)

Left (Table 15)

(Figure 11)

Discussion

The present randomized controlled trial was conducted to find out the effectiveness of Mulligan mobilization with movement technique and McKenzie Exercises with the usual conventional physiotherapy given for knee osteoarthritis.

In the present study, the demographic data of subjects showed no statistical difference between two groups at baseline. Severity of knee osteoarthritis was assessed according to kellegren-Lawrence scale. In the Mulligan group, 7 subjects had a severity of grade 1, while 15 subjects were with grade 2 and 8 subjects with grade 3 knee osteoarthritis. While in McKenzie group 10 subjects were observed to have a severity of grade 1, 13 subjects with grade 2 and 7 subjects with grade 3 knee osteoarthritis. As observed more number of subjects with grade 2 knee osteoarthritis.

Our result was similar to the study done by Deyle et al. [28] May et al. [42] conducted a prevalence study on mechanical classification syndrome which showed most of the patients were in derangement syndrome category. Improvement occurred in patients with derangement syndrome due to repeated movement which causes the rapid abolition of symptoms. In McKenzie group, 3 subjects

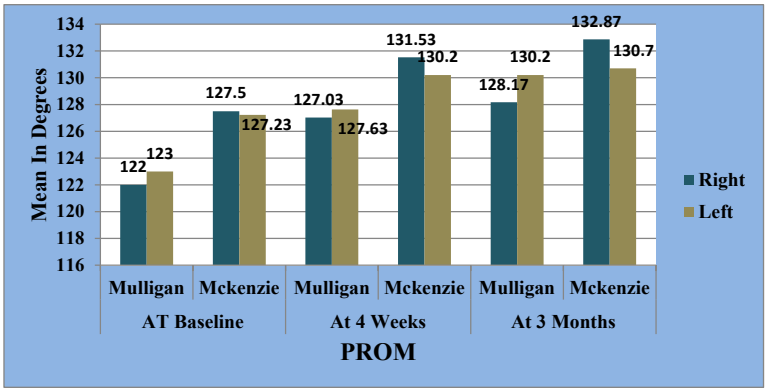

Figure 9: Between group comparisons- Mean of passive range of motion.

	Group	Mean	±SD	P value	t value	Result
AT Baseline	Mulligan	3.53	0.56	0.6391	0.4817	Not significant
	McKenzie	3.6	0.49			
At 4th Week	Mulligan	4.03	0.31	0.6564	0.4472	Not significant
	McKenzie	4.06	0.24			
At 3 Months	Mulligan	4.5	0.5	0.4448	0.7693	Not significant
	McKenzie	4.4	0.48			

It showed comparison of flexor MMT on right and left side. For that Unpaired t test was used to find out the difference between groups.

At Baseline, there was no significant difference (p=0.6391, t=0.4817)

At 4th week there was no significant difference (p=0.6564, t=0.4472)

While at 3 Months, there was no significant difference (p=0.4448, t=0.7693)

Table 12: Between group comparisons- Mean of manual muscle testing: Right

	Group	Mean	±SD	P value	t value	Result
AT Baseline	Mulligan	3.43	0.49	0.2028	1.288	Not significant
	McKenzie	3.6	0.48			
At 4th Week	Mulligan	4.06	0.35	0.7026	0.3837	Not significant
	McKenzie	4.1	0.3			
At 3 Months	Mulligan	4.5	0.5	0.4448	0.7693	Not significant
	McKenzie	4.4	0.48			

At Baseline, there was no significant difference (p=0.2028, t=1.288)

At 4th week there was no significant difference (p=0.7076, t=0.3837)

While at 3 Months, there was no significant difference (p=0.4448, t=0.7693)

Table 13: Left- Flexor-MMT.

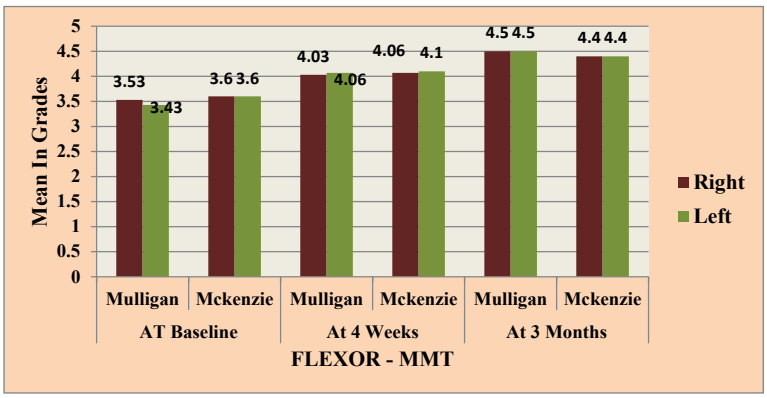

Figure 10: Between group comparisons-Mean of manual muscle testing.

	Group	Mean	±SD	P value	t value	Result
At Baseline	Mulligan	3.93	0.35	0.4707	0.7261	Not significant
	McKenzie	3.86	0.33			
At 4th Week	Mulligan	4.1	0.39	0.0249	2.303	Significant
	McKenzie	4.36	0.48			
At 3 Months	Mulligan	4.56	0.49	0.0007	3.559	Extremely significant
	McKenzie	4.93	0.24			

It showed comparison of extensor MMT on right and left side. For that Unpaired t test was used to find out the difference between groups.

At Baseline, there was no significant difference (p=0.4707, t=0.7261)

At 4th week there was significant difference (p=0.0249, t=2.303)

While at 3 Months, there was extremely significant difference (p=0.0007, t=3.559)

Table 14: Between group comparison-Mean of manual muscle testing (Extensor): Right

	Group	Mean	±SD	P value	t value	Result
At Baseline	Mulligan	3.93	0.35	0.4202	0.8118	Not significant
	McKenzie	4	0.25			
At 4th Week	Mulligan	4.13	0.34	0.0043	2.973	Very significant
	McKenzie	4.46	0.49			
At 3 Months	Mulligan	4.56	0.49	0.0007	3.559	Extremely Significant
	McKenzie	4.93	0.24			

At Baseline, there was no significant difference (p=0.4202, t=0.8118)

At 4th week there was very significant difference (p=0.0043, t=2.973)

While at 3 Months, there was extremely significant difference (p=0.0007, t=3.559)

Table 15: Left

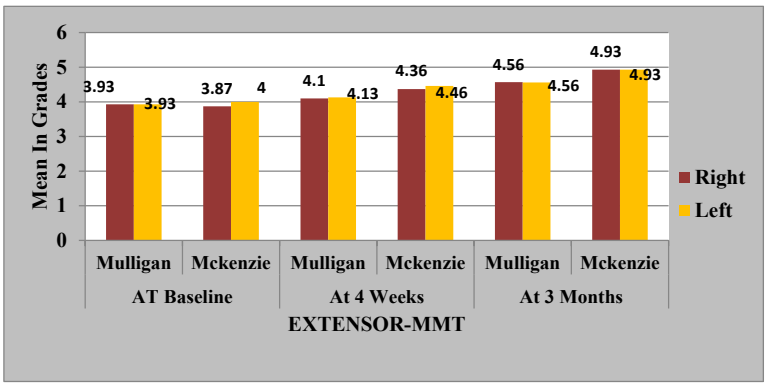

Figure 11: Between group comparison-Mean of manual muscle testing (Extensor).

were affected with dysfunctional and 27 subjects with derangement syndrome. In McKenzie group, treatment was given based on directional preference of subject according to McKenzie assessment and treatment in the lower extremity. In that 22 (73.33%) subjects responded to extension directional preference while 8 (26.66%) subjects responded to flexion direction.

May et al. [45] conducted a systemic review on spine in relation with centralization & directional preference, their study showed that repeated extension movement in spinal areas (70-80%), then lateral flexion(20%) and minor flexion (<10%) were most commonly used directional preference in relation to the centralization. We also found more subjects with extension directional preference in knee osteoarthritis.

Previous study done by Rosedale et al. [43] stated that sub-grouping of patients in knee OA respond to repeated movement rather than patho-anatomical classification and this should be considered as non-anatomical classification system. We accept the null hypothesis and reject alternate hypothesis to compare both groups of outcome measures like KOOS Index, Knee ROM, Time up and go test and knee flexor muscle strength. Whereas, for knee extensor, muscle strength we accept the alternate hypothesis and reject the null hypothesis. In between group comparison, there was no significant difference in all components of KOOS Index. Till date none of studies compared the effectiveness of Mulligan Mobilization with Movement technique versus McKenzie exercises in knee osteoarthritis. The reason may be that both techniques by its own mechanism proved that they were effective in reducing pain, disability and improvement in overall functional performance.

Vicenzinoet al. [46] stated that biomechanical and neuro-physiological mechanism which causes reduction of pain in MWM technique. It was proved that biomechanical correction of positional fault could relieve the pain; while in neurophysiological mechanism it is due to changes in descending pain inhibitory systems and central pain-processing mechanisms. Manual therapy techniques play important role in pain reduction.

According to Schenebel et al. [47] pain gate control theory plays

important role in relief of pain and Derosa et al. [48] stated due to the increased afferent input causes the pain modulation because of the stimulation of arterial, venous and lymphatic or mechanoreceptor stimulation [32]. Previous study done by Hagberg et al. & Thoren et al. [49, 50] stated the mechanism behind improvement in McKenzie group. An activity related pain was decreased due to increasing endorphins and activation of stretch receptors by the strong muscle contractions which occurred after intervention. Both peripheral and central pain was blocked; by the afferents from the receptors i.e. endogenous opioids are released and also it causes the release of beta-endorphin from pituitary. When compared between groups, there was no significant difference in improvement of range of motion.

Ganguly et al. [51] concluded that the effect of kinesiotaping followed by mulligan mobilization which improve the balance and functional ability in knee osteoarthritis. Cheraladhan et al. [52] suggested the efficacy of mulligan mobilization for improving ROM and functional performance in patients with tibiofemoral knee osteoarthritis. Similar results obtained in this study, Mulligan group showed that with the application of mulligan mobilization with movement improvement occur in Range of Motion ($p<0.0001$).

Based on a previous literature, Babula et al. [53] conducted a study on the effectiveness of McKenzie method in patients with low back pain. It concluded that there was reduction in pain, disability and improvement in range of motion of flexion and extension after the 6th month and 12th month of completion of treatment. This study we applied common technique as a conventional physiotherapy which consisted of hamstring, gastrocnemius & soleus stretching exercises; that cause improvement in ROM. A study was done by Khuman et al. [54] showed a single session of post-isometric relaxation and bent leg raising causing significant improvement in pain and hamstring flexibility. When between groups comparison was done for time up and go test, it showed there was no significant difference. In this study showed significant improvement within group i.e. Mulligan as well as in McKenzie group in time up and go test ($p<0.0001$) at 4th week and 3 months when compared at baseline. Improvement within the group can be because of combined effect of manual therapy techniques and exercises.

Recently systemic review with meta-analysis conducted by Stathopoulosa et al. [55] to know the effect of mobilization with movement technique to reduce pain and improve functional ability in peripheral joint between 2008-2017. For this study; 16 articles with 576 participants were included in four separate meta-analyses for pain and disability. So overall study shows that there was stastistically and clinically significant difference was observed to reduce pain and improve functional ability in mobilization with movement technique.

Riya Sadana and Dr. Shrikant Mhase [56] compared McKenzie exercises with conventional physiotherapy; and it concluded that both the techniques were effective to improve knee range of motion and functional ability after ACL reconstruction. But conventional physiotherapy showed significant difference in improving knee flexion than McKenzie exercises. There was no significant difference in both techniques to improve knee extension and functional ability. Oliveira et al. [57] showed that exercises comprised of stationary bike, hamstring stretching and knee extensor strengthening exercises significantly improved the functional ability of patients in knee osteoarthritis. Both the groups showed significant improvement in muscle strength when compared within group but on comparison between two groups no significant improvement was found in knee flexor strength.

According to Folland et al. [58] gaining of strength is by neurological and morphological factors. Morphological changes cause increase in cross-sectional area of whole muscle and individual muscle fibers due to an increase a myofibrillar size and number. Along with this, other adaptations also occur which cause hyperplasia, changes in fibre type, muscle architecture, myofilament density and the structure of connective tissue and tendons. While neurological adaptations include changes in coordination and learning which facilitate the improved recruitment and activation of involved muscles during a specific strength task. When between groups comparisons were done, it showed significant improvement in knee extensor muscle strength in the McKenzie group.

Our result is similar with previous study done by Lange et al. [59] on strength training in knee osteoarthritis. Self- reported outcome measures like pain, function, walking speed were studied. They concluded that strength training significantly improved the muscle strength, physical function along with reduction of pain in knee osteoarthritis. While in McKenzie group, there was significant improvement in knee extensor muscle strength at 4th week and after 3 months compared to mulligan group. The reason may be that, as most of the subjects responded in extension directional preference. Extensor exercises were given along with conventional physiotherapy comprising of static quadriceps and close chain exercises. Mikkelsen et al. [60] concluded that combination of Closed Kinematic Chain and Open Kinematic Chain exercises improved the quadriceps strength better than using Close Kinematic Chain exercises alone. Seated legs press up also contributed to the improvement in knee extensor muscle strength at 4th week and after 3 months. This result in line with previous study done by Nammat et al. [61] concluded that 8 weeks training of seated leg press up exercise cause significant improvement in knee extensor muscle strength in elderly. While study conducted by Farzaneh et al. [62] to see the effectiveness of McKenzie exercises improve muscle strength in anterior knee pain; it showed that McKenzie exercises like common exercises can improve the strength of quadriceps muscle; our result was in line with this result.

Hence, our study shows that Mulligan mobilization with movement and McKenzie exercises are equally effective in reducing pain; improve Range Of Movement, functional performance and muscle strength if given along with conventional physiotherapy in cases of knee osteoarthritis.

Conclusion

McKenzie exercises and Mobilization with movement technique are equally effective in improving functional outcome and knee range of motion but McKenzie exercises are more effective in improving knee extensor strength.

Limitations

- Mulligan mobilization in weight bearing position not given.
- According to McKenzie lower extremity assessment; number of subjects in dysfunctional syndrome was less.
- Only few subjects in our study responded in flexion directional preference according to McKenzie lower extremity assessment.
- Short term follow up.
- One more group with only conventional physiotherapy was not included.

Conflict of Interest

The author's report no conflict of interest.

References

1. . World Health Organization (2002) World Health Report 2002-Reducing Risks, Promoting Healthy Life. Geneva, WHO.
2. Bijlsma JW, Knahr K (2007) Strategies for the prevention and management of osteoarthritis of the hip and knee. Best Pract Res Clin Rheumatol 21: 59-76.
3. Haq SA, Davatchi F (2011) Osteoarthritis of the knees in the COPCORD world. Int J Rheum Dis 14: 122-129.
4. Felson DT, Naimark A, Anderson J, Kazis L, Castelli W, et al. (1987) The prevalence of knee osteoarthritis in the elderly. The Framingham Osteoarthritis Study. Arthritis Rheum 30: 914-918.
5. Cliborne AV, Wainner RS, Rhon DI, Judd CD, Fee TT, et al. (2004) Clinical hip tests and a functional squat test in patients with knee osteoarthritis: reliability, prevalence of positive test findings, and short-term response to hip mobilization. J Orthop Sports Phys Ther 34: 676-685.
6. Oatis CA, Wolff EF, Lennon SK (2006) Knee joint stiffness in individuals with and without knee osteoarthritis: a preliminary study. J OrthopSports Phys Ther 36: 935-941.
7. Thomas SG, Pagura SM, Kennedy D (2003) Physical activity and its relationship to physical performance in patients with end stage knee osteoarthritis. J Orthop Sports Phys Ther 33: 745-754.
8. Fitzgerald GK, Piva SR, Irrgang JJ (2004) Reports of joint instability in knee osteoarthritis: its prevalence and relationship to physical function. Arthritis Rheum 51: 941-946.
9. Minor MA (1999) Exercise in the treatment of osteoarthritis. Rheum Dis Clin North Am 25: 397-415.
10. Slemenda C, Brandt KD, Heilman DK, Mazzuca S, Braunstein EM, et al. (1997) Quadriceps weakness and osteoarthritis of the knee. Ann Intern Med 127: 97-104.
11. Hassan BS, Mockett S, Doherty M (2001) Static postural sway, Proprioception, and maximal voluntary quadriceps contraction in patients with knee osteoarthritis and normal control subjects. Ann Rheum Dis 60: 612-618.
12. Jordan KM, Arden NK, Doherty M, Bannwarth B, Bijlsma JW, et al. (2003) Standing Committee for International Clinical Studies Including Therapeutic Trials ESCISIT: EULAR Recommendations 2003: an evidence based approach to the management of knee osteoarthritis: Report of a Task Force of the Standing Committee for International Clinical Studies Including Therapeutic Trials (ESCISIT) Ann Rheum Dis 62: 1145-1155.
13. 13. Centers for Disease Control and Prevention and the Arthritis Foundation. A National Public Health Agenda for Osteoarthritis 2010. Semin Arthritis Rheum 39: 323-326.
14. Hochberg MC, Altman RD, April KT, Benkhalti M, Guyatt G, et al. (2012) American College of Rheumatology American College of Rheumatology 2012 recommendations for the use of non-pharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. Arthritis Care Res (Hoboken) 64: 465-474.
15. Richmond J, Hunter D, Irrgang J, Jones MH, Snyder-Mackler L, et al. (2010) American Academy of Orthopaedic Surgeons American Academy of Orthopaedic Surgeons clinical practice guideline on the treatment of osteoarthritis (OA) of the knee. J Bone Joint Surg Am 92: 990-993.
16. Zhang W, Doherty M, Arden N, Bannwarth B, Bijlsma J, et al. (2005) EULAR evidence based recommendations for the management of hip osteoarthritis: report of a task force of the EULAR Standing Committee for International Clinical Studies Including Therapeutics (ESCISIT). Ann Rheum Dis 64: 669-681.
17. Zhang W, Moskowitz RW, Nuki G, Abramson S, Altman RD, et al. (2007) OARSI recommendations for the management of hip and knee osteoarthritis, part I: Critical appraisal of existing treatment guidelines and systematic review of current research evidence. Osteoarthritis Cartilage 15: 981-1000.
18. Zhang W, Moskowitz RW, Nuki G, Abramson S, Altman RD, et al. (2008) OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence-based, expert consensus guidelines. Osteoarthritis Cartilage 16: 137-162.
19. Zhang W, Nuki G, Moskowitz RW, Abramson S, Altman RD, et al. (2010) OARSI recommendations for the management of hip and knee osteoarthritis: part III: Changes in evidence following systematic cumulative update of research published through January 2009. Osteoarthritis Cartilage 18: 476-499.
20. Hochberg MC, Altman RD, April KT, Benkhalti M, Guyatt G, et al. (2012) American College of Rheumatology 2012 recommendations for the use of non-pharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. Arthritis Care Res 64: 465-474.
21. Richmond J, Hunter D, Irrgang J, Jones MH, Levy B, et al. (2009) Treatment of osteoarthritis of the knee (non-arthroplasty). J Am Acad Orthop Surg 17: 591-600.
22. National Collaborating Centre for Chronic Conditions. Royal College of Physicians; London: 2008. Osteoarthritis: National Clinical Guideline for Care and Management in Adults Royal College of Physicians.
23. Ettinger WH Jr, Burns R, Messier SP, Applegate W, Rejeski WJ, et al. (1997) A randomized trial comparing aerobic exercise and resistance exercise with a health education program in older adults with knee osteoarthritis: the Fitness Arthritis and Seniors Trial (FAST). JAMA 277: 25-31.
24. Baker KR, Nelson ME, Felson DT, Layne JE, Sarno R, et al. (2001) The efficacy of home based progressive strength training in older adults with knee osteoarthritis: a randomized controlled trial. J Rheumatol 28: 1655-1665.
25. Deyle GD, Henderson NE, Matekel RL, Ryder MG, Garber MB, et al. (2000) Effectiveness of manual physical therapy and exercise in osteoarthritis of the knee: a randomized, controlled trial. Ann Intern Med 132: 173–181.
26. Petrella RJ, Bartha C (2000) Home based exercise therapy for older patients with knee osteoarthritis: A randomized clinical trial. J Rheumatol 27: 2215-2221.
27. Van Baar ME, Dekker J, Oostendorp RA, Bijl D, Voorn TB, et al. (2001) Effectiveness of exercise in patients with osteoarthritis of hip or knee: nine months' follow up. Ann Rheum Dis 60: 1123-1130.
28. Deyle GD, Allison SC, Matekel RL, Ryder MG, Stang JM, et al. (2005) Physical therapy treatment for osteoarthritis of the knee: a randomised comparison of supervised clinical exercise and manual therapy procedures versus a home exercise programme. Phys Ther 85: 1301-1317.
29. Mulligan BR. Manual therapy ''NAGS'', ''SNAGS'', ''MWMs'' etc., 6th ed. Plane View Services, Wellington, New Zealand; 2010.
30. Konstantinou K, Foster N, Rushton A, Baxter D (2002) The use and reported effects of mobilization with movement techniques in low back pain management; a cross-sectional descriptive survey of physiotherapists in Britain. Man Ther 7: 206-214.
31. Brian R. Mulligan. Manual therapy: "NAGS", "SNAGS", "MWMS" (2004) 5th edn., Wellington, N.Z. : Plane View Services Ltd.
32. Van Baar ME, Dekker J, Oostendorp RA, Bijl D, Voorn TB, et al. (2001) Effectiveness of exercise in patients with osteoarthritis of hip or knee: nine months' follow up. Ann Rheum Dis 60: 1123-1130.
33. 33. Vicenzino B, Hall TM, Hing W, Rivett DA (2011) Mobilisation with Movement: The Art and the Science.1st edn.
34. McKenzie R, May S (2003) Mechanical Diagnosis and Therapy. Waikanae, New Zealand: Spinal Publications.
35. Machado LA, de Souza Mv, Ferreira PH, Ferreira ML (2006) The McKenzie method for low back pain: A systematic review of the literature with a meta-analysis approach. Spine 31: 254-262.
36. Maguire K (2005) Outcome analysis in those who demonstrated a directional preference from those who did not: Audit of MDT. J Mech Diag Ther 13: 21-26.
37. McKenzie R, May S (2000) The Human Extremities: Mechanical Diagnosis and Therapy. Wellington, New Zealand: Spinal Publications New Zealand Ltd.
38. Long A, Donelson R, Fung T (2004) Does it matter which exercise? A randomized control trial of exercise for low back pain. Spine (Phila Pa 1976) 29: 2593-2602.
39. May S, Aina A (2012) Centralization and directional preference: a systematic review. Man Ther 17: 497-506.
40. Paungmali A, O' Leary S, Souvlis T, Vicenzino (2003) Hypoalgesic and sympathoexcitatory effect of mobilization with movement for lateral epicondylagia. Phys Ther 83: 374-383.
41. Takasaki H, Hall T and Jull G (2013) Immediate and short-term effects of Mulligan's mobilization with movement on knee pain and disability associated

with knee osteoarthritis-A prospective case series. Physiother Theory Pract 29: 87-95.

42. McKenzie RA: Treat Your Own Back. Spinal Publications Ltd Waikanee New Zealand, 1980 (NZ).
43. LaPrade R, Engebretsen A, Ly TV, Johansen S, Wentorf FA, et al. (2017) The Anatomy of the Medial Part of the Knee. J Bone Joint Surg Am 89: 2000-2010.
44. Greg L, May S (2013) Directional preference at the knee: A Case Report using mechanical diagnosis and therapy. J Man Manip Ther 21: 60-66.
45. May S, Aina A (2012) Centralization and directional preference: a systematic review. Man Ther 17: 497-506.
46. May S, Donelson R (2008) Evidence-informed management of chronic low back pain with the McKenzie method. Spine J 8: 134–141.
47. Schnebel BE, Watkins RG, Dillin W (1989) The role of spinal flexion and extension in changing nerve root compression in disc herniation; spine 14; 835-837.
48. Porterfield JA, DeRosa C (1998) Mechanical low back pain-perspective in functional anatomy, 2nd edition. Philadelphia, PA: WB Saunders Company.
49. Thoren P, Floras JS, Hoffmann P, Seals DR (1990) Endorphins and exercise: physiological mechanism and clinical implications. Med Sci Sports Exerc 22: 417-428.
50. Hagberg M, Harms-Ringdahl K, Nisell R, Hjelm EW (2000) Rehabilitation of neck-shoulder pain in women industrial workers: A randomized trial comparing isometric shoulder endurance training with isometric shoulder strength training. Arch Physic Med Rehab 81:1051-1058.
51. Ganguly T, Alam MF, Sharma R, Pabla N, Kaur T, et al. (2019) Short Term Effects of Kinesotaping with Mobilization on Balance in Patients with Osteoarthritis of Knee Joint. Acta Scientific Orthopaedics 2: 14-21.
52. Sambandam CE, Sailor SN, Alagesan J (2011) Effect of Mulligan Mobilization and Maitland Mobilization in Subjects with Unilateral Tibiofemoral Osteoarthritis - Randomized Controlled Trial. Journal of Pharmaceutical and Biomedical Sciences 11.
53. Gracjan Babula, Łukasz Nagraba (2010) The analysis of the effectiveness of the McKenzie method in patients with low back pain – based on the literature. Arthroscopy and Joint Surgery 6: 34-44.
54. Khuman R, Devi LS, Patel P, Chavda D (2014) Immediate Effects Of Single Session Post Isometric Relaxation Muscle Energy Technique Versus Mulligan's Bent Leg Raise Technique On Pain And Hamstring Flexibility In Knee Osteoarthritis Participants: A Randomised Controlled Study. Interational Journal of Scientific Research 3: 310-313.
55. Stathopoulos N, Dimitriadis Z, Koumantakis GA (2019) Effectiveness of Mulligan's mobilization with movement techniques on pain and disability of peripheral joints: a systematic review with meta-analysis between 2008–2017. Physiother 105: 1-9.
56. Sadana R, Mhase S (2018) Comparison of effects of Mckenzie exercises and conventional therapy in ACL reconstruction on knee range of motion and functional ability. International Journal of Applied Research 4: 415-420.
57. Oliveira AM, Peccin MS, Silva KN, Teixeira LE, Trevisani VF, et al. (2012) Impact of exercise on the functional capacity and pain of patients with knee osteoarthritis: a randomized clinical trial. Rev Bras Reumatol 52: 870-882.
58. Folland J, Williams A (2007) The Adaptations to Strength Training Morphological and Neurological Contributions to Increased Strength. Sports Med 37: 145-168.
59. Lange AK, Vanwanseele B, Fiatarone Singh MA (2008) Strength Training for Treatment of Osteoarthritis of the knee: A Systemic Review. Arthritis Rheum (Arthritis Care & Research) 59: 1488-1494.
60. Mikkelsen C, Werner S, Erikson E (2000) Closed kinetic chain alone compared to open and close kinetic chain exercises for quadriceps strengthening after anterior cruciate ligament reconstruction with respect to return to sports: A Prospective matched follow up study. Knee surgery sports Traumatol Arthroscop 8: 337-342.
61. Naamat KK, Sadeghi H, Sahebozamani M, Nazari S, et al. (2013) Effect of Seated Leg Press Exercise on Knee Extensor Strength in Elderly; Middle-East Journal of Scientific Research 18: 732-737.
62. Farzaneh JF , Akbari M, Takamjani EE, Mohsenifar H (2018) Effect of McKenzie Techniques on Muscle Strengthening in Anterior Knee Pain. Journal of Modern Rehabilitation 12: 38-38.