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 [3]. 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 transcunaneous 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 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 associated 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 determined 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.
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)**

#### Table 1: Pain

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SD</th>
<th>p value</th>
<th>t value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>At Baseline</td>
<td>Mulligan</td>
<td>47.5 ± 14.61</td>
<td>0.3697</td>
<td>0.904</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>50.7 ± 12.56</td>
<td></td>
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</tr>
<tr>
<td>At 4th Week</td>
<td>Mulligan</td>
<td>75.7 ± 12.9</td>
<td>0.2584</td>
<td>1.141</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>72.4 ± 8.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 3 Months</td>
<td>Mulligan</td>
<td>79.6 ± 8.88</td>
<td>0.2124</td>
<td>1.261</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>76.85 ± 7.86</td>
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</tr>
</tbody>
</table>

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 2: Symptoms

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SD</th>
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<th>t value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>At Baseline</td>
<td>Mulligan</td>
<td>59.76 ± 21.91</td>
<td>0.1922</td>
<td>1.32</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>65.94 ± 12.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 4th Week</td>
<td>Mulligan</td>
<td>78.45 ± 13.96</td>
<td>0.2176</td>
<td>1.246</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>82.85 ± 12.92</td>
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</tr>
<tr>
<td>At 3 Months</td>
<td>Mulligan</td>
<td>82.97 ± 9.96</td>
<td>0.8056</td>
<td>0.2473</td>
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<tr>
<td></td>
<td>McKenzie</td>
<td>82.38 ± 8.29</td>
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</table>

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 3: Activities of daily living

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SD</th>
<th>p value</th>
<th>t value</th>
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</tr>
</thead>
<tbody>
<tr>
<td>At Baseline</td>
<td>Mulligan</td>
<td>48.57 ± 14.47</td>
<td>0.1647</td>
<td>1.407</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>53.08 ± 9.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 4th Week</td>
<td>Mulligan</td>
<td>73.87 ± 8.73</td>
<td>0.5931</td>
<td>0.5373</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>75.19 ± 9.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 3 Months</td>
<td>Mulligan</td>
<td>79 ± 7.6</td>
<td>0.8899</td>
<td>0.1391</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>79.12 ± 5.65</td>
<td></td>
<td></td>
</tr>
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</table>

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 4: Sports and recreational activities

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SD</th>
<th>p value</th>
<th>t value</th>
<th>Result</th>
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<tr>
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<td>0.1647</td>
<td>1.407</td>
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<tr>
<td></td>
<td>McKenzie</td>
<td>53.08 ± 9.40</td>
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<tr>
<td>At 4th Week</td>
<td>Mulligan</td>
<td>73.87 ± 8.73</td>
<td>0.5931</td>
<td>0.5373</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>75.19 ± 9.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 3 Months</td>
<td>Mulligan</td>
<td>79 ± 7.6</td>
<td>0.8899</td>
<td>0.1391</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>79.12 ± 5.65</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 5: Quality of life.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SD</th>
<th>P value</th>
<th>t value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>At Baseline</td>
<td>Mulligan</td>
<td>24.58 ± 18.1</td>
<td>0.2612</td>
<td>1.135</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>29.79 ± 16.82</td>
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</tr>
<tr>
<td>At 4th Week</td>
<td>Mulligan</td>
<td>57.9 ± 12</td>
<td>0.4886</td>
<td>0.697</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>60.8 ± 15.16</td>
<td></td>
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</tr>
<tr>
<td>At 3 Months</td>
<td>Mulligan</td>
<td>60.41 ± 14</td>
<td>0.6009</td>
<td>0.526</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>58.54 ± 18.85</td>
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</tr>
</tbody>
</table>

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=0.697)
While at 3 Months, there was no significant difference (p=0.6009, t=0.526)

Table 6: Time up and go test.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SD</th>
<th>P value</th>
<th>t value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>At Baseline</td>
<td>Mulligan</td>
<td>15.5 ± 6.17</td>
<td>0.5468</td>
<td>0.6061</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>14.7 ± 3.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 4th Week</td>
<td>Mulligan</td>
<td>13.33 ± 4.64</td>
<td>0.6569</td>
<td>0.4466</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>12.86 ± 3.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 3 Months</td>
<td>Mulligan</td>
<td>12.76 ± 3.91</td>
<td>0.9435</td>
<td>0.0716</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>12.7 ± 3.18</td>
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<td></td>
</tr>
</tbody>
</table>

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=0.0716)

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

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SD</th>
<th>P value</th>
<th>t value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT Baseline</td>
<td>Mulligan</td>
<td>114.07 ± 15.95</td>
<td>0.1064</td>
<td>1.64</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>120.07 ± 11.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 4th Week</td>
<td>Mulligan</td>
<td>120.4 ± 13.23</td>
<td>0.4209</td>
<td>0.8106</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>123.06 ± 11.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 3 Months</td>
<td>Mulligan</td>
<td>122.5 ± 12.14</td>
<td>0.6148</td>
<td>0.5059</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>124.1 ± 11.94</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SD</th>
<th>P value</th>
<th>t value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT Baseline</td>
<td>Mulligan</td>
<td>114.1 ± 14.22</td>
<td>0.1985</td>
<td>1.301</td>
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<tr>
<td></td>
<td>McKenzie</td>
<td>118.4 ± 10.71</td>
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<tr>
<td>At 4th Week</td>
<td>Mulligan</td>
<td>119.26 ± 13.39</td>
<td>0.2134</td>
<td>1.258</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>123.2 ± 10.2</td>
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<tr>
<td>At 3 Months</td>
<td>Mulligan</td>
<td>122.7 ± 12.16</td>
<td>0.6265</td>
<td>0.4892</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>124.16 ± 10.6</td>
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</table>

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)
and McKenzie Exercises with the usual conventional physiotherapy given for knee osteoarthritis.

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=0.1611, 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.

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

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

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>Mean</th>
<th>±SD</th>
<th>P value</th>
<th>t value</th>
<th>Result</th>
</tr>
</thead>
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<tr>
<td>AT Baseline</td>
<td>Mulligan</td>
<td>3.43</td>
<td>0.49</td>
<td>0.2028</td>
<td>1.288</td>
<td>Not significant</td>
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<td>McKenzie</td>
<td>3.6</td>
<td>0.48</td>
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<tr>
<td>At 4th Week</td>
<td>Mulligan</td>
<td>4.06</td>
<td>0.35</td>
<td>0.7026</td>
<td>0.3837</td>
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<td></td>
<td>McKenzie</td>
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<td>0.3</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>At 3 Months</td>
<td>Mulligan</td>
<td>4.4</td>
<td>0.5</td>
<td>0.4448</td>
<td>0.7693</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td>McKenzie</td>
<td>4.4</td>
<td>0.48</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

At Baseline, there was no significant difference (p=0.2028, t=1.288)
At 4th week there was no significant difference (p=0.7026, 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.
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 subgrouping 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 Stathopouloua 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 statistically 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

41. Takasaki H, Hall T and Jul G (2013) Immediate and short-term effects of Mulligan’s mobilization with movement on knee pain and disability associated


