Type of Manuscript: Original Article

Title
EFFECTS OF MOTOR IMAGERY TECHNIQUE IN QUADRICEPS MUSCLE STRENGTHENING- AN EXPERIMENTAL STUDY
Vandana J. Rathod¹ Jagatheesan Alagesan² Ami Vacchani³

Authors and affiliations
1. Vandana J. Rathod - Lecturer, SPB physiotherapy college, Veer Narmad South Gujarat university, Surat, India.
2. Jagatheesan Alagesan - Associate Professor, Saveetha college of physiotherapy, Saveetha university, Chennai, India.
3. Ami Vacchani, Assistant physiotherapist, Deep surgical home, Junagadh, India.

Address for Correspondence
Dr. Vandana J. Rathod, M.P.T, M.I.A.P,
Lecturer,
SPB Physiotherapy college,
Ugat bhesan road, Surat
India - 395005.
Mobile: +91 9725401671.
ABSTRACT

Background and objectives:

Physiotherapy treatment plans developed for a wide variety of orthopedic and neurologic diseases frequently includes the goal of increasing the strength of specific muscles or muscle groups. Techniques used by physical therapists to improve muscle strength include resistance exercises with weights, elastic bands, isotonic and isokinetic machines and the use of neuromuscular electrical stimulation. Research studies have suggested that, through the use of motor imaginary technique, it may be possible to improve muscle strength without actually requiring significant muscle contraction. The objective of the study was to find the effect of motor imaginary technique to increase the strength of quadriceps muscle.

Method: 40 college going female students of the age group between 18 to 25 years satisfying the inclusion criteria were included in the study after obtaining informed consent. Subjects were randomly assigned into two groups- motor imaginary group and strengthening group the by lottery method. The outcome measure i.e. Quadriceps strength was calculated and recorded as 1 RM for each subject before and after the intervention.

Results: The statistical analysis of the data showed a significant increase in 1 RM of quadriceps strength in both the groups with \( p=0.116 \). Mean and standard deviation of motor imaginary group is 22.05 and 1.66 respectively. Mean and standard deviation value of strengthening group is 21.05 and 1.60.

Conclusion: The influence of motor imagery technique on quadriceps muscle strengthening is as significant as quadriceps muscle strengthening exercises in improving quadriceps muscle strength.

KEY WORDS: Quadriceps strength, Motor imaginary technique, Normal subjects
INTRODUCTION

Motor imagery refers to a dynamic state whereby individuals mentally simulate the performance of a specific motor action.\(^1,2\) It is cognitively reproducing or visualizing an object, scene, or sensation as though it were occurring in the physical reality. Imagine yourself in a very quiet, beautiful, peaceful place as an example of using MI as a relaxation and stress-reduction technique. Learning a motor skill is a complex process that requires spatial temporal and hierarchical organization of the central nervous system. Performance is reflection of learning and improvement in it results from practice or experience. There are different measures of learning include retention, generalization and resistant to contextual change.\(^3\)

Motor learning can be facilitated through the use of effective training strategies which involves a significant amount of practice and feedback, with a high level of information processing related to control, error detection and correction.\(^4\) Practice is most important part of training strategy. The organization of it will depend on several factors, including the person’s motivation, attention span, concentration endurance and the type of task.\(^4,5\)

Treatment plans developed for a wide variety of orthopedic and neurologic diseases frequently includes the goal of increasing the strength of specific muscles or muscle groups. Techniques used by physical therapists to improve muscle strength frequently include resistance exercises with weights, elastic bands, isotonic and isokinetic machines and the use of neuromuscular electrical stimulation. In all of these techniques, the patient is required to contract the muscles being trained. However, in some orthopedic and neurologic lesions muscle contraction may cause pain or may not even be possible. Research studies have suggested that, through the use of mental practice, it may be possible to improve muscle strength without actually requiring significant muscle contraction.\(^6\)

Humans have the ability to generate mental correlates of perceptual and motor events without any triggering external stimulus, a function known as Imagery. Mental
practice is defined as 'the process of imaging and rehearsing the performance of a skill with no related overt actions'. It has been suggested that the brain structures or systems mediating the mental stimulation and the physical execution are alike. Also, an increase in the heart and respiration rates is noticed in the subjects engaged in the motor imagery of effortful actions.\(^{(7)}\)

Results from research support the notion that mental practice, similar to physical practice, can improve the performance of a motor skill and that this increase in performance is associated with physiologic and plastic changes at the cerebral level.\(^{(8)}\) It has been shown that cortical regions activated by motor planning are also activated during motor imagery, data suggesting that a precise stimulation of motor behavior is produced during motor imagery.\(^{(9,10)}\) Regions, like the primary motor cortex and lateral cerebellum that were previously thought to be activated only during executed movements, have now been shown to be activated also during motor imagery.\(^{(7)}\)

The quadriceps is strong extensor of the knee joint. This action is very important in standing, walking and running. In addition, the Rectus femoris flexes the hip joint along with the iliopsoas and helps to maintain the erect attitude; and the vastus medialis prevents lateral displacement of the patella. The muscle is tested by attempting to extend the knee joint against resistance and palpating the contracting quadriceps muscle.\(^{(11)}\) Quadriceps strengthening can help to improve the strength and size of lower limb. It improves the locomotion and also increases the tolerance and endurance. Some of the exercises and resisted activities are helpful for the strengthening of quadriceps which includes straight leg raising, lying leg lift, wall slide, squatting, wall sit quads exercise, wall slide quads exercise, resisted exercises.

Studies have shown mental practice to be an effective training technique for enhancing the performance of motor skills when used in combination with physical practice and even when used in isolation.\(^{(12,13)}\) While physical practice is considered to be superior, mental practice can augment physical practice and has the advantage that in
situations where physical practice is not possible it is better at improving motor skills than no practice at all.\(^{(6)}\)

However, controversies still persist regarding the efficiency of this training technique.\(^{(7)}\) Many theories have been proposed to explain the mechanisms by which mental practice acts to increase performance in motor learning.\(^{(12)}\) Yet, few have been experimentally tested and none offers a satisfactory explanation for the existing findings. Therefore the objective of the study is to find the effect of mental practice to increase the strength of quadriceps muscle.

**Method**

For this experimental study, subjects were taken from College of physiotherapy in Vadodara, between the age group of 18-25 years. Prior to participation in the study, all female participants were explained in detail about the procedures and risk and benefits of the specific study. They acknowledged their participation through signing the informed consent. They were randomly divided into two treatment groups, strengthening group (SG) and motor imaginary group (MG). Randomization was performed by lottery method. Subjects with learning disability and who has not done any motor imaginary training to improve strength were not included in this study. Males and individuals with cardiopulmonary, neurological, psychological condition which may interference with training were excluded from the study. The study was approved by Institutional Review Board.

The outcome measure i.e. Quadriceps strength was calculated and recorded as 1 RM, for each person.\(^{(13,14)}\) The weight according to the first phase of De Lorme's protocol was derived for each person and the subject was allowed to lift that weight once and experience the feeling of lifting weight. Before the training strengthening group was taught quadriceps strengthening exercise and motor imagery group was taught motor imaginary technique once. Quadriceps muscle strength was measured with 1 RM before starting the intervention.
Experimental group will be given quadriceps strengthening exercise: \(^{(15,16)}\)

1. Wall slide

   Stand with your arms at your sides and your feet (18 to 24 inches from the door frame) about shoulder width apart. Lean against the door frame or other surface with your back straight, and your neck aligned with your spine. With breathe out, bend your knees and slide down the surface until you are in a sitting position. Your knees should be slightly behind or just over your ankles. Breathe in and out as you hold this position. Hold this position for as long as you can up to 60 seconds. Then straighten your knees and slide back up the surface to the starting position.

2. Bent leg raise

   Sit on a chair and straighten one leg. Hold for one minute. Bend your knee to lower that leg about halfway to the floor (a 45-degree angle) and hold for 30 seconds. Return to starting position and rest for one minute.

3. Isometric static quadriceps

   Static Quadriceps exercises: In this exercise, you tighten your kneecap till the count of 3 seconds and loosen it for another count of 3 seconds.

   This exercise regime was progressed according to the De Lorme's protocol (without resistance). And at each progression stage the subject was made to experience a percentage of 10 RM weight. The experimental group after experiencing the initial weight according to the De Lorme's protocol was made to do same exercises. These subjects assigned to the mental practice group were given instructions from a prepared script on how to use kinesthetic mental imagery. The subject was asked to imagine lifting the same weight without producing actual movement or visible muscle contraction at knee. The number of repetitions and progression was based on De Lorme's protocol. At each progression stage, the subject was made to experience the percentage of 10 RM weight for that stage once. The program was continued for four weeks for each group. All subjects performed 5 sessions’ sets of 10 repetitions, 3 times a week. One RM was again calculated at the end of the program for all the subjects.
Data analysis and result

All the statistical analysis was done by using SPSS 17 for windows software. Intra group comparison for both groups was done by using Paired t test. Descriptive analysis for both groups was also done. Groups were analyzed with mean and standard deviation. The intergroup comparison was analyzed by using independent t test to check the homogeneity at baseline and treatment effect after intervention.

Table 1: Intra group comparison of MG and SG

<table>
<thead>
<tr>
<th>GROUP</th>
<th>MEAN</th>
<th>STANDARD DEVIATION</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>MG</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before intervention</td>
<td>22.48</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>After Intervention</td>
<td>27.88</td>
<td>3.8</td>
<td>9.560</td>
<td>0.000</td>
</tr>
<tr>
<td>SG</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before Intervention</td>
<td>21.16</td>
<td>5.32</td>
<td>8.746</td>
<td>0.000</td>
</tr>
<tr>
<td>After Intervention</td>
<td>23.91</td>
<td>5.31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The intra group comparison of both the groups was done by using paired t test. The t value of both the groups shows significant difference between the interventions. This suggests that motor imagery technique as well as quadriceps strengthening exercises is significant in improving quadriceps muscle strength.
Table 2: Before intervention group comparisons

<table>
<thead>
<tr>
<th>GROUP</th>
<th>UPPER</th>
<th>LOWER</th>
<th>MEAN</th>
<th>SD</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>MG</td>
<td>4.22</td>
<td>-1.57</td>
<td>1.32</td>
<td>1.43</td>
<td>0.925</td>
<td>0.052</td>
</tr>
<tr>
<td>SG</td>
<td>4.23</td>
<td>-1.58</td>
<td>1.32</td>
<td>1.43</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Inter group comparison before intervention was done by using independent t test. The t value for before intervention inter group comparisons of MG & SG is 0.925 and p value is 0.052 which shows before intervention homogeneity of group A and B.

Table 3: After intervention group comparisons

<table>
<thead>
<tr>
<th>GROUP</th>
<th>UPPER</th>
<th>LOWER</th>
<th>MEAN</th>
<th>SD</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>6.90</td>
<td>1.02</td>
<td>3.96</td>
<td>1.45</td>
<td>2.731</td>
<td>0.116</td>
</tr>
<tr>
<td>Group B</td>
<td>6.91</td>
<td>1.01</td>
<td>3.96</td>
<td>1.45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The inter group comparison after intervention was done by using independent t test. The t value for after intervention inter group comparisons of MD and SG is 2.73 and p value is 0.116 showing there is no significant difference in motor imagery technique and quadriceps strengthening exercises in improving quadriceps strength.
Discussion:

The study was designed to explore an intervention strategy that physical therapist might consider to gain strength of quadriceps muscle whose weakness might be a limiting factor in a person’s functional capacity, by using the motor imagery technique. Motor imagery refers to a dynamic state whereby individuals mentally simulate the performance of a specific motor action. Literature review shows number of previous studies which have shown that there has been effect of motor imagery technique on quadriceps muscle strengthening. Lebon F et al., (2010)\(^{17}\) and Ruth D et al., (2007)\(^{18}\) studies were designed to explore the mechanism by which motor imagery can mediate increase in motor performance.

40 female subjects were selected out of which 20 were kept in motor imagery group & 20 in strengthening group. Before the training strengthening group was taught quadriceps strengthening exercise and motor imagery group was taught motor imaginary technique once. Quadriceps muscle strength was measured with 1 RM before starting the intervention. After giving quadriceps strengthening exercise and motor imagery training the muscle strength of both the groups was measured again with 1 RM.

Analysis was done with the base line data and post treatment scores. Intra group comparison of the groups was done through paired t test and inter group comparison was done through independent t test. The intra group comparison for both group shows \(p < 0.001\), proving significant in improving quadriceps strength. The inter group comparison shows \(p = 0.11\) thus indicating there is no significant different in motor imagery technique and quadriceps muscle strengthening in improving quadriceps muscle strength.

Certain variables were uncontrolled in the current study and their influence on the results was assumed to be null. Whether or not the subjects in the experimental group were actually doing the mental imagination in proper repetition and accurately could not be determined and were out of control of the tester and therefore it was assumed that they were doing it perfectly. Also it was assumed that life-style and dietary habits had no
effects on the muscle strengthening and improvement on it. It is also assumed that during 4 weeks subjects didn’t underwent any treatment.

This study did not include long-term follow up period, though exercises are effective for long term benefits of the interventions. In this study, quadriceps strengthening was assessed by physiotherapist before and after the intervention but the greater effects of motor imagery was found in improvement of quadriceps strengthening.

This study concludes that the influence of motor imagery technique on quadriceps muscle strengthening is as significant as quadriceps muscle strengthening exercises in improving quadriceps muscle strength. Further studies could focus on the long-term benefits of physical therapy for this condition and the relative effectiveness of these treatment regimens compared with other approaches. This study can be conducted with randomized control trial for the effectiveness of motor imaginary programme in improving strength of quadriceps muscle.

Conclusion

This study concludes that the influence of motor imagery technique on quadriceps muscle strengthening is as significant as quadriceps muscle strengthening exercises in improving quadriceps muscle strength.
References:


