Effect of Mental Imagery Coupled with Plyometric on Vertical Jump and Agility

Kanika Taneja¹, Kalpana Zutshi², CS Ram³, Anuradha Solanki⁴

¹Research Student, Physiotherapist Sir Ganga Ram Hospital, New Delhi, India.
²Assistant Professor/Incharge Rehabilitation Centre, Department of Rehabilitation Sciences, Jamia Hamdard, Hamdard University, New Delhi, India.
³Director, Department of Physiotherapy, ITS College Uttar Pradesh, India.
⁴Sports Psychologist, Sports Authority of India, New Delhi, India.

Background: Among the extensive research done, there are many studies on imagery use by athletes. These studies have looked at athletes imagery use under a number of different conditions except its use clubbed with physical training which has less available evidences.¹,²,⁹,¹³,¹⁵

The additional advantage being in the case of acute injuries, when actual training is not possible, imagery training is believed to be extremely beneficial without causing any further exertion to the injury.

The objective of the study is to study the efficacy of a program combining mental and physical practice with the efficacy of a program composed of only plyometric training or only mental practice on vertical jump and Agility.

Methods: A total of 36 healthy male volunteers participated in the study from Hamdard University and Darbari Lal D.A.V. Model School. It was a different subject experimental study with a Pre-Test – Post Test design. They were randomly assigned between three groups. Main outcome measure was vertical jump using Stand and reach test and Agility t-test for Agility.

The data was analyzed with the help of statistician using SPSS 15.0 version.

Paired-t test was used to see the within Group analysis of both the outcome measures as vertical jump and Agility t-test. Results of training from pretesting to post testing were analyzed using a one-way ANOVA and compared across three groups. When a significant F-ratio was found, a Bonferoni’s post-hoc test was used to determine differences between mean values across the three groups. Alpha was set at .05 to achieve statistical significance for all analysis.

Results: It was seen that all the three groups i.e. combination (plyometric and mental imagery) group C, mental imagery training (group B) and plyometric training (group A) has yielded significant improvements on both the outcome after training for 6 weeks. Combined training...
Introduction

The famous psychologist William Jones wrote that “the greatest discovery...is that human beings by changing the inner attitudes of their minds, can change the outer aspects of their lives”.55

According to Linda Warner, if you close your eyes and imagine yourself standing in a swimming pool, you are using mental imagery. You can mentally practice a physical skill, such as doing the backstroke across a swimming pool, by visualizing yourself doing it. Various researchers shows that, Mental imagery has been used as a technique for influencing physical components in various disciplines.1,2,5,5,58

In recent years the study of mental imagery has sparked the interest of many scholars in the field of sport psychology. It is now recognized that, in general, imagery is used by most people. In addition, many athletes and coaches have realized the important role that imagery plays and have incorporated its use into their training regimens.38

In general, imagery is defined as “those quasi-sensory and quasi-perceptual experiences of which we are self-consciously aware and which exist for us in the absence of those stimulus conditions that are known to produce their genuine sensory or perceptual counterparts”.49

There are several reports about mental imagery and mental practice being used in sports training11,16,17,48,1,20 and for neurological rehabilitation.3,12,44,51,52 From a sports medicine perspective, imagery is seen as a key component in mental training programs for athletes.38 In application, imagery is a form of simulation used by athletes most often for improving skill acquisition, motivation and performance.38 Individual asked to imagine they performing skilled, serial movements of the digits manifested increased cerebral blood flow in non-primary motor regions of the cerebral cortex without evidence of activating the primary motor cortex.50

Mental imagery practice has been proposed as an alternative mode of exercise therapy that bears little cost and has no safety risks. Its positive effects on motor performance and skill, especially when combined with physical practice, have not been well established.50

The present study was meant to examine the use of imagery in the Sports Physical therapy. The use of imagery by athletes has been researched extensively in a number of different capacities.38,39

Of particular interest, have been that the mental practice may be used as a noninvasive complement to physical therapy to improve performance in terms of agility and vertical jump. Mental imagery has been studied to be benefited on various psychological factors as self efficacy, anxiety, confidence, attention or concentration5,32 but not much research is being done in correspond to physical performance factors.

Could a similar effect be achieved by using the plyometric training to enhance vertical jump and agility?

Material and Methods

A total of 36 healthy male volunteers participated in the study for 6 weeks from Hamdard University and Darbari Lal D.A.V. Model School. A written informed consent was obtained from those volunteers who fulfilled the Inclusion and exclusion criteria.

Inclusion criteria: Healthy Collegiate athletes
- Age group: 18-25 years
- 10 single leg squats in 15 seconds
- 10 single leg step ups in 15 seconds
- Have strength base level to lift 1.5 - 2.5 x body weight in free squat

Exclusion criteria: Current participation in any lower limb training program
- Prior history of lower limb pathology
- Gross instability
- Taking regular mental imagery or any psychological training

They were randomly assigned between three groups as: Group A (Plyometric Training), Group B (Mental training) and Group C (Combination of Plyometric and Mental Training). It was a different subject experimental study with a Pre-Test–Post Test design used to find out effects of Mental Imagery training combined with Plyometric Training on Vertical Jump and Agility. Interventions divided...
as 12 subject received Plyometric training (Group A), 12 underwent Mental imagery training (Group B) and 12 received combination of both plyometric training and Mental Imagery training (Group C) training was given for 6 weeks with frequency of 2 days per week.

Subjects were identified, informed consent was taken and randomly assigned to three group’s. Prior to pre-test recordings and familiarization with the test was done. Familiarization included practicing of vertical jumps and Agility T-Drill with proper instructions. Constant feedback was given to rectify any errors when performing them.

The Movement Imagery Questionnaire was filled by Group B (mental imagery) and Group C (combination of plyometrics and imagery) to know what type of imagers they were.

Baseline measurement by vertical jump height and agility test was measured by Stand and Reach test and T-Drill. The mental imagery and plyometric training lasted for six weeks with two sessions of both every week. During the imagery sessions, the participants was told to imagine jumps and Agility T-Drill according to the described instruction repeatedly for 1.5 minutes followed by a 30s rest period. This was repeated four times. It was done in the form of audio tapes using mp3 player and headphones.

Plyometric training was followed as per the protocol

Post intervention Outcome measures vertical jump and agility test were again measured as average of three readings and recorded for analysis.

Data Analysis

A total of 36 subjects participated in the study with their demographic data was analyzed by comparing means of descriptive. They have their mean age $\pm$S.D as 21.5±2.23, 21.5±2.2 and 21.0±2.1 for Group A, B and C respectively.

The mean height recorded for each Group was 159.2±6.9 (Group A), 159.3 ±4.12 (Group B) and 164.4 ±8.2 (Group C)

The average weight of the subjects included in study was recorded as 58±4.59, 57±6.08 and 59±5.7 for Group A, B and C respectively.

The ‘p’ value and f value for each age, height and weight was found out to be Age (p-value .813, f=-.208), Height (p-value.115, f-value2.314) and Weight (p-value.698, f-value.364). Each of these indicates that there is insignificant difference between these parameters.

The ‘p’ value and the f-value for baseline pretest values of vertical jump and Agility t-test was also found to be ‘p’ value .408 and f value .922 and p value .773 and f value .259 respectively indicating the insignificant difference between them, hence allowing them to be compared in the study.

Within Group results

It was done using Paired sample t-test on each Group and with each outcome measure

The comparison for within Group significance was done using Paired sample t-test which was conducted to see difference between vertical jump pre and vertical jump post in each Group

**Vertical Jump**

It was found that on comparing vertical jump pre and vertical jump post the p and t-values (p-value .000 and t-value 9.513) shows it to be significant.

For group B, Paired sample t-test was conducted to see difference between vertical jump pre and vertical jump post in each group. It was found that (p-value was .000 and t-value 5.211) which shows it to be significant.

### Table 1 (1) Descriptive analysis of demographic factors

<table>
<thead>
<tr>
<th></th>
<th>Group A Mean ± S.D</th>
<th>Group B Mean ± S.D</th>
<th>Group C Mean ± S.D</th>
<th>f-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>21.5±2.23</td>
<td>21.58±2.23</td>
<td>21.0±2.1</td>
<td>.208</td>
<td>.813</td>
</tr>
<tr>
<td>Height</td>
<td>159.28±6.9</td>
<td>159.3±4.12</td>
<td>164.4±8.2</td>
<td>2.314</td>
<td>.115</td>
</tr>
<tr>
<td>Weight</td>
<td>58±4.59</td>
<td>57±6.08</td>
<td>59±5.7</td>
<td>.364</td>
<td>.698</td>
</tr>
<tr>
<td>Vertical jump Pre-test</td>
<td>26.84±7.05</td>
<td>30.8±6.6</td>
<td>29.1±7.96</td>
<td>.922</td>
<td>.408</td>
</tr>
<tr>
<td>Agility t-test Pre-test</td>
<td>13.51±1.12</td>
<td>13.25±1.28</td>
<td>13.5±1.03</td>
<td>.259</td>
<td>.773</td>
</tr>
</tbody>
</table>

### Table 1 (2) Vertical jump difference for Group A

<table>
<thead>
<tr>
<th></th>
<th>Vertical Jump Pretest value Mean±SD</th>
<th>Vertical Jump Posttest value Mean±SD</th>
<th>t-test</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group C</td>
<td>29.15±7.96</td>
<td>35.97±7.17</td>
<td>16.845</td>
<td>.000</td>
</tr>
</tbody>
</table>

**Table 1(2).Vertical jump difference for Group A**

<table>
<thead>
<tr>
<th></th>
<th>Vertical Jump Pretest value Mean±SD</th>
<th>Vertical Jump Posttest value Mean±SD</th>
<th>t-test</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>26.84±7.05</td>
<td>30.91±6.53</td>
<td>9.513</td>
<td>.000</td>
</tr>
</tbody>
</table>
In group C, 'p' value ('p' value .000 and t-value 16.845) for vertical jump pretest and post test comparison which found out the result to be significant.

**Agility t-test**

For within group results, Agility t-test was the outcome measures and its effect on each group was studied.

It was seen that the agility t-test pre and agility t-test post (p-value.000 and t=9.423) seen all through in Group A and were seen as significant.

The result when compared by agility t-test pre values and Agility t-test post values in Group A and seen, p-value .000 and t value 6.552 showing the result found was significant.

The result when compared by agility t-test pre values and Agility t-test post values in Group C and seen p-value .000 and t-value 14.524 showing that the result found was significant.

**Between Group Analysis**

Since the baseline characters of subjects in three groups were comparable, the outcome variables i.e. vertical jump and agility scores were compared across the three groups using one way ANOVA followed by post hoc, Bonferroni test was used.

Between group analysis shows that 'p' value for difference in Vertical Jump was .000 and f-value=31.65 showing it to be significant. The differences in agility test scores indicate significant results with p-value.000 and f-value 59.96 at 5 % significance level.

The mean±S.D values allow giving the difference with which both the outcomes vary in each group.

Considering Vertical Jump as outcome measure, it was seen that mean±S.D of vertical jump difference is 4.22±1.53, 2.10±1.39 and 6.81±1.40 for Group A, B and C respectively, indicating greatest gain in Group of 6.81±1.40.

When Agility t-test was compared between three groups it was seen that the values of mean±S.D for each, it was seen that mean±S.D of Agility test scores was .95±.34, .54±.21and 2.1±.21 for Group A, B and C respectively, indicating greatest gain in Group C indicating better results and signifying the differences with which improvement has occurred.

With multiple comparisons done using Bonferroni, for difference in Vertical Jump outcome measure, when Group A is compared to Group B, p-value .003 which shows statistically significant difference was seen. When Group B and C are compared. p-value is seen as .000 which was statistically significant. With comparison between Group C and Group A, p-value .000 which was statistically significant differences.
Table I(5). Difference of Agility t-test in group A

<table>
<thead>
<tr>
<th></th>
<th>Agility t-test Pretest value Mean±SD</th>
<th>Agility t-test Posttest value Mean±SD</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>13.51±1.12</td>
<td>12.56±0.97</td>
<td>9.423</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.000</td>
</tr>
</tbody>
</table>

Table I(6). Difference of Agility t-test in group B

<table>
<thead>
<tr>
<th></th>
<th>Agility t-test Pretest value Mean±SD</th>
<th>Agility t-test Posttest value Mean±SD</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group B</td>
<td>13.25±1.28</td>
<td>12.70±1.24</td>
<td>6.552</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.000</td>
</tr>
</tbody>
</table>

Table I(7). Difference of Agility t-test in group C

<table>
<thead>
<tr>
<th></th>
<th>Agility t-test Pretest value Mean±SD</th>
<th>Agility t-test Posttest value Mean±SD</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group C</td>
<td>13.57±1.03</td>
<td>11.38±0.77</td>
<td>14.524</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.000</td>
</tr>
</tbody>
</table>

Figure 1(2). Within group for Agility t-test Pre and Post-test

Table I(8). Between Group comparison of difference of Vertical Jump and Agility t-test

<table>
<thead>
<tr>
<th></th>
<th>Group A Mean±SD N=12</th>
<th>Group B Mean±SD N=12</th>
<th>Group C Mean±SD N=12</th>
<th>ANOVA</th>
<th>Post hoc analysis (LSD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>‘p’</td>
<td>A v/s B ‘p’</td>
<td>A v/s C ‘p’</td>
<td>B v/s C ‘p’</td>
</tr>
<tr>
<td>Vertical Jump Diff</td>
<td>31.65</td>
<td>.000</td>
<td>.003</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>Agility t-test Diff</td>
<td>59.96</td>
<td>.000</td>
<td>.046</td>
<td>.000</td>
<td>.000</td>
</tr>
</tbody>
</table>

Figure 1(3). Between groups of both the outcome measures
Considering the difference in Agility t-test scores, comparison between Group A and Group B shows p value .046 and with comparison between Group B and C, p-value .000 and on comparing Group C and Group A shows ‘p’ value to be .000 showing the good significance level.

The Independent t-test was used to state difference for male and female and found equivocal showing insignificant effects in Group A and B. But in Group C which showed statistical significant variation for Agility t-test scores as ‘p’ value of .003

Results

The result to the study was that after the six weeks of intervention, all the three groups i.e. combination (plyometric and mental imagery) group C, mental imagery training (group B) and plyometric training (group A) has yielded significant improvements on the outcome measures. It was also seen that the combination of plyometric training and mental imagery training has provided with superior results than the intervention of plyometrics and mental imagery training alone. Considering Vertical Jump as outcome measure, it was seen that mean±S.D of vertical jump difference is 4.22±1.53, 2.10±1.39 and 6.81±1.40 for Group A, B and C respectively, indicating greatest gain in group C of 6.81±1.40. When Agility T test was compared between three groups it was seen that the values of mean±S.D for each, it was seen that mean±S.D of Agility test scores was 0.95±0.34, 0.54±0.21 and 2.1±0.21 for Group A, B and C respectively, indicating greatest gain in group C indicating better results and signifying the differences with which improvement has occurred.

Discussion

Within Group analysis

The analysis for within Group comparison has yielded the results showing each Group has significantly improved on both the outcome measures.

Effects of Plyometrics on Vertical jump

The enhanced vertical jump with plyometrics was also in agreement with study by Matavulj74 and Brown.7 It was found that increase was associated with an increase in both maximum voluntary force of hip extensors and rate of force development in knee extensors. It supported the findings on improvement with concerning the elastic loading of muscle.7

Effectiveness of Mental imagery

It was seen that Group B intervention of mental imagery has significantly improved both the outcome measures but its effectiveness is less in comparison to other two groups. A well supported study by Olsson et al11 found that intervention of mental imagery showed 50 % greater gain than in the control Group suggesting that internal imagery training program helped to improve the bar clearance component of high jump.

Between group analysis

Our main result was obtained by contrasting effects of intervention used for three different groups and it was seen that combination (Group C) gives superior results than plyometric (Group A) and imagery (Group B) alone. It was seen that the values for mean for 1 st outcome measure vertical jump was 6.8 cm in Group C and 4.2 cm and 2.1 cm in Group A and Group C respectively. On the timings for agility test, Group C outperformed (2.1 sec) by 0.9 sec and 0.5 sec in Group A and B respectively.

The timings for T test for agility measures was improved significantly in Group C (2.1 secs) which underwent combination training and 0.9 sec s in Group A which underwent plyometric training and 0.5 secs in Group B with mental imagery intervention.

The Group C being better than the other two groups could be explained on the basis of the additive effects of plyometric training and imagery training leading to enhanced effects when used together.

Group C effectiveness

Coupled effects with combination

Combined training significantly improved performance in agility test and vertical jump as compared to plyometrics and imagery alone (‘p’ value=.000 for difference Vertical Jump and ‘p’ value=.000 for difference Agility t-test at p=5 % significance)

Limitations of the study

Lack of funds and infrastructure, many resources like measuring heart rate along cannot be utilized in the study.

Larger sample would have brought more clarity to the research.

Due to lack of research assistant, blinding in observations trends was not possible.

Conclusion

It was concluded through the study that combination of mental imagery training along with plyometrics yields better and added effects on vertical jump and agility than plyometrics and mental imagery training alone.

Acknowledgment

My parents, my grandmother, my sister and my husband have always been there as support system for me, also constant motivation from my friends have indeed been the great factor.

Conflict of Interest: None
References


