



Original Article

Effects of Graded Motor Imagery Techniques on Grip Strength in Female Patients with Colles Fracture

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ABSTRACT

Background: Colles fracture usually occurs with a fall on an outstretched hand and the post-traumatic complication of this fracture includes loss of grip strength, pain and decreased functional outcome. **Objective:** To determine the effects of graded motor imagery technique on grip strength in female patients with Colles fracture. **Methods:** A quasi-experimental study was conducted on females with the Colles fracture and decreased grip strength. Participants were divided into experimental and conventional groups, with the same baseline treatment based on convenience. Only females with Colles fractures of age 40 to 70 years and those who were conservatively managed were included in the study. Whereas patients with any systematic diseases e.g. rheumatic disease or fracture treated by internal fixation were excluded from the study. A modified sphygmomanometer for assessing grip strength and a patient-rated risk evaluation questionnaire were used. Data was collected using a purposive sampling technique and a sample of 44 was divided into two groups. Patient-rated wrist evaluation and a modified sphygmomanometer were used as data collection tools. The SPSS 20.0 version was used for data analysis. Mean and standard deviation was calculated for group statistics. Active variables were tested with an independent sample t-test. **Results:** The results of the comparison of experimental and conventional groups, grip strength after six weeks of treatment showed a difference of 66.64 and 43.8 for the conventional group respectively, with a value of $p:0.000$, showing significant differences in all variables. The results regarding the comparison of groups for patient-rated wrist evaluation were categorized into functional and pain components, mean functional score of wrist joint before and after treatment in the experimental group was $M=89.63$ and $M=37.68$ respectively whereas the conventional group showed a lesser reduction with $M=88.35$ and $M=43.85$. After six weeks of treatment, the total score had an average difference of -3.39 , with a p -value of 0.543 . while the degree of freedom was 40. **Conclusion:** The findings of this study concluded that the graded-motor imagery technique combined with traditional rehabilitation protocol is effective in improving grip strength in females with Colles fractures.

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INTRODUCTION

The transverse fracture of the distal radius bone is Colles fracture. It is categorized as the most commonly occurring fracture in the upper extremity. It is also frequently observed as fractures in the osteoporotic population consequential from low energy or traumatic events linked with low and high strain rates. Beyond the age of 65 compared to all other fractures, the distal radius fractures had a record of 18%, and the ratio is 5 folds more in women than in men.^{1,2} In the elderly like at the age of 55 years or above, there is rapid incidence for women, which every 10 years increases two folds until 90 years of age.³ The experiments on Colles fracture accounts work on various loading degrees alternating from static to impact loadings.⁴ Multiple soft tissue injuries were associated with stable and unstable Colles fractures. Extensor pollicis longus is the most commonly damaged tendon; the natural occurrence is unknown, but the damage occurs to this tendon with minimal to no displacement.⁵

Traumatic carpal tunnel syndrome is another associated complication of distal radius fractures. Acute and chronic compartmental syndromes are prevalent to occur during the process of management and healing. Other complications associated with these fractures include post-traumatic arthritis, tendonitis, tenosynovitis, tendon rupture adhesions, scarring trigger fingers and Dupuytren contracture. These described soft tissue injuries result in decreased joint play and overall functional outcome of the wrist joint, following decreased grip strength and unmanageable pains.⁶ Hand strength can also help understand general disabilities in the elderly population and their prognosis⁷. The valid and reliable assessment of grip strength is of principal value in establishing the accomplishment of different surgical or cures measures.⁸ The physiotherapy treatment after a Colles fracture proceeds in two domains;

pain management and regain of functional mobility.⁹ Women experiencing this fracture are vulnerable to decreased arm motion, sensorimotor changes, excessive swelling and fluid accumulation, and type I complex regional pain syndrome (CRPS).¹⁰ As CRPS initiation is likely liable to changes in the brain somatosensory region, a therapeutic intervention, graded motor imagery (GMI), intends to re-establish cortical illustration and sensory and motor function of the affected limb.¹¹

The main objective of the GMI technique is it lessens; both sensory and physical symptoms of pain. The first stage of implicit motor imagery targets the pre-motor area and mirror neurons in the brain for laterality reconstruction.¹² Static pictures of other limbs were shown to the individuals to build left and right-side discrimination. The second stage of explicit motor imagery works by targeting mirror neurons of the brain that cause the progression of a person to visualize from static third person pictures to the dynamic first-person observing, visualizing self to self-performing.¹³ Much evidence on the encouraging outcomes of motor imagery technique on motor effects and learning in sportsperson, normal individual as well as individuals with brain disorders (e.g., stroke, spinal cord injury, Parkinson's disease) has been published. On basis of these evidences this study is aimed to apply GMIT for improvement of grip strength in female with Colles fracture. If proved effective this technique would prove to be a beneficial addition to existing treatment techniques and a revolutionary technique of physiotherapy rehabilitation of Colles fracture.

METHODS

A quasi-experimental study with 44 patients was conducted in Benazir Bhutto and Holy Family Hospital, Rawalpindi for six months. After conducting the pilot study 0.91 effect

size was measured by using this effect size 40 patients were recruited and the sample size was calculated by using G-power analysis with a 95% confidence interval and 5% margin of error, 80% power of the study, as 10% attrition rate was assumed so 44 sample size was taken in the study. T-test is used for finding the mean difference between two independent means (two groups). Data was collected using a purposive sampling technique. All female patients within the age limit of 40 to 70 years with Colles fractures were included. Subjects who had undergone any elective or emergent surgical procedure, having radiculopathies and systemic diseases, were excluded. Participants were allocated into two equal groups, i.e., experimental and conventional. In an outpatient rehabilitation program, the graded motor imagery technique was administered along with baseline treatment to participants in the experimental group. However, the conventional group only received baseline treatment. There were two dropouts in the conventional group. After taking written consent from the participants, the researcher evaluated the wrist functionality and grip strength using patient rated wrist evaluation (PRWE)¹⁴ and a modified sphygmomanometer respectively. The initial readings obtained were considered as a baseline for future assessments. The treatment was given twice a week for six weeks. Final readings were obtained after six weeks.

Data was entered and analyzed by using SPSS software version 20. After accessing the normality by Shapiro Wilk test and Q-Q plot, the data were normally distributed as the (p-value>0.05). Inferential statistics included independent samples t-test for comparison of means between two groups. The qualitative variables were presented in frequency tables and percentages, whereas quantitative variables were presented as mean and standard deviation.

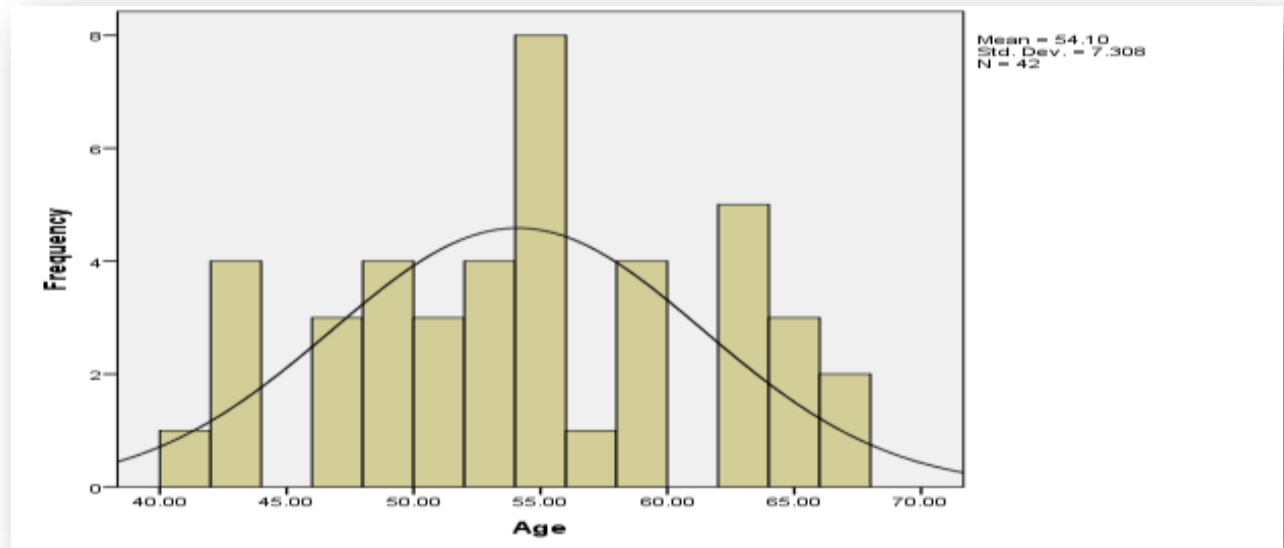
RESULTS

The mean age of 42 participants aged between 40 to 70 years was 54.1 ± 7.308 (Figure 1). According to the findings the mean and standard deviation for grip strength before and after treatment in the experimental group were ($M=31.5 \pm 9.67$ and $M=66.63 \pm 12.12$) whereas the conventional group showed minimum improvement with ($M=31.45 \pm 10.22$ and $M=43.8 \pm 8.41$) and a p-value of <0.05 suggests significant findings (Figure 2). PRWE findings were categorized into functional and pain components. Mean and SD for the Functional score of the wrist joint before and after treatment in the experimental group was ($M=89.63 \pm 7.97$ and $M=37.68 \pm 15.17$). However, participants in the conventional group showed a lesser reduction with ($M=88.35 \pm 6.06$ and $M=43.85 \pm 11.45$). Regarding pain score Mean and SD before and after treatment in the experimental group were ($M=45.90 \pm 3.853$ and $M=21.22 \pm 6.78$) through conventional group showed a lesser reduction in pain intensity with ($M=88.35 \pm 6.06$ and $M=8.55 \pm 5.77$). The findings suggested more improvement in grip strength, pain reduction, and functional outcomes in the experimental group compared to the conventional group.

DISCUSSION

This study was designed to assess the effectiveness of GMI as an adjunct technique with conventional therapy for improving grip strength in females with Colles fractures by reducing pain and improving overall functionality. The GMI refers to brain training intended to improve motor behavior after injury and brain training refers to the use of visual and motor imagery.¹⁵ In the recent past, the novel technique of graded motor imagery got quite positive attention in many domains of functional rehabilitation and neuropathic pain and neurological conditions like stroke, CRPS, Parkinson's disease, multiple sclerosis and older women's balance improvement was

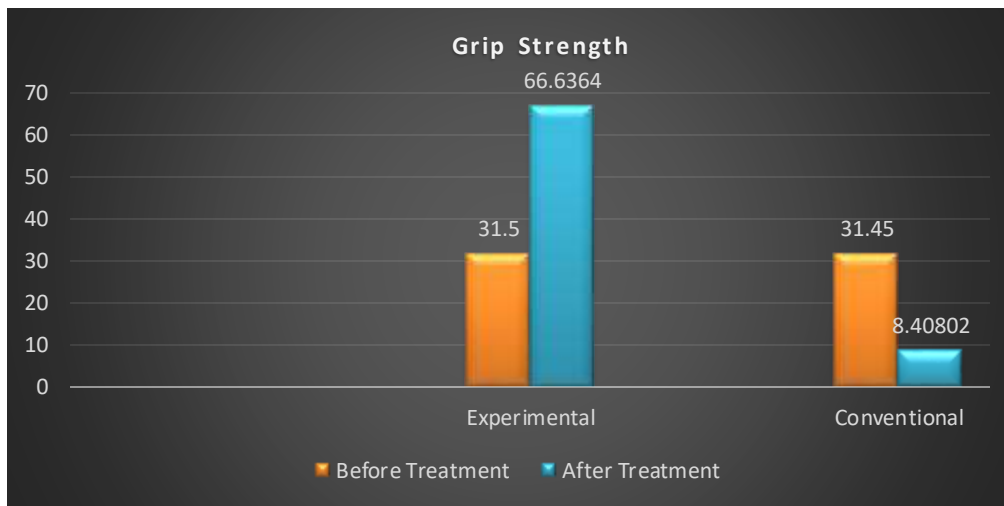
Figure 1: Mean Age of Participants



also a goal achieved with GMI.¹⁶ In combination with conventional practice, neurological training has been used to rehabilitate motor discrepancies in patients with subacute stroke. The positive effects of GMI have been reported by several studies for enhancement in strength and function and making use of both upper and lower extremities, most importantly it is used in the management of chronic pains.

Moseley used the combination of motor imagery exercises and mirror training in persons presented with chronic regional pain syndrome type I and documented a significant effect in reducing levels of pain at both rest and during activity plus the edema-reducing effects were also noticed. The underline mechanism of action on which this GMI produced outcomes is not In 2018, Dike et al. provided positive evidence of the effectiveness of GMI in distal radius fractures acute stage rehabilitation. In his RCT, he evaluated the improvement of grip strength and overall functionality of the upper limb, plus a reduction in pain by applying the GMI technique.⁹ Some other interventions such as

transcutaneous electrical nerve stimulation have been generally utilized to help with discomfort; nonetheless, the impact remains questionable. The authors hypothesize that TENS can be effective in intense discomfort. Therefore, a single-blinded Colles fracture study was designed based on postoperative pain. Regarding all the evidence present on the effectiveness of GMIT and some of them described above, this quasi-experimental study also shows the significant effectiveness of GMIT in gaining grip strength reduction of pain and overall functionality of the hand in a female with colles fracture. The GMIT can be incorporated into a list of traditional treatments, as it has very good effects in improving pain and functionality without causing pain as all the work is done well elaborated in the literature but in some studies, it is hypothesized that after fracture the fixation period cause alteration in proprioception of joint and mental exercises and mirror therapy helps in improving the kinesthetic sense of joint and building the new kinesthetic pathways in the brain cortex. Shortly GMI is retrained in the brain.¹⁷ This technique can be very good in the initial

Figure 2: Grip Strength Analysis in Experimental and Conventional Groups Before and After Treatment**Table 1: Functional and Pain Score Analysis in Experimental and Conventional Groups**

Variables	Group of the participant	Mean	Std. Deviation	P- value
PRWE: Function Score Before Treatment	Experimental	89.6364	7.96747	0.562
	Conventional	88.3500	6.06348	
PRWE: Function Score after Treatment	Experimental	37.6818	15.17952	0.148
	Conventional	43.8500	11.45828	
PRWE: Pain Score Before Treatment	Experimental	45.9091	3.85337	0.457
	Conventional	44.9500	4.41856	
PRWE: Pain Score after Treatment	Experimental	21.2273	6.78185	0.178
	Conventional	18.5500	5.77176	

stages as it is very helpful in getting back the confidence and willingness to perform activity which is not possible because of fear of pain. This also helps full in reducing anxiety and mental stress because of trauma and lack of mobility. As this new technique involves a lot of learning and concentration there were patients who due to being conscious and lacking the ability to discriminate switching of body sides during treatment could not understand and benefit from it as compared to

patients who understood the therapy and cooperated more during sessions. The power of hand grip, generally measured with the specific tool called a handgrip dynamometer, is a decent pointer of upper extremity functionality in stroke patients and may be a sign of the overall strength insufficiency of the entire paralyzed upper limb. The modified sphygmomanometer test also gives intent and reasonable outcomes relevantly at minor expenditure. Grip strength measured with this

test could be used to account for upper extremity overall strength in patients with partial motor paralysis.¹⁹ Therefore, a modified sphygmomanometer can be used as a reliable measuring tool in this study. Moreover, the functional outcome depends upon the functioning level of the individual. Therefore, the management plan for fracture should consider the functioning level of a person rather than only considering the pattern of fracture, patient preferences, other medical conditions and the expertise of the surgeon should also be considered.²⁰ GMIT targets individual needs and hence addresses this concern as well.

The limitations of this study were that the sample size was relatively small and the confounding variable of body mass index was not controlled, which may influence the grip strength in patients. Further multi-centered randomized controlled trials are required before it can be said that graded motor imagery should be practiced with conventional physical therapy in all rehabilitation setups.

CONCLUSION

The findings of this study concluded that the GMI technique in combination with traditional rehabilitation protocol is effective in improving grip strength in females with Colles fractures, in addition, the graded motor imagery technique also has a good effect in managing pain and in improving overall functional mobility of wrist joint and hand. As the work is mainly done with the sound hand in GMIT, the grip strength of the unaffected hand is also improved as shown by the statistics. since the size of the sample taken is small, and with constricted variety of individuals and demographics boundary in the study, Further multicentered randomized control trials are required before it can be certainly said that graded motor imagery should be practiced with conventional physical therapy in all rehabilitation setups.

DECLARATIONS

Consent to participate: Written consent had been taken from patients. All methods were performed following the relevant guidelines and regulations.

Availability of data and materials: Data will be available on request. The corresponding author will submit all dataset files.

Competing interests: None

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Authors' contributions: All authors read and approved the final manuscript.

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