

Can Brain Cure Pain and Fear? Effect of Graded Motor Imagery on Post Operative Lumbar Degenerative Diseases -Randomized Control Trial

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Abstract

Objective: The study aimed at evaluating the effect of GMI on fear of movement, LBP, leg pain and disability post degenerative lumbar spine surgery.

Design: RCT.

Materials and Method: 60 participants were randomly allocated to Group-A and Group-B. FAB, back & leg pain, and disability was assessed using FABQ, NPRS and ODI. In Group-A, participants were given GMI twice a week for 3 weeks. In Group-B, participants were not given any active intervention. After 3 weeks, both the groups were evaluated again on FABQ, NPRS and ODI.

Results: Pre and Post-treatment scores of FABQ, NPRS-back, NPRS-leg, and ODI was obtained. In both groups, each outcome measure had significant results with p value of 0.0001 (95% CI), however, Group-A showed better outcome compared to Group-B.

Conclusion: The study concluded that GMI training during immediate post-operative period may be beneficial for reducing fear of movement, pain and disability.

Key Words: Degenerative Lumbar Spine Surgery, Fear Avoidance Belief, Pain, Graded Motor Imagery.

Introduction

Spinal surgery is chosen over conservative treatment for patients only when they don't get relief from persistent pain, sciatica, motor deficits, decreased functional status, peripheral and central sensitization.^{1,2,3} Abnormal processing of pain can be due to multiple factors such as cognition (distraction and catastrophizing), mood, beliefs and genetics.^{4,5} Pain is not only caused by body tissues (i.e. anatomical structures of low back ache), but it is experience in the brain (output).⁶ Emerging advances in neuroscience and brain imaging studies argues that there is another reason for persistence of pain post lumbar spine surgery.⁷ Persistent pain may be due to the functional changes in the brain⁸

The perception of pain which is created by particular pattern of activity can be considered as 'neurotag' for

pain, which becomes 'Sensitized' and 'Disinhibited'.^{6,8} Because of Disinhibition, pain spreads, moves, defies the anatomical structure and can affect other body related neurotags leading to "Smudging and Blurring" of body maps. Smudging of the motor areas makes the body parts difficult to use. Smudging of sensory areas in brain makes nearby body parts sensitive.^{6,8} Fear is a powerful motivator that is associated with movements and pain. The way we move, behave and experience pain is also contributed by fear.^{6,8,9} All types of fear ultimately lead into the cycle of pain and disability from which it can be difficult to break free but not impossible.⁶

Graded Motor Imagery (GMI) is a collective term that describes various "brain exercise" which includes left/right discrimination, motor imagery, sensory discrimination, sensory integration and graphesthesia.¹⁰ Motor retraining involves, Implicit Motor Imagery

(Left/Right Discrimination Training), Explicit Motor Imagery (Imagined Movements) and mirror therapy.⁸ The functional representation of the brain gets replaced by perceptual disorganization of pain and activates neurotag. Any sensory or motor stimuli is a conditioned stimulus to neurotag causing central pain. Over a period of time, inaccuracy of left/right discrimination develops due to overlapping regional representation group. By giving left/right discrimination training, premotor cortex gets activated and it helps in re-establishing left/right concepts in the brain.^{11,12,13,14} Imagined movements will activate the same area of the brain as actual movement does without evoking pain neurotag.^{8,11,12,13,14}

Presence of fear and pain associated with movement can be expected to be dealt by GMI in post lumbar spine surgery patients.¹⁰ Very few studies are done to find the effectiveness of GMI in patients having fear and pain post lumbar surgeries. Hence, there is a need to find the effect of GMI on; fear of movement, low-back pain and leg-pain post lumbar spine surgery.

Method

A convenient sample size of 60 was taken, randomly allocated by concealed envelope method.

Inclusion Criteria:

1. Patients of either gender between the age group of 40-80 years.^{15,16}
2. Patients operated for Lumbar Degenerative Diseases.
3. Patients who had fear of movement and back/leg pain on Fear Avoidance Beliefs Questionnaire (FABQ) and NPRS (numerical pain rating scale), respectively.

Post operatively.^{17,18}

4. Patients who agreed to sign the consent form.

Exclusion Criteria:

1. Lumbar spine surgery secondary to tumor, trauma, infection, fusion surgeries re-operated for lumbar degenerative diseases.
3. Patients who scored zero on FABQ and NPRS.
4. Patients who are unable to follow the instructions

of motor imagery and not willing to participate.

Procedure:

The FABQ, NPRS and ODI was administered at 1st week and last day of 3rd week for both groups.

GROUP-A (experimental-group):

GMI approach was given twice a week for 3 weeks.^{10,19}

A. Laterality Training

This was carried out using Recognize Back App. Further, left/right discrimination was divided into 5 stages of tests, where every next stage becomes more challenging than the previous stage. Quick test was done in the app before starting the training. This test consisted of random pictures of either left/right side of the trunk. Patient needs to recognize and answer by selecting left or right on the screen of the cell phone. It was performed in order to make the patient understand the technique of using it. Once the patient understood it, they were then made to practice in the app. Stage wise progression was made if the participant scored $\geq 80\%$ of accuracy in the previous stage. Participants who scored $< 80\%$, were given the same stage to perform again in every session until they reached $\geq 80\%$.

B. Motor Imagery

This stage involved imagining movements. Two videos were made of a person who slowly performed 10 repetitions of variety of movements. The first video shown in the first week of therapy included small-range lumbar spine movements (pelvic tilt and rotations), bilateral arm elevation keeping back still, and in standing position performing hip flexion keeping back still. The second video shown in the 2nd week included full-range lumbar spine movements including forward flexion, extension, side flexion and rotation. Patients were instructed to watch the videos and imagine themselves performing the same movements in pain free manner. Each video lasted for about 5-6 minutes. Participants were asked to watch the videos twice per session, 3 times each day.

C. LOCALIZATION TRAINING

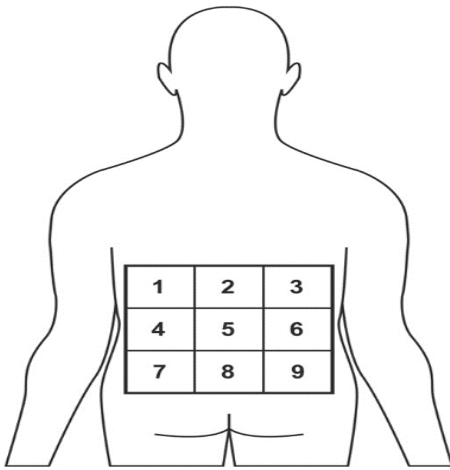


Figure 1: Localization Grid

Patients in high sitting position with lower back exposed. A grid picture of lumbar spine was shown to the participants on whom 9 dots were marked (Refer Figure-1). Randomly, using the blunt end of the pen, therapist lightly presses on a particular point for about 2 seconds. Participants were instructed to refer the picture and answer which point has been stimulated. All the participants who gave wrong answers were corrected and same point was stimulated again. Using a random number sequence, 60 stimuli were given during the therapy. Patients were advised to practice the same at home, 60 stimuli for 3 times a day. In the next session, same procedure was continued as above but this time patient had to identify which block has been stimulated without looking at the grid picture. Participants were eligible for the next step only when they achieve an accuracy of $\geq 80\%$ in this stage.

D. SENSORY DISCRIMINATION

In this stage participants should localize the stimuli and type of stimuli used. To facilitate sensory discrimination, the participant's low-back was stimulated with the dull-end of the pen and the sharp-end of paper clip. Using a random number table, both position of the

stimuli and type of stimuli were randomized. A total of 60 stimuli were given and participants were advised to practice the same at home, 60 stimuli for 3 times a day. An accuracy of $\geq 80\%$ was required to proceed further in treatment.

E. GRAPHESTHESIA

This training was done by using various letters or numbers over the patient's low-back with dull-end of pen. A random sequence of 60 letters/numbers were generated for each treatment, 3 sets of 60 letters/numbers were used. Participants were instructed to identify the number/letter drawn. Progression was made by reducing the size of the letter/number, alternating the speed or using 2 or 3 letter words. An accuracy of $\geq 80\%$ is required to proceed further.

F. TWO-POINT DISCRIMINATION

Aesthesiometer was used by alternating the skin pressure between one and two-point stimulation. Patient was asked to determine the feeling of one or two points. Distance at which the patient first perceived two distinct points was taken as the initial threshold value. To facilitate two-point discrimination, the process was then repeated by reducing the distance from the initial threshold value.

GROUP-B (control-group):

Based on the literature present exercises were initiated post 6-weeks of surgery so that there is sufficient tissue healing. Hence, no active intervention was given to the Group-B.^{20,21,22}

Data Analysis

Statistical analysis was done using SPSS version 20.0. Descriptive analysis was done and presented as means, percentages, and standard deviation (SD) for the baseline characteristics. Level of significance was kept at $p \leq 0.05$.

Results

Table-1: Sociodemographic data and clinical characteristics

Characteristics	Group-A	%	Group-B	%
Age(years)				
40-49	17	56.67	14	46.67
50-59	7	23.33	10	33.33
60-70	6	20.00	6	20.00
Chi-square= 0.8201 P = 0.6642				
Sex				
Male	14	46.67	18	60.00
Female	16	53.33	12	40.00
Chi-square=1.0710 P = 0.301				
Occupation				
Not working	14	46.67	13	43.33
Working	16	53.33	17	56.67
Chi-square=0.0672 P = 0.7951				
No. of levels				
2 level Laminectomy Discectomy	17	56.67	12	40.00
3 levels Laminectomy Discectomy	7	23.33	9	30.00
4 levels Laminectomy Discectomy	1	3.33	1	3.33
2 levels Laminectomy 3 levels Discectomy, 3 levels Laminectomy 2 levels Discectomy, 4 levels Laminectomy 2 levels Discectomy, 5 levels Laminectomy	5	16.67	8	26.67
Chi-square=1.7126 P = 0.4255				
Duration of back-pain				
<=2	22	73.33	22	73.33
<=5	8	26.67	6	20.00
>=6	0	0.00	2	6.67
Chi-square=2.2862 P = 0.3191				

Table-2: Comparisons of FABQ scores by independent t test

Time points	Group-A		Group-B		t-value	p-value
	Mean	SD	Mean	SD		
Pre-test	51.23	5.79	53.20	4.96	-1.4127	0.1631
Post-test	23.63	7.77	41.90	6.74	-9.7215	0.0001*
Difference	27.60	8.78	11.30	6.18	8.3197	0.0001*
% of change	53.87		21.24			
Paired t	17.2268		10.0208			
p-value	0.0001*		0.0001*			

Table-3: Comparison of NPRS back scores by Mann-Whitney U Test

Time points	Group-A		Group-B		MW, Z-value	p-value
	Mean	SD	Mean	SD		
Pre-test	5.40	1.45	5.53	1.38	-0.4066	0.6843
post-test	1.53	1.31	3.47	1.55	-4.3836	0.0001*
Difference	3.87	1.14	2.07	1.51	-4.4797	0.0001*
% of change	78.02		44.71			
WM, Z-value	4.7821#		4.1558#			
p-value	0.0001*		0.0001*			

Table-4: Comparison of NPRS leg scores by Mann-Whitney U Test

Time points	Group-A	Group-B	MW, Z-value	p-value
	Mean (SD)	Mean (SD) SD		
Pre-test	6.10 (1.06)	5.47(1.17) 1.17	-2.0698	0.0385
post-test	1.70 (1.42)	3.77(1.81) 1.81	-4.1840	0.0001*
Difference	4.40 (1.22)	1.70(1.37) 1.37	-5.8177	0.0001*
% of change	72.13	31.10		
WM, Z-value	4.7821#	4.1203#		
p-value	0.0001*	0.0001*		

Table-5: Comparisons of ODI scores by independent t test

Time points	Group-A		Group-B		t-value	p-value
	Mean	SD	Mean	SD		
Pre-test	54.35	5.69	55.02	4.60	-0.5040	0.6162
post-test	28.79	11.39	45.53	7.23	-6.7965	0.0001*
Difference	25.56	8.87	9.50	6.86	7.8458	0.0001*
% of change	47.03		17.26			
Paired t	15.7820		7.5765			
p-value	0.0001*		0.0001*			

DISCUSSION:

Table-1 shows Sociodemographic and clinical characteristics. Table-2 shows the total scores of FABQ, where pre-test to post-test change in Group-A was 53.87% and in Group-B was 21.24%, which was statistically significant with p value of 0.0001. Based on the literature present, fear avoidance beliefs are important factors for low-back pain. Studies have shown that, pre-operative and early post-operative (6 weeks) fear of movement predicted pain intensity and disability at six months.¹⁷ Our study showed significant scores of FABQ post-operatively between 2-3 weeks. High levels of fear-avoidance are often closely associated with pain, limited movement and function.²³ GMI would have reduced pain associated with movement and so FABQ improved. There could also be a reversal of processes in anterior cingulate gyrus and precuneus which mediate fear avoidance aspect of pain processing.⁷

In our study, the NPRS back (table-3) and NPRS leg (table-4) scores showed significant difference within Group-A and within Group-B with p value of 0.0001. But Group-A showed better reduction in pain as compared to Group-B.

The mechanisms involved in reduction of back-pain and leg-pain could be due to the graded stages of mental exercises. Implicit motor imagery activates the premotor cortex, which is important in planning of movement and sends messages to specific cells of the primary motor cortex that is involved with the movement. This means that, premotor brain cells have the capability of causing change in the excitement of M1 cells without even activating them. This basically decreases sensitization and increases inhibition.^{6,8,10} Mental exercises aim to engage the cortical motor networks without triggering the protective response of pain. The altered image of our pain perception due to threatening stimulus is conditioned by the mental imagery program.^{6,8,10}

In our study as FABQ improved, the ODI scores also improved and patient were less dependent and disabled. Table-5 shows change in ODI scores in Group-A was 47.03% with p value of 0.0001 and in Group-B was 17.26% with p value of 0.0001. Fear avoidance beliefs is considered as a conditioned stimulus that can ultimately lead to disability. Studies have shown that fear avoidance is a significant predictor of disability.²³ In our study there

was a significant improvement in the FABQ and NPRS scores, which could have had an impact on disability.

Conclusion

Based on the results of this study, there was increase fear avoidance beliefs, persistent leg/back pain in patients post lumbar spine surgery. These factors also affected the daily activities of the patients and it was also found that these patients were more disabled. Patients when evaluated on FABQ, NPRS for leg and back and ODI at baseline and at 3 weeks, both the group showed significant changes. As rest is advised in post lumbar surgery, no active intervention was given to the control group. But experimental group that received graded motor imagery during this period showed better improvement as compared to controls. These additional changes can be due to the effect of GMI program.

Conflict of Interest – No Conflict of Interest

Source of Funding- Self

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