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DOES MOTOR CONTROL EXERCISE DECREASES LUMBAR PAIN, IMPROVES MUSCLE ACTIVITY AND REGIONAL FUNCTION IN INDIVIDUALS WITH ACUTE AND SUB ACUTE NON-SPECIFIC LOW BACK PAIN

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ABSTRACT

Background: Non-specific low back pain (LBP) is defined as LBP that poses signs and symptoms which cannot be related to a recognizable cause, and Motor Control Exercise (MCE) usually is the choice of treatment for conditioning lumbar muscles for chronic LBP group. Limited information is available regarding their clinical application for participants with acute and sub-acute LBP. Hence, the main aim of this study is to find out this clinical utility.

Methods: A quasi-experimental study with 30 participants of less than six weeks and twelve weeks duration of LBP were included in the study and are divided into an experimental and control group. Pain intensity using numeric pain rating scale (NPRS), lumbar range using modified Schober's test, muscle function using surface electromyography (EMG) and functional disability using Roland Morris Disability Questionnaire (RMDQ) were recorded pre and post-treatment. The experimental group received lumbar MCE with general exercises and the control group received only general low back exercises aiming to improve lumbar range and muscle efficiency for six-session spread over three weeks duration along with therapy for pain reduction.

Results: Subjects in both experimental & control groups had significant improvement in pain ($p<.001$) and RMD Questionnaire ($P<.001$), Lumbar range of motion had improved significantly only in the experimental group (Flexion $p<.001$, Extension $p<.001$) compared to control group. Though lumbar muscle activation had improved in both the groups, subjects in the experimental group showed significant and uniform improvement in lumbar muscle activation following MCE than the control group.

Conclusion: Motor Control Exercise provides better clinical improvement in pain, lumbar muscle activation and regional functional ability without exacerbating symptoms in subjects with LBP during the acute and sub-acute phase.

Keywords: MCE, EMG, acute and sub-acute LBP, Lumbar muscle strength.

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INTRODUCTION

Low back pain (LBP) is one of the leading causes of axial pain, resulting in work loss, functional limitation and affects the quality of life globally [1,2]. LBP could be defined as pain and discomfort located between the ribs and above the gluteal crease region, with or without referred pain into the leg [3]. The term 'Non-specific LBP' can be defined as LBP that cannot be related to a recognizable or specific pathology such as nerve root compression or serious spinal problems [3]. 'Acute LBP' can be described as pain which lasts for less than six weeks, and 'Sub-acute LBP' refers to pain, which prevails between six and twelve weeks in duration[3].

Individuals with LBP have altered motor control of trunk muscles, and the common problem identified with trunk muscles is increased co-contraction of flexors and extensors, altered timing of muscle function, and balance between agonists and antagonists [4,5]. This delayed deep trunk muscle response was found to be a predisposing factor for LBP to develop in the future, making it a recurrent disorder [6]. Position sense of the lumbar extensors was found to be altered in patients with LBP [7] and there is strong evidence available which relates faulty lumbar motor control and inefficient inter deep segmental stabilizers function [8-10]. More generally, many researchers support the movement impairment system that pain being provoked by a particular direction of movement due to deficiency in the muscles that control it [10]. Thus, Motor Control Exercises (MCE) was developed to target these muscle deficiencies, aiming to restore the individual's muscle co-contraction/ normal function and regional motor control.

Exercise therapy is recommended as an effective treatment for individuals with chronic non-specific LBP in various clinical guidelines and systematic reviews [11]. But there is limited information available about their effect on the acute and sub-acute LBP group. Very recent Cochrane review concluded that the effect of motor control exercises on the above groups was uncertain and warranted more research to understand its clinical application [12,13].

A motor control exercise (MCE) is based on the principles of motor learning, with the clinical benefit of reorganizing and optimization of motor control and co-ordinated function of axial muscles during various functions. MCE is designed to train muscles that are identified as having poor control and to reduce the activity of muscles that are overactive [14]. MCE is implemented in stages, based on progression with functional goals. It starts with isolated static contraction of deep muscles, then static and dynamic simple activities that mimic the function and finally pacing muscle work for daily needs [15,16].

MCE / Core stability exercises being commonly practiced for chronic low back pain individuals, very few and limited research (only three reviews) is available exploring their value in individuals with acute and sub-acute LBP. Hence this study is aimed to find this clinical utility.

MATERIALS AND METHODS

This quasi-experimental study was approved by the ethics committee (REF: CSP/17/JAN/54/46) and was conducted in the outpatient department, Faculty of physiotherapy. The estimated sample size was determined using the software n* Power, to detect a medium effect size considering the power of 80% and 95% confidence level, a sample size of 30 was obtained. (15 per group).

Participants with the main complaint of LBP of less than 90 days duration, with or without referred pain into the leg and of age between 18 and 65 yrs, were considered for inclusion in the study. Participants with discogenic pain/prolapse, nerve root compression, lumbar deformity, presence of any serious spinal pathologies, spinal inflammation/infection and Prior surgery to lumbar and/or sacral region were excluded.

The subjects who meet the inclusion criteria are screened for enrollment, and after obtaining consent, the eligible subjects are divided into two groups, i.e., control group and intervention group. A standardized physical therapy assessment was done to quantify pain using (NPRS), lumbar range (MEASURING TAPE), muscle function (SURFACE EMG) and functional disability (RMDQ). The Experimental group received motor control and general back exercise, and the control group received only general back exercises aiming to improve the lumbar range. Muscle efficiency — the subjects underwent treatment for six sessions spread over three weeks duration.

The muscle activities of the lumbar multifidus, rectus abdominis, transverse abdominis and external oblique were assessed by using surface EMG electrodes. Before electrode placement, each subject was familiarized with the procedures by being instructed in and practicing sub-maximal voluntary isometric contraction (sub-MVIC), for the above muscles. When the subjects could correctly perform each muscle test, the sites for electrode placement were prepared by abrading the skin with fine sandpaper and cleansed with 70% isopropyl alcohol. The raw EMG data generated during sub-maximal voluntary isometric contraction (sub-MVIC) was used to detect changes in levels of motor activity during the performance.

Participants in the control group received the general low back exercises either flexion or extension biased. Exercises were performed in sitting, supine, or quadruped for flexion and in prone, prone on elbows or prone press-up for an extension. Participants in the intervention group received lumbar motor control exercises in addition to the above. Initially, every subject was trained with abdominal drawing-in maneuver (ADIM) for isolated low-load activation of the transverse abdominis (TrA) and lumbar multifidus (LM) muscle in prone lying and sitting imposing low load on the spine. Abdominal hollowing in prone lying, alternate straight-leg raise in supine, abdominal hollowing in sitting, crook lying another heel slide, 4 point kneeling pelvic shift (side to side), trunk curl in crook lying, pelvic tilt in sitting and alternating knee raise in sitting was performed after the initial training.

Participants in both groups performed ten repetitions of each of the above exercises three times a day. All participants were treated twice a week for three weeks for a maximum of 6 sessions. To ensure the promptness and compliance of exercises performed, the performance was re-assessed every session and only progressed if satisfactory else, the participants were asked to continue the same exercises. The participants were motivated at regular intervals to adhere to the care advices and continue their daily home exercises. Pre-treatment measured data are collected again and both pre and post data are considered for statistical analysis.

Data Analysis

The data was analyzed using SPSS 22.0 version. To describe the descriptive, categorical, and continuous variable frequency analysis, percentage analysis, and mean, the standard deviation was used. To find out the significant difference between the bivariate samples in Paired groups (Pre & Post), the Paired sample t-test was used. In independent groups, unpaired sample t-test was used for normal data. For all the above statistical tools, the probability value at .05 considered statistically significant.

RESULTS

Subjects in both experimental & control groups had significant improvement in pain (p<.001) and RMD Questionnaire (P<.001). The lumbar range of motion had improved significantly only in the experimental group (Flexion p<.001, Extension p<.001) compared to the control group. Though lumbar muscle activation had improved in both the groups, subjects in the experimental group showed significant and uniform improvement in lumbar muscle activation following MCE than the control group.

On analyzing the data relating to LBP duration, pain intensity had significantly reduced in the acute category and the RMD value reflecting disability had improved considerably only in the experimental group of subacute category.

Table 1: Demographics and Baseline data of subjects in both the Experimental & Control group

Variables		Experimental Group (n=15)	Control Group (n=15)
Age (mean years)		28.33	29.27
Gender	Male	11(73.3%)	14(93.3%)
	Female	4(26.7%)	1(6.7%)
Duration (weeks)	Acute (<6weeks)	7(46.7%)	8(53.3%)
	Sub acute (6-12 weeks)	8(53.3%)	7(46.7%)
Lumbar range in cm (mean SD)	Flexion	3 (.92)	4.2 (.94)
	Extension	1.33(.48)	1(.00)
Pain (mean SD)		4.93(.79)	5.20(.77)
RMD (mean SD)		15.87(1.8)	15.4(1.68)
EMG in μv (mean SD)	RA	1.24(0.29)	1.18(0.52)
	TA	1.05(0.25)	1.16(0.49)
	LM	1.28(0.68)	1.37(0.60)
	EX OB	0.87(0.31)	1.08(0.30)

RMD - Rolland Morris Questionnaire. EMG-Electromyography. TA-Transverse abdominis.

RA- Rectus abdomins. LM- Lumbar multifidus. EX OB - External oblique.

Table 2: within and between-group analysis and significance value of a range of motion, disability and electromyogram for the experimental and control group

VARIABLES		WITHIN GROUP ANALYSIS						BETWEEN GROUP ANALYSIS
		Experimental(mean, SD)		n=15	Control(mean, SD)		n=15	
		pre	post	Sig*	pre	post	Sig*	Sig**
Lumbar range in cm (mean SD)	Flexion	3 (.92)	4.93(.70)	<.001	4.2 (.94)	4.60(.63)	<.009	0.183
	Extension	1.33(.48)	2.13(.51)	<.001	1(.00)	1.40(.51)	<.009	<.001
Pain (mean SD)		4.93(.79)	.60(.63)	<.001	5.20(.77)	1.53(.51)	<.001	<.001
RMD (mean SD)		15.87(1.8)	2.00(1.06)	<.001	15.4(1.68)	3.87(1.35)	<.001	<.001
EMG in μv (mean SD)	RA	1.24(0.29)	1.62(0.42)	<.001	1.18(0.52)	1.26(0.52)	<.001	<.008
	TA	1.05(0.25)	1.70(0.62)	<.002	1.16(0.49)	1.26(0.55)	<.002	<.044
	LM	1.28(0.68)	1.87(0.58)	<.001	1.37(0.60)	1.41(0.62)	<.073	<.046
	EX OB	0.87(0.31)	1.45(0.33)	<.001	1.08(0.30)	1.18(0.37)	<.006	<.043

RMD - Rolland Morris Questionnaire. EMG-Electromyography. TA-Transverse abdomins. *Paired t-test

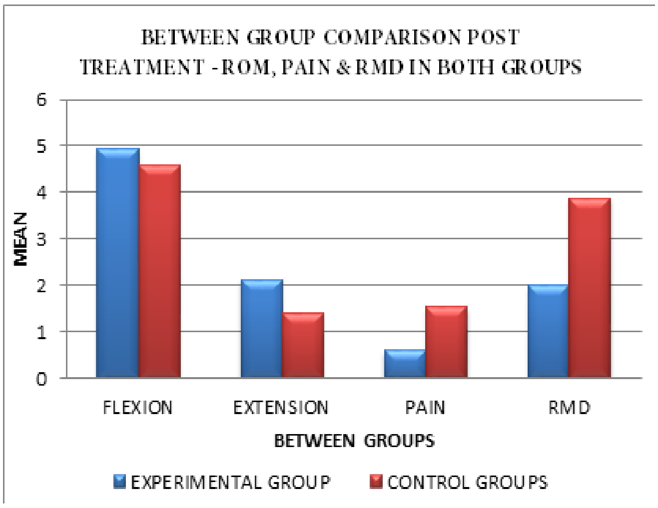
RA- Rectus abdomins. LM- Lumbar multifidus. EX OB - External oblique. **Unpaired t test. P<.05

Table 3: Between-group analysis and significance value of a range of motion, disability and electromyogram for the experimental and control group in Acute & Subacute category

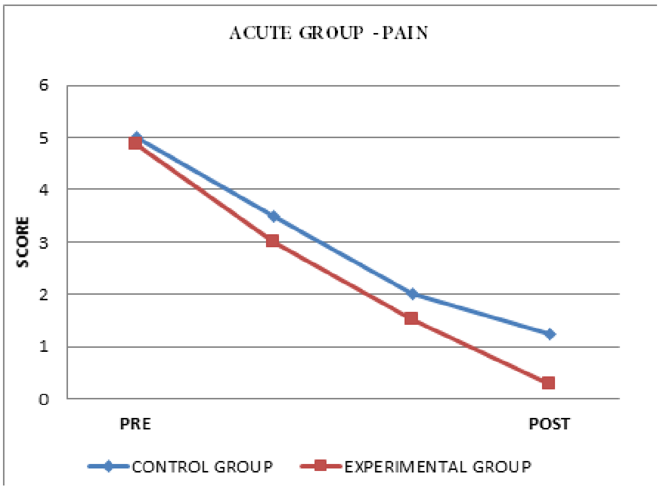
VARIABLES		ACUTE					SUB ACUTE				
		Experimental (mean, SD) n=7		Control (mean, SD) n=8			Experimental (mean, SD) n=8		Control (mean, SD) n=7		
		pre	post	pre	post	Sig*	pre	post	pre	post	Sig*
Lumbar range in cm (mean SD)	Flexion	3.29(.75)	5.43(.53)	4.50(.92)	4.8(.64)	0.095	2.75(1.03)	4.50(.53)	3.86(.90)	4.29(.48)	0.435
	Extension	1.2(.48)	2.29(.48)	1.00(.00)	1.38(.51)	0.004	1.38(.51)	2.00(.53)	1.00(.00)	1.43(.53)	0.059
Pain (mean SD)		4.86(.90)	.29(.48)	5.00(.75)	1.25(.46)	0.002	5.00(.75)	.88(.64)	5.43(.78)	1.86(.37)	0.004
RMD (mean SD)		16.14(1.95)	2.00(1.41)	15.25(1.75)	3.25(1.03)	0.07	15.63(1.76)	2.00(.75)	15.57(1.71)	4.57(1.39)	0.001
EMG in μv (mean SD)	RA	1.15(0.14)	1.70(0.45)	1.22(0.59)	1.34(0.63)	0.228	0.95(0.29)	1.55(0.40)	1.10(0.37)	1.17(0.39)	0.085
	TA	1.19(0.36)	1.62(0.51)	1.36(0.52)	1.46(0.54)	0.557	1.28(0.22)	2.08(0.66)	0.96(0.45)	1.03(0.49)	0.004
	LM	1.37(0.74)	1.99(0.59)	1.43(0.55)	1.46(0.58)	0.105	1.20(0.66)	1.77(0.59)	1.33(0.70)	1.36(0.71)	0.243
	EX OB	.83(0.32)	1.40(0.32)	1.17(0.30)	1.25(0.33)	0.383	0.89(0.32)	1.50(0.35)	0.98(0.29)	1.11(0.43)	0.7

RMD - Rolland Morris Questionnaire. EMG-Electromyography. TA-Transverse abdomins.

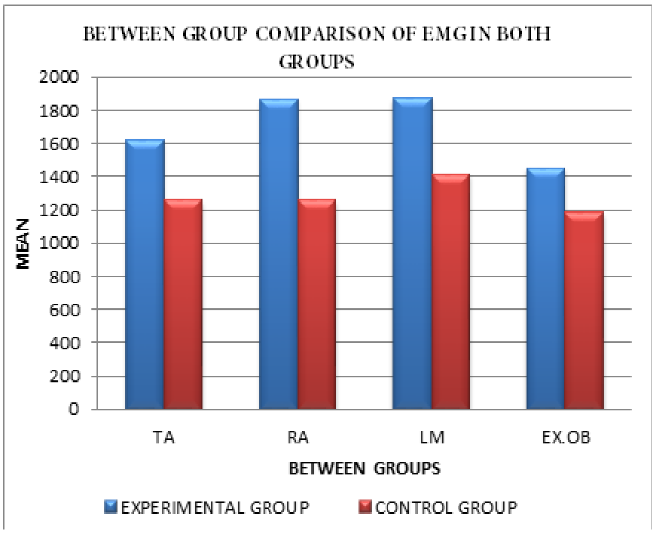
RA- Rectus abdomins. LM- Lumbar multifidus. EX OB - External oblique.*Unpaired t test. P<.05



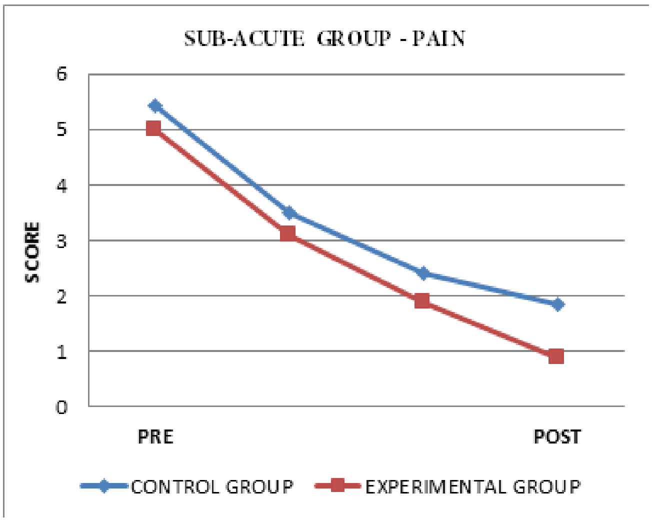
Graph 1: Represents the between-group comparison of lumbar ROM, pain, and RMD.



Graph 3: Represent the comparison of pain score between the groups of acute category



Graph 2: Represent between group comparisons of EMG values.



Graph 4: Represent the comparison of pain score between the groups of sub-acute category

DISCUSSION

Low Back Pain is one of the prime reasons for disability around the globe leading to more significant functional loss and chronicity resulting in high healthcare costs. The cause for 90% of LBP is non-specific and less proportion comes from a specific pathology [17]. There is enough support that LBP occurs due to changes in lumbar motor control & muscle function including changes in the timing of activation, muscle contraction and thickness in deep muscles of anterior and posterior region. Both muscles play an important role in spinal stability & position sense [18]. In the present study individuals who received motor control exercises showed better improvement with core and abdominal muscle function (strength & endurance), lumbopelvic dynamic stability & pain relief.

The age range of the subjects in both experimental and control group are comparable and this goes by the finding that the incidence of low back pain is highest in the third decade for acute/subacute LBP and the overall prevalence increase with age until 60-65 years [19] [Table 1].

Both in the experimental and control group number of male subjects is included than females. The global age-standardized point prevalence in 2010 was estimated to be 9.4% and was higher in men compared with women but heterogeneous primarily to men. Epidemiology of LBP in the Indian population obtained in a review concluded that the prevalence of LBP in the Indian population is in-conclusive [20]. Based on the above mentioned facts, the gender difference in this study could not be justified, possibly resulted due to convenient sampling [Table 1].

The lumbar range of motion had improved significantly only in participants belonging to the experimental group (Flexion p<.001, Extension p<.001), then the control group [Table 2]. Improved/optimized position sense and muscle activity during end range spinal motion attainted by performing MCE could be the reason for this change, as it was found that LBP subjects exhibit poor proprioception and muscle activity during function, making it a unique contributing factor [21]. Lumbar proprioception was not evaluated and correlated in the current study, not to deviate from the study objective. Future research can be conducted to relate and explore position sense, muscle work and LBP.

Subjects in both experimental & control group had significant improvement in pain (p<.001), however there was a more significant difference observed for subjects in experimental group (NPRS-4.33) than those in control group (NPRS-3.67) [Table 2], Subjects who belong to Acute LBP group shows significant improvement in pain (p<.002) than Sub-acute group (p<.004)[Table 3, Graph 3 4]. The above two findings reflect the fact that performing MCE in the acute and Sub-acute phase had resulted in the reduction of pain, and the individuals can perform the exercises without worsening of symptoms. This supports the earlier claim that MCE is superior to minimal interaction and results in particular benefit in relieving pain at all times [22, 23].

Subjects in both experimental and control groups showed significant improvement in disability scores obtained through RMD (P<.001) and there was no significant difference between the groups [Table 2]. On analyzing the improvement in disability relating to symptom duration, subjects belonging to the sub-acute category in the experimental group alone showed significant improvement in RMD (p<.001) than their counterparts in the control group. (p<.001)[Table 3]. This goes in similar to the finding by Majid Artus et al. (2010) that MCE is beneficial and brings improvement in disability in the long term than the short term. The influence of pain duration for this to occur is inconclusive [24].

Though lumbar muscle strength had improved in both the groups, Subjects in the experimental group showed significant improvement in EMG values following MCE (TA – p<.001, RA – p=0.002, LM – p<.001, EX.OB – p<.001). Subjects in the control group did not improve uniformly (TA – p<.001, RA – p<.001, LM – p=0.073, EX.OB – p=0.006) lumbar multifidus and external obliques does not show significant improvement in the control group [Table 2]. Pain has decreased considerably in both groups, so pain reduction alone would not have influenced this improvement and is very evident that specific MCE had resulted in this change.

Limitations: Small sample size and the same subjects are not followed up further, hence details about reoccurrence and long term effect of MCE was not known. Further findings can address above and consider the use of pressure bio-feedback for exercise training.

CONCLUSION

Motor Control Exercise provides better clinical improvement in pain, lumbar muscle activation, and regional functional ability without exacerbating symptoms in subjects with LBP during the acute and sub-acute phases. Further studies can be conducted to know its long term effect and ability in preventing a recurrence.

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