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Can Lumbar Stabilization Exercises Influence Synergy Pattern and Recruitment Time of Core Muscles in Chronic Mechanical Low Back Pain? Pre-Post Experimental Study

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ABSTRACT

Background: Chronic low back pain (CLBP) is a condition in which there is active inhibition of recruitment of local stabilizers, causing the onset of deep abdominal muscle activity to be delayed. Change in Synergy Pattern (SP) and Recruitment Time (RT) of core muscles after treatment with Lumbar Stabilization Exercises (LSE) is lacking in the research literature. Objectives were to assess pre and post-intervention changes in SP and RT of Transversus Abdominis (TA), Rectus Abdominis (RA), Superficial Lumbar Multifidus (SMF), Longissimus (LG) bilaterally with surface Electromyography (sEMG) after treating with LSE.

Methods: The trial was registered under the Clinical Trail Registry- India (CTRI/2022/09/046066). Thirty-seven participants (M=6, F=31) with CLBP aged 20-40 years were treated with LSE for 6 weeks, 3 alternate days per week. Participants were assessed at baseline for CLBP, post 3 and 6 weeks. Outcome measures were changed in SP measured in microvolts (µV) and RT in milliseconds (ms) of TA, RA, SMF, and LG bilaterally by sEMG and Pain that was assessed with NPRS should be out of bracket.

Results: Repeated measures ANOVA was used as statistical analysis. sEMG revealed significant improvement in SP for TA and SMF bilaterally ($p<0.05$). Significant improvement was observed only in SMF in terms of RT ($p<0.05$). Also, significant improvement was seen in NPRS at rest and on activity with $P<0.001$.

Conclusion: Lumbar stabilization exercises effectively improve TA and SMF's synergy pattern. Also, it is effective in improving recruitment time, mainly superficial multifidus.

Keywords: EMG, muscle onset latency, local stabilizers, global mobilizers.

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INTRODUCTION

Low back pain (LBP), one of the most frequently occurring musculoskeletal problems, accounts for about 80% of all cases [1]. According to a prevalence study by Shetty et al.(2022), the annual prevalence of LBP was 51%, and the lifetime prevalence was 66% among the Indian population. Pooled prevalence was 48%, highest among females [2]. Chronic mechanical low back pain (CMLBP) is a complex condition characterized by muscle dysfunction in the back (multifidus), abdominals (transversus abdominis), and hip (gluteus maximus), as well as decreased lumbar flexibility [3]. Patients with LBP are observed to have increased activity of superficial muscles, decreased activity of postural muscles, and lack of spinal flexibility due to impaired muscular coordination. Poor muscle recruitment patterns may impair the usual effective stability of the spine, with plausible reasons including changes in function and structure throughout the nervous system that impact sensorimotor control [4]. The primary core stabilizers, such as the Lumbar Multifidus (LM) and Transversus Abdominis (TA), cannot create considerable joint motions but mainly stabilize the spine. Secondary stabilizers, such as the internal oblique, the medial fibers of the external oblique, and the quadratus lumborum, have great stabilizing capacity while simultaneously facilitating movement at spinal joints. Taking this classification a step forward, mobilizers could be considered 'tertiary stabilizers' because their action is predominantly to move the joint. Still, they can also stabilize in severe situations, for example, muscle spasms in a state of pain [3,5].

Muscle synergy is the ratio of muscle co-activation required to synchronize body segments to complete a motor subtask. Muscle synergies are group motor subtasks in which the nervous system combines various ways to produce natural and completed movements. As a result, a single brain instruction can trigger a muscle synergy, allowing the motor subtask to be performed reliably. Furthermore, several synergies can be activated in varying quantities at the same time, resulting in a diverse set of reasonable movements [5]. Recently, training of specific muscles surrounding the lumbar spine, functioning to offer dynamic stabilization and segmental control to the spine, has become a key component in managing chronic LBP [6]. Lumbar Stabilization Exercises (LSE) is thought to be important to preserve dynamic spinal and trunk stability as it enhances core endurance, strength and neuromuscular control. It is viewed as a risk-free exercise with the advantages of numerous stages at a minimal cost. The intensity level of each exercise can be adjusted to promote compliance with changes in upper and lower extremity postures and exercise duration [7,8]. Evidence states that LSE help in recruiting core muscles/ local stabilizers [3,9]. The weakness of stabilizers ultimately causes an imbalance of trunk and lumbar spine muscles. As the mobilizers take over the role of stabilizers, it can further result in low back pain, which causes active inhibition of recruitment of local stabilizers as they primarily respond to high-load activities such as quick movement, rapid movement, high force, and a large shift in the Centre of Gravity. The onset of activity in deep abdominal muscles has been reported to be delayed in people with CMLBP. In their study, Shah et al. (2020) explained changes in synergy pattern between back extensors and highlighted differences in muscle activation [10]. It was further explained that LSE could increase local muscle activity instead of overactivating global muscles. However, there is a dearth of literature regarding changes in synergy patterns and improvement in recruitment timing of core muscles after giving LSE in CMLBP patients. This study aimed to find the effect of Lumbar Stabilization Exercises on Synergy Pattern and Recruitment Time of Transversus Abdominis (TA) with Rectus Abdominis (RA),

Superficial fibres of Lumbar Multifidus (SMF) with Longissimus (LG) muscles in patients with CMLBP.

METHODS

Study Design

It was an experimental study, Pre and Post intervention without control group. The study was approved by Institutional Ethical Committee (DYPCPT/IEC/15/2022) with trial registered under Clinical Trail Registry- India (CTRI/2022/09/046066). The study was conducted at Dr. Y. Patil Medical Hospital and Research Centre as well as from Dr. D.Y.Patil Physiotherapy Out Patient Department, Pimpri, Pune, India. Recruitment period of the participants was from 1stOctober 2022 to18th March 2023.

Study Participants

Thirty-seven participants were recruited with convenient sampling. Calculation of sample size was done by using WinPepi software (version 11.65) with Confidence level of 95%, acceptable error of 5% as per the study conducted by Lozano et al. (2020) [11] taking Mean (M) 42.52 and Standard Deviation (SD), 11.13 of Surface Electromyography (sEMG) into consideration. 50 participants were screened, and 37 (M=6, F=31) were identified according to the inclusion criteria with MLBP more than 3 months, aged between 20 and 40 years, where BMI was considered. Participants with cardiac conditions, neurological conditions, pregnancy, any pathological conditions related to the spine, or any other pathology that prevent participants from performing the proposed training were excluded. Details are mentioned in Figure 1.

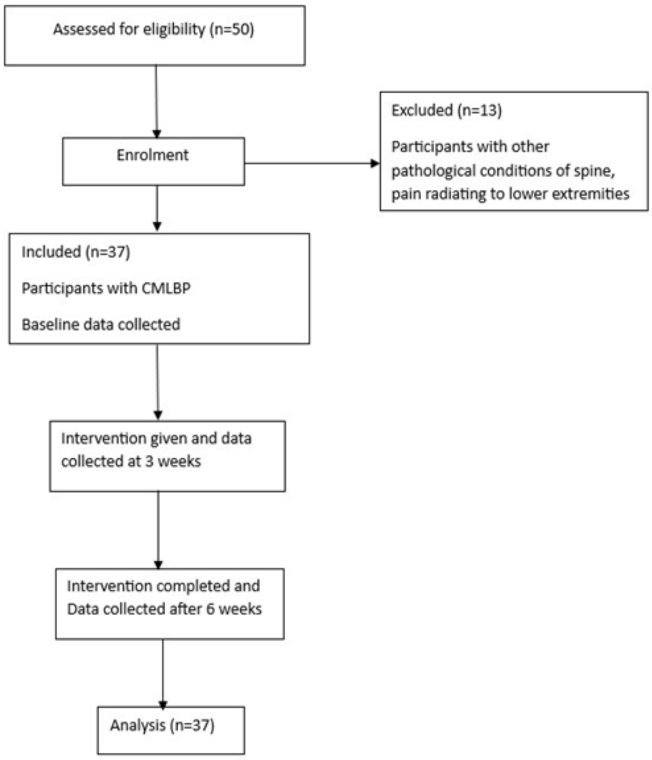

Figure 1: Flow diagram of the participants treated with Lumbar Stabilization Exercises

Intervention Procedures

LSE was given to all participants on alternate days for 6 weeks. The Exercise program lasted 30 minutes per session with 10 seconds rest between repetitions [6,18,19]. Progression of exercises was given after 3 weeks. All participants were recommended to continue their daily activities throughout the study. Details of the intervention and progression of exercises has been mentioned in Table 1.

Table 1: Intervention Programme

WEEK	EXERCISE	REPITI-TIONS	HOLD TIME (sec)
0 to 3 weeks	**Abdominal Hollowing Exercises:**		
	1. For Transversus Abdominis	**5**	10
	2. For Lumbar Multifidus	**5**	10
	Stabilization exercises **Abdominal Hollowing done before each exercise:**		
	SUPINE:		
	1. One leg bent and supported on floor		
	• Lift other bend leg to 90˚ hip flexion	10	10
	• Slide heel to extend knee	10	10
	2. Patient holding opposite leg at 90-90 hip knee flexion with hands		
	• Lift other bent leg to 90˚ hip flexion.	10	10
	• Lift straight leg at 45˚	10	10
	3. Double knee to chest	10	10
	QUADRUPED:		
	• Flex 1 upper extremity (UE)	10	10
	• Extend 1 LE by lifting it off the MAT.	10	10
	• Flex 1 UE and contralateral LE	10	10
4 to 6 weeks	**SUPINE**		
	1. Patient actively hold 1 LE at 90˚ hip knee flexion	10	10
	• Lift other bent leg to 90˚ hip flexion	10	10
	• Lift straight leg at 45˚	10	10
	2. Both LE moving		
	• Lift bent legs to 90˚ hip flexion	10	10
	• Lift straight legs at 45˚	10	10
	3. Pelvic lifts	10	10
	4. Curl Ups	10	10
	PRONE		
	1. Extended both LE	10	10
	2. Superman pose	10	10

Assessment Procedure

The Outcome measures primarily used were Synergy Pattern (SP) and Recruitment Time (RT) by sEMG and secondarily Pain was considered. All outcome measures were assessed at baseline, after 3 weeks and 6 weeks of intervention**.** Surface Electromyography (sEMG) signals were acquired using 8-channel Clarity Octopus EMG Machine (Octopus software version 5.02). Bilateral sEMG signals from TA, RA, SMF, LG muscles were recorded. sEMG is proved to have test-retest reliability between 0.77-0.87 for core muscles (Shah et al. 2020) [10]. The skin was prepared, and electrodes were aligned parallel to muscle fibers. The standard surface electrodes were used for the analysis of activation of muscles and are pre-amplified bipolar surface electrodes with gel coated silver chloride discs. The area where the electrodes were to be placed was cleaned with alcohol, followed by electrodes and conduction gel. The active electrode (Cathode) was placed over the muscle, and the ground electrode over the right lateral epicondyle [13].

Electrodes placement to TA was located 2 cm medially towards the anterior superior iliac spine, RA located 2 cm lateral to the umbilicus [13], LG muscle, 2 cm lateral to the L1 spine and SMF 2 cm lateral to midline, centred at the level of L5 spinous process [10]. Positions to check muscle activation were posterior pelvic tilt for TA, abdominal crunches for RA, pelvic bridging for SMF and LG muscles. The sEMG recording was performed during maximal contraction of each mentioned muscle to check synergy pattern (SP). The peak-to-peak amplitude of Maximum Voluntary Contraction (MVA) measured in microvolts (µV) was analysed. Three trials were taken to obtain the average EMG (AEMG) amplitude with a rest of 10 seconds between the trials. After normalization % MVA was calculated for selected muscles using a formula: $\%MVA = \frac{AEMG}{MVA} \times 100\%$ [13, 14].

For Muscle Onset Latency (MOL), Quantitative Motor Unit Potentials (QMUP) were obtained. Motor Unit Potentials (MUPS) were recorded during muscular contraction using average programme incorporated into software that determines amplitude, number of phases, turns and duration. Turns and phases were counted manually, while other parameters were calculated using the EMG equipment software. Calculations were made to calculate with amplification of 100 μV/div and a sweep speed of 5ms/div using cursor location, that is pre- set in EMG equipment algorithm for QMUP [15]. Evidence for QMUP with sEMG has been reported by Shah et al [12].

The Numeric Pain Rating Scale (NPRS) was used to quantify pain intensity on a range of 0 (no pain) to 10 (worst pain possible). The NPRS has a high level of test-retest reliability (r=0.79-0.96) in individuals with chronic pain [16, 17].

Statistical Analyses

The IBM SPSS statistics (version 26.0) was used to analyze the data in this study. The Kolmogorov-Smirnov test was used to examine the normality of data. Analysis of Variance (ANOVA) with repeated measures was utilized at baseline, post 3 weeks and post 6 weeks for within group analysis. The significance level was established at $p<0.05$ with 95% as confidence interval.

RESULTS

Physical Characteristics of Participants

Thirty-seven participants (M=6, F=31) with CMLBP were recruited in this study. All participants completed the study protocol. The percentage of female population was higher than male population. A detailed explanation of physical characteristics of the participants is mentioned in Table 2.

Table 2: Demographic Representation of Chronic Mechanical Low Back Pain (CMLBP) Group.

VARIABLES		GROUP – CMLBP (n=37)
AGE (in years) Mean(±SD)		29.78 (±6.73)
GENDER (%)	MALE	16.22
	FEMALE	83.78
DURATION OF LBP (months) Mean(±SD)		6.72(±3.14)

Results of Synergy Pattern

Table no 3 showed significant improvement in SP of TA bilaterally from baseline values at the end of 3 and 6 weeks($p<0.05$). Table no 4 showed significant improvement in SP of SMF bilaterally($p<0.05$). For LG, no significant difference was seen in terms of SP post intervention ($p>0.05$). Hence, it can be summarized that after 6 weeks of intervention with LSE, the activity of global mobilizers (RA and LG) was replaced by local stabilizers (TA&SMF).

Table 3: Comparison of Synergy pattern for TA and RA

Comparison of sEMG at SP-pre, SP post 3 weeks and SP post 6 weeks											
sEMG		N	Mean	SD	SEM	95% CI		Min	Max	F-value	p- value
						LL	UL				
RT TA	SP-Pre	37	289.51	103.82	17.07	254.89	324.12	96.70	554.70	100.225	<.001*
	SP post 3 week	37	429.75	94.23	15.49	398.33	461.16	151.30	586.00		
	SP post 6 week	37	770.55	219.37	36.06	697.41	843.70	302.70	1152.00		
LT TA	SP-Pre	37	250.85	89.35	14.69	221.06	280.64	88.00	566.30	73.882	<.001*
	SP post 3 week	37	412.40	104.16	17.12	377.67	447.13	228.70	667.70		
	SP post 6 week	37	713.35	252.87	41.57	629.04	797.66	225.70	1121.30		
RT RA	SP-Pre	37	395.51	227.83	37.45	319.55	471.47	149.30	926.70	1.195	0.307,NS
	SP post 3 week	37	341.13	80.86	13.29	314.17	368.09	160.70	571.00		
	SP post 6 week	37	355.23	124.62	20.49	313.68	396.78	184.30	682.70		
LT RA	SP-Pre	37	351.44	188.06	30.92	288.74	414.15	138.30	795.30	0.160	0.852,NS
	SP post 3 week	37	351.38	96.40	15.85	319.24	383.52	191.70	522.00		
	SP post 6 week	37	366.31	81.90	13.46	339.00	393.62	174.00	576.70		

Notes: *$p<0.05$, NS: Not significant, SD-standard deviation, 95% CI- 95% confidence interval, UL- upper limit, LL-lower limit, SEM-standard error of mean, SP-Synergy Pattern, RT -Right, LT-Left, sEMG: Surface EMG.

Table 4: Synergy pattern for SMF and LG

Comparison of sEMG at SP-pre, SP post 3 weeks and SP post 6 weeks BOX TABLE											
sEMG		N	Mean	SD	SEM	95% CI		Min	Max	F- value	p- value
						LL	UL				
RT SMF	SP-Pre	37	290.18	69.92	11.50	266.87	313.49	115.30	435.30	49.955	<.001*
	SP-post 3week	37	394.71	92.45	15.20	363.88	425.53	213.70	540.00		
	SP-post 6week	37	923.46	492.62	80.99	759.22	1087.71	266.00	1906.30		
LT SMF	SP-Pre	37	294.80	63.91	10.51	273.49	316.11	146.30	414.30	71.653	<.001*
	SP-post 3week	37	403.54	92.50	15.21	372.70	434.38	277.30	677.00		
	SP-post 6week	37	699.76	235.40	38.70	621.28	778.25	298.30	1123.00		
RT LG	SP-Pre	37	443.62	210.70	34.64	373.37	513.87	161.30	954.30	3.934	0.022*
	SP-post 3week	37	379.95	70.06	11.52	356.59	403.31	223.00	541.70		
	SP-post 6week	37	359.95	67.55	11.11	337.43	382.47	181.30	474.30		
LT LG	SP-Pre	37	412.86	201.57	33.14	345.65	480.07	193.30	935.70	2.293	0.106,NS
	SP-post 3week	37	380.59	87.58	14.40	351.39	409.79	195.00	531.70		
	SP-post 6week	37	345.20	84.57	13.90	317.00	373.39	185.30	525.30		

Notes: *p<0.05, NS: Not significant, SD-standard deviation, 95% CI- 95% confidence interval, UL- upperlimit, LL-lower limit, SEM-standard error of mean, SP-Synergy Pattern, F-value: Repeated Measures ANOVA, RT =Right, LT=Left, sEMG: Surface EMG

Results Of Muscle Onset Latency

In Table no.5, significant difference was observed in terms of MOL at pre, post 3 and post 6 weeks in SMF bilaterally (p<0.01) and LT TA (p<0.05). However, there was no discernible difference observed in RT TA (p=0.247), RT RA (p=0.118), LT RA (p=0.382), RT LG (p=0.337), LTLG (p=0.185).

Table 5: Muscle onset latency for RA, TA, SMF, LF

Comparison of mean of sEMG at Pre MOL, Post 3 weeks MOL and Post 6 weeks MOL											
sEMG		N	Mean	SD	SEM	95% CI		Min	Max	F-value	P-value
						LL	UL				
RT TA	Pre MOL	37	9.27	3.85	0.63	7.98	10.56	2.13	19.35	1.415	0.247, NS
	Post 3 Weeks MOL	37	10.02	3.45	0.57	8.87	11.17	3.48	23.43		
	Post 6 weeksMOL	37	8.56	3.93	0.65	7.25	9.87	1.85	23.43		
LT TA	Pre MOL	37	9.24	3.57	0.59	8.05	10.43	2.50	20.25	3.054	0.051*
	Post 3 Weeks MOL	37	10.31	3.29	0.54	9.21	11.40	5.13	24.42		
	Post 6 weeksMOL	37	8.21	4.06	0.67	6.86	9.56	2.50	24.42		
RT RA	Pre MOL	37	9.09	3.71	0.61	7.85	10.33	2.43	19.15	2.178	0.118, NS
	Post 3 Weeks MOL	37	10.37	4.04	0.66	9.02	11.71	3.08	26.64		
	Post 6 weeksMOL	37	8.46	4.22	0.69	7.06	9.87	3.05	26.64		
LT RA	Pre MOL	37	9.25	5.00	0.82	7.58	10.92	3.48	28.80	0.972	0.382, NS
	Post 3 Weeks MOL	37	10.14	4.02	0.66	8.80	11.48	4.88	26.86		
	Post 6 weeksMOL	37	8.70	4.35	0.72	7.25	10.15	2.68	26.86		
RT SMF	Pre MOL	37	10.26	3.27	0.54	9.16	11.35	4.35	23.87	5.369	0.006*
	Post 3 Weeks MOL	37	9.67	2.52	0.41	8.83	10.51	5.65	15.53		
	Post 6 weeksMOL	37	7.96	3.51	0.58	6.79	9.13	0.25	15.53		
LT SMF	Pre MOL	37	10.09	3.65	0.60	8.87	11.30	4.85	25.87	6.088	0.003*
	Post 3 Weeks MOL	37	9.63	3.30	0.54	8.53	10.73	2.13	17.00		
	Post 6 weeksMOL	37	7.44	3.50	0.58	6.27	8.61	0.80	16.87		
RT LG	Pre MOL	37	10.39	3.72	0.61	9.15	11.63	3.08	21.23	1.098	0.337, NS
	Post 3 Weeks MOL	37	9.53	3.71	0.61	8.30	10.77	3.00	20.76		
	Post 6 weeksMOL	37	9.08	4.14	0.68	7.70	10.46	1.05	20.76		
LT LG	Pre MOL	37	10.47	4.38	0.72	9.01	11.93	2.68	20.76	1.713	0.185, NS
	Post 3 Weeks MOL	37	8.83	3.81	0.63	7.56	10.10	2.43	20.40		
	Post 6 weeksMOL	37	9.02	4.26	0.70	7.60	10.44	1.25	20.40		

Notes: *p<0.05, NS: Not significant, SD-standard deviation, 95% CI- 95% confidence interval, UL- upper limit, LL- lower limit, SEM-standard error of mean, SP-Synergy Pattern, RT -Right, LT-Left, sEMG: Surface EMG.

Results of Pain

Within-group analysis using ANOVA test revealed that there were significant difference in pain intensity (NPRS) at rest and on activity when compared at baseline, post 3 and post 6 weeks as mentioned in Table no 6 (p<0.05).

Table 6: Comparison of Pain

Comparison of Pain (NPRS) at pre, post 3 weeks and post 6 weeks											
NPRS		N	Mean	SD	SEM	95% CI		Min	Max	F-value	p- value
						LL	UL				
On rest	Pre	37	2.65	2.08	0.34	1.95	3.34	0.00	8.00	26.565	<.001*
	Post 3 week	37	1.46	1.35	0.22	1.01	1.91	0.00	7.00		
	Post 6 week	37	0.16	0.55	0.09	-0.02	0.35	0.00	3.00		
On activity	Pre	37	6.89	1.85	0.30	6.27	7.51	2.00	10.00	209.842	<.001*
	Post 3 week	37	4.08	1.64	0.27	3.53	4.63	2.00	8.00		
	Post 6 week	37	0.08	0.28	0.05	-0.01	0.17	0.00	1.00		

Notes: *p<0.05, NS: Not significant, SD: standard deviation, 95% CI: 95% confidence interval, UL:upper limit, LL: lower limit, SEM: standard error of mean

DISCUSSION

The purpose of the study was to find the effect of Lumbar Stabilization Exercises on Synergy Pattern, Recruitment Time of core muscles and Pain in individuals with Chronic Mechanical Low Back Pain. Surface EMG was used to determine the muscle synergy patterns and muscle onset latency, expressed as a % MVIC. This study revealed significant improvement in synergy patterns of TA and SMF bilaterally. A study conducted on effect of increased lumbar lordosis in patients with CLBP using sEMG of SMF and LG by Shah et al., (2020), [10] explained that during stabilization exercise, an increase in muscle activity ratio is mostly attributable to an increase in local muscle activity against global muscular activity. The effective strategy of increasing SMF activation is to restore SMF function that can be used to reduce LBP remission. The findings of present study are also consistent with previously mentioned study conducted by Kumar et al. (2015) [3]. They stated that the greater activation of TA could be because of its independent activation as well as co-activation with SMF, which in turn is responsible for further activation. The capacity to contract SMF was related to the ability to contract TA, with patients who also had a good TA contraction having a 4.5 times higher chance of having agood SMF contraction [3].

Muscle onset latency showed significant improvement in SMF post 6 weeks of intervention. This could be due to the reason that during postural disturbances, the spine maybe stabilized by the contraction of more than one sequence of core muscles. Improved segmental trunk muscle activation with the goal of achieving multi-segmental synergist activation ratios is the most efficient means of achieving trunk stability. Recruited earlier than other core muscles because the early contraction of the SMF was intended to maintain trunk alignment and reduce the displacement of the centre of mass in all three planes at once [13]. Shenoy et al. (2010) studied long latency reflex response of superficial trunk muscles in athletes with CLBP, exploring late response to unexpected perturbations in RA [20].

The results showed significant improvement when NPRS determined pain at rest and on activity. Stabilization exercises have shown to help reduce pain by decreasing the signal given to pain-receptive tissues such as ligaments and joint capsules. As a result, the strain on the lumbar vertebrae is minimized and the function of core stabilizer muscles improves, leading to trunk positional control [9]. Patients with CLBP may experience changes in sensory function, excitability and organization of the motor cortex, as well as alterations in the activity distribution between or within synergistic muscles and motor response planning due to motor adaptation to pain [4]. Oddsson et al. conducted a study on lumbar spine muscle activation imbalances in the presence of CLBP. They explained that their findings of altered EMG parameters in LBP patients are due to the effects of both central and peripheral factors. Central sensitization, caused by prolonged nociceptor activity from tissue injurysites, is linked to hyperalgesia and a heightened and persistent experience of pain, even in the absence of damage. This is known as a nervous system 'disease state', in which the principal afferent neurotransmitter, substance P, reorganizes spinal cord circuitry, resulting in chronic and aggravated pain. This could be directly related to their findings since chemicals released and altered during the central sensitization process, such as substance P, can modify motor neuron excitability via pre and postsynaptic effects, altering motoneuron pool recruitment properties and thus causing imbalance [21]. LSE give stability by strengthening the lumbar deep muscles in CLBP patients [22]. A review conducted by Pandya et al., support the influence of LSE on pain reduction and function improvement by minimizing the stimuli provided to pain sensitive tissues (ligaments and joint capsules), hence lowering the load on the lumbar vertebrae [23].

As per our knowledge, there are no studies to find the effect of lumbar stabilization exercises on recruitment timings as it is one of the important measures that would be beneficial from rehabilitation point of view, which is a strength of our study. Body Mass Index (BMI) was not considered, that could be one of the limitations as palpation of deep muscles mainly TA was difficult in obese participants thus may have led to crosstalk. However, further studies can be done to compare the effect of LSE in male and female population. In future, Randomized Controlled Trials can be conducted to compare the effect of LSE with conventional treatment to observe changes in Synergy Patterns and Recruitment timings of spinal muscles. Also, movement control exercises can be compared with LSE to observe the effect of the same outcome measures that would greatly benefit the physiotherapy research community.

CONCLUSION

The analysis shows that lumbar stabilization exercises effectively improve synergy pattern and reduce pain. Also, these exercises are effective in early recruitment of core muscles, mainly superficial fibres of lumbar multifidus.

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DECLARATION OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Ramdas J, Jella V. Prevalence and risk factors of low back pain. International Journal of Advanced Medicine.2018;5:1120-3.

[2] Shetty GM, Jain S, Thakur H, Khanna K. Prevalence of low back pain in India: A systematic review and meta-analysis. *Work*. 2022;73(2):429-452.

[3] Kumar T, Kumar S, Nezamuddin M, Sharma VP. Efficacy of core muscle strengthening exercise in chronic low back pain patients. Journal of back and musculoskeletal rehabilitation. 2015;28(4):699-707.

[4] Hlaing SS, Puntumetakul R, Khine EE, Boucaut R. Effects of core stabilization exercise and strengthening exercise on proprioception, balance, muscle thickness and pain related outcomes in patients with subacute nonspecific low back pain: a randomized controlled trial. BMC Musculoskeletal Disorders. 2021;22(1):1-3.

[5] Safavynia S, Torres-Oviedo G, Ting L. Muscle synergies: implications for clinical evaluation and rehabilitation of movement. Topics in spinal cord injury rehabilitation. 2011; 17(1):16-24.

[6] ReddyA SB, Jerome E, N Sk. Effects of core stabilization program and conventional exercises in the management of patients with chronic mechanical low back pain. International journal physiotherapy. 2015;2(2):441-7.

[7] Heo, M.-Y., Kim, K., Hur, B.-Y., Nam, C.-W. The effect of lumbar stabilization exercises and thoracic mobilization and exercises on chronic low back pain patients. The Journal of Physical Therapy Science. 2015;27: 3843–3846.

[8] Yamamalini, S., & Srikanth, I. A study to assess the effectiveness of core muscle stabilization regimen in patients with mechanical low back ache. International Journal of Adapted Physical Education & Yoga. 2018;3(10): 8-16.

[9] Saleem S, Khan MH. Effect of Lumbar Stabilisation Exercises using the Stable and Unstable Surface on Pain, Disability and Electromyography (EMG) Activity in Chronic Low Back Pain. International Journal of Current Research and Review. 2021;13(20):66-70.

[10] Shah J, Tanwar T, Iram I, Aldabbas M, Veqar Z. Effect of increased lumbar lordosis on lumbar multifidus and longissimus thoracis activation during quadruped exercise in patients with chronic low back pain: an EMG study. Journal of Applied Biomechanics. 2020;36(6):436-43.

[11] Oliva-Lozano, José M, and José M Muyor. Core Muscle Activity During Physical Fitness Exercises: A Systematic Review. International journal of environmental research and public health. 2020; 17(12):4306.

[12] Shah V, Palekar T, Guruprasad P. Surface Electromyography of Perineal Muscles in Children with and without Enuresis: A Cross-sectional Study. Journal of clinical and diagnostic Research. 2022;16(1):SC01-SC03

[13] Silfies SP, Squillante D, Maurer P, Westcott S, Karduna AR. Trunk muscle recruitment patterns in specific chronic low back pain populations. Clinical biomechanics. 2005;20(5):465-73.

[14] Li X, Lo WL, Lu SW, Liu H, Lin KY, Lai JY, Li L, Wang CH. Trunk muscle activity during pressure feedback monitoring among individuals with and without chronic low Back pain. BMC musculoskeletal disorders. 2020; 21(1):1-9.

[15] Papagianni AE, Kokotis P, Zambelis T, Karandreas N. MUAP Values of Two Facial Muscles in Normal Subjects and Comparison of Two Methods for Data Analysis. Muscle & Nerve . 2012;46(3):346-350.

[16] Cheatham SW, Stull KR, Kolber MJ. Roller massage: is the numeric pain rating scale a reliable measurement and can it direct individuals with no experience to a specific roller density. The Journal of the Canadian Chiropractic Association. 2018;62(3):161-169.

[17] Markman JD, Czerniecka-Foxx K, Khalsa PS, Hayek SM, Asher AL, Loeser JD, Chou R. AAPT diagnostic criteria for chronic low back pain. The Journal of Pain. 2020; 21(11-12):1138-48.

[18] Demirel AY, Oz MÜ, Ozel YA, Cetin HA, Ulger O. Stabilization exercise versus yoga exercise in non-specific low back pain: pain, disability, quality of life, performance: a randomized controlled trial. Complementary therapies in clinical practice. 2019; 35:102-108.

[19] Kisner Carolyn, Colby Lynn Allen. Therapeutic Exercise: Foundations and techniques. 6thed; 2012.

[20] Shenoy S, Balachander H, Sandhu J S. Long Latency reflex response of superficial trunk musculature in athletes with chronic low back pain. Journal of Back and Musculoskeletal Rehabilitation. 2013; 26(4):445-450.

[21] Oddsson LI, De Luca CJ. Activation imbalances in lumbar spine muscles in the presence of chronic low back pain. Journal of applied physiology.

2002;94(4):1410-20.
[22] Heo MY, Kim K, Hur BY, Nam CW. The effect of lumbar stabilization exercises and thoracic mobilization and exercises on chronic low back pain patients. J Phys Ther Sci. 2015 Dec;27(12):3843-6.
[23] Pandya RP, Shukla YU. 2021 Effect of Lumbar Stabilization Exercises on Stable versus Unstable Surface on Pain and Function in Mechanical Low Back Pain-an Evidence Based Study. International Journal of Science and Healthcare Research. 6(2):273-9.