Effectiveness of Maximum Voluntary Contraction Using Surface Electromyography on Erector Spinae and Tensor Fascia Latae Muscle Along With Muscle Energy Technique in Chronic Non-Specific Low Back Pain

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KEYWORDS
CNSLBP, MET, SEMG (ES, QL, TFL and iliopsoas muscles), CMSE.

ABSTRACT
Background: Low Back Pain (LBP) one of the major health issues over the world. It affects quality of life and work absentness leads to disability. Non-specific Low Back Pain (NSLBP) does not have specified problem. In this type, muscle imbalance, distributed muscle strength, endurance, movement co-ordination impairment, poor posture might enhance the nociceptor stimuli.
Muscle energy technique (MET) is an active manual technique focused over muscle stretching, strengthening, relaxing. Aims to restore normal joint mobility and reduce pain.
Aim: To determine the effect of muscle energy technique in chronic non-specific low back pain.
To study the effectiveness of muscle energy technique in subjects with chronic non-specific low back pain on pain, functional disability and Surface electromyography (SEMG) measures.
Material and Method: A total of 40 subjects were included in the study. 20 subjects with CNSLBP were allocated in a group A. whereas group B was allocated with Core Muscle Strengthening exercises (CMSE) for three weeks. All the participants were clearly explained about the procedure and informed consent attained.
In group A, MET was applied over four muscle groups namely quadratus
Lumborum (QL), erector spinae (ES), iliopsoas, tensor fascia latae (TFL). SEMG study was done over the two muscles, ES and TFL. At rest period measurement was done after their maximum voluntary contraction was recorded.
Results: Pre-post-test comparison was analysed by Wilcoxon's matched pair test. Between group analysis done by Mann Whitney U test, the experimental groups exhibit VAS, ODI, SEMG-ES (Rt and Lt), TFL (t and Lt) shown significance at p value = 0.001.
Conclusion: MET was effectively reducing functional disability, decreases pain, muscle strength improved in ES and TFL muscles of both sides evaluated through SEMG.

1. Introduction

LBP viewed as serious health issue and economic burden in the lives. Almost 84% of the patients being diagnosed as NSLBP. NSLBP does not possess with serious pathoanatomic origin. NSLBP is characteristics without any structural involvement with no disc space reduction, nerve compression, bone or joint injury that may lead to back pain.[1] NSLBP reduce the range of motion which was linked with mechanical restriction between the vertebral and associated with muscular spasm. The commonest complaint being the limitation mobility. In addition, stabilising muscle function and co-ordination often impaired,[2] decreased back endurance,[3] along with long-term back related disability.[4]

NSLBP caused due to imbalance typically occur between functional load, affects work activities in daily living and potential for performing the activities.[5]

The co-ordinated function of lumbar stabilising muscles particularly extensors impaired with LBP. Sorenson of his studies, good endurance of back extensors act as safeguard from pain. ES strain and fatigue is one of its common causes of pain.[6]

MET is a class of osteopathic soft tissue manipulation method incorporates patient initiated controlled isometric/ isotonic contraction, its well design to improve musculoskeletal function and reduce pain.[5, 7, 8]

MET is an active manual technique considered as choice of therapy because it lengthens the shortened muscle, mobilize the restricted mobility, strengthen weakened muscle and also reduce oedema and passive

congestion.[7,8,9]

The functional co-ordination endurance of lumbar spinae muscle is often impaired. It is necessary to study the certain muscle. MET validly applied over the four muscles namely QL, ES, iliopsoas, TFL. Before the application of technique, it was properly assessed over the muscle shortened position of each individual muscle.

Each muscle was tested by separate blinders, who does not know above the whole intervention plan and does not reveal it over the participants.

The lack of objective method to detect the impaired muscles, the myoelectric activity of paraspinal muscles in CNSLBP by SEMG is a great value in assessment of such patients. SEMG could provide monitory the alteration of signal amplitude of myoelectrical activity of paraspinal muscles in CNSLBP and explore its correlation with symptom relief in application of MET in the patients.

It is appropriate to study the recruit patterns of these muscle SEMG.

2. Methodology

The diagnosis of CNSLBP was well categorized and investigated from physician, physical medicine outpatient department. A total of 40 subjects were recruited and satisfying the selection criteria were channelized to respective examiner.

Study Design

Interventional study (As per advice of our institutional ethical committee- EC/NEW/INST/2020/1249)

Sampling

Convenient Sampling

Materials Required

Couch

Towel

VAS Chart

ODI Scale

SEMG Equipment

Inclusion criteria

Age group	:	20 to 45 years
Gender	:	Both Male and Female
Duration of pain	:	12 weeks and more

Exclusion criteria

Intervertebral Disc Prolapse,

Lumbar Spondylosis,

Spondylolisthesis,

Spine Fracture,

Malignancy, Tumours,

Any Hip Pathology,

Abnormal neurological signs in lower extremities,

Obesity,

Spinal deformities,

pelvic lesions in female patients,

pregnant women.

Outcome Measures:

Outcome measures:

These groups were evaluated with visual analysis scale (VAS) for pain, Oswestry disability index (ODI) for functional disability, SEMG recording the Maximum Voluntary contraction of TFL and ES muscles. pre and post-test measurement of their scales would be recorded after their selective intervention.

Procedure:

By random sampling technique from available sample to ensure implementation of patient sequence without knowledge of which patient receive which treatment procedures. There will be divided into two groups, 20 subjects in each group. Experimental Group A receive MET and control group B receive CMSE.

Group A received MET for 6 repetitions, 3 sessions per week over a three-week period. Group B received CMSE every day for 3 weeks.

Both groups underwent treatment duration of 3 weeks estimation using VAS for pain, ODI for functional disability and SEMG for maximum voluntary contraction in the resting position of erector spinae-lumbar, TFL muscle before and after therapy.

VAS:

VAS is a self-reported pain rating scale.[10] It's a 10 cm line represents two ends, left end considered as "no pain", right end of the scale as "worst pain". Patients are asked to mark the symptoms corresponding to the scale.[11]

ODI:

ODI is a reliable and valid tool in evaluate the disability of LBP,[12] follow-up and assessment. The questionnaires made up of 10 categories. Each category of 6 items scores from 0 to 5. The highest level 5 considered as worst state.[13]

The following classification reveals severity of disability: Score (%)

0 – 20 = Minimum disability

21 – 40 = moderate disability

41 – 60 = severe disability

61 – 80 = extreme severe disability

81 – 100 = confide to bed

The calculation of score:

Example: 18 (total score) out of 50 items

16/50X100 = 36%

SEMG:

Surface electromyography was used to measure the activation of TFL and ES muscles during maximum voluntary contraction. Patients were clearly explained about the SEMG electrodes placement attached to the skin and careful cleaning and shaving with alcohol 70 % swabs to reduce the skin impedance. The procedure and instructed to adopt a position with pillow support. The electrodes for the TFL were placed two fingerbreadths distal to the ASIS and two fingerbreadths medial to the greater trochanter, [14] Fig:1. and erector spinae muscle just 4cm away L1 spinous process with a distance of 2cm between electrodes.[15] Fig:2. The reference electrode attached over the skin of the tibia. Before and after the intervention the maximum voluntary contractions was recorded and statically analysed.

Application of Interventions

Experimental Group

MET applied over the four muscles namely QL, ES, iliopsoas, TFL.

Pretest is recorded before the application of MET, after intervention post-test measurement was recorded of each muscle.

MET was applied in four different muscles

MET application over these four muscles: QL, ES iliopsoas, TFL. the patient was advised to contract 20% of his muscle force against the therapist's force, instruct to contract for 7 seconds, relax for 5 seconds, 6 repetition and then exhale, 3 sessions per week over a three-week period. The muscle moves on to a new restriction barrier by therapist, finally 30 seconds as an end barrier -stretch with three repetitions.

Testing of the muscles and application of MET

Testing of QL

The patient must stand with their feet shoulder-width apart against a wall to perform a pure side-bending and run their hand along their lateral thigh towards calf. If side-bending to one side is restricted means the opposite side's QL is tight.

Technique applied for tight QL: 'Banana' position

The patient is in a supine position with their feet crossed at the ankle and heel is positioned just off of the table, the patient slight side-bending towards the not being treated side. Now the patient is positioned in banana shaped, with the head and feet turned away from the side that will be treated and the pelvis leaning toward that side. When the side-bend is reached the restricted barrier is detected accurately. The therapist stands on the side opposite the patient's shoulders to hold the treated side axilla and the caudal hand is firmly put on the ASIS of that side. the patient is advised to side-bend towards the treated side to produce QL muscle contract isometrically for 7 seconds and after completely relax. The therapist then side bend the patient to next new barrier. The shortened musculature can lengthen achieved and finally stretch the patients for 30 seconds. [7] Fig.3.

Testing of Lumbar ES

The patient is advice to continue flex down vertebrae by vertebrae while sitting at the end of the table and their chin down to his chest. When the therapist feels an increase in muscle tension in their hand after palpating the top of the iliac crest and PSIS with their thumb, the test is finished. The lumbar ES us considered as tight by a measurement of more than 15 cm from the forehead to the top of the knee.

Technique applied for Lumbar ES

The patient is instructing to adopt prone position, pillow kept beneath their abdomen. the therapist inserts his right hand in the cross-hand position on the sacrum and his left hand on the lower thoracic spine. The patient is advice to raise their shoulders off the couch. After seven seconds of holding, the therapist relaxes by placing his both hands position. The hand placement promotes ES lengthening.[7] Fig.4.

Testing of iliopsoas (Kendall test)

The patient rest supine with their knees bent over the edge of the examination table. ask the patient to flex the opposite knee towards chest and hold it. The tested knee should stay at 90 degree means if it does not tightness is present.[16]

Technique applied for tight iliopsoas

The patient is advice to grasp onto his left knee against his chest while lying on his back on the couch's edge. The therapist now stabilises the patient's right hip by one hand and other hand placed above the patient's right knee. The patient is advice to flex their hip against resistance for 7 seconds. The therapist gradually applies downward pressure while the patient is relaxed. [7] Fig.5.

Testing of TFL (Ober's Test)

The patient is side-lying with the lower leg flexed at the hip and knee. For stability the knee flexed to 90 degrees, the therapist passively abducts and extends the patient's upper leg. If there is tightness, the leg stays abducted and does not drop to the table as the therapists gradually lower the upper limb.[16]

Technique for TFL

The patient lies in supine position. Therapist crosses the patient's non-tested leg over the leg to the treated and foot of the non-test leg remains in touch with the couch. The therapist stands on the non-test leg side of the patient. The patient's non-tested knee is controlled by therapist with right hand and holds onto the patient's ankle of the leg to be treated. The therapist advice the patient to abduct the treated leg against the resistance for 7 seconds. Then the patient is to relax and the therapist further adduction into new barrier. [7] Fig.6.

Group B (Control group- CMSE)

CMSE have some set of exercises namely, abdominals, back extensors, Pelvic bridging, Cat – camel, plank. Each exercise 6 repetitions every day for 3 weeks. The available data analysed statistically.

Statistical analysis

The present work was aimed to investigate the effectiveness of MET on CNSLBP. Forty CNSLBP patients were selected and were randomly divided into two groups viz experimental and control. Group A was treated with MET whereas CMSE was the choice of treatment for controls. The outcome measures used were VAS, ODI, and EMG activities of ES and TFL. Basic characters such as age, gender, BMI were analyzed between groups using Mann-Whitney U test. Within group pre-post comparison was analyzed by

Wilcoxon's matched pair test. Between groups analysis was carried out by Mann-Whitney U teat. Test of normality was conducted by Shapiro Wilks test. The entire statistical analysis was performed using statistical packages of social sciences (SPSS-21).

Fig: 1. SEMG for TFL muscle.

Fig: 2. SEMG for ES muscle

Fig. 3. MET for QL muscle 'Banana' position

Fig. 4. MET for ES muscle

Fig.5. MET for iliopsoas muscle

Fig. 6. MET for TFL muscle

Table – 1 Basic character of study patients

Variables	Experimental		Control		Total			Test statistics	
Age in yrs (M,S.D)	35.30	6.87	34.35	6.51	34.75	6.63	Z	0.47	0.635
Gender (N, %) Male Female	 14 6	 70 30	 13 7	 65 35	 27 13	 67.5 32.5	Z	0.33	0.739
BMI (M, S.D)	22.62	1.37	23.08	2.42	22.85	1.96	Z	0.87	0.387

M-Mean, S.D-Standard deviation, N-Number, %-Percentage, z-Mann-Whitney U test, p-Probability

The mean age of patients was 34.75±6.63 years. The majority of study patients were male (67.5%). There was no significant difference in age and gender between groups as shown in Table 1.

Table – 2 Comparison of VAS & ODI within groups

	Pre		Post		M.D		Test statistics	
	M	S.D	M	S.D	M	S.D	Z	P
VAS Experimental Control	5.35 5.25	0.74 0.78	1.95 2.90	0.79 1.17	2.85 1.85	1.18 0.81	3.97 4.05	0.001* 0.001*
ODI Experimental	38.60	1.73	4.70	2.54	30.00	10.38	3.96	0.001*
Control	38.40	1.67	9.80	4.05	24.60	8.54	3.97	0.001*

M-Mean, S.D-Standard deviation, Z-Wilcoxon's signed rank test, M.D- Mean difference p-Probability, *-Significant.

There was significant improvement in the VAS and ODI following treatment in both groups as shown in Table 2.

Table – 3 Comparison of ES & TFL within groups

ES	Pre		Post		M.D		Test statistics	
	M	S.D	M	S.D	M	S.D	Z	P
ES (Right)								
Experimental	97.10	2.20	259.45	91.27	172.19	62.37	3.81	0.001*
Control	95.25	3.04	154.05	52.91	68.34	23.68	2.46	0.014*
ES (Left)								
Experimental	96.80	1.90	259.05	52.91	172.29	61.90	3.81	0.001*
Control	94.42	2.73	153.78	52.89	68.73	24.13	2.46	0.014*
TFL (Right)								
Experimental	86.64	2.58	235.86	83.44	157.88	57.76	3.81	0.001*
Control	83.09	2.60	115.23	40.29	40.49	15.59	2.46	0.014*
TFL (Left) Experimental Control	86.96 83.54	3.16 2.88	236.60 116.73	83.56 40.75	158.46 41.47	57.73 15.67	3.81 2.46	0.001* 0.014*

M-Mean, S.D-Standard deviation, Z-Wilcoxon's signed rank test, M.D- Mean difference p-Probability, *-Significant.

The SEMG activities of ES and TFL had demonstrated significant improvement after treatment in both groups as shown in Table 3.

Table – 4 Comparison of outcome variables between groups

Variables	M.D	Z	p
VAS	1.00	3.41	0.002*
ODI	5.40	4.41	0.001*
ES Right Left	 103.84 103.57	 4.39 4.38	 0.001* 0.001*
TFL Right Left	 117.37 116.99	 4.38 4.37	 0.001* 0.001*

M.D-Mean difference, Mann-Whitney U test, p-Probability, *-Significant.

Between groups analysis revealed that there was significantly higher improvement in VAS with the MD of 1 point higher in the MET compared to controls. Likewise, there was significantly higher improvement in ODI in the MET with the obtained magnitude of difference was 5.40. ES and TFL had demonstrated significantly higher improvements in the MET as shown in Table 4.

3. Results

In Group A comparison of pre and post mean differences, there was significant improvements in VAS (Z=3.97, P=0.001), ODI (z=3.96, p=0.001), SEMG Right ES muscle (Z=3.81, P= 0.001), Left ES Muscle (Z=3.81, P= 0.001), TFL Right MUSCLE (Z=3.81, P= 0.001), TFL Left muscle (Z=3.81, P= 0.001).

In Group B, comparison about pre and post mean difference, there was significantly improvement seems in VAS (Z=4.05, P=0.001), ODI (Z=3.97, P=0.001), SEMG Right ES muscle (Z=2.46, P=0.014), Left ES Muscle (Z=2.46, P=0.014), TFL Right MUSCLE (Z=2.46, P=0.014), TFL Left muscle (Z=2.46, P=0.014).

4. Discussion

The average mean age of patients 34.82±6.69 not shown any significant difference among the age groups. Majority of the study patients were male participants 67.5%, the mean BMI value is 22.85 ±1.96.

VAS comparison between the groups, shows the mean difference in improvement of VAS in group A was 2.85 Whereas it was 1.85 for group B. there was a statistically significant improvement in group A, Z= 3.41. Whose P value was 0.001<0.05.

The possible explanation for improvement of pain as follows

Reduction in pain due to MET can be explained on the basis of neurophysiology as described by chaitow, the subsequent reduction in tone of the agonist muscle after isometric contraction, after post isometric relaxation.[7]

This occurs to due to stretch receptors called Golgi tendon organs which further inhibit muscle contraction i.e., the efferent nerve impulse from Golgi tendon organ enters the dorsal root of spinal cord and meets with inhibitory motor neuron.

Greenman increases joint mobility and length the contracted muscles, beneficial increase joint mobility and improve pain.[9]

Shiby Varghese revealed the effectiveness of MET as compared with manipulation therapy in chronic LBP and finalised MET effective treatment was not harmful option in low back pain and it improves articulation and mobilize the soft tissue in NSLBP.[17]

In our study there was a significant improve in experimental group value, whole “P” value 0.001<0.05.

The reason behind improvement as follows. MET found as advantage in case LBP associated with ES muscle spasm, reduction in pain usually accompanied with increased ROM. MET helpful in increase blood supply and also decrease stiffness thereby restore the ROM helps in increase mobility and strengthen back muscle. It’s a kind of Manipulative therapy comprises isometric and stretching effectively reduce somatic dysfunction. Numerous studies have shown the benefits of MET in LBP,[18,19,20,21,22] but among of the studies linked with combined therapy. since its alone effects still under discussion.[18] stretching of soft tissues in the affected area, moving the fluids out of the inflamed area, reflexively relax on tone of the muscle. According to Saeid Al Matif et al, adequate MET technique increases lumbar extension in subjects. The present study results too shown increased lumbar ROM match with Schenk et al.

Controversy

MET shows is effectiveness to improve disability and functional level in acute LBP. But for chronic cases, it’s very limits. On deep analyses, its six-day review compared with Maitland mobilization. From the franke H et al results suggest evidence was poor. Since the studies were small and short-term outcomes, they are determined high risk of bias.[19]

Many studies evaluated MET along with other programs such as with other manual therapy or with supervised exercises. Thus, future with large sample size. efficacy MET can be tested to generalised the results.

ODI was a valid and reliable scale to measures functional disability in measuring CNSLBP. Group A experimental shown significant improvement with “Z” value = 4.41, Whole “P” value = 0.001<0.05.

Due to the debate of accuracy of muscles, where some studies utilised ultrasonography or MRI guidance in precise selection of muscles but not handled in our study. So only two muscles are included, in future expand to other relevant muscles producing dysfunction. The objective measurement of SEMG of maximum voluntary

contraction were recorded at rest before and after therapeutic application measurements were recorded.

5. Conclusion

MET is an effective treatment in improving pain and gain trunk muscle strength in CNSLBP patients in addition improvement spinal extension movements.

Limitation

1. This study conducted with less sample size.
2. Some factors cannot be recorded like in between the intervention.

Recommendations

1. MET added to conventional therapy for CNSLBP.
2. SEMG analysis to other muscle also QL, iliopsoas.
3. Follow up after the treatment.

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