Original Article

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Effect of Neural Mobilsation on EMG and Disabilty Index in Lumbar Radicular Pathology

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Abstract

Background: Adverse neurodynamic tension is a commonly seen clinical condition. It is found in across all age groups. The lumbar radiculopathy can be quite disabling as well. Therefore we sought to find out the effect of neural mobilisation on muscle activity and the disability caused by this problem. *Methods*: 24 male athletes were recruited from university clinic after clinical diagnosis. They were allocated to two different arms ie experimental arm (Group A n=12, age-22.2±3.51) and conventional PT arm (Group B n=12, age 24.8±4.06). Measurements for s EMG of ipsilateral and contralateral multifidus and disability (Oswestry disability index) were taken at baseline and after 14 treatment sessions. *Results:* Mixed model ANOVA showed significant main effects for time $F(1,21) = 32.11$, $p < 0.001$ and time-group interaction $F(1,21) = 6.871$, $p = 0.016$ while for group $F(1,21) = 0.931$, $p = 0.346$. there was more interaction effect in neural mobilisation group than conventional treatment group which implies that increase in ipsilateral and contralateral EMG is more in neural mobilization group. The disability index (ODI) improvement in both groups remained the same. *Conclusion:* lumbar radiculopathy patients had better clinical outcomes in terms of ipsilateral and contralateral EMG .The improvement is related to correction of the neural mobility impairment. Further studies are needed including randomized controlled trials to confirm these findings, neural mobilization effects as a standalone treatment and establish possible mechanism for neurodynamic treatment in lumbar radiculopathy.

Keywords: Lumbar Radiculopathy; Disc Herniation; Neural Mobilisation; EMG; ODI.

Introduction

Lumbar radiculopathy is a combination where there is adverse neural tension in the nerves which supply the lower quadrant. a retrospective study done on professional football players found that most of the discherniation occurred at lumbar L5 S1 level nerve root. 97% of Players were able to return to sports after average of 6.6 months after diagnosis of disc herniation. Lumbar disc herniation results in neuromuscular imbalance in the lumbar region. EMG isa important tool in development, recording and analysis of the myoelectric signals. Chronic low back pain results in lowering the lumbar multifidus myoelectric activity. Similar findings were recorded by another author who found that lumbar radiculopathy resulted in severe and extensive atrophy of the lumbar multifidus in patients with lumbar disc herniation with radiculopathy and without radiculopathy [11].

Low back exercises program resulted in increase in superficial erector spinae activity. Lumbar disc herniation results in compressive, tensile and shear loading of the neural structures. This leads to decrease inintraneural blood flow andaxoplasmic flow leading to ischaemia and impaired function [2]. External compression leads to increase intrafasciular pressure which again decreases blood flow resulting in downward spiral.

Lumbar disc herniation, osteophyte, spinal stenosis cause compressive load on the nerve fibres. Decrease in the intraneural blood flow leads to upregulation of inflammatory mediators which stimulate further pain. Inflammation also leads to

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adhesions between herniated disc and nerve root impairing nerve glide.

Neurodynamic concept was given by Shacklock in 1995 [4]. It deals with concept of interaction between physiological and mechanical systems. Body is considered tobe the container and muscular system is the interface of this neural system. During body movements the neural system undergoes mobility to compensate or adapt. The nerve glides, elongates, slides, alteration of cross-sectional area occurs, angulates as part of the bodily movements.

During early range of motion, nerve slack is taken up, midrange includes nerve gliding and in the last range nerve tension occurs. Neuraltissues possess viscoeleastic properties. If constant loading occurs there are chances that there can be plastic deformation of the nerve roots and peripheral nerves [4]. There are two techniques according to butler and Shacklock - Gliding technique and Tensile loading technique. Gliding technique also known as sliders. These are the manoeuvre causing sliding movements between the non-neural and neural structures. Wiederien RC et al. in 2002 conducted a randomised controlled trial which found that neural gliding techniques along with cervical lateral gliding were effective in reducing outcomes of pain and disability [5].

Another study demonstrated that incorporating tendon and nerve gliding techniques in the treatment protocol along with the conservative treatment reduced the need of surgical intervention by 30% in cases of carpel tunnel syndrome. Tensile loading technique – these techniques enable the neural tissue to movements which causes lengthening of nerves. These are not stretches. Tensile loading techniques are performed in an oscillatory manner gently engaging resistance during the movement thereby eliciting gentle stretching sensations [6,3]. These techniques are employed with the purpose of restoring physical capabilities of nerve so that the movements that cause lengthening of the nerve beds can be tolerated. These are contraindicated in cases with evidence of impulse conduction impairment. According to a clinical trial conducted by Kornberg & Lew in 1989 on American Rules Football players suffering from hamstring strain (Grade 1) and positive slump test, providing tensile loading techniques along with conservative management led to faster return to play [7]. EMG is a technique which involves the development, recording and analysis of myoelectric signals. In lumbar radiculopathy, neuromuscular imbalance is found in the lumbar region. Danneels et al. (2002) reported significantly lower electromyographic activity of lumbar multifidus in chronic low back patients [8]. Min et al. (2013) concluded from his study that more severe and extensive atrophy in the lumbar multifidus muscle was present in radiculopathy as compared to low back pain without radiculopathy [9]. Tobias renkawitzin 2006 study found that there is a clinical significant association exists between neuromuscular imbalance and low back pain erector spinae activity was increased in patients with low back pain. It was found that there is decrease in EMG activity of ipsilateral and contralateralerector spinae after self neurodynamic sliding technique [10].

Methodology

Subjects

Twenty four (24) referred maleathletes attended the physiotherapy clinic at JamiaMilliaIslamia, new Delhi. Patients with clinically diagnosed lower lumbar radiculopathy were recruited for the study. There was one drop out in the study as the subject got relieved with the intervention and he was not able to come to give his post intervention readings due to his busy schedule. Institutional review board gave the ethical clearance for the study.

Sample Size

The number of subjects are determined using Software G Power 3.15 using data of changes in erector spinae EMG activity from a similar study done by Giselle Horment-Lara et al. (2015). The sample size was calculated as per effect size of 1.58, alpha level of 0.05 and power (1- beta) of 0.95.

Inclusion Criteria

1. Athletes from Jamia Millia Islamia aged between 18 years and 35 years
2. Clinically diagnosed lower lumbar radiculopathy as per Luijsterburg PAJ et al. [11]:
3. Pain extending distal to knee joint
4. Increased pain on manoeuvres which increase intraabdominal pressure (IAP)
5. Positive straight leg raising test
6. Suffering from lumbar radiculopathy for 3 months or more than 3 months
7. NPRS > 4/10

8. Greater than 10 percent increase in baseline Oswestry Score

Exclusion Criterion

1. Patients with inflammatory, infectious, metabolic diseases of spine, malignancy and lumbar spinal stenosis
2. Subjects with history of vertebral fractures and spinal surgery
3. Red flag signs such as sinister pathology.
4. Subject with cardiovascular and neurological disorders

Study Design

Two arm parallel pre-test post-test experimental design.

Study Design

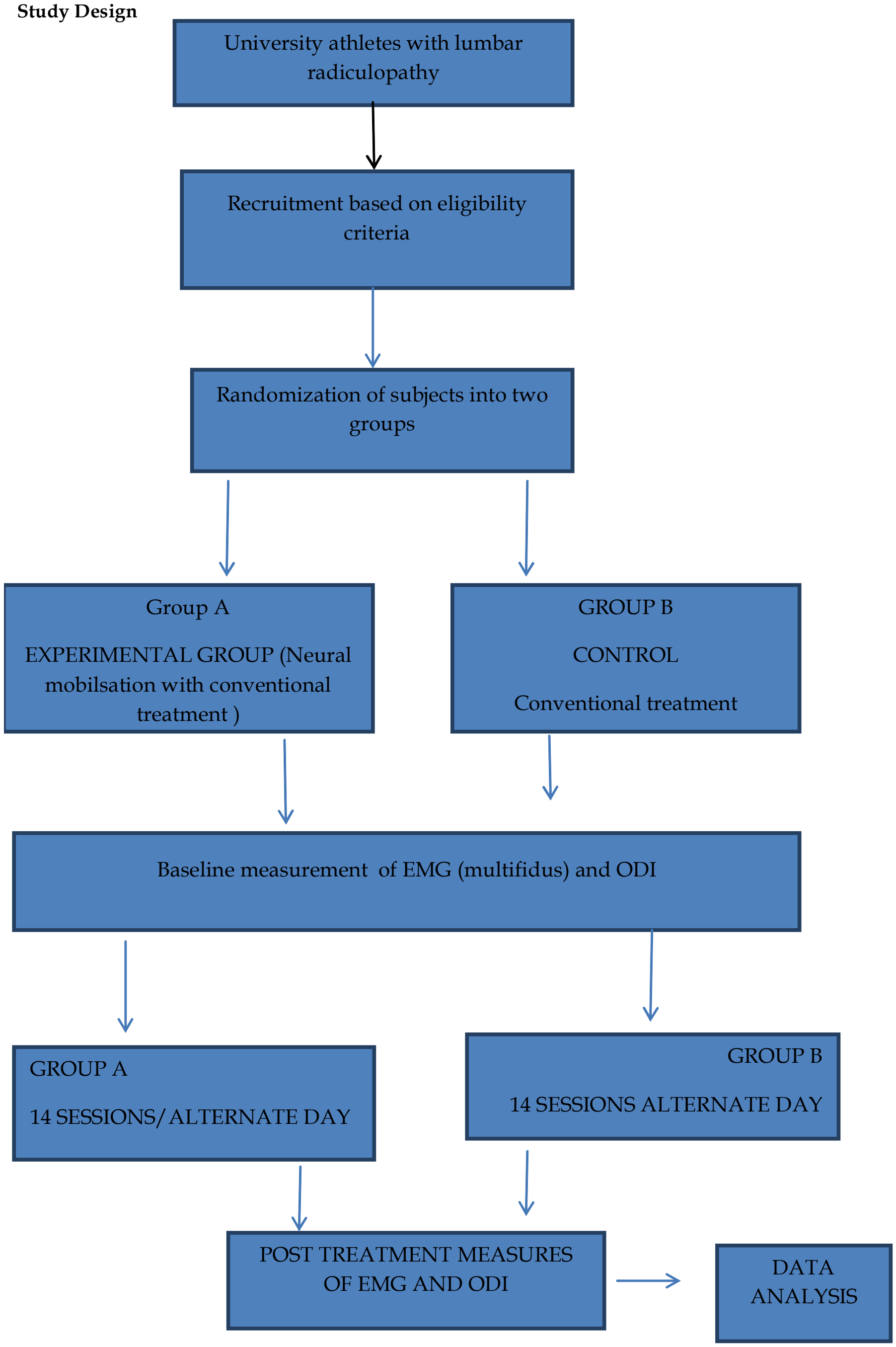

Fig. 1: Depiction of study flow from enrollment to data analysis

Independent Variables

Neural mobilization, Conventional Physiotherapy

Dependent Variables

Electromyographic (EMG) response

Oswestry Disability index (ODI)

Equipment used

AD instrument Power Lab EMG system (Australia).

Procedure for Data Collection

After recruiting patients as per inclusion criteria, written consent was obtained .confidentiality was maintained regarding details of the patient. Each patient was allocated a number to prevent revealing identity. Patients were selected on above mentioned criteria and then divided into 2 groups: group A and group B. Patients in group A were treated with neural mobilisation along with conventional therapy and patients in group B were treated with conventional treatment alone.

Fig. 2A: Ankle Plantarflexion

Fig. 2B: Ankle Dorsiflexion/Eversion

Fig. 2: Neural mobilization technique of tibial nerve A) Ankle Plantarflexion B) Ankle Dorsiflexion/Eversion

Patients on both the groups were treated for 14 sessions on alternate days (Figure 1).

Protocol

Group A: neural mobilization with conventional physiotherapy

Neural mobilization with tibial nerve bias (David S. Butler, mobilization of the nervous system). The patient was supine lying relaxed on the treatment couch with the trunk and pelvis in neutral position. The therapist was standing on the opposite side to the patient placing one hand under the ankle joint and the other above the knee joint. Affected leg was raised from the bed with knee kept in extension as in SLR testing position. This was progressed to a point where symptoms were reproduced or where the resistance to movement was encountered [12]. From this symptomatic position limb was lowered a few degrees down. At this point, ankle dorsiflexion/eversion was performed to mobilize the sciatic nerve. This was performed for 5 sets of 30 repetitions with a break of 10 seconds between the sets [3]. A total of 14 sessions on alternate days were performed. Patient response a clinical situation directed amplitude of treatment [13]. [Figure 2(a) and(b)].

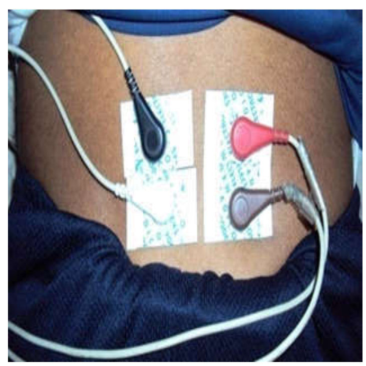

Fig. 3(a): Electrode placements for forlumbar multifidus bilateral

Fig. 3(b): Ground electrode placement

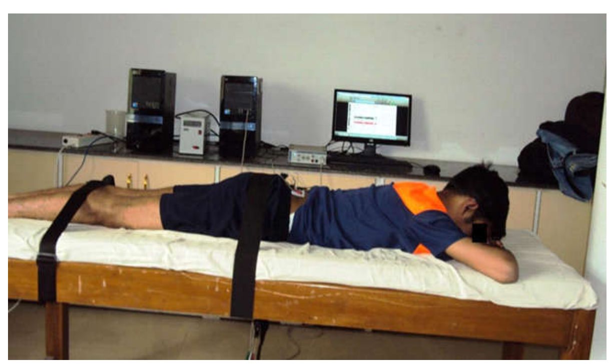

Fig. 4: Patient position for recording s EMG

Group B: Conventional Physiotherapy alone

This group received Postero – anterior lumbar spine mobilization, stretching of unilateral piriformis and bilateral rectus femoris and lumbosacral stabilization exercises for 14 sessions on alternate days 13. The program consisted of abdominal bracing, Bridging, pelvic tilts and alternate arms/legs raise(which had been shown to give clinically meaningful improvements in functional disability. Patients were asked to perform 2 sets of 10 repetitions in each session. Patient's exercise routine was progressed according to the symptoms [14].

Fig. 5: MVC procedure for lumbar multifidus

Fig. 6: AD instrument Power Lab EMG system (Lab chart, Australia)

Criterion Measures

Disposable Ag/Ag Clsurfaceelectrodes diameters of 1cm were placed on the shaved skin surface (alcohol swab wipe to decrease impedance). For lumbar multifidus, electrodes were placed lateral to the midline of the body on both the sides, above and below a line connecting both posterior superior iliac spines [8,15,16]. The inter electrode distance was kept at 2.5 cm an grounding was by placing electrode at the left superior iliac crest [Figure 3(a) and(b)].

Maximal Voluntary Contraction (MVC) Assessment

Exercise is used as a measure to normalise EMG signals. Three trials of MVIC are one before experimental test. The maximal activation of multifidus of multifidus was done by resisting the posterior aspect of scapula. Maximumeffort was put in for 5 seconds.Then 1 minute rest is given in between trials. During this five second manoeuvre only the peak 3 second period is taken for, measurement to minimise error.

Exercise procedure

The subjects were asked to lie in the prone position while resting their arms on a plinth. The patient extended the trunk as far as possible with their hands over their head and legs resting on the plinth. The isometric contraction for maintained for 5 seconds and the exercise was performed three times (Figure 4, 5).

Instrumentation

The raw surface EMG signals were band passed – filtered between 10 and 500 Hz and amplified 1000 times. The sampling frequency was 1000 Hz. The root mean square (RMS) of EMG amplitude was calculated for MVC from the prone trunk extension. The mean RMS of three MVC trials for EMG amplitudes obtained normalization of data (%MVC). The static phase of the prone trunk extension was analyzed, using

Table 1: Comparison of demographic data between groups

Variables	Group A mean±SD	Group B mean±SD	t - value	p-value
Age	22.25±3.51	24.83±4.06	1.665	0.110
Weight (kg)	65.94±7.80	65.68±5.88	0.883	0.387
Height (m)	170.83±3.56	169.67±2.87	0.094	0.926
BMI	22.80±2.16	22.83±1.72	0.033	0.974

mean of three trials for each muscle of three seconds after starting point of the holding position. The mean of root mean square (RMS) for the three repetitions of prone trunk extension after normalization (%MCV) was used for the comparison [17]. Oswestry disability questionnaire (ODI) was used to calculate low back pain related disability, Subjects were asked to fill this scale before and after 14 treatment sessions. Total score was added and calculated to help in categorization of disability (Figure 6).

Statistical Analysis

The SPSS version 21.0 software program was used for data analysis. The Shapiro – Wilk test was used to verify the normality of variables distribution. Those data which did not met to normal distribution then the data was log transformed. After that mixed model analysis of variance (ANOVA) was used to compare the sEMG and ODI between the 2 groups. Independent t test was used to compare the baseline criterion measurement between the 2 groups to prove their homogeneity. The confidence interval used was 95% with level of significance set at $p<0.05$ (Table 1 and Figure 7).

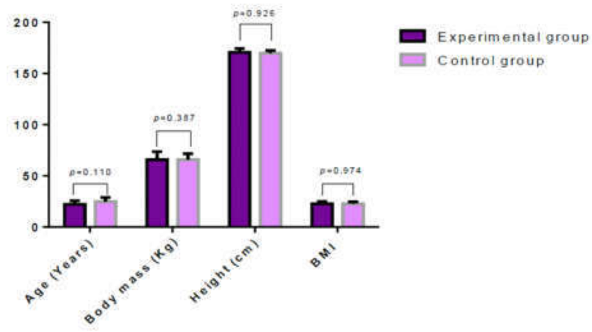

Fig. 7: Demographic data of subjects included in both groups

Table 2: Comparison of baseline criterion measures

Variable	Group A mean±SD	Group B mean±SD	t-value	p- value
S EMG IL	72.50±28.84	73.78±25.38	0.115	0.909
S EMG CL	88.20±25.62	75.40±20.55	1.349	0.191
ODI	31.29±12.58	33.69±4.90	0.616	0.544

SEMG IL- Electromyography ipsilateral , s EMG CL -Electromyography contralateral ODI= Oswestry disability index

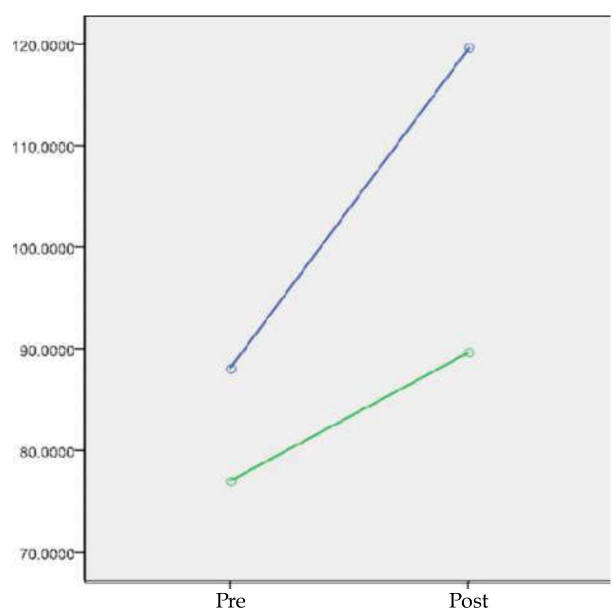

Fig. 8: Changes in surface electromyography on ipsilateral side in both the groups

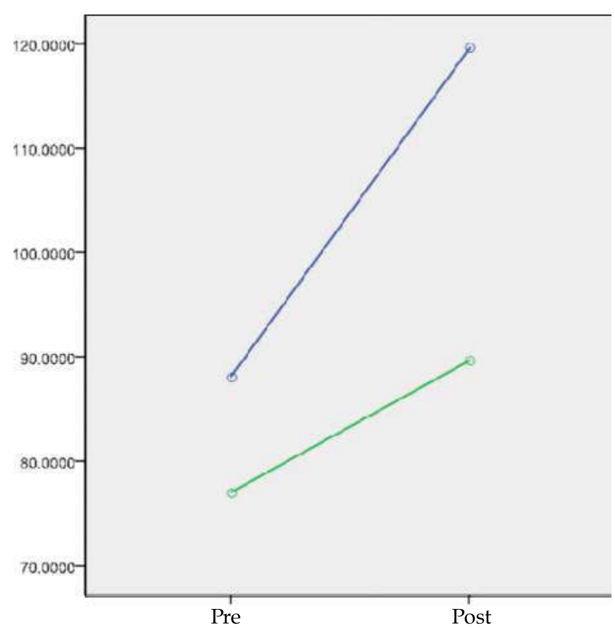

Fig. 9: Changes in surface electromyography on contralateral side in both the sides

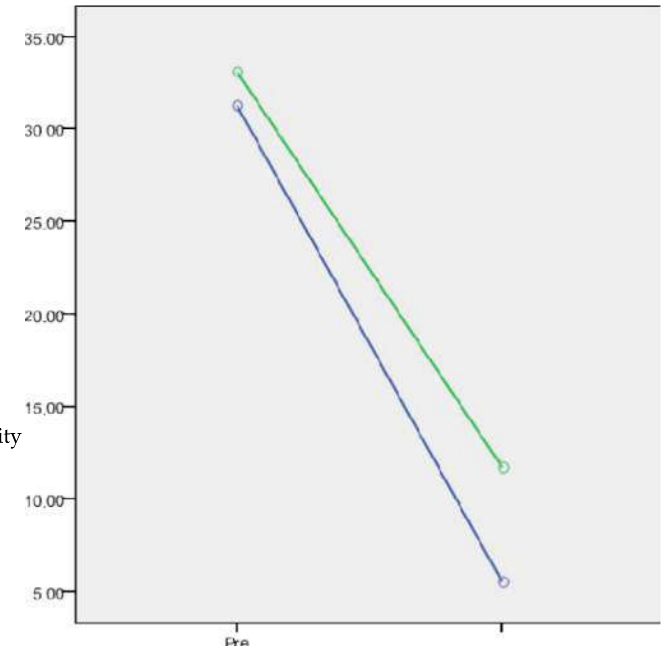

Fig. 10: Changes in Oswestry disability index score in both the groups

Table 3: Comparison of mixed model ANOVA

Variable	Source	DF	F value	Sig	Partial Eta squared
S EMG IL	Time	1	32.117	<0.001*	0.605
	Group	1	0.931	0.346	0.042
	Time group	1	6.871	<0.016*	0.247
S EMG CL	Time	1	47.291	<0.001*	0.692
	Group	1	5.208	0.033	0.199
	Time group	1	8.645	0.008*	0.292
ODI	Time	1	157.91	<0.001	0.883
	Group	1	2.384	0.138	0.102
	Time group	1	1.351	0.258	0.060

sEMG IL- Electromyography ipsilateral , sEMG CL - Electromyography contralateral ODI= Oswestry disability index
* Significant difference

Results

Comparison of baseline criterion measurement between the two groups was doneusing independent t –test to prove the homogeneity between the groups. No significant difference in surface electromyography (sEMG) and Oswestry disability Questionnaire (ODI) was found between the groups (Table 2).

Surface Electromyographic activity of ipsilateral multifidus-Mixed model ANOVA showed significant main effects for time F (1, 21) = 32.11, p <0.001 and time-group interaction F (1, 21) = 6.871, p = 0.016 while for group F (1, 21) = 0.931, p = 0.346, it was non-significant. The results showed significant improvement in sEMG IL post intervention, in boththe groups. Despite the main effect for group was insignificant, the group and time interaction showed that sEMG IL was more improved in group 1 following intervention than group 2 (Table 3) (Figure 8).

Surface Electromyographic activity of Contralateral multifidus- Mixed model ANOVA demonstrated significant main effects for time F (1,21) =47.29, p <0.001, group F (1,21) = 5.20, p = 0.033 and time – group interaction F (1,21) = 8.64, p = 0.008. The results suggested significant improvement in sEMG CL following intervention, in both the groups. Interaction effect implies that there was significantly higher improvement in group 1 post intervention as compared to group 2 (Table 3) (Figure 9).

Oswestry Disability Index (ODI)

Mixed model ANOVA showed significant main effect for time F (1, 21) =157.91, p <0.01 while for group F (1, 21) = 2.384, p = 0.138 and time × group interaction F (1,21)=1.351, p = 0.258, it was non-significant. The results showed significant improvement in functional disability post intervention, in both the groups. However, the interaction effect showed that both the groups improved in a similar pattern with time (Table 4, Figure 10).

Discussion

The purpose of this study was to examine the effect of neurodynamic technique on pain, functional disability and electrophysiology in university athletes with Lower lumbar radiculopathy. The results of this study showed that both groups had significant improvement in functional disability and muscle activation pattern of lower lumbar multifidus. All the outcome parameters were measured before and after 14 sessions of intervention in both the groups and it was found that both the groups showed significant improvement in all the parameters post intervention. However, the group which received neurodynamictechnique along with conventional physiotherapy showed greater improvement in, surface electromyography of lumbar multifidus bilaterally and as compared to the other group. But in relation to Oswestry Disability Index, both the group followed similar pattern of improvement.

Muscle activity of lumbar multifidus was evaluated bilaterally before and after 14 sessions of intervention and it was seen that after intervention surface electromyographic activity of lumbar multifidus on ipsilateral and contralateral sides improved significantly in both the groups. However, improvement was more in group receiving neural mobilisation. Danneels et al. (2002) reported significantly lower electromyographic activity of lumbar multifidus in chronic low back patients [8]. Min et al. (2013) concluded from his study that more severe and extensive atrophy in the lumbar multifidus muscle was present in radiculopathy as compared to low back pain without radiculopathy. The improvement seen in the group 2 can be explained by the effect of lumbar stabilisation exercises on lumbar multifidus [9].

Freeman 2010 demonstrated that lumbopelvic exercises provided stability of the spine. Prolonged long term exercises increase the physiologic cross sectional area of the lumbar multifidus. This also results in lesser disability. Lumbar stabilisation exercises improve strength of lumbar multifidus and prevent atrophy of multifidus in low back pain patients [19]. The outcome of our study is also in line with the study done by Puntumetakul et al. [20]. He reported significant increase in the lumbar multifidus electromyography activity after 10 weeks of lumbar stabilisation exercise program. The more increase in the group receiving neural mobilisation could be explained as a result of a modification in motor strategy after neural mobilisation.

Neural mobilisation leads to positive alteration in the motor control after neural mobilisation treatment.Neural mobilisation upregulates the discharge of the alpha motor neurons to the multifidus. Due to this the inhibit multifidus starts functioning with proportionate decreasein activity of the erector spinae. Multifidus are stabiliser group of muscles which help in maintaining neutral zone of the spine. Over this stable base larger cross sectional area erector spinae executes physiologic action.

Both groups showed clinically significant decrease in ODI scale score. Improvement in the functional disability can be attributed to the lumbar stabilisation exercises performed by subjects in both the groups. Sekendiz et al reported that stabilisation exercises help to decrease the neutral zone whichreduces the joint interplay. This gives the larger erector spinae group to work on a stable and strong background. The dual onus of physiologic action along with vertebral stability is cut short [21]. Igsoo et al. (2015) concluded from his study that Lumbar stabilization exercise is more effective than conservative treatment for improving functional disability [1]. However some studies are available which supports neural mobilisation with lumbar stabilisation exercises to be more effective in reducing functional disability than lumbar stabilisation exercises alone [22,23]. The results in the present study found no difference in reduction of ODI between the two groups.

Clinical relevance of the study- Neurodynamic technique can be used as an advanced physiotherapy procedure which provider quicker relief in athletes. Clinically, these results may also have implications for the selection of neurodynamic techniques as a treatment protocol for managing lumbar radiculopathy in athletes. Utilising this technique for managing lumbar radiculopathy will help in avoiding unnecessary operative management in athlete. This will help an athlete to return to his sport as early as possible.

Limitations of the study-No long term follow up were taken to determine the sustainability of results. Results of this study cannot be generalized to all the all patients and athletes suffering from lumbar radiculopathy as the subjects included in the study were of non-elite level

From this study, we conclude that neurodynamic techniques have a positive effect on the electrophysiological parameters likesurface electromyographic activity of lumbar multifidus. Also, we found that neurodynamic techniques when added to the conventional physiotherapy were more efficient in reducing pain and functional disability in athletes suffering from lumbar radiculopathy. Hence, for the effective management of lumbar radiculopathy, neurodynamic technique should be combined with conventional treatment protocol.

Conclusion

The study concludes that neurodynamic techniques have a positive effect on the electrophysiological parameters like surface electromyographic activity of lumbar multifidus. Also, the study demonstrated found that neurodynamic techniques, when added to the conventional physiotherapy, were more efficient in reducing pain and functional disability in athletes suffering from lumbar radiculopathy. Hence, for the effective management of lumbar radiculopathy, the neurodynamic technique should be combined with the conventional treatment protocol.

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