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RESEARCH ARTICLE

EFFECTIVENESS OF TRUNK PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION TRAINING IN MECHANICAL LOW BACK PAIN

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ABSTRACT

Background: Mechanical low back pain accounts for 80-90 % of the low back pains. Interventions in the management of low back pain shows conflicting results. PNF training is one of the interventions that is less investigated in the management of LBP.

Objectives: The main objective is to compare the effectiveness of combination of trunk Proprioceptive neuromuscular facilitation training and conventional strengthening exercises with conventional strengthening exercises alone in the management of mechanical low back pain.

Methods: A total of 40 male patients with mechanical low back pain who meets the inclusion and exclusion criteria are recruited for the study. 20 were allotted to Experimental group who received Trunk proprioceptive neuromuscular facilitation training along with conventional strengthening exercises and another 20 was allotted to Control group who received Conventional strengthening exercises alone. Outcome measures were Visual Analogue Scale (VAS), Modified Oswestry Low Back Pain Disability Questionnaire and Trans versus Abdominis Activation Capacity. Data was collected twice for the study; pre treatment and post treatment after 3 weeks.

Results: At baseline, the two groups did not differ significantly with respect to age and outcome measures. Comparing the differences between experimental group and group after 3 weeks, the t value for VAS, Modified Oswestry Low Back Pain Disability Questionnaire and Trans versus Abdominis Activation Capacity were 4.231 ($p<0.05$), 4.003 ($p<0.05$) and .477 ($p>0.05$) respectively.

Conclusions: The findings suggest that trunk neuromuscular facilitation training along with conventional strengthening exercises in subjects with mechanical low back pain induces a greater improvement on pain and functional disability as compared to conventional strengthening exercises alone

INTRODUCTION

Lumbar spine functions as a complex interplay of musculoskeletal and neurovascular structures creating a mobile, yet stable transition between the thorax and pelvis. The lumbar region repetitively sustains enormous loads throughout one's lifetime, while still providing the mobility necessary to allow a person perform myriad tasks associated with daily living. Considering the magnitude and complexity of the functional demands, it is not surprising that low back is the common site of dysfunction [1]. Low back pain is a disorder with many possible etiologies, occuring in many groups of the population, and with many defenitions. Risk factors of low back pain are many, but none are convincingly causal. Probable risk factors include genetic factors, age, smoking, back pain history, job dissatisfaction, heavy physical work, static work postures, lifting, vibration, obesity, and psychosocial factors[2]. Mechanical low back pain implies that the source of pain is in the spine or its supporting structures due to abnormally short or prolonged stresses that cause damage to the articular or muscular components of the lumbar and pelvic regions. Mechanical low back pain accounts for 80-90 % of back pain. The causes of mechanical low back pain are unknown cause, usually attributed to muscle strain or ligamentous injury (65%-70%), degenerative disc or joint disease, vertebral fracture, Spondylolysis and instability [3]. Evidences suggests that back exercise alone or with co-interventions are more effective than no treatment and most passive modalities in improving pain, disability, and other patient-reported outcomes in CLBP [4,5]. Proprioceptive neuromuscular facilitation (PNF) exercises are designed to enhance the response of neuromuscular mechanisms by stimulating proprioceptors. The patterns of PNF have spiral, diogonal direction and the perfomance of these patterns is in line with the topographic arrangement of muscles being used [6]. The perfomance of the movements of the PNF patterns permit muscle to act in ways that are close to the actions found in various sports. Therefore, these exercises should be better suited for perfomance enhancement than in conventional single plane or single direction training programmes. Studies have reported that the PNF programmes are appropriate for improving thickness of lumbar deep muscles, trunk reposition error, trunk muscle endurance, trunk mobility, pain, functional ability, in people with chronic low back pain and among the PNF techniques "combination of isotonics" (COI) technique was found to be more effective[7,8]. COI include resisted concentric contraction of the agonist muscle through the range is followed by a stabilizing contraction (isometric) and then an eccentric lengthening contraction, moving slowly back to the starting position with is no relaxation between the type of contraction[9]. PNF is a widely used therapeutic approach by physiotherapists in clinical practice, but irrespective of the long history of PNF concept, its therapeutic implication in the management of LBP is less investigated. Whatever available evidence directs towards the positive effects of PNF training in improving pain, back pain related functional disability, back endurance and flexibility in low back pain population. Researchers have demonstrated that significant difference exist in the proprioceptive function of the low back, between individuals with and without low back pain and researchers have suggested that interventions that address the proprioceptive function must be investigated for their effects in LBP population. The need to address the proprioceptive function of the low back pain population and paucity of evidence regarding the effectiveness of PNF training in low back pain, the present study is conducted to examine the

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beneficial effects of PNF training in improving pain, back pain related functional disability and trans versus abdominis activation capacity in mechanical low back pain population. The main objectives of this study was to compare the effectiveness of combination of trunk Proprioceptive neuromuscular facilitation training and conventional strengthening exercises with conventional strengthening exercises alone in the management of mechanical low back pain.

METHODOLOGY

Selection of Sample

A total of 40 male patients, between the age group of 18 – 45 years diagnosed with Mechanical Low Back Pain for a period 3 or more months were recruited by purposive sampling method, for this experimental study. An informed written consent was collected from all the subjects included in the study. The patients were referred from the Orthopaedic Department of K.S. Hegde Hospital, Mangalore. These patients were randomly assigned Experimental group and Control group of 20 each. Inclusion criteria was male patients between 18-45 years of age with mechanical low back pain for 3 months or more and Exclusion criteria included Migrated hernia Intervertibral disc prolapse, Spondylolisthesis, surgery within last 6 months, tumour, rheumatic disorder, hip osteoarthritis, renal disease, abdominal aortic aneurysms, peripheral vascular disease, epidural steroid injection, spinal deformities.

- GROUP I (Experimental Group)
- GROUP II (Control Group)

Pre treatment scores of the outcome measures, Visual Analogue Scale, Modified Oswestry Low Back Pain Disability Questionnaire and Trans versus Abdominis Activation Capacity using stabilizer pressure biofeedback unit were collected for all the patients included in the study. The intervention started immediately after the baseline evaluation. Session was conducted with one-to-one supervision with the therapist. The intervention for both the groups was designed as 15 sessions for three weeks. The frequency set for the exercises was five times a week for three weeks. Patients in the experimental group were treated with proprioceptive neuromuscular facilitation training along with conventional strengthening exercises. Patients in control group are given conventional strengthening exercises alone. After 3 weeks of intervention the post treatment scores of the outcome measures, Visual Analogue Scale, Modified Oswestry Low Back Pain Disability Questionnaire and Trans versus Abdominis Activation Capacity were collected for all the subjects in both the groups.

Proprioceptive neuromuscular facilitation (PNF) training

Combination of isotonic exercises

Patient assumes a high sitting position. Therapist stands facing the patient and keeps both hands on the patient's upper trunk. Then patient is instructed, from the seated position to flex the trunk against the resistance provided by the therapist (5seconds).

When maximum trunk flexion is achieved patient is instructed to maintain the position (5seconds).

Upon the maintenance of static position the subject returns to the starting position (trunk extension) against the resistance offered by the therapist (5seconds).

3 sets of 15 repetitions were given. Rest interval of 30 seconds was included between the repetitions. The sets were repeated at the interval of 60 seconds.

Total treatment duration of Trunk PNF training 30 to 35 minutes.

Conventional strengthening exercises (CSE)

Curl ups, Trunk extension, Leg lifts, exercise for Trans versus abdominis in 4 point kneeling or prone lying, Exercises for lumbar multifidus in prone lying or sitting, Co-contraction of the trans versus abdominis and lumbar Multifidus in upright position. Each exercise consists of 15 repetitions with 6 second hold in the beginning and gradually progressing to 10 second hold. Total treatment duration of conventional exercises is 25-30 minutes

Results

Statistical analysis was performed with the SPSS Version 20.0. .05% of probability was adopted as the level for the statistical significance. Intergroup comparisons of experimental group and control group are performed using Independent t test. Intra group comparisons of pre treatment and post treatment of experimental and control group was performed using paired t test VAS, Modified Oswestry Low Back Pain Disability Questionnaire and trans versus abdominis activation capacity were evaluated in this study as the outcome measures. In Intra group comparison for the VAS outcome in experimental group, the mean pre treatment value was 5.3100 and mean post treatment values was 1.905. Which showed mean difference of 3.405 and t value is 96.208 and P value 0.0000 ($p<.05$). (Table 2, Figure 1) and in control group, the mean pre treatment value was 5.1950 and mean post treatment values was 2.7000. Which showed mean difference of 2.495 and t value is 20.144 and P value 0.0000 ($p<.05$). (Table 2, Figure 1)

Table 1. Pre test and post test means and standard deviations of experimental and control group for VAS, MODI and TAAC

	Experimental group		Control group	
	Pre Mean±SD	Post Mean±SD	Pre Mean±SD	Post Mean±SD
VAS	5.3100 ±1.14932	1.9050 ±.52463	5.1950 ±1.01384	2.7000 ±.68441
MODI	19.3000 ±3.72898	11.3000 ±2.53606	18.7000 ±3.32613	13.5000 ±2.60566
TrAC	2.1500 ±1.03999	5.0500 ±1.14593	2.0500 ±.82558	4.8000 ±1.28145

Table 2. Intra group comparison of Pre test and Post test means of experimental and control group for VAS, MODI, TAAC

Outcome measure	Group	Average improvement	t-value	p-value	result
VAS	Experimental group	3.405	12.148	0.000	P<0.05 sig
	Control group	2.495	20.144	0.000	P<0.05 sig
MODI	Experimental group	8	16.387	0.000	P<0.05 sig
	Control group	5.2	10.855	0.000	P<0.05 sig
TAAC	Experimental group	2.9	14.222	0.000	P<0.05 sig
	Control group	2.75	11.293	0.000	P<0.05 sig

Table 3. Intergroup comparison of pre test and post test values for VAS, MODI and TAAC between experimental and control group

Outcome measure	Group	N	Average improvement	t-value	p-value/result
VAS	Experimental group	20	3.4050	4.231	0.000/sig
	Control group	20	2.4950		
MODI	Experimental group	20	8.0000	4.003	0.000/sig
	Control group	20	5.2000		
TAAC	Experimental group	20	2.9000	0.477	0.636/not sig
	Control group	20	2.7500		

Independent t test for VAS between experimental group and control group shows that average improvement in experimental group is 3.405 and in control group is 2.495 , t value is 4.231 and P value 0.000($p<0.05$). (Table 3). In Intra group comparison for the Modified Oswestry Low Back Pain Disability Questionnaire in experimental group, the mean pre treatment values was 19.3000 and mean post treatment values was 11.3000 which shows a mean difference of 8.000 and t value is 96.208 and P 0.000 ($p<.05$). (Table 4, Figure 2) and in control group mean pre treatment values was 18.7000 and mean post treatment values was 13.5000 which shows a mean difference of 5.2 and t value is t- value is 10.855 and P 0.000 ($p<.05$). (Table 2). Independent t test for Modified Oswestry Low Back Pain Disability Questionnaire between experimental group and control group shows that average improvement in experimental group is 8.0000 and in control group is 5.2000, t-value is 16.387 and P 0.000 ($p<0.05$). (Table 3). In Intra group comparison for the "Trans versus abdominis activation capacity" in experimental group, the mean pre treatment value was 2.1500 and mean post treatment values was 5.0500. Which showed mean average improvement of 2.9000 and t value is 14.222 and P 0.000 ($p<.05$). (Table 2) and in control group, the mean pre treatment value was 2.0500 and mean post treatment values was 4.8000 and showed mean average improvement of 2.7500 and t value is 11.293 and P 0.000 ($p<.05$). (Table 3). Independent sample statistics for **"**trans versus abdominis activation capacity" between experimental group and control group shows that average improvement in experimental group is 2.9000 and in control group is 2.7500, t-value is 0.477 and P 0.636 ($p>0.05$). (Table 7, Figure 4)

DISCUSSION

The purpose of this study was to compare the effectiveness of Trunk PNF along with conventional strengthening exercises and conventional strengthening exercises alone in patients with Mechanical low back pain. In the study, a total of 40 male patients were recruited and they were a randomly assigned into 2 groups. Both groups were assessed to determine the intensity of pain, Back pain related functional disability and Trans versus abdominis activation capacity, using the outcome measures. The mean age of patients (Table 10) of experimental group was 33.25 ± 6.24816 and mean age of patients in the control group 33.50± 6.87099. In the experimental group, patients were given Trunk PNF along with conventional strengthening exercises and for the patients in the control group, conventional strengthening exercises alone was given. The results of the Group I, which is the Experimental group, had an initial mean values of Visual Analogue Scale of 5.3100±1.14932 had reduced to 1.9050± .52463 after 3 weeks showing reduction in pain intensity. Initial mean values of Modified Oswestry Low Back Pain disability Questionnaire of19.3000±3.72898 had reduced to 11.3000±2.53606 showing the significant improvement in functional ability of the patient. Initial values of Trans versus abdominis activation capacity, 2.1500±1.03999 significantly improved to 5.0500±1.14593. The result of the Group II, the control group had an initial mean value of Visual Analogue scale of 5.1950±1.01384 dad reduced to 2.7000±.68441after 3 weeks showing reduction in pain intensity. Initial values of Modified Oswestry Low Back Pain disability Questionnaire of 18.7000±3.32613 had reduced to 13.5000±2.60566, showing a significant improvement in the functional ability of the patients in this group. Initial values of Trans versus Abdominis Activation Capacity of 2.0500±.82558 also significantly improved to 4.8000±1.28145.

In the intergroup comparison between Experimental group and control group Visual Analogue Scale t-value was 4.231 and P 0.000 ($P< 0.05$). For Oswestry Low Back Pain Disability Questionnaire t-value was 4.003 and P 0.000 ($P< 0.05$) and for Trans versus Abdominis Activation Capacity t- value was 0.477 and P 0.636 ($P>0.05$). These results show that there is more significant improvement in pain and in functional ability in Experimental group when compared to Control group. In Trans versus abdominis Activation Capacity both Experimental and Control group shows equally significant improvement. The results the present study proves that, Trunk PNF training along with conventional strengthening exercises obtained significantly better improvement in pain levels and back pain related functional disability when compared to conventional strengthening exercises alone. The findings of the present study goes along with the results of the similar studies conducted by kofotolis *et al.* (2006) and Kumar *et al*. (2011) that also concluded that Trunk PNF significantly improved pain levels and functional disability in patients with mechanical low back pain. The control group in the study who received conventional strengthening alone also showed significant improvement of pain, back pain related functional disability and Trans versus Abdominis Activation Capacity. The conventional exercises in this study included superficial strengthening exercises as well as segmental stabilization exercises .This result is in line with the study conducted by Stankovic *et al*. (2012) which concluded that combination of segmental stabilization exercises and strengthening exercises is more effective than traditional exercises in improving pain , function and quality of life.

Panjabi (2003) assumed a relationship between abnormal intervertebral motion and LBP and he suggested that a decrease in the abnormal intervertebral motion in a patient with LBP may result in reduced pain. The Conventional strengthening exercises, that was given in common for both experimental and control group included exercises that addressed the spinal stabilizers. Improved function of the spinal stabilizers might have resulted in a reduction of abnormal intervertibral motion and thus a significant reduction of pain occurred in both experimental and control group. Neurophysiologic studies by Yamashita *et al.* (1990) and Gill *et al.* (1998) suggested a close relationship between the back pain and disturbances in proprioceptive function and reported that these impairments in certain aspects of proprioception can persist if proprioception is not specifically addressed. Trunk PNF exercises are the exercises that enhance the neuromuscular mechanism by stimulating the proprioceptors and this might have contributed to the more significant reduction of pain in the experimental group were Trunk PNF was given in addition to conventional strengthening exercises compared to control group. van Dieën *et al.* (2003), Dankaerts *et al*. (2006), Luomajoki *et al.* (2008) concluded that there is impaired function of superficial and deep trunk muscles and there is a reduced ability to actively control the movements of the back. The control of the movements of the low back requires continues proprioceptive feedback and neuromuscular re-adjustments. Trunk proprioceptive neuromuscular facilitation training might have helped in promoting muscle sensitivity by enhancing the sensitivity of muscle spindle and Golgi tendon organs which are responsible for proprioception.

This enhanced control of movement helps in the reduction of local stress and thereby pain This also explain the additional benefit of using Trunk PNF training as an adjunct to conventional strengthening exercises in the management of mechanical LBP. In the present study Experimental group demonstrated better improvement functional ability (as registered by the Modified Oswestry Low Back Pain Disability Questionnaire) which can be attributed to the addition of PNF exercises. The improvements in functional ability could be seen as a direct result of pain, lumbar flexibility, endurance and general strength improvements as concluded by kofotolis *et al.* (2006) and kumar *et al*. (2011), thereby providing further support for the effectiveness of PNF exercises for CLBP treatment. In the Intergroup comparison of the Trans versus Abdominis Activation Capacity between Experimental group and control group Trunk PNF along with conventional strengthening exercises are found to be not better than conventional strengthening exercises alone. Both yielded equally significant improvement after 3 weeks of intervention. Significant improvement in Pain levels and function in the experimental group without more significant improvement in the Trans versus Abdominis Activation Capacity (TAAC) when compared to control group can be explained by the results of the study done by Grenier *et al*. (2007) who concluded that the potential of the trans versus abdominis to

enhance stability, on its own, appears to be very limited. Muscles other than the trans versus abdominis contribute relatively more to avoiding an unstable spine. The more significant improvement in Pain and Function in the Experimental group can also be attributed to the therapeutic benefit of "irradiation". Trunk PNF might have caused the indirect activation of muscles of limbs and upper trunk which promote generalised improvement. Further support for this concept is the study conducted by Gontijo *et al.* (2012) who reported Trunk PNF could be utilized to indirectly activate the muscles of lower limb. Limitations of the study were, smaller sample size, only male patients were included in the study, more precise and objective measure of Trans versus Abdominis Activation capacity is EMG, isolated effect of Trunk PNF is not examined and total treatment duration of treatment for experimental group was more when compared to control group. The effectiveness of Trunk PNF can be further investigated in the future, in combination with other exercise interventions, electro physical modalities, psycho- behavioural therapies, with larger sample size and long term follow-up and in other variants of low Back Pain.

Conclusion

The results of the present study proves that Trunk PNF along with conventional strengthening exercises is more effective than conventional strengthening Exercises alone in improving pain and Back Pain Related functional disability in the management of Mechanical LBP and experimental hypothesis is accepted. This study concludes that trunk PNF is a suitable adjunct to conventional strengthening exercise in the management of Mechanical low back pain. This study also reveals the scope of PNF in the management of musculoskeletal disorders and movement dysfunctions which need to be further investigated.

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