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Original Research Article

Effect of Thoracic Spinal Manipulation on Lower Limb Neurodynamics in Healthy Young Adults: Neural Link to Regional Interdependence

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ABSTRACT

Background: Thoracic spine most of the times get neglected by physiotherapists especially in most reviewed clinical conditions i.e. neck and back problems with or without radicular pain. Regional interdependence theory suggests that each and every segment of body is somehow interconnected and treatment of a distant segment can produce changes in the conditions of remote segments. The aim of present study was to overlook regional interdependence and find out the effect of thoracic spinal manipulation on lower limb neurodynamics in young and healthy individuals.
Methodology: This test-retest study included 22 young healthy subjects (age of 21.95±2.36yrs) with normal neurological status. Straight leg raise test measurements were taken pre and post to thoracic spinal manipulations (i.e. preSLR1, preSLR2, postSLR1 & postSLR2) and the results were compared. The level of significance was set at $p \leq 0.05$.
Results: Significant difference was there between preSLR1 and postSLR1 (t=-9.247) as well as between preSLR2 & postSLR2 (t=-6.753). After giving the non-specific thrust manipulation the range of motion for first onset of neural stretch as well as maximal tolerable neural stretch were significantly raised.
Conclusion: Nonspecific thrust manipulation of thoracic spine can significantly increase the neurodynamics of lower limbs.

Key words: spinal manual therapy; neurodynamics; regional interdependence; straight leg raise; thoracic spine; manipulation; osteopathy.

INTRODUCTION

The spine is a continuous structure composed of segment or units made by the interbody & zygapophyseal joints (Levangie PK & Norkin CC; 2005). The nervous system is also a continuous structure that can be altered by any change in the mobility or tension in pathway or mechanical interface (Butler DS; 1984: Shalock M; 1995). In human body both these continuous structure are in close approximation i.e. loss of mobility or tensional change in one can alter the others dimensions and create spinal dysfunctions and altered neural tension.

An evidence report in UK and other researches on spinal manual therapy (SMT) suggests that it is an effective tool for such spinal dysfunction and neural alterations in both younger as well as older adults. SMT is effective for headaches; spinal pain; spinal radiculopathies; coccydynia; myofascial disorders; temporomandibular & other joints disorders (Bronfort et al; 2010: Puentedura et al; 2011: Szlezak et al; 2011: Singh et al; 2014).

Results from the recent SMT studies also suggest some new inter-body relationship i.e. lumbar spine manipulation increases the hip ROM & diminishes anterior knee pain similarly hip manipulation can reduce low back pain (Brenner et al; 2009: Jayaseelan et al; 2014: Burns et al; 2009) and thoracic spine manipulations reduce neck pain, shoulder pain & lower back pain (Strunce et al; 2009: Walser et al; 2009: Bronfort et al; 2010: Vismara et al; 2012). The suggested theory behind these effects is regional interdependence (RI) which states that unrelated impairment in a remote anatomical area may contribute to or be associated with the patient's primary complaints. The beauty of this concept lies within its clinical implication which include interventions directed at one region of the body will often have effects at remote and seeming unrelated areas (Sueki et al; 2013).

Thoracic spine is almost a central unit of the human spine and recent studies demonstrate its effects on cervical spines, lumbar spines and peripheral joint conditions but still in clinical environment the thoracic spine receive negligence. In the present study we would focus on that neglected spine and we would try to add neural component to the regional interdependence theory by giving SMT to the thoracic spine and test the changes in lower limb neurodynamics.

So our experimental hypothesis suggested that SMT of thoracic could improve lower limb neurodynamics (SLR). Our null hypothesis suggested that there were no change in lower limb neurodynamics after nonspecific high velocity low amplitude (HVLA) thrust manipulation of thoracic spine.

For measuring lower limb neurodynamics straight leg raise (SLR) test was used. SLR is a most reliable measure which can add considerable caudal movement of lumbosacral nerve roots in relation to intervertebral foramina, cranial movement of tibial nerve distally in relation to its mechanical interface and a tension point posterior to the knee where the nerve/interface movement remains constant (Butler, 1989; Boyd et al., 2010: Szlezak et al., 2011).

Osteopathic HVLA thrust manipulation in prone lying was used to manipulate thoracic spines in a non-specific manner.

MATERIALS AND METHODS

Present study was a test-retest study. The samples were selected on the basis of convenience from two institutions in Hisar, Haryana (India) i.e. Jindal Institute of Medical Sciences and physiotherapy OPD of Guru Jambheshwar University of Science & Technology. The inclusion criteria for the present study include healthy young adult with normal neurological status; age from 18 to 30 years; meeting the flexibility requirements i.e. isolated hip flexion ≥90°, full knee extension, ankle dorsiflexion ≥0° and plantar flexion ≥30° (Boyd et al; 2010). The exclusion criteria for present study were any trauma/surgery to spine or extremities; any degenerative disease; spinal pain or radiculopathy; any infection or inflammation of central nervous system or spine; malignant tumor; chemo therapy in past year; pregnancy; any systemic or metabolic disorder; drug abuse or alcoholism; any psychological or psychiatric disorder; any communicable disorder etc. The independent & dependent variables of present study were HVLA SMT of thoracic spine and neurodynamics of lower extremity respectively. SLR was the outcome measure. Instruments used were exercise couch, stop watch, aesthesiometer, weighing machine and digital inclinometer.

Procedure: The study was performed in the air conditioned temperature room with increase thermostat at 23^0c to standardize treatment conditioned. After fulfill the selection criteria a total 22 young and healthy subjects (11 male and 11 female) were selected for the study. Informed consent was taken from all subjects and whole study protocol was approved by departmental ethical committees. The purpose and need of study was explained to the participants. SLR was measured once before giving and once after giving the high velocity thrust to thoracic spine.

Protocol:

SLR (Boyd et al; 2010: Szlezak et al; 2011): Randomly left leg was selected as reference extremity for SLR ROM measurements as our previous study suggested that neurodynamics of both lower limbs were extremely correlated (Ganer N & Yadav V; 2014). Participants were positioned in supine on the treatment couch in a standardized position, with the non-tested right leg strapped to the plinth mid way between the greater trochanter and head of fibula. The tested left leg was maintained in full available knee extension and the ankle in plantar grade with the help of static ankle foot orthosis [figure 1(a)]. This standardized positioning of limb put a preload stress to the neural structures in the posterior chain. Maintaining this knee position, the subject's hip was slowly moved passively into flexion while manually avoiding hip rotation, abduction, or adduction. During this passive hip flexion movement, the subject pressed the hand held trigger in the android smartphone to identify the moment they first felt the onset of any symptoms (SLR1) and when their symptoms became too intense to continue and they felt they could not tolerate any further movement (SLR2). The SLR test was stopped at SLR2 [figure 1 (c)] and this position was held for 5 seconds before the limb was returned to resting on the plinth. Hip flexion range of motion (ROM) was measured in degrees relative to the horizontal with a digital inclinometer secured to lateral thigh (5 cm above patella) with straps (Yeomans SG & Liebenson C; 1996).

Figure-1 (a): Showing the starting position of SLR test with knee in 0 degree of flexion and ankle in plantar grade position with AFO.

Figure-1 (b): Showing first onset of symptoms (SLR1).

Figure-1 (c): showing maximal onset of symptoms (SLR2).

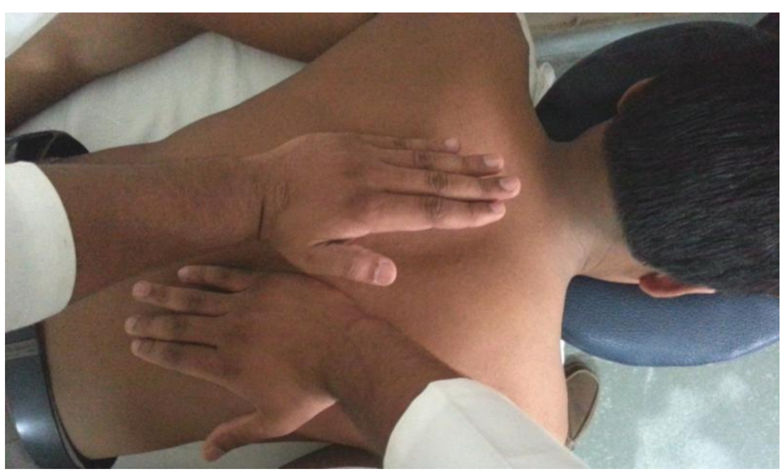

Figure 2: showing thoracic manipulation technique.

Then the patient was given ten-minute rest. Then non-specific HVLA trusts were applied to the thoracic spine and the SLR1 & SLR2 were recorded again of the reference limb.

Thoracic Manipulation (Nicolas AS & Nicolas EA; 2012): The patient lies prone with the head and neck in neutral. The therapist stood at the patient's left for greater efficiency; however, either side may be used. Therapist then placed the right thenar eminence on the right transverse process of thoracic spine with the fingers pointing cephalad. Therapist placed the left hypothenar eminence on the left transverse process of thoracic spine with the fingers pointing caudally. The patient inhales and exhales, and on exhalation, a thrust impulse is delivered in the direction in which the fingers (figure 2) are pointing.

Data Analysis: Data analysis was performed using software package SPSS 21v. for windows. Mean and S.D. of age, height, weight, pre SLR & post SLR were calculated. Means of variables were compared using pre & post t-Test (2 tailed hypothesis). Variables included for analysis were age, height, weight, preSLR1, pre SLR2, postSLR1 and postSLR2. Data was analyzed at significance level of 95% ($p \leq 0.05$).

RESULTS

Baseline characteristics of all subjects who completed the study are shown in table 1. There was no research mortality/loss of subjects during the study. No adverse event was reported during the whole study.

Table 1 Showing descriptive statistics of participants:

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	22	19	30	21.95	2.360
HEIGHT	22	150	175	161.48	7.546
WEIGHT	22	42	75	57.50	8.568
preSLR1	22	32	77	58.18	11.987
preSLR2	22	47	114	81.59	14.332
postSLR1	22	53	101	71.64	11.112
postSLR2	22	72	127	90.73	13.256

Table 2.1 showing the t-Test statistics for preSLR1 & preSLR2 and postSLR1 & postSLR2

	Paired Differences					T	df	Sig. (2-tailed)
				95% Confidence Interval of the Difference				
	Mean		Std. Deviation	Std. Error Mean	Lower	Upper		
preSLR1 - preSLR2	-23.409	8.567	1.827	-27.208	-19.611	-12.816	21	.000
postSLR1 - postSLR2	-19.091	5.291	1.128	-21.437	-16.745	-16.925	21	.000

Table 2.2 showing the t-Test statistics for preSLR1 & postSLR2 and preSLR2 & postSLR2

	Paired Differences					t	df	Sig. (2-tailed)
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
preSLR1 - postSLR1	-13.455	9.490	2.023	-17.662	-9.247	-6.650	21	.000
preSLR2 - postSLR2	-9.136	5.375	1.146	-11.519	-6.753	-7.973	21	.000

On analysis significant difference was there between preSLR1 and preSLR2 (t=-12.816) as well as between postSLR1 & postSLR2 (t=-16.745) significant at $p \leq 0.05$ (refer table2.1). It stated that in both conditions (non-thrust and thrust) the first onset of neural stretch and maximal tolerable neural stretch have significant difference in SLR ROM (refer figure 3.1 & 3.2).

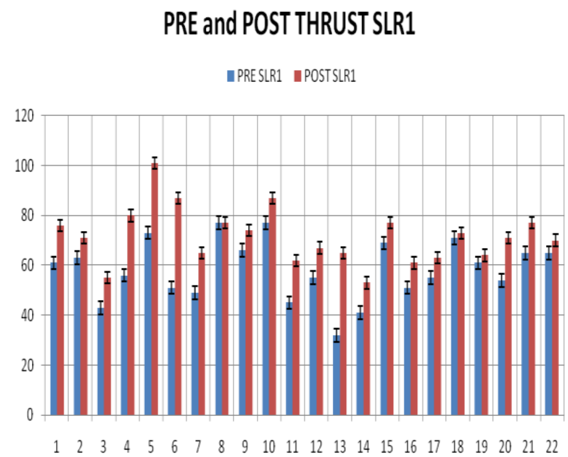

Figure 3.1 showing difference between the preSLR1 and preSLR2

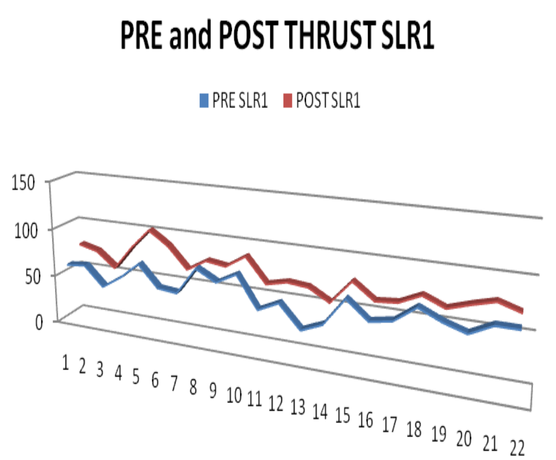

Figure 3.2 showing difference between the preSLR1 and preSLR2

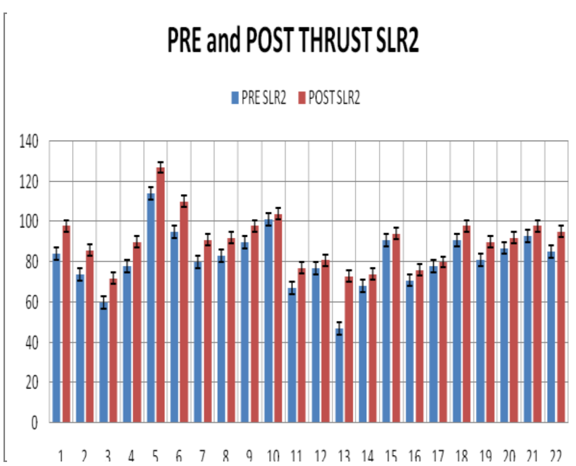

Figure 4.1 showing difference between the postSLR1 and postSLR2

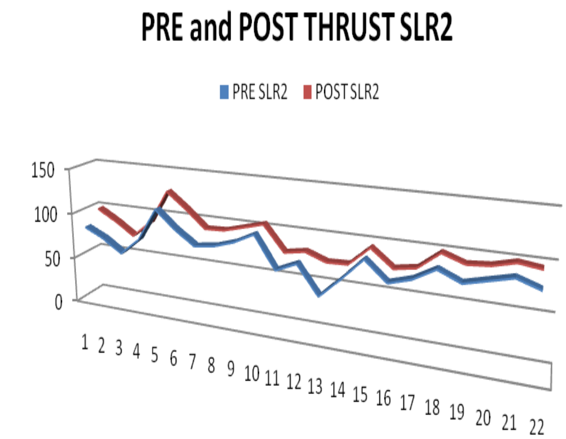

Figure 4.2 showing difference between the postSLR1 and postSLR2

Similarly on analysis significant difference was also there between preSLR1 and postSLR1 (t=-9.247) as well as between preSLR2 & postSLR2 (t=-6.753) at $p \leq 0.05$ (refer table-2.2). It suggested that in the same group after giving the non-specific thrust manipulation ROM for first onset of neural stretch as well as maximal tolerable neural stretch had significantly raised (refer figure 4.1 & 4.2).

DISCUSSION

The characteristic of present study was to establish significance of thoracic SMT in neurodynamics of lower limb and add another link to RI theory.

There were researches linking thoracic spine more to upper quarter (Cleland et al; 2004: Flynn et al; 2004: Strunce et al; 2009: Puentedura et al; 2011: Dunning et al; 2012: Huisman et al; 2013: Sueki et al; 2013). Flynn et al (2004) have reported preliminary data suggesting that thoracic SMT results in an immediate reduction in pain and increases in cervical range of motion in individuals presenting with primary neck dysfunction. Cleland JA and collogues (2004) suggested that thoracic spine manipulation results in immediate analgesic effects in patients with mechanical neck pain. Puentedura EJ and collogues

(2011) also found thoracic SMT beneficial to patient suffering from acute mechanical back pain when used with cervical SMT. Dunning JR and colleagues (2012) found the similar results when they compare thoracic and cervical SMT to the nonthrust measures for cervical spine alone in mechanical neck pain patients. Huisman PA and colleagues (2013) suggested thoracic SMT with cervical SMT is more effective to some patients with neck pain, when compared to electrotherapy/thermal programme, infrared radiation therapy, spinal mobilization and exercises. Strunce et al (2009) suggested that thoracic spine SMT can help the patients suffering from shoulder joint dysfunctions or injuries. Almost all these researches found no superior effects of thoracic SMT when used alone.

Lack of evidences reported for any link between thoracic spine and lower quarter. Hodges et al (2009) and Jones et al (2012) in their studies suggested presence of trunk stiffness in patients with recurrent LBP. Vismara et al (2012) used HVLA thrust in thoracic spine, cranial techniques and myofascial release and found that multidisciplinary SMT is effective in reducing pain and disability in cLBP obese patients when compared to exercises alone. Our study can link the thoracic spine to lower quarter as during the study no lumbosacral SMT or myofascial correction was done still significant changes were found.

The results from this study were supporting our experimental hypothesis which stated that nonspecific thrust manipulation of thoracic spine had an effect on lower limb neurodynamics. Infect both SLR1 & SLR2 ROM were significantly increased after application of nonspecific HVLA thoracic spine thrusts ($t = -9.247$ & $t = -6.753$ respectively at $p \leq 0.05$). So experimental hypothesis was accepted and null hypothesis was rejected. The results may be due to some biomechanical relationship between the thoracic spine and lumbar spine, perhaps correction in joint mobility in the thoracic spine serve as an underlying contributor to the enhanced neurodynamics of lower extremities.

These results are also in accordance to RI model for SMT which states that the interdependence between regions of the body may involve the musculoskeletal system, but that neurophysiological, biopsychosocial, and somatovisceral systems can also influence musculoskeletal function both locally and at remote sites (Sueki et al; 2013). So the results from present study can aid the neurophysiological component of the RI theory.

CONCLUSION

Nonspecific thrust manipulation of thoracic spine can increase the neurodynamics of lower limbs.

Limitations: The limitations of the present study include small sample size and sample selection from a smaller area/town.

Scope of Future Study: Further study can be done to know the clinical implication of thoracic SMT in low back pain patients with lower extremity radiculations.

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