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Review Article

Thoracic Spinal Manual Therapy and Regional Interdependence: A Review

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ABSTRACT

Thoracic spinal vertebrae and its zygapophyseal joints are primarily required to contribute stability to the axial skeleton. Thoracic spine is also in close proximation between internal organs, shoulder complex and pelvis. Injury to the intervertebral disc, the zygapophyseal joints or other nociceptive structure of thoracic spine may contribute local or referral pain. This inter segmental relationship in human body gave rise to the concept of regional interdependence. Theory of regional interdependence stated that unrelated impairments in a remote anatomical region may contribute to or be associated with the patient's primary complaints. Aims of this review were first to compile available literature on efficacy of thoracic spine manipulation or mobilization techniques on pathologies related to distant structures and second to dignify the need of inclusion of thoracic spine in clinical reasoning and evidence based practice. This article reviews available data on effect of spinal manual therapy of thoracic spine on shoulder complex, hip joint, cervical spine, lumbar spine, pelvis & nervous system and strengthen the theory of regional interdependence. Based on the present review it can be suggested that inclusion of thoracic spine in the clinical diagnosis and treatment protocol can result in reduction in neck pain, low back pain, and cervicogenic headache, central sensitization of pain, migraine frequencies, vertigo, mental stress and fear. This can also result in increased range of motion of cervical spine, lumbar spine, and pelvic complex, shoulder complex, hip joint, and may improve proprioception & neural mobility.

Key words: regional interdependence, thoracic spine, shoulders complex, cervical spine, lumbar spine, pelvis, hip joint and nervous system.

INTRODUCTION

Thoracic spinal vertebrae and its zygapophyseal joints are primarily required to contribute stability to the axial skeleton. Thoracic spine is also in close proximation between internal organs, cervical spine, lumber spine, shoulder & pelvic complex, Injury to the intervertebral disc, the zygapophyseal joints or other nociceptive structure of thoracic spine may contribute local or referral pain. For example more predictable dermatomal pattern in the thoracic region symptoms may depart from conventions. Vague pain noted in the region of shoulder may relate to disturbance of the cervico-thoracic junctions and, similarly, buttock, hip and inguinal region symptoms may have low thoracic origin (Maigne JY;

2000). Similarly pain in the cervical spine could also be felt in the thoracic segments. [1]

This inter-segmental relationship in human body gave rise to the concept of regional interdependence. Theory of regional interdependence stated that unrelated impairments in a remote anatomical region may contribute to or be associated with the patient's primary complaints. Dysfunction in any unit of system will cause delivery of abnormal stresses to other systems with the development of a subsequent dysfunction in other systems also. Response to a disorder or condition and the associated clinical outcomes are not limited to local and adjacent regions of body but can involve a neuromusculoskeletal response that may be more widespread. [2,3]

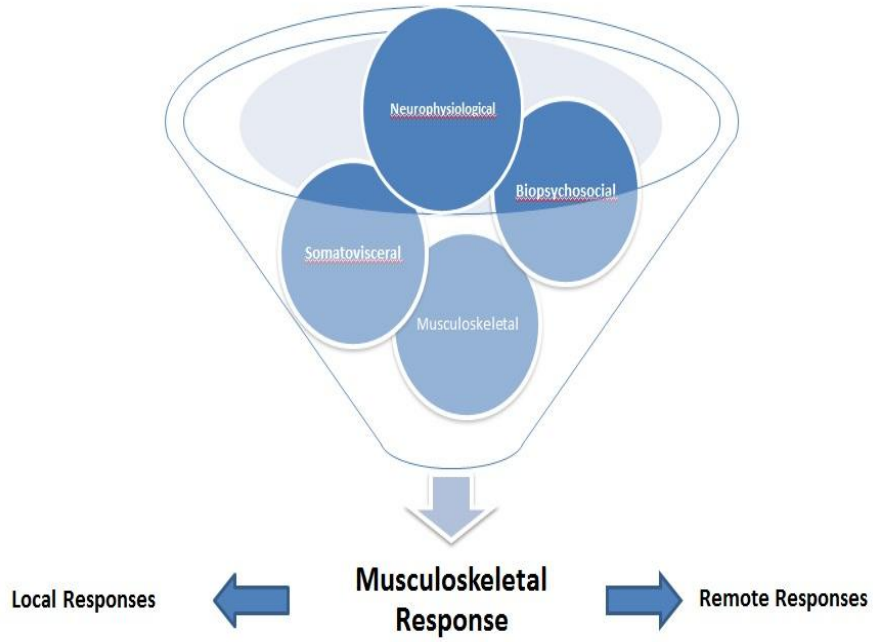

Figure 1: showing the concept of regional interdependence.

Spinal manual therapy has been widely as well as wildly used to treat various spinal disorders. According to World Health Organization, the term spinal manual therapy includes all the procedures where the hands or mechanical devices are used to mobilize, adjust, manipulate, apply traction, massage, stimulate or otherwise influence the spine and paraspinal tissues with the aim of influencing the patient's health. [4]

The aims of this review were first to compile available literature on efficacy of thoracic spine manipulation or mobilization techniques on pathologies related to distant structures and second to dignify the need of thoracic spine in clinical reasoning and evidence based practice. This article reviews available data on effect of spinal manual therapy of thoracic spine on shoulder complex, hip joint, cervical spine, lumbar spine, pelvis & nervous system and strengthen the theory of regional interdependence.

METHODOLOGY

We reviewed online libraries and open access journals (Cochrane, Medline, Scopemed, Pubmed, Researchgate, Google Scholar etc.). Forty four records were identified via virtual database systems using the key words "regional interdependence", "thoracic spine manipulation", "spinal manual therapy" etc.

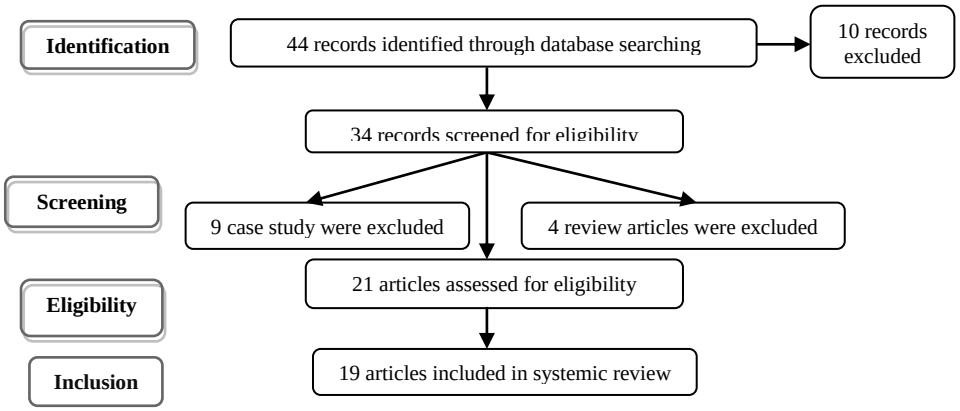

Figure 2: PRISMA flow diagram.

Table 1: Showing summary of literature reviewed.

Sr. No	Author	Year	Design	Title	Number of patients/ Groups	Outcome Measures	Conclusion
1	Ganer Naveen	2015	Pre-test post-test	Effect of thoracic spinal manipulation on lower limb neurodynamics in healthy young adults: Neural link to regional interdependence.	n = 22, (mean age = 21.95 ± 2.36years)	Straight leg raise (SLR)	Nonspecific thrust manipulation of thoracic spine can significantly increase the neurodynamics of lower limbs
2	Puntumetakul R, Suvarnato T, Wirasirirat P, Uthaikhup S, Yamauchi J, Boucaut R.	2015	Assessor-blind, randomized controlled trial.	Acute effect of single and multiple level thoracic manipulations on chronic mechanical neck pain: a randomized controlled trial.	N = 54, n = 48 (mean age = 26.54 + 8.35 years) Group 1: Single thoracic manipulation (n = 16) Group 2: Multiple thoracic manipulation (n = 16) Group 3: Control Group (n = 16).	Visual Analogue Scale (VAS), Thai Version of Neck Disability Index.	Single-level and multiple-level thoracic manipulation improves neck disability, pain level, cervical ROM at 24 hours and 1 week follow-up patients with chronic mechanical neck pain.
3	Yang J, Lee B, Kim C	2015	Randomized control trial	Change in proprioception and pain in patients with neck pain after upper thoracic manipulation.	N = 30, Manipulation Group: (n = 15), Control Group: (n = 15).	Visual Analogue Scale (VAS), Proprioception	Both cervical stability training and upper thoracic manipulation for patients with chronic neck pain was more helpful for the improvement of proprioception and pain than cervical stability training alone
4	Hawangbo P, Hawangbo G, Park J, Sangyong L	2014	Experimental	The effects of thoracic joint mobilization and self-stretching exercises on pulmonary functions of patients with chronic neck pain.	N = 34, Thoracic joint mobilization group (TJMG, n = 11), Self-stretching exercise group (SSEG, n = 11), thoracic joint mobilization and self-stretching exercise group (TJMSSEG, n = 12).	Forced Vital Capacity (FVC), Forced Expiratory Volume at one second (FEV1), and Peak Expiratory Flow (PEF) were measured using Cardio Touch equipment.	Thoracic joint mobilization and self-stretching exercise are effective Interventions for increasing FVC, FEV1, and PEF among pulmonary functions.
5	Karas S and Hunt MJO	2014	Randomized clinical trial	A randomized clinical trial to compare the immediate effects of seated thoracic manipulation and targeted supine thoracic manipulation on cervical flexion range of motion and pain.	N = 39, General manipulation (n = 20), (mean age = 38.6 ± 12.2 years). Targeted Manipulation (n = 19), (mean age = 41.9 ± 10.0 years).	Numeric Pain Scale of 0–10, Cervical Flexion ROM	A targeted supine thoracic manipulation may be more effective in reducing cervical spine pain and improving cervical flexion ROM than a seated thoracic manipulation.

Table 1: Continued….							
6	Sung Y,, Lee J, Park Y	2014	Multi-group experimental	Effects of thoracic manipulation on function and mental state in chronic low back pain.	N = 36 Group A: (n=12), (mean age = 47.3±5.9 years) Group B: (n=12), (mean age = 48.9±5.8 years) Group C: (n=12), (mean age = 47.4±6.9 years)	Oswestry disability index (ODI), Lumber ROM	Application of Mobilization or manipulation to thoracic lumbar vertebrae has a positive effect on function, mental state, and ROMin patients with lower back pain.
7	Suvarnnato T, Kaber D, Arayawichanon P	2013	Prospective, Assessor blind pilot study	The effects of thoracic manipulation versus mobilization for chronic neck pain: a randomized control trial pilot study.	N = 42, n = 39 Group 1: Control Group (n = 13), (Mean age = 35+10.96 years) Group 2: Single Thoracic Manipulation (n = 13), (mean age = 37 + 12.49 years). Group 3: Single Thoracic Mobilization (n = 13), (mean age = 39.91 + 11.52 years).	Cervical ROM, Visual Analogue Scale.	Improvement in Cervical ROM and pain score immediately and after 24 hours follow-ups in both single level thoracic manipulation and thoracic mobilization in chronic neck pain.
8	Dunning JR, Cleland JA, Waldrop MA, Arnot C, Young I, Turner M, Sigurdsson G	2012	Randomized clinical trial	Upper cervical and upper thoracic manipulation versus non-thrust mobilization in patients with mechanical neck pain: a multi-center randomized trial.	N = 107, High Velocity low Amplitude (HVLA) thrust manipulation (n = 56) and non-thrust mobilization (n = 51) groups.	Neck Disability Index, Numeric Pain Rating Scale, flexion-rotation test for measurement of C1-2 passive rotation range of motion, and craniocervical flexion test for measurement of deep cervical flexor motor performance	The combination of upper cervical and upper thoracic high velocity low amplitude thrust manipulation is appreciably more effective in the short term than non-thrust mobilization in patients with mechanical neck pain.
9	Noudeh YJ, Vatankhah N, Baradaran HR	2012	Pre-test post-test	Reduction of current migraine headache pain following neck massage and spinal manipulation.	N = 10, (mean age 32.0 ± 10.59 years).	Verbal Analog Scale, Percent Pain Score Reduction, 7 point Satisfaction Scale.	The applied cervical and upper thoracic massage and manipulation technique could reduce the headache attack pain intensity in patients with migraine headaches
10	Vismara et al	2012	Randomized controlled	Osteopathic manipulative treatment in obese patients with chronic low back pain.	N = 19 Group A: Specific Exercises (SE) + Osteopathic Manipulative Treatment (OMT) Group B: SE were studied during the forward flexion of the spine using an optoelectronic system	Visual Analogue Scale (VAS), Roland Morris Disability QuestionnaireOswestry Low Back Pain Disability Questionnaire.	Combined rehabilitation treatment including osteopathic manipulative treatment (OMT + SE) showed to be effective in improving biomechanical parameters of the thoracic spine in obese patients with chronic low back pain (CLBP).
11	Bishop M, Beneciuk JM, George SZ	2011	Randomized experimental	The immediate reduction in temporal sensory summation after thoracic spinal manipulation.	N = 90 (mean age 22.9 ± 2.7 years). Group 1: High velocity, Low Amplitude Intervention(SMT), Group 2: Specific Cervical exercise (CE) or, Group 3. Control Group	Experimental Pain Sensitivity, Pressure pain Threshold, Thermal Stimuli, Temporal sensory summation.	Thoracic Spinal manipulation technique reduces temporal sensory summation (TSS) in healthy subjects.
12	Cebic et al.	2011	Retrospective descriptive	Lumbosacral pain caused by blockage of dynamic vertebrogenic segments of thoraco lumbar transition.	N = 1882		The number Of patients with low back pain of thoracic origin should not be disregarded.

Table 1: Continued….							
13	Sillevis R, Cleland J, Hellman M, Beekhuizen	2010	randomized clinical trial	Immediate effects of thoracic spine thrust manipulation on the autonomic nervous system: a randomized clinical trial.	N = 100, Chronic Cervical Manipulation Group (n = 50), Chronic Placebo Group (n = 50)	Visual Analog Scale (VAS), Friedman's test, Wilcoxen Signed-ranks test	Manipulation did not result in a change in sympathetic activity. Additionally, there was no significant difference in the subject's pain perception when comparing the effects of the thrust manipulation to the placebo intervention within this group of subjects with chronic neck pain.
14	Penas CF, Cleland JA, Huijbergts P, Cerro LP, Iglesisas JG	2009	Secondary Analysis	Repeated Applications of Thoracic Spine Thrust Manipulation do not Lead to Tolerance in Patients Presenting with Acute Mechanical Neck Pain: A Secondary Analysis.	N = 45 Group A: Control group received electro- and thermotherapy for 5 sessions, Group B: Experimental group received the same program and also received a thoracic thrust manipulation once a week for 3 consecutive weeks	Neck pain and cervical mobility	Patients receiving thoracic manipulation do not exhibit tolerance to repeated applications with regard to pain and mobility measures in acute mechanical neck pain.
15	Strunce JB, Walker MJ, Boyels RE, Young BA	2009	Test-retest	The immediate effect of thoracic spine and rib manipulation on subjects with primary complaints of shoulder pain.	N = 21 (10 males, 11 female), Mean age = 47 ± 12.6 years	100mm Visual Analogue Scale (VAS), 15-pint Global Rating Scale (GRS).	Thoracic spine and upper rib manipulative therapy is associates with improvement in shoulder pain and ROM immediately following intervention in patients with primary complain of shoulder pain.
16	Karuss J, Creigton D, Ely JD, Ely JP.	2008	Randomized clinical trial	The immediate effects of upper thoracic translatoric spinal manipulation on cervical pain and ROM: a randomized clinical trial.	N = 32, Experimental Group(n = 22), (mean age 34.2±9.56 years). Control Group: (n = 10), (mean age 35±10.51 years).	Cervical ROM, Faces Pain Scale	Application Of Translatoric Spinal Manipulation to the upper thoracic segments may also be a useful treatment option for management of the same. Cervical rotation range of motion improved in all subjects following the application of this form of manipulation to the upper thoracic Segments.
17	Cleland JA, Glynn P, Whitman JM, Ebarhart S, McDonald C, Childs JD.	2007	Randomized clinical trial	Short term effect of thrust versus non-thrust mobilization/manipulation directed at the thoracic spine in patients with neck pain: a randomized clinical trial.	N = 60 (mean age = 43.3 ± 12.7 years) Group A: Thrust Mobilization/manipulation (n = 30), (Mean age = 42.7 ± 13.9 years). Group B: Non-thrust mobilization/manipulation (n = 30), (Mean age = 43.8 ± 11.5 years).	Numeric Pain Rating Scale (NPRS), Neck Disability Index (NDI), Fear-Avoidance Beliefs Questionnaire (FABQ).	Thoracic spine thrust mobilization/manipulation results in significantly Greater short-term reductions in pain and disability than does thoracic non-thrust mobilization/manipulation in people with neck pain.
18	Cleland JA, Flynn TW, Childs JD, Eberhart S	2007	Cohort	The audible pop from thoracic spine thrust manipulation and its relation to short term outcomes in patients with neck pain.	N = 78, (mean age = 42.0 ± 11.3years) Group A: ≤ 3 pops (n = 27), (Mean age = 43.1 ± 12.1 years). Group B: > 3 pops (n = 51) (Mean ag =41.3 ± 10.9 years).	Numeric Pain Rating Scale (NPRS), Neck Disability Index (NDI), Global Rating of Change (GROC),Cervical Range Of Motion (CROM)	There is no relationship between the number of audible pops during thoracic spine thrust manipulation and clinically meaningful improvements in pain, disability, or CROM in patients with mechanical neck pain

Table 1: Continued….							
19	Cleland JA, Childs JD, Mcrae M, Palmer JA, Stowell T	2004	Randomized clinical trial	Immediate effects of thoracic manipulation in patients with neck pain: a randomized clinical trial.	N = 36 Group A: Thoracic Spine Manipulation (n = 19) mean age = 36±8.5 years Group B: Placebo Manipulation (n = 17), mean age 35±11.3 years.	100mm Visual Analog Scale (VAS), Neck Disability Scale (NDI)	Thoracic spine manipulation results in immediate Improvements in perceived levels of cervical pain in patients with mechanical neck pain.

DISCUSSION

The reported studies mainly concentrated over effect of thoracic SMT on neck. Just few were reported effect on lower back, shoulder, ANS, CNS, PNS etc. Cleland et al compared thrust and non-thrust thoracic spinal manual therapy (SMT) and suggested that thrust SMT is more effective in short term reduction of pain and disability than non-thrust SMT of thoracic spine. [6] Similarly Dunning et al, Cleland et al and Krauss et al found high velocity low amplitude thrust manipulation (HVLATM) of upper thoracic spine in combination with cervical SMT results in patient with mechanical neck pain immediate analgesic effect and increased ROM in patient with mechanical neck pain (MNP). [7-9] Investigation done by Suvarnato et al and Puntumetakul et al demonstrated that both single level or multiple level thoracic manipulation and mobilization gives immediate improvement of pain and range of motion (ROM) even at 24 hours and 1 week follow-up in chronic neck pain (CNP) patient. [5,10]

Karas et al compared seated thoracic SMT and targeted supine thoracic SMT in MNP. They found targeted supine thoracic SMT more superior than seated thoracic manipulation in pain reduction, disability reduction and cervical ROM. [11]

Penas et al conducted a study with an aim to determine whether patient receiving thoracic thrust manipulation exhibit tolerance to repeated application in acute MNP. They suggested that patient receiving thoracic manipulation didn't exhibit tolerance to repeated manipulation with regard to pain and mobility in MNP. [12]

Cleland et al tried to determine the relationship between numbers of audible pops with thoracic manipulation. They suggested that there was no relationship between number of audible pops during thoracic manipulation and clinical meaningful improvement in pain, disability and cervical ROM. [13]

Yang et al concluded that upper thoracic manipulation along with cervical stability training was more helpful for improvement in proprioception and pain in CNP. [14]

Noudeh et al concluded that thoracic manipulation in combination with cervical manipulation and massage could reduce the headache attack, pain intensity in male patients suffering from migraine. [15]

Sung et al suggested that thoracic mobilization and manipulation have a positive effect on function, mental state and ROM in patient with chronic low back pain (CLBP). [16] Vismara et al concluded that a combined rehabilitative technique including osteopathic manipulation of thoracic spine and specific exercises are effective in improving biomechanical parameters of thoracic spine in obese patients with CLBP. [17] Cebic et al suggested that patient with LBP of thoracic origin should never be disregarded. Treatment for these kinds of patients if concentrated only on lower segment of lumbar spine would give unsatisfactory therapeutic results. [18]

Talking about the effect on shoulder; Strunce et al investigated thoracic and rib manipulations in shoulder pain. They found improvement in shoulder pain and ROM. [19]

Hwangbo et al suggested that thoracic joint mobilization and self-stretching exercises are effective interventions for increasing pulmonary functions i.e. FVC, FEV1 and peak expiratory flow (FEF). [20]

When searching for the thoracic SMT effect on nervous system; Bishop et al found reduced temporal sensory summation located to the application of thoracic SMT distal to the application of thoracic SMT which can affect central sensitization of pain. [21] One of our pre-post design experimental studies concluded that non-specific manipulation of thoracic spine results in increased lower limb neurodynamics in young and healthy individuals without even touching the lumbosacral spine. [22] While Sillevis et al suggested no effect on autonomic nervous system (ANS). [23]

All these literature strengthen the theory of regional interdependence and moreover it may be suggested that either alone or in combination with other manual therapies thoracic spine stood equally important in treatment of patients suffering from distant impairments. Still thoracic spine is one of the most neglected segments of the human body by the physiotherapists and clinicians in India and across the world.

RESULTS

Present study included 19 research articles 11 studies demonstrated thoracic SMT effects in NP. Among these only 1 study denied the immediate pain reducing effect of thoracic spinal else all other researches stated reduced pain, increase ROM all improved proprioception. Three researches demonstrated lower thoracic SMT as an important tool for reducing pain, disability, stress and fear among LBP patients. One reported increased shoulder ROM following upper thoracic SMT. One study reported reduction in intensity and frequency of headaches in migraine patients. One study showed improved pulmonary functions after thoracic SMT. Other Studies reported thoracic SMT effective in modulation of pain and increased peripheral nerve mobility in lower limbs.

CONCLUSION

Inclusion of thoracic spine in the clinical diagnosis and treatment protocol can result in reduction in neck pain, low back pain, and cervicogenic headache, and vertigo, central sensitization of pain, migraine frequencies, mental stress and fear. This can also increase ROM of cervical spine, lumbar spine, shoulder joint, hip joint, and also results in improved proprioception and neuromobility.

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