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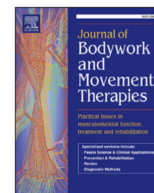

Fascia Science and Clinical Applications

Association of thoraco-lumbar fascia length in individuals with non-specific low back pain - an observational study

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A R T I C L E I N F O

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A B S T R A C T

Objective: The purpose of the study was to assess the length of TLF and to evaluate the strength of muscles attached to it in subjects with and without nonspecific low back pain (NSLBP).
Methods: 31 patients with NSLBP and 31 healthy individuals were included in the study. In each subject the TLF length was assessed by quantifying lumbar rotation using Back range of motion (BROM-II) instrument. The endurance of transverses abdominis was assessed using the pressure biofeedback unit while the strength of Latissimus dorsi, internal and external oblique's were assessed using MMT. Outcome measure such as Range of Motion (ROM) was compared across the group using independent sample T-test. While the muscle strength of Latissimus dorsi and oblique's were compared across the group using Man-whitney U- test. Transverse abdominis endurance was tested using chi-square test.
Results: There was statistically significant difference in the length of TLF of subjects with NSLBP when compared with subjects without NSLBP. When the strength of Latissimus dorsi muscle, transverses abdominis muscle and internal and external oblique's muscle was assessed no significant (p value > 0.05) difference was found in either group.
Conclusions: There was statistically significant reduction in length of TLF but there was no difference in the strength of Latissimus dorsi, internal and external oblique's or endurance of transverses abdominus attached to the TLF in individuals with NSLBP and without low back pain. This study will help in determining the inclusion of TLF and the associated structures in evaluation and management of subjects with NSLBP.

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1. Introduction

Low back pain (LBP) is a common, economically costly and disabling musculoskeletal condition among general population [Woolf and Pfleger, 2003]. It is also documented to be an extremely common health problem [Skovron, 1992]. It is well documented to be the leading cause of activity limitation and work absence throughout the world [Woolf and Pfleger, 2003]. Non specific low back pain (NSLBP) is defined as back pain not attributable to a recognized, known specific pathology [Balagué et al., 2012]. Despite the high prevalence, the causes of low back pain are not well understood, resulting in a non-specific diagnosis in approximately 85%–90% of the cases [Adhia et al., 2016]. Conventional treatment for LBP focuses on lumbar spine [Ebadi et al., 2012; Costa et al., 2013; Corrêa et al., 2016], but contributing areas remote to lumbar spine have yet to be identified. Research has shown the importance of regional approach to musculoskeletal examination [Bach et al., 1985; Nourbakhsh and Arab 2002]. According to kinetic chain theory, the body is a combination of several successively arranged joints constituting a complex motor unit [Sciascia and Cromwell, 2012]. A break or alteration in kinetic chain could lead to decreased optimal force generation or efficiency and subsequent decrease in performance [Silfies et al., 2015]. All structures function in chains, or slings, connecting to each other to form more powerful movers of the body. The Thoraco-Lumbar Fascia (TLF) crosses the entire lower back region forming key component in connecting the opposite shoulder to hip. It also forms critical part of a Myofascial girdle that surrounds the lower portion of the torso that helps in stabilization and load transfer from upper limbs to lower limbs [Vleeming et al., 1995]. The connection that the TLF has with the

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posterior ligaments of the lumbar spine allows it to assist in supporting the vertebral column [Willard et al., 2012]. It has also been argued that Latissimus dorsi and gluteal muscle have common attachment to the TLF which means that it has an important role in integrating load transfer between different regions [Vleeming et al., 1995]. TLF also gives attachments to deep abdominal muscles like transversus abdominis (TrA), internal oblique's and external oblique's [Willard et al., 2012]. Deep abdominal muscles create a rigid cylinder resulting in enhanced stiffness of lumbar spine [Stokes et al., 2012]. An increase in intra-abdominal pressure has been suggested to increase stability of the spine [Kim and Lee, 2013]. However weakness of any of these muscles will lead to a decrease force transmission via the TLF and may reduce stability of the spine. Disruption in the three-dimensional alignment of the fascia reduces biomechanical functions [Vleeming et al., 1995]. The subsequent reduced stability and altered biomechanics may be a potential cause for low back pain.

As the TLF plays a key role in generation, dispersal of forces and stabilization, it is important to consider its role in back pain for evaluation and developing intervention strategies. Above stated reasons have lead research to investigate TLF as a potential pain generating structure in the back [Stevens et al., 2010; Langevin et al., 2011; Schleip, 2004]. One study showed increased thickness and echogenicity of the TLF in patients with chronic low back [Stevens et al., 2010]. In a recent study which used MRI to test the length of TLF it was found that shortened length of TLF may be associated with high intensity LBP [Ranger et al., 2015]. However no studies could be retrieved that assessed the length of TLF clinically in individuals with low back pain. We believe that since TLF plays an important role in generation and dispersal of force, through its various attachments that support the back, any change in its length may affect its function. Hence, a need was felt to evaluate the length of TLF and see if there is any difference in its length between subjects who have NSLBP and those who do not have NSLBP. The secondary objective of this study was to assess the strength of the muscles attached to the TLF and compare them across the groups.

2. Methods

A Cross-sectional study was conducted at Department of Physiotherapy, of a Tertiary hospital. The Sample size was estimated to be 62 (31 in each group) with 90% power (β at 10%) , with α at 5%, d (minimum expected difference in range) = 4.49°, and Standard deviation = 2.27. The study was approved by the Scientific Committee and Institutional Ethics Committee, of the college. Subjects who were diagnosed with NSLBP, referred by a physician or an orthopaedic surgeon to physiotherapy were approached. The purpose of the study was explained to the subjects and informed consent was taken from willing participants. Subjects were screened for their eligibility to participate based on inclusion and exclusion criteria for NSLBP and those who fulfilled the criteria were taken in the case group of the study. The eligibility criteria for inclusion in the case group consisted of age of 18 years and above and medically diagnosed NSLBP. NSLBP was defined as back pain not attributable to a recognized, known specific pathology. Age and gender matched asymptomatic volunteers without any history of NSLBP was recruited from general community as controls in the study. Exclusion criteria for both the groups included any obvious back deformity, pregnancy or post 6 months of pregnancy, unstable medical conditions, fractures of lower limb, spine and upper limb in the past one year, neurologic or vestibular disorder, history of radiculopathy, spinal surgeries and VAS of 6 or more in patients with NSLBP.

Demographic data, history and specific pain provocation examination pertaining to NSLBP was done in the case group. This was followed by the measurement of lumbar Range of Motion (ROM), TLF length and muscle strength for both the case and control groups. All the measurements were done by the same examiner who was a qualified physiotherapist pursuing her Master's degree in Musculoskeletal Physiotherapy.

2.1. Assessment of back ROM

The standard procedure was used to assess the ROM of lumbar spine flexion, extension, side flexion and rotations using the Back Range Of Motion-II (BROM-II). This instrument was used as it showed good intra- and interexaminer reliability of flexion (0.91 and 0.77, respectively) and lateral flexion (0.91 and 0.85 respectively) for extension (0.63 and 0.35, respectively) and rotation (0.57 and 0.36 respectively)[Breum et al., 1995]. Concurrent validity of the BROM II and double inclinometer methods has also been partially supported (Intraclasscorrelation coefficients in all planes range from 0.27 to 0.75) [Breum et al., 1995].

2.2. Assessment of TLF length

BROM-II was used to assess the length of TLF which was the Primary outcome measure of the study. TLF length was clinically measured using the following method. The subject was asked to sit on a stool with knees bent to 90° the feet placed shoulder width apart. The subject placed hands across the chest and the therapist stood behind the subject and asked him/her to fully rotate to the left and then to the right (Fig. 1). The subject was then asked to forward flex the arms to 90° and laterally rotate the arms and adduct the arms so that the little fingers of both the hands touch each other and the palms face upwards, while the elbow is maintained in extension.

Holding this position the subject was then again asked to rotate to the left and then to the right as far as possible (Fig. 2). In these two positions the ROM during rotation was noted by observation method as well as recorded by BROM-II as described earlier for the measurement of lumbar rotations. To have an objective data of the rotation deficit BROM-II was used to measure the rotations. Restrictions may be seen in second set of rotations by observation method if TLF or Latissimus dorsi is tight [David, 2008]. Latissimus dorsi length was assessed using the standard procedure reference [David, 2008].

2.3. Assessment of the strength of latissimus dorsi, internal oblique and external oblique muscles and transversus abdominis

The strength of latismus dorsi, internal oblique, external oblique's and transversus abdominis was assessed. The need was felt to assess these muscles as they are biomechanically linked to the TLF the latismus dorsi, internal and external oblique's muscles were assessed using the standard Manual Muscle Testing (MMT) procedure [Kendall et al., 1993]. The strength of these muscles was graded 3, 4, 5 respectively.

A pressure biofeedback unit (Chattanooga Group, Australia) is cost-effective, readily available clinical tool to objectively assess Transversus abdominis (TrA) activation, during an abdominal drawing in manoeuvre (ADIM). Assessing transversus abdominis strength using pressure biofeedback in prone has shown higher test-retest reliability [Costa et al., 2006]. But the test is also utilized in supine with no published research regarding its validity to assess TrA in supine [Drysdale et al., 2004]. The individual was first asked to lie in crook lying. Than pressure bladder was placed between the lumbar spine and the cuff and then inflated to a base pressure of 40 mm of Hg. They were then asked to look at the pressure gauge. They were instructed to gently draw their abdominal in to prevent sudden

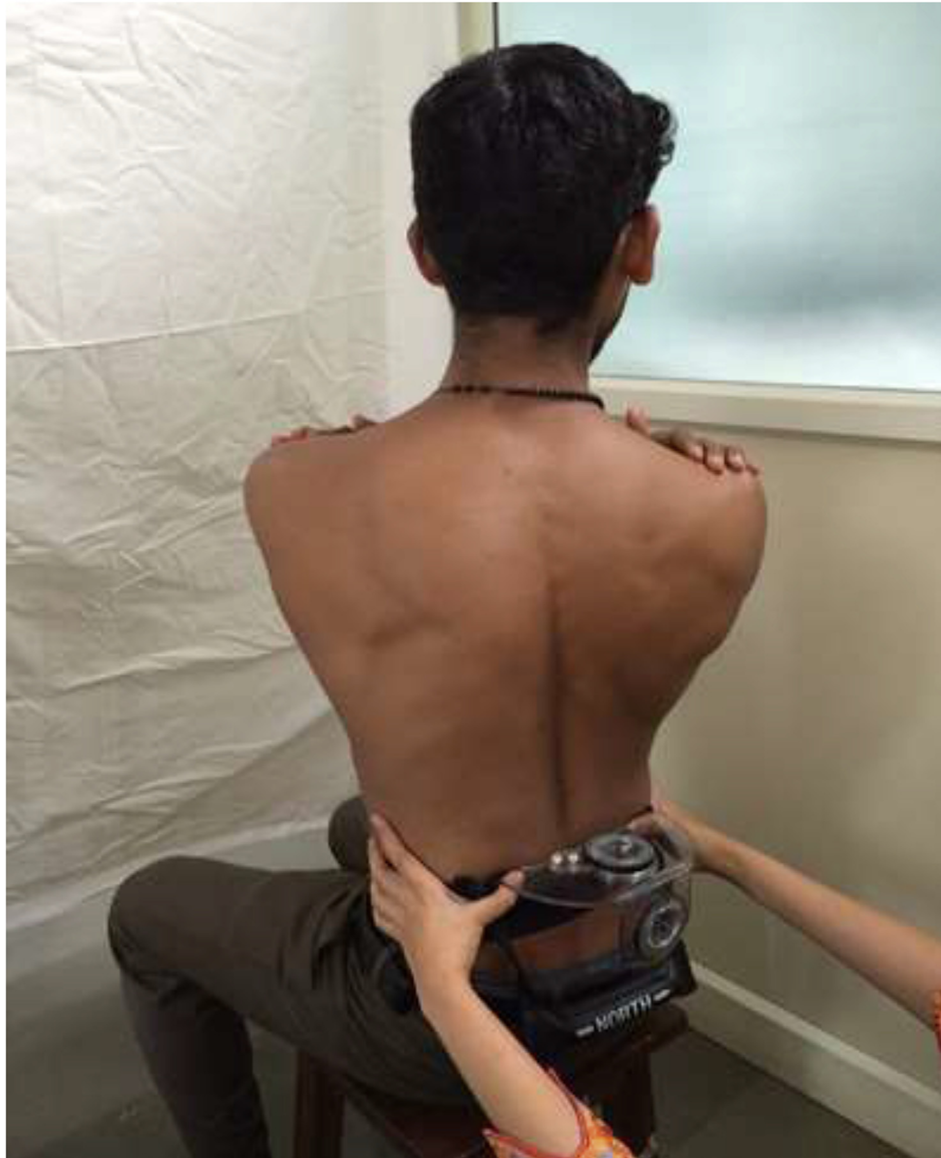

Fig. 1. Position for 1st set of rotations using BROM to assess TLF tightness.

contraction of TrA, as the TrA contraction does not require pelvic or spinal position change, which would produce compensatory muscle-activation patterns of the rectus abdominis, Internal oblique's, external oblique's, or erector spinae musculature, indicating possible loss of TrA motor control while maintaining the pressure at 40 mm of Hg. The therapist confirmed the contraction by palpating the transversus abdominis muscle. The muscle strength was graded based on how long the individual was able to maintain the cuff pressure at 40 mm of Hg, was given instructions to breath continuously (Fig. 3). For this study the strength was graded as poor if the individual was not able to maintain the contraction for 5 sec or less, and was graded strong if they maintained contraction for more than 5 sec.

2.4. Disability among individuals with low back pain

The Roland Morris Disability questionnaire RMDQ is a scale to measure the health status in individuals with low back pain. It was designed for use as an outcome measure for clinical trials as well as to monitoring patients in clinical practice. It is short, simple to complete, and readily understood by patients. Since the Roland Morris disability questionnaire is better suited to individuals with mild to moderate disability this scale was used in this study [Roland, 2000].

2.5. Statistical analyses

Statistical analysis was done using the Statistical Package for Social Sciences (SPSS). P value < 0.05 was considered statistically significant. With 95% confidence interval and 90% power. Chi square test was used to analyse the difference in categorical variable of gender between the groups. Demographic variables of age, height, weight and outcome measures of ROM using independent sample T-test. Man-whitney U- test was used to compare between group difference in muscle strength as measured using the MMT. Transverse abdominis strength was tested using chi-square test. Odds ratio was estimated to test the strength of association of TLF length with NSLBP.

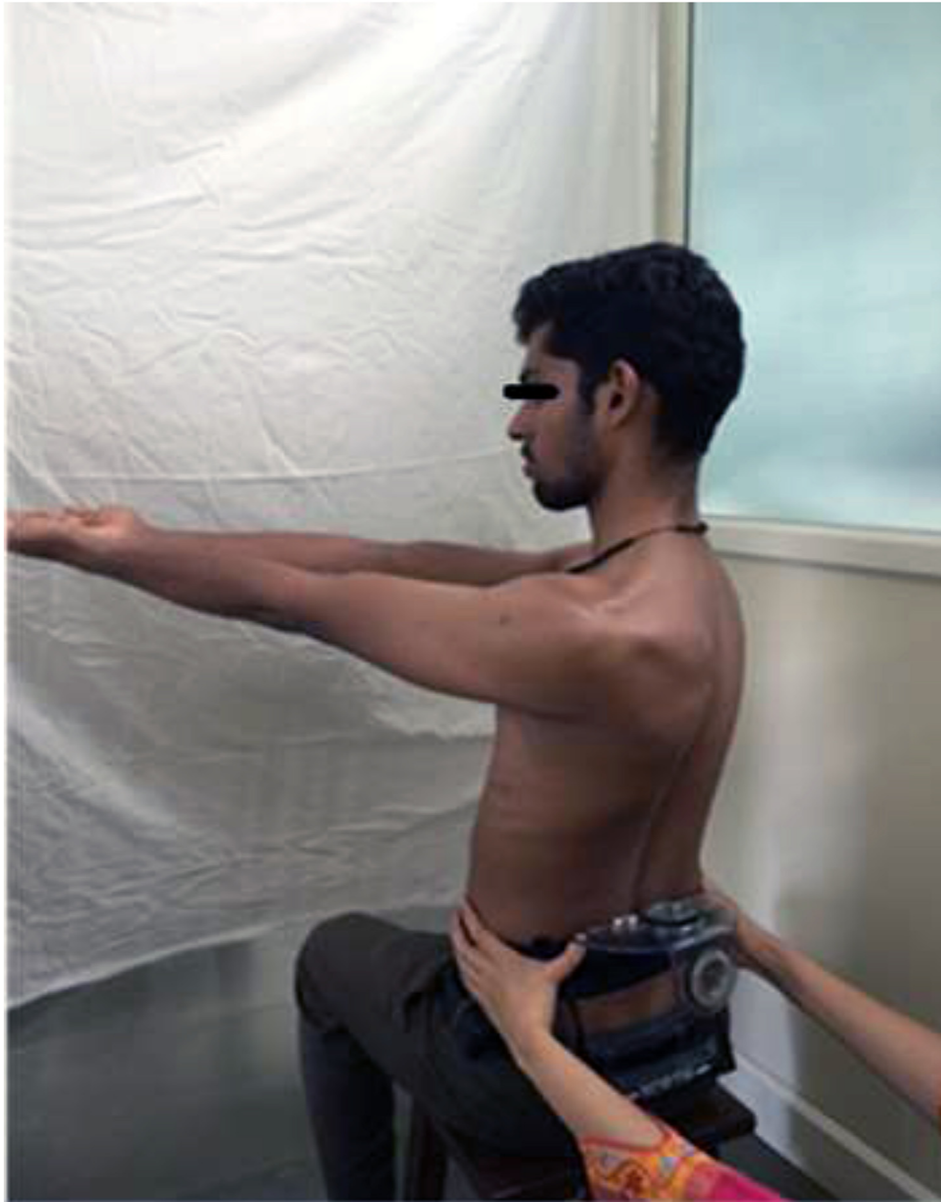

Fig. 2. Position for 2nd set of rotations using BROM to assess TLF tightness.

3. Results

A total of 62 subjects were included in the study. 31 each in case and control group. Each group had 14 (45.2%) males and 17 (54.8%) females. There was no significant difference between the groups in terms of age, height and weight (Table 1).

All subjects in the study were right hand dominant. Physical activity was also evaluated based on the number of times the subjects indulge in exercise or recreation activities like playing cricket, swimming etc in a week. There was no significant difference in the physical activity ($\times 2 = 2.647$, $p = 0.449$) in both the groups. When the pain characteristics of the case group was assessed 21 (67.7%) presented with pain in lumbar spinal region, 25 (80.6%) inparaspinal region and 7 (22.6%) individuals had pain referred to the gluteal region. The onset of pain was gradual in 58.06% individuals, insidious in 25.81% and sudden in 16.3% individuals. The nature of pain was intermittent in 64.52% and constant in 35.48% individuals.58.06% individuals presented with dull aching type of pain. Between group comparisons showed no statistically significant difference between the cases and controls in lumbar extension, side flexion or rotation. However it was found that there was a statistically significant difference in the lumbar flexion ROM between the groups ($p < 0.005$) (Table 2).

Lumbar rotation ranges when compared across groups with TLF held in stretched position (TLF test positions) showed statistically significant difference between cases and controls (p value < 0.005) (Table 3).

No significant difference was seen in the endurance of Transversus abdominis ($\times 2 = 2.44$,$p = 0.11$), latismus dorsi, internal and external obliques across the groups (Table .4). Disability levels in subjects diagnosed with NSLBP as measured by Roland Moris disability questionnaire was found to be 6.22 ± 2.43.

3.1. Odds ratio

Transversus abdominis strength was not found to be

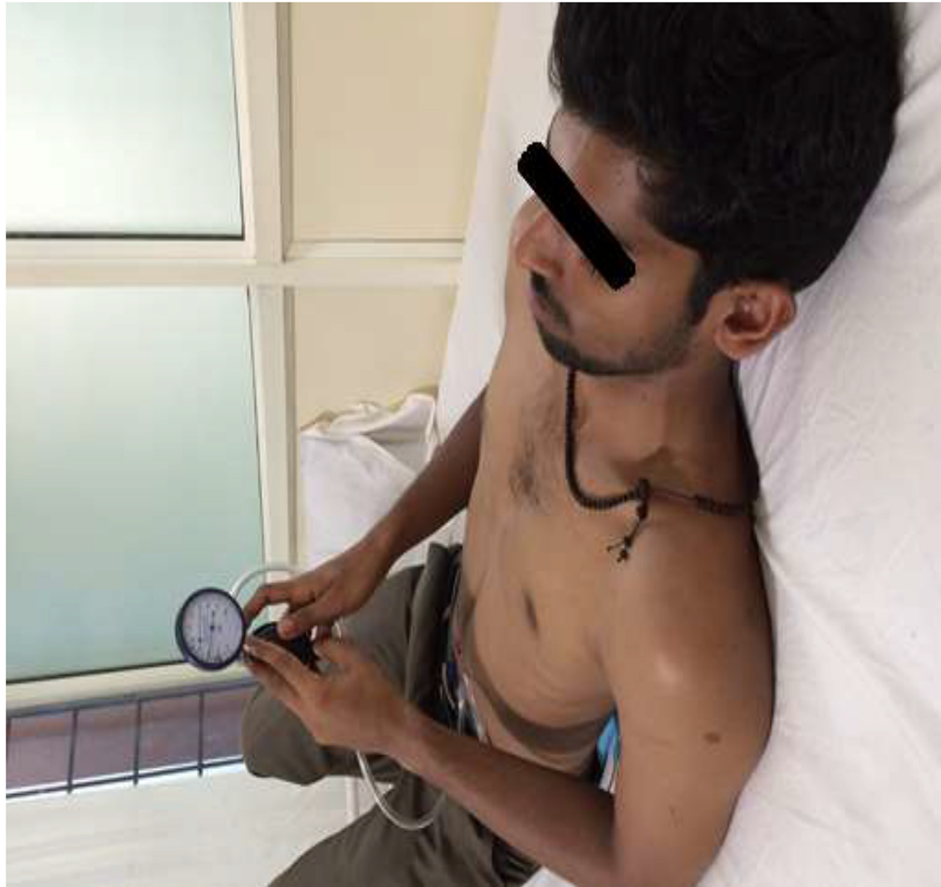

Fig. 3. Position for assessment for TrA strength.

Table 1
Comparison of demographic data of Age, Height and Weight in Case and Control.

Variables	Total	Cases	Controls	p-value
No of subjects	62	31	31	
Age (Years)	18–62	30.90 ± 11.75	30.90 ± 11.75	1.000
Height (Cms)		159.32 ± 8.12	156.71 ± 27.73	0.395
Weight (Kgs)		64.70 ± 13.61	62.25 ± 12.88	0.521

Case –individuals with NSLBP; Control-individuals without low back pain.
p value < 0.05 significant.

Table 3
Comparison of lumbar rotation ranges when done along with the TLF test.

Variable – ROM (degrees)	Cases (n = 31)	Controls (n = 31)	p-value
Rt. rotations (Degrees)	6.94 ± 1.66	8.42 ± 1.57	<0.001*
Lt. rotations (Degrees)	7.03 ± 1.67	8.52 ± 1.52	<0.001*

Rt = right, Lt = left, TLF = thoracolumbar fascia.
Case –Individuals individuals with NSLBP.
Control-Individuals without low back pain.
*p value < 0.05 significant.

Table 2
Comparison of lumbar ROM in the case and the control group.

Variable – ROM (degrees)	Cases (n = 31)	Controls (n = 31)	z-value	p-value
Lumbar flexion ROM	48.61 ± 5.52	53.87 ± 4.97	3.93	0.001 *
Lumbar extension ROM	12.54 ± 3.82	13.61 ± 3.04	1.21	0.20
lumbar side flexion R	20.35 ± 2.65	20.67 ± 2.37	0.50	0.76
Lumbar side flexion L	20.03 ± 2.54	20.12 ± 4.05	0.11	0.59
Lumbar rotation R	8.96 ± 1.01	9.45 ± 0.99	1.89	0.20
Lumbar rotation L	8.87 ± 1.11	9.51 ± 0.96	0.20	0.07

ROM = range of motion, R = right, L = left.
Case –Individuals with NSLBP; Control- Individuals without low back pain.
*p value < 0.05 significant.

Table 4
Comparison of Strength of the muscles attached to the TLF in individuals in case and control group.

Variables	Case	Control	z-value	p-value
MMT of Latissimus dorsi R	31	31	−1.092	0.27
MMT of Latissimus dorsi L	31	31	-.875	0.38
MMT of obliques R	31	31	−1.022	0.30
MMT of obliques L	31	31	−1.022	0.30

MMT- Manual muscle testing,R = right, L = left, Case −Individuals with NSLBP, Control- Individuals without low back pain p value < 0.05 significant.

significantly (0.11) associated with NSLBP with an Odds ratio of 2.29with C.I of (0.80−6.53). The odds ratio shows there is a greater chance of finding right sided TLF tightness in individuals with NSLBP, than a normal TLF length. (Odds ratio of 4.87 and C.I of 1.49 ± 15.99).

4. Discussion

The study examined the association between TLF length and low back pain in individuals with NSLBP. Sub-acute and chronic NSLBP has been reported in 60%−67% of males [Heitz et al., 2009]. The mean age of all the individuals in this age and gender matched study was found to be 30.9 years with a duration of 24 months of pain. Mean age of 30−48 years has been reported in sub acute patients and for the chronic patients from 39 to 49 years [Heitz et al., 2009]. The intensity of pain in subjects in this study was mild (3.95 cm ± 0.95). The fact that the variables of height, weight and dominance did not statistically show any significant difference on comparison added to the strength of the study.

The level of physical activity varied across different sections of population. In our study we found that approximately 55% were students, 9% each of the population was represented by house wives and farmers. On analysis of their physical activity level we found it to be low in students and housewives and high in farmers. It was also found that in subjects who reported no physical activity, 25% had NSLBP and 45% had no low back pain. Though it was seen level of physical activity varied in both the groups, no significant difference was seen between the two groups. . It has been found that activity levels of patients with NSLBP are neither associated with, nor predictive of, disability or pain level [Hendrick et al., 2011]. These findings are in accordance with previous study where the activity levels was similar in both the groups where TLF was evaluated ultrasonically [Stevens et al., 2010].

The present study used clinical test commonly used in routine clinical practise to assess the length of TLF and to evaluate the strength of muscles attached to it. To get a more objective data on the amount of restriction in rotation BROM was used which has shown good reliability and validity [Breum et al., 1995]. The aim was to test if there is any association between TLF length and NSLBP. TLF acts as an abdominal brace which reduces the shear force on the spine but this function may be compromised if the mobility of TLF is reduced or if the contraction of deep muscles attached to the fascia is affected [Schleip and Vlemming 2007].

Reduced mobility can alter the structural extensibility which over a period of time may be the reason for reduced lumbopelvic stability and other biomechanical alterations [Willard et al., 2012; Schleip and Vlemming 2007]. As per our knowledge, this is the first study of its kind where TLF has been objectively assessed.

Research over the years has shown TLF length as the potential pain generating structure. [Schleip and Vlemming 2007; Taguchi et al., 2008; Malanga and Colon 2010]. There is evidence demonstrating, increased thickness, altered echogenicity of the perimuscular connective tissue forming TLF, and reduced TLF shear strain in individuals suffering from NSLBP [Langevinet al., 2011]. Fibrosis and adhesions with repetitive injury or due to abnormal patterns of trunk muscle activity and/or intrinsic connective tissue pathology within the layers of TLF can limit the mobility of TLF and be a potential source of pain [Stevens et al., 2010]. As it was demonstrated by previous study, our study also found forward flexion to be significantly reduced in patients with NSLBP and was also found to be the aggravating factor for LBP in our study [Langevin et al., 2011]. When the lumbar ROM was compared between the case and the control groups, lumbar flexion was found to be significantly reduced in the cases. There was also statistically significant difference in rotation ROM in case as compared to control. Though we cannot comment on the cause of TLF in our study, the fact that the odds ratio of 2.29with C.I of (0.80−6.53) was found indicates that the chances of patient having TLF length exist in NSLBP and could be a contributing factor. Previous studies done in individuals with nonspecific low back pain also showed prolonged sitting to be one of the aggravating factors for NSLBP [Harrianto, 2010; Harkness et al., 2003; Aoki et al., 2012]. The cause for this could be that prolonged awkward posture and repetitive increase load transfer via TLF which could result in injury and fibrotic changes in TLF Latissimus dorsi which is attached to the TLF at superficial lamina of the posterior layer of the TLF and helps in load transfer across the lower back region this could also have been one of the reasons for decreased TLF mobility. In our Latismus dorsi length was significantly shortened in nine cases as compared to four in the controls but the difference was not statistically significant. TFL also has attachment to oblique's and transverse abdominis which increase the stability of spine, weakness of these muscles decreases the force via TFL and may reduce stability of spine and be a potential cause for LBP. However in our study there was no significant reduction in the strength of the muscles evaluated. TLF being less vascular than other structures the potential for healing following injury is reduced therefore could be a more likely facilitator of chronic back pain. As stated by Robert TLF is more prone to stress than ligaments [Schleip and Vleeming 2007]. This stresses might cause repetitive injury and less nutrition supply may hamper the healing causing pain, disability and reduced mobility. In our study disability was found mild as shown by low score of 6.22 ± 2.43 on Roland Morris disability scale.

On analysing the risk for back pain with TLF length it was found that the odds ratio was significant for shortness of TLF on the right side however it was not found to be significant on the left side. This significant correlation between TLF length and LBP could suggest that length of TLF could be an important biomarker for the pathophysiological process that can cause LBP. Further studies could be done to evaluate the posture of these patients to explain the disparity seen between the length on the left and the right sides and its associated risk with LBP.

There were some limitations to the current study, firstly there was only one assessor and the assessor was not blinded. Some muscles attached to the TLF such as gluteus maximus which can influence the mechanics of fascia was not assessed in the current study. Only proximal muscles were analysed, but distal muscles like hamstrings which could have an effect on TLF biomechanics was not assessed. The sample size estimation was done based on statistics for TLF length alone and as such might not have been sufficient for analysing the influence of Latissimus dorsi muscle length between the two groups.

5. Conclusion

TLF length was found to be significantly reduced in individuals with NSLBP. There was no difference found between the strength of Latissimus dorsi, transversus abdominis, internal and external

oblique's attached to the TLF in individuals with and without low back pain.

CRediT authorship contribution statement

Shellette D' Almeida: Conceptualization, Investigation, Methodology, Visualization, Writing - original draft, Writing - review & editing. **Charu Eapen:** Conceptualization, Methodology, Supervision, Project administration, Writing - review & editing. **Shyam Krishnan:** Conceptualization, Methodology, Software, Validation, Data curation, Formal analysis, Writing - review & editing.

Declaration of competing interest

The authors declare that there are no conflicts of interest.

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