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Review Article

Thoracolumbar Fascia and the Low Back Pain-A Narrative Review

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Abstract

Human body is a miracle one, meant for both stability and mobility. Each part of the human body is having a specialized function. Certain structures are for stability and some meant for mobility. But the common structure which connects both mobility and stability structures is admirable and known as "Fascia" which is of a connective tissue in nature. The importance of this structure been studied by many scientists. Any abnormality of this fascia results in interlinking problems in other structures too, which the person feels pain that alerts not to creates further issues or that prevents further problem in that particular site. This narrative review been done to narrate how the structure linked to all parts of body and the function of this fascia, and the problem of fascia results in pain, especially the Thoraco Lumbar Fascia (TLF) and its role in low back pain.

Keywords: Fascia; Mechanotransduction; Tensigrity; Thoracolumbar Fascia (TLF); Low Back Pain

Introduction

The recent awareness, knowledge and publications on 'fascia' made everyone to notice about 'the fascia'. The word Fascia derived from Latin, with the meaning of band, bandage, ribbon like or swathe. Many dated back scripts used the term of fascia were found. Crooke (1651), used the terms *fasciam* and *fasciam latam*, and defined it as 'a membranous tendon' Godman (1824) defined it as 'a section of dense fibrous tissue and membranous tissue covers the internal organs.' The well known Gray (1858) termed it as 'a distinct connective tissue', and 'a global connective tissue' by Still (1899). Eighteenth century itself the term fascia was used in the English medical dictionary by the medical lexicographers [1]. On the whole these terms says about the widespread of this structure everywhere in the human body from exterior to interior layers, which is an interesting one.

Lower back pain is very common problem in the society who suffers silently for years. The thoraco lumbar muscles and the thoraco lumbar fascia plays major role as a force transmitters during movements and maintaining stability at this junction. The dysfunctions on any of these structures end up with myofascial pain syndrome. Nowadays many 'hands-on treatment techniques' are available to reduce the pain. Pharmacological methods sometimes may create complications either in short or long term basis. This review will provide an overview of the structures, functions, and the clinical aspects of thoracolumbar fascia.

Arrival of the definition

Many different definitions and terminologies were there, 'The Fascia Nomenclature committee' (FNC), the subcommittee of Fascia Research Society (FRS) recommended two terminologies - "a fascia" and "the fascial system" (Figure 1) [2].

Adstrum., *et al*. 2017, in their article on defining the fascial systems, mentioned that the proposed functional definition, suggested by the FNC are 'Fascia is a sheath, a sheet, or any other dissectible

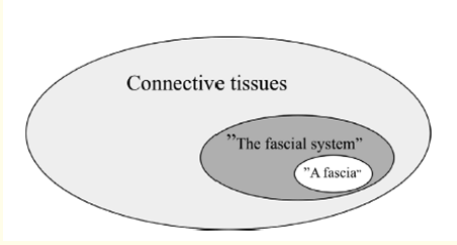

Figure 1: Schematic diagram of nomenclatures arrived by FNC, [2].

aggregations of connective tissue that forms beneath the skin to attach, enclose, and separate muscles and other internal organs'. 'The fascial system consists of the three-dimensional continuum of soft, collagen containing, loose and dense fibrous connective tissues that permeate the body. It incorporates elements such as adipose tissue, adventitiae and neurovascular sheaths, aponeuroses, deep and superficial fasciae, epineurium, joint capsules, ligaments, membranes, meninges, myofascial expansions, periostea, retinacula, septa, tendons, visceral fasciae, and all the intramuscular and intermuscular connective tissues including endomysium/perimysium/epimysium' [1].

The fascia derived from the mesoderm. In the scoping review of Blottner D., *et al.* (2019), explained about the various layers of the fascia continuum starting from epimysium, perimysium, endomysium, myofascia, epitendon, periosteum and ehthese. Fascia is comprised of viscoelastic tissue, forms a collagenous matrix for a three dimentional function. Even though fascia is a hidden structure, in the body few areas of it can be palpable like thoracolumbar fascia, iliotibial tract and plantar fascia. The appendicular fascia of muscle known as myo-fascia continues as epitendon, ends as enthesis where the tendon merges with the fascia of bone. They were also studied under ultrasonic images for their structural, functional and clinical importance [3].The fascial system surrounds, interweaves between, and interpenetrates all organs, muscles, bones, and nerve fibers, endowing the body with a functional structure, and providing an environment that enables all body systems to operate in an integrated manner [1].

To the better understanding, fascia is a three dimensional sheath, connective tissue which lies beneath the skin, spreads all over the body as a web, that attaches, separates and protects many structures like bone, muscles, nerves, blood vessels and all other internal organs. This continuum web allows each structure to function in an integrated manner.

Functional anatomy of fascia

Fascia composed of connective tissue, extracellular matrix (ECM) and fibrous collagen proteins, forms the three dimensional continuum. The collagen network of type I and III with the cross links helps for the mechanical properties of fascia [1]. Szotek., *et al*, 2016 who tried to characterize the main cell populations within human fascia lata and their role in health and diseases from the specimens found that collagen type I is responsible for the tissue stiffness and type III is for compliance. Combination of these collagen types results in the properties of tissue deforming forces and tensile strength [7].

Fascia is also having the property known as (bio) tensegrity which is defined as the act of compression and tension. Tensigrity term was proposed by the American Architect Buckminster-Fuller in early 1960 s, which means that tension preserves the integrity property [4]. Ingber DE., *et al*., (1993, 2003) explained about the term tensigrity, later applied to mechano transduction of biological structures known as biotensigrity [3-5]. The physical factors like mechanical forces can create some changes in the biological systems of the human body known as mechanobiology, also known as Mechan transduction. The fascial system in human body senses this change in forces and tries to convert these mechanical stimuli into biochemical stimuli in the matrix level [6,8]. Blottner., *et al*., (2019) in their review mentioned that the extracellular matrix (ECM) has the visco elastic property. The link proteins help for the anchor system of biotensigrity property and reacts on mechanical loadings [3].

Kumka., *et al*., (2012) on describing the morphological classification system of fascia noted that the Mechan transduction occurs through filaments of ECM. Myofibroblasts within fascia shows contractile properties. Increased amount of myofibroblasts were noticed in pathological fascia resulted in tissue contractures as in case of plantar fibromatosis, Dupuytren's contracture and adhesive capsulitis. According to the functions of fascia at various location and the Mechan transduction role, 'Federative International Committee on Anatomical Terminology (FICAT)' developed a functional classification system that defines four categories of fascia as linking, fascicular, compression, and separating fascia [8].

Problems that encountered by fascia

As we age the water content of body losses. The water content in fascia called hyaluronan is higher as 75% too can lose. Fascia is affected by the age, composition, occupational stress, overloading, sports moves and even prolonged adaptation of posture [12]. Skin

is a larger organ, which have connection to the interior structures through fascia. Fascia is highly innervated by many nerve endings belongs to the sympathetic system. Any scar formed in these structures will interrupt the function of the fascia [9, 10]. When the fascia gets injured either by overload or trauma or by surgery, that resulted in dysfunction of the fascial system. A scar in the ankle can cause problem in the fascial tissues located in the back, even shoulder which is been explained well by Stecco., *et al*., 2013 [9].

Thoracolumbar fascia and low back pain

Thoraco Lumbar Fascia (TLF) is an important structure that located in lower lumbar region which encompasses muscles of lumbar region. With the three layered structures anterior, middle and posterior, it helps for the posture, movements and respiration. Fascial connections from TLF extends to iliac fascia, rectus abdominis fascia, to the upper limb by pectoral fascia, deltoid and brachial fascia and to the lower limb by fascial muscles like tensor fasciae latae, and the superficial fascia (**cribriform fascia)** of the hip and thigh.

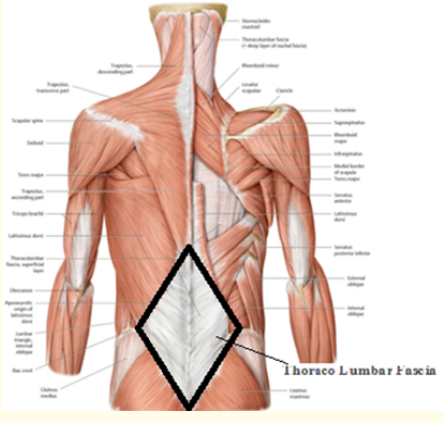

Figure 2: The Back Muscles and Thoracolumbar Fascia.

Thoraco lumbar fascia is composed of dense connective tissue layers, partitioned by loose connective tissue layers. These compartments are occupied with muscles of back. Erik Korzen, (2016) in his review and commentary about the study by Willard., *et al*. 2012 on 'The thoracolumbar fascia: anatomy, function and clinical considerations' [14] clearly explains that the structures affected and taken care will be of lumbo pelvic complex, upper, lower body dysfunctions. Advised to use manual, instrumental releasing techniques along with the application of taping techniques in the tight structure of Thoracolumbar fascia [13].

Schuenke., *et al*. (2012) in their study on the anatomical description of the lateral margin of the TLF, with specimens and MRI findings explained about the layers of TLF, lateral margin of TLF and its connections to the extremities, hypaxial (ventral trunk) and epaxial (paraspinal) muscles. Described that the paraspinal muscles that are enveloped by a continuous Paraspinal Retinacular Sheath (PRS) which is formed by the deep lamina of posterior layer of TLF that extends from spinous process to transverse process. At the lateral border of PRS, the aponeurosis separates into two laminae which forms the Lumbar Inter Fascial Triangle (LIFT), is of dense connective tissue known as lateral raphe. This is formed at the junction where the abdominal myofascial structures join to the PRS [15].

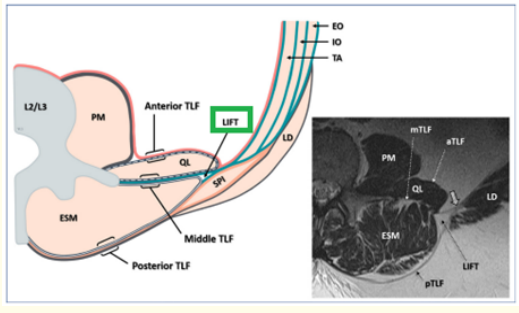

Figure 3: The location of Lumbar Inter Fascial Triangle (LIFT), [15].

The cause of Low back pain can be with specific pathology and without pathology. This is most debilitating problem in the working population which has sickness absenteeism, disability reimbursements in many countries even early retirements. The severity may have familial, social and economical burden. More than half of the patients complaining of back pain will have no specific pathologies. The nonspecific low back pain can be due to the over use or over loaded forces in the muscles, ligaments, joints, nerves and the thoracolumbar fascia. This repetitive stress to these structures either in routine activities or added with occupational tasks might be the culprit, results in trigger point at the sites. When the trigger occurs, that protects the structure further with spasm, which is a vicious cycle. The pain related to myofascial structures are also known as myofascial pain syndrome.

The fascia is an important organ that helps for stability, mobility and proprioception. Thoracolumbar fascia includes core muscles. Core muscles are the muscles considered in chronic low back pain condition. It consists of diaphragm on the top, abdominals in the front, paraspinal muscles, gluteals at the back and pelvic floor mus-

cles in the down. The superficial/outer/global core muscles are Rectus Abdominis, External Obliques, Erector Spinae. The deep/inner/local core muscles are Transversus Abdominis (TrA), Multifidus, Internal Obliques (IO), Diaphragm and Pelvic floor muscles which provides stability and controlled movements.

The shear forces acting upon in the fascial structures need to be considered on analyzing the influence of pain. Langevin., *et al*. (2011) published a study with 121 human subjects, who had chronic low back pain for more than 12 months with no pain condition, quantified the shear stress that occur in the TLF made only at the L2-3 level, with the help of ultrasound elastography imaging technique. They found that there was a 20% reduction of stress shear on passive flexion test in these structures. Also founded that in males there was a positive correlation between shear strain and LBP duration [16]. Wilke., *et al*. (2017) in their review on histological morphological and nociceptive and nociception-related evidences expressed that the nociceptive anatomical considerations of TLF/Lumbodorsal Fascia is the main cause of low back pain [17].

According to Siegfried Mense (2019) who collected the sensory functions of the thoracolumbar fascia (TLF) with the tissue specimens of rat and human found that the TLF is not elastic in the sense of stretchability. The author proposed that the inner layer of TLF consists of loose connective tissue and few elastic fibers, which may not enough to build up the elastic forces. The great proportion of sympathetic fibres in the specimen showed approximately 40% of the entire fascia innervation consisted of postganglionic sympathetic fibres are of vasoconstrictor. TLF also has an extensive innervation with nociceptors. This explains well in lower back pain cases that are under psychological stress, expresses more pain is of interesting [18].

The TLF structure is the attachment site for many trunk and limb muscles through the aponeurosis like Latisimus Dorsi, trapezius, Scalene Posterior Inferior, Gluteus Maximus. Vleeming., *et al*. (2007) note that, the Gluteus Maximus coupled with the contralateral Latissimus Dorsi through thoracolumbar fascia. The Gluteus maximus is also having connection with tensor fasciae latae of lower limb.

Turan Z., *et al.* (2022) evaluated the changes in the thickness of transversus abdominis (TrA) and internal oblique (**IO**) muscles during bridge with arm extension and abdominal hollowing ultrasonographic images. The transversus abdominis (TrA) arises from the middle layer of TLF. This fascia tends to transmit load through lumbar spine, pelvis and contra lateral limb. On activation of this TrA, **IO is the first one to recruit for the stabilization of core for the movements in spine. Abdominal hollowing contracts these muscles and stretches the TLF. The erector spinae activated and stabilizes the spine. Pelvic bridging also activates gluteus maximus (**GMax) **along with** TrA, **IO. On analyzing through** ultrasonographic images, in both the cases they found that the thickness of TrA and IOwas increased. Additionally the bridge exercise activated GMax which is connected to TLF. This fascia tends to transmit load through lumbar spine, pelvis and contralateral limb [20]. On treating the low back pain the abdominal hollowing is one of the exercise usually we encourage. When the co-activation of Latissimus Dorsi and Gluteus Maximus muscles during abdominal contractions are encouraged, the abdominal muscle functions in a better way through TLF and myofascial chain [19].

Fascial dysfunction research works:

Many fascial structure related as well as dysfunction related researches were went on. Resting myofascia exhibit both viscoelastic and linear elastic characteristics (Nair., *et al.,* 2016); Trigger point pathophysiology in myofascial pain syndrome (Sarah Money 2017); the lower lumbar myofascial tone/tension and dynamic stiffness have been documented in younger adults with ankylosing spondylitis (AS) when compared to matched, healthy control subjects (Andonian., *et al*., 2015; White., *et al.,* 2018); Sadia Ilahi., *et al*, (2020) done a study on quantitative analysis on the five physical properties of stiffness, frequency (tone), decrement (inverse of elasticity), creep, and *SRT* using the MyotonPro® at the L3-L4 level myofascia in chronic idiopathic LBP [20].

Recent studies have revealed an association between increases in TLF thickness and reduced TLF gliding in patients with LBP. Tamartash H., *et al*, (2022) in their study found out the elastic behavior -coefficient of lumbar fascia in patients with LBP by using ultrasonic images of TLF. They evaluated and analysed the force transmission through PTLF to the right and left latissimus dorsi, and right and left lower trapezius muscles during isometric contraction of right and left gluteus maximus. Results showed that the TLF elastic coefficient in patients with LBP was reduced compared to healthy individuals and directly related to LBP severity [21,22].

Pirri Carmelo., *et al*, 2023 published a study tomeasure and compare by ultrasound (US) imaging the thickness of the TLF at the bilateral L3 level of the lumbar spine in the longitudinal and transverse axes in chronic non-specific LBP and in healthy subjects. US imaging evaluation on TLF thickness behavior suggest that the LBP patients lost anisotropy of the TLF, with it becoming homo-

geneously thicker and losing adaptability in the transversal direction. The thickness behavior of TLF in CNSLBP patients, explains about the altered fascial remodeling occurred when compared to healthy individuals and termed it as 'frozen back' [23].

Low back pain is associated with increased trunk stiffness in paraspinal muscles. These are the muscles of stability and mobility of the region. Maud Creze., *et al*., (2019) done a study to find out the quantitative stiffness changes in healthy paraspinal muscles (longissimus, iliocostalis, multifidus), which are inside the fascia called thoracolumbar fascia (TLF),used supersonic shear wave elastography at the lumbosacral level (L3 and S1) for six static postures. Passive postures (rest, passive flexion 30^0, passive extension30^0) and active postures (upright, bending forward30^0, bending backward30^0) with rest posture for reference were performed in sixteen healthy volunteers. Significant intra- and inter-muscular changes were observed with posture which revealed about the different biomechanical behaviour of the multifidus, the longissimus, and the iliocostalis [24].

Management on CLBP

Many treatment techniques been applied by various medical fraternities, worldwide for the management of low back pain. For acute condition those responds well. But in case of chronic condition the answer is questionable where we need to consider many external factors. The Physician, Physiotherapists, Massage therapists, Manual therapists, Psycotherapists works for them to overcome pain. In chronic condition what we are talking about the issues on fascia TLF needs to be addressed. Sharan D., *et al,* (2014) mentioned that the myofascial low back pain requires multidisciplinary treatment protocol [25].

Stecco A., *et al*, (2013) in their article explained about the role of Hyaluronic Acid (HA) on maintaining the better health of fascial system and quoted the pathological changes of the Fascia. The alteration of HA viscosity made the receptors of fascia to sense and send the pain message to the centers. They quoted many research findings about the interaction between HA, lactic acid and alterations of pH in fascial tissues. The fascia composed of dense connective tissue (collagen fibers type Iand III) and loose connective tissue (adipose cells, glycosaminoglycans-GAGsand HA). The accumulation of lactic acid alters the pH level, stimulates the reaction that increases HA viscosity.As a treatment it is necessary to reverse the changes in HA. The higher viscosity area like trigger points need to be focused to balance the qualities and properties of fascia. Many physical therapy and manual therapy techniques help for this. Manipulation, massage, trigger release, myofascial release, deep compression and friction also identified to give better effect from pain. They described the difference between Fibrosis and Densification. Explained that when morphological changes happened can be known as fibrosis, where it's difficult to modify the dense connective tissus (DCT), when only functional alteration occurs will be of densification of fascia, in which a change in the viscosity of loose connective tissue (LCT) been done, the function will be normal [26].

Brandl A., *et al*, (2021) studied the immediate effects of a myofascial release (MFR) technique on the thoracolumbar fascia and of an osteopathic treatment (OMT) on postural parameters in patients with acute low back pain (aLBP). With 71 subjects the spinal shape parameters (functional leg length discrepancy (fLLD), kyphotic angle, and lordotic angle) were measured before and after the intervention using video raster stereography, concluded that the fLLD and kyphotic angle reduced significantly within the MFR and OMT groups and added that these effects are also clinically relevant [27].

Santos GK., *et al*, (2022) in their systematic review and meta analysis included researches published between 2005 and 2020, with the participants of 822, ranging the treatments from 1 week to 8 weeks, covering Muscle Energy Technique (MET) compared with other techniques. They found that MET is a safer, effective technique that can be applicable for LBP condition [28]. Al Matif, S., *et al*, (2023) conducted a systematic review on the Effectiveness of muscle energy technique on pain intensity and disability in chronic low back patients. With 17 studies, it was observed that MET alone and in conjunction with other interventions was found that the pain and disability level were reduced by improving the lumbar rages [29].

Amstel RV., *et al*. (2023) with the 4xT method consists of four components: Test (functional diagnostic test), Trigger (fascia tissue manipulations), Tape (elastic taping), and Train (exercise) a RCT was done to find out the effects of these interventions. Participants had two weekly treatments for six weeks, each incorporating various FTMs with different mechanical effects**.** Among 46 participants who completed the protocol were analysed with Repeated Measure ANOVA, concluded thatthis 4xT method as a promising and impactful treatment option for individuals dealing with nonspecific chronic low back pain [30].

Tu SJ., *et al*. (2016) explored the taping mechanisms using an *in vivo* ultrasound measurement to assess the changes in thoracolumbar fascial thickness, structure and shear strain are associated with lower back pain (LBP). They found that there was a signifi-

cant reduction in the mean movement of subcutaneous tissue during lumbar flexion before and after taping [31]. Aalishahi T., *et al*. (2022), conducted a study to find out the effects of Kinesio tape on LBP and disability in 80 pregnant women with LBP and found that the Kinesio tape reduced the disability caused by LBP during pregnancy and had a lasting effect after the tape was removed [32].

A review done by Kodama Y., *et al*. (2023) about the current state of knowledge on the molecular level response to the mechanical properties of the fascia and its response to other physiological challenges, including mechanical changes, innervation, injury, and aging; imaging techniques available to study the fascial system; and therapeutic interventions targeting fascial tissue in sports medicine, exposed the details on hormonal changes during menstrual cycle, taking oral contraceptives by sports person as well as estrogen replacement in older postmenopausal females inhibits collagen synthesis, which increases muscle damage on sports activities and even doing exercises. The physical and chemical properties of hyaluronic acid (HA)which helps for the smooth gliding of fascial structures, changes with age. The viscosity increases with age, lactate accumulation increases with exercises may result in the sliding quality of fascia. Recommended the use of US imaging which helps for the assessment in a dynamic situation of fascia, whereas the MRI imaging will help to observe the deep fascia, bone, bone marrow edema, and the adjacent soft tissues.

They gave caution about the sedentary lifestyle and repetitive overuse of the muscles with a limited range of motion, can lead to myofascial pain syndrome. The study gave informations on many treatments like Physical Therapy, Manual Therapy techniques, Myofascial Release (MFR),mild myofascial stretching and the injection of local anesthetics into the interfascial space for Muscle and Fascia Dysfunction. Self-myofascial release (SMFR) using foam rolling (FR) has become popular used to prevent injuries and maintain performance in sports [33].

Niederer., *et al*. Trials (2020), done a prospective meta analysis on motor control stabilization exercises in non specific low back pain patients of 2391 at various centers, single-blind two armed randomized controlled trial to evaluated theeffects of a 12-week (3 weeks supervised centre-based and 9 weeks home-based) individualized sensorimotor exercise program in adults with non-specific low back pain assessed for pain scales, concluded that a moderate-to-high quality evidence for Motor control stabilisation exercise as a treatment for non-specific low back pain [34].

Ryskalin L., *et al*. (2022) reviewd about the use of extracorporeal shock wave therapy (ESWT)on decreasing pain in chronic musculoskeletal pain conditions including myofascial pain syndrome [35]. Vining., *et al*. (2022) done a feasibility study, with 20 chronic low back pain patients of having pain for ≥ 1 year, on the application of multimodal chiropractic care for 8-weeks of intervention (twice-weekly chiropractic care) including spinal manipulation, education, exercise, self-management advice and myofascial therapies. The TLF shear strain was computed using 2 methods. Found the better effect on this multimodal chiropractic care, as well as the Shear strain increased in females over the same timeframe, but not in males [36].

Conclusion

Being an important structure of our body, the fascia needs to be taken care to lead a healthy, active life. Keep on moving the fascia. Engaging the fascial system can avoid injuries, overuse in any part of the body. Musculoskeletal system is meant for movements. Movement encourages blood flow, lymphatic drain, which can reduces pain. Non invasive treatment techniques of this connective tissue helps for the remodeling process in chronic low back pain cases. Exercises, Myofascial releases and Yoga poses will help on reducing low back pain. Be active and keep the fascia healthy. A multimodal form of therapy which includes heat therapy to the local site, myofascial release, trigger release, stretching, self releasing techniques, posture corrections both in rest time and working time, relaxing techniques or keeping away from stressful things can improve their mind and body to feel ease which can show benefits to the chronic sufferers. These intervention can reduce the pain, can be free from the complications of medications and can improves the quality of life.

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