Introduction to fascial tissue

Article · March 2017

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PHYSIOTHERAPY UPDATES

ORIGINAL ARTICLE

INTRODUCTION TO FASCIAL TISSUE

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For quite a long time the term 'fascial tissue' was rather vague, used in anatomy to refer to the undifferentiated tissue that covered different structures and that was dissected without relating it to any adjacent structures. However, the scientific advances in the last decade (which have led to 4 editions of the *International Fascia Research Congress*) have demonstrated the importance of fasciae, both in normal and pathological functioning, in the different structures of the human body. This new, more detailed knowledge has allowed the development of new physiotherapy techniques like myofascial induction, fascial manipulation or the *Scar Modelling Technique*, and has helped to back up the effectiveness of existing techniques.

The aim of this article is to provide a brief introduction to fascial tissue based on some of the most relevant and recent publications on this topic so that the therapist can better understand the nature of this tissue and its importance in manual treatments, which are commonly used in everyday practice.

FASCIAE AND THEIR ORIGIN

The term fascia comes from Latin and etymologically it means "long, narrow strip or band". The Roman encyclopaedist Celsus, in his work *De re medica*, used the term to refer to the therapeutic action of bandaging or dressing injuries (1). Later on, Galenus was one of the first to relate this term to what we know understand as subcutaneous cellular tissue. But it was not until Vesalius that the term was connected with a structure close to muscle tissue (1). Although nowadays there are still discrepancies regarding its definition (2,3), the term *fascia* can be defined as a "viscoelastic, functional, and three-dimensional network of connective tissue, made up basically of collagen fibres (4,5), which surrounds and interpenetrates all the structures of the human body in all directions, and which is difficult to isolate as a whole" (6).

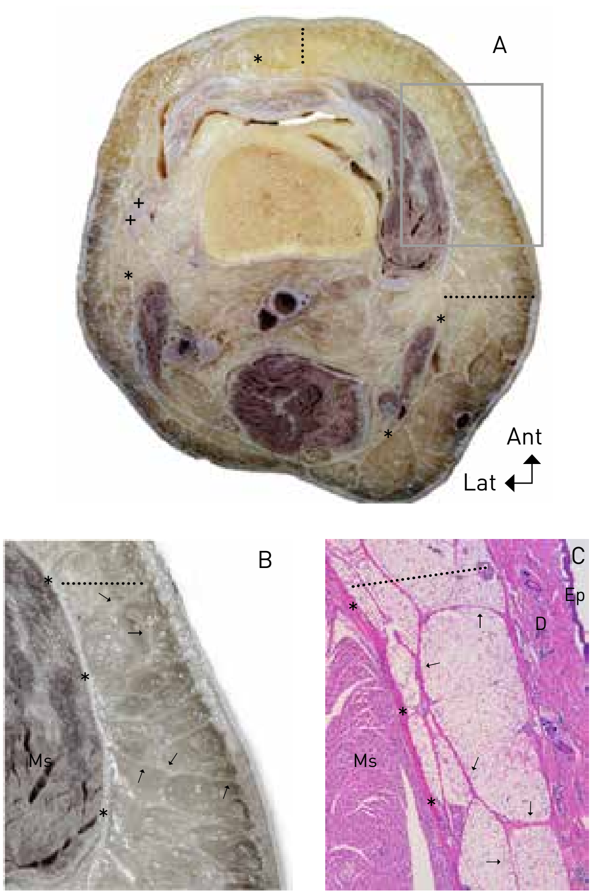
Not many studies exist on the ontogeny of fasciae in general, but the importance and functions of mesenchymal tissue of mesodermal origin (as a key and indispensable element of the morphogenesis of the musculoskeletal system) have been widely studied in animals (7-9). Recently it has been demonstrated how this transition from an undifferentiated and poorly organised tissue into a more mature tissue with variable morphotypes (according to region and their distribution), occurs within weeks 22-39 of human foetal development (10). Thus, initially it is fascial undifferentiated fibroblasts which indicate myoblasts about their precise distribution depending on the specific muscle they will make, whereas the continuous dialogue between these two elements will continue into their maturity, that of the muscular tissue and that of the fascial tissue (10).

CLASSIFICATION OF FASCIAE

The concept of fascia is quite generic, so different classification systems have been proposed. Some of them are based on the structure or the tissue with which fasciae interact and we can then distinguish between neurofascia (covering nervous tissue), visceral fascia (surrounding viscera) and myofascial (covering and related to muscles). Other more integrative classifications take into account both anatomical and histological and functional characteristics (11). However, the classification system which is the most commonly used and accepted by the International Nomina Anatomica categorises fasciae based on their location in the human body into superficial and deep fasciae (Fig. 1).

Figure 1

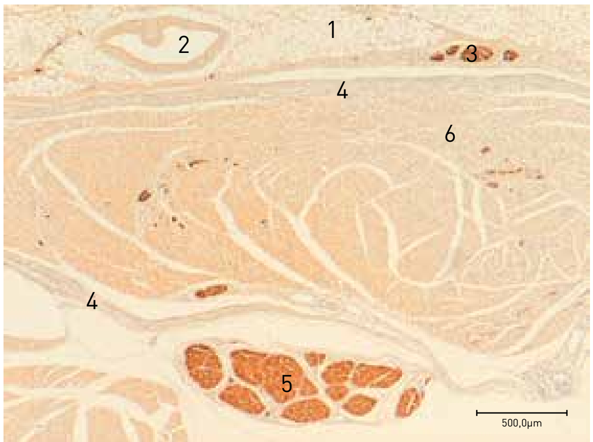
A. Transversal cut of the distal third of the thigh, phenol sample. The thickness of the superficial fascia (dotted line) and deep fascia (*) are marked. The thickening of the deep fascia (++) in the ilioitibial part is shown. Anatomical (B) and histological (C) enlargement of Figure A. The variable thickness of the superficial fascia (dotted line) and how the adipose tissue it is made up of is compartmentalized (arrows), forming the cutaneous retinaculum, are indicated. The relationship of the fascial tissue with the epidermis (Ep), dermis (D), hypoderma (or superficial fascia, marked with a dotted line) and deep fascia (*), as well as muscular tissue (Ms), are marked. The image (C) shows an embryo sample, dyed with hematoxylin-eosin.



Superficial fascia consists of adipose and connective tissue and is found immediately underneath the skin (12) (Fig. 1). This structure, apart from being a storage medium of adipose tissue, also contains nerves and vessels (13) (Fig. 2). It is made up of networks of dense and/or lax connective tissue that goes from the subcutaneous layer to the deep fascia and forms different walls in all directions comprising a three-dimensional network typically known as cutaneous retinaculum (Fig. 1.B and 1.C). These walls connect the superficial fascia with the dermis and store superficial fat in small compartments, they also determine the fascia's capacity of sliding and defining both body form and shape (14).

Figure 2

Embryo image of the flexor carpi ulnaris, dyed with s100. In the superficial fascia (1) there is a variable deposit of fat, with veins (2) and cutaneous nerves (3). At a deeper level, the close relationship of the deep fascia (4) with muscular tissue (6) and nervous tissue (5) is shown (this latter connection is very important in adults when using peripheral nerve mobilization).



Deep fascia is made up of dense, regular connective tissue (Fig. 1) that is histologically distributed in a maximum of three layers with small quantities of lax connective tissue in between them (15, 16). Its thickness and direction varies (Fig. 3), and they could increase if undergoing excessive mechanical demand (17). This fascia covers and surrounds the muscles, viscera, vessels and nerves. It forms retinacula and compartments or septa, which group muscles according to their main functions (for example, flexors and extensors).

It also allows continuity between separated regions or anatomical structures, such as the fascial continuity between the pectoral and brachial areas (18) or the thoracolumbar fascia and the long head of the femoral biceps through the sacrotuberous ligament (19,20-22); relations that, depending on the bibliography, are described as myofascial meridians, channels or chains. This type of fascia is also responsible for the subdivision and compartmentalization of the different tissues, through epi-, peri-, and endo-structures (Fig. 4).

The continuity and subdivisions of the deep fascia allow 30% of the power generated by a contraction in the muscular tissue to be transmitted through the

Figure 3

A. Transversal cut of cryopreserved arm. The image shows how the fascial tissue covers and connects all the anatomical structures. B. Enlargement of the image, the multidirectionality of the fascial tissue, its relationship with surrounding structures and the compartmentalization of the different types of tissue are shown.

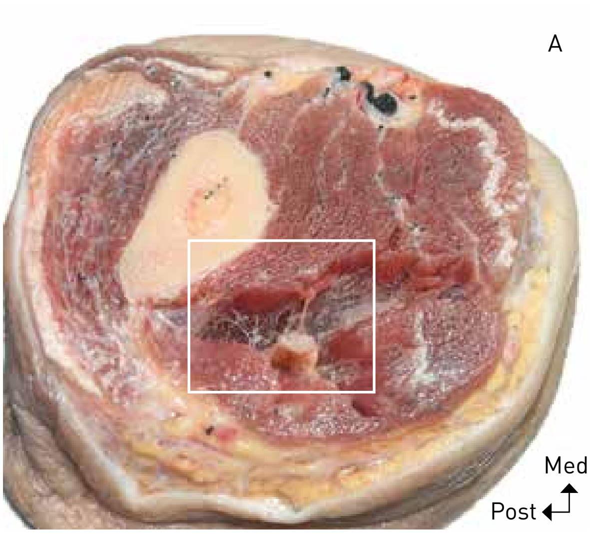


Figure 4

Relationship of fascial tissue with tendinous tissue. The epitendon (EpT) surrounds the whole tendon. The peritendon (PeT) covers tendinous bundles and the endotendon (EnT) surrounds each and every tendinous cell.

fascia and not through the muscular tissue and this to be done with synergic and antagonists muscles alike (23-26).

COMPOSITION OF FASCIA

Although fascial composition is similar to the rest of structures that form connective tissue, fasciae present a higher degree of irregularity in the distribution of their fibres (particularly when comparing fasciae to ligaments or tendons) and a variable composition of lax connective tissue (greater in deep fascia) or denser tissue (when analysing intermuscular fascia or septa) (27). Therefore, the histological composition of connective tissue (and consequently of all its components, including fasciae) is:

Extracellular matrix: it is all the extracellular components that are part of fascial tissue. We can find:

- **Elastin fibres**. It is a protein whose network distribution gives fascial tissue elasticity and, at the same time, resilience (28).
- **Collagen fibres** (mainly type I). Their distribution provides resistance and helps fascial tissue to adhere (17,28).
- **Reticular fibres**. These fibres predominate in the embrionary phase of fascial tissue and are eventually substituted by collagen fibres. Their presence, together with collagen fibres, contributes to the sliding of fasciae (29).

Cells:

- **Fibroblasts**. They are spindle-shaped cells with extensions whose main function is to secrete the components of the extracellular matrix, among which essential proteins for fasciae (elastin and collagen). They can easily adapt and remodel themselves in response to the different mechanical stimuli they receive (30-32).
- **Myofibroblasts**. They allow fascial tissue to contract to a certain extent (33-35), but their presence is not that clear in human fasciae since they have only been found in animal or pathological fasciae.
- **Adipose cells**. They accompany fibroblasts and their main function is to store lipids.
- **Macrophages**. They eliminate cellular and tissular debris and prepare fascial tissue for cicatrisation (36).

Ground substance: It occupies all the space in between cells and fibres of connective tissue. It is a viscous substance formed by long molecules of proteoglycans and glycosaminoglycans with hydrophilic properties, which allow nutrients and waste matter to circulate. Hyaluronic acid is one of the molecules most commonly found in ground substance and it enhances the sliding between fascial and muscular tissue (37,38). Lately, some studies suggest that the molecules of hyaluronic acid in fascial tissue may be connected with myofascial pain syndrome (39,40).

MAIN PROPERTIES AND FUNCTIONS OF FASCIA

The anatomical and histological composition of fascia gives it three key properties for its behaviour and treatment. These are: tensegrity, thixotropy, and piezoelectricity. Tensegrity of fascial tissue is one of the main characteristics of fascia, which allows us to understand how the increase in tension in a tissue can be stabilised or compensated by increasing tension in some of its parts (41) and so transfer this tension to all the elements in the tissue (42). This property can help the therapist to understand the concept of globalness and unity of the human being and account for the response of the human body to excessive tension or compression that can either be felt at the same site or somewhere else in the body. Thixotropy in fascia is made possible by the ground substance and it refers to the thinning property of this tissue when mechanical or thermic energy is applied, which then returns to its original state when this energy stops (43). This might explain why some fascial therapies are applied in a slow and continuous way like the *Scar Modelling Technique* (44). Piezoelectricity is given by the collagen in the fascia and is the capacity of generating some response resulting from mechanical pressure (45). All these properties make fascia one of the few tissues able to modify their consistency when it undergoes manipulation or tension (46,47), thus having an effect at cellular level.

The histological characteristics of fascia also account for its main functions (25,48), and some of the most important ones are:

- Compartmentalisation, support, and fixation (10,49).
- Transmission of forces (23,26).
- Absorption and dissemination of tensions (50).
- Coordination of movements (19).
- Facilitation of circulatory return and haemodynamics (51).
- Connection between different systems of the human body.
- Contribution to diffusion of nutrients and other elements, since fascial tissue has blood vessels that nourish surrounding tissues.

In short, fasciae form an exoskeleton that turns the body into a whole and that relates, interconnects and coordinates all the regions of the body (12).

CLINICAL IMPLICATIONS OF FASCIA

The importance of fascia for the therapist lies in the implication of this tissue in pathological processes. Frozen shoulder, plantar fasciitis, trigger points, or, more generally, fascial or myofascial restrictions (that can lead to articular and muscular movement restrictions) are some examples of fascial dysfunctions that therapists often have to treat. Thus, in patients with chronic lumbago, it's been observed how the fascia in that area was 25% thicker compared to healthy patients, with collagen fibre degradation, and microcalcifications (52). This tissue is also involved in scar formation and connective tissue fibrosis (53), which can lead to some limitation in sliding not only between different anatomical planes but also between different viscera (54) or nerves (principle of neurodynamics or peripheral nerve manipulation (55)). The latter case may cause neuropathies and nerve compressions close to the restriction site (56-58).

As if the properties and functions of fascia were not important enough for the clinical practice, it must be underlined that this tissue is the base of many medical, rehabilitation, and physiotherapy techniques. The fascial compartments and interfascial space are used for different anaesthetic routes and for blocking pain in different parts of the body (59,60). The principles of acupuncture and dry puncture are also based on fascial tissue. Some of the acupuncture points are distributed along the exit or perforation route of a cutaneous nerve of the deep fascia (61). Different studies have demonstrated that when inserting and rotating acupuncture needles, a small bundle of collage forms around the needle, which causes a mechanical stimulus and helps in the restoration of the extracellular matrix of connective tissue (62-65), which explains part of the effectiveness of acupuncture and dry puncture. In the same way, most of the beneficial effects of massage are based on the principle of tensegrity of fasciae (66), which accounts for the fact that, when massaging some parts of the body, motion range and flexibility increase and pain decreases (67,68). The effectiveness of some manual methods on meningeal or visceral structures can also be accounted for by the fascial bridges between suboccipital muscles and the dura mater (69) or the links and connections between fasciae and viscera (70).

CONCLUSION

Taking into account everything aforementioned, fascia is demonstrated to be an important tissue that works as an integrative structure of human anatomy, particularly of the musculoskeletal system. Because of that, the general term of pathology or muscular tear should be revised and the type of fascia involved in the lesion, determined. We should concentrate our therapeutic efforts not only on the contractile part of the musculoskeletal system but also on its fascial components.

ACKNOWLEDGEMENTS

We would like to thank corpse donors for their generosity, which allows anatomical sciences to advance. Thanks to all the staff at Servei de Donació de Cossos (Body Donation Service) and Dissection Room of Universitat de Barcelona (Campus de Bellvitge), especially to Mr J. Ll. Ramon, Ms N. Cayuela, Mr C. Martín and Ms G. Ramon. Thanks to Ms E. Sánchez for the histological processing of the samples. For his professionality and agility in bibliographical management, we are grateful to Mr L. Álvarez from Servei d'Obtenció de Documents (Document Management Service) of Universitat Internacional de Catalunya. Thanks to Ms A. Valls-Solsona for the retouch of photographs and iconography.

BIBLIOGRAPHY

1. Smith-Agreda V, Ferres-Torres E. FASCIAS. Principios de anatomo-fisio-patología. : Editorial Paidotribo; 2004.
2. Hedley G. Fascial nomenclature. J Bodywork Movement Ther 2015.
3. Langevin HM, Huijing PA. Communicating about fascia: history, pitfalls, and recommendations. International journal of therapeutic massage & bodywork 2009;2(4):3.
4. Yahia L, Pigeon P, DesRosiers E. Viscoelastic properties of the human lumbodorsal fascia. J Biomed Eng 1993;15(5):425-429.
5. Stecco A, Macchi V, Stecco C, Porzionato A, Ann Day J, Delmas V, *et al*. Anatomical study of myofascial continuity in the anterior region of the upper limb. J Bodywork Movement Ther 2009;13(1):53-62.
6. LeMoon K. Terminology used in fascia research. J Bodyw Mov Ther 2008;12(3):204-212.
7. Kardon G, Harfe BD, Tabin CJ. A Tcf4-positive mesodermal population provides a prepattern for vertebrate limb muscle patterning. Developmental cell 2003;5(6):937-944.
8. Mathew SJ, Hansen JM, Merrell AJ, Murphy MM, Lawson JA, Hutcheson DA, *et al*. Connective tissue fibroblasts and Tcf4 regulate myogenesis. Development 2011 Jan;138(2):371-384.
9. Sato T, Koizumi M, Kim JH, Kim JH, Wang BJ, Murakami G, *et al*. Fetal development of deep back muscles in the human thoracic region with a focus on transversospinalis muscles and the medial branch of the spinal nerve posterior ramus. J Anat 2011;219(6):756-765.
10. Blasi M, Blasi J, Domingo T, Pérez-Bellmunt A, Miguel-Pérez M. Anatomical and histological study of human deep fasciae development. Surg Radiol Anat. 2015 Aug;37(6):571-8. doi: 10.1007/s00276-014-1396-1.
11. Kumka M, Bonar J. Fascia: a morphological description and classification system based on a literature review. J Can Chiropr Assoc 2012 Sep;56(3):179-191.
12. Benjamin M. The fascia of the limbs and back--a review. J Anat 2009 Jan;214(1):1-18.
13. Abu-Hijleh MF, Roshier AL, Al-Shboul Q, Dharap AS, Harris PF. The membranous layer of superficial fascia: evidence for its widespread distribution in the body. Surg Radiol Anat 2006 Dec;28(6):606-619.
14. Lockwood TE. Superficial fascial system (SFS) of the trunk and extremities: a new concept. Plast Reconstr Surg 1991;87(6):1009-1018.
15. Stecco C, Porzionato A, Lancerotto L, Stecco A, Macchi V, Day JA, *et al*. Histological study of the deep fasciae of the limbs. J Bodyw Mov Ther 2008 Jul;12(3):225-230.
16. Stecco C, Pavan PG, Porzionato A, Macchi V, Lancerotto L, Carniel EL, *et al*. Mechanics of crural fascia: from anatomy to constitutive modelling. Surg Radiol Anat 2009 Aug;31(7):523-529.
17. Pilat A. Terapias miofasciales: Inducción miofascial. McGraw-Hill Interamericana de España; 2003.
18. Stecco C, Porzionato A, Macchi V, Stecco A, Vigato E, Parenti A, *et al*. The expansions of the pectoral girdle muscles onto the brachial fascia: morphological aspects and spatial disposition. Cells Tissues Organs (Print) 2008;188(3):320-329.
19. Vleeming A, Pool-Goudzwaard AL, Stoeckart R, van Wingerden J, Snijders CJ. The Posterior Layer of the Thoracolumbar Fascial Its Function in Load Transfer From Spine to Legs. Spine 1995;20(7):753-758.
20. Barker PJ, Briggs CA, Bogeski G. Tensile transmission across the lumbar fasciae in unembalmed cadavers: effects of tension to various muscular attachments. Spine 2004;29(2):129-138.
21. Barker PJ, Briggs CA. Attachments of the posterior layer of lumbar fascia. Spine 1999;24(17):1757.
22. Sato K, Nimura A, Yamaguchi K, Akita K. Anatomical study of the proximal origin of hamstring muscles. J Orthop Sci 2012 Sep;17(5):614-618.
23. Huijing PA, Baan GC. Myofascial force transmission causes interaction between adjacent muscles and connective tissue: effects of blunt dissection and compartmental fasciotomy on length force characteristics of rat extensor digitorum longus muscle. Arch Physiol Biochem 2001 Apr;109(2):97-109.
24. Huijing PA, Baan GC. Extramuscular myofascial force transmission within the rat anterior tibial compartment: proximo-distal differences in muscle force. Acta Physiol Scand 2001 Nov;173(3):297-311.

25. Huijing PA, van de Langenberg RW, Meesters JJ, Baan GC. Extramuscular myofascial force transmission also occurs between synergistic muscles and antagonistic muscles. Journal of Electromyography and Kinesiology 2007;17(6):680-689.
26. Maas H, Baan GC, Huijing PA. Intermuscular interaction via myofascial force transmission: effects of tibialis anterior and extensor hallucis longus length on force transmission from rat extensor digitorum longus muscle. J Biomech 2001 Jul;34(7):927-940.
27. Schleip R, Jager H, Klingler W. What is 'fascia'? A review of different nomenclatures. J Bodyw Mov Ther 2012 Oct;16(4):496-502.
28. Culav EM, Clark CH, Merrilees MJ. Connective tissues: matrix composition and its relevance to physical therapy. Phys Ther 1999 Mar;79(3):308-319.
29. Kawamata S, Ozawa J, Hashimoto M, Kurose T, Shinohara H. Structure of the rat subcutaneous connective tissue in relation to its sliding mechanism. Arch Histol Cytol 2003 Aug;66(3):273-279.
30. Eagan TS, Meltzer KR, Standley PR. Importance of strain direction in regulating human fibroblast proliferation and cytokine secretion: a useful in vitro model for soft tissue injury and manual medicine treatments. J Manipulative Physiol Ther 2007;30(8):584-592.
31. Meltzer KR, Cao TV, Schad JF, King H, Stoll ST, Standley PR. In vitro modeling of repetitive motion injury and myofascial release. J Bodywork Movement Ther 2010;14(2):162-171.
32. Jiang H, Grinnell F. Cell-matrix entanglement and mechanical anchorage of fibroblasts in three-dimensional collagen matrices. Mol Biol Cell 2005 Nov;16(11):5070-5076.
33. Masood N, Naylor I. Effect of adenosine on rat superficial and deep fascia and the effect of heparin on the contractile responses. Br J Pharmacol 1994;113:112P-112P.
34. Klinge U, Si ZY, Zheng H, Schumpelick V, Bhardwaj RS, Klosterhalfen B. Collagen I/III and matrix metalloproteinases (MMP) 1 and 13 in the fascia of patients with incisional hernias. J Invest Surg 2001 Jan-Feb;14(1):47-54.
35. Schleip R, Klingler W, Lehmann-Horn F. Fascia is able to contract in a smooth muscle-like manner and thereby influence musculoskeletal mechanics. J Biomech 2006;39:S488.
36. Leibovich S, Ross R. The role of the macrophage in wound repair. A study with hydrocortisone and antimacrophage serum. The American journal of pathology 1975;78(1):71.
37. Piehl-Aulin K, Laurent C, Engstrom-Laurent A, Hellstrom S, Henriksson J. Hyaluronan in human skeletal muscle of lower extremity: concentration, distribution, and effect of exercise. J Appl Physiol (1985) 1991 Dec;71(6):2493-2498.
38. Laurent C, Johnson-Wells G, Hellstrom S, Engstrom-Laurent A, Wells AF. Localization of hyaluronan in various muscular tissues. A morphological study in the rat. Cell Tissue Res 1991 Feb;263(2):201-205.
39. Stecco C, Stern R, Porzionato A, Macchi V, Masiero S, Stecco A, *et al.* Hyaluronan within fascia in the etiology of myofascial pain. Surg Radiol Anat 2011 Dec;33(10):891-896.
40. Stecco A, Gesi M, Stecco C, Stern R. Fascial components of the myofascial pain syndrome. Curr Pain Headache Rep 2013 Aug;17(8):352-013-0352-9.
41. Ingber DE. The architecture of life. Sci Am 1998;278(1):48-57.
42. Kassolik K, Andrzejewski W. Tensegration massage. 2010.
43. Myers TW. Anatomy trains: myofascial meridians for manual and movement therapists. Elsevier Health Sciences; 2009.
44. Rodríguez RM, del Río FG. Mechanistic basis of manual therapy in myofascial injuries. Sonoelastographic evolution control. J Bodywork Movement Ther 2013;17(2):221-234.
45. Schleip R, Findley TW, Chaitow L, Huijing P. Fascia: the tensional network of the human body: the science and clinical applications in manual and movement therapy. : Elsevier Health Sciences; 2013.
46. Stecco L. Fascial manipulation for muscoloskeletal pain. Piccin Nuova Libraria SpA; 2004.
47. Ingber DE. Tensegrity and mechanotransduction. J Bodywork Movement Ther 2008;12(3):198-200.
48. Gordon MK, Hahn RA. Collagens. Cell Tissue Res 2010 Jan;339(1):247-257.
49. Perez-Bellmunt A, Miguel-Perez M, Blasi-Brugue M, Cabus JB, Casals M, Martinoli C, *et al.* An anatomical and histological study of the structures surrounding the proximal attachment of the hamstring muscles. Man Ther 2015 Jun;20(3):445-450.
50. Benjamin M, Kaiser E, Milz S. Structure-function relationships in tendons: a review. J Anat 2008 Mar;212(3):211-228.
51. Caggiati A. Fascial relations and structure of the tributaries of the saphenous veins. Surgical and Radiologic Anatomy 2000;22(3-4):191-196.
52. Liptan GL. Fascia: A missing link in our understanding of the pathology of fibromyalgia. J Bodywork Movement Ther 2010;14(1):3-12.

53. Bordoni B, Zanier E. Skin, fascias, and scars: symptoms and systemic connections. J Multidiscip Healthc 2013;7:11-24.
54. Hedley G. Notes on visceral adhesions as fascial pathology. J Bodywork Movement Ther 2010;14(3):255-261.
55. Barral J, Croibier A. Manipulaciones de los nervios periféricos. Elsevier; 2009.
56. Puranen J, Orava S. The hamstring syndrome. A new diagnosis of gluteal sciatic pain. Am J Sports Med 1988 Sep-Oct;16(5):517-521.
57. Puranen J, Orava S. The hamstring syndrome--a new gluteal sciatica. Ann Chir Gynaecol 1991;80(2):212-214.
58. Young IJ, van Riet RP, Bell SN. Surgical release for proximal hamstring syndrome. Am J Sports Med 2008 Dec;36(12):2372-2378.
59. Domingo T, Blasi J, Casals M, Mayoral V, Ortiz-Sagristá JC, Miguel-Pérez M. Is interfascial block with ultrasound-guided puncture useful in treatment of myofascial pain of the trapezius muscle? Clin J Pain 2011;27(4):297-303.
60. Vachon CA, Bacon DR, Rose SH. Gaston Labat's Regional Anesthesia: the missing years. Anesth Analg 2008 Oct;107(4):1371-1375.
61. Dung H. Anatomical features contributing to the formation of acupuncture points. Am J Acupunct 1984;12(2):139-143.
62. Kimura M, Tohya K, Kuroiwa K, Oda H, Gorawski EC, Zhong XH, *et al*. Electron microscopical and immunohistochemical studies on the induction of "Qi" employing needling manipulation. Am J Chin Med 1992;20(01):25-35.
63. Langevin HM, Churchill DL, Cipolla MJ. Mechanical signaling through connective tissue: a mechanism for the therapeutic effect of acupuncture. FASEB J 2001 Oct;15(12):2275-2282.
64. Langevin HM, Yandow JA. Relationship of acupuncture points and meridians to connective tissue planes. Anat Rec 2002;269(6):257-265.
65. Giebel J. Mecanotransducción y transducción de señales a través del tejido conjuntivo: Mecanismos que explicarían el efecto terapéutico de la acupuntura. Revista Internacional de Acupuntura 2008;2(1):9-14.
66. Kassolik K, Jaskólska A, Kisiel-Sajewicz K, Marusiak J, Kawczyński A, Jaskólski A. Tensegrity principle in massage demonstrated by electro-and mechanomyography. J Bodywork Movement Ther 2009;13(2):164-170.
67. Rushton A, Spencer S. The effect of soft tissue mobilisation techniques on flexibility and passive resistance in the hamstring muscle-tendon unit: a pilot investigation. Man Ther 2011 Apr;16(2):161-166.
68. Kassolik K, Andrzejewski W, Brzozowski M, Wilk I, Górecka-Midura L, Ostrowska B, *et al*. Comparison of Massage Based on the Tensegrity Principle and Classic Massage in Treating Chronic Shoulder Pain. J Manipulative Physiol Ther 2013.
69. Enix DE, Scali F, Pontell ME. The cervical myodural bridge, a review of literature and clinical implications. J Can Chiropr Assoc 2014 Jun;58(2):184-192.
70. Johnson IP. Colorectal and uterine movement and tension of the inferior hypogastric plexus in cadavers. Chiropractic & manual therapies 2012;20(1):1.