
BACKGROUND: Whiplash associated disorders commonly affect people after a motor vehicle accident, causing a variety of disabling manifestations. Some manual and physical approaches have been proposed to improve myofascial function after traumatic injuries, in order to effectively reduce pain and functional limitation. AIM: To evaluate whether the application of the Fascial Manipulation© technique could be more effective than a conventional approach to improve cervical range of motion in patients with subacute whiplash associated disorders. DESIGN: Pilot randomized clinical trial. METHODS: Eighteen patients with subacute whiplash associated disorders were randomized into two groups. Group A (N.=9) received three, 30-minute sessions, (every five days during a two week period) of neck Fascial Manipulation©. Group B (N.=9) received ten, 30-minute sessions (five days a week for two consecutive weeks) of neck exercises plus mobilization. Patients were evaluated before, immediately after and two weeks post-treatment. Primary outcome measures: cervical active range of motion (flexion, extension, right lateral flexion, left lateral flexion, right rotation, and left rotation). RESULTS: A statistically significant improvement in neck flexion was found after treatment in favour of Group A (60.2±10.8°) compared with Group B (46.3±15.1°). No differences were found between groups for the other primary outcomes at post-treatment or follow-up. CONCLUSION: The Fascial Manipulation© technique may be a promising method to improve cervical range of motion in patients with subacute whiplash associated disorders. CLINICAL REHABILITATION IMPACT: Myofascial techniques may be useful for improving treatment of subacute whiplash associated disorders also reducing their economic burden.


Recent studies reveal the role of the ankle retinacula in proprioception and functional stability of the ankle, but there is no clear evidence of their role in the outcomes of ankle sprain. 25 patients with outcomes of ankle sprain were evaluated by MRI to analyze possible damage to the ankle retinacula. Patients with damage were subdivided into two groups: group A comprised cases with ankle retinacula damage only, and group B those also with anterior talofibular ligament rupture or bone marrow edema. Both groups were examined by VAS, CRTA and static posturography and underwent three treatments of deep connective tissue massage (Fascial Manipulation technique). All evaluations were repeated after the end of treatment and at 1, 3 and 6 months. At MRI, alteration of at least one of the ankle retinacula was evident in 21 subjects, and a further lesion was also identified in 7 subjects. After treatment, VAS and CRTA evaluations showed a statistically significant decrease in values with respect to those before treatment (p < 0.0001). There were also significant improvements (p < 0.05) in stabilometric platform results. No significant difference was found between groups A and B. The initial benefit was generally maintained at follow-up. The alteration of
retinacula at MRI clearly corresponds to the proprioceptive damage revealed by static posturography and clinical examination. Treatment focused on the retinacula may improve clinical outcomes and stabilometric data.


This article reviews fascia research from our laboratory and puts this in the context of recent progress in fascia research which has greatly expanded during the past seven or eight years. Some readers may not be familiar with the terminology used in fascia research articles and are referred to LeMoon (2008) for a glossary of terms used in fascia-related articles.


The layers of loose connective tissue within deep fasciae were studied with particular emphasis on the histochemical distribution of hyaluronan (HA). Samples of deep fascia together with the underlying muscles were taken from neck, abdomen and thigh from three fresh non-embalmed cadavers. Samples were stained with hematoxylin-eosin, Azan-Mallory, Alcian blue and a biotinylated HA-binding protein specific for HA. An ultrasound study was also performed on 22 voluntary subjects to analyze the thickness of these deep fasciae and their sublayers. The deep fascia presented a layer of HA between fascia and the muscle and within the loose connective tissue that divided different fibrous sublayers of the deep fascia. A layer of fibroblast-like cells that stained prominently with Alcian blue stain was observed. It was postulated that these are cells specialized for the biosynthesis of the HA-rich matrix. These cells we have termed "fasciacytes", and may represent a new class of cells not previously recognized. The ultrasound study highlighted a mean thickness of 1.88 mm of the fascia lata, 1.68 mm of the rectus sheath, and 1.73 mm of the sternocleidomastoid fascia. The HA within the deep fascia facilitates the free sliding of two adjacent fibrous fascial layers, thus promoting the normal function associated with the deep fascia. If the HA assumes a more packed conformation, or more generally, if the loose connective tissue inside the fascia alters its density, the behavior of the entire deep fascia and the underlying muscle would be compromised. This, we predict, may be the basis of the common phenomenon known as "myofascial pain."


**SUMMARY:** The perception of what appears to be connective tissue fibrosis, and its consequent modification during therapy, is a daily experience for most manual therapists. The aim of this study was to evaluate the time required to modify a palpatory sensation of fibrosis of the fascia in correlation with changes in levels of patient discomfort in 40 subjects with low back pain utilizing the Fascial Manipulation technique. This study evidenced, for the first time, that the time required to modify an apparent fascial density differs in accordance with differences in characteristics of the subjects and of the symptoms. In particular, the mean time to halve the pain was 3.24 min; however, in those subjects with symptoms present from less than 3 months (sub-acute) the mean time was lesser (2.58 min) with respect to the chronic patients (3.29 min). Statistically relevant (p < 0.05) differences were also evidenced between the specific points treated.

Classical anatomy still relegates muscular fascia to a role of contention. Nonetheless, different hypotheses concerning the function of this resilient tissue have led to the formulation of numerous soft tissue techniques for the treatment of musculoskeletal pain. This paper presents a pilot study concerning the application of one such manual technique, Fascial Manipulation, in 28 subjects suffering from chronic posterior brachial pain. This method involves a deep kneading of muscular fascia at specific points, termed centres of coordination (cc) and centres of fusion (cf), along myofascial sequences, diagonals, and spirals. Visual Analogue Scale (VAS) measurement of pain administered prior to the first session, and after the third session was compared with a follow-up evaluation at 3 months. Results suggest that the application of Fascial Manipulation technique may be effective in reducing pain in chronic shoulder dysfunctions. The anatomical substratum of the myofascial continuity has been documented by dissections and the biomechanical model is discussed.


According to Fascial Manipulation theory, patellar tendon pain is often due to uncoordinated quadriceps contraction caused by anomalous fascial tension in the thigh. Therefore, the focus of treatment is not the patellar tendon itself, but involves localizing the cause of this incoordination, considered to be within the muscular fascia of the thigh region. Eighteen patients suffering from patellar tendon pain were treated with the Fascial Manipulation technique. Pain was assessed (in VAS) before (VAS 67.8/100) and after (VAS 26.5/100) treatment, plus a follow-up evaluation at 1 month (VAS 17.2/100). Results showed a substantial decrease in pain immediately after treatment (p<0.0001) and remained unchanged or improved in the short term. The results show that the patellar tendon may be only the zone of perceived pain and that interesting results can be obtained by treating the muscular fascia of the quadriceps muscle, whose alteration may cause motor incoordination and subsequent pathology.


INTRODUCTION: In recent times new surgical approaches have been developed, in which subcutaneous tissue is the primary object, such as flaps and fat removal techniques, but different descriptions and abundance of terminology persist in Literature about this tissue. AIM AND METHODS: In order to investigate the structure of abdominal subcutaneous tissue, macroscopic and microscopic analyses of its layers were performed in 10 fresh cadavers. Results were compared with in vivo CT images of the abdomen of 10 subjects. RESULTS: The subcutaneous tissue of the abdomen comprises three layers: a superficial adipose layer (SAT), a membranous layer, and a deep adipose layer (DAT). The SAT presented fibrous septa that defined polygonal-oval lobes of fat cells with a mean circularity factor of 0.856 ± 0.113. The membranous layer is a continuous fibrous membrane rich in elastic fibers with a mean thickness of 847.4 ± 295 μm. In the DAT the fibrous septa were predominantly obliquely-horizontaly oriented, defining large, flat, polygonal lobes of fat cells (circularity factor: mean 0.473 ± 0.07). The CT scans confirm these findings, showing a variation of the thickness of the SAT, DAT and membranous layer according with the subjects and with the regions. DISCUSSION: The distinction of SAT and DAT and their anatomic differences are key elements in modern approaches to liposuction. The membranous layer appears to be also a dissection plane which merits further attention. According with the revision of Literature, the Authors propose that the term "superficial fascia" should only be used as a synonym for the membranous layer.


PURPOSE: To create computerized three-dimensional models of the crural fascia and of the superficial layer of the thoracolumbar fascia. METHODS: Serial sections of these two fasciae, stained with Azan-
Mallory, van Gieson and anti-S100 antibody stains, were recorded. The resulting images were merged (Image Zone 5.0 software) and aligned (MatLab Image Processing Toolkit). Color thresholding was applied to identify the structures of interest. 3D models were obtained with Tcl/Tk scripts and Paraview 3.2.1 software. From these models, the morphometric features of these fasciae were evaluated with ImageJ.

**RESULTS:** In the crural fascia, collagen fibers represent less than 20% of the total volume, arranged in three distinct sub-layers (mean thickness, 115 μm), separated by a layer of loose connective tissue (mean thickness, 43 μm). Inside a single sub-layer, all the fibers are parallel, whereas the angle between the fibers of adjacent layers is about 78°. Elastic fibers are less than 1%. Nervous fibers are mostly concentrated in the middle layer. The superficial layer of the thoracolumbar fascia is also formed of three thinner sub-layers, but only the superficial one is similar to the crural fascia sub-layers, the intermediate one is similar to a flat tendon, and the deep one is formed of loose connective tissue. Only the superficial sub-layer has rich innervation and a few elastic fibers. **DISCUSSION:** Computerized three-dimensional models provide a detailed representation of the fascial structure, for better understanding of the interactions among the different components. This is a fundamental step in understanding the mechanical behavior of the fasciae and their role in pathology.


**PURPOSE:** To investigate the macroscopic anatomy and histological characteristics of the transverse carpal ligament and the flexor retinaculum of the wrist and to investigate their anatomical relationships and define appropriate terminology. **METHODS:** The volar regions of the wrists of 30 unembalmed subjects were examined by dissection and by histological and immunohistochemical staining. In vivo magnetic resonance imaging studies were also carried out on 10 subjects. **RESULTS:** The dissection study showed that the antebrachial fascia at the volar aspect of the wrist presents a reinforcement. From a histological point of view, it is composed of 3 layers of undulated collagen fiber bundles. Adjacent layers show different orientations of the collagen fibers. Many nerve fibers and Pacini and Ruffini corpuscles were found in all specimens. Under this fibrous plane is another fibrous structure, placed transversely between the ulnar-sided hamate and pisiform bones, and the radial-sided scaphoid and trapezium bones. The deeper fibrous structure shows completely different histological characteristics, having parallel, thicker collagen fiber bundles and few nerve fibers. Magnetic resonance images confirm the presence of 2 clearly distinguished fibrous structures in the wrist, the first in continuity with the antebrachial fascia and the second located in a deeper plane between the hamate and scaphoid. **CONCLUSIONS:** Two different fibrous structures with different histological characteristics are present in the volar wrist: the more superficial one is in continuity with the antebrachial fascia and could be considered its reinforcement; the deeper one is composed of strong lamina, with histological features similar to those of a ligament. For these reasons, we suggest that the term transverse carpal ligament should be used to indicate the fibrous lamina connecting the hamate and pisiform to the scaphoid and trapezium and that the term flexor retinaculum of the wrist should be abandoned because it does not correspond to any specific.


**STUDY DESIGN:** Research report. **OBJECTIVES:** To evaluate the anatomical characteristics of the ankle retinacula and their relationship with the fasciae and muscles in healthy subjects and in patients with ankle sprain outcomes. **BACKGROUND:** The role of the retinacula in proprioception has begun to emerge, but without clear anatomical bases or descriptions of their possible damage in patients with ankle sprain outcomes. **METHODS:** Dissection, histological and immunohistochemical analysis of 27 legs. An in vivo radiological study by MRI was also performed on 7 healthy volunteers, 17 patients with outcomes of ankle
sprain, and 3 amputated legs. RESULTS: The retinacula are thickenings of the deep fascia presenting bone or muscular connections. They are formed of 2-3 layers of parallel collagen fibre bundles, densely packaged with a little loose connective tissue, without elastic fibres but many nervous fibres and corpuscles. By MRI, the retinacula appeared as low-signal-intensity bands with a mean thickness of 1 mm. In patients with outcomes of ankle sprain, MR findings were abnormal retinacula thickness, signal intensity, and full-thickness gap. DISCUSSION: The retinacula are not static structures for joint stabilisation, like the ligaments, but a specialisation of the fascia for local spatial proprioception of the movements of foot and ankle. Their anatomical variations and accessory bundles may be viewed as morphological evidence of the integrative role of the fascial system in peripheral control of articular motility.


A constitutive model is proposed to describe the mechanical behavior of the plantar fascia. The mechanical characterization of the plantar fascia regards the role in the foot biomechanics and it is involved in many alterations of its functional behavior, both of mechanical and nonmechanical origin. The structural conformation of the plantar fascia in its middle part is characterized by the presence of collagen fibers reinforcing the tissue along a preferential orientation, which is that supporting the major loading. According to this anatomical evidence, the tissue is described by developing an anisotropic fiber-reinforced constitutive model and since the elastic response of the fascia is here considered, the constitutive model is based on the theory of hyperelasticity. The model is consistent with a kinematical description of large strains mechanical behavior, which is typical of soft tissues. A fitting procedure of the constitutive model is implemented making use of experimental curves taken from the literature and referring to specimens of human plantar fascia. A satisfactory fitting of the tensile behavior of the plantar fascia has been performed, showing that the model correctly interprets the mechanical behavior of the tissue in the light of comparison to experimental data at disposal. A critical analysis of the model with respect to the problem of the identification of the constitutive parameters is proposed as the basis for planning a future experimental investigation of mechanical behavior of the plantar fascia.


The purpose of this study was to investigate the morphology of the superficial musculoaponeurotic system (SMAS). Eight embalmed cadavers were analyzed: one side of the face was macroscopically dissected; on the other side, full-thickness samples of the parotid, zygomatic, nasolabial fold and buccal regions were taken. In all specimens, a laminar connective tissue layer (SMAS) bounding two different fibroadipose connective layers was identified. The superficial fibroadipose layer presented vertically oriented fibrous septa, connecting the dermis with the superficial aspect of the SMAS. In the deep fibroadipose connective layer, the fibrous septa were obliquely oriented, connecting the deep aspect of the SMAS to the parotid-masseteric fascia. This basic arrangement shows progressive thinning of the SMAS from the preauricular district to the nasolabial fold (p < 0.05). In the parotid region, the mean thicknesses of the superficial and deep fibroadipose connective tissues were 1.63 and 0.8 mm, respectively, whereas in the region of the nasolabial fold the superficial layer is not recognizable and the mean thickness of the deep fibroadipose connective layer was 2.9 mm. The connective subcutaneous tissue of the face forms a three-dimensional network connecting the SMAS to the dermis and deep muscles. These connective laminae connect adipose lobules of various sizes within the superficial and deep fibroadipose tissues, creating a three-dimensional network which modulates transmission of muscle contractions to the skin. Changes in the quantitative and qualitative characteristics of the fibroadipose connective system, reducing its viscoelastic properties, may contribute to ptosis of facial soft tissues during aging.

AIM: Analysis of the pectoral fascia from a macroscopic and histological point of view. RESULTS: The pectoral fascia appears as a thin collagen layer (mean thickness of 297 microm) formed by undulated collagen fibres and many elastic fibres, within which small nerves are highlighted. Numerous septa detach from its internal surface, creating an intimate connection between the fascia and the pectoralis major muscle. DISCUSSION: The pectoral fascia and the pectoralis major muscle should be considered together, given that the anatomical base is effectively a myofascial unit, term that defines the muscles and the fascia of a specific region that have a precise functional organization. The capacity of force transmission between the inferior and superior limbs needs to be attributed to this entire myofascial complex. We hypothesize that the superficial, large muscles of the trunk developed inside the superficial layer of the deep fascia to enhance modulation of tension transmission between the different segments of the body.


Ten dissections of inferior limbs and histological studies were performed to describe the structural conformation of the muscular fascia of the leg (crural fascia) and to propose a constitutive model to be adopted for the analysis of its biomechanical behaviour. The crural fascia had a mean thickness of 924 microm and was composed of three layers (mean thickness 277.6 microm) of parallel, collagen fibre bundles separated by a thin layer of loose connective tissue (mean thickness 43 microm). Only a few elastic fibres were highlighted. The disposition of the collagen fibres gives the crural fascia anisotropic characteristics. In addition, their crimped conformation is the cause of the non-linear elastic behaviour of the tissue. Both these aspects are included in the constitutive model. The constitutive modelling of the crural fascia represents a useful tool to rationally interpret the correlation between functional behaviour and structural conformation.


The palmaris longus (PL) is a muscle of the forearm with a long distal tendon that is continuous with the palmar aponeurosis (PA). It is generally assumed that the muscle lies deep to the antebrachial fascia from origin to termination, but a detailed description is lacking. The relationship of the PL tendon with the antebrachial fascia was studied in 30 dissections. The PL was completely absent in six specimens (20%), whereas the PA was identified in all. Average length of the forearm was 25.5 cm (SD: 2.1 cm, range 22-29 cm), overall length of the PL muscle 26.9 cm (SD: 2.6 cm, range 22.5-31.5 cm), muscular belly 13.8 cm (SD: 3.4 cm, range 9.5-23 cm), tendon 13.1 cm (SD: 3.3 cm, range 8-15.5 cm). Proximally, the PL was situated deep to the antebrachial fascia, then in the lower third of the forearm its tendon perforated the antebrachial fascia (at 4.7 +/- 1.7 cm from the bistyloid line) moving to a suprafascial plane, inserting in the PA. The PA could be divided into two layers: the superficial one formed by longitudinal fibers and adherent to the skin, the deep one formed by transverse fibers continuous laterally with the deep fascia of the hand. The PL tendon was found to be in continuity only with the longitudinal fibers of the PA. Based on the anatomical findings, it may be suggested that the superficial part of the PA is situated in the subcutaneous planes of the palm, and that the muscle should be considered as a tensor of the superficial fascial system of the subcutaneous tissue.

Fifteen unembalmed cadavers were dissected in order to study the "anatomical continuity" between the various muscles involved in the movement of flexion of the upper limb. This study demonstrated the existence of specific myofascial expansions, with a nearly constant pattern, which originate from the flexor muscles and extend to the overlying fascia. The clavicular part of the pectoralis major sends a myofascial expansion, with a mean length of 3.6cm, to the anterior region of the brachial fascia, and the costal part sends one to the medial region of the brachial fascia (mean length: 6.8cm). The biceps brachii presents two expansions: the lacertus fibrosus, oriented medially, with a mean height of 4.7cm and a base of 1.9cm, and a second, less evident, longitudinal expansion (mean length: 4.5cm, mean width: 0.7cm). Lastly, the palmaris longus sends an expansion to the fascia overlying the thenar muscles (mean length: 1.6cm, mean width: 0.5cm). During flexion, as these muscles contract, the anterior portion of the brachial and antebrachial fascia is subject to tension. As the fascia is rich in proprioceptive nerve endings, it is hypothesized that this tension activates a specific pattern of receptors, contributing to perception of motor direction. If the muscular fascia is in a non-physiological state, these mechanisms are altered, and the proprioceptors


The aim of this study is to analyse the deep fasciae of limbs in order to evaluate the collagen and elastic fibre arrangement and the types of innervation. Histological and immunohistochemical stains were performed in 72 specimens. The deep fascia of the limbs is a sheath presenting a mean thickness of 1mm, formed by two to three layers of parallel collagen fibre bundles. In the adjacent layers, they show different orientations. Each layer is separated from the adjacent one by loose connective tissue, permitting the sliding of the collagen layers. Nerve fibres were found in all specimens, while muscular fibres were evidenced only in one specimen. The described structure permits the fasciae of the limbs to have a strong resistance to traction, even when exercised in different directions. The capacity of the different collagen layers to glide one on the other could be altered in cases of overuse syndrome, trauma, or surgery.


The aim of this study was to analyse the organization of the deep fascia of the pectoral region and of the thigh. Six unembalmed cadavers (four men, two women, age range 48-93 years old) were studied by dissection and by histological (HE, van Gieson and azan-Mallory) and immunohistochemical (anti S-100) stains; morphometric studies were also performed in order to evaluate the thickness of the deep fascia in the different regions. The pectoral fascia is a thin lamina (mean thickness +/- SD: 297 +/- 37 mum), adherent to the pectoralis major muscle via numerous intramuscular fibrous septa that detach from its inner surface. Many muscular fibres are inserted into both sides of the septa and into the fascia. The histological study demonstrates that the pectoral fascia is formed by a single layer of undulated collagen fibres, intermixed with many elastic fibres. In the thigh, the deep fascia (fascia lata) is independent from the underlying muscle, separated by the epimysium and a layer of loose connective tissue. The fascia lata presents a mean thickness of 944 mum (+/- 102 mum) and it is formed by bundles of collagen fibres, arranged in two to three layers. In each layer, the fibres are parallel to each other, whereas the orientation of the fibres varies from one layer to the adjacent one. The van Gieson elastic fibres stain highlights the presence of elastic fibres only in the more external layer of the fascia lata. In the thigh the epimysium is easily recognizable under the deep fascia and presents a mean thickness of 48 mum. Both the fascia lata and pectoral fascia result innerved, no specific differences in density or type of innervations is highlighted. The deep fascia of the pectoral region is morphologically and functionally different from that of the thigh: the fascia lata is a relatively autonomous structure with respect to the underlying muscular plane, while the pectoralis fascia acts as an additional insertion for the pectoralis major muscle. Different portions of the pectoralis major muscle are activated according to the glenohumeral joint movements and, consequently, selective portions of the pectoral fascia
are stretched, activating specific patterns of proprioceptors. So, the pectoralis muscle has to be considered together with its fascia, and so as a myofascial unit, acting as an integrated control motor system.


BACKGROUND/AIMS: The aim of this study was to analyse the relationships between the expansions of the pectoral girdle muscles, i.e. pectoralis major, latissimus dorsi and deltoid, and the brachial fascia.

METHODS: Thirty shoulder specimens from 15 unembalmed adult cadavers were studied by dissection and in vivo radiological studies were performed in 20 patients using magnetic resonance (MR) imaging.

RESULTS: The clavicular part of the pectoralis major muscle sent a fibrous expansion onto the anterior portion of the brachial fascia, its costal part onto the medial portion and medial intermuscular septum. The latissimus dorsi muscle showed a triangular fibrous expansion onto the posterior portion of the brachial fascia. The posterior part of the deltoid muscle inserted muscular fibres directly onto the posterior portion of the brachial fascia, its lateral part onto the lateral portion and the lateral intermuscular septum. In MR images, the brachial fascia appeared as a low-signal-intensity sinuous line of connective tissue, sharply delineated in T1-weighted sequences.

CONCLUSION: The expansions of the pectoral girdle muscles onto the brachial fascia were present in all the subjects and showed a quite constant course with a specific spatial organization. During the various movements of the arm, these expansions stretch selective portions of the brachial fascia, with possible activation of specific patterns of fascial proprioceptors.


The aim of the study was to analyse the appearance of the superficial musculo-aponeurotic system (SMAS) in radiological images (Magnetic Resonance -MR- and Computed tomography -CT- scans, 10M, 10F randomly selected) in the three regions of the face (the parotid and cheek regions and the nasolabial fold). In axial CT images, the SMAS appears as a relatively hyperdense tortuous line between the hypodense superficial fibroadipose tissue (SAT) and the hypodense deep adipose tissue (DAT). In parotid region SAT is well represented (mean thickness 4.32 +/- 2.9 mm), whereas DAT is very thin (0.33 +/- 0.48 mm); SMAS appears as a thin hyperdense line, close to the parotid gland (0.76 +/- 0.43 mm). In cheek region, SAT is well represented (5.57 +/- 1.17 mm), whereas DAT is thinner (2.94 +/- 0.62 mm), and SMAS is well recognisable (1.69 +/- 0.52 mm). At the level of the nasolabial fold, the SAT is poorly represented (0.37 +/- 0.06 mm); the SMAS continues in the mimic muscles (2.41 +/- 0.05 mm), and DAT shows a mean thickness of 2.15 +/- 0.63 mm. In the MR examination, the SMAS appears as a thin continuous line hypointense in the T1-and T2-weighted sequence, from parotid region to nasolabial fold, comprising mimic muscles in the anterior region of the cheek and at the level of the nasolabial fold. No significative differences in thickness between CT and MR were found. Our anatomo-radiological study confirms that the subcutaneous architecture of the face consists of multiple layers of tissues that connect facial muscles with the dermis. This pattern of arrangement shows a progressive centrifugal thinning towards the adjacent regions.


We examined 30 upper limbs in order to study the tendinous muscular insertions into the deep fascia and to verify whether they have a specific anatomical arrangement and to measure their resilience to traction. We have found that the fascia receives many tendinous muscular insertions, which are always present and exhibit a constant anatomical structure. In particular, the pectoralis major fascia always continues with the
brachial fascia in two distinct ways: the fascia overlying the clavicular part of pectoralis major had an expansion towards the anterior brachial fascia, whereas the fascia covering its costal part extended into the medial brachial fascia and the medial intermuscular septum. The lacertus fibrosus was also composed by two groups of fibres: the main group was oriented downwards and medially, the second group longitudinally. The palmaris longus opened out into a fan-shape in the palm of the hand and sent some tendinous expansions to the flexor retinaculum and fascia overlying the thenar eminence muscles. In the posterior region of the arm, the fascia of the latissimus dorsi sent a fibrous lamina to the triceps brachial fascia. The triceps tendon inserted partially into the antebrachial fascia, while the extensor carpi ulnaris sent a tendinous expansion to the fascia of the hypothenar eminence. It is hypothesized that the tendinous muscular insertions maintain the fascia at a basal tension and create myofascial continuity between the different muscles actuating flexion and extension of the upper limb, stretching the fascia in different ways according to the different motor directions.


INTRODUCTION: The aim of this work was to obtain a preliminary investigation of the mechanical properties of the human plantar aponeurosis based on regional observation, in order to rationally plan a subsequent larger experimental campaign and develop suited constitutive models to characterize the mechanical response of this tissue. MATERIALS AND METHODS: Different in vitro mechanical tests were developed on eleven samples taken from the plantar aponeurosis of human cadaver (man, age 78 years). The samples were tested along the distal-proximal direction. Range of elasticity of the tissue, development of damage phenomena and stress relaxation at different levels of strain were evaluated. RESULTS: The strength of the tissue was found in the order of that proposed in previous works, with peak stress of about 12.5 MPa. The compliance of the plantar aponeurosis was in line with in vivo evaluation. A softening behaviour appeared for tensile strain larger than 12%. In relaxation tests, the stress was reduced of 35-40% in 120 s. The percentage stress relaxation was found independent on the level of the applied strain. DISCUSSION: The evaluation of the mechanical characteristics is fundamental for a subsequent development of numerical models of the plantar aponeurosis. Such approach is helpful to understand its response to overuse, but also to understand the clinical results of different manual and physical therapies that use warm, pressure or stretch to modify this tissue.


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