**GROSS ANATOMY: fasciae of the upper limb**

- Subcutaneous tissue of the forearm
- Deep fascia of the posterior region of the forearm
- Deep and epimysial fascia of the biceps brachii muscle

**MORPHOMETRIC ANALYSIS: the deep fasciae of the limbs**

- The deep fascia is easily separable from the epimysium of the underlying muscles
- It shows aponeurotic features and it is very resistant to traction.
- It presents different thicknesses according to the evaluated zones.

![Graph showing thicknesses of fasciae](image)

**Fascia is too weak to tension force in the upper limbs**

(Stecco et al, Morphologie, 2007)

To understand the resistance of the fascia to tension, 25 upper limbs from 14 subjects, neither embalmed nor frozen were analysed.

![Image of a subject undergoing analysis](image)

**Table 1:** Measurements for the thickness of the deep fasciae in the upper limbs. (Stecco et al, Morphologie, 2007)

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Pectoralis major</th>
<th>Biceps brachii</th>
<th>Triceps brachii</th>
<th>Pronator teres</th>
<th>Superficial flexor</th>
<th>Deep flexor</th>
<th>Radial</th>
<th>Brachioradialis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value (mm)</td>
<td>1.2</td>
<td>1.8</td>
<td>1.5</td>
<td>1.7</td>
<td>1.4</td>
<td>1.5</td>
<td>1.8</td>
<td>1.7</td>
</tr>
<tr>
<td>Load (kg)</td>
<td>5.5</td>
<td>6.5</td>
<td>5.5</td>
<td>6.5</td>
<td>5.5</td>
<td>6.5</td>
<td>5.5</td>
<td>5.5</td>
</tr>
</tbody>
</table>

*Load values are given in kg, values are median (I)*
HISTOLOGICAL STUDY: the deep fasciae of the limbs

Multiple layers of undulated collagen fibre bundles form the deep fascia. In each layer the bundles are parallel to each other.

A thin layer of loose connective tissue separates the different layers. Adjacent layers of collagen fibers show different orientations.

HISTOLOGICAL STUDY: the deep fasciae of the limbs

In the muscular fascia of the upper limb, few elastin fibers are also present. They form an irregular mesh.

In the deep fascia of the inferior limb, we found very few elastin fibers.

3D RECONSTRUCTION of the collagen fibers

The collagen fibers are disposed parallel to each other to form 2/3 layers (277.6 µm). In adjacent layers, the bundles show different orientations, creating an angle of 78°. The collagen volume fraction is about 18%.
Only a few, short elastic fibers are present, forming an irregular mesh. Their volume is less than 1%. Their concentration increases descending to the deeper layers.

Thanks to the different orientations of the collagen fibers in the layers, the fascia has strong resistance to traction even when it is exercised in different directions.

The presence of loose connective tissue interposed between adjacent layers permits local sliding, and so from a mechanical point of view the single layers could be considered independently.
The loose connective tissue permits the different layers to slide one on the other

Presence of HA in the connective tissue

“Hyaluronic acid is ubiquitously distributed in the extracellular space of higher animals; the highest concentrations are found in soft connective tissues”

TC Laurent and JR Fraser; Hyaluronan; The FASEB Journal, 1992 Vol 6, 2397-404.
HA is present in most connective tissues and abundant in loose connective tissue.


Quadriceps femoris muscle

The deep fascia is a simple structure of connective tissue, which produces a gliding interface in conjunction with the epimysial capsule of the muscle and the intervening areolar tissue plane.


The deep fascia is localized to the deep or muscular surface (arrow) of the deep fascia


Presence of HA in the connective tissue

Presence of HA under deep fascia

Deep fascia produces HA
The retinacula are thickenings of the deep fascia.

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.
FROM PHYSIOLOGY TO PATHOLOGY

The capacity of the different collagen layers to glide one on the other could be altered in cases of overuse syndrome, trauma or surgery.

Male, 65 ys, diabetic, amputation after 10 months of immobility following trauma.

GROSS ANATOMY: the deep fasciae of the trunk

The pectoral fascia is a thin lamina, enveloping the pectoralis major muscle. It strongly adheres to the muscle, thanks to many intramuscular septa.

This close relationship allows selective spatial stretching of the fascia according to the muscular contraction.
HISTOLOGICAL STUDY: the pectoral fascia

It appears as a thin lamina of collagen fibers, with a structure similar to a single layer of limb fasciae.

Many elastic fibers (~15%) are present, forming an irregular mesh.

SUPERFICIAL LAYER OF DEEP FASCIA OF THE TRUNK

The pectoralis major, latissimus dorsi, trapezius, deltoid and gluteus maximus muscles are comprised within the superficial lamina of the deep fascia, and are not separable from the same. The continuity given by this fascia permits the connection among these muscles and the muscles of limbs.

Crossing of the collagen fibers of the pectoral fascia over the xyphoid process

Crossing of the external oblique fascia over the symphysis pubis
DISCUSSION: THE DEEP FASCIAE OF THE LIMBS

- Thicker (0.5-1.8 mm)
- Partially separated from the underlying muscles
- Few elastic fibers
- Multilayer structure
- Scarcely adaptable
- Perfect for the force transmission

DISCUSSION: THE DEEP FASCIAE OF THE TRUNK (superficial layer)

- Thinner (apart from the thoracolumbar region)
- Strongly adherent to the underlying muscles
- The superficial layer of the muscles of the trunk are developed inside the superficial layer of the fasciae
- The roles of the fasciae of the trunk in the movements cannot be separated from the actions of the muscles