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**Introduction**

Patel and Lieber (1997) and Huijing (1999) have shown that:

- 70% of the transmission of muscle tension is directed (in series) through tendons
- 30% of muscle force is transmitted through the connective structures in parallel

**Innervation of the deep fascia**

In the last years, various researches have demonstrated the presence of many free and encapsulated nerve terminations, particularly Ruffini and Pacini corpuscles, inside the fasciae.

- Small nerves were revealed in all specimens, whereas Ruffini and Pacini corpuscles were present only in some.
- The flexor retinaculum resulted the more innervated structure, while lacertus fibrosus was the less innervated.

<table>
<thead>
<tr>
<th></th>
<th>Brachial fascia</th>
<th>Lacertus fibrosus</th>
<th>Antibrachial fascia</th>
<th>Flexor retinaculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nerve</td>
<td>48.57</td>
<td>27.36</td>
<td>44.37</td>
<td>53.55</td>
</tr>
<tr>
<td>Pacini Corpuscle</td>
<td>0.43</td>
<td>0.26</td>
<td>0.26</td>
<td>0.66</td>
</tr>
<tr>
<td>Ruffini Corpuscle</td>
<td>0.29</td>
<td>0.1</td>
<td>0.26</td>
<td>0.55</td>
</tr>
</tbody>
</table>

Number and types of mechanoreceptors in 1 cm²
Relationships among nerves and fascia

The capsules of the corpuscles and the free nerve endings are connected to the surrounding collagen fibres.

Stretching of the deep fascia activates these receptors.

Large nerve fibres and deep fascia

The larger nerve fibres are often surrounded by different layers of loose connective tissue that preserves the nerve from traction to which the fascia is subjected.

Fascia and proprioception

Could the nerve terminations within the fascia perceive the state of contraction of the underlying muscles?

In the trunk:

Intimate relation between fascia and underlying muscles.

The fascia is immediately stretched by the contraction of the underlying muscle.

Activation of specific patterns of receptors within the fascia.

Gluteus maximus and its fascia.
Different pattern of receptors are activated according to the degree of joint movement. Sectorial activation: The muscle is activated in single sectors, stretching specific portions of the corresponding deep fascia.

In the trunk, the fascial receptors could have a proprioceptive role. Sartorius sheath and its epimysium: The fascia is relatively separated from the underlying muscles.

In the limbs: The deep fascia of the limbs could have a proprioceptive role? Crural fascia posterior region: The fascia is relatively separated from the underlying muscles.

Lateral portion of crural fascia: The fascia is relatively separated from the underlying muscles.
**Insertion of muscles into deep fascia**

Origin of muscular fibers from the deep fascia that presents a thickening in correspondence with these insertions.

**Continuity between muscular fibers and fascia**

The deltoid muscle has some muscular fibers that distally tapers into a fascial insertion. In particular, we can see here the endomysium and epimysium of the muscle that merge with the brachial fascia.

**The myofascial expansions**

Many muscles have myofascial expansions. When these muscles contract, they also stretch the deep fascia connected with the expansion.

**Specific spatial organization**

(Stecco et al, CTO, 2008)

The relationships between the expansions of the pectoral girdle muscles (i.e., pectoralis major, latissimus dorsi and deltoid) and brachial fascia were analyzed.
From myofascial connections to the perception of direction of movement

During various movements of the arm, these expansions stretch selective portions of the brachial fascia, with possible activation of specific patterns of fascial proprioceptors.

Model of the perception of the movement

During abduction the myofascial expansion stretches the lateral portion of the brachial fascia stimulating specific receptors localized in that region.

Myokinetic Chains

- This spatial organization of the myofascial expansions could be also recognized along the limbs, connecting the different segments.

- This organization could guarantee a perceptive continuity along the entire limb, probably representing the anatomical base of the myokinetic chains.

Fascia and proprioception

Fascia is rich in proprioceptive nerve endings.

Each movement could activate a specific pattern of receptors.

The deep fascia could have a role in proprioception.
Sliding system

"A plane of potential movement exists in the form of the areolar tissue layer, and this appears to be lined with a lubricant, hyaluronic acid".


Structure of the fascia

Hyaluronic acid is one of the chief components of the extracellular matrix.


Could hyaluronic acid's alteration change the physiology of the fascia?

Distribution of Hyaluronic acid

More important regions where HA is present

Haluronic acid

Between muscles fibres

Under the deep fascia (50X)

Over the muscle
Etiology: overuse syndrome

“The retention of HA after exercise, as well as its endomysial location, is in accordance with the concept that HA is a substance that is present to lubricate and facilitate the movements between the muscle fibers”.


Etiopathology

- “Evidence of HA aggregation has also been reported: short HA segments have been demonstrated to self-associate in physiological solution, while a variety of intermolecular aggregates were observed when HA was spread on surfaces”.

- “By increasing the concentration of HA, HA chains begin to entangle conferring to the solution distinctive hydrodynamic properties: the viscoelasticity is dramatically increased”.

Gate control

The adaptation of the fascia is possible within certain limits

This mechanism allows a sort of "gate control" on the normal activation of the intrafascial receptors

Beyond this level the nerve terminations are activated

If the fascia’s sliding system is altered, the receptors could send a message of pain from stretching that is within the physiological range

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Tissue viscoelasticity shape the dynamic response of mechanoreceptors

Normal sliding system

Decrease of sliding system

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From physiology to pathology

PATHOLOGIC FASCIA

PAIN

ADHESION

The adhesion alters the distribution of lines of force within the fascia and so the surrounding mechanoreceptors send a message of pain.
Therapy:

Therapy: alkanulation

- At the exhaustion, the muscular pH was 6.82 ± 0.05 in the training leg and 6.69 ± 0.04 in the un-training leg.

- During the muscular exercise the pH decrease until 6.69 ± 0.04 (training leg) and until 6.82 ± 0.05 (un-training leg)

- The muscular pH decrease from 7.14 at rest until 6.71 (range 6.50-6.87) at the exhaustion.

Therapy: increase in temperature

- "These chain-chain interactions were reported to be reversibly disaggregated by:"
**Transition**

“The Differential Scanning Calorimetry (DSC) curve enables the detection of an exothermic and an endothermic transition at 25-35 °C and at 45-60 °C, respectively. The latter was ascribed to a gel-like to fluid-like transition”.

“These values are compatible with weak noncovalent interactions like those characteristic of van der Waals and hydrophobic forces, which are frequently responsible for the structuring of polysaccharide systems”.

**A possible effect of all superficial heating modalities?**

But what are the particular effects of Fascial Manipulation?

1. We work on the area where there is a densification and not where there are the symptoms!
2. An inflammatory reaction lasting for 48 hours appears after the treatment.

**Densification: gel-like phase**

“DSC pointed out the existence of a gel-like to fluid-like transition, while it excluded any involvement of strong intermolecular interactions”.

**Function of the myofascial unit**

The CC of the RE-TA unit corresponds to the centre of the vectors formed by:

1. Traction of the muscle fibers of that motor unit;
2. Tension of the endo-peri-epimysium;
3. Tension of the local segment of deep fascia.

A physiological sliding system in the CC is necessary to create a correct final vector

Centre of Coordination (CC) is situated in the deep fascia, where vectors from muscle fibre contraction converge together

Centre of Perception (CP) is where movement is perceived when the MF Unit is activated.
Muscle spindles

*The capsule of the muscle spindles is either attached to the perimysium, or to fascial septae, or fine connective tissue threads on in the intramuscular spaces*. Baldissera


FUNCTIONS:

a) Responses during fusimotor action; b) Passive responses

1. Controls and maintains muscle tone
2. Activates the dynamic stretch reflex mechanism
3. Maintains muscle contraction against the constant force of gravity
4. Controls fine motor movements.

Increase of Hyaluronic acid’s viscosity

More important regions where HA is present

- Between the layers of DF
- Inferior surface of deep fascia (highest concentration)
- Endomysium surrounding the muscle fibers

*Stecco C. University of Padova*

Physiology of muscle spindles

1. Gamma motoneuron become active
2. Contraction of intrafusal fiber
3. Stretching of anulospiral ring
4. la afferent fibre
5. Stimulation of alpha motor neuron
6. Contraction of extrafusal muscle fibres
Pathology of muscle spindles

1. Gamma motoneuron become active
2. Contraction of intrafusal fiber
3. The alteration of the capsule don’t permit the stretching of the anulospiral ring

NO CONTRACTION OF EXTRA fusAL MUSCLE FIBRES

The symptoms appear only if the HA’s gel phase is present also in the CC!

HA aggregation
Viscoelasticity is dramatically increased

The location is also in the CC
The location is NOT in the CC

Dysfunction: symptoms
NO symptoms

Dysfunction:
- Increase of the viscosity of HA in the Centre of Coordination
- Decrease of the sliding system in the CC
- Decrease activation of muscle spindles
- Improper recruitment of muscle fibres
- The resulting vector becomes faulty
- Mechanical incoordination in the articulation
- Phase of compensation
- Symptoms in the Center of Perception

Effect of Fascial Manipulation treatment

Pressure + Friction + Time

Increase of temperature + Stress
Effect of Fascial Manipulation:

"Under conditions of stress hyaluronan becomes depolymerized and lower molecular mass polymers are generated"

Paul W. Noble; Hyaluronan and its catabolic products in tissue injury and repair; Matrix Biology 21, 2002. 2529

Post Fascial Manipulation effects:

- **0-15 min**
  - Start of the inflammatory reaction

- **15min-12h**
  - Increase in signs and symptoms of inflammatory reaction:
    - calor, tumor, dolor, functio laesa

- **12h-24h**
  - Peak of inflammatory reaction

- **24h-48h**
  - Resolution of the inflammatory reaction and of the symptoms

“The smallest products of the HA catabolic cascade can turn about and suppress the action of larger predecessors, and thereby mollifying their effects.”


Thanks