THE FASCIAL SYSTEM AND WATER EXERCISE
By Lynda Keane MSc.

What is Fascia
Fascia is the most common component of connective tissue that runs through the body like a protective network (Schleip 2018). It comprises of collagen, elastin and ground substance and creates a structural continuity that gives form and function to every tissue and organ. The fascia creates different interdependent layers with several depths, from the skin to the periosteum, forming a three-dimensional mechano-metabolic structure. In 1989 the International Federation of Associations of Anatomists (IFAA), coined the term "The superficial fascia" as a "whole loose layer of subcutaneous tissue lying superficial to the denser layer of fascia profunda." The deep fascia profunda, according to this definition, lies below the superficial fascia, highlighting two fasciae areas (Bordoni et al 2021).

In 2014 the Fascia Research Society broadened the description as "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, adventitia, and neurovascular sheaths, aponeuroses, deep and superficial fasciae, epineurium, joint capsules, ligaments, membranes, meninges, myofascial expansions, periosteum, retinacula, septa, tendons, visceral fasciae, and all the intramuscular and intermuscular connective tissues including endo-/peri-/epimysium. The fascial system interpenetrates and surrounds 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."

Movement
Normal body movement is permitted due to the presence of the fascial tissues and their inseparable interconnection, this allows the slide and glide of the muscular structure, the sliding of nerves and vessels between contractile muscle and joints, and the ability of all organs to slide and move with each other due to movement and body positioning. A fundamental characteristic of fascia is its ability to adapt to mechanical stress, to the remodelling of cellular/tissue structure due to repetitive movement patterns and mirroring of the functional necessity of the environment where the tissue lies (Bourne et al 2021).

There is a relatively common understanding of the fascial lines described by Tom Myers in his anatomy trains (Myers 2018). The pictures below are a representation of the superficial front line in lighter pink and the deep functional front line depicted in red. The white depicting the fascial lining of the thoracic rib cage.

Fig 1: Different lines in the human body

Superficial and deep front lines
These lines represent the superficial front line in pink and the deep functional line in red. The white represents the thoracic fascia

Superficial and deep back lines
These lines represent the superficial back line in light blue and deep functional back lines in dark blue. The white represents the thoracolumbar fascia

Spiral Line (posterior)

Spiral line (anterior)

These green and yellow lines depict the double helixes of the spiral line

It is the fascial web that provides a framework for all movement rather than the muscles alone, it governs the entire system including the spring-loaded joint mechanism for the legs and arms as well as blood and lymphatic flow.

Fascia Health

When fascia is healthy it is hydrated and has a functional blend of stability and flexibility, which is needed to ensure all the body's systems run optimally. Good nutrition, hydration and interstitial fluid flow is vital for fascial health and without this the fascia will become damaged or traumatized. Unhealthy fascia morphs structurally and its function becomes impaired, it becomes dehydrated, dense, less mobile and compresses.

When the fascial system is not working optimally it can cause pain and restricted movement, resulting in poor biomechanics and can develop issues such as inefficient gait, running pattern training efficiency and bad posture. Fascia can become unhealthy due to a simple lack of movement so if a part of your body has been immobilised for a time the collagen can begin to grow haphazardly interrupting fluid flow and creating movement impairments.

Fascia becomes sticky when it is subjected to stress and strain. This can cause the fascial sheath surrounding nerves to stick to nearby structures such as muscle tissue, bone, joints and skin. This means that the nerves become adhered in place and every time the body is moved, the nerve gets tugged as it tries to move through its normal pathway. This in turn leads to irritation of the nerve and over time, injury combined with nerve-related sensations results.

Healthy Fascia is a colloid which is a substance that contains both liquid and solid materials. The solid materials, predominantly collagen fibres, are suspended within the liquid, plasma containing glycosaminoglycan and proteoglan (Blottner et al 2019). The properties of fascia are both viscous and elastic enabling it to slowly deform when under pressure, this ability is called creep.

Fascial Structure and Force Transmission

Historically as fitness professionals our training has focused on muscle activation, however, increasingly the industry is incorporating fascial training and tension. Fascial tensioning is how the body produces stability and strength which provides power and force and the dynamic stability that we all need within our joints to prevent injury.

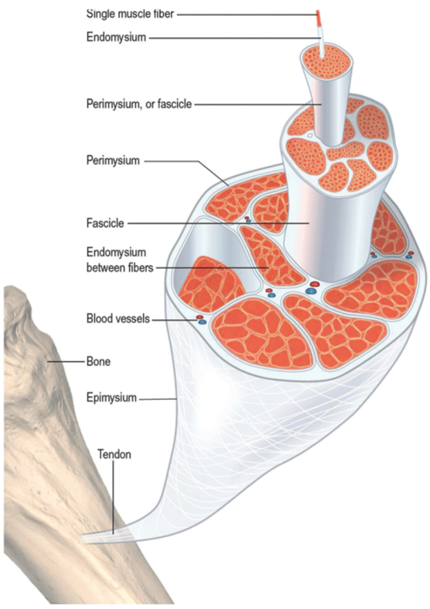

Fig 2: The different layers that build the structure of a muscle

Figure 2 shows how fascia surrounds every fibre, bundle and muscle into the tendon and bone, the connectivity of fascia holds everything in place. Without fascia the body would not be able to function, this means all systems would fail and all movement would cease including the ability to stand.

The different layers of fascia surrounding each structure of a muscle are collectively termed the Fascia profunda. These layers have different roles in movement:

- Endomysium – muscle fibres are covered with a delicate connective tissue membrane. It coordinates forces and deformations within the fascicle, protects damaged areas of fibres against over-extension, and provides a mechanism whereby myofibrils can be interrupted to add new sarcomeres during muscle growth without loss of contractile functionality of the whole column. It also provides an efficient mechanism for transmission of contractile forces from adjacent muscle fibres within fascicles
- Perimysium – a tougher connective tissue that binds together a group of skeletal muscle fibres (fascicles); it runs the length of the muscle from tendon to tendon. The folding interdigitating ends of these muscle fibres forms the myotendinous junctions. It occurs in different thicknesses and merges seamlessly into the epimysium and the two are connected mechanically. An alternative role for the perimysium involves the definition of slip planes between muscle fascicles which can slide past each other to allow large shear displacements due to shape changes in the whole muscle during contraction.

- Epimysium – a course sheath covering the muscle as a whole, this can be two parallel sets of waxy collagen embedded in a proteocollagen matrix crossed ply arrangement in long strap-like muscles or in pennate muscles arranged parallel to the long axis of the muscle forming a dense surface layer that acts like a surface tendon.

The perimysium and epimysium are capable in some circumstances to act as pathways for myofascial force transmission. As the endomysium is compliant in tension, force transmission may be by shear linkage through its neighbours. This offers a highly efficient force transduction pathway from one muscle to its neighbouring structures and ensures uniform sarcomere lengths are maintained by the co-ordination of non-contracting fibres with adjacently lying contracting fibres.

Other structures in the muscle:
Tendon – a flexible, semi-elastic cord of strong fibrous collagen tissue attaching a muscle to a bone
Aponeurosis – a type or a variant of the deep fascia in the form of a sheet of pearly-white fibrous tissue that attaches sheet-like muscles needing a wide area of attachment, whether it be bone or other muscles. An example of this is the thoracolumbar fascia and when this is traumatized it can be a cause of non-specific chronic lower back pain.
Tendon sheath - a layer of synovial membrane around a tendon It permits the tendon to stretch and not adhere to the surrounding fascia.

Fascial recoil
Loading of connective tissue is a dominant part of all body movement from light recreational walking to high level running and athletic activities such as jumping, throwing and water exercise These are all activities that use elastic recoil to assist a movement. Elastic recoil is when the tendons and fascia store energy from an impact force then when the associated muscle reaches its maximum safe stretch the muscle contracts releasing this energy. If the energy is released more rapidly than it is stored, muscle power can be amplified, this will exceed the limits of the muscle alone and can be improved through training.

Due to this the tendons and surrounding fascia needs to resist high levels of loading from muscular contractile activity, which can result in acute injuries of fascial structures and bone. This is especially true when exercising on land though when exercising in water the probability of injury due to these forces decreases significantly due to the water's supportive properties.

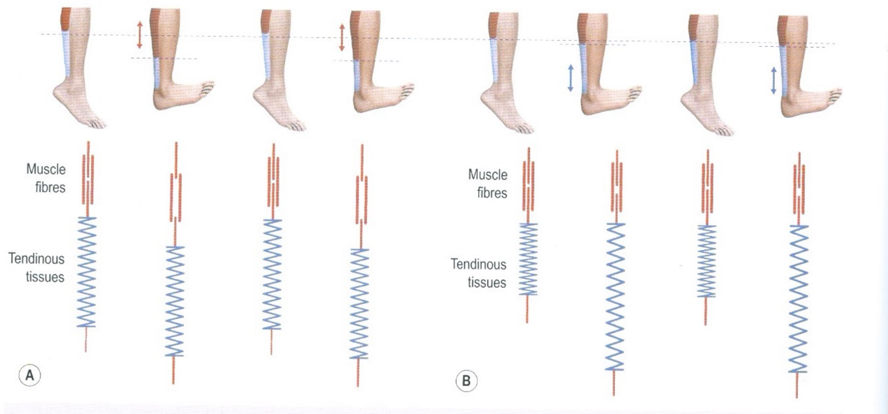

Figure 3: This illustrates how the directional flow of energy in muscle-tendon systems determines mechanical function. (A) no elastic recoil including cyclic movements such as cycling, (B) elastic recoil including explosive movements such as running or jumping

Fascia as a sensory organ

Nerves pass through muscles, alongside bone, through joint spaces, in the seams between muscles, and in and around organs. In all of these cases nerves are wrapped in a protective coat of fascia with more nerve receptors being in the fascia than in muscle. This is particularly true in the transition zone between the fascia profunda and the subdermal loose connective tissue. These nerve receptors include the Golgi tendon organs that measure load, paciniform endings to measure pressure, Ruffini endings to inform the central nervous system of shear forces in the soft tissues, and ubiquitous small interstitial nerve endings that can report on all these plus pain (Stecco et al. 2011; Taguchi et al. 2009).

The role of fascia as a sensory organ is to provide a fluid, moveable, and protective shield around the nerves. Under normal circumstances, nerves should be able to slide approximately one centimetre as the body moves. The fascial coat around the nerves allows this to happen, if this was missing or if the fascia becomes damaged or traumatised, nerves would be abraded and irritated with every move causing pain.

How is aquatic exercise helping fascia

With regular aquatic movement fascia will gradually adapt to the load put upon it by hydrostatic pressure caused by the water and resistance created when moving through water, with or without equipment. However, as with many things, if exercise does not continue the fascia will revert to its prior condition, especially if the client does not or cannot address the original causes.

The buoyancy and hydrostatic pressure of the water constantly signals and suppresses the sympathetic nervous system calming the reticular activating system deep inside the brain (Mano et. al. 1985 cited in Becker & Cole 2010). Along with an increase in plasma dopamine levels also seen, these effects will dull muscle pain.

The buoyancy also allows for natural three-dimensional movement patterns with greater ease than when affected by gravity. As the body is not working against gravity the muscles and fascia are able to unwind more and the aquatic exercise class is able to affect the deeper layers of fascia without causing additional tissue trauma and with a lower load. Therefore, it is possible that due to the fluid movement of the body in water, fascial adhesions could dissipate with greater ease and as a result myofascial sequencing will be optimised and the transmission of force will be increased.

Gentle stretching water exercises such as Ai Chi, Aquatic yoga or Aquatic Pilates (Peyow aqua pilates) can assist with nerve related pain as they are able to coax the adhered areas that affect the nerves to release. These techniques stretch the fascia around the muscle fibres as these are the structures inhibiting optimal nerve function.

When performing aquatic stretching exercises you are stretching the fascia not the muscle fibres as it is the element that forms the adhesion. If done correctly, nerve receptors will remain fairly unaffected by the stretching, the adhesion will release, and full function, motion, and sensory capacity of the nerve will be restored.

References for The Fascial System and Water Exercise:

Cole, A,J. Becker, B,E. (2004). *Comprehensive Aquatic Therapy*. 2nd ed. USA: Butterworth-Heinemann,

Bordoni B, Simonelli M, Morabito B. The Other Side of the Fascia: Visceral Fascia, Part 2. Cureus. 2019 May 10;11(5):e4632. [PMC free article] [PubMed]

Bordoni, B. Mahabadi, N. Varacallo, M. . (2021). *Anatomy. Fascia.* Available: https://www.ncbi.nlm.nih.gov/books/NBK493232/. Last accessed 12th July 2022.

Blottner, D. Huang, Y. Trautmann, G. Sun, L.. (2019). The Fascia: Continuum linking Bone and Myofascial Bag for Global and Local Body Movement Control on Earth and in Space. A Scoping Review. *REACH - Reviews in Human Space Exploration*. 14-15, 1-11

Bourne M, Talkad A, Varacallo M. StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL): Aug 11, 2021. Anatomy, Bony Pelvis and Lower Limb, Foot Fascia. [PubMed]

Magill, P. Recoil: Running's Superpower, Runners World, 2014, May, www.runnersworld.com

Myers, T. (2013). *Anatomy Trains: Myofascial Meridians for Manual and Movement Therapists*. USA: Churchill livingston.

Stecco, C. Macchi, V. Porzionato, A. Duparc, F. De Caro, R.. (2011). The Fascia : the Forgotten Structure. *Italian Journal of Anatomy & Embryology*. 116 (3), 127-138.

References