ANATOMY OF SOFT TISSUE

MUSCLE

There are two forms of muscle, striated and smooth. Striated muscle tissue is further subclassified on the basis of its location, whereas skeletal muscle is composed of connective tissue and contractile cells that are embedded in long, cylindrical cells. Skeletal muscle facilitates movement by applying forces to bones and joints through a contraction and is generally under volitional control. Muscles have an origin and insertion as end point, a thick mid-portion called the muscle belly, and a tendon.

Muscle fibers are cellular elements, whereas connective tissue fibers are extracellular products of connective tissue cells (1). The connective tissue associated with muscle is named according to its relationship with the muscle fibers. The three connective tissue layers of the muscle include the endomysium, perimysium, and epimysium. The endomysium has a strong lymphatic system and is composed of reticular fibers that are richly innervated and vascularized. Bundles of between 10 to 100 or more individual muscle cells are called fascicles, and the connective tissue that surrounds the fascicles is called the perimysium. The perimysium is a thicker connective tissue layer than that of the endomysium. These fascicles are functional units of muscle fibers that tend to work together to perform a specific function. The epimysium is a layer of dense connective tissue that sheaths the entire muscle. Similar to the perimysium, it is composed of dense, irregular connective tissue and is continuous with fascia and other connective tissue wrappings of muscle including the endomysium and the perimysium (Figure 16.1) (1).

Muscle fibers are grouped into fascicles, which are in turn grouped together to form a muscle. The size (length) and number of fascicles determine the strength and range of movement of a muscle. There are common fascicle patterns. Parallel fascicles have their long axes parallel to each other. Parallel fascicles can be flat, or strap-like, or can bulge at the muscle bellies and take a spindle, or fusiform, shape. Circular fascicles are arranged in concentric rings. Muscles with this pattern form sphincters that control the opening and closing of orifices. Pennate fascicles are short and attach obliquely to a long tendon that
extends across the entire muscle. In a unipennate pattern, the muscle resembles one-half of a feather (the tendon is represented by the shaft of the feather). A bipennate pattern resembles a complete feather, with fascicles attached to both sides of a central tendon. A multipennate pattern of fascicles resembles three or more feathers attached at each of the fascicle’s base.

Figure 16.1: The Endomysium, Perimysium, and Epimysium Layers within the Muscle

NEUROMUSCULAR JUNCTION

The region in which the motor neuron axon connects to the muscle fibers is called the neuromuscular junction. At a neuromuscular junction, the dendrites at the end of the axon meet muscular material instead of another neuron. The axon ends at the neuromuscular junction and is separated from the muscle fiber itself by a synaptic cleft. The surface of the muscle fiber forms small, ridged folds for the end of axon to rest within. Inside these folds are depressions called synaptic vesicles that are filled with acetylcholine receptors (Figure 16.2). Neurotransmitters such
as acetylcholine cross the synaptic cleft and transmit the chemically converted electrical impulse causing the muscle to contract (1).

![Figure 16.2: The Neuromuscular Junction](image)

The neuromuscular junction is a common site for myofascial trigger points (albeit, not the only site). It has been hypothesized that a myofascial trigger point is formed when a sensitive locus, the nociceptor, and an active locus, the motor end plate, coincide (1). It is possible that sensitive loci are distributed widely throughout the entire muscle but are concentrated in the trigger point region.

**TENDONS**

Although tendons are the physical link between muscles and bones, tendons do not actively produce motion. The muscles and tendons work together to form the muscle-tendon unit, which acts as a dynamic restraint. Tendinous tissue is composed of tightly packed, longitudinally running collagen fibers, is relatively acellular, and has a low oxygen and nutrient requirement; it also has a
limited blood supply. The limited vascularity of tendons results in delayed healing when injured (2). The collagen fibers of tendons are firmly tethered to the muscle fibers of skeletal muscles at specialized areas called myotendinous insertions or junctions.

The attachment of the tendon to muscle at the myotendinous junction (MTJ) comprises interdigitation between collagen fibers and muscle cells (3). Individual muscle fibers develop an interdigitating surface that is tightly anchored to the collagen fibers of the intramuscular portion of the end of the tendon (4). The collagen fibrils bundled together are known as fibers. The groups of the fiber bundles enclosed by a loose connective tissue sheath are known as the endotendon; these make up a secondary bundle known as a fascicle. The tendon is enclosed by the epitendineum, a thin, outer fibrous capsule that protects the tendon from friction damage. Tendons are surrounded by a thin collagenous sheath lined by synovial-type mesothelial cells secreting lubricating fluid. This tendon sheath and the synovium related to the epitendineum make up the tenosynovium and allow the tendon to slide with ease and without friction within a lubricated sheath.

The fibrocartilaginous attachment of the tendon on to the bone occurs by type I collagen fibers, which pass through the periosteum and penetrate some way into the bone (5). This interdigitation provides a gradual transition between tissues and aids in force distribution and prevention of injury (6).

**Fascia**

Fascia, which is either superficial or deep, is a form of inert, loose, irregular connective tissue that permeates throughout the human body. Superficial fascia is regarded as the layer of areolar connective or adipose tissue that lies directly below the skin, whereas deep fascia is a dense connective tissue that connects to muscles, tendons, and organs within the body. Deep and superficial fascia is commonly integrated, whether through various indiscrete connections or where deep fascia creates tunnels for structures that run through the superficial fascia. The fiber arrangement with the increased amount of ground substance and improved vascularity differentiates this connective tissue from the dense connective tissues.
Integrated fascia includes superficial and deep fascia that assists in increasing the integrity of skin and muscle. This fascia has been found to glide freely over the muscular fiber, thereby transmitting tension from proximal to distal and inserting to the muscular fibers that stretch it. The myofascial continuity is theorized to give the anatomical basis to explain the myokinetic chain. Due to the muscular insertions into the fascia, it is therefore possible that, in conformity with the tone of the muscles, the fascia is maintained in a tensional state; only a tensioned fascia is capable of perceiving any variation in its length (7). The range of that movement is considerable depending on the joint and the surrounding musculature. It is often found that the fascia has also become involved in the chronic stages of myofascial pain. Clinically, such involvement gives the impression of binding of tissue as if the tissues appear stuck together.

Some argument exists to the innervation of fascia. Most anatomists feel that fascia and muscle share common innervations and that the two in concert, when damaged, can send pain messages to the body. It is commonly accepted that fascia does not have an independent innervation (8).

SKIN

The skin is a living, changing organism that contains a number of specialized cells, structures, and functions. The skin functions as a protective barrier to the outside environment and has immunological responsibilities. Skin reduces the risk of injury and infection to underlying elements such as muscle, organs, and other tissues such as the nerves and vessels. The skin is the largest organ in the body; it makes up 12–15 percent of body weight and has a surface area of 1–2 meters.

The three layers of skin include the epidermis, dermis, and subcutaneous tissue. The epidermis is the outermost layer of the skin and is thickest at the palms and soles of the feet (1.5 mm). Within the epidermis are five specific layers named: 1) stratum basale, 2) stratum spinosum, 3) stratum granulosum, 4) stratum lucidum, and 5) stratum corneum. The bottom-most layer, the
stratum basale, forms cells that evolve into higher layers, and as the cells move into the higher layers, each eventually sloughs off and dies.

Specialized cells such as sensory cells allow the skin to send signals to the central nervous system on what the tissue encounters within its environment. In particular, the sensory cells function to record at least five different senses: pain, heat, cold, touch, and pressure. Meissner’s corpuscles are deep sensory receptors that are concentrated in the epidermis of the fingers and lips that make these areas very sensitive to touch. Pacinian corpuscles respond to pressure and vibration and are located deep in the epidermis.

**Summary**

- The anatomical aspects of the body germane to soft tissue mobilization include the muscle, tendon, fascia, skin, and neuromuscular junction.
- The neuromuscular junction is the region in which the motor neuron axon connects to the muscle fibers.
- Tendinous tissue is composed of tightly packed, longitudinally running collagen fibers, is relatively acellular, and has a low oxygen and nutrient requirement; it also has a limited blood supply. Fascia, which is either superficial or deep, is a form of inert, loose, irregular connective tissue that permeates throughout the human body.

**ARTHROLOGY CONCEPTS OF SOFT TISSUE**

Arthrologically, skin, fascia, muscle, and surrounding inert tissue are designed to move and stretch but stabilize and support structures within the body. Nerve, vessel, and lymphatic tissue all course through the network of soft tissue, and injury to an area can affect the ability of those systems to appropriately function. In essence, soft tissue is either inert or contractile: active tissue is limited to muscle, whereas inert tissue involves fascia, tendon, and skin.

**Contractile Tissue**

The sliding filament theory is a theory associated with the contractile function of the muscle. In summary, during contraction there is an influx of calcium, which triggers an exposure to the binding sites of actin. The myosin then binds to the actin (which are in contact), which triggers sliding of the filaments and a pulling process of the muscle fibers. Adenosine-5'-triphosphate (ATP) then
binds to myosin, which assists in the process of release of actin and myosin. The cycle allows the transport of calcium back into a sarcoplasmic reticulum, allows preparation for another contraction, and is associated with a typical muscle contraction. Optimal muscle function is important because muscles are the motors that work with the fascial layers to direct the movement forces (1). Tissues respond to injury with predetermined programmed mechanisms to replace the damaged components and to improve or restore function. The details of inflammation, repair, and remodeling and maturation are discussed in many excellent textbooks of pathology and histology and are beyond the scope of this chapter.

Inert Tissue

The primary functions of fascia are more passive in nature, existing to compartmentalize structures and as an exoskeletal to other structures, for maintenance of structural integrity. Fascia also provides support and protection and functions to promote movement at superficial structures and at muscle layers. Deep fascia has a circulatory function by assisting blood flow return to the heart at distal extremities by compression of the surrounding structures.

Some have advocated that fascia is a plastic and malleable tissue that is able to adjust to the mechanical thermal and metabolic stresses and can possibly be restored to its physiological condition through external manipulation through the connective tissue theory (9). At present, the exact nature and ability of fascia, skin, and other inert tissues to respond accordingly are mostly unknown. Regardless of the theories, effective treatment of soft tissue involves understanding the biomechanical and biochemical aspects of injury followed by the knowledge of the repair and healing process.

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Online References