## Muscle growth

### Objectives

1. Describe the anatomy of a muscle
2. Describe the embryology and postnatal growth of muscle

### Discussion points

1. How are force and velocity related to muscle structure?
2. What are the differences between type I and type II fibers?

### Discussion

A muscle is composed of many multinucleated fibers called muscle fibers. Groups of fibers are characteristically placed into bundles known as fasiculi. The arrangement of fasiculi determines whether is muscle is pennate, bipennate, fusiform, or other form. Endomysium is the connective tissue between fibers, perimysium surrounds fascicles, and epimysium surrounds the entire muscle. The epysium is continuous with the epitenon, or tendon sheath. Motor nerve fibers contain alpha efferents, which branch to supply the neuromuscular junction (motor end plate); and gamma efferents, which supply the muscle spindle. The muscle spindle is a specialized structure in the muscle that controls tension. Muscle is 75% water, and most of the rest is protein, actin or myosin. Muscle contracts by an elegant overlapping filaments of actin (the predominant component of the "I" band) and myosin (the predominant component of the "A" band). During contraction, the myosin filaments overlap the actin filaments, producing shortening. The "I" bands are divided by the dark "Z" lines. The distance between 2 "Z" lines comprises one sarcomere.

Skeletal muscle originates from primitive mesenchymal cells, located in the myotome (contained in the somites). The mesenchymal cells differentiate into myoblasts, which by the seventh to ninth week are elongating and fusing to form primitive myotubes. Actin and myosin are forming by this time, and individual skeletal muscles are well formed by the tenth week. By the sixteenth week, new myotubes are no longer formed, and the histologic structure of the muscle does not change after that point. During childhood, muscle growth occurs by adding sarcomeres at the musculotendinous junction, which has been called the "muscle growth plate". Muscle repair and regeneration after injury follow a pattern very similar to the original embryologic development. At one year of life, muscle fiber diameter is roughly 30% of adult size, at 5 years, it is 50%.
Type I fibers have a relatively slow contraction time, and fatigue less easily. Type II fibers, including 3 subtypes, have a faster contraction time, but fatigue more easily. Coding of fiber type is genetically determined, on chromosome 17. Training does not alter fiber type, but it can increase the size of fibers. In general, velocity of a muscle is also related to length (number of sarcomeres acting in series), and force is related to bulk (number of sarcomeres acting in parallel).

References

