Figure 1.1: Movements of the thumb.
Figure 1.5: Pulley system of the fingers.

Acknowledgement: www.orthopaedicprinciples.com
Figure 1.6: Demonstration of structure and layers of connective tissue in tendon.

Acknowledgement: www.frontbiosci.org
Figure 1.12: Illustrates the embryology of the upper limb.

Acknowledgements: A and B- www.apsu.org, C and D-www.reproduction-online.org, E- www.embryo.chronolab.com

A and B shows the three germ layers. It also shows the different parts of the mesoderm i.e, somites, intermediate mesoderm and lateral plate mesoderm. The lateral plate mesoderm divides to form the outer somatic layer and the inner splanchnic layer.

C- The ventrolateral segment of the somites gives rise to dermatome and myotome. These migrate to form the future skin and muscles. The chondrogenic core and the pretendinous mesenchymal cells migrate from the somatic layer of the lateral plate mesoderm to form the future bone and tendons.

D- The chondrogenic core divides the muscles into dorsal and ventral muscle groups.

E- The growth of the limb bud happens to give rise to the digital ray.
Ventral muscle group of forearm

A, B, C shows the normal development and attachment of the tendons in the dorso-ventral axis. The tendons develop earlier and anterior to the muscle blastemae. They join with the correct muscle group and develop further.

A1, B1, C1 shows the effect of inversion of dorso-ventral axis on the normal development of tendon. As normal, the tendons develop earlier and anterior to the muscle blastemae. However, when the dorso-ventral axis is inverted the tendons continue to grow but attach to the wrong group of muscle (dorsal muscle group) and develop further.

Figure 1.13: Illustrates the experiment done by Kieny and Chevallier in 1979.
A: Illustrates the normal structure of a FDS tendon at carpal tunnel

The FDS tendon strands are tightly packed and better organised than the FDP tendons. The FDS tendons are covered by the visceral layer of the tenosynovium which in turn are enveloped by the parietal layer of tenosynovium.

B: Illustrates the normal structure of a FDP tendon at carpal tunnel

The FDP tendon strands are loosely packed. The visceral layer of the tenosynovium recognises each tendon strand to be a tendon and wrap around them. At the carpal tunnel, there is criss crossing of these tendon strands and their accompanying visceral tenosynovium. This arrangement may lead to trapping of the tenosynovium between the tendon strands and could predispose to interconnections.

Figure 1.14: Illustrates the normal arrangement of the tendon strands of FDS and FDP tendons at carpal tunnel.
Figure 3.29: Images taken during pilot study.
Figure 3.30: Images taken with the volunteer. The image quality is poor with artefacts.
Identify the muscles FPL, FCU, FCR, FDS and FDP by either following their tendon from their insertion or by their anatomical relation to each other.

Calculate the TCSA of these tendon (Area of ellipse = \[ \pi \times \frac{1}{2} (\text{width} \times \text{thickness}) \]) at the following points:
- FCR and FCU - 2cms above their insertion
- FPL, FDS and FDP - 2cms above the entrance of carpal tunnel

Measure the tendon lengths between the proximal and distal ends (proximal end: from the distal end of the muscle insertion onto the tendon; distal end: their respective bony insertions)

But for FPL, FDS and FDP - point of entry into the carpal tunnel.

Measure the angle of pennation using the pennator at the midpoint of the muscle belly (determined using the measurement on a flexible measuring tape). If the muscle is multipennate, the mean of all the medial and lateral angles are taken. The mean of the medial and the lateral angle is taken and the muscle is summed up to be an unipennate muscle.

Remove the muscle meticulously for the limb and calculate the mass and density (density = mass/volume).

Immerse the muscle belly in warm Biocide solution overnight. Following morning, dissect the muscle fibre using a pair of forceps and measure the fibre length against a flexible measuring tape.

Substitute all the above values into the equation:
\[ \text{PCSA} = \frac{m \cos \alpha}{lp} \]

Where, ‘m’ is the muscle mass in grams, ‘\( \alpha \)’ is the average angle of pennation of muscle fibres in degrees, ‘l’ is the muscle fibre length in centimetres and ‘p’ is the muscle tissue density in g.cm\(^{-3}\).

Table 2.1: Summarises the dissection steps undertaken.
On observation: if the gross angle of flexion at the IPJ of thumb $>40^\circ$ along with flexion of dependent DIP of index or middle fingers

Accepted on to the study and series of photographs of angle of flexion of the relevant joints taken (n=12)

No flexion of the DIP of the index and middle fingers up on flexion of the IPJ or MCPJ of the thumb.

Eliminated from the study

Angle of flexion at the MCPJ of the thumb ($30-45^\circ$), IPJ of thumb ($45-55^\circ$) and flexion of DIP of dependent finger ($20-45^\circ$). The volunteers selected depended on the angle of flexion drawn on printed photographs.

Accepted for USS study (n=4)

Table 2.2: Summarises the criterion used for volunteer selection.
Figure 2.3: Showing the relations of the median nerve at the wrist.
Joining points A, B and C forms the angle of pennation.

Figure 2.7: Illustrate the pennator and how the angle of pennation was plotted and calculated.
Figure 2.9: Shows the different steps undertaken to calculate the PCSA, TCSA and the area of median nerve.
Figure 2.10: Illustrates the height, distance and angle at which the camera was set.
Figure 2.15: Shows the graduated background that was used for repeatability and reliability study. Note the reference points A, B, and C.
Figure 2.16: Demonstrating the angle of flexion of the thumb and the dependent fingers (A) at rest, (B) initial movement, (C) mid position and (D) fully flexed at mid prone position of volunteer 1. Taken during reliability and repeatability study.
Figure 2.17: Demonstrating the angle of flexion of the thumb and the dependent fingers (A) at rest, (B) initial movement, (C) mid position and (D) fully flexed at supine position of volunteer 1. Taken during reliability and repeatability study.
Table 4.1: Illustrates the pathophysiology of tendon healing, scarring and tendinous interconnections.