Vascularization of the Long Flexor Tendon

By

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Summary: The arterial supply of the long flexor tendon of the index and ring fingers were studied morphologically on 36 cadaver hands.

Our studies, showed that the long flexor tendons were supplied by two main sources. Primarily by small arteries which ran in the vinculum longum and vinculum brevis and reached the dorsal surface of the tendon. Also by small intrinsic longitudinal vessels which ran parallel to the collagenous fibers of the tendon and extended from the muscular attachment of the long flexor tendons. No morphological difference on the vascularization of the index and ring fingers were observed.

Although many studies have demonstrated the arterial supply of the long flexor tendons; still there is lack of agreement. Ochiai et al. studied the vincular system of each finger. Mayer noted that the flexor tendons within the human digital sheath have vascular connections at the muscular tendinous junction. Verdan describes the importance of vascularization in healing of tendon laceration. Mattheus suggested that the sheath containing synovial fluid may nourish the outer vascular layer of the tendon by diffusion. Caplan et al. described the intrinsic blood supply of sheathed flexor tendons and the effects of suturing methods on intrinsic blood supply.

There are many publications describing the vascular pattern supplying the long flexor tendons, but still detailed anatomy is not clear. In this study we anatomically stated the location and the length of the vinculum longum and brevis for both index and ring fingers. Additionally, histological sections from several regions of the tendon were taken to show the arterial supply of the index and ring fingers.

Materials and Methods

The index and ring fingers of 36 cadaver hands were dissected at Marmara University Faculty of Medicine Department of Anatomy. The digital fibrous sheath was dissected and the vinculum longum and brevis were exposed. Gross measurements of the vincula were taken with a compass.

Histological specimens were taken from the below regions of the tendon.
1-Close to the muscular fibers
2-At the level of vinculum longum
3-Between the vinculum longum and brevis
4-At the level of vinculum brevis

Result

There are two vincular system (vinculum longum and vinculum brevis) for each tendon. The vinculum longum is slender and the vinculum brevis is dens and pyramidal in shape (Figs. 1, 2). Of the 36 cadaver hands the vinculum longum was present in 30 index fingers (83%) and in 27 ring fingers (75%). It connects the long tendon to the proximal interphalangeal joint.

The vinculum longum of the index finger were double in 9(25%) cases and single in 21(58%) cases. For the ring finger in 7(19%) cases were double and in 20(56%) cases were single (Table 1). The double vinculae either passed between the two limbs of the superficialis tendon or one passed on the radial and the other on the ulnar side of the tendon, and in few cases both extended to the radial or to the ulnar side of the tendon (Table 2). The average length of the vinculae longum for the index fingers were 0.96 cm, and 0.97 cm for the ring finger. Well developed strong vinculum brevis was present in all specimens for both index and ring finger. It is triangular in shape. It attaches to the distal interphalangeal joint.
Table 1. The percentage of single and double vinculae longa for both index and ring finger.

<table>
<thead>
<tr>
<th>Vinculum Longum</th>
<th>Index Finger %</th>
<th>Ring Finger %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>58</td>
<td>56</td>
</tr>
<tr>
<td>Double</td>
<td>25</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>83</td>
<td>75</td>
</tr>
</tbody>
</table>

Table 2. The varying extensions of the vinculum longum.

<table>
<thead>
<tr>
<th>Vinculum longum</th>
<th>Index Finger %</th>
<th>Ring Finger %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both radial</td>
<td>5.4</td>
<td>2.7</td>
</tr>
<tr>
<td>Both ulnar</td>
<td>2.7</td>
<td>2.7</td>
</tr>
<tr>
<td>Between the two limbs of superficialis</td>
<td>55.3</td>
<td>58.3</td>
</tr>
<tr>
<td>One on the radial the other on the ulnar</td>
<td>19.3</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>83</td>
<td>75</td>
</tr>
</tbody>
</table>

In same cases it contained fenestrations. The average length of the base (bony attached border) of vinculae brevis of the index finger were 1 cm and the height were 0.64 cm. For the ring finger 0.92 cm were the base and 0.72 cm were the height. The vinculum longum of the index and the ring finger consists of usually 1-3 minute arteries where as the vinculum brevis consisted of 2-5 small arteries, some nerve fibers entering the dorsal surface of the tendon.

The minute arteries which are carried within the vinculae longa and brevia were from transverse arteries which were further branches of the palmar digital arteries.

Histological sections from the tendon;
1. Proximal to the vinculum longum; showed intrinsic blood vessels in the connective tissue between the collagen bundles of the tendon (Fig. 3).
2. At the level of vinculum longum; showed blood vessels and nerve bundles entering the tendon and protruding between the collagenous bundles (Figs. 4, 5).
3. Between vinculum longum and brevis; showed intrinsic vessels between the collagenous bundles (Fig. 6).
4. At the level of vinculum brevis; showed numerous blood vessels and nerve bundles entered the tendon through its dorsal surface. Additionally, continuation of intrinsic blood vessels were also observed at the distal end of the tendon (Figs. 7, 8).

Discussion

The source of the arterial supply to the long flexor tendon is of lack of agreement. Various studies on the vascularization of the long flexor tendons either described a non-interrupted intrinsic longitudinal vascular system or arterial supply by means of diffusion. The vinculum brevis, addition to its arterial supply, is also said to transmit some flexion force even after laceration of the tendon at the interphalangeal joint. Also, it is thought to hold the lacerated tendons near its insertion if the vinculum brevia is intact.

Our studies showed that, although the index finger is more functional compared to the ring finger, there were no apparent morphological differences between the vascularization of the two long flexor tendons. Histological sections from different regions of the tendon showed that there were small arteries running parallel to the collagen bundles, which were described as intrinsic vessels by Pennington. Histological sections showed that these intrinsic vessels most probably extended from the muscular attachment of the tendon. They were present in all sections of the tendon. In cases where vinculum longum was absent most probably the nutrition to the proximal portion of the tendon is supplied by these intrinsic vessels. Sections of the tendon, from the level of vinculum longum and brevis, showed that the arteries were transmitted to the tendon from its dorsal surface. Besides vessels, nerve fibers also entered the tendon via vinculum longum and brevis. As a conclusion of our study, the primary vascular supply is by the arteries within the vinculum longum and brevis and secondary by small intrinsic vessels extending from the muscular attachment of the tendon. The nutrient pathway to the flexor tendons is important to the surgeons involved in hand surgery. Also, the intratendinous arrangement of vessels, intrinsic parallel vessels and the different types of vincular system are important in analysing the prognosis of primary suture of the flexor tendon injuries being treated.

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Explanation of Figures

Plate I

Fig. 1. Gross appearance of the vinculum brevis (VB) and double vinculum longum (VL) of the index finger.

Fig. 2. Gross appearance of the vinculum brevis (VB) and double vinculum longum (VL) of the ring finger.
Plate II

Fig. 3. Histological cross section of the tendon from the level proximal to the vinculum longum; intrinsic blood vessels (V) in the connective tissue between the collagen fiber bundles.

Fig. 4. Histological cross section of the tendon from the level of vinculum longum; Blood vessels (V) nerve (N) bundles entering the tendon and protruding between the collagen bundles.

Fig. 5. Histological cross section of the tendon from the level of vinculum longum; The continuations of intrinsic blood vessels (V) between the collagen bundles.
Plate III

Fig. 6. Histological cross sections of the tendon between the vinculum longum and brevis; Continuation of the intrinsic blood vessels (V).

Fig. 7. Histological cross section of the tendon from the level of vinculum brevis; Numerous blood vessels (V) and nerve (N) fibers entering the tendon through its dorsal surface.

Fig. 8. Histological cross section of the tendon from the level of vinculum longum: continuation of intrinsic blood vessels (V).