THE ANATOMY OF THE DIGITOPALMAR ARCHES

ANDRZEJ ZBRODOWSKI, STANISLAV GAJISIN, JANUSZ GRODECKI

From the Division of Anatomy, Department of Morphology,
University of Geneva Medical School

The arterial supply to the flexor tendons of the fingers was studied by means of angiography, by the injection of coloured latex, and by microdissection. It was established that there were no anastomoses between the intra-osseous circulation and that of the synovial sheath. Two separate sources of blood supply to the sheath were found: the digitopalmar arches and the specific arteries of the sheath. The findings indicate that the ideal location for incision into the digital sheath is in the midline of the palmar surface. The flexor tendons within the sheath are supplied only by branches of the digitopalmar arches. Considerable differences were observed in the details of blood supply of the tendon of flexor superficialis and that of flexor profundus.

The details of blood supply to the digital sheath and flexor tendons have not been completely described. A number of authors (Dychno 1936; Bunnell 1952; Brockis 1953; Edwards 1960; Lang 1963; Zbrowdowski 1966) have claimed that there is no collateral circulation for these tendons. Others (Boyes 1950; Aronsson 1955; Peacock 1959; Wilson and Swenson 1959; Smith 1965; Verdan 1972; Lundborg and Myrhage 1977; Zbrowdowski, Gajisin and Grodecki 1979, 1980) have reported that a collateral circulation exists only in certain parts of the tendons and that the arterial territories are not connected, but no clarification of this problem could be found in recent histological studies of the subject (Edwards 1946; Minne and Depreux 1962; Winckler 1970; Leffert, Weiss and Athanasoulis 1974; Zbrowdowski 1974).

The purpose of the present study was to define both the source and the topography of the arterial blood supply to the tendons within the synovial sheath.

MATERIAL AND METHODS

Thirty human cadavers of both sexes aged between 20 and 80 years were used 48 to 96 hours after death. The arteries of the arm were rinsed for six hours at room temperature with 500 millilitres of a physiological solution containing 1000 units of heparin. Injection was then made into the axillary artery using a 500 millilitre metal syringe with a screw-type piston which allowed the maintenance of constant pressure during injection.

Three types of injection were used. In some specimens radio-opaque substances, for angiography, included a solution of Urographin and 20 per cent barium sulphate. In others 200 millilitres of latex coloured with either 10 grams of lead oxide with 50 millilitres of Indian ink, or with one gram of light violet autoquinone, was used in preparation for corrosion studies. In the third group 10 per cent gelatin in Indian ink solution was injected for later microdissection.

A volume of 100 to 150 millilitres of the selected solution was injected and a tourniquet placed on the uppermost third of the arm when the substance began to appear in the veins. An additional 200 millilitres was then injected over a period of three to six hours at a given pressure. The artery was then tied and the specimen immersed in 10 per cent formaldehyde for 10 days. The specimens were studied by the following techniques.

Radiography. Four radiographs were made at different stages of dissection: first, of the entire specimen; second, after removal of the skin and the tendons of the extensor muscles; third, after removal of the flexor tendons within and beyond the synovial sheath; fourth, of the skeleton after removal of the flexor sheath. Acid corrosion. Specimens of the whole hand injected with latex were immersed in concentrated hydrochloric acid for four to eight hours, depending on the thickness of the soft tissues.

Microdissection. Specimens of the entire hand, were preheated to 30 degrees Celsius and injected with Indian ink solution containing 10 per cent gelatin. A Bausch and Lomb dissecting microscope was used for dissection and a Wild photomicroscope for photography.

RESULTS

Radiography. Latex coloured with lead oxide was found to be the most effective of the three injections in clearly revealing the anatomy of the digitopalmar arches and their vascular distribution in the sheath and the tendons (Figs 1 to 4). It was noted that the vascularisation of the tendons was dependent on the capillary system while the precapillaries brought blood to the mesotendons.

The digitopalmar arches described by Brockis (1953) could be seen near the interphalangeal joints. These arches are formed by branches of the digital arteries which join at the midline of the finger. Lateral radiographs show them to lie between the phalangeal periosteum and the tendon sheath. This location was further confirmed by the anteroposterior view (Fig. 4)
Key
1. Radial artery
2. Ulnar artery
3. Superficial palmar arch
4. Deep palmar arch
5. Common digital artery
6. Digital artery proper
7. Digitopalmar arch

Arteriography. Figure 1—The intact hand. Figure 2—The hand after removal of skin and extensor tendons. Figure 3—Tendons from index and ring fingers without synovial sheaths and of middle and little fingers with synovial sheaths. Figure 4—Skeleton after removal of tendons and tendon sheaths.
which shows the digitopalmar arches in a specimen which included the synovial sheath and bone from which the flexor tendons had been removed.

**Acid corrosion.** Separation of the deep surface of the synovial sheath from the periosteum revealed that the periosteal vessels did not penetrate the digital sheath and confirmed the absence of anastomoses between the intra-osseous circulation and that of the sheath. At the distal phalanx, however, anastomosis did occur between the periosteal vessels and the end of the tendon.

The results of acid corrosion studies confirmed the existence of the digitopalmar arches seen on radiographs, as well as their location between the periosteum and the deep surface of the synovial sheath (Figs 5 to 6). These arches were seen to be branches of the digital arteries and were proximal or distal to the articular space. Thin arterial branches extended from these arches to the interior of the mesotendon and the vincula. Similar branches extended from the base of the digitopalmar arches to the deep part of the sheath.

**Microdissection.** This showed short arterial trunks stemming from the digitopalmar arches and dividing into three branches of equal calibre, leading to the synovial sheath, to the tendon and to the dorsal side of the finger (Figs 7 to 9). The branch leading to the sheath divided into several smaller branches providing a supply to the lateral walls of the sheath and forming numerous anastomoses with the arterial network of the opposite side. This vascularisation varied greatly. At the proximal phalanx, numerous branches filled the space of the articular capsule and covered the lateral and palmar surfaces, while the area of the middle phalanx was very poorly vascularised. The blood supply of the walls of the digital flexor sheath is shown in Figure 8.

The branches to the tendon from the digital artery met the synovial sheath at the base of its lateral wall, between the sheath and the periosteum, and reached the dorsal surface of the tendon through the vincula longa, vincula brevia and the mesotendons (Figs 10 and 11). Numerous branches from the digitopalmar arches extended in both distal and proximal directions and were seen to form a network on the tendon within its synovial sheath (Figs 12 and 13). A network was also seen on the deep surface of the sheath and was particularly dense at the level of the digitopalmar arches (Fig. 9). Thus the walls of the digital sheath have a double blood supply, from the digital arteries proper and from the digitopalmar arches. The blood supply to the tendon of flexor digitorum superficialis reached it from the proximal and the distal ends of the sheath. Within the sheath, the arterial network was more abundant in the superficialis tendon than in the profundus tendon.

**DISCUSSION**

Study of the blood supply to the digital flexor tendons is of particular interest to clinicians dealing with problems of the function of the hand. The anatomy of the blood supply to the tendon has been variously described in the literature (Edwards 1946; Smith 1965). Anastomosis between the intra-osseous and intratendinous circulation has been reported in several papers (Edwards 1960; Leffert, Weiss and Athanasoulis 1974; Lundborg and Myrhage 1977). No such anastomoses were observed in the present study except at the distal phalanx. Radiographic and corrosion studies clearly revealed that the principal source of blood supply to the digital flexor tendons in the synovial sheath comes from the digitopalmar arches. The principal branches to the sheath from the digital arteries proper were found in the lateral wall of the sheath while the palmar surface was only slightly vascularised. These differences bear on the question of the site of a surgical incision which may be either on the lateral or on the palmar side of the sheath.
**Key to numbers** (Figs 5 to 13)
6. Digital artery proper
7. Digitopalmar arch
8. Perforating branch to the sheath
9. Tendoneal artery
10. Artery of the sheath
11. Capillary network of the floor of the sheath
12. Capillary network of the flexor digitorum profundus tendon
13. Vinculum breve

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**Fig. 7**

Microdissections of the synovial sheath. Figure 7—Arterial supply of the dorsal surface of the synovial sheath. Figure 8—Short arterial trunks stemming from the digitopalmar arches. Figure 9—Capillary network of the floor of the sheath.
For many years both sites have been considered suitable (Bunnell 1952; Aronsson 1955; Peacock 1959; Wilson and Swenson 1959). The present study shows that for the proximal and middle phalanges incision should be along the midline of the sheath, thus avoiding damage to the principal arterial supply.

Several papers (Edwards 1946; Boyes 1950; Verdan 1972; Lundborg and Myrhage 1977) have reported the presence in tendons of zones in which there are few blood vessels, where nutrition seems to depend on diffusion. The present study showed that while poorly vascularised zones were observed after injection of latex mixture, the Indian ink technique clearly revealed the presence of a dense capillary network in the tendon. Also seen were zones of the superficial flexor tendon which were supplied by the vessels at the ends of the sheath and at the tendinous insertion to the periosteum (Winckler 1970). In the area where the flexor digitorum superficialis is perforated by the flexor digitorum profundus, the tendon of the former is vascularised by branches from the latter (Dychno 1936; Boyes 1950; Bunnell 1952; Edwards 1960; Verdan 1972).

The tendon of the flexor digitorum profundus shows a rich vascular network which has been previously described (Brockis 1953; Minne and Depreux 1962; Lang 1963; Zbrodowski 1974). The supply to this tendon reaches its dorsal surface through the vincula and there divides in T-shaped fashion into distal and proximal branches, continuing longitudinally as simple, double and triple anastomosed capillary loops. The superficialis and profundus tendons were found to have independent arterial networks, and the opposing tendinous surfaces within the sheath that are in direct contact with each other contain only terminal vessels.
This independence of blood supply is explicable in terms of the considerable friction to which the tendons are submitted (Dychno 1936; Wilson and Swenson 1959). This also explains the fact that the dense arterial network is on the palmar surface of the flexor digitorum superficialis and on the dorsal surface of the flexor digitorum profundus.

This study shows that there is no anastomosis between the intra-osseous circulation and that of the tendon sheath except at the tendon insertion on the distal phalanx; that the wall of the sheath has a double vascularisation and that the digitopalmar arches are the principle source of blood supply for the tendons within the digital sheath. It is clear that the site of election for an incision into the digital sheath of the finger is along the median line.

We are greatly indebted to Mrs Judith Noebels for her patient and highly competent assistance in the editing and translating of this paper. We also wish to thank Mr Henri Chauffat for technical assistance. Mr Daniel Wey for photography and Mrs Nadine Maaloufi for the typing.

REFERENCES


