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Analysis of the vascular anatomy of the palm and its clinical relevance in Morbus Dupuytren

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Summary. The triangular center of the palm is supposedly hypovascularized. Intraoperative clinical studies have shown numerous vessels and nerves rising through the palmar aponeurosis into the skin in this area. To investigate these findings we have dissected 7 cadaver hands in order to analyze the vascular and neural structure of the palm. On an average we have found 30 bundles in the center of the palm. At least half of them were vascular-nerve bundles, the other bundles consisted either of a nerve, an artery or a vein. By means of histological testing we have also found lymphatic vessels accompanying the blood vessels and the nerves. Our study shows a greater number of vessels rising into the skin than has been previously described in the literature, so that we cannot confirm the triangular hypovascular zone in the center of the palm.

Key words: Palma manus – Skin – Vessels – Nerves – Morbus Dupuytren

Introduction

Within the palma manus, the A. radialis and the A. ulnaris form two arterial arcs, the Arcus palmaris superficialis and the Arcus palmaris profundus. These two arcs are accompanied by very small veins. The Arcus palmaris superficialis supplies the skin through vertically rising vessels which are accompanied by nerves. In the center of the palma manus these vessels and nerves perforate the palmar aponeurosis. Their number should be few and their caliber very small. Larger vessels should be seen only in the region of the Monticuli. In angiographic studies Conway and Stark (1954) have found a central triangular zone of the palm that is supposedly hypovascularized. The intraoperative clinical study by Schrader et al. (1997) shows an average of 4 to 5 bundles within a small region of this area. It is not known whether arteries, veins, lymphatic vessels and nerves are present in these bundles. Our studies were performed on cadaver hands.

Material and methods

Preparation: Seven macroscopically intact cadaver hands (4 female and 3 male hands) have been dissected. They were cut from the distal part of an arm. Immediately after cutting both palmar arcs were rinsed through the Aa. ulnaris et radialis with a cacodylate buffer and then perfused with a 10% solution of formaldehyde. Within this solution the hands were stored 4–6 weeks. After this procedure they were frozen to minus 25.5 degrees Celsius and cut sagittally in 7 slices each 1 cm thin (Fig. 1). The lines of subdivision were placed randomly in the middle of each digit and in between. The ulnar and radial edges of the hands were not included in the preparation because vascular bundles in this area could have their origin on the back of the hand. The sagittal slices were kept in a solution of 40–50% absolute alcohol, 50–60% water and 0.5% formaldehyde. They were dissected in each case beginning from the ulnar and the radial side at 5–10 fold magnification using a light microscope. The subcutaneous fat was pulled out with fine forceps. Then the collagen fibers were cut and removed. The goal of this strategy was to expose vessels and nerves rising through gaps within the palmar aponeurosis into the skin. Because of a strong connective tissue in some areas we were not able to identify all vessels and nerves in the epiaponeurotic space. Therefore, in some slices we could expose their course only beneath the palmar aponeurosis and not the ascendence of these vessels and nerves. The origin of the main vessels out of the arcus palmaris superficialis however was always visible. The bundles which entered the corium were marked with needles.

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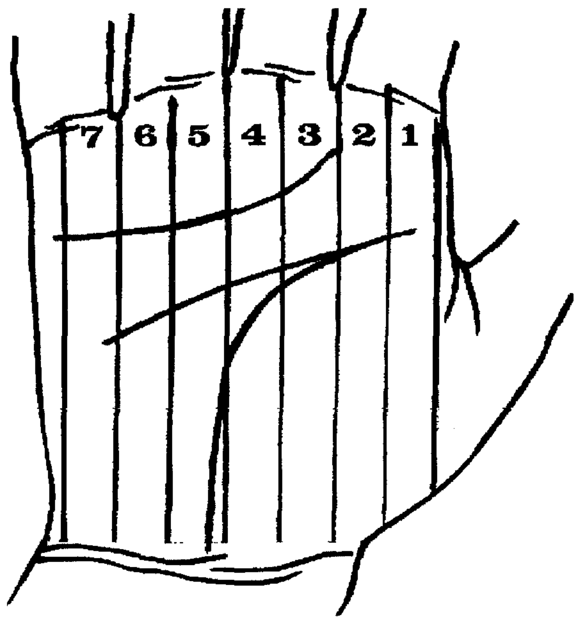


Fig. 1. Cutting sections of frozen cadaver hands.

Documentation: a) The dissected slices were photographed from the ulnar and radial sides. We took close-up and overview pictures. b) Cartography was used to document the localization and the number of bundles. A schematic figure of the palm was split up into small squares, each 0.5 cm^2 in size. The squares were divided into three zones (Fig. 2):

Zone 1 – a triangular zone in the middle of the palm
Zone 2 – the region of the palmar aponeurosis without zone 1
Zone 3 – the edges of the palm without zones 1 and 2.

Light-microscopy: The content of the prepared bundles was checked histologically using light-microscopy. Because of the large number of bundles we decided to analyze only the bundles gained from zone 1 of one hand and 57 randomly selected bundles from the 3 zones of all hands. To prepare the specimens for analysis, they were fixed in 2.5% of buffered glutaraldehyde (pH 7.2, 0.1 mol) for 24 hours. After this procedure the bundles were postfixed in buffered osmiumtetroxide (1%) for two hours, then dehydrated in a graded series of alcohol and finally embedded in Araldit.

The embedded bundles were cut into semithin sections using an "Ultracut" (Reichert-Jung) and then stained with methylene blue-azure II (Richardson et al. 1960). For microscopy and photodocumentation we used a Photomikroskop III (Zeiss).

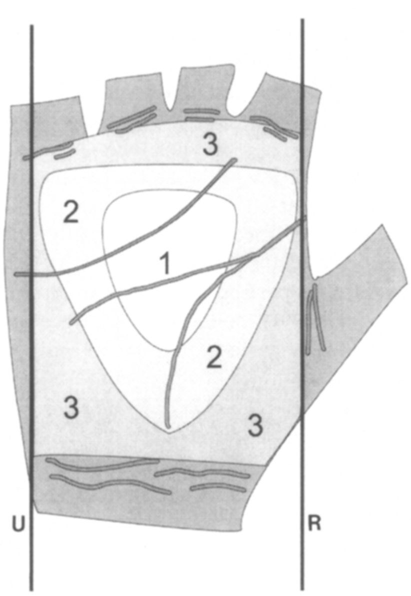


Fig. 2. Cartography of the palma manus. Division into a central triangular *zone 1*, a *zone 2* and a *zone 3*. U = ulnar side of the 7th slice, R = radial side of the 1st slice.

Results

In all preparations we could isolate vessels and nerves which arise into the skin through preformed gaps in the palmar aponeurosis. The vessels originate from the Aa. digitales palmares communes out of the Arcus palmaris superficialis and the nerves originate from the Nn. digitales palmares communes (Fig. 3). On the ulnar side of the palm the vessels perforate the M. palmaris brevis. They show tighter structural packing than vessels in the other regions of the palm (Fig. 4, 5). Schrader et al. (1997) showed intraoperatively that some vessels from the Aa. digitales palmares communes run along the dorsal side of the palmar aponeurosis and finally rise into the skin distal the transversal fibres. In our anatomic preparations we can confirm these findings (Fig. 6). The median number of bundles found within the three zones of the palm is displayed in Table 1. The zones 1 and 2 show no significant difference in the median number per cm^2, however in zone 3 the number of bundles per cm^2 was less.

The results from the histological analysis of all 30 bundles from zone 1 of one hand and the randomly selected bundles from all zones of all hands are displayed in Table 2.

If a bundle contained at least one artery or vein and a nerve we called it a vascular nerve bundle (VNB). Out of the 30 bundles from zone 1 we found 16 VNBs and out of the 57 random samples 28 VNBs (Fig. 7). A large artery or a large nerve were found in 21 of the 30 bundles from zone 1 and in 44 of the 57 bundles of all three zones (Fig. 8). In a few bundles we discovered up to 5 small arteries or nerves. In 8 out of a total of 87 analyzed bundles we found a lymphatic vessel. There were only two samples in which we did not find any relevant structures. Figure 9 shows the homogeneous distribution of the histological structures in both groups.

Discussion

It is possible that some small bundles containing vascular and neural structures were overlooked in producing the slices and during dissection of the bundles. Therefore the median number of bundles is likely to be slightly higher

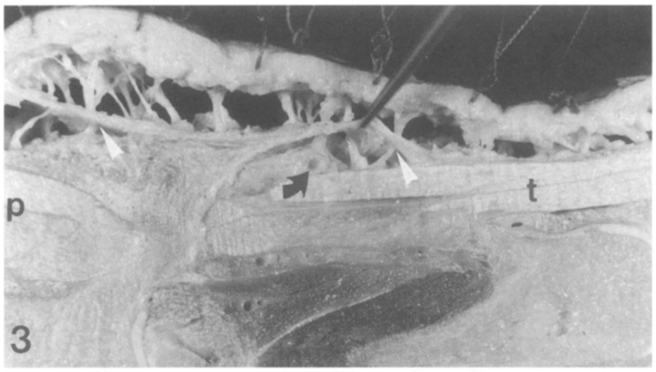
Table 1. Median number of bundles in the three zones of the palm of one hand. The bundles rise into the skin.

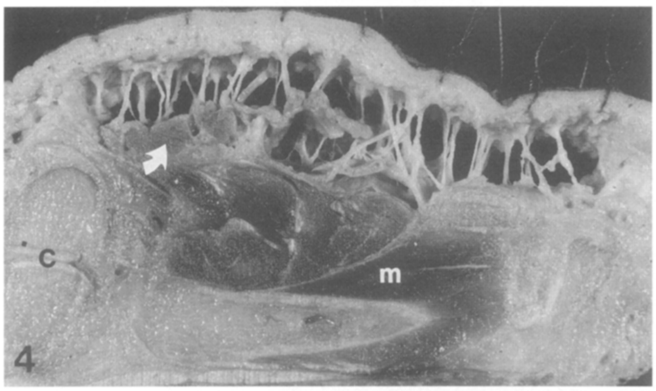
Zone	Median number of bundles	Median number of bundles per 0.5 cm^2	Standard deviation
1	31.9	0.68	0.1225
2	72.1	0.71	0.1372
3	47.8	0.39	0.1147

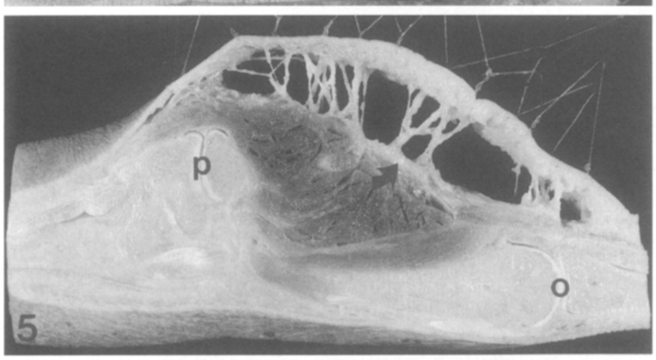
within the three zones. The data displayed in Table 1 show the incidence of vascular and nervous structures, as expected, at low levels. The anatomic structures within the histologically analyzed bundles show an even pattern of distribution (Table 2, Fig. 9). Therefore we can assume that our dissections of all hands are of similar quality. Only two bundles out of 87 histologically examined samples consisted entirely of connective tissue. The error rate should not be higher in regards to the rest of the unchecked bundles. Half of the dissected bundles are VNBs. The vessels and nerves rising into the skin by perforating the palmar aponeurosis and those ascending in the Monticuli area had almost the same diameter. We guess that these rising vessels and nerves mainly provide blood supply and innervation to the palmar skin. Veins were rarely found. Schmidt and Lanz (1992) proposed that venous drainage of the superficial layer of the palm is provided by small veins lying on the top of the palmar aponeurosis. The hypothesis of Skoog (1974) that lymph is only drained at the edges of the palm is not confirmed by our results. In 8 out of the 87 histologically examined bundles

Table 2. Histological structures found in the bundles among the three zones. Out of the 30 bundles from zone 1 (zentral zone) 16 bundles contained an artery, 2 bundles a vein, 2 bundles a lymphatic vessel.

Structures	Zentral zone of one hand n = 30 bundles	Random samples out of 7 hands n = 57 bundles
artery	16	35
vein	2	7
lymphatic vessel	2	6
small artery	27	45
nerve	20	35
Vater-Pacini corpuscule	2	9







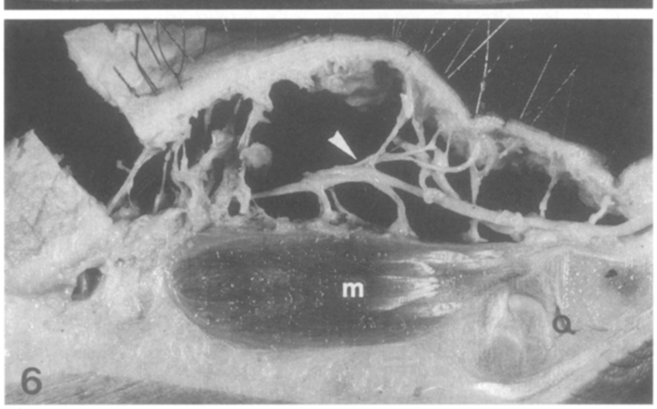


Fig. 3. 5^{th} sagittal slice, radial aspect. Aa. digitales palmares communes originating from the Arcus palmaris superficialis (cross sectioned, arrow). Nn. digitales palmares communes are perforating the palmar aponeurosis through preformed gaps (arrow head) and are rising into the skin. t = Tendines m. flexoris digitorum superficialis et profundus. p = proximal. 1,5 ×.

Fig. 4. 6^{th} sagittal slice, radial aspect. Numerous vascular nerve bundles, some of them are rising into the skin through the M. palmaris brevis (arrow). m = M. interosseus palmaris, c = Os hamatum et Os capitatum. 1,5 ×.

Fig. 5. 2nd sagittal slice, radial aspect. Rather scarce appearance of vascular nerve bundles. p = Articulatio carpometacarpea pollicis, o = Articulatio metacarpophalangea II. arrow = fascia of the thenar. 1,5 ×.

Fig. 6. 7^{th} sagittal slice, ulnar aspect. Vessels originating from the A. ulnaris digiti minimi (arrow head) rise into the skin distal to the transverse fibres of the palmar aponeurosis. o = Articulatio metacarpophalangea V, m = M. opponens digiti minimi. 1,5 ×.

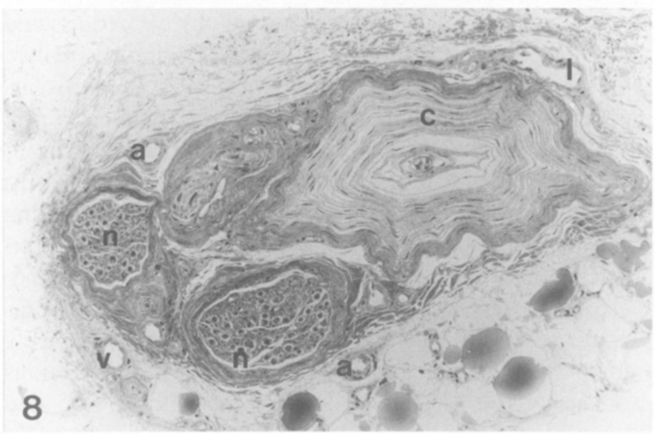


Fig. 7. Semithin section through a vascular nerve bundle. a = artery, n = nerve. Staining with methylene blue-azure II (Richardson et al. 1960).

Fig. 8. Semithin section through a nerve bundle. n = couple of large nerves, c = Vater-Pacini corpuscule, a = arteriole, v = venule, l = lympathic vessel. Staining with methylene blue-azure II (Richardson et al. 1960).

we discovered lymphatic vessels. In quantitative terms this is not sufficient. However it is well known that lymphatic vessels tend to be collapsed in histological specimen and it is therefore difficult to detect these structures. That is why it is very much likely that lymphatic vessels are more frequent within the bundles and contribute to palmar lymphatic drainage.

Our anatomical study shows a greater number of vessels rising into the skin than has been previously described in the literature (Salmon 1988; Kinoshita et al. 1991). We cannot confirm the triangular hypovascularized zone in the very center of the palm as proposed by Conway and Stark (1954) using angiographical means.

The vessels and nerves of the palm are of great clinical relevance, especially during operations for Morbus Dupuytren. Intraoperative preservation of these structures rising into the skin contribute not only to a faster postoperative recovery of sensibility of the palma manus, but also reduce the incidence of postoperative hematoma, edema and disturbance in wound healing.

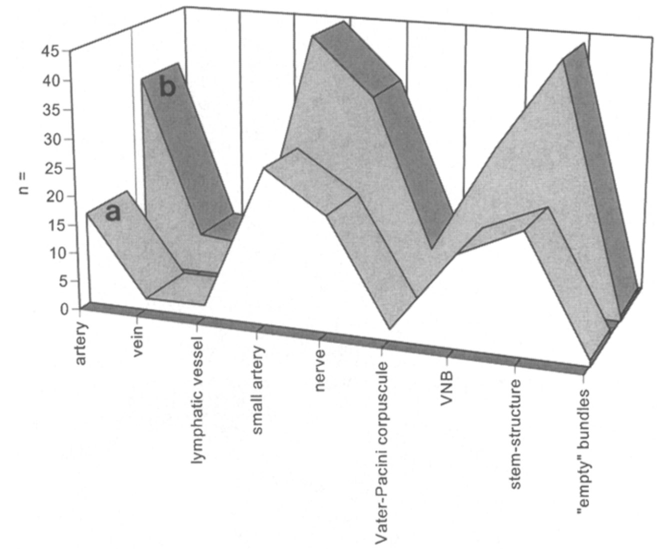


Fig. 9. Quantitative distribution of the specific anatomic structures among the histologically examined bundles. Statistical analysis revealed no significant difference between the 30 bundles of zone 1 of a single hand (a) and the randomly selected 57 bundles of the three zones of all hands (b). VNB = bundle which contain at least one artery or vein **and** nerve. Stem structure = artery **or** nerve **or** vein.

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