VARIATIONS IN THE NERVES OF THE THUMB AND INDEX FINGER

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The digital nerves to the thumb and index finger have been studied by dissecting twenty-five embalmed upper limbs. The palmar digital nerves to the thumb were constant in position and course, with a short lateral cutaneous branch from the radial palmar digital nerve in 30 per cent of cases. The palmar digital nerves to the index finger had a variable pattern, the commonest arrangement, well described in Gray's Anatomy, occurring in 74 per cent of cases. The variations and their frequency are described. By examining histological cross-sections of the index finger it was found that of about 5,000 endoneurial tubes entering the finger, 60 per cent passed beyond the distal digital crease to supply the pulp and nail bed. The depth of the palmar digital nerves was about 3 millimetres, but less at the digital creases, and their diameter lay between 1 and 1.5 millimetres as far as the distal digital crease. Clinical applications of the findings are discussed.

Modern knowledge of the sensory nerve supply of the hand is based on the work of Stopford (1918). Little work has, however, been done on the detailed anatomy of the cutaneous nerves supplying the digits. In past years this was of less importance, but recently, with increased use of local anaesthetics and developments in plastic surgery of the skin of the fingers, a detailed knowledge of the sensory supply and its variations in the fingers has become increasingly important.

This study is divided into two. Firstly, the topographic anatomy of digital nerves of the thumb and index finger was studied by dissection of cadavers. Secondly, a more detailed examination was made of the arrangement of the nerves within the index finger.

MATERIALS AND METHODS

Twenty-five upper limbs from normally embalmed adult males and females were examined. In two limbs, the radial and ulnar arteries were injected with red latex solution (Tompsett 1970) to aid the identification of structures during dissection. It was found unnecessary to do this in the rest of the specimens.

In the second investigation, an undissected freshly embalmed index finger from a sixty-five-year-old female was sectioned transversely ten times at measured intervals to include the palmar digital creases. From each segment serial histological sections 7μ thick were prepared and stained with an iron-haematoxylin-Van Gieson stain. The nerve fibres within the finger were studied by counting the endoneurial tubes in each section with a light microscope at a magnification of ×400. Three serial sections were counted and the average taken.

The cross-sectional area of nerve fibres at different levels was also determined by projecting the sections at ×10 magnification on to graph paper and measuring the area, including the epineurial sheath, of the individual nerve profiles.

RESULTS

Course of digital nerves

Thumb—Dissection of the nerves to the twenty-five thumbs showed the pattern of distribution to be remarkably constant; this is illustrated in Figure 1. Two palmar digital nerves, derived from the median nerve, passed distally on the radial and ulnar side of the thumb anterior (palmar) to the digital artery, then at the level of the distal digital crease each nerve divided into three or four...
branches to supply both the pulp and the nail bed. In no case did the palmar nerves give off a dorsal branch, but in eight cases (30 per cent) a short lateral cutaneous branch from the radial palmar digital nerve supplied the skin over the radial side of the first metacarpophalangeal joint.

During dissection no evidence of cross-over of nerve supply to the other side of the thumb from the two main digital nerves was found.

**Index finger**—Fifty palmar digital nerves were identified and examined and the frequency of each pattern was assessed.

There was much variation in detailed anatomy of the nerves, although all were branches of the median nerve. The most common pattern (Fig. 2) occurred in thirty-seven (74 per cent) of the nerves. In this the palmar digital nerves passed through the palm, deep to the digital artery. The one destined for the ulnar side of the digit passed to it between the superficial and deep transverse metacarpal ligaments. Within the digit the digital nerve passed down the radial or ulnar side, lying anterior (palmar) to the adjacent artery at the side of the fibrous flexor sheath. At the distal digital crease it divided into three or four branches which terminated distally by supplying the pulp and nail bed. Again no cross-over innervation of the pulp was apparent. Just proximal to the proximal digital crease, the palmar digital nerve gave a dorsal branch which passed either deep (twenty cases) or superficial (seventeen cases) to the digital artery. An incomplete connective tissue septum (Cleland’s ligament) joining dermis to periosteam and lying dorsal to the digital artery was present in all specimens, and divided the digit into flexor and extensor compartments. The dorsal branch of the palmar nerves perforated this septum, and after anastomosing with the dorsal digital nerve supplied the skin over the dorsum of the middle and distal phalanges but not the nail bed.

In five palmar digital nerves no large dorsal branch was found, but one or two small twigs did communicate with the dorsal digital nerve which is shown as pattern 2 in Figure 3, which also shows the other variations and their frequencies; mainly the differences related to the supply of the dorsum of the finger. In one case, however,
shown as pattern 6 in Figure 3, the dorsal branch of the palmar digital nerve was given off proximally within the palm and passed into the digit as a quite separate nerve, to supply virtually all of the dorsum of the finger.

The communication always present between the dorsal digital nerve and the palmar digital nerve (usually through its dorsal branch) means that the cutaneous supply of the dorsum cannot be defined accurately.

On the radial side of the index finger the course and branches of the nerve was most constant, with pattern 1 being the commonest in twenty-three fingers and pattern 3 in the other two. On the ulnar side the commonest pattern was seen in fourteen cases and other patterns in the remainder. Hence variation is most marked on the ulnar side.

The dorsal digital nerves to the thumb and index finger all arose from the radial nerve. The number of branches entering the digits varied from two to five dorsal branches to the thumb, and two to four branches to the index finger.

**Structure and position of digital nerves**

The detailed arrangement of the nerves within the index finger was studied by examining the prepared histological sections.

In order to gain some insight into the number of nerve fibres entering the digit, the number of endoneurial tubes within nerve bundles entering the finger (at the level of the proximal digital crease) was counted. The number of endoneurial tubes at the level of the distal digital crease was also counted. The results are shown in Figures 4 and 5.

It was found that of about 5,000 endoneurial tubes entering the finger, about 3,000 passed beyond the distal digital crease, carrying fibres which terminated in the pulp and nail bed of the finger. The endoneurial tubes within the finger were found to be symmetrically placed in position and number on either side of the digit.

The depth of the palmar digital nerves within the index finger was studied (Fig. 6). The depths were measured from the surface of the skin to the most superficial part of the epineurium of the nerve bundle. The depth was found to be of the order of 3 millimetres, but the bundle became more superficial at the palmar digital creases.

![FIG. 7](image)

The cross-sectional area of the palmar digital nerves within the index finger.

Further work was carried out to determine the cross-sectional area of the palmar digital nerve (Fig. 7). It was found to change little in size as it passed from the palm to the distal digital crease. Its diameter lay between 1 and 1·5 millimetres during this part of its course.

**DISCUSSION**

After the first world war, Stopford (1918) reviewed cases of complete lesions of the median, ulnar or radial nerves. He assessed the origin of the cutaneous supply of the hand by studying the resultant areas of anaesthesia following nerve lesions, and indicated the apparent variations in the nerve supply of the hand. In a study of Chinese hands, using necropsy specimens and anatomical dissections, P'An (1939) determined the distribution of median, ulnar and radial nerves. Further information on the general distribution of the main cutaneous nerves to the hand was obtained from injuries described in the Medical Research Council Memorandum (1942).

Having noted that the part of the human hand which possesses papillary ridges corresponds exactly to the ventral side of the embryonic hand plate, Dankmeijer...
and Waltman (1950) studied the nerve supply of the digits. They showed by dissection that the dorsal digital nerves to the thumb and little finger extended as far distally as the nail bed, whereas in the other digits the dorsal nerves passed only as far as the proximal interphalangeal joint or the region of the middle phalanx.

The results of an investigation of the variations of the detailed arrangements of the nerves within the digits does not appear to have been published, though the most common pattern is described in current anatomical texts (Gray's Anatomy 1973). In the present work the palmar digital nerves to the thumb were found to supply only the palmar aspect of the digits, the pulp and nail bed, while those to the index finger supply in addition, and with many variations, the dorsum of the digit. These findings are in keeping with the results of local anaesthetic block of the nerves.

A detailed knowledge of the course and depth of the nerves in the digits is of importance in planning incisions and flaps for plastic surgery of the hand, especially for those that involve the transference of flaps of skin with their blood and nerve supply intact either within the finger or from one digit to another. The advancing of a volar digital flap as described by Moberg (1964) for finger tip injuries depends for its success on a good knowledge of the palmar digital nerves. If applied to digits other than the thumb, the presence of the dorsal branch of the palmar digital nerve should be appreciated. The findings are also relevant to a recent operation developed by Littler (1960) and Tubiana and Duparc (1961) in which skin of a neurovascular island flap is transferred from one digit to another, its nerve supply from the palmar nerve being retained; one effect of this procedure is to remove the nerve supply to the dorsum of the donor finger on one side. This operation has been extended by Heoston (1965) to include transferring the skin from the dorsum of the donor finger as well. The variations in supply to the dorsum as described in the current work are thus relevant to these procedures, though the presence of the dorsal-palmar digital nerve communications means that some skin must inevitably be denervated.

The apparent lack of anatomical cross-over innervation of the pulp in both the thumb and index finger is in keeping with the findings of Honner, Fragiadakis and Lamb (1970), who applied local anaesthesia to the palmar digital nerves. The present work also indicates that the majority of nerve fibres entering the digits are destined for the terminal phalanx.

The depth of the palmar digital nerves, which lie about 3 millimetres deep throughout the finger, is interesting, but some caution is required applying this to the living finger. In the sectioned finger the depth may be altered slightly by the histological preparation of the material, when slight shrinkage of soft tissues takes place, and secondly the thickness of skin and subcutaneous tissue varies from person to person. The generally held impression that the palmar digital nerves become more superficial at the digital creases has been confirmed.

The relative size of the palmar digital nerve as it passes along the digit is important in relation to digital nerve repair after injury. From both dissection and microscopic examination of specimens it is apparent that digital nerve suture is still possible in the region of the middle phalanx, and indeed almost as far as the distal digital crease.

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