

ON THE DISTRIBUTION OF THE CUTANEOUS NERVES ON THE DORSUM OF THE HUMAN HAND.

By H. ST. JOHN BROOKS, M.D.;

Chief Demonstrator of Anatomy in the University of Dublin.

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IN the commencement of the present Session (1887-88), I was led to investigate the anatomy of the cutaneous nerves on the dorsum of the hand by some passages I had met with in Létievant's "Treatise on Sections of Nerves." In his preface, this author states that after section of a nerve-trunk, sensation is never completely lost in the area of distribution of the divided nerve—a certain amount of sensibility always persists. Létievant explains this by the part played by "anastomoses" and by "ébranlement des papilles à distance."^a Communications between nerves or "anastomoses" afford a very inadequate explanation of many of the phenomena which this great neurotomet describes in his book; and although the supposition, that distant nerve-endings can be affected by shock transmitted through the skin, may throw some light on the persistence of sensibility in the area of distribution of a divided nerve, it entirely fails to explain the fact that the partial loss of sensation sometimes extends beyond the limits which should be reached by the ultimate twigs of the nerve which has been cut, if the accounts given in anatomical text books are correct. A striking example

^a *Traité des Sections Nerveuses*. Paris, 1873. "Malgré la section d'un nerf il reste toujours, dans sa région, de la sensibilité, quand la division a porté sur un nerf sensitif ; . . ."—Preface, p. xiv. "On ne saurait nier, certes, le rôle des anastomoses ; il convient même d'insister sur leur importance. Mais, chez l'homme, il y a, de plus, une perception des sensations tactiles par ébranlement des papilles à distance."—Ibid, p. xvi.

of this is shown in Fig. 6,^a where the fourth and fifth fingers are seen to be considerably affected by section of the musculo-spiral nerve.

Having incidentally observed, in the course of my usual work in the dissecting-room, that the twigs of the radial and ulnar nerves occasionally crossed one another, or overlapped in their distribution, on the dorsum of the hand, it occurred to me that the phenomena observed after section of nerves might be explained by something more than mere anastomoses, that it was possible that a given area of skin might be very commonly supplied by twigs from two different nerves. I was at that time unaware that R. Jacobi^b had already advocated a similar theory in regard to the "collateral innervation of the skin." As I believed that by means of special dissection it would be possible to trace the nerves nearly to their terminations, I proceeded as follows:—After securing the trunks of the palmar digital branches of the median and ulnar nerves, and also the radial, the dorsal branch of the ulnar and the external cutaneous branch of the musculo-spiral, I proceeded to remove the skin, superficial and deep fascia, with the nerves included, from the back of the hand and from the fingers. A longitudinal incision was made along the centre of each finger on its volar aspect, the skin reflected towards the dorsum, and the nails, with as much of their matrix as possible, were also retained in connection with the skin. The skin was then pinned down, with the deep surface upwards, in a cork-lined tray, and the nerves followed out under water. The first hand that I examined in this way was somewhat disappointing, inasmuch as the amount of crossing of the nerves was inconspicuous. The second example, however, showed considerable intercrossing of the radial and ulnar nerves, and I therefore determined to make every effort to ascertain the ultimate distribution of their twigs. The dissection occupied about twenty-six hours, and the result is shown in Fig. 1. As the nerves were

^a Op. cit., p. 105. This figure has been reproduced in the accompanying plate. See Fig. 5.

^b "Ein merkwürdiges Sensibilitätsphänomen." Von Dr. Rud. Jacobi. Berliner klin. Wochenschrift, 6 und 20 Juni, 1887.

dissected in connection with the skin, it has been thought better to represent them in the drawing in this way rather than to show them in relation to the fascia and tendons, as is the more usual practice. In determining the exact positions of the various branches, the following three points were observed:—1. The folds corresponding to the metacarpo-phalangeal and inter-phalangeal articulations. 2. The clefts between the fingers. 3. The usual position of the larger branches as determined from hands dissected in the ordinary way. To insure accuracy, pins were thrust through the centre of each of the skin-folds. The nerves were at first drawn as they appeared in the dissection, and afterwards reversed and transferred on to a drawing made from the hand of another subject, which was selected for the purpose on account of its similarity to the one in which the nerves were dissected. The following points will be observed:—1. The dorsal branches of the ulnar and radial nerves intercross for the space of three fingers; the basal parts of the index, middle and ring fingers, and a considerable part of the skin of the dorsum of the hand are thus shown to have a double nerve-supply. 2. The smaller twigs always cross on a plane superficial to the larger branches. 3. The communications or anastomoses are inconsiderable (in this case), while the nerves freely cross one another. 4. Speaking generally, the radial nerve retreats for the space of one joint as it advances from the radial to the ulnar side, and the ulnar behaves in a similar manner in its course from the ulnar to the radial side; thus the radial nerve reaches the ungual phalanx of the thumb, the distal inter-phalangeal joint of the index finger, the proximal inter-phalangeal articulation of the middle, and the metacarpo phalangeal joint of the ring finger. The dorsal branch of the ulnar supplies the skin about the nail of the little finger, and gradually becomes more and more proximal in its distribution until it reaches the index finger.

The advantages of the method employed are obvious. As the ends of the nerves are fixed in the skin, they are maintained in position, and also the fine twigs are preserved which would inevitably be removed in skinning the subject in the ordinary way. This mode of tracing cutaneous nerves has been often employed,

and it appears to have been a favourite method with Henle.^a I am not aware, however, if the nerves of the dorsum manûs have been previously treated in this way *under water*. When the preparation is placed under water and traction is made on the trunks of the radial and ulnar nerves alternately, the general distribution of each nerve and many of the finer branches can be seen without further dissection; this applies more particularly to the back of the hand; in the fingers, on account of the tough and opaque nature of the fascia, the results are not so good.

I have examined the nerves by the above method in six hands, and have also succeeded in seeing the crossing of the nerves in four other hands, which I dissected in the ordinary way. In another of the six cases dissected under water I found the radial and ulnar nerves crossing in their distribution to the extent of three fingers (index, middle, and ring); in the others, the area of skin thus doubly supplied was much smaller; in one case being not more than a quarter of an inch in breadth. While regarding the amount of crossing of the two nerves which is displayed in Fig. 1, as unusually large, I am inclined to think that the amount of skin on the back of the fingers, which is supplied by the dorsal digital nerves, is fairly typical. In five of the ten cases, the dorsal branches of the ulnar nerve were traced to the nail of the little finger, and, from the size of the nerves, they probably extended equally far in the other five cases also. In the thumb, as is well known, the branches of the radial regularly extend as far as the nail. In the index and ring fingers, I found that the dorsal nerves usually reached the second inter-phalangeal joint. In the middle finger the dorsal nerves generally extend only as far as the first inter-phalangeal articulation; but in one case I found a branch of the ulnar nerve, and in another subject, a combined branch of the ulnar and radial nerves, reaching as far as the ungual phalanx of this digit.

In Fig. 2^b of Létiévant's book, the dorsum of the ungual phalanx of the thumb is shown to be profoundly affected by section of the median nerve. This led me to pay particular attention to the

^a Handbuch der Nervenlehre. 1879. Fig. 285, 286, 291 u. 292.

^b This figure is reproduced in the accompanying plate. See Fig. 6.

distribution of the palmar digital branches of the median to the thumb. In the hand from which Fig. 1 was taken I could not follow any of the twigs on to the dorsal surface; but in most of the other cases I found twigs which would amply account for the loss of sensation depicted in Létievant's figure. In three cases I traced particularly strong branches under the thumb nail, and found them ramifying in the bed of the nail. This arrangement is shown in Fig. 2. The twigs from the median passed in these cases under cover of a ligamentous band, and wound round the ungual phalanx, keeping close to the bone, to reach the dorsal surface.

In Fig. 1 a twig from the external cutaneous branch of the musculo-spiral is shown crossing the branches of the ulnar nerve; in two of the other five cases dissected under water this nerve communicated with branches of the radial just below the wrist-joint. In two others its distribution was much more extensive. In one case it reached the metacarpo-phalangeal articulation of the little finger, and communicated, in this situation, with one of the branches of the ulnar nerve. In the other example it was as large as one of the ordinary dorsal digital branches of the ulnar nerve, and it supplied the skin on the dorsal surface of the base of the proximal phalanx of the ring finger and extended on the little finger as far as the base of the middle phalanx of that digit. In Létievant's case of section of the musculo-spiral nerve (above referred to) the little finger may therefore have received a partial supply from the external cutaneous branch of the musculo-spiral.

A twig of the musculo-cutaneous nerve was in one case found crossing the branches of the radial on the back of the hand. It is well known that the musculo-cutaneous nerve communicates with the radial on the back of the wrist; in one subject I found large branches joining the branch of the radial which supplies the radial side of the thumb, and another considerable branch joining the division of the radial which bifurcates to supply the adjacent sides of the thumb and index finger. These communications from the musculo-cutaneous were proportionally of sufficient size to have taken a considerable part in the sensory supply of the dorsum of the thumb, and possibly of the index finger also. Dr. David Hepburn

has recorded a case in which the musculo-cutaneous nerve constituted the sole supply of the radial border of the thumb, and shared with the ulnar in the supply of the ulnar border of that digit, the radial nerve being absent.^a

I have never succeeded in following the internal cutaneous as far as the back of the wrist; it stops immediately above the lower end of the ulna.

It appears from the above facts that certain areas of the skin on the back of the hand may be supplied by no less than three nerves—viz., part of the ring finger by the radial, ulnar, and median nerves; a small area below the ulnar side of the wrist by the radial, ulnar and musculo-spiral nerves, and, more rarely, a very limited area, situated more towards the radial side, by the radial, ulnar and musculo-cutaneous nerves. It also appears that the amount of intercrossing varies very greatly in different hands.

I have not been able to find any description of a double innervation of the skin of the hand in the literature of the subject. Most anatomists do not even hint at such a thing. Henle,^b however, figures a twig of the ulnar crossing the radial for a very short distance, but he does not describe it in the text. Ranney,^c referring to a figure representing the areas of distribution of the median, ulnar, and radial nerves on the back of the hand, says:—“This diagram limits the distribution of each nerve with more positiveness than can well be verified, since the cutaneous filaments of two nerves may supply the *borders* of any of these regions, as the nerves tend to overlap each other.”

With regard to the cutaneous supply of the fingers, some text-books have represented the dorsal digital nerves extending uniformly as far as the ungual phalanges of the fingers; these statements do not require to be seriously criticised. In “Quain’s Anatomy” and in the German text-books the dorsal nerves are represented as extending to the nail only in the case of the thumb; the dorsal branches

^a Journ. of Anat. and Phys. Vol. XXI., p. 511.

^b Op. cit. Fig. 291., p. 545.

^c Applied Anatomy of the Nervous System. By A. L. Ranney. London. 1881. P. 411.

to the four inner digits are described as reaching no further than the first inter-phalangeal joint, the palmar digital nerves curving round beyond that point to supply the fingers on their dorsal aspect. Henle^a has stated very positively that in the case of the thumb the palmar (median) twigs do not reach the dorsum, the same is asserted by Hilton,^b and also by Krause.^c

Through the kindness of Mr. Wheeler, Surgeon to the City of Dublin Hospital, and of Mr. Corley, President of the Royal College of Surgeons, Ireland, I have had the opportunity of examining two cases of nerve section in the living subject. Case I. was a woman of about fifty years of age, in whom the ulnar nerve had been divided above the elbow in May, 1887. I made a careful examination of the affected hand with the aesthesiometer, and I have shown the result in Fig. 3. Over the ulnar margin of the hand, the little finger, and half of the ring finger, the sensation appeared to be completely lost; sensation was also greatly impaired over a considerable part of the dorsum of the hand and over the radial side of the proximal phalanx of the ring finger; this is indicated by the blue shading in the figure. A narrow band (indicated by red shading) on the radial side of the area just described, showed slightly affected sensation. This case differs greatly from the case described by Létiévant,^d in which the loss of sensation was confined to the little and ring fingers, and the transition from affected to sound parts was abrupt. It differs also inasmuch as sensation appeared to be completely lost on the ulnar side of the hand, while in Létiévant's case a certain amount of sensibility was preserved.

^a Op. cit., p. 550. "Der Daumen ist der einzige Finger, an welchem die dorsalen Nerven sich bis unter den Nagel erstrecken; an den übrigen Fingern enden sie an der Mittelphalange und wird die Endphalange von Zweigen der volaren Nerven auch an der Rückseite versorgt. Mit Rücksicht auf den nervenreichsten und empfindlichsten Teil der Finger, das Nagelglied, gehören also die Dorsalflächen der drei medialen Fingerränder dem N. ulnaris, der fünf nächsten dem N. medianus, der zwei radialen oder Daumenränder dem N. radialis an."

^b "Rest and Pain." Fourth Edition. 1887, pp. 196, 197.

^c Handbuch der menschlichen Anatomie. Hannover. 1879. Zweiter Band. S. 897.

^d Op. cit. Fig. 4., p. 84.

That sensation may be completely lost in such cases is shown by a case lately published by Dr. Jencken,^a in which, after traumatic section of the ulnar nerve, sensation was so completely lost in the little finger that the man would often allow it "to remain in contact with the flame of a lamp or gas jet until the skin was burnt, for the amusement of his comrades."

The difference between Létiévant's case and the one which I examined appears to indicate that in the one patient the crossing of the radial and ulnar nerves was very slight, and that in the other it was considerable.

Case II. was a man of about forty years of age, in whom the ulnar and median nerves had been divided just above the wrist by an accident which occurred in February, 1875. Sensation was impaired, but nowhere completely lost. The loss of sensibility was more marked on the palmar than on the dorsal surface of the fingers, the maximum anaesthesia being on the palmar surfaces of the little finger and ulnar half of the ring finger. An inspection of the diagram (Fig. 4) suggests the probability that either the radial nerve or the external cutaneous branch of the musculo-spiral crossed as far as the little finger in this case, and that the amount of distribution of the ulnar nerve on the back of the hand was small.

It appears from the above facts that the sensory effects of section of a nerve, *e.g.*, the ulnar, may vary considerably. (*a*) The amount of skin affected is much greater in some patients than in others (compare the above case—Case I.—with Létiévant's). (*b*) The degree of loss of sensibility is subject to considerable differences (compare Dr. Jencken's case, in which sensibility was entirely lost, with Létiévant's cases, in which a certain amount of sensation always persisted). These differences in the clinical facts find a ready explanation in the greater or lesser degree of intercrossing of the nerves which has been already described.

That great differences exist in the distribution of the grosser branches of the radial and ulnar nerves on the dorsum manûs, has

^a "Suture of Divided Ulnar Nerve after Six Months." *British Medical Journal*, 10 Dec. 1887, p. 1274.

long been known ; Henle ^a represents the normal arrangement as follows :—“The little and ring finger and the ulnar half of the middle finger, as supplied by the ulnar and the other two and a half digits by the radial ; Krause’s ^b account is substantially the same, but he is inclined to give the radial nerve a larger share in the innervation of the middle finger ; he notices that in rare cases this nerve may supply the fourth or even the fifth finger.^c Quain states that the radial nerve supplies the dorsum of the thumb, the index and the radial border of the middle finger ; the ulnar nerve on the other hand is distributed to the little finger and to the ulnar border of the ring finger ; while the adjacent sides of the middle and ring fingers receive their nerve-supply from combined twigs of the radial and ulnar nerves.^d

I have already referred to the able paper by Dr. R. Jacobi which appeared in the *Berliner klinische Wochenschrift* last year. This observer suffered, in his own person, the accident of section of the median and the musculo-spiral nerves. His observations led him to the conclusion that a “collateral” (double or multiple) innervation of the skin existed which would account for the clinical phenomena. I regret that I have not had the opportunity of consulting his larger work on the “Collateral Innervation of the Skin,”^e but, from what I can gather from the paper I have read, he appears not to have made any anatomical researches with a view of demonstrating the collateral innervation of the skin. He mentions, however, the following interesting observation :—That if one of the four nerves which supply any of the toes is cut, and

^a Op. cit., p. 550.

^b Op. cit., p. 896.

^c Op. cit. Dritter Band, p. 209. “N. radialis superficialis. Liefert selten auch Nn. digitales dorsales für den vierten Finger, oder (sehr selten) zugleich für den fünften Finger, während der N. ulnaris dorsalis fehlt.” In Dr. Hepburn’s paper (above referred to) a case is recorded in which the dorsal branch of the ulnar nerve was absent. “Here the radial nerve supplied the cutaneous branches for the entire dorsum of the hand and fingers.” He also describes a case in which the radial nerve was wanting, the dorsum of the hand being supplied by the ulnar and musculo-cutaneous nerves.

^d Quain’s Anatomy. Ninth Edition. 1882. Vol. I, pp. 610 and 616.

^e Archiv für Psychiatrie u. Nervenkrankh. Bd. XV. S. 151-183 u. 506-559.

a portion of the peripheral stump subjected to microscopical examination some weeks after the section, a certain number of perfectly intact fibres will be found lying among the degenerated fibres. This gives evidence, not of a true double innervation of the skin, but offers an example of "nerves without ends" as described by Hyrtl. Such communications are well known to occur abundantly on the dorsum of the hand and fingers, and are of the nature of the "anastomoses," on which Létiévant throws so much weight in the explanation of the clinical phenomena.

EXPLANATION OF PLATE.

Fig. 1.—Shows a dissection of the cutaneous nerves on the dorsum of a hand. The radial nerve is shown in blue, the ulnar in red, the median and the external cutaneous branch of the musculo-spiral, *msp*, in black. *r*, Radial nerve. *u*, Dorsal branch of the ulnar nerve. *m*, Branch of the median nerve. Observe that the twigs of the radial and ulnar nerves cross one another for the breadth of three fingers.

Fig. 2.—Thumb taken from another subject, showing twigs from the median nerve ramifying under the thumb nail.

Fig. 3.—Diagram of the case of section of the ulnar nerve, described in Case I. (In this and in the succeeding figures the dark shading indicates the parts most profoundly affected, the blue those in which the sensibility is less impaired, and the red shows the area in which but slight loss of sensation occurs.)

Fig. 4.—Diagram of the case of section of the median and ulnar nerves, described in Case II.

Fig. 5.—Section of musculo-spiral nerve (after Létiévant.)

Fig. 6.—Section of median nerve (after Létiévant).

Fig. 1.

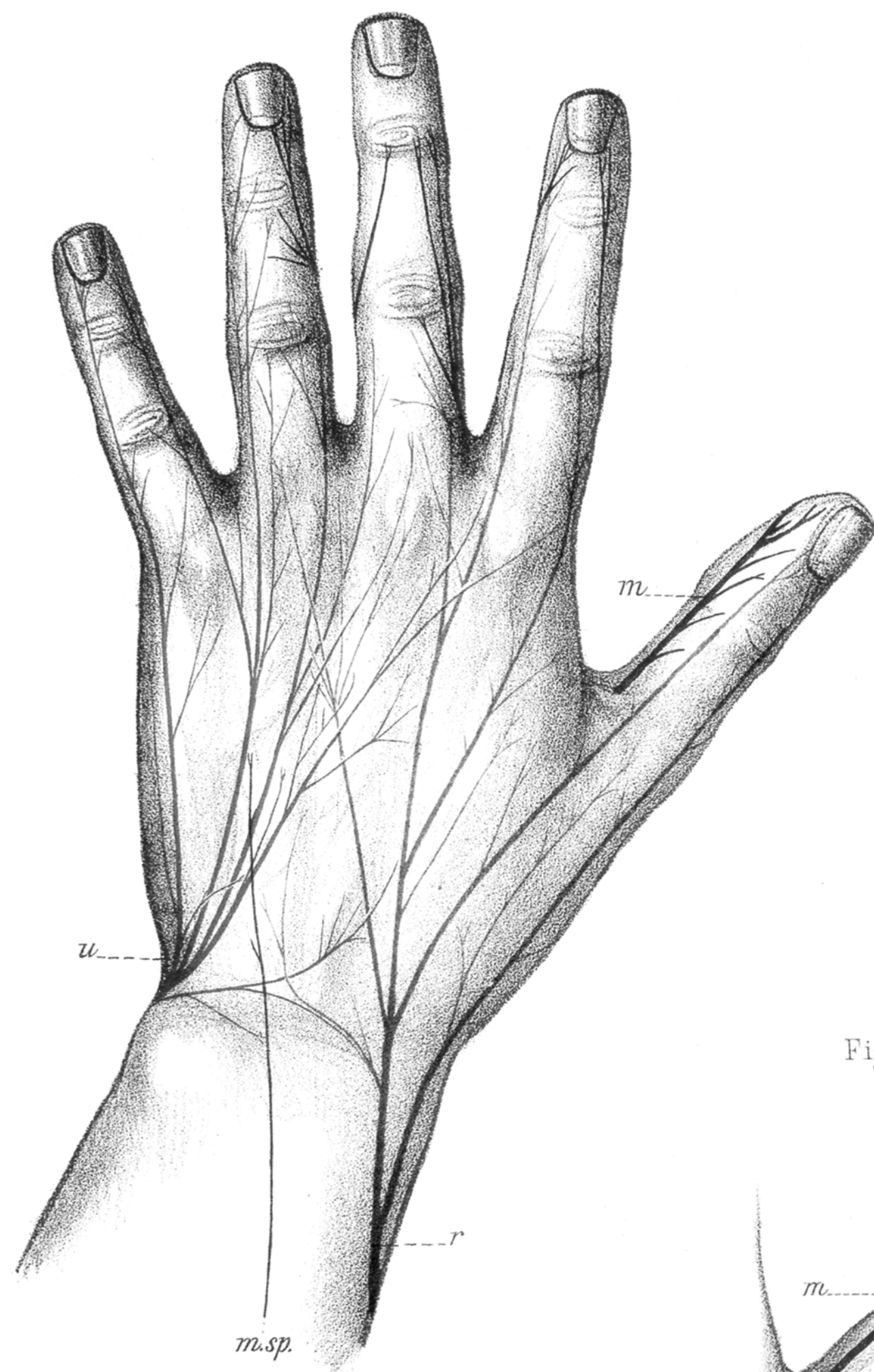


Fig. 2.

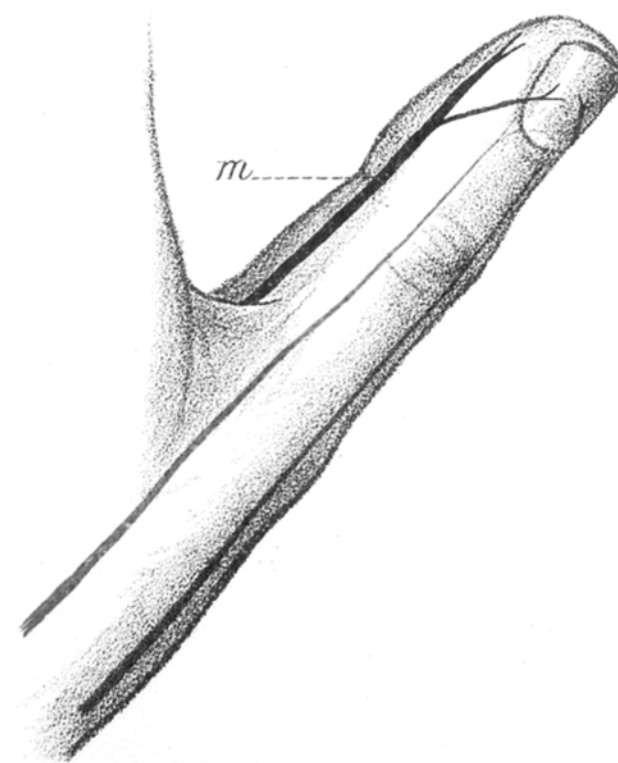


Fig. 3.

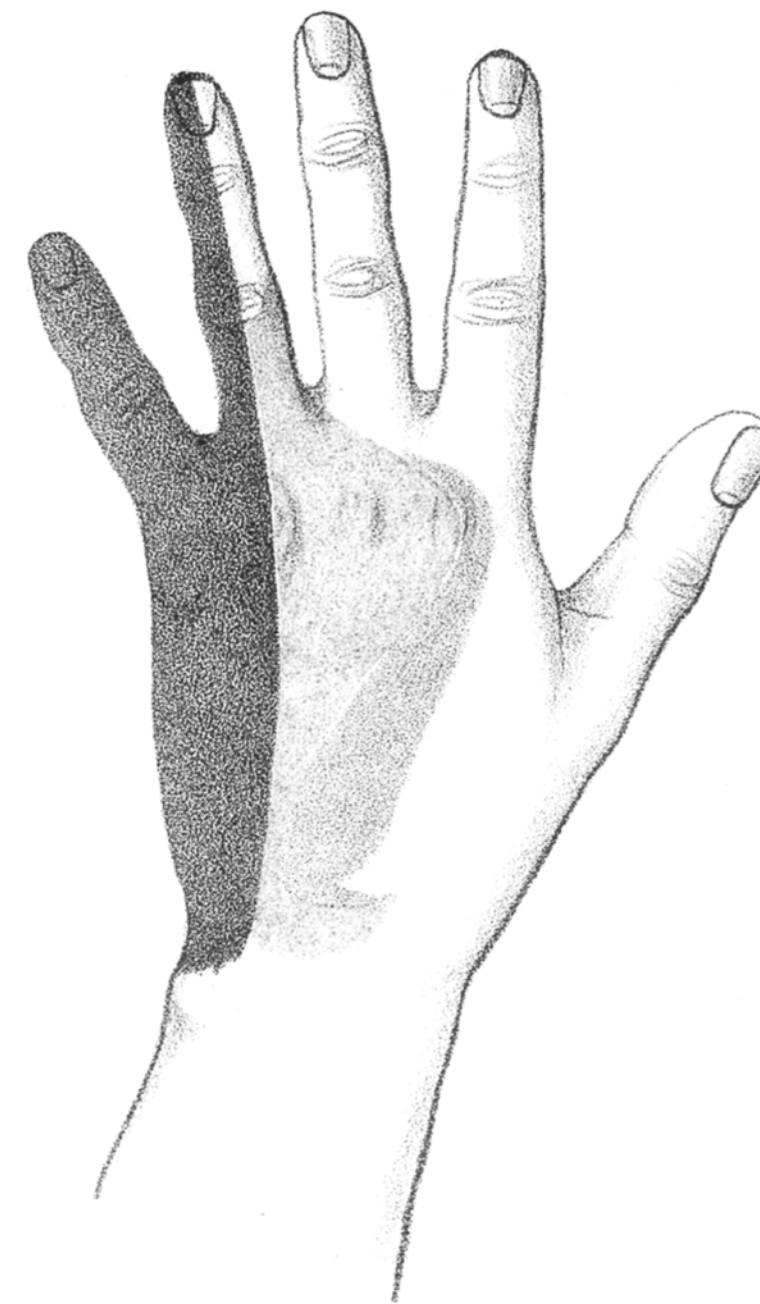


Fig. 4.

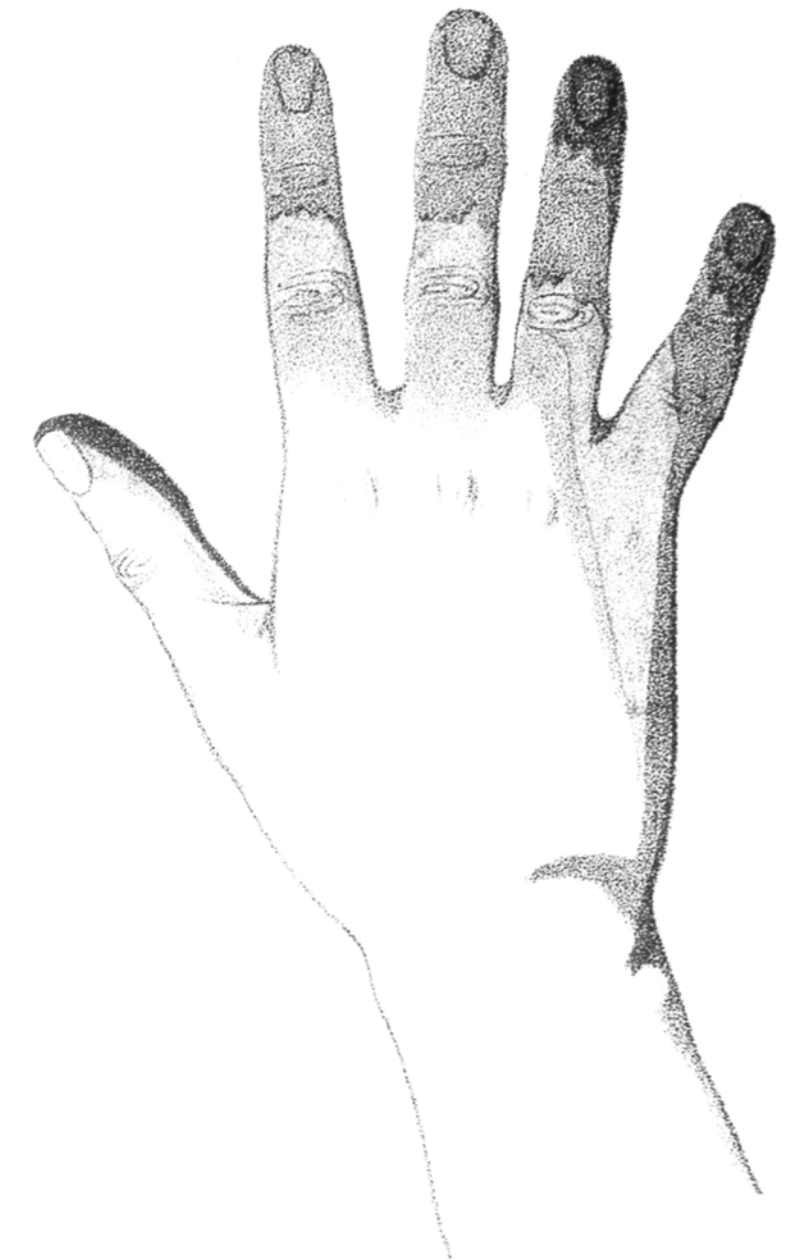


Fig. 5.

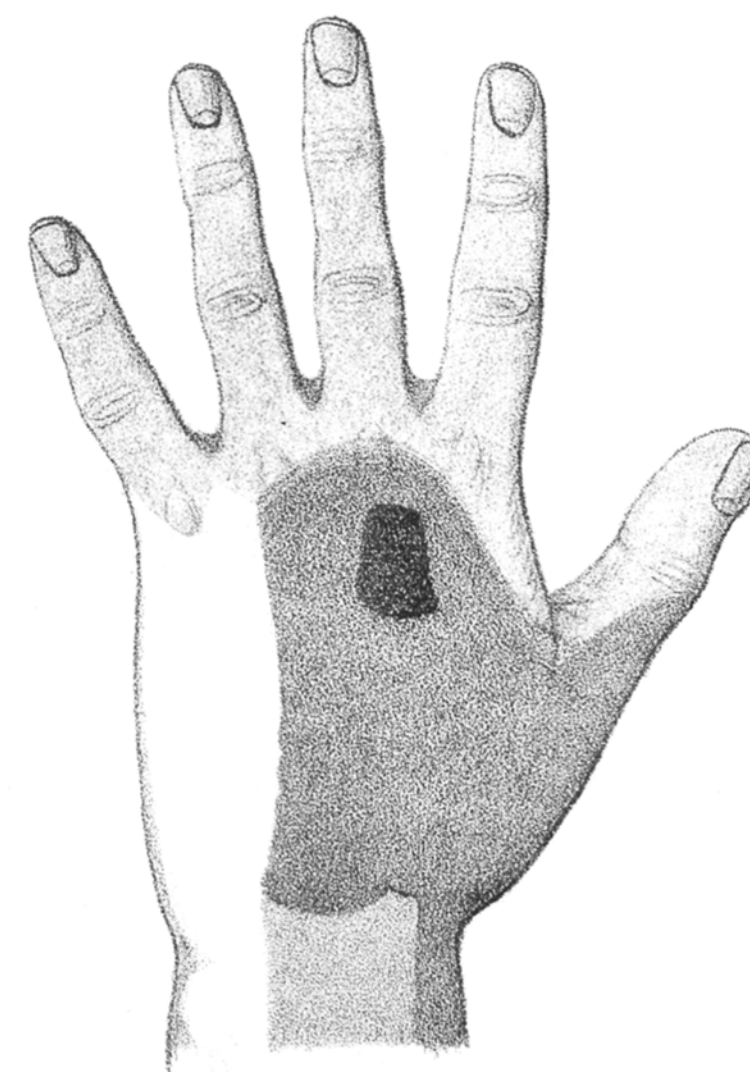


Fig. 6.

