SURGICAL PROCEDURES IN GENERAL PRACTICE

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INFECTIONS OF THE HAND AND FINGERS—I

BY

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There is no need to emphasize that the disabilities which follow in neglected cases of infections of the hand and fingers are of the gravest economic importance. It is usually considered that the loss of an eye is one of the most serious results of any injury, but there can be little doubt that the loss of the right hand is a more severe, if less dramatic, sequel. Similarly, the patient who has lost both hands is obviously more helpless than the patient who has lost his sight completely.

In this connexion it is of some interest to note that at the Ford factory in Detroit a survey has recently been made to see what percentage of the different jobs could be carried out by disabled men. It was found that of a total of 7,882 kinds of jobs, 2,637 could be done by one-legged men and only 715 by one-armed men. It must be remembered, however, that these figures refer to the peculiarly mechanical repetition work done in mass-production factories, and they also involve an expression of great good will and helpful intention on the part of the employer. In the open labour market the one-armed man's chances are obviously much smaller than these figures indicate.

It follows, therefore, that the treatment of cases of this type deserves the most careful attention. There is possibly no part of the body in which a knowledge of anatomical features is of greater importance, for rational and efficient surgical treatment depends as much upon anatomical as upon pathological knowledge in these cases. A review of the main anatomical points must therefore form an indispensable preliminary to any considerations of treatment.

Skin and Fascia

The skin of the palmar aspect of the fingers is thick and tough, and in the vicinity of the joints it is held down to the digital extensions of the palmar fascia to form characteristic creases. The interphalangeal creases lie slightly proximal to the level of the corresponding joints, but the metacarpo-phalangeal crease at the base of the digits lies about half an inch distal to the knuckle-joint. Over the palm also the skin is intimately attached to the underlying palmar fascia. The creases here form the characteristic "lines" of the palmist, but have little surgical significance. A small amount of fat intervenes between skin and fascia, and is divided into a large number of small loculi by fibrous septa. Over the proximal and intermediate phalanges, too, a similar arrangement holds, while in the pulp of the distal segment the arrangement is so characteristic and important as to deserve special consideration. The object of these attachments of skin to deeper structures is clearly to prevent excessive movement of the skin during prehension, otherwise the facility with which objects are held would be considerably diminished. In the pulp of the fingers and thumb the fibrous septa are particularly well marked, and

the amount of fat is, of course, greater than in the other segments of the digit. These fibrous septa, extending from the skin to the periosteum of the terminal phalanx, divide the fat into a series of loculi disposed with their long axes vertical to the surface. The pulp is thus divided into a large number of spaces arranged rather like the cells of a honeycomb (Fig. 1).

FIG. 1.—*a* and *b*, transverse sections through proximal and distal phalanges of finger. *c*, longitudinal section through termination of finger. Note the loculation of the fat, especially in the terminal phalanx, and the relation of the long tendons to the epiphyseal line.

In the presence of infection, inflammatory exudations are therefore unable to spread widely, as they can do elsewhere, but are retained in the loculi, producing an extreme degree of tension which is frequently sufficient to interfere with the blood supply. This arrangement, too, provides many channels by which superficial infection of the skin can be conveyed directly down to the underlying bone. Under the skin creases there is very little subcutaneous fat, and here the tendon sheaths closely approach the surface, so that minor penetrating wounds may carry infection into them.

On the dorsal aspect of both fingers and hand the skin is much looser, to permit of flexion; this produces the characteristic creases over the backs of the fingers. These lie roughly at the same level as the corresponding joints. The dorsal subcutaneous tissue is also loose and areolar; it thus accommodates large quantities of inflammatory exudation, and is indeed the position in which such exudations tend to collect even when the causative infection is on the palmar aspect of the hand. The bed of the nail is fairly firmly attached to the underlying periosteum; the nail itself thus affords good counter-pressure to forces applied to the finger-tips, and in this way helps prehension. Only the slightest amount of to-and-fro movement can normally be detected in the nails; the range is increased and the movement becomes painful in affections underlying the nail, in its bed or in the bone.

The palmar fascia forms a dense fibrous barrier which usually prevents deep-seated pus from reaching the surface

of the palm. In the proximal half of the hand it forms a fairly continuous ensheathing layer, but in the distal half its digital prolongations separate from one another, and in the intervals the digital nerves and vessels become more superficial. At the sides the dense palmar fascia is continued as a thinner sheath covering the muscles of the thenar and hypothenar eminences (Fig. 2).

Under cover of the fascia, in an areolar interval, lie the superficial palmar vascular arch with its digital

FIG. 2.—Diagram of the palmar fascia.

branches and the digital branches from the ulnar and median nerves. At first the nerves lie deep to the vessels, but as the roots of the fingers are approached the nerves come to occupy an anterior position and run along the digits on the lateral aspects of the flexor sheaths (Fig. 3).

FIG. 3.—Lateral view of finger showing the relative positions of digital vessels and nerves.

Tendon Sheaths

Deep to the vessels and nerves lie the tendons in their sheaths. The latter afford a ready means for the spread of infection, so that special attention must be paid to their arrangement. This is subject to a little variation, but in general it may be accepted that the sheaths of the flexor tendons of the second, third, and fourth fingers extend from the base of the terminal phalanx to the distal skin crease of the palm. In the case of the little finger the theca usually extends up through the palm and becomes continuous with the large palmar bursa (common flexor sheath), which surrounds the profundus and sublimis

tendons proximally. This large sheath extends upwards under the anterior annular ligament of the wrist into the forearm, terminating about two fingerbreadths proximal to the ligament. The long flexor of the thumb has a sheath of its own which extends from the base of the terminal phalanx up under the annular ligament and ends

FIG. 4.—Transparency showing the relation of the tendon sheaths to the chief overlying structures. The horizontal lines represent the limits of the anterior annular ligament.

at the same level as the palmar bursa (Fig. 4). All the digital synovial sheaths are contained within fibro-osseous canals, formed on the deep aspect by the periosteum of the phalanges and over the joints by the glenoid ligaments thereof, on the palmar and lateral aspects by a transversely fibred arch with which the digital extension of the palmar fascia is blended. These sheaths are especially thickened where they lie over the proximal and intermediate phalanges, but opposite the joints they are thinner and more lax. Cruciate bands are usually present at the junction of these sections. Even when the sheath is distended by inflammatory exudations the tendon remains a fairly tight fit at the restricted points, and it is here that localizing adhesions may form to limit the spread of infection.

Initially during development a tendon running in a sheath has a complete mesotendon bearing the same relation to it as the mesentery does to the intestine. The special arrangement of the flexor tendons of the fingers by which the superficial one splits to permit the passage of the deep tendon does not, however, allow of the persistence of this early arrangement. Most of the mesotendon therefore disappears, but the remains can be recognized as the vincula tendinum. This small point is of special importance because the blood supply of a tendon

reaches it, at least in part, through the mesotendon. In the fingers, therefore, the vascular supply will be derived chiefly from the ends of the synovial sheath, and will receive but little reinforcement along the length of the tendon. Small vessels extend along the tendon in the synovial covering, and from them the substance of the tendon receives its nutritive supplies, mainly by transudation. It will thus be seen that the nutritive supply of the digital flexor tendons is particularly precarious. It is true that passive structures such as tendons require very little nutrition in normal circumstances, but any slight increase in tension within the theca will be sufficient to cut off the blood supply entirely, and this, of course, will lead to necrosis followed by invasion of the tendinous tissue by the organisms.

Fascial Spaces

Kanavel has described the routes by which infection spreads in the hand. By the injection of opaque materials into various regions of the palm he was able to demonstrate, both radiographically and by dissection, that the spread of these substances tended to be restricted to certain compartments, and upon this basis he was able to establish rational methods of surgical drainage. Valuable as Kanavel's work was from the anatomical point of view, we must not forget that the barriers which limited the spread of his injected materials would not, of necessity, have more than a temporary retarding effect upon the spread of organisms. As a basis for our studies, therefore, his ideas will be admirable, but in practical application we must be prepared to find that infection is only rarely limited to any one particular space or structure.

We have seen that only the thinnest layer of fibro-fatty tissue intervenes between the skin and the palmar fascia, and so loculated is this tissue that infection in the superficial layer is unable to spread beyond a short distance before the skin is perforated and spontaneous drainage stops further extension. On the dorsal aspect of the hand there are two loose areolar spaces, one between the skin and the extensor aponeurosis (the dorsal subcutaneous space) and one between the aponeurosis and the bones (the dorsal subaponeurotic space). These are the spaces in which oedema is chiefly seen in infections involving the palmar spaces, the great density of the palmar fascia preventing anything more than an undue fullness of the "cup" of the palm when deep-seated infection is present.

Deep to the palmar fascia the areolar intervals are divided into two main sections by the fascia covering the adductor transversus muscle. The palmar (mid-palmar) space is an extensive and important area lying deep to the profundus tendon and anterior to the third, fourth, and fifth metacarpal bones, with their corresponding interossei (Fig. 5). It is bounded on the inner and outer sides by partitions passing from the deep aspect of the palmar fascia to the third and fifth metacarpals respectively; the former is strong, and separates this space from the thenar space. Proximally the palmar space extends, by a narrow passage, to the deep space of the forearm, while distally it is continuous with the third and fourth web spaces and, by prolongation along the lumbrical tendons, with the dorsal subaponeurotic space. The thenar space lies between the palmar fascia and the adductor muscle, extending around the distal border of that muscle on to its dorsal aspect. It is separated from the palmar space by the fascia already mentioned; this corresponds superficially with the skin crease running along the inner aspect of the thenar eminence. Externally it extends deep to the thumb muscles as far as the first metacarpal bone,

and distally it communicates with the web spaces of the index and thumb, and, via the first lumbrical canal, with the dorsum of the hand. It has no extension to the deep spaces of the forearm.

The web spaces lie between the heads of the metacarpals and are continuations of the palmar and thenar spaces to the dorsal aspect of the bases of the fingers; there they communicate with the subcutaneous spaces of

FIG. 5.—Diagrammatic transverse section of the palm showing disposition of the various spaces, (a) The palmar space, (b) thenar space, (c) dorsal subaponeurotic space, (d) dorsal subcutaneous space, (e) common flexor sheath (ulnar bursa), (f) tendon of extensor longus pollicis, (g) extensor tendons, (h) adductor pollicis, (i) palmar fascia, (k) digital vessels and nerves.

the dorsum of the hand. The deep fascial space of the forearm lies under the profundus tendons and superficial to the pronator quadratus. It continues proximally, superficial to the interosseous membrane, so far as the origin of the deep muscles from that structure.

It must be realized that the common flexor sheath lies immediately superficial to the palmar space, while the sheath of the flexor longus pollicis is surrounded by the thenar space; infections therefore extend with ease from one structure to the other.

Joints

The interphalangeal and metacarpo-phalangeal joints are all in fairly intimate relation to the tendon sheaths, and it has already been mentioned that their volar (glenoid) ligaments form part of the thecal canal. The phalanges themselves have, before the age of about 20, an epiphysis at their proximal end, and the same applies to the first metacarpal. The other metacarpals have an epiphysis at the head. The blood supply to that part of the bone derived from the epiphysis reaches it largely along the capsule of the joint, through the section of the digit immediately proximal (see Fig. 1). This is important in the case of the terminal phalanx, for when the pressure of exudation in the terminal segment cuts off the blood supply to the bone its base is still able to derive a supply in this way, and so bony necrosis rarely extends beyond the level of the epiphyseal line (even when this is completely ossified in the adult), and infection of the interphalangeal joint is thus prevented; the insertions of both flexor and extensor tendons remain intact and the theca is not involved.

The main palmar bursa (common flexor sheath) is considerably restricted as it passes deep to the anterior annular ligaments; at this point, therefore, the spread of infection may be at least temporarily arrested. For the same reason any subsequent adhesions are always densest

at this level. Since the theca of the little finger is continuous with the main bursa it is obvious that the nervous and vascular supplies of the ulnar border of that finger must cross the sheath. The vascular and nervous supplies of the radial side of the index finger cross the proximal end of the theca of that finger deep to the palmar crease in this situation. The thumb sheath is deeply buried as it passes between the muscles of the thenar eminence. It is important to note that this sheath is crossed superficially by the branches from the median nerve which supply these muscles.

(To be continued)

A COMPARISON OF PHYSICAL STANDARDS IN TWO GROUPS OF NEWCASTLE CHILDREN

BY

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Investigations into the physical standards of sample groups of school children of various social classes have shown in most instances that the children of the upper classes are taller and heavier and have blood richer in haemoglobin than children of the poorer type; while Spence has shown that in Newcastle there was a wide difference between the health and development of the infants in his sample group of "city children" and the similar group of "professional class children" which he examined.¹

The present investigation was carried out in an endeavour to assess the result of an improvement in environment at an early age on one of two groups of children of strictly comparable heredity. The most hopeful approach seemed to be in comparing, by the same individual technique as that used by Spence, a group of slum children with children living in the physically favourable environment of an orphan institution, the latter having a heredity comparable to, and certainly no more favourable than, the former. The group chosen were the seventy-five children between the ages of 5 and 14 years residing in the Newcastle Education Committee's Ponteland Children's Home—the "Ponteland children"—and a similar number of children of identical age and sex distribution attending the Jubilee Street Council School, situated in a poor part of Newcastle—the "Jubilee children."

The difference in environment may be inferred from the fact that the Ponteland children were living in a pleasantly situated self-contained village some miles from Newcastle, eating a diet costing an average of just over four shillings and sixpence a head per week (and purchased *en bloc*), which was properly balanced and included meat at least once a day and an average of just under one pint of fresh milk daily. The parents of 50 per cent. of the Jubilee children were unemployed, and these children were presumably eating a diet costing at any rate not more than three shillings per week which the Unemployed Assistance Board provides for all the necessities of life; with, in addition in certain cases, free milk daily and in a very few cases (not 5 per cent.) free meals. On inquiry not more than 10 per cent. of the Jubilee children had eaten protein of any kind at their midday meal on the day of examination—broken biscuits appeared to be a staple article of diet.

The two groups of seventy-five children were carefully examined by me with reference to their general condition, their height, weight, and chest measurement, their teeth, and their haemoglobin indices.

The Ponteland children were not admitted to the home until the age of 3, and no accurate information was obtainable about their environment during the first three years of life. All that can be said of these early years, which are shown to exert a crucial influence on the later development of the children, is that they were spent in the large majority of cases either in a Poor Law institution or under very unfavourable conditions of life outside. It seems improbable, however, that under normal conditions any more sharply defined groups as regards environment will be obtainable.

The assessment of general condition was of course subjective, but I endeavoured to take into account colour, muscle tone and stance, skin temperature, and general alertness.

General Condition

	Ponteland	Jubilee
Optimum (children in every way fit) ..	37	7
Poor (children obviously unfit)	1	9
Others	37	59

For comparisons of weights and heights optimum zones were made by weighing and measuring several hundred children in Newcastle high schools and preparatory schools, plotting their weights and heights on graphs, and constructing zones to include the large majority. Separate zones were made for boys and girls, but for convenience of reference the results are here grouped together:

	Heights		Weights	
	Ponteland	Jubilee	Ponteland	Jubilee
Children above optimum zone	0	0	0	1
Within	24	19	10	15
Below optimum zone	51	56	65	59

As will be seen, the children of both groups fall almost completely below the optimum zones of the "high-school" children. When the zones used were based on the figures of the British Association's Anthropometric Committee (1875-83), employing the committee's average as an upper limit and a line 10 per cent. below this as the lower limit of the zone, the Ponteland and Jubilee children are seen to fall very well within these limits and show no significant discrepancy—that is to say, the difference between the weights and heights of the high school and the Ponteland children is of the same order as that between the high school and the Jubilee children.

	Heights		Weights	
	Ponteland	Jubilee	Ponteland	Jubilee
Above B.A. average zone ..	12	17	20	18
Within	61	57	40	46
Below	2	1	15	11

It is of interest to note that when the weights and heights of the high school group were plotted against these B.A. zones the following results were obtained.

	Heights	Weights
Above average zone	93 per cent.	84 per cent.
Within	7 ..	16 ..
Below	0 ..	0 ..

¹ Spence, J. C. (1934): *Investigation into the Health and Nutrition of Certain of the Children of Newcastle*, Newcastle.