BILATERAL EPIPHYSIS AT THE BASAL END OF THE SECOND METACARPAL

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The occasional appearance of an additional epiphysis at the base of a metacarpal or of a metatarsal bone other than the first is of interest morphologically, surgically, and also from the standpoint of the radiologist.

The following case of a basal epiphysis of the second metacarpal in both hands occurred in a female child aged two years. The only other child in the family was a girl aged four years whose epiphyses, as ascertained by skiagrams, were normal for that age.

The ossific centres of the heads of the four inner metacarpals are well developed while that for the basal end of the first metacarpal is only just indicated in the skiagram. The only carpal bones which showed any sign of ossification were the os magnum and unciform. The epiphysis for the distal end of the radius is present while that for the head of the ulna has not yet appeared.

In both hands the basal part of the second metacarpal appears to be separated from the shaft by a well-marked constriction. The ossific centre for the basal epiphysis of the first phalanx of each of the four inner digits is well marked, and is just indicated in the proximal phalanx of the thumb on the left side. The ossific centres of the epiphyses for the bases of the second phalanges of the first, second and third fingers were present but those for the little fingers had not yet appeared. The nucleus for the epiphysis of the distal phalanx was present in the thumb and second finger only.

It may be worth while recapitulating the various theories which have been put forward in explanation of the peculiarities and ossification of the first metacarpal and metatarsal bones and the reduction in the phalanges in the thumb and great toe.

Since the time of Galen in the second century, the difference between the thumb and the remaining digits has attracted the interest of anatomists and surgeons; and, on account of the resemblance in the ossification of the first metacarpal bone to that of a true phalanx and the absence of one phalanx in the thumb and great toe, it was considered that the metacarpal and metatarsal bones of the thumb and great toe represented morphologically the first phalanx.

Gegenbaur, however, contested the prevailing theory and brought forward evidence to show that the metacarpal bone of the thumb was in reality a true metacarpal bone and that the same evidence applied to the metatarsal

bone of the great toe. The principal evidence which was brought forward in favour of Gegenbaur's theory was concerned with the relations of the muscles of the thumb and great toe; the occasional presence of a distal epiphysis in the first metacarpal or metatarsal bone and in the fact that the apparent exceptions to the rule that the epiphysis of the first metacarpal in certain of the mammalia such as the rabbit were in reality due to an error in the numbering of the digits in these animals. In the rabbit what is apparently the first metacarpal or metatarsal bone is proved on closer examination to be the second; a rudimentary first metatarsal being developed in embryonic life and

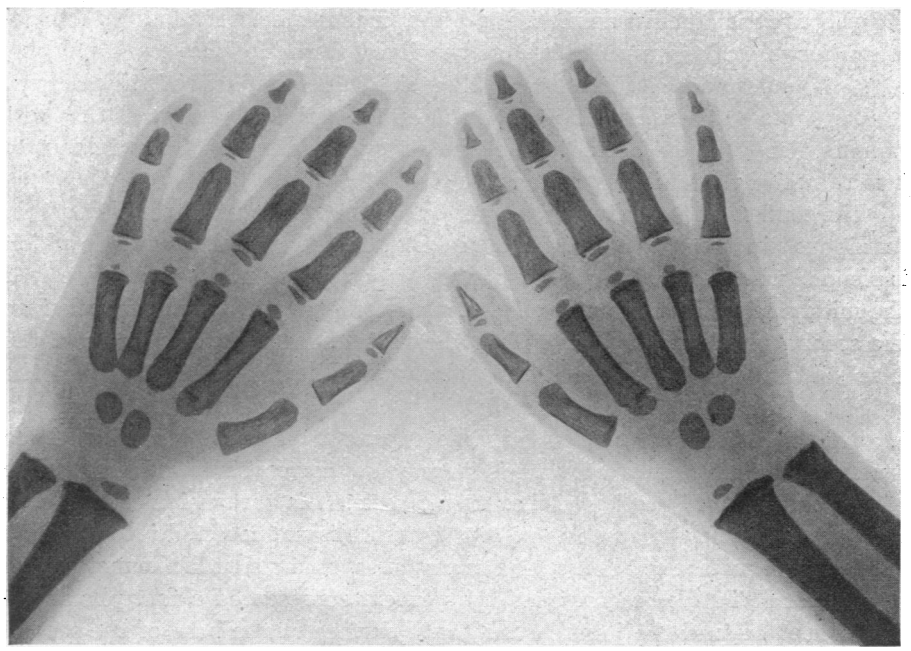

Fig. 1.

being easily visible in the foot of a young rabbit during the first month of extrauterine life. In the adult animal, however, this rudiment together with the first cuneiform fuses with the base of the second metatarsal and appears merely as a projecting tubercle on its inner aspect.

If one considers the musculature, one is struck with the large development of the muscles of the ball of the thumb in the adult as compared with those of the first phalanges of the other fingers in which on the dorsal aspect there is only the aponcurosis of the tendons of the extensor communis digitorum muscle into which are inserted, with the exception of the fifth finger on the dorsal side, the corresponding lumbrical muscles and on the palmar aspect, the interossei muscles. As regards comparative anatomy the developmental

history of the human subject shows a gradual evolution of the thumb musculature by a differentiation of the radially situated interossei muscles which has led to the characteristic capability of opposition of the human thumb.

Welcker emphasizes the importance of the origin of the first dorsal interosseous muscle, the insertion of the opponens pollicis muscle and other muscles of the thumb as evidence of the metacarpal nature of the first metacarpal bone. The extensor "longus and brevis" pollicis muscles are originally separated bundles of the extensor communis digitorum muscle. The extensor longus pollicis muscle must be regarded as a radially disposed slip of the extensor communis digitorum muscle to the distal phalanx of the thumb, and the extensor brevis pollicis as an ulnar slip of the same muscle. The tendon of the extensor longus pollicis muscle passes to the dorsal surface of the second phalanx of the thumb, and is situated on the ulnar side of the long axis of this phalanx. It represents on the ulnar side of the thumb the terminal portion of the most radially placed tendon of insertion of the extensor communis digitorum muscle into the third phalanx of a finger.

The tendon of the extensor longus pollicis muscle is reinforced by a thin tendinous slip from the ulnar side of the extensor brevis pollicis muscle which is blended with the tendon of the extensor longus pollicis muscle and represents the middle slip of a tendon of the extensor communis digitorum muscle into the second phalanx. Given off from the radial border of the tendon of the extensor brevis pollicis muscle, is a still stronger bundle corresponding to the radial slip of the lateral insertion of the extensor communis digitorum muscle into the third phalanx of a finger. The expanded principal insertion of the tendon of the extensor brevis pollicis muscle thus corresponds with the middle slip and tendon of insertion of the latter muscle. This part which courses over the long axis of the first phalanx of the thumb is not inserted into the base or the dorsal surface of the first phalanx as one would expect if the metacarpal of the thumb in the greater part of its extent represented a first phalanx—but it goes beyond the joint to the dorsal surface of the base of the second phalanx—indicating that the third phalanx of the thumb has absorbed the original second phalanx, the two being represented by a single enlarged phalanx bearing the nail.

With regard to the palmar aspect of the thumb, Fürst pointed out that the strong bundle known as the Fasciculus Exilis which springs from the flexor sublimis digitorum muscle and joins the long flexor of the thumb represents the flexor sublimis pollicis muscle which would like the proper tendons of the flexor sublimis digitorum muscle be inserted into the second phalanx of the thumb. The long thin tendon of the fasciculus is inserted along with the tendon of the flexor longus pollicis muscle into the distal phalanx which has assimilated an element which in the other fingers is represented by the second phalanx.

Thomson has also discussed the position of the first metacarpal and first metatarsal bones and confirmed Schwegel's theory that frequently in the

thumb traces of a distal, and in the remaining digits, traces of a proximal epiphysis are found, and that these have fused with the shaft at an earlier period of development.

Ufflemann attempted to unite the two opposed theories and prove that the first "middle hand" and "middle foot" bones were neither true "middle hand" or "foot" bones nor first phalanges, but could be explained as a representative of both. According to Ufflemann at a certain stage of development which lasts for a period of several years, there is an appearance of a special bony nucleus in the head of the first metacarpal, although in reality such a nucleus is never really present. In the new-born infant the distal cartilaginous epiphysis is somewhat less extended in the distal direction than the proximal epiphysis. In the remaining metacarpals it presents an annular constriction. The proximal epiphysis appears in the third year and fuses with the diaphysis in the sixteenth year, which is an earlier date than any other epiphysis of the hand bones. Between the end of the first and third year after birth, a stump-like process from the lower or distal end of the diaphysis grows into the cartilaginous epiphysis which on the radial side remains widely separated from the surface of the cartilage; on the ulnar side, however, it does not reach the surface. In the eighth year the diaphysis projects by means of this process nearly to the articular surface. On the radial side there remains between this process and the corresponding part of the extremity of the diaphysis a thin layer of cartilage which is for a long time excluded from the articulation. This layer at the twelfth year is 0·7 mm. thick. Sections therefore which pass somewhat to the radial side of the longitudinal axis of the bone, afford at this period the picture of an independent nucleus, while further ulnarwards the bony substance of the shaft and head are continuous. At the twelfth year the intervening cartilaginous disc gradually ossifies from the deeper part towards the surface. Before ossification is completed, the macerated bone shows a more or less deep groove on the radial side between the head and middle piece, which might be regarded as indicating an incompletely fused epiphyseal border.

The condition of nutrient foramina in the bones of the thumb was studied by Humphry and W. Krause. While in the first phalanges of the four inner fingers the nutrient foramina are situated near the distal end of the proximal third of the bone and are all directed distally. In the first metacarpal the nutrient foramen is directed distally and somewhat to the ulnar side. The nutrient foramina of the second, third, fourth and fifth metacarpals are situated near the radial border of the volar surface of the shaft, and lead to a proximally directed canal. In this character the first metacarpal does not conform to the arrangement in the other metacarpal bones but corresponds with that of the phalanges. The condition of the nutrient arteries and their canals indicate that the growth of the bones at a certain embryonic period is relatively less rapid than that of the blood vessels and soft parts, for the nutrient arteries become proximally directed.

Pfitzner also attempted to explain the two segments of the thumb by a coalescence of two bony rudiments. He believed that the large distal phalanx of the thumb and great toe had assimilated the second phalanx and become indistinguishably fused with it. Soon after Pfitzner had propounded his assimilation theory, Salzer published the case of a man with three phalanges in both thumbs; and this man's sister had a thumb with two phalanges, the distal phalanx was exceptionally long and a constriction was present in the centre of the bone, an indication that fusion of two phalanges might have taken place.

Salzer agreed completely with Pfitzner in considering the last phalanx of the thumb as homologous with the second and third phalanges.

Reider came to the same conclusion by studying the case of a man with three segments in the thumb; and this man's four children all had the same deformity.

Fürst at a later date agreed with Pfitzner's assimilation hypothesis on account of the study of a hand in a man with a three jointed thumb.

Pfitzner himself at a later date described two cases in which there were three phalanges to the thumb on each side; thus he was able to demonstrate his hypothesis which he had propounded some years before.

With regard to comparative anatomy, W. Krause is of the opinion that no explanation is to be expected because the thumb is more highly developed in the human subject than in any other species of the whole animal kingdom. Even in the apes the thumb is rudimentary. However, on the other hand Thomson points out that in some animals, for instance the kangaroo, koala and elephant, there is a much more complete and regular formation of a distal epiphysis in the metacarpal and metatarsal bones than in the higher mammalia, constituting in them what is apparently the normal mode of ossification. Further the peculiar condition observed in the seal in the forefoot of which animal the ossification follows the usual plan, while in the hind foot distal epiphyses are fully developed in the first metatarsal bone and in all the phalanges except the terminal. Moreover in Ornithorhynchus there is a tendency towards the formation of both distal and proximal epiphyses in all the metacarpal bones, and, finally in the Cetacea the fullest extension of these accessory points of ossification is met with, proximal and distal epiphyses being present in all the metacarpal bones and all the phalanges except the less developed distal series.

It may not be out of place to give an historical survey of the various theories which have led up to the present conception of the morphology of the metacarpal and metatarsal bones of the hand and foot.

1. First metacarpal and metatarsal bones regarded as the basal phalanx of the thumb and toe on account of the proximal position of the epiphysis and the presence of only two segments in the thumb and great toe. (Galen.)
2. The position and direction of the nutrient canals in the first metacarpal and metatarsal bones are similar to that of a phalanx. (Krause and Humphry

3. First metacarpal and metatarsal bones are the true middle hand and middle foot bones. (Gegenbaur.)
   (*a*) Gegenbaur's view supported by the homologies of the associated muscles. (Welcker and others.)
   (*b*) The occasional presence of distal epiphyses in the first metacarpal and metatarsal bones; and the confirmation of these observations in the human subject by the presence as the normal condition of true epiphyses at both ends of the metacarpal and metatarsal and proximal series of phalanges. (Thomson and Schwegel.)
   (*c*) Occasional presence of three phalanges in the thumb and great toe. (Salzer and others.)
   (*d*) Critical examination of pseudo-epiphyses at the bases of the second metacarpal and metatarsal bones. (Michaelis and Von Wyss.)
4. First metacarpal represents the true metacarpal which appears as the proximal epiphysis and in addition the first phalanx which forms the shaft and distal end. (Ufflemann.)
5. Occasional epiphyses at distal ends of the first metacarpal and metatarsal and at the bases of metacarpals and metatarsals 2 to 5 are false or pseudo-epiphyses. (Freund.)
6. Accessory carpal bones which may be mistaken for true basal epiphyses of the second or third metacarpals and form one type of pseudo-epiphysis.
   (*a*) Parastyloid.
   (*b*) Trapezoides secondarium. (Pfitzner.)
7. Distal phalanx of thumb and great toe represents the fused second and third phalanges. Assimilation hypothesis. (Pfitzner.)

In conclusion the balance of evidence seems to be in favour of Gegenbaur's original assumption, that the first metacarpal and metatarsal bones are true middle hand and middle foot bones, and Pfitzner's theory that the two phalanges of the thumb may be explained as resulting from the fusion of the middle with the distal phalanx is apparently correct.

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