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The vascular blood supply of the second metacarpal bone: anatomic basis fcr a new vascularized bone graft in hand surgery

An anatomical study in cadavers

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Summary. After traumatic loss of the index finger the second metacarpal bone is often used as a free graft to reconstruct bony defects of the thumb. Since clinical experience has shown numerous advantages of using a blood supplied bone graft, an anatomical study was performed in 104 cadaveric hands to investigate the vascularization supply of this bone. After dye injections into the arterial system the vascular situation of the second metacarpal was studied and a classification was made. Six variations in arterial vascularization were found. The nutrient vessels to the bone originate from the radial artery or from the deep palmar arch and correspond to variable metacarpal arteries. Selective injection studies via the respective pedicles showed sufficient perfusion and complete dye distribution in the bone. Further dissections could demonstrate the feasibility of raising a pedicled bone graft only partially with preservation of the index finger. The second metacarpal as a vascularized graft may be harvested entirely in serious injuries with destruction of the index finger in emergency cases of skeletal thumb reconstruction or partially as an elective procedure. All types have a useful arc of rotation and their pedicles allow transpositions within the radial side of the hand, especially for applications in the thumb and carpus. The clinical application of these procedures could be shown in five cases. The results of this study therefore provide the anatomical basis for transposition or free microvascular transplantation of the second metacarpal as a vascularized bone graft for a variety of indications in hand surgery.

Vascularisation du deuxième métacarpien. Bases anatomiques pour un nouveau greffon vascularisé en chirurgie de la main

Résumé. Après une perte de substance osseuse post traumatique du pouce associée à une perte de l'index, un greffon osseux vascularisé est souvent utilisé pour reconstruire le pouce à partir du deuxième métacarpien. Un transfer osseux présente des avantages quand il est vascularisé. Pour cette raison les auteurs ont étudié, sur 104 mains prelevées sur des cadavres, les bases anatomiques et les possibilités d'une transposition du métacarpe II avec un pédicule vasculaire. Après l'injection intraartérielle, la vascularisation du 2eme métacarpien II a été étudiée et une classification a été faite. Les auteurs ont trouvé six variantes différentes. Les artères nourricières proviennent de l'a. radiale ou de l'arcade palmaire profonde et forment les aa. métacarpiennes de situation variable. Des injections sélectives avec bleu de méthylène dans les artères ont prouvé les bonnes conditions de perfusion avec une diffusion de la substance colorante dans l'os entier. La longueur des pédicules vasculaires permet une rotation correcte de ce transfert osseux sur le versant radial de la main dans chaque variante, plus particulièrement dans le cas des applications au pouce et à la racine de main. Les résultats de ces recherches constituent la base anatomique pour une nouvelle méthode reconstructive dans la chirurgie de la main.

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The vascular system of the hand is supported by three vascular arches, a superficial palmar, a deeper palmar and a rudimentary dorsal, from which many different branches arise to supply the carpus, the metacarpus and the single fingers [20]. These combine to form several anastomoses and an abundant vascular network with a large scope of variations [1, 39]. The vessel anatomy at the base of the second metacarpal has been extensively described [19, 21, 23, 39]. According to the systematic anatomical classification we find a well defined situation (Fig. 1): A dorsal carpal branch arises from the radial artery after having left the anatomical snuffbox and runs into the dorsal carpal rete. A dorsal vascular arch can exist here from which the dorsal metacarpal arteries may arise. The first metacarpal artery leaves the radial artery a bit further radially and distally and is commonly called A.princeps pollicis. The radial artery then bends in a palmar and ulnar direction to terminate in the deep palmar arch. The palmar metacarpal arteries II to IV will originate here running distally on the palmar undersurface of the respective metacarpal bone (Fig. 1).

This work deals in particular with the possibilities of the vascularization of the second metacarpal (MC II), because this bone has a special position in reconstructive plastic surgery after hand injuries. Many excellent systematic anatomical classifications of the vessel anatomy in this region exist [19-21, 23, 39]. The vascularity of this bone in clinical terms, however, in regard to location and entry of vascular pedicle(s), arc of rotation and its clinical use as a vascularized graft, is not clear. It was the purpose of this anatomical study to clarify the detailed vascular anatomy and the clinical use of this bone in hand surgery.

Material and methods

Dissection study

A dissection study was carried out with examination of 104 cadaveric hands of both sexes with an equal distribution of right and left hands. Intraarterial injection using a liquid glue mixed with minium-dye after the method of Spanner, modificated by Thiel [44] was performed. After this substance had become firm the radial artery and the deep palmar arch with all vessels branching off to the second metacarpal were meticulously dissected. Due to the positive characteristics of this injection technique it was possible to follow vessels down to a diameter of 0,1 millimetre. After dissection and description of the metacarpal vascular conditions a classification of the different types to be found was made.

Selective injection

Spanner's mass of injection seemed to be too viscous for a sufficient distribution in small vessels with a diameter smaller than 0,1 mm. Therefore additional selective injections with methylene hydrocyanic acid were carried out in all of the six types. After having dissected the respective nutritive pedicle directly at the MC II, a thin venous catheter was introduced. Methylene blue was injected at low pressure directly into the vascular pedicle via the line to demonstrate the distribution of dye in the bone.

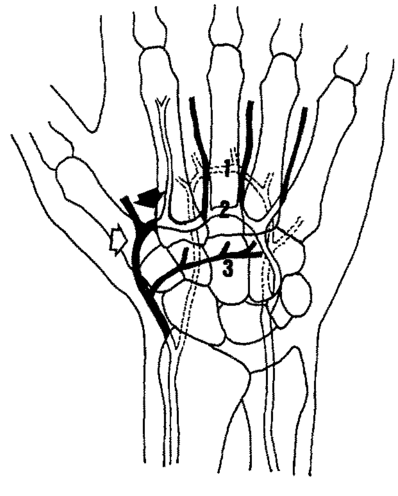
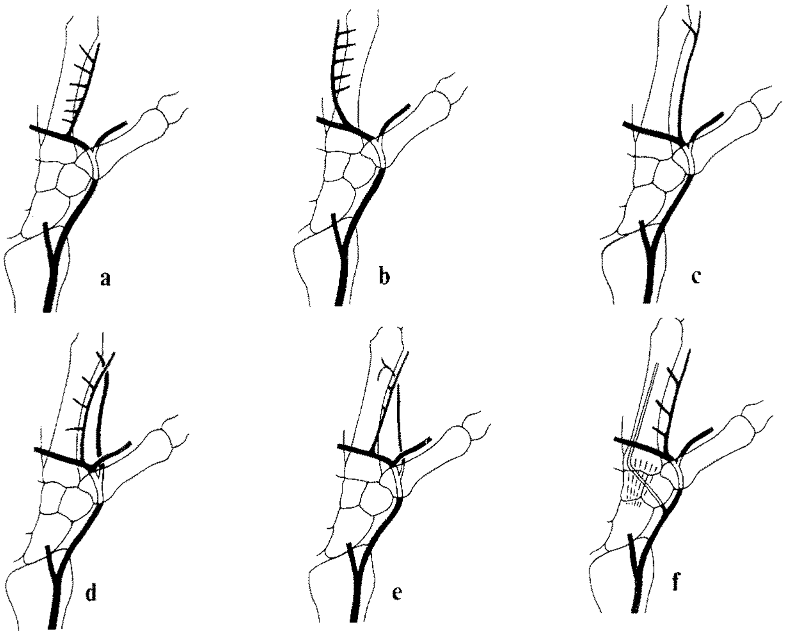


Fig. 1
Vascular arches of the hand, right side, dorsal view *1* superficial palmar arch *2* deep palmar arch *3* dorsal arch with origins of dorsal metacarpal arteries. Arrows on either side of princeps pollicis artery indicate source areas of radial types (*light arrow*) and metacarpal types (*dark arrow*)

Arcades vasculaires de la main, coté droit, vue dorsale *1* arcade superficielle *2* arcadc profonde *3* arcade dorsale avec les origines des artères métacarpiennes dorsales. Les flèches de l'autre coté de l'artère principale du pouce montrent la zone d'émergences en cas de vascularisation radiale-type (*flèche claire*), et en cas de vascularisation type métacarpien (*flèche foncée*)

Osteotomy and clinical applicability

Further dissection studies in all different types were effected to scan the technical feasibility of raising only part of MC II, with preservation of the index finger. After identification of the pedicle entry site into the bone an osteotomy with inclusion of the respective pedicle was performed (Fig. 11). The practicability of transposition of this pedicled graft to adjacent osseous structures, the reach to important bones of the carpus and the resultant arc of rotation were tested. In order to assess the resistance of MC II to subsequent fractures the stability of the remaining bone was checked by exerting manual force at the osteotomy site.



Figs. 2 a-f
Schematic representation of variations of the vascular supply of MC II, right hand, palmar view. **a** metacarpal-type radial **b** metacarpal-type ulnar **c** metacarpal-type distal **d** radialis-type dominant **e** radialis-type accessory **f** radialis-type dorsal; explanations in text

Représentation schématique des la vascularisation du MC II, main droite vue palmaire **a** type métacarpien radial **b** type métacarpien ulnaire **c** type métacarpien distal **d** type radial dominant **e** type radial accessoire **f** type radial dorsal. Voir les explications dans le texte

Angiography

The fact that minium-dye is radiopaque made it possible to carry out additional angiography and to compare this with intravital x-ray anatomy of vessels of this region. Cadaver x-rays of all of the six different types to be found were compared to 50 hand angiographies of a healthy series to check the possibility of a preoperative diagnosis of the vascular type to expect.

Results

Anatomy of blood supply

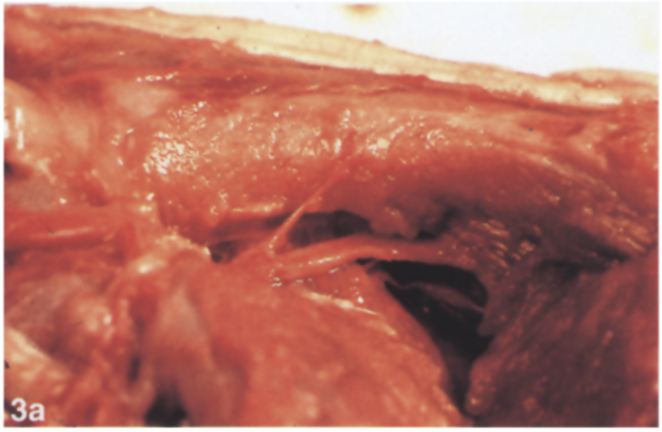
Arteries: The blood supply of MC II comes from direct branches arising either from the radial artery or from the palmar metacarpal artery originating in the deep palmar arch. In this clinically orientated classification the relation of these vessels to the origin of the constant A. princeps pollicis was used as a distinctive feature. This point of reference was chosen because of the surgical importance of this vessel. If the nutritive vessel of the second metacarpal sprang from the radial artery *proximal* to the origin of the A. princeps pollicis, this situation was referred to as a *radial-type*. On the other hand, if the branches spreading to the metacarpal mainly arose from a vessel, most probably the metacarpal artery, with its origin *distal to the A. princeps pollicis*, they were called *metacarpal-type* (Fig. 1). Within each of these two groups we could distinguish three subtypes. Depending on the site of the vessel running to the MC II we found in the metacarpal-type a *radial, ulnar and a distal subtype*. As far as the radial-type is concerned another three possibilities could be shown: a *dominant, accessory and dorsal subtype*. Thus there are six different types of vessels nourishing the second metacarpal (Fig. 2). They will be described in more detail in the following:

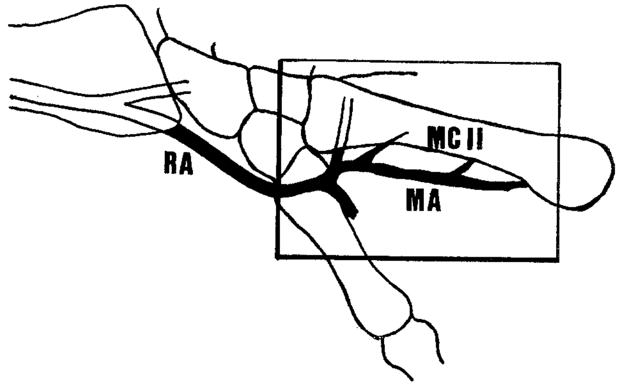
Metacarpal-Type Radial - 49%: The nutritive vessel corresponds to the second palmar metacarpal artery. It arises from the deep palmar arch radially and can be dissected between the metacarpal bone and the muscle bellies of the first dorsal interosseous. It is located at the palmar and radial aspect of MC II and gives off fine branches to the bone throughout its course (Figs. 2a, 3 a,b).

Metacarpal-Type Ulnar - 15,4%: The second palmar metacarpal artery branches off the deep palmar arch at the ulnar side of MC II or even further distally between the second and third metacarpals. To raise this pedicle the dissection has to be carried out in an ulnar extension between the metacarpal bone and the palmar interosseus muscle. As in the radial metacarpal type several delicate branches lead into the bone (Figs. 2b, 4a,b).

Metacarpal-Type Distal - 10,6%: The supplying vessel, coming from the deep palmar arch, makes its way on the radial side of MC II to enter the bone distally, in most cases at the level of the neck. It can easily be found, due to its more superficial course. Anatomically, it can be either a well developed second dorsal metacarpal artery or a palmar metacarpal artery with an atypical high origin (Figs. 2c, 5a,b).

Radial-Type Dominant - 9,6%: The main vessel supplying the bone seems to be a well developed dorsal metacarpal artery. It originates from





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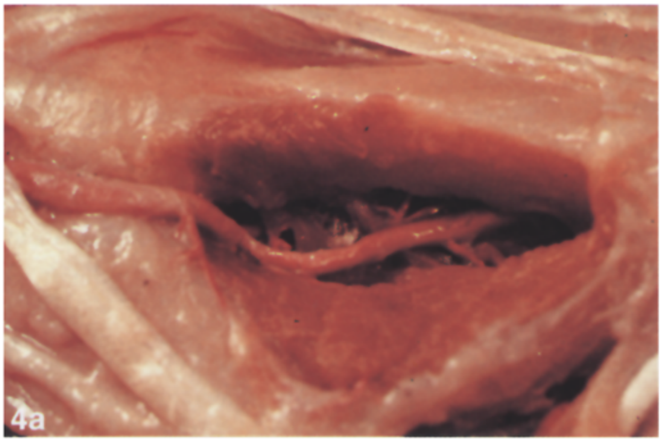

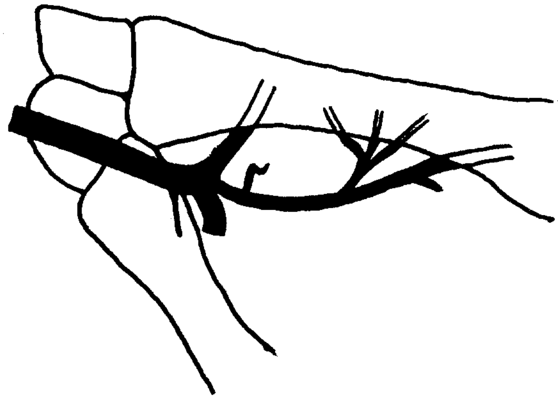

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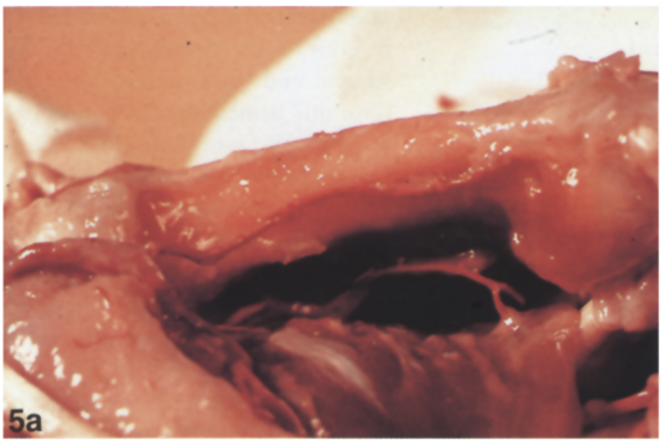

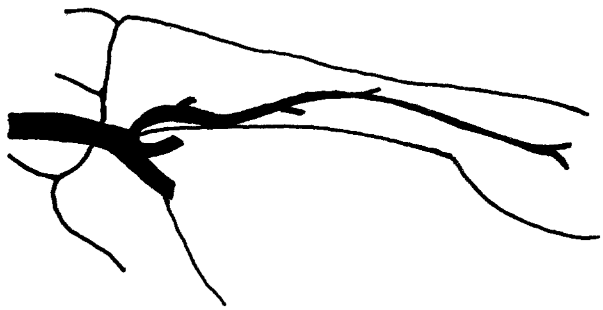

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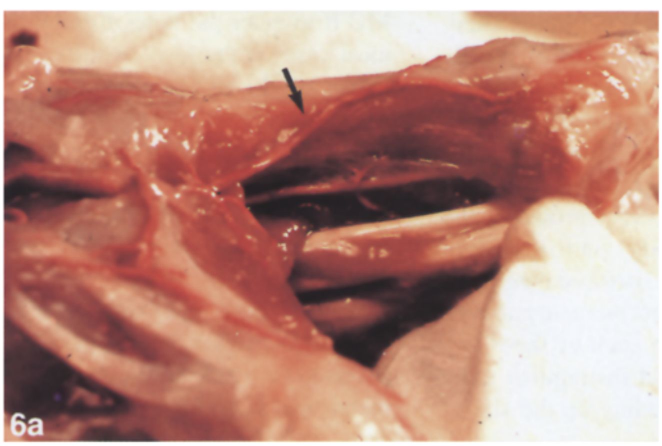

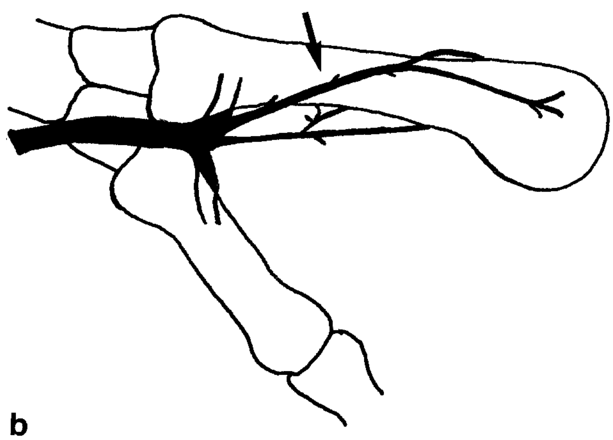

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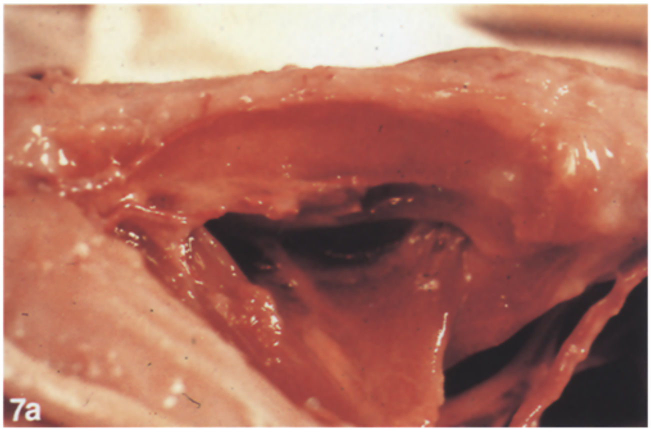

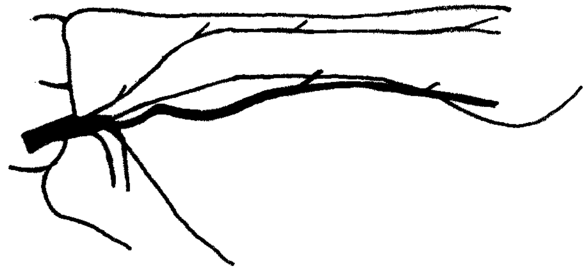

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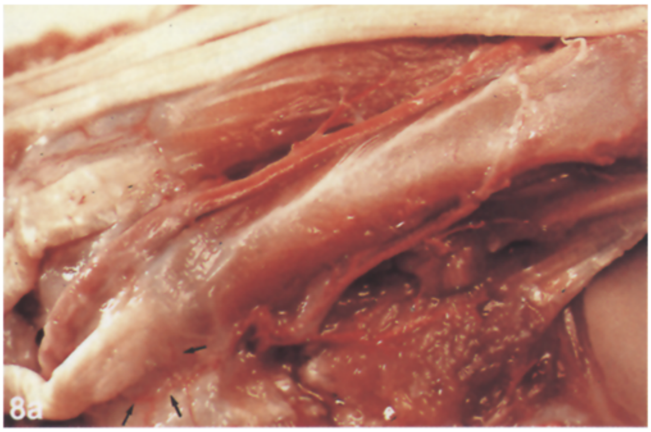

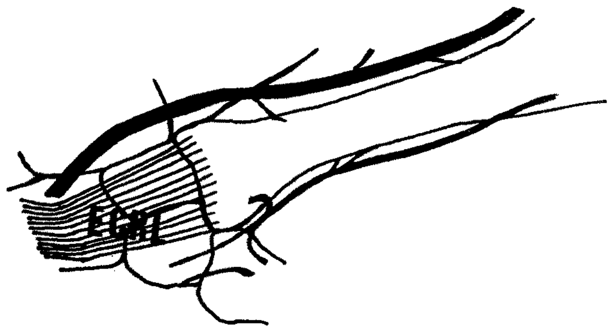

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Figs. 3a-b - 8a-b

a Anatomical dissection specimen, all left hands with a radial view, **b** schematic representation of **a**. **3a** Metacarpal-type radial - anatomical specimen. **3b** Schematic drawing of **3a** the anatomical region of interest (as represented in **3a-8a**) is indicated by a frame: *MC II* second metacarpal bone *RA* radial artery *MA* metacarpal artery. **4a,b** Metacarpal-type ulnar, vessels branching off the metacarpal palmar artery will enter the bone on its ulnar side. **5a,b** Metacarpal-type distal. **6a,b** Radial-type dominant, there is a better developed dorsal vessel (*arrow*). **7a,b** Radial-type accessory, the dorsal vessel is clearly smaller with an additional palmar metacarpal artery. **8a,b** Radial-type dorsal, rare variation with a stronger developed dorsal metacarpal artery running below the *ECRL* tendon; *ECRL:* tendon of extensor carpi radialis longus muscle. *Arrows* indicate phylogenetically remarkable vessel circle (see text)

a Vues de dissections, mains gauches en vue radiale, **b** représentation schématique de **a**. **3a** Type métacarpien radial. **3b** représentation schématique de **3a**, la zone intéressante est encadrée: *MC II* second os métacarpien, *RA* a. radiale, *MA* a. métacarpienne. **4a,b** Type métacarpien ulnaire. Les vaisseaux venant de l'artère métacarpienne palmaire pénètrent dans l'os sur son versant ulnaire. **5a,b** type distal. **6a,b** type radial dominant. Le vaisseau dorsal est plus développé (*flèche*). **7a,b** type radial accessoire. Le vaisseau dorsal est nettement plus petit, il existe une artère métacarpienne palmaire supplémentaire. **8a,b** type radial dorsal : variation rare avec artère métacarpienne dosale volumineuse passant derrière le tendon du m. LERC. *La flèche* indique le vaisseau circulaire (voir texte) qui est remarquable au plan phylogénétique.

the radial artery just distal to the anatomical snuffbox, comes up to MC II on its radial side and runs into the bone about the middle of the shaft. The diameter of the vessel is about 1 mm and this vessel size should be enough to nourish the bone on its own (Figs. 2d, 6a,b).

Radial-Type Accessory - 11,6%: The artery takes the same course as in the dominant radial-type. The average dimension however is markedly smaller (about 0,5 mm). We regard this type as a variation with a poorly developed dorsal metacarpal artery. In most cases an additional supplying vessel originating from the palmar metacarpal artery can be found (Figs. 2e, 7a,b).

Radial-Type Dorsal - 3,8%: This rare type is based on a vessel arising from the radial artery either directly in or distal to the anatomical snuffbox. It is located dorsal to the MC II with short branches to the bone. Very seldom (in only one of all dissected hands) it may wind around the insertion of the extensor carpi radialis longus tendon

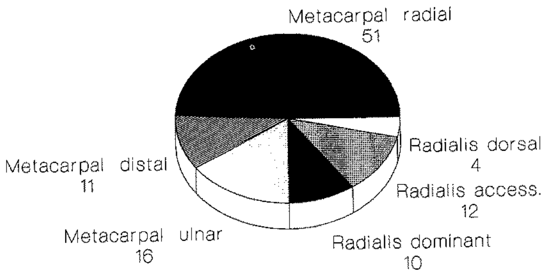


Fig. 9
Distribution of frequency of vascular types of blood supply of the second metacarpal bone (n=104)

Distribution des différents types de vascularisation du MC II

(ECRL) at the base of the second metacarpal to reach the bone. The dorsal radial-type is supposed to correspond to a dominant dorsal metacarpal artery that arises high up at the wrist from the dorsal carpal rete and reaches MC II nearly at its ulnar side (Figs. 2f, 8a,b).

Veins:

One or two concomitant veins following the course of the artery and providing venous drainage were found in all cases.

Distribution of frequency:

Regarding the distribution of variations of vascular supply of the metacarpal bone there is a clear predominence of metacarpal types, the metacarpal-type radial leading in nearly half of all dissections (Fig. 9).

Selective injection

It was of major clinical interest to determine if a single pedicle would be sufficient to perfuse the bone completely. After selective injections into the respective pedicle complete discoloration of the whole bone up to the subchondral part could be shown in every type (Fig. 10). We conclude from these results along with our clinical experience and investigations with angiography and radionuclide imaging of bone [22] that MC II bone graft is well perfused and we consider that the vascular pedicle is sufficient to nourish the bone.

Clinical applicability

Partial use of MCII with preservation of the index finger:

When harvesting a flap or a graft in plastic surgery the donor site morbidity must be kept to a minimum. A possible donor site in the hand with sacrifice of an important finger would therefore be unacceptable. Anatomical dissections and three clinical applications with preservation of the index finger showed the possibility of harvesting only part of the metacarpal bone on a vascular pedicle with a reliable perfusion (Figs. 11, 12). The function of the index finger was unimpaired and in spite of obvious weakening of the cortical bone by resection of nearly half of its circumference no increased tendency to fractures in cadavers as well as in the applications could be observed.

Arc of rotation

The length of the pedicle allows an arc of rotation to cover the radial side of the hand in all types. With the exception of a rare variation (1% in our dissection material) of radial-type dorsal - penetration of the vessel on the ulnar side of ECRL tendon (Fig. 8a) - there is a convenient reach of the graft for different sites of the thumb and the wrist. This can be further extended by division of the deep palmar arch and eventually the princeps pollicis artery (Figs. 13, 14).

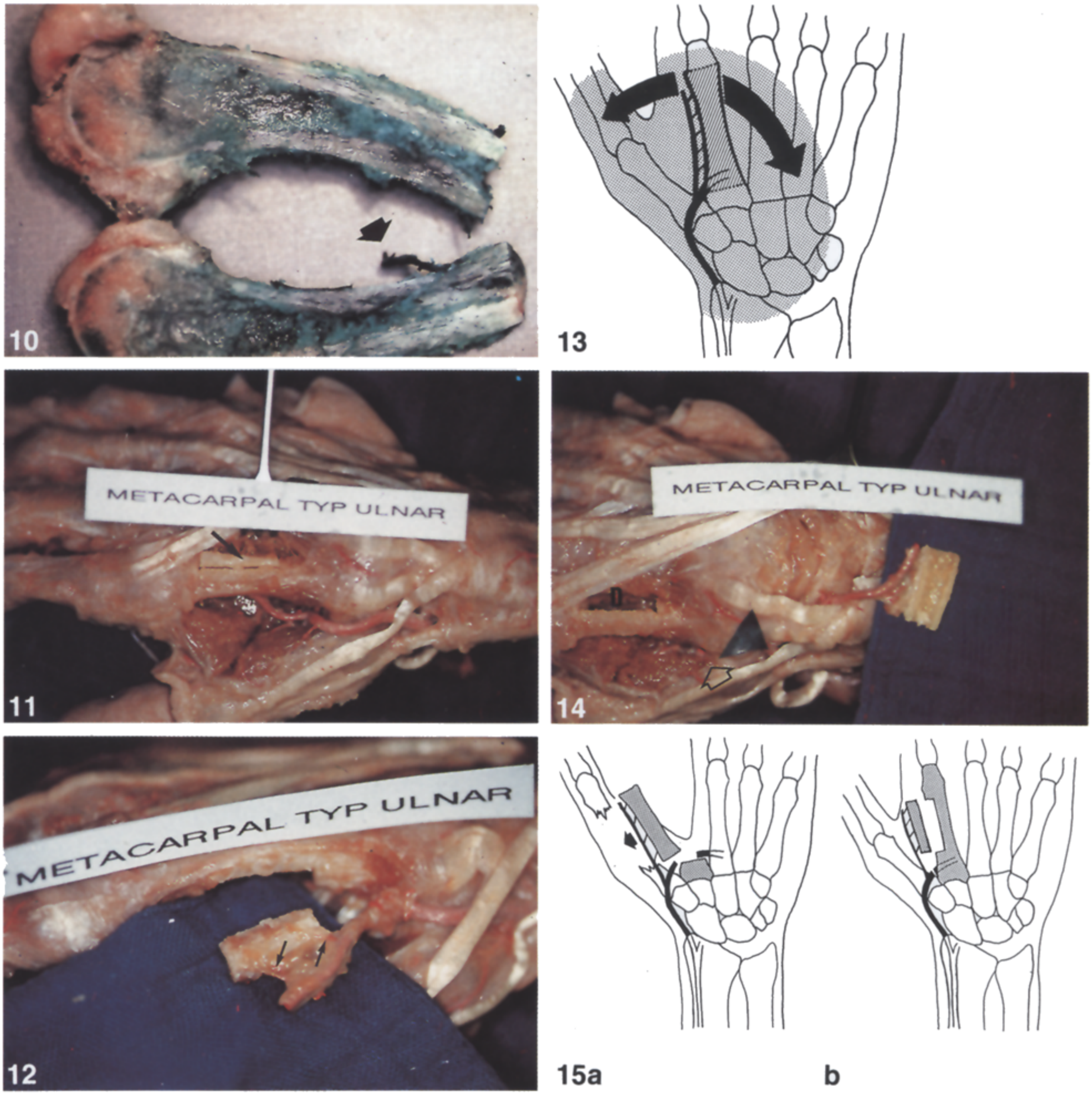
Angiography

The angiographical findings did not allow a definite assignment to the different anatomical vascular types. After having applied magnification technique, it was possible in angiograms to distinguish between metacarpal and radial types by the course of the vessel and its position as compared to the bone. Further discrimination of different subtypes was only to be made at random and a precise correlation could not be established. Preoperative angiography is therefore concluded to be only of very limited value as far as a reliable diagnosis of vascular types is concerned.

Discussion

Anatomic basis

There is a certain degree of arbitrariness within every classification because of the variable formation of vessels and flowing transitions between types. Nevertheless a more simple but reliable clinical classification is more useful for surgical applications to facilitate intraoperative decisions by providing an easily reproducable scheme. From the anatomist's point of view the six types of our classification can be seen merely as variations in the development of the second palmar and dorsal arteries. Frequently both vessels existed, sometimes rudimentary, but in most cases with the clear predominance of one of the two twigs. Referring to the systematic classification of the vascular supply of the second metacarpal bone, [39] the following presumptions were therefore made: When both vessels - metacarpal palmar and dorsal - exist, the stronger developed vessel was regarded as the nutritive vessel. According to this supposition all radial types correspond to a vascular supply of the MC II by a dominant dorsal meta-



Figs. 10-15
10 Dye distribution in the second metacarpal bone after selective injection of the vascular pedicle (pedicle *arrowed*). **11** Ulnar osteotomy of part of the second metacarpal bone (*arrow*) in a metacarpal-type ulnar. **12** Partial use of MC II in a metacarpal-type ulnar. Vascularity of the graft is provided by delicate vessels branching off the metacarpal artery (*arrows*). **13** Arc of rotation (*dotted area*) of the pedicled MC II bone graft after division of the connection to the deep palmar arch. A further increase to reach all of the carpal bones and the distal radius can be achieved by division of the princeps pollicis artery (see Fig. 14). **14** Extended arc of rotation after division of princeps pollicis artery (*small arrow*) in a metacarpal-type ulnar. *Blue arrow* points at radial artery; the graft will easily reach the distal radius, *D* donor site. **15** Schematic representation of possibilities of pedicled transposition of MC II; **a** use of the entire bone in case of index finger destruction after trauma or resection (e.g. for reconstruction of a bony defect of the thumb skeleton as indicated by *arrow*); **b** partial use of the MC II (for possible indications see text, Arc of rotation see Figs. 13 and 14)

10 Injection du MC II après cathétérisme vasculaire sélectif (*flèche*). **11** Ostéotomie de la moitié ulnaire d'un MC II de type métacarpien ulnaire. **12** Prélèvement partiel d'un MC II de type métacarpien ulnaire. La vascularisation du greffon est fournie par un petit vaisseau qui vient de l'artère métacarpienne (*flèches*). **13** Arc de rotation (*zone tramée*) du pédicule d'un greffon de MC II après dissection du pédicule branché sur l'arcade palmaire profonde. La dissection de l'a. principale du pouce permet d'accroître les possibilités de rotation du greffon. **14** Arc de rotation amélioré par dissection de l'a. principale du pouce (*petites flèches*) dans un MC II de type métacarpien ulnaire (*la flèche bleue* indique l'a. radiale). La greffe atteint facilement le radius distal; *D* site donneur. **15** Présentation schématique des possibilités de transposition d'un greffon pédiculé de MC II; **a** prélèvement de l'os entier après destruction traumatique de l'index, utilisable pour reconstruction du pouce (comme indiqué par *la flèche*); **b** prélèvement partiel du MC II (voir indications dans le texte, pour l'arc de rotation se reporter Figs. 13 et 14) carpal artery (Fig. 2). The ulnar and radial metacarpal-type on the other hand belong to the circulation area of the second palmar metacarpal artery. The distal metacarpal type cannot be classified exactly. According to our classification the pedicle corresponds with the palmar metacarpal artery because its origin is located distally to the princeps pollicis artery, but considering its course the vessel is more likely to be a dorsal metacarpal artery (Fig. 5).

In the majority of hands the finger arteries arise mainly from the better developed vessels of the palm, i.e. the superficial palmar arch and the palmar metacarpal arteries [39]. The dorsal metacarpal arteries on the contrary are fed by dorsal vessels in Europeans in most cases and rarely come from the palm through perforating branches Many racial differencies exist and a different ratio in Japanese dissection material was shown [1]. Adachi did extensive vascular dissection studies on 396 hands [1]. He showed six principles of variation in the behaviour of the radial artery on the dorsum of the hand, all of which in developmental anatomy can be derived from a basic arrangement, a vessel circle around the extensor carpi radialis longus tendon. The proximal part of this ring, just below the tendon, usually corresponds to the beginning of the dorsal carpal branch and in well injected hands the closure of this circle by a delicate artery could occasionally be seen in our material (Fig. 8a). The vast majority of Adachi's hands (96.2%) belonged to Type I, with the radial artery running below the dorsal tendons of the thumb and radially to the ECRL-tendon, then bending down into the first web space between the bellies of the first dorsal interosseous muscle. The other Types II-VI (all of them less than 1%) consist of different variations with the radial artery penetrating the palm between second and third metacarpal bones. There is a good concordance with the dorsal radial type of our classification. Adachi found a well developed dorsal metacarpal artery in about a quarter, with most of the radial artery terminating on the dorsum. This distribution of frequency may correspond approximately to the radial types (27%) in our dissection material (Fig. 9). Considering the rich vascular variations and the racial differencies in this region, the distribution of types to be found and their percentages could differ in another dissection series. But considering the excellent vascular supply of MC II and the basic feasibilty of transposition of all different types, this should not be a disadvantage in clinical application.

Clinical significance

General aspects of vascularized bone grafts

Vascularized bone grafts offer significant advantages over conventional methods of treatment with bone grafting. A segment of bone, along with its accompanying nutrient vessels, can be detached from its donor site and transferred to a recipient site with preservation of the nutrient blood supply. With the perfusion being preserved, osteocytes and osteoblasts in the graft can survive and healing of the graft to the recipient bone is facilitated. Unlike the nonvascularized bone graft, which is mostly composed of dead bone matrix, the vascularized "bone flap" maintains its cellular viability. Bone healing occurs in a manner analogous to simple fracture healing. "Creeping substitution" [3] of dead bone matrix by slow replacement of bone-forming cells at the periphery [4] is not required. The vascularized graft will undergo less resorption [10], infection is less common [13] and healing will take place more quickly and more safely because the transplant does not depend on the blood circulation of the recipient site. Central resorption in a conventional bone graft causes it to become mechanically weaker than vascularized bone transfers [28]. Thus, more rapid stabilization of bone fragments separated by a defect or by avascular necrosis can be achieved by vascularized grafts [45], with bony consolidation being attainable in nearly half the time [12, 17, 29, 46]. This is especially important in a highly traumatized or irradiated area with significant scarring and relative avascularity, precluding the incorporation of conventional bone grafts. Therefore vascularised bone grafts are widely used in plastic surgery for repair of bony defects [5, 12, 25, 38, 40]. The microsurgical technique has vastly expanded the potential for vascularized bone reconstruction. Microvascular anastomosis makes transfer of nearly any bone donor site to any recipient site possible [29]. Common donor sites include ribs [2, 7], radius [9, 35], fibula [26, 27, 37], scapula [36, 43], iliac crest [41, 42] and others, but their overall number in the body is relatively limited.

Vascularized bone grafts in hand surgery

The need for vascularized bone grafts arises in hand surgery as well as in other areas. An ideal graft will imitate the characteristics of small bones of the hand in strength and structure. A donor site in the hand for vascularized bone is not available yet. Muscle pedicled bone grafts, which use adherent muscle as a vascular carrier for the bone transfer, have been used for treatment of scaphoid nonunion [6, 8].

A questionable axial blood flow through the muscle pedicle with doubtful viability of the attached bone and a short rotation arc severely limits this flap's versatility and wider application. Microvascular bone grafts from distant donor sites can be used [30], but due to the donor location their osseous structures can be very different from the hand and they are very often too bulky. The reverse flow osteocutaneous forearm flap can be another pedicle choice with excellent results for thumb reconstruction [17, 18], but the radial artery has to be ligated. The use of the common donor sites for vascularized bone in hand surgery consequently implies either a lengthy microvascular operation or the sacrifice of a major artery of the hand with an adverse influence on its blood supply [11].

Clinical applications of the vascularized metacarpal bone graft

The vascular situation in the first and second webspaces [14, 16] and their cutaneous clinical applications [15, 33, 24, 34] are well known, but the detailed vascular anatomy of the second metacarpal bone and its vascularized use as a pedicled bone graft has not been described yet. In order to perform transpositions safely and successfully it is essential in clinical applications to know about the anatomical basis of vascular pedicles and their variations. Based on our anatomical study the MC II can be elevated completely or partially (Fig. 15) on any of the vascular pedicles.

Complete use

Hand injuries caused by radial penetrating machines causing destruction of thumb and index finger with combined tissue defects gave rise to this investigation. If the index finger is severly damaged with no hope of reconstruction, then a reduction of the hand by means of slanting amputation of this finger at metacarpal level is often performed for functional and aesthetical reasons. Thus the first webspace is deepened and a better grip between thumb and third finger is achieved. The lack of a conspicuous amputation stump improves the cosmetic appearance of the hand. When using this operative technique the second metacarpal bone has to be resected almost completely. This bone, however, is very suitable as a vascularized graft for reconstruction of defects of the thumb skeleton (Fig. 15 A). Since the second metacarpal would be discarded after resection in these cases its application as a pedicled bone graft does not imply a donor site defect.

Partial use

Further dissection studies had shown the basic possibility of pedicled transposition of only part of the MC II as a small vascularized graft. When using this modification the index finger can be preserved without impairment of its function. The partial metacarpal bone graft (Fig. 15b) may therefore become an interesting alternative choice for elective hand surgery, where a well vascularized bone is favourable. The arc of rotation of the pedicled graft will cover all important carpal and metacarpal bones (Figs. 13, 14) making this treatment procedure conceivable for a variety of indications of bony defect reconstruction, complicated fractures and nonunions, arthrodesis of small joints and revascularisation of avascular bone necrosis in the proximal two thirds of the hand, e.g. scaphoid non-union, Kienböck's disease, fusion of the metacarpotrapezial joint etc.

In our own clinical series the vascularized metacarpal bone graft was used entirely in two cases of serious hand injuries as an emergency procedure for reconstruction of skeletal defects of the thumb with clinical, angiographical and scintigraphical signs of vitality [22]. Treatment of complicated scaphoid nonunion was successfully accomplished in three cases with encouraging results by using the MC II partially as a small pedicled graft, in a modificated "vascularized Matti-Russe" procedure [31, 32].

Conclusion

The second metacarpal bone has a particular importance within the hand. It is frequently resected in complex hand injuries to achieve improved function; there is easy surgical access to this bone, a close vicinity to larger vessels and the thumb and similarity in size and structure to the bones of the thumb. Investigation in the vascular properties of MC II showed six different types of arterial patterns based on the radial artery. In all of them the length of the pedicle allows an arc of rotation to cover the radial hand and a convenient use of this method for different indications in the thumb and the carpus, where a well vascularized lood supplied bone is needed. With this anatomical knowledge the MC II can be partially or completely elevated as a pedicled bone graft. The clinical application of this new method was successfully shown in five cases. The second metacarpal bone may therefore be considered a new donor site for vascularized bone in hand surgery.

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