SUCCESSFUL REPLANTATION OF A HAND AMPUTATED THROUGH THE METACARPUS

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A successful replantation is reported of a hand completely severed by a circular saw through all five metacarpals. The sequence of primary reconstruction of all important structures beginning three hours after the injury and the functional result eighteen months later are presented.

The value of replantation of parts of the upper limb is well established (Ch'en, Ch'ien and Pao 1963; Herbsman, Lafer and Shaftan 1966; Vogt 1970; Marty 1973; Harris and Malt 1974). In many accident centres of the world replantation of a digit has now become a standard procedure (Kleinert, Serafin, Kutz and Atasoy 1973; O'Brien and Miller 1973; Shanghai Sixth People's Hospital 1975). However, there are few reports of successful replantation of a hand amputated through the metacarpus (O'Brien and Miller 1973; Peking Chishueit'an Hospital 1975). This may be due to the anatomical complexity of the region and to the rarity of such an injury. We therefore think that the following case is worthy of record.

CASE REPORT

On June 24, 1974, a right-handed carpenter aged twenty-eight who was using a high speed circular saw to cut dressed timber sustained a guillotine type of amputation of his right hand through the middle of all five metacarpals. While he was adjusting the piece of wood exactly at right angles to the saw, he had inadvertently touched with his knee a switch below the bench which put into action both the saw and the holding mechanism. Thus his hand was fixed to the wood and in a fraction of a second both had been cut through. The amputated hand stayed on the bench.

The patient insisted that his workmates should take the hand along with him to his family doctor, who lived near by. After applying a firm dressing, his doctor drove him to the nearest hospital seven miles away. The air temperature that day was 26 degrees Celsius (77 degrees Fahrenheit). At this hospital some time was wasted in taking radiographs and considering what to do with such a case. Eventually instructions were given by telephone and the hand was wrapped in sponges moistened with sterile saline and put in a plastic bag, though without ice as had been advised. A bulky compression dressing was applied to the stump and the patient was transferred to our Hand Unit forty miles away, where he arrived almost three hours after the accident in good general condition and with no evidence of major blood loss. The clean cut nature of the injury in this young workman left no doubt that replantation should be attempted (Fig. 1).

Cooling of the hand was started by putting it, still wrapped in moist sponges, on ice. In the operating room the hand was thoroughly cleaned with a rubber brush and a 0.5 per cent aqueous solution of Desogene (tolconium-methsulphate). A fine silastic tube was introduced into the ulnar end of the superficial palmar artery, and microvascular clamps were applied to the radial ends of the superficial and deep palmar arteries. Thirty thousand units of Heparin were added to one litre of Kondex solution, which is used in Clinic A of our hospital for kidney perfusion before transplantation and contains several electrolytes, glucose and dextran. Irrigation with this solution at 4 degrees Celsius was started by raising the bottle about 60 centimetres above the hand; after 600 millilitres all removable blood seemed to have been washed out from the hand and the irrigation was stopped.

Fig. 1

The palmar aspect of the amputated hand taken at operation.

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Figure 2—A radiograph showing the method of internal fixation after shortening of all five distal metacarpal fragments by approximately 7 millimetres. Three microvascular clamps remain in situ. Figure 3—A diagram of the arterial reconstruction performed after repair of the flexor tendons, showing end-to-end suture of the radial artery in the first interspace and a vein graft of the ulnar artery.

Figure 4—The palmar aspect of the hand after operation. Figure 5—An arteriograph taken six months after operation. All five metacarpals have united. Three digital arteries, on the index, long and little finger, show occlusion, probably due to thrombosis during the period of ischaemia.
Replantation was then performed in the following order: 1) meticulous debridement of both cut surfaces and indentification of important structures, all the stumps of major vessels having microvascular clamps applied; 2) shortening of all the distal metacarpal fragments by approximately 7 millimetres in order to reduce tension on all subsequent sutures; 3) internal fixation of the second to fifth metacarpals with double Kirschner wires, and of the first metacarpal by a miniature AO plate (Fig. 2); 4) with the aid of a 3.5 loupe and 10-0 monofilament nylon, end-to-end anastomoses of one major vein in the first space and of the deep branch of the radial artery, which restored an adequate circulation in thumb, index and middle finger (Fig. 3); 5) the transverse carpal ligament was divided, the four superficial flexor tendons were resected, synovectomy of the four deep flexor tendons and of the tendon of flexor pollicis longus was performed and all five were united by suture; 6) the ulnar side of the superficial palmar arch was then reconstructed; a vein graft 3 centimetres long proved to be necessary, and restored the arterial circulation of the ring and little finger (Fig. 3); 7) all the extensor tendons were sutured and six dorsal veins were anastomosed; the median and ulnar nerves, both of which had been severed at the level of bifurcation, were repaired; and 8) finally the skin was loosely sutured, leaving the wound in the palm partly

FIG. 6
An oscillograph taken ten months after operation showing good amplitude in all five digits of the right hand.

FIG. 7
Photographs taken eighteen months after injury showing the range of active movement of the digits.
open for drainage (Fig. 4). A bulky loose dressing was applied without a cast to avoid any compression, and the hand was fully elevated.

The operation time was seventeen hours, during which the patient was under nervelept-anæsthesia. Four surgeons were engaged in the operation, including one resident in plastic surgery and two residents in traumatology; all the reconstructions were performed by the fourth surgeon (V. M.).

No doubt due to fatigue, three microvascular clamps were not replaced by ligatures, fortunately a matter of little importance.

The overall time of ischaemia of the hand was nine hours thirty minutes—two hours forty minutes at the ambient temperature of 26 degrees Celsius and six hours fifty minutes at 4 to 6 degrees Celsius. Systemic heparinisation had been started in the operating room. After operation an anticoagulant regimen was instituted as recommended by O'Brien, MacLeod, Hayhurst and Morrison (1973); this entailed giving 0.5 litre of Macrodex 6 per cent intravenously for three days. A continuous drip of Heparin in normal saline was given to maintain a clotting time of about thirty minutes. In addition, aspirin 1 g daily and dipyridamole 25 milligrams four times a day were given for three weeks to reduce platelet adhesiveness.

After three weeks anticoagulant therapy was continued by acenocumarol alone. Antibiotic cover was provided by Kefzol, a semi-synthetic cephalosporin, 3 g daily for ten days, starting before operation. During the first week the replanted hand showed marked swelling, which had begun in the operating room. On the fourth day a dorsal skin incision was made to improve drainage. After two weeks the wound on the palmar aspect was covered by split skin. Most of the swelling had subsided by three weeks. There was no sign of infection at any stage. Active exercises were started after four weeks, and at five weeks the patient left hospital.

Progress—Aided by strong motivation, the patient strictly followed a comprehensive programme of active exercise complemented by dynamic splinting. Three months after operation all eight Kirschner wires were removed and the constricting circumferential scar was released on the radial side by Z-plasty. After six months an angiograph showed patency of all the arterial anastomoses and a venous return within normal time limits (Fig. 5). By causing venous congestion of the forearm four patent vein anastomoses became easily palpable. All anticoagulant therapy was stopped after six months. Ten months after replantation the oscillograph of both hands showed good amplitude in all the affected digits (Fig. 6).

The patient returned to his former work as a carpenter six months after the accident. By this time the tips of the fingers in full flexion reached to between 1.5 and 2.5 centimetres from the mid-palmar creases. As for the thumb, active flexion of the metacarpo-phalangeal joint was 30 degrees and of the interphalangeal joint 40 degrees, but active opposition was absent. Sensibility was sufficiently protective. One year after replantation the working capacity was estimated as two-thirds in his original job as a carpenter, which meant that the insurance company paid one-third of his wages as a final result. After eighteen months the patient had no pain in the hand. There was slight cold intolerance, which had developed over the previous eight months. Two-point discrimination was approximately 12 millimetres on all digits. There was no motor reinnervation from the median nerve, in contrast to the ulnar nerve where useful motor power had returned. Active abduction and adduction of the little finger were possible. However, a certain degree of intrinsic tightness with moderate ulnar drift had developed which might need correction (Fig. 7). It was intended to perform a tendon transfer to restore opposition of the thumb.

DISCUSSION

The present case demonstrates clearly the value of the concept that in replantation surgery all important structures should be repaired primarily whenever possible. From more recent experience of replantations we think that flushing of the amputated part is not essential; on the contrary we have the impression that swelling after operation is less pronounced without it.

The use of magnification for anastomoses of small vessels has greatly contributed to the survival rate of distal replantations. With such a high degree of precision of vascular repair heparinisation of the patient during replantation does not seem to be mandatory, and blood loss can thus be considerably reduced. In the present case neither flushing nor heparinisation prevented plugging of three digital arteries.

How far the time of ischaemia without irreversible tissue damage can be extended by cooling the amputated part is not yet clear. In the contracture of the intrinsic muscles in our case tissue damage from ischaemia was possibly of importance. This aspect is one for further investigation.

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