Upper limb replantation

How I do it

Jan Holmberg

Department of Hand Surgery, General Hospital, S-214 01 Malmö, Sweden. Tel +46–40 33 67 69. Fax –40 92 88 55
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Replantation is a resource-consuming and expensive activity. The mean operation time is around 6 hours for one finger and it is not unusual for a multiple-finger replantation to take more than 24 hours. In most industrialized countries replantation surgery has become routine. It is reasonable to demand clear indications for this kind of surgery, but unfortunately these cannot yet be expressed in well documented distinct points. The patient, the mechanism of injury and the level and extent of amputation must be considered to balance the risks and costs of replantation against possible benefits. This is true also of recirculation for survival of partially amputated parts with interrupted circulation. A better result can be expected after recirculation than after replantation.

The patient

Multiple injuries and advanced cardiovascular or pulmonary disease greatly increase the risks of a lengthy operation and can be an absolute contraindication. Renal disease increases the risk of renal failure after macroreplantations. Peripheral vascular surgery may be impossible in cases of advanced peripheral arterial disease, such as Bürger's disease, diabetes and sclerodermia. The lower the patient's age, the better the functional results that can be expected; the indications for replantation are very wide in children, including infants. With advancing age, the restitution of sensibility and active motion decreases, but there is no absolute upper age limit for replantation (Biemer and Duspiva 1982). The patient's occupation has no great influence on the decision to replant or not. It has been argued that cold sensitivity may be so great a handicap that replantation should not be attempted in outdoor workers in a cold climate. Not only replanted fingers, but also amputation stumps are cold-sensitive, however, and in the only study where replanted fingers have been compared with amputation stumps in this respect no difference was detected (Backman et al. 1991). Clerical workers can often perform the manual part of their tasks without a finger or 2, but are often hampered in their off-duty activities and disturbed by the disfigurement.

Mechanism of injury

Damaged tissue must be debrided at the level of replantation. Revision in extensive crush or avulsion injuries may leave so little undamaged tissue that replantation is meaningless. In avulsion injuries, the vascular injury is extensive and vascular grafts must be used. The nerve ends are tapered and when nerve branches have been pulled out from a nerve trunk poor restitution of their function can be expected. The best functional results are achieved where the mechanism of injury is a sharp cut or a saw.

Level and extent of amputation

This is the most discussed point. There are surgeons who can perform delicate operations with fewer than 10 fingers or even with 1 hand and amputees who can perform unbelievable tricks, such as tying their shoe-laces after bilateral carpal amputation. This is often taken as an argument against replantation. In all probability, however, most of these highly motivated patients would do so much better after a successful replantation that the cost of such an operation would be very low for the functional gain obtained. In extensive finger- and hand-amputations the minimal aim is to preserve a chuck-grip between the thumb and 2 opposable fingers or at least to reconstruct a key grip between the thumb and a steady ulnar post. Every reasonable effort should be made towards this aim, even if it will include a secondary toe transfer.

There is general agreement that thumbs should be replanted whenever the patient's general status and local conditions permit. There are several reasons for that. One is that the thumb is half the hand because of its unique position to oppose the ulnar fingers. Most thumb amputations are distal to the carpometacarpal joint, and even if the 2 distal joints should end up totally stiff, the thumb can usually be opposed to the tip of the little finger and thus perform its essential functions very well. Even a totally anesthetic thumb is very useful in a pinch grip against a finger with good sensibility.

There is little indication, except cosmetic, for replanting a single finger proximal to the proximal interphalangeal joint (Hovgaard et al. 1994). Global hand function is better without a stiff, replanted finger. Replantation in single-finger amputation distal to the sublimis tendon insertion may well be indicated for cosmetic reasons because good mobility can then be expected. In multiple-finger amputations the indications for replantation increase in a radial direction, because less mobility is needed for good function in the radial than in the ulnar fingers.

In multiple transmetacarpal amputations, the indications for replantation are very strong in order to preserve at least a pinch grip (Tamai et al. 1983). The alternative to replantation in carpal amputations is a prosthesis. An advanced, myoelectric prosthesis can perform a graduated pinch grip without any sensibility but has usually a poor cosmesis. The indication for replantation is thus very strong, although contracture of the intrinsic muscles often causes limited motion, particularly if restoration of circulation cannot be made within 5–6 hours.

For more proximal amputations, muscle necrosis can produce not only stiffness and fibrosis in the replant but also crush syndrome with renal damage. In cases where the replant has been cooled rapidly, the limit for safe replantation is around 6 hours (Chen et al. 1982). In amputation above the elbow joint, very little useful hand function can be expected, but a replanted forearm can be useful as a prosthesis carrier.

The above considerations can in some cases be used at a peripheral hospital to spare an unnecessary transport to a replantation center. In the most extensive injuries, however, replantation should be considered, keeping Bunnell's maxim in mind: "For those who have nothing, little is much". It is important to make clear to the patient that he is transferred in order to be replanted, if it is possible, so the decision can be made by an experienced replantation surgeon. The decision cannot be left to the patient, whose judgement is likely to be obscured by his situation (Biemer and Duspiva 1982).

For transport, amputated parts are draped in saline-moistened compresses and put into a watertight bag, or if more convenient, an operation glove, which is sealed and placed in a jar, containing a mixture of water and ice. The object is to cool the amputate to 0 °C. Freezing must be avoided. Partially amputated parts are cooled as far as possible by packing operation gloves containing ice and water around them. Cooled fingers have been replanted after more than 24 hours of cool ischemia, whereas circulation must be restored within about 6 hours of cool ischemia in parts containing muscle.

Although a return to full function is rare, replanted patients are, with few exceptions, satisfied with their operation and secondary amputation of replanted parts is extremely rare.

References

Backman C, Nyström A, Backman C. Cold-induced arterial spasm after digital amputation. J Hand Surg 1991; 16B (4): 378–381.

Biemer E, Duspiva W. Reconstructive Microvascular Surgery. Springer-Verlag, Berlin Heidelberg, New York, 1982.

Chen Z-W, Yang D-Y, Chang D-S. Microsurgery. Shanghai Scientific and Technical Publishers. Springer-Verlag Berlin, Heidelberg, New York 1982; 110–112.

Hovgaard C, Angermann P, Hovgaard D. The social and economic consequences of finger amputations. Acta Orthop Scand 1994; 65 (3): 347–8.

Tamai S, Michon J, Tupper J, Fleming J. Report of subcommittee on replantation. J Hand Surg 1983; 8A (5): 730–2.