Occasional Review

Survival after replantation

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Abstract

Over a seven-year period in one unit performing replantation surgery 63 parts were replanted in 49 patients with an overall survival rate of 60%, which represents a worthwhile salvage of tissue otherwise not available for reconstruction. As the median operation time was eight hours (range 5-22) the implication of providing such prolonged operative procedures on the resources of the Health Service must be seriously considered. Yet there is a failure of awareness among the medical profession of the possibilities of such treatment, and potentially viable parts may be being discarded.

Introduction

The possibility of replantation—that is, the surgical reattachment—of amputated parts of the body was shown experimentally by Buncke¹ in 1965, and Komatsu and Tamai² reported the first clinical success, a thumb, in 1968. Replantation of large pieces of tissue such as entire limbs, is possible by the standard techniques of vascular surgery, but an operating microscope is needed to achieve a high chance of success where the vessel size is 2 mm or less. In the United Kingdom microvascular replantation was first reported by Bowen and Poole³ in 1975. In contrast with large series reported from China,⁴ Japan,⁵ Australia,⁶ and West Germany⁷ (table) the total experience here has been small. Replantation is now being undertaken in several specialised centres, providing a national service, and we report the experience of one plastic surgical unit active since 1975.

Survival rate in four overseas series

Author	Duration (years)	No of total and subtotal replantations	Survival rate %
Chen <i>et al</i> (1978) ⁴	10	416	57.5
	(1963-1973)		
	4	65	92.3
Tamai <i>et al</i> (1978)/ McLeod <i>et al</i> (1978) ⁶ Biemer (1981) ⁷	(1973-1977)		
	(using microscope)		
	10	168	89
	7	130	74
	6	892	80

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Patients and methods

From January 1975 to August 1981 49 patients had 63 parts replanted. For most of the period patients were referred from all over Scotland. We have included both total and subtotal amputations, and the replantations were deemed successful if the part survived for more than one month. The term amputate is widely used in Europe for the detached part. As no concise terms exists in the English language, perhaps amputate should be accepted.

In all cases the decision to attempt replantation was taken after examination of the injured vessels under the operating microscope.⁸ On several occasions it was decided to abandon the replantation operation after several hours of surgery and perform a primary amputation. We have classified these cases as failures. The operations were performed whenever possible under regional anaesthesia by a changing group of interested senior and junior surgeons.

Results

Of the 63 replantation operations 38 amputates survived for over one month giving an overall successful survival rate of 60%.

There were 33 total and 30 subtotal amputations and the survival rates were not statistically different (58% and 63% respectively). The subtotal type of amputation consisted of those amputates that were still partly attached—for example, by skin or flexor tendon—but had no clinical evidence of circulation and could not have survived without microvascular intervention. The term revascularisation is confusing but has been defined by Biemer⁹ as the improvement by a vessel anastomosis of a residual circulation. Such cases with residual circulation have not been included. In the total amputations the circulation was restored by both arterial and venous reconstruction except in two cases. In these distal amputations an artery alone was repaired and venous congestion was treated by massage and topical anticoagulation for a few days until capillary link-up was adequate for venous return.

Of 30 subtotal replantations, 17 required arterial reconstruction alone, one required venous reconstruction alone, and 12 required restoration of arterial and venous flow to achieve an adequate circulation.

Over the seven-year period the number of suitable cases referred for replantation (fig 1) varied, although these numbers have increased recently. The survival rate throughout has remained similar.

The age of the patients ranged from 2 to 64 (mean 28). Age did not influence the survival of the replanted part.

More men (41) than women (8) underwent replantation surgery. No difference in the rate of replantation survival was noted. More patients were injured at work (28) than elsewhere (21). Again there was no difference in the rate of replant survival.

The mechanism of most injuries produced a relatively clean-cut amputation (24)—for example, from a circular saw—with a 67% survival rate. Diffuse injuries included various mechanisms of injury such as crushing, avulsion, and combinations of these, which were in practice difficult to distinguish. In this group structures such as bones, nerves, and tendons were divided at several different levels, and the tissues traumatised at a distance from the wound edges on both the amputate and the stump. Diffuse injuries (39) had a 56% survival rate.

Thumb, index, middle, ring, and little fingers were replanted in that order of frequency (fig 2). The success rate in the different fingers did not differ statistically.

The median transportation time from the place of injury to the replantation centre was three and a half hours. The median operation time was eight hours (range 5-22). The median period in hospital was 22 days (range 6-76), though this depended much on the availability of physiotherapy near their homes. The median ischaemic time—that is, the time from injury to the restoration of circulation or at least arterial inflow—for the amputate was eight hours (range 6-15). This range of ischaemic time did not influence replant survival.

FIG 1—Annual success rate for replantation 1975 to August 1981.

FIG 2—Sites of amputation and the relative success rates.

Most microvascular anastomoses were performed directly between the proximal vessels and the amputate. In the others an interpositional vein graft¹⁰ was required, and these were generally harvested from the forearm. In this series 35 replantations were performed without interpositional vein grafts—that is, direct vessel suture—with a survival rate of 66% while in 28 replantations that required an interpositional vein graft for the artery, vein, or both the survival rate was 54%.

Twenty-five replants did not survive. The reason for these failures was assessed on clinical grounds: six were due to arterial thrombosis, seven to venous thrombosis, and four to both arterial and venous thrombosis. The reasons for failure of the other eight were not documented.

In general terms regarding the arterial anatomy the more proximal the amputation the larger the vessels and the technically easier the microvascular anastomosis. The most distal replantations possible are at the level of the lunula of the nail bed. In our series most replanta-

tions (25) were done at the level of the digital vessels, which are roughly 1 mm in diameter, and in this region the best survival rate (72%), that of the fingers, was achieved.

Discussion

The numbers presented in this series represent most of the patients referred for replantation surgery from the population of Scotland during 1975 to 1981. Compared with series from abroad,⁴⁻⁷ the number of cases referred for this type of surgery per head of population is small. McGrouther⁸ has suggested that either injuries of this type may happen less often than elsewhere or that fewer patients are referred. Are potentially healthy fingers being thrown away?

It is difficult to obtain statistics on the number of patients sustaining amputations when the detached part has been preserved and brought to the hospital. Probably, however, in view of the failure of awareness among the medical profession of the possibilities of such treatment some potentially viable parts are being discarded. Although the media have paid considerable attention to this subject¹¹ there is among surgeons engaged in the primary management of trauma a general lack of awareness of the possibilities. This may be partly explained by the lack of information in British medical publications and such possibilities are unlikely to be included in undergraduate training. Certainly, in West Germany publicity in the press and the teaching of undergraduates on the possibilities of replantation have increased the number of referrals (E Biemer, personal communication). Microsurgery has also been conspicuously absent from postgraduate training and examination. Several microsurgical courses have been started in Britain to give instruction in laboratory technique, but only a few motivated surgeons undertake instruction.

In assessing the value of this type of surgery two questions must be answered. What is the percentage survival, and are the restored parts functionally worth while? The percentage of viability success reported here (60%) is lower than other series (table). This is pessimistic, however, as we have included within our failures patients who have been explored and in whom it was found impossible to re-establish a circulation. Also, the types of cases being referred in Britain may represent a more diffuse type of injury as most of our patients did not have clean-cut injuries. There is no doubt that results improve with surgical experience, and larger series would be expected to have a higher percentage success rate. This may be an argument for centralising this type of surgery in a few centres.

The percentage success rate, however, of 60% represents a very worthwhile salvage of tissue that would otherwise have no potential for reconstruction. Replantation surgery is therefore well justified by such a viability rate, particularly as this rate could be expected to rise considerably with improved techniques and understanding of the factors that control vessel flow.

As to the mechanism of injury, there are basically two groups of injuries—clean-cut and diffuse injuries. All the accident and emergency surgeon who makes the initial assessment needs to understand is that despite the difference between these types of injury both are capable of being replanted. Biemer⁹ has divided the mechanism of injury into crush, crush-avulsion, avulsion-degloving, etc. Although separation into such grouping may be worth while to appraise the viability rate in a large series, there is no practical application for such fine distinction.

The diffuse injury can be replanted. Although initial attempts at replantation were restricted to clean cuts, a good viability rate (56%) can be achieved in diffuse injuries. Debridement of the devitalised tissue in the damaged zone is necessary, and the damaged vessel must be bypassed by vein grafts that can be interposed in the arterial or venous circulation. Assessment of the length of arterial damage is difficult and requires further investigation.

Amputated tissue will only remain viable for a limited period. This may be prolonged by cooling to 4°C. In this series one part-

was successfully revascularised after 15 hours. The technique of cooling is vitally important. Parts should be placed dry in a polyethylene bag which in turn should be immersed in ice. Suitable parts have been destroyed by maceration with various physiological fluids and direct contact with ice. Extreme cases of mishandling have even occurred where the part has been frozen in liquid carbon dioxide or immersed in formol saline. The safest advice is to do nothing with the detached part until the replantation surgeon has been contacted by telephone. He can give specific advice on how he would like the part to be handled. For short journeys, no specific cooling is necessary.

These operations are extremely long. The median time was eight hours and the maximum time 22 hours. The demand for such prolonged operative procedures on the resources of the Health Service must be seriously considered. It is not possible to undertake such surgery in a theatre used for general emergency surgery, as no other emergency surgery requires such prolonged use of operation facilities. It must be possible to monopolise the theatre for an indefinite time. Sufficient nursing staff must be provided to avoid exhaustion. In addition to the manpower and facility requirements, a suitable operating microscope and instruments are needed. Most operations are performed under regional nerve block anaesthesia, and where this is possible the anaesthetist need not be constantly present.

All these provisions are well justified if the functional outlook for the patient is improved. Certain types of replantations have an undisputed value, such as the scalp¹² and replantation of the thumb or the whole hand. The decision to replant individual fingers depends on a careful analysis of the patient's age, general health, the severity of the injury, the level of the injury, the presence or absence of other injured parts, the patient's own wishes, and the likely functional outcome. We are currently undertaking a functional analysis of the successful cases to help

in selecting patients for such surgery. This will form the basis of a further report.

Currently, the decision to replant the part or not must be taken by a surgeon experienced in microvascular replantation surgery and for this reason all patients coming to hospital with detached parts should have the benefit of being referred to a replantation centre.

References

- 1 Buncke JH, Schulz WP. Experimental digital amputation and re-implantation. *Plast Reconstr Surg* 1965;**36**:62-70.
- 2 Komatsu S, Tamai S. Successful replantation of a completely cut-off thumb. *Plast Reconstr Surg* 1968;**42**:374-7.
- 3 Bowen JE, Poole MD. Multiple digital replantation. *Br J Plast Surg* 1975;**28**:8-9.
- 4 Chen CW, Qian YQ, Yu ZJ. Extremity replantation. *World J Surg* 1978;**2**:513-24.
- 5 Tamai S, Hori Y, Tatsumi Y, et al. Microvascular anastomosis and its application in the replantations of amputated digits and hands. *Clin Orthop* 1978;**133**:106-21.
- 6 McLeod AM, O'Brien BM, Morrison WA. Digital replantation: clinical experiences. *Clin Orthop* 1978;**133**:26-34.
- 7 Biemer E. *Digital replantation in recent advances in plastic surgery*. Edinburgh: Churchill Livingstone, 1981:45-66.
- 8 McGrouther DA. The operating microscope: a necessity or a luxury? *Br J Plast Surg* 1980;**33**:453-60.
- 9 Biemer E. Definition and classifications in replantation surgery. *Br J Plastic Surg* 1980;**33**:164-8.
- 10 Biemer E. Vein grafts in microvascular surgery. *Br J Plast Surg* 1977;**30**:197-9.
- 11 Piquet E. The boy with the miracle arm. *Reader's Digest* 1981;**119**:21-6.
- 12 McGrouther DA, Chan TS, Downie PA, Sully L, Webster MHC. Reconstruction of scalp avulsion injury by replantation and a local skin flap. *Br J Plast Surg* 1981;**34**:44-6.

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Letters to a Young Doctor

Choosing to become a consultant

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For a doctor to have a career in hospital it is now essential to obtain a higher qualification of a royal college or faculty. The qualifying first degree from the university is now simply an "entry" qualification to read for a further diploma. A diploma is quite different from a doctorate of medicine, MD, or doctorate of philosophy, PhD, which is awarded by a university on the basis of research work and a written thesis. The Mastership in Surgery is usually similar.

University higher degrees are important later, but your first task after full registration is to start working for the fellowship of a royal college of surgeons, or for membership of the Royal Colleges of Physicians of the United Kingdom; the Royal College

of Obstetricians and Gynaecologists; the Royal College of Pathologists; the Royal College of Psychiatrists; or the Royal College of Radiologists; or for the fellowship of the Faculty of Anaesthetists of the Royal College of Surgeons, or membership of the Faculty of Community Medicine of the Royal College of Physicians.

Knowing that you must obtain one of these diplomas and that there is absolutely no escape from this requirement, any more than there is from passing the qualifying examinations, you must find out—preferably during your second preregistration house officer post—the regulations for your chosen higher diploma. If you have not made a choice find out about all of the examinations by writing to the secretary of the appropriate college or faculty. There is no substitute for doing this because the regulations often change and you must know the most recent ones. You must not guess or accept anyone's beliefs about them, however eminent the person may be. Your circumstances might fit some aspect of the regulations and not another, and no one can know about this but you.

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