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Original Article

Microsurgery in Trauma

S. Raja Sabapathy * MS., M.Ch (Plastic)., DNB., FRCS (Edin).,
Hari Venkatramani ** MS., M.Ch (Plastic)., DNB.,
Gaurav Sawhney *** MS (Ortho)..

Abstract :

The treatment goals in trauma management has evolved from the stage of life preservation to limb preservation and to the present stage of functional restoration. This needs to be achieved at the earliest possible time with the least amount of cost and morbidity. Reconstructive microsurgery is one tool to achieve this goal. It is primarily helpful in reattaching amputated parts, restoring blood circulation to ischemic limbs, better repair of nerve injuries and coverage of wide defects in soft tissue. Very often microsurgical procedures reduce the number of days of hospital stay, cost of treatment and provide better functional outcome.

Key Words : *Microsurgery; Replantation; Free Flaps.*

Introduction

Management of trauma is as old as mankind. The treatment goal has evolved through various stages. We have passed from the era of life preservation, to the era of limb preservation and now we are in the era of functional restoration. It has become imperative that the patient achieves this stage as early as possible with minimum morbidity. In the present conditions of scarce resources, the treatment has also to be cost effective. Reconstructive microsurgery helps in the management of many trauma victims to reach this goal.

What is reconstructive microsurgery?

Microsurgery is a techinique where surgeons use the operating microscope to perform the surgical procedures. Surgeons took to magnification to help them to do what they were doing a lot better. ENT surgeons, ophthalmologists and neurosurgeons were the early users of the microscope. Plastic surgeons were late to enter into the field, but when they took up microsurgery they learned to suture vessels as small as 1 mm in diameter, which opened up new opportunities and increased the capability of the surgeons. Amputated limbs were replanted and no longer discarded into the bin and hitherto unmanageable wide soft tissue defect could be covered in a single operation. Trauma care was never the same again. Advances in resuscitation, aided by the availability of sophisticated monitoring equipment for the anaesthesiologist, made long operations on trauma patients possible. In an established microsurgical unit, experienced surgeons can perform complex microsurgical operations

* Head of the Department, Department of Plastic, Hand & Reconstructive Microsurgery, Ganga Hospital, No.2, Swarnambika Layout, Ramnagar, Coimbatore, Tamil Nadu-641 009.
** Consultant in Plastic Surgery *** Registrar.

Address for Correspondence : S. Raja Sabapathy, HOD, Department of Plastic, Hand & Reconstructive Microsurgery, Ganga Hospital, No.2, Swarnambika Layout, Ramnagar, Coimbatore, Tamil Nadu-641 009.

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be a flask or a thermocool box (Fig. 2). In this way the temperature of the part would be around 4 degrees Celsius. On no account should ice be placed in direct contact with the part. Direct contact causes intra cellular crystal formation and cell death. The part sould also not be put in any solution like Ringer's lactate or glucose saline. This makes the part sodden and difficult to dissect. If the part is big, like an above elbow amputation, the ice should be put into many plastic bags and placed all around the amputated part. Time is crucial in replantation and it is important to rush the patient to the replantation centre. The earlier the part is preserved and the earlier revascularization is done the better are the chances of success of the replantation surgery. A high level of awareness among the public and the medical profession about the possibility of replantation and the nearest centre where it is possible is essential if time is not to be lost in transport.

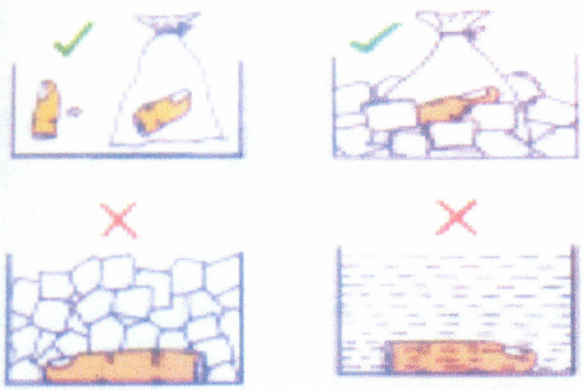

Fig. 2

a : The amputated part is placed in a plastic bag and tightly sealed with a knot.

b : It is surrounded by ice.

c&d : Part should not come in direct contact with ice or water.

Outcome of replantation surgery

Replantation surgeons unanimously work to Chen's dictate that **"....survival without restoration of function is not success"**. Functional outcome of replantation surgery has to be compared to the alternative of revision amputation. When such comparisons are made, most of the time replantation scores better in the long run when compared to revision amputation and fitting of myo-electric prosthesis. This is very true in the upper limb where good functional prosthesis are difficult to obtain. In countries like India where insurance cover is not widespread replantation surgery is less expensive than a functional prosthesis. Replantation in the lower limb has to be done very selectively, mainly at distal levels and in children.

Bridging gaps in soft tissue defects

When there was a wide defect in skin and soft tissue after trauma (e.g. open fractures of leg with soft tissue loss) or a combined tissue loss (e.g. defect of bone and overlying soft tissue) there were no easy solutions for reconstruction by conventional plastic surgical techniques. The solutions often involved staged reconstruction. During that period the fracture site in open fractures remained exposed. Exposure and desiccation caused necrosis and infection. It resulted in increased morbidity and in many cases ended in amputation. Fear of exposing the fracture site and the absence of techniques to cover wide defects also led the trauma surgeon to be conservative in debridement. It was found that conservative debridement again led to increased incidence of infection. This was the single important reason for poor results in open fractures particularly in lower third of the leg. This was radically changed by the advent of microsurgery. With microsurgery, we can transfer a muscle like latissimus dorsi and gracilis with their nutrient vessels to the defect and anastomosis of the flap vessels to local vessels in the recipient area. In a single operation wide defects can now be covered (Fig.3). Confidence in reconstruction gave

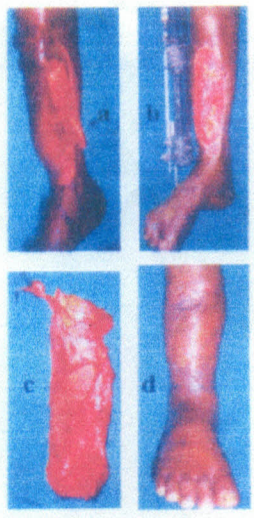

Fig. 3

a : Open fracture of both bones leg with extensive soft tissue loss

b : After debridement and skeletal fixation

c : Harvested Latissimus Dorsi muscle free flap with its vasclar pedicle (arrow).

d : Well healed leg after 1 year.

of relatively short duration and such operations can no longer be considered to possess any additional risk.

Broadly the use of reconstructive microsurgery in trauma will fall in one of the three situations.

1. Replantation of amputated parts
2. Bridging gaps in soft tissue defects
3. Microsurgery in peripheral nerve surgery

Replantation of amputated parts

Replantation of an amputated upper limb at the level of midhumerus of a year old young boy was first done by Malt at Boston in 1962. Techniques have now been perfected so that replantation of fingertips at the level of the middle of the nail is possible. Survival of the part is no longer the end point. Instead useful function is the end point. While survival depends upon the quality of the vessel anastomosis, function depends upon bone fixation and the quality of repair of tendons and nerves and soft tissue coverage. Decades of experience in replantation in many centres has helped define the indications for replantation (Table.1).

Table.1
Replantation Strategies

Definite indications for replantation:

- Thumb
- Multiple Fingers
- Hand amputations through palm
- Distal forearm
- Arm (sharp only)
- Any part in a child
- Scalp

Contra indications for replantation

- Severely crushed or mangled parts
- Branchial plexus injury
- Multi level amputations
- Associated life threatening injuries
- Prolonged ischemia time

The important deciding factors are the duration of ischemia, the level of amputation and age. Amputated parts, such as digits, which do not have much muscle in them can be replanted for many hours after injury, if they are preserved properly. If the amputated part has much muscle, revascularization has to be done within 4-6 hours. Muscle degenerates fast and on replantation the products of degeneration can depress the myocardium when they enter the systemic circulation. Myoglobunuria can severely affect the kidneys and pulmonary affliction can result in ARDS. This contrasts with digital replants. We performed a five finger replant of a young man who reached our centre 9hours after the accident. Replantation was done with the thumb first and the little finger last and the ischemia period for the little finger was 26 hours (Fig.1). All fingers survived and are functional. This gives the message, that when an important part like the thumb gets amputated we have adequate time to transfer him to the replantation centre to give the best possible chance for reconstruction. The key thing is early preservation of the amputated part.

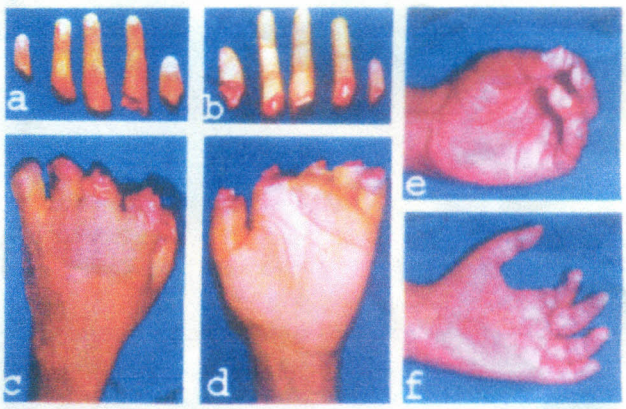

Fig. 1

(a&b) : Five fingers amputated in a 21 year old male
(c&d) : Proximal amputated stumps
(e&f) : The hand in use at 6 months follow up

How to preserve the amputated parts?

The amputated part has to be put inside a plastic bag and tightly sealed with a knot. It is not essential to clean the part. Any plastic bag can be used. Ice has to be placed around the plastic bag. The outer container could

courage during debridement. Radical debridement became the order of the day and free flaps were done early, radically changing the outcome in open fracture treatment. Microsurgery and aggressive management of wound were responsible for the better outcome in open fractures than the advent of any fixation system of the fractures per se.[2,3,4,5]

Composite free flaps are flaps which contain more than one type of tissue. For example most of the fibula can be transferred with an overlying island of skin to cover both the defect in bone and adjoining soft tissue in one stage. This again revolutionized trauma management. Once transfer of tissue by anastomosis of vessels became possible, it was exploited by the ingenuity of the surgeons only limited by their imagination. Fractures with distal non vascular limbs with soft tissue loss were managed in one stage by flaps from forearm based on the radial artery. Trauma care was never the same again after the advent of microsurgery.

Microsurgery in peripheral nerve surgery

Obtaining predictable good results after peripheral nerve repair is considered as the last frontier in hand surgery. In any field good techniques generally could be expected to yield good results. In nerve surgery, good results do not necessarily follow good technique. Since obtaining good results is difficult, it is imperative that technical perfection must be aimed while performing nerve repair. Use of magnification is considered as one of significant steps towards getting good results.

The first step in performing nerve repair is to prepare the edges. The magnification of the microscope is invaluable to freshen the edges to the level of good fascicles. When nerve repair is delayed the cut ends of the nerves become bulbous with sprouting axons and fibrous tissue. Magnification is important to trim the end to viable fascicles. Again during suturing, the nerves it helps to approximate the fascicles accurately and prevent the interposition of the epineurium. Brachial plexus surgery is another field where microsurgery has helped make progress. Direct nerve surgery is done in many instances to gain shoulder and elbow function. In what was considered a disastrous situation, some useful recovery is now possible.

The Need of the Hour - Availability and Awareness of Microsurgery

The inclusion of a Reconstructive surgeon with microsurgical capability in a trauma team will greatly reduce the morbidity in trauma and help salvage many limbs from amputation. When a microsurgeon forms a part of the primary trauma team, soft tissue cover of open fractures can be done primarily or within a few days. This will greatly reduce the number of days of hospitalization, the incidence of infection and the use of antibiotics. About 30% of beds in any trauma unit will be occupied by patients needing soft tissue cover of the fracture site. If this is done quickly precious resources can be saved. It is important that developing countries take up to microsurgical solutions. Though a microsurgical procedure can take 4 to 6 hours to do overall they fare favorably when compared to the total operating time when staged reconstruction is done. It is cost effective. Further procedures like replantation are needed by young people. A procedure like replantation of the thumb literally gives back 'life' to the individual. To benefit from microsurgery, overall awareness of its use must be high amongst the medical profession and the public. Awareness is also proportional to the availability of the services. With the setting up on quality microsurgery training labs in Coimbatore, Mumbai and New Delhi opportunity exists for quality training in microsurgery and the day is not far when a reconstructive micro surgeon will be considered an integral part of every major trauma unit.

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