Emergency protocols

Introduction & Acknowledgement

We proudly present to you Emergency Protocols in various specialties, compiled and reviewed under the supervision of **Prof. Dr. Muhammad Mustafa Abdel Ghaffar**, Chairman of General Organisation for Teaching hospitals and institutes, and **Prof. Dr. Sherif Mohamed Safwat**, Vice President of the Organization for Technical Affairs.

We would like to express the deepest gratitude and all the appreciation to all who made this project a reality, to each one of the great advisory committee doctors in various specialties for the effort expended in these protocols, Whose collaborative efforts brought these protocols to fruition.

Committee
Prof. Dr. Maurice Fikri Khalil
Prof. Dr. Mahmoud Abdel Rahman Ali
Prof. Dr. Belal Abdullah Almobarak
Prof. Dr. Muhammad Suleiman Al-Badawi
Prof. Dr. Wissam Ibrahim Abdel Salam
Dr. Essam Mohamed Mohamed
Dr. Ahmed Mahmoud Ibrahim

Plastic Surgery

CRUSHED LOWER LIMB

1. A multidisciplinary team, including orthopedic and plastic surgeons with appropriate experience, is required for the treatment of complex open fracture. If not available arrange for immediate referral to the nearest specialist center.
2. The primary surgical treatment (wound debridement/excision and skeletal stabilization and soft tissue reconstruction) of these complex injuries takes place at the specialist center. Rapid access to theatres is essential to avoid delay in management where right surgeon with the right facilities and with minimal delay so get union rates similar to those of closed fractures

Primary management in the emergency department

1. Airway with spinal control, Breathing and Circulation managed according to Advanced Trauma Life Support principles.

2. Stop external hemorrhage by direct pressure or, as a final resort, application of a tourniquet (record the time).

3. Neurovascular examination of the limb.

4. Analgesia if appropriate.

6. Repeat neurovascular examination.

7. Remove gross contaminants from the wound. Leave wound undisturbed until patient reaches the operating theatre. Wounds are handled only to:

(a) Remove gross contaminants

(b) Photograph for record

(c) Seal from the environment

- A 'mini debridement' of the open fracture in the emergency room does not aid treatment .Digital exploration of the wound is unnecessary, reveals little real information and should be avoided. Lavage through the open wound serves to drive particulate debris further in.

8. Photograph wound.

9. Cover wound with sterile, moist (saline) dressing and adhesive film or light bandage. Antiseptics in the dressing should not be used .

11. Splint fracture (if not done prehospital).

12. Repeat neurovascular examination after any intervention.

13. IV antibiotics: co-amoxiclav (1.2 g) or cefuroxime (1.5 g) 8 hourly, or clindamycin 600 mg if the patient is allergic to penicillin.

14. Check tetanus status and administer prophylaxis if required.

15. X-ray: two orthogonal views, two joints – knee and ankle.

16. Immediate referral to the orthoplastic team

- **Examine circulation** by capillary refill, dorsalis pedis and posterior tibial pulses palpation or by Doppler.

If major blood vessel injury is suspected, immediately refer to vascular surgeon. Muscle death starts to occur within 3-4 h of warm ischemia. Repeated examinations are done

- Compartment syndrome may not be evident at first check or there may be difficulties in a satisfactory clinical assessment owing to patient's general condition. Severe pain increased by active or passive movement of the toes or ankle or local pressure raises the possibility of compartment syndrome. Compartment pressures should be measured if clinical suspicion is aroused. Do not wait till full picture of pain, pallor, parethesia, loss of function is established.

- **Neurological examination** is done motor and sensory

Toes and ankle dorsiflexion (common peroneal nerve) and plantar flexion (posterior tibial nerve) should be tested and the possibility of more proximal injury (to the sciatic nerve, nerve roots or spinal cord) considered. Muscle paralysis is also seen with prolonged ischemia after arterial injury. Appreciation of light touch should be tested on the sole of the foot (posterior tibial nerve) and in the first dorsal web space (deep peroneal nerve).

Antibiotic Prophylaxis

1. Antibiotics should be administered as soon as possible after the injury and certainly within 3 h.

2. The antibiotic of choice is co-amoxiclav (1.2 g 8 hourly) or a cephalosporin

(e.g. cefuroxime 1.5 g 8 hourly), and this should be continued until soft tissue closure or

for a maximum of 72 h, whichever is sooner.

4. Gentamicin 1.5 mg/kg and either vancomycin 1 g or teicoplanin 800 mg should be given on induction of anesthesia at the time of skeletal stabilization and definitive soft tissue closure. These should not be continued post operatively. The vancomycin infusion should be started at least 90 min prior to surgery.

5. Patients with anaphylaxis to penicillin should receive clindamycin (600 mg IV 6 hourly preoperatively) in place of co-amoxiclav/cephalosporin. For those with lesser allergic reactions, a cephalosporin is considered to be safe

Wound Debridement

1. The only reasons for immediate surgical exploration are the presence of: (a) Gross contamination of the wound (b) Compartment syndrome (c) A devascularized limb (d) A multiply injured patient.

2. In the absence of these criteria, the wound, soft tissue and bone debridement is performed by senior plastic and orthopedic surgeons working together on scheduled trauma operating lists within normal working hours and within 24 hours of the injury unless there is marine, agricultural or sewage contamination. The 6 hour rule does not apply for solitary open fractures.

3. Traumatic wounds are excised comprehensively and systematically as follow

(a) Initially, the limb is washed with a soapy solution and a tourniquet is applied

(b) The limb is then 'prepped' with an alcoholic chlorhexidine solution, avoiding contact of the antiseptic with the open wound and pooling under the tourniquet

(c) Soft tissue debridement/excision is safely performed under tourniquet control, especially in cases of extensive degloving. This allows identification of key structures such as neurovascular bundles, which may be displaced, and permits accurate examination of tissues by avoiding blood-staining

(d) Visualization of the deeper structures is facilitated by wound extensions along the fasciotomy lines.

(e) The tissues are assessed systematically in turn, from superficial to deep (skin, fat, muscle, bone) and from the periphery to the center of the wound. Non-viable skin, fat, muscle and bone are excised

Skin is relatively resilient but is vulnerable to torsion/avulsion injuries, which lead to degloving in a plane superficial to the deep fascia and disruption of the septocutaneous and musculocutaneous perforating vessels. Crushing injuries lead to direct devitalization. In cases of extensive flap lacerations, care must be taken to ensure that as much of the integument as possible is preserved, although all non-viable skin must be excised

subcutaneous fat is relatively vulnerable and the zone of fat necrosis is often more extensive than that of the overlying skin. Extension of the wounds along fasciotomy lines (see Figures 13.1 and 13.2) allows for access to and excision of the subcutaneous fat as necessary.

Devitalized muscle may be difficult to assess, especially in cases of multiplanar degloving. The four 'C's should be looked for: colour (pink not blue), contraction, consistency (devitalized muscle tears in the forceps during retraction) and capacity to bleed. It is important to inspect the muscle groups behind the tibia as the fractured bone ends are often driven posteriorly and devitalized muscle fragments may be lodged in the medullary canal.

Bone debridement is reliant upon the surgical exposure and delivery of the bone ends to enable removal of particulate foreign material and a complete assessment of bone and soft tissue viability. Lavage is indicated but is not a substitute for debridement and should only follow after an adequate surgical removal of contaminants and devitalized tissue is performed.

(f) At this stage the injury can be classified and definitive reconstruction planned jointly by the senior members of the orthopaedic and plastic surgical team. There will be occasions when the soft tissue damage is difficult to assess. A secondlook should be undertaken 24-48 h later. However, multiple serial debridement has been shown to be associated with worse outcomes11 and is unnecessary.

(g) If definitive skeletal and soft tissue reconstruction is not to be undertaken in a single stage, then a vacuum foam dressing (or antibiotic bead pouch if there is significant segmental bone loss) is applied until definitive surgery

At the end of wound excision the wound bed should approach elective surgical conditions whenever possible, allowing the insertion of internal fixation if appropriate, followed by flap closure.

BONE Debridement

1- Extension of the traumatic wound is along the nearest fasciotomy incisions
2- Whilst a bloodless field during soft tissue debridement may be helpful, deflating the tourniquet before bone debridement allows satisfactory confirmation of a 'capacity of the bone endsto bleed'.Thisis probably the most useful determinant of bone viability
3- Careful surgical delivery of bone ends through the wound extension aids circumferential assessment.

4. Particulate foreign matter is removed with periodic irrigation to keep clear

visibility of the surgical field.

5. Loose fragments of bone which fail the 'tug test' are removed.

6. Fracture ends and larger fragments which fail to demonstrate signs of viability are removed.

7. Major articular fragments are preserved as long as they can be reduced and

fixed with absolute stability.

8. Lavage follows once a clean wound is obtained by a meticulous zone-by-zone

debridement.

9. High pressure pulsatile lavage is not recommendet

Temporary Wound Dressings

Following excision of all non-viable tissues, if the soft tissue reconstruction is not performed immediately, the wound should be covered with a dressing which prevents bacterial ingress and avoids dessication. The application of gauze soaked in antiseptic solutions such as povidone iodine

does not have the desired antibacterial effect asthe povidone iodine is rapidly inactivated by serum at the concentrations available commercially, and there is a small risk of systemic toxicity. Furthermore, repeated dressing changes should be avoided to reduce bacterial ingress.

- 1. Negative pressure dressings: Foam dressings with the application of negative pressure meet some of the criteria of an ideal dressing in the form of the Vacuum Assisted Closure
- Negative pressure dressings may reduce bacterial ingress and tissue desiccation as well as avoid pooling of serous fluid.
- 2. Negative pressure dressings are not used as a substitute for meticuloussurgical
- wound excision.
- 3. Negative pressure dressings are not a substitute for coverage of exposed
- fractures with vascularized flaps.
- 4. Antibiotic impregnated bone cement beads under a semi-permeable membrane are associated with reduced infection rates.
- 5. These beads are most applicable in patients with segmental bone loss, gross
- contamination or established infection, perhaps in combination with negative
- pressure dressings

-

- Timing of Soft Tissue Reconstruction

1. Local flaps are safely performed at the same time as skeletal fixation. Internal fixation is only undertaken if soft tissue coverage can be performed at the same time.
2. Free flap reconstruction is best performed on scheduled trauma lists by experienced, dedicated senior surgical teams following adequate preparation of the patient, including imaging such as angiography or computed tomography (CT) scanning of comminuted fractures. This should be undertaken in a specialist center.
3. There is little evidence for the 5-day rule. Microsurgery is best performed before the vessels become friable or fibrosed and this becomes increasingly likely after the first week. We recommend that definitive soft tissue reconstruction be undertaken within the first 7 days after injury.

SOFT TISSUE RECONSTRUCTION

1- Non exposed bone, split thickness graft is suitable

2- If exposed bone or deep tissue loss or exposed vital structure,

A. *Upper third leg :* Gastrocnemius muscle flap, Sural flap or recurrent genicular perforator flap

B. *middlethird leg* : solius muscle flap, Fasciocuteneous flap or perforator flap

C. *Lower third leg* : Reversed Sural flap or perforator flaps

D. If this is not suitable: free flap is the solution

When Things Go Wrong with Soft Tissues

1. Necrosis of a local flap over the fracture site is managed by early return to theatre and revision surgery to achieve healthy soft tissue coverage.
2. Limited tip congestion may respond to leech therapy.
3. Some local fasciocutaneous flaps may be more prone to develop complications in patients with comorbidities.
4. Free flap complications are reduced by patient preparation, careful planning and performing the anastomoses outside the zone of injury: ideally proximally.
5. There is a low threshold for immediate re-exploration of a free flap with suspected circulatory compromise.
6. Deep infection requires a return to the operating theatre, fracture site exploration, debridement, dead space management and antibiotic therapy. Fracture fixation may need revision.

Guidelines for Primary Amputation

1. A primary amputation is performed as a damage control procedure if there is uncontrollable haemorrhage from the open tibial injury (usually from multiple levels of arterial/venous damage in blast injuries) or for crush injuries exceeding a warm ischemic period of 6 h.
2. Primary amputation is also needed for incomplete traumatic amputations where the distal remnant is significantly injured.
3. A primary amputation is considered an option where injury characteristics include one or several of the following:

(a) Avascular limbs exceeding a 4-6 h hour threshold of warm ischaemia
(b) Segmental muscle loss affecting more than two compartments
(c) Segmental bone loss greater than one-third of the length of the tibia.

4. Absent or reduced plantar sensation at initial presentation is not an indication for amputation.
5. Amputation levels are preferably transtibial or transfemoral (if salvage of the knee is not possible). Through-knee amputations are not recommended for adults.
6. The decision to amputate primarily should be taken by two consultant surgeons with, if possible, patient and family involvement.
7. Discussion with the nearest specialist center is advised when there is uncertainty or disagreement between surgeon recommendations and patient/family wishes.

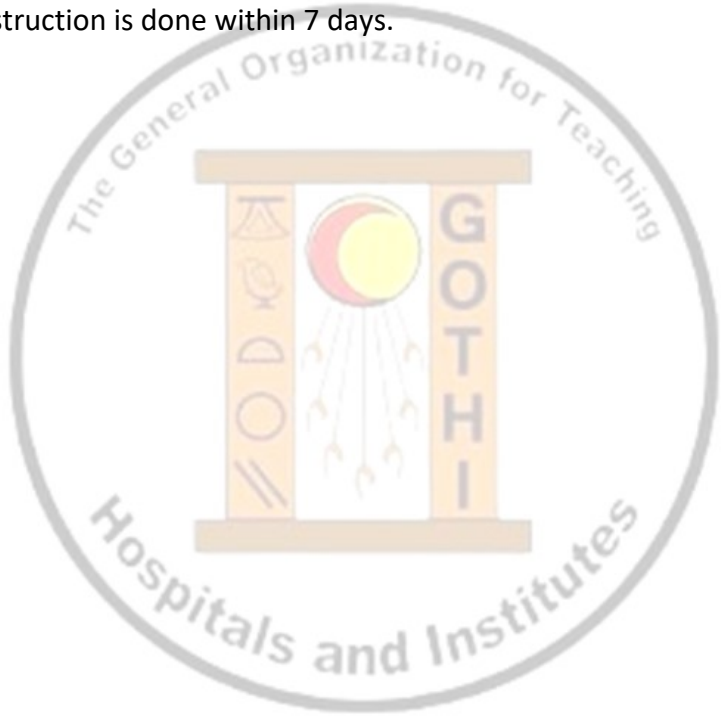
Degloving

Degloving of the limb occurs in the plane superficial to the deep fascia and the extent of injury is often underestimated.

1. Thrombosis of the subcutaneous veins usually indicates the need to excise the overlying skin.

2.. Circumferential degloving often indicates that the involved skin is not viable.

3. In severe injuries, multiplanar degloving can occur, with variable involvement of individual muscles and these may be stripped from the bone.
4. A second look may be necessary 24 -48 hours later to ensure that all the non-viable tissues have been excised
5. definitive reconstruction is done within 7 days.



Guidelines for management of crush injuries of the hand

The hand is a complex structure comprising of several tissues (skin, nerves, blood vessels, tendons, bones joints and intrinsic muscles) that are closely packed in a small space.

Hand injuries can be complex and difficult to classify. Each injury has a unique pattern and requires a unique plan of management. Crush injuries of the hand involve damage to multiple structures within the hand, loss of tissue, devascularisation and possibly amputation of digits. There are no set procedures that can be described, however fundamental principles can be laid down to guide surgical management.

The common features of these injuries are:

- Severe injury
- Multiple structures are damaged
- Different tissues are damaged to varying degrees
- Tissue loss
- Devascularisation

Optimal management of such injuries requires a clear understanding of principles of management, correct decision making and wide repertoire of surgical techniques.

Due to the varying patterns there is no standard operating procedure, however based on principles and guidelines correct treatment can be formulated for each patient

Optimum management requires a planned and decisive approach. The surgeon or the team must be well versed with techniques necessary for management of all the structures within the hand, microsurgery and free tissue transfer.

The overriding principle of reconstruction is to provide a maximally functional hand in the shortest period of time with minimum number of surgical procedures. Each procedure must be performed with clear goals and should set stage for the next procedure

Midgeley and Entin in 1979[1] provided a succinct list of characteristics that constitute functionality in the hand, These are.

- Strength,
- Position,
- Length,
- Stability,
- Mobility,
- and Sensibility

The essential components of management are, accurate assessment of the injury and creating a reconstructive plan by structures. The essential components for primary surgery are precise and complete debridement, skeletal stabiliation, vascular repair and if vessels are exposed, soft tissue cover. Secondary surgery should include procedures to enhance the function of the hand or to improve the aesthetics of the hand. These include bone grafting, fusion, tendon and nerve reconstruction, flap de-bulking and toe to hand transfers.

Assessment: A complete assessment is crucial. Accurate assessment leads to better planning

History should include the following:

When (Time of injury): indicates ischemia time and risk of infection.

How (Mechanism): Indicates severity of injury.

Where (Environment): indicates the possible infective agent, for example anaerobes in barnyard injuries, and marine organisms in injuries involving sea water.

Age of the patient and co-morbidities: such as associated diabetes, cardiac and renal conditions which may compromise the safety of surgical procedures.

If the patient is found to have life threatening comorbidities attempts should be made to optimise the patient for anaesthesia or the surgery may be considered under regional anaesthesia if possible.

1.1. Examination of the patient: life before limb

It is easy to be focussed on the injured hand, however in any trauma an overall examination of the patient must be performed in order to rule out any **associated life threatening trauma.**

Crush injuries of the hand may be associated with head injuries, thoracic injuries or abdomino-pelvic injuries causing the patient to collapse or decompensate during surgery.

This should be followed by lifesaving procedures if necessary which includes fluid resuscitation, blood transfusions, chest tube etc.

Amputated Parts: Amputated parts should be cleaned with saline, wrapped in a moist gauze and placed in a dry plastic bag. The bag should be placed in a container with ice. The container should be labelled clearly with patient's name and identification number. The parts should never be discarded. They can either be replanted or used for spare parts.

1.2. Examination of the hand

A conventional examination of the hand may not be possible. Light touch sensation may be carried out to assess sensation in the digits; formal muscle testing may be impossible due to pain, bleeding and anxiety. However synthesis of anatomical knowledge, the posture of the hand, the colour of digits and visible location and depth of trauma can provide a fairly accurate diagnosis of the injury.

1. Skin: Skin flaps with a narrow base, The nature of skin separation and the length-breadth ratio of skin flaps will indicate whether the skin flaps will survive or will need to be excised and primary or secondary skin cover may be needed.
2. Loss of cascade: indicates injury to tendons or proximal innervation. Extended posture of digits indicates flexor tendon injuries, whereas finger drop indicates extensor injuries.
3. Pale or cyanosed digits: indicate devascularisation. Since arteries and nerves are within the same sheath, concomitant nerve injury should be anticipated.
4. Rotation or deviation of fingers: indicates fractures or joint dislocations.

Other procedures to be done

1. **Antibiotics:** Intravenous antibiotic therapy should be commenced in the emergency department itself. In general broad spectrum coverage for gram positive, gram negative and anaerobic organisms is necessary. Specific

antibiotics may be needed in special circumstances such as exposure to biological contaminants (agricultural or barnyard injuries) or sea water.

2. **Sterile dressing**: should be applied in order to send the patient to radiology

3. **X-rays:** x-rays are essential in all cases. However it may be impossible to obtain good X-ray views particularly when the hand has been bandaged. Hence it may be necessary to perform X-Rays preoperatively on table when the patient is under anaesthesia and the wounded hand can be positioned without pain. X-ray images of the amputated parts should also be obtained.

4. **Recording:** Once the patient has been resuscitated the hand may be inspected in the emergency department. Photographs should be taken which can be reviewed without having to repeatedly open the wounds. These photographs also serve as records for future reference. The photographs should be stored in secure electronic medical records or secure servers and not shared on social media.

5. **Planning:** Once a visual examination has been performed, a systematic record of injuries should be made in structure by structure manner. This is essential for creating a reconstructive plan.

The list should include.

- Palmar skin
- First dorsal interossei, Thenar and hypothenar muscles
- Palmar/Digital arteries
- Palmar/digital nerves
- Metacarpals/phalanges of individual digits and joints
- Dorsal skin
- Vascularity of individual digits (highlighting devascularised or congested digits)
- Each structural loss should be complemented with a reconstructive plan. For example.
- Palmar skin: groin flap
- First dorsal interossei, Thenar and hypothenar muscles: debridement
- Palmar/Digital arteries: vein grafts from ipsilateral forearm
- Palmar/digital nerves: sural nerve graft
- Metacarpals/phalanges of individual digits and joints: K wire fixation& cerclage wiring
- Dorsal skin: groin flap may need a combined superficial epigastric flap
- Vascularity of individual digits (highlighting devascularised or congested digits): devascularised Middle finger (arterial injury in the palmar region)

Preparation: The above plan guides preemptive surgical positioning and preparation and avoids setbacks during surgery.

1.3. Surgical preparation

The prepared parts will be chosen according to the needs as follows

- Sural nerve graft, saphenous vein graft: Prepare the leg or use spare-parts
- Smaller vein grafts: Prepare the Forearm
- Tendon: Prepare the forearm Palmaris longus, sacrifice FDS, use spare-parts
- Flap: Prepare the Groin/abdomen and prepare the ipsilateral thigh for skin grafting the abdominal donor defect.

Goals of surgical management

- Restoration of maximal function
- In shortest possible time
- Through minimum number of procedures
- Each procedure should be performed with clear goals and should set stage for the next procedure

Primary (Emergency) surgery: A well performed primary surgery is critical for optimum outcomes. It should accomplish the following goals

1. Excisional debridement
2. Skeletal stabilisation
3. Revascularisation
4. Skin cover

NB. May or may not include tendon and nerve reconstruction/bone grafts.

1. **Excisional debridement:** Excisional debridement is performed in layer by layer fashion. Skin flaps are excised to healthy bleeding skin. Contused or de-vascularised fat and muscles should be completely excised as they will form nidus for infections that may compromise the vascular repairs and the flaps. Contaminated fracture ends should be shortened using saw and medullary cavity should be curetted.

- Longitudinal structures: intact arteries and nerves are preserved. Contamination should be removed through excision of the adventitia under magnification. Cut or crushed arteries and nerves should be debrided under magnification until healthy ends are seen. Intact tendons should be preserved

and paratenon or partial longitudinal excision may be carried out to remove contamination. Cut tendon ends should be debrided.

NB. Repeated and incomplete debridement should be avoided. This potentially results in secondary infection of non-viable tissue and delays reconstructive procedures. However in certain circumstances such as biological or faecal contamination a cautious approach of staged debridement may have to be taken.

Intraoperative 'triage' and decision making: Decide Early What is salvageable, what is not[3, 4, 5]

- Thumb ray reconstruction is the first priority, if distal stump is available, any suitable digital stump can be used to restore the thumb
- The **least injured fingers are then salvaged** irrespective of the position.
- The **best amputated segment** is transferred **to the best available stump.**
- **Severely traumatized digits** may be **used as a source of spare parts**

2. **Skeletal stabilisation:** Forms the foundation for the entire reconstruction. Decision regarding the method of stabilisation is governed by the nature of contamination, adequacy of debridement, and presence of bone loss. If contamination is minimal plate and screw fixation can be performed. Bridge plates are used for maintaining length. However in cases of significant contamination K-wire fixation or external fixation is preferred. The placement of implants especially external fixation should be planned such that it does not interfere with the placement of the flap. Bone grafts represent non-viable tissue and are preferably performed as secondary procedures in open contaminated injuries.

3. **Revascularisation:** The next essential step is that of revascularisation. For successful revascularisation the vessels should be adequately debrided and healthy ends approximated. Whenever necessary reversed vein grafts should be used for arteries. For circumferential wounds it is essential to anastomose veins or venae commitans.

4. **Skin cover:** Flap cover is essential if blood vessels are exposed. Skin cover can be performed as a secondary procedure if vessels have a viable skin or muscle cover. In situations of major vascular injuries abdominal or groin flaps are performed as they do not sacrifice donor vessels from the injured limb.[6] However if the hand requires revascularisation, anterolateral thigh flap[7] or a radial artery forearm flap from the contralateral upper limb may be used a flow through flaps. Some composite flaps such as the dorsalis pedis flap can be used to provide simultaneous reconstruction of tendons and skin.[8,9]

If vessels are not exposed the wound can be sealed using a sterile dressing and a flap cover may be planned electively within next 48 h. Undue delay may result in tissue desiccation and microbial colonisation. Vacuum assisted dressing (V.A.C) may assist in providing a sterile closure.

Rehabilitation: Rehabilitation in crush injuries may be complex and needs to be tailored to each injury. It can be affected by several factors such as strength and stability of skeletal fixation, combined flexor and extensor injuries in the same digit, and repaired ligaments such as collateral ligaments.

The aim should be to allow wound healing, maintain joint mobility, prevent adhesions and contractures and enhance scar maturation.

Secondary surgery: secondary surgery is performed after complete healing of the initial surgery. It is usually timed beyond 6 weeks from the initial trauma. During this period joints are mobilised to prevent stiffness, and soft tissue massage is performed to reduce oedema which may compromise the results of final reconstruction. The aim of secondary surgery is to enhance function and the appearance of the hand.

Secondary surgery is used to address the following:

1. Nerve reconstruction using nerve grafts
2. Tendon grafts or tendon transfers
3. Bone grafting
4. Joint fusion

Other reconstructive procedures such as **toe transfer** are planned either in the secondary stage or tertiary stage. Flap de-bulking is performed as a secondary or as the final procedure to improve the appearance of the hand as well as to enhance the function.

References

1. Midgley R.D., Entin M.A. Management of mutilating injuries of the hand. *Clin Plast Surg.* 1976;3:99–109. [PubMed] [Google Scholar]

2. Moran S.L., Berger R.A. Biomechanics and hand trauma: what you need. *Hand Clin.* 2003;19:17–31. [PubMed] [Google Scholar]

3. Peng Y.P., Lahiri A. Spare-part surgery. *Semin Plast Surg.* 2013;27(4):190–197. [PMC free article] [PubMed] [Google Scholar]

4. Soucacos P.N. Indications and selection for digital amputation and replantation. *J Hand Surg Br.* 2001;26:572–581. [PubMed] [Google Scholar]

5. Buchler U. Traumatic soft-tissue defects of the extremities. Implications and treatment guidelines. *Arch Orthop Trauma Surg.* 1990;109:321–329. [PubMed] [Google Scholar]

6. Sabapathy S.R., Bajantri B. Indications, selection, and use of distant pedicled flap for upper limb reconstruction. *Hand Clin.* 2014;30:185–199. [PubMed] [Google Scholar]

7. Qing L., Wu P., Liang J., Yu F., Wang C., Tang J. Use of flow-through anterolateral thigh perforator flaps in reconstruction of complex extremity defects. *J Reconstr Microsurg.* 2015;31:571–578. [PubMed] [Google Scholar]

8. Caroli A., Adani R., Castagnetti C., Pancaldi G., Squarzina P.B. Dorsalis pedis flap with vascularized extensor tendons for dorsal hand reconstruction. *Plast Reconstr Surg.* 1993;92:1326–1330. [PubMed] [Google Scholar]

9. Katsaros J. Indications for free soft-tissue flap transfer to the upper limb and the role of alternative procedures. *Hand Clin.* 1992;8:479–507. [PubMed] [Google Scholar]