60 Amptations

N.B. For amputation in general and specific techniques in different antatomical regions: 35.3-7

60.1 Amputation in trauma

INTRODUCTION

You may have to decide whether you can save a severely injured limb or not. Your surgical judgement is very important and will not always be correct. You may need to balance the prospect of an amputation against prolonged hospital stay, sepsis, repeated and complicated operations and maybe fatal complications.

Remember, an amputee is a patient for life: "it is the beginning and not the end of treatment". Not only must artificial limbs be replaced on a regular basis, but a high percentage of patients develop anatomic complications in the stump and psychological problems.

Most amputations following road traffic accidents and during armed conflict affect young and healthy adults in the prime of their productive life. The resulting impairment may remove 2 or more people from independent living: the victim and the carer. Physical rehabilitation, socio-economic integration programmes and vocational training are sorely lacking in many poor resource countries.

Get a 2nd opinion! This may be easier than you think, using a photo and electronic communication.

It is the most severe soft-tissue injury, not the bone injury, which dictates the amputation level. Aim to preserve as much length as possible, compatible with good and durable prosthetic fitting. *Don't gain length, though, at the expense of poor stump healing and coverage*. *A common error is to amputate in the distal ⅓ of the lower leg.* Fashion a disarticulation in preference to a bony amputation close to a joint.

A fracture proximal to the amputation level is *not* an indication for a more proximal amputation, especially not in children and healthy adults. Immobilize the fracture and carry out an amputation at the level of soft-tissue injury.

Do not greatly delay performing a distal amputation for severe injuries; otherwise you may need to perform a more proximal amputation later!
Get consent & fully inform the family. Whenever possible, get consent for a more proximal amputation, especially for war wounds, as the soft tissue injury may be much worse than you expect from an initial evaluation (*e.g.* 'Umbrella effect', 60.10).

Get good cover of the stump with muscle (*the Syme's amputation is an exception)*; if there is viable soft tissue covering the stump, you will be able to put a skin graft on it later, if necessary, but *not straight on bone!*

However, if you are in doubt, preserve as much of the limb as you can. If the patient is haemodynamically stable you will be able to re-amputate more proximally later.

INDICATIONS
(1) Pre-existing traumatic amputation.
(2) Irretrievable damage (60.3).
(3) Ischaemic tissue damage, usually from unrelieved vascular damage, crush injury or compartment syndrome.
N.B. For muscle damage of one group, an extensive debridement & fasciotomy may be adequate.
(4) Haemorrhage (when other efforts fail).
(5) Overwheming sepsis.
(6) Chronic continuing sepsis.
(7) A finger or toe where function is more important than loss of a part.

N.B. All war and most road accident wounds are contaminated, and many are 'mangled', but not all require amputation. Anti-personnel mine injuries are an exception (60.6). Assume all traumatic amputations are potentially or actually infected.

Your decision to amputate must take into account your actual working circumstances (*e.g.* conflict scenario, mass casualty event) including the availability of blood transfusion, the level of post-operative and physiotherapy care, as well as the accessibility of prostheses and physiotherapy.

A patient may request amputation for a useless limb. But up to 50% of victims can regenerate sensation (*e.g.* in the sole) over 2yrs after trauma.
N.B. Nerve transfer may make a limb useful again!

A good amputation wound presents a healthy, bleeding muscle surface that contracts as the last compress is removed.

The aim is not merely to close the wound but also, and especially, to fashion a suitable stump with a sufficient padding of muscular soft tissue for later fitting of a suitable prosthes.

If there are other serious injuries, proceed according to ABC (41.1). You might, rarely, have to decide rather to perform a quick amputation or disarticulation if required.

In damage control, *remember 'life before limb'.* This might also apply in a mass casualty situation.

The initial aim is to excise all dead and contaminated tissue in preparation for delayed primary closure (DPC).

Drain the vessels by elevating the limb before the operation! Use a tourniquet, but keep in mind that the muscle retracts back in relation to the skin and bone after removal of the tourniquet. *Release it prior to the end of the operation for proper haemostasis*.

CONSIDERATIONS FOR TRAUMA AMPUTATIONS

(1) Unlike standard amputation flaps, you must usually resort to 'flaps of opportunity' as determined by the injury. *Do not attempt to fashion definitive flaps at the first operation*.

(2) Excise all damaged soft tissue first and then plan the bone section as distal as feasible. To allow as much leeway as possible to accomplish DPC and fashion a sturdy and painless stump fit for a prosthesis, save all viable skin and muscle distal to the bone section, however irregular the remaining tissue. You can always excise excess bone and soft tissue at DPC.

(3) When you raise the flaps, *do not dissect the skin from the underlying fascia*. Excise all non-viable soft tissue & skin distal to the bone section. Plan this to be as distal as possible. So, cut the flaps long; they will naturally retract.

(4) Cut back muscle obliquely across its fibres, *not transversely*. Try to retain a specific muscle in its entirety if you can. It is often possible to 'save' the entire *gastrocnemius*.

N.B. If you cut a muscle across its fibres, *it swells considerably* in the first few days post-operatively, owing to simple inflammatory oedema, especially in young men with bulky muscle.

Flaps which approximate at the primary operation may only do so under tension at DPC.

(5) Divide the bone as distally as possible *after you have removed damaged tissues.* However, you should nonetheless be able to cover the bone end with muscle without tension. *Don't amputate in the distal $^1/_3$ of the tibia* (60.5). Be sure to bevel the front edge of the tibia, & cut the fibula 2cm shorter.

N.B. Don't leave behind any splintered or loose bone.

(6) Treat blood vessels, nerves, and the wound as in non-trauma amputations (35.3).

(7) Obliterate any dead space (although this may be difficult if extensive tissue is lost). *Put suction drains where there is dead space!*

N.B. Never suture structures under tension!

At the end of the initial operation, the skin and muscle should approximate easily, without tension, over the bone end. *Don't put in any skin sutures.*

Remove the tourniquet and assure haemostasis. Irrigate the wound with copious amounts of normal saline or potable water (up to 8-10L) using simple pressure by squeezing an IV infusion bag, or by gravity flow through hanging up the bag.

Then dress the stump with a bulky absorbent dressing made of dry fluffed-up gauze reinforced with a layer of absorbent cotton wool. Hold it in place with a loose crepe bandage or non-circumferential adhesive tape.

N.B. A tight bandage wrapped around the limb and soaked with drying exudate will have a tourniquet effect and cause extreme pain.

Don't pack the gauze compresses too tightly in the wound. This will only impede drainage. The aim is to draw inflammatory exudate out of the wound and into the dressing. Exposed tendons and joint capsules may be covered with saline-soaked compresses.

Don't remove the dressing until you take the patient to the operating theatre for DPC. *Dressings put on in the ward are an invitation to nosocomial infection.*

N.B. Resist the temptation to change the wound dressing to 'have a look at how it is doing'.

Each dressing change constitutes trauma to the healing granulation tissue and exposes it to cross-infection. Instead, a good look at the patient will suffice: the wound is doing quite well if the patient is smiling, eating, and sitting comfortably in bed.

If the dressing and bandage have become soaked with exudate, either overdress with more absorbent cotton, or take down the bandage and wet cotton and replace it *without disturbing the gauze compress in direct contact with the wound*.

N.B. The state of the dressing is never a reliable indication of the state of the wound.

DON'T CHANGE DRESSINGS OF WOUNDS AWAITING DPC UNTIL FORMAL CLOSURE.

If there is continuing haemorrhage or signs and symptoms of severe infection (fever, toxicity, excessive pain and tenderness, warmth, redness or a shiny surface of dark skin, oedema and induration, or a moist wound dressing with an offensive smell), the patient needs further surgical excision which you must perform in the operating theatre, *not by changing the dressing in the ward*.

If the wound is infected or parts are necrotic, debride it. You may need to shorten the bone and leave the flaps open for 1-2wks, and close it only when it is clean.

If the soft-tissue wound breaks down, it will leave the bone end exposed and require further bone shortening.

POSTOPERATIVE CARE
Keep the limb elevated in bed to reduce oedema and keep the stump in a position to prevent joint contractures. A PoP posterior slab worn at night is effective. Pay great attention to post-operative pain and administer adequate analgesia. This helps initiate appropriate physiotherapy to maintain muscle tone and keep remaining joints mobile.

Start physiotherapy immediately, even before DPC, to get a good range of movement at the joint proximal to bone section. This must continue long after the wound has healed & include vocational training.

DELAYED PRIMARY CLOSURE
You should employ this routinely, but it is mandatory:
(1) if the limb is already infected or may soon be so.
(2) if the blood supply of the stump is uncertain.
(3) if there is much soft tissue injury.
(4) in all war wounds.

A good amputation wound is healthy-looking with, a bleeding muscle surface that contracts as the last compress, which is stuck to the granulations, is removed.

The dressings may give off a sour ammoniacal odour. This is due to the breakdown products of serum proteins, and *is normal. It is not a sign of infection*. It is a 'good-bad smell'.
N.B. An infected stump has a 'bad-bad smell' and the last compress slides off the layer of pus without any resistance.

The aim of DPC is not merely to close the wound but also, and especially, to fashion a suitable stump with a sufficient padding of muscular soft tissue. Although whatever soft tissues remain may limit you and have to make do with 'flaps of opportunity', long posterior flaps give the best possible stumps.

If your judgement was good during the initial operation and infection has been avoided, you usually don't have to shorten the bone. Otherwise, divide it until you can be sure of tension-free soft-tissue cover.

If you have achieved tension-free DPC, place a suction drain deep to the muscle layers to evacuate any ooze of blood. Remove this after 24h.
In a young and healthy patient, especially if you can save a joint, it is worth fighting for a longer extremity with repetitive debridements. To avoid shortening the bone and having to fit a poor prosthesis, you may have to put a skin graft over exposed bone *(provided it still has a periosteum)* if the remaining skin is insufficient or retracts after the initial operation.

In an old, weak or critically ill patient, in whom you want to avoid further surgery, it may be better to amputate at a safer, more proximal level.

If there is still infected soft tissue or even bone, you *must* amputate higher up and leave the stump open again for another attempt at DPC.

Quite apart from the physical loss, and the functional disability, an amputee often suffers psychological trauma, unemployment & social ostracism (resulting in family expulsion, marriage breakdown, and loss of self-image). *An amputee may 'feel' that the (phantom) limb is still there*! Loss of the right hand in some cultures may mean all these results!
Mentoring and support for other amputees may be extremely therapeutic from an amputee.

LATE COMPLICATIONS
Make a systematic examination of a stump, including a radiograph. Check:
(1) The status of the stump
- length, shape, joint mobility, contracture,
(2) The skin
- irritation, infection, blistering, ulceration,
- callosity, epidermal cysts,
- venous engorgement (prosthesis too tight)
(3) The scar
- suppleness, adherent, sensitive,
- pressure points, 'dog ears'
(4) The soft tissue
- excessive or not enough
- neuroma, heterotopic ossification
(5) The bone
- length, bevelled edges, bony extruberances
- osteomyelitis, osteophytes.

N.B. A neuroma gives sharp 'electric shocks' on palpation; it feels like a hard lump up to 2cm in size. Cut this out and divide the nerve (using a fresh blade) more proximally, burying it under fascia.
N.B. Before diagnosing 'phantom limb pain' you must exclude other causes as listed above!

60.2 The mangled limb

INTRODUCTION
The mangled extremity is defined as massive anatomic disruption of the bone, muscle, tendon, nerve, vasculature, and/or soft tissue that threatens limb viability and functionality.

Obviously, other life-threatening injuries may take precedence. *Always apply the ABC rule* (41.1).

Therefore, the only critical aspect of the mangled extremity management during the primary survey is control of bleeding.

If direct pressure on the wound or a proximal tourniquet does not control hawemorrhage, other options are (1) direct vascular clamping, (2) shunting or (3) emergency amputation as damage control. *Don't try to refer a bleeding patient elsewhere!*

***REMEMBER:* LIFE BEFORE LIMB !**

The decision to amputate may be very difficult, especially as these patients are usually young working people.

A MANGLED LIMB

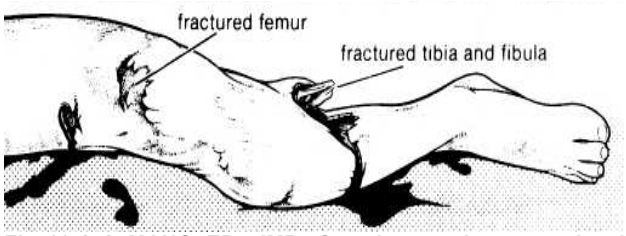

Fig 60-1 A MANGLED LIMB. One that needs amputation is defined as having massive anatomic disruption of the bone, muscle, tendon, nerve, vasculature, and/or soft tissue that threatens limb viability and functionality. Unless there is uncontrollable hemorrhage or major nerve damage, *this case is not an indication for amputation.* Reducing the fractures would be the 1st priority here.

Ask yourself:
(1) Is an attempt to save the limb possible?
(2) Is an attempt to save the limb reasonable?
(3) Will limb salvage get a better final result than amputation & prosthetic limb fitting?

This calamity most often involves the lower leg; for the arm, you should lean more towards salvage. You must also take cultural constraints into consideration.
For some the integrity of the body may seem more important than life itself, but counselling can help.

Your major focus is on restoring the victim's ability to resume a normal lifestyle. Keep in mind that both amputation & limb salvage are associated with risks of long-term disability. Your goal should be the best possible functional result, avoiding complications.

So how will you define a good outcome, and assess the risks? Is it better to save a useless insensitive foot with a couple of operative procedures, with whom the patient won´t be able to walk? Or is a primary amputation and a quick rehabilitation with a good prosthesis the better solution? Will the patient´s functional independence following reconstruction be better, or will it be worse than after amputation and prosthetic limb fitting?

The answer will vary according to age, vocation, medical health, social status, the demands of the patient's chosen occupation and the cultural context.
It also depends on the availability of a prosthesis, especially in resource-poor environments.

Does the patient have the means to afford a prosthesis? Is one available at all? If you try to save a limb, keep in mind that a long-lasting, burdensome, multiple-step treatment programme might overstretch the patient's financial & physiological capacity and so might be even life-threatening.

The result of salvage is sadly (even in sophisticated centres) often not as satisfactory as primary amputation. An early decision for amputation may often reduce a victim's suffering. Try to view an amputation as reconstructive rather than destructive surgery.

Remember:
(a) Tourniquet
(b) Vascular shunting
(c) Fasciotomy
(d) External skeletal fixation
(e) Multiple wound assessments

TREATMENT PRINCIPLES FOR MANGLED LIMBS
Document your neurovascular examination early on. Take photographs if at all possible.

Keep a low threshold for fasciotomy (49.6) in patients at high risk of the compartment syndrome: it is best to react prophylactically than lose a leg!

As a general rule, *don't amputate as a primary measure* if at all avoidable. You will only be able to make a definitive assessment of the soft tissue damage in the operating theatre during the initial debridement. This you should plan as early as possible, especially if you suspect a major vascular injury.

AVOID PRIMARY AMPUTATION

Carefully debride all non-viable tissue. Because of the high risk of post-traumatic infection, the quality of your initial debridement is central. *Meticulously remove all foreign material as well.* If this is likely to take you >2h, an amputation may be the better option, if you have many other patients to see to.

However, in polytraumatized patients, the criteria for limb salvage must be stricter than with isolated limb injury as limb salvage procedures are an additional physiological burden ('2nd hit').

In unstable polytrauma patients, stick to damage control surgery and concentrate only decontamination and controlling haemorrhage.

All else is unwise as the duration of procedures in such patients is critical to outcome. You can always re-assess the situation over next 48h and make a decision then. So, initially just debride, control bleeding and immobilise the limb(s) in slabs over fluffy dressings.

Leave definitive immobilisation till whenthe patient is stabilized, during a 're-look'; then decide whether or not to salvage a limb.

N.B. this applies only to UNSTABLE polytrauma patients.

Anticipate the definitive bony and soft tissue treatment from the beginning. Leave any contaminated soft tissue wounds open.

N.B. You'll get a better functional outcome with an amputation *with s*evere soft tissue injury around the ankle & foot.

Finally stabilize the bone, *e.g.* by using external fixators or splints. These should allow you access to all open wounds.

In the presence of combined major vascular injury and long bone fractures, vascular shunting (49.3), followed by external fixators are expedient damage control options.

After initial debridement and stabilization of the limb, discuss further intervention, risks and perspectives with the patient and the family. Make sure that these discussions are timely, transparent, non-coercive, and you clearly **document everything**.
Take into account any comorbidity such as diabetes, peripheral arterial disease and nicotine abuse, as well as available personnel and resources.

You may need to make several assessments of the soft tissue injury, before coming to a final decision.

SCORING SYSTEMS
Multiple scoring systems exist to classify the severity of mangled extremity to help establish guidelines regarding the decision to amputate or not.
These include the following: Extremity severity score (MESS). Predictive salvage index (PSI), Limb salvage index (LSI), NISSA score, Hannover fracture scale (HFS), Mangled extremity severity index (MESI) & Ganga hospital open injury severity score.

None of these systems have been shown to be useful in prospective clinical decision-making for amputation versus limb salvage, *especially not for the inexperienced*. In particular, *they are not predictive of the functional recovery after successful limb reconstruction*. In general they could be considered only as a help deciding to amputate or not a mangled limb.

Furthermore these scores are relevant only for the lower extremity in adults and *not for upper extremities* and *not for mangled extremities in children*.

Here are some guidelines which may help in the decision-making process. Not all mangled wounds with vessel damage warrant amputation. In these situations of vascular injury & severe tissue damage, an amputation is advisable.

(a) Haemorrhage with extensively comminuted fracture & bone defect, 2-finger sized wound cavity, and the sum of entry & exit wounds >10cm diameter.
(b) Transection of major nerves.
(c) Other life-threatening injuries.

If vascular repair by shunt & fasciotomy, & fracture immobilization is possible, limb salvage is worth trying. *Close observation over 48h is mandatory!*
However, if soft tissue damage is so severe that closure is impossible, limb salvage will probably fail.

If revascularization has failed, or severe sepsis ensues, amputation is necessary.

N.B. Insensitivity of the sole of the foot is not a criterion for amputation, as >50% recover over 2yrs.

60.3 Guillotine amputation

INTRODUCTION
Don't perform a Guillotine amputation as a routine procedure. It is only indicated in extreme situations such as the extraction of a victim under rubble or in a vehicle wreck. You might use it as a rapid damage-control procedure in a critically ill *e.g. with gas gangrene, neglected tourniquet application* (46.11)*, gross sepsis with diabetes* when later definitive amputation will take place at a different & more proximal level.

Guillotine amputation is quick, and the flaps are less likely to necrose if the blood supply is poor. This is important in the forearm, fingers or toes, because if you do a formal operation and it becomes septic, you lose more length.
However, if you don't have clear demarcation between healthy and septic or irreparably damaged tissue, you may also lose more length.

GUILLOTINE AMPUTATION (GRADE 2.2)
Cut the skin, fascia and muscle in one straight cut; the amputation knife is made for this purpose.
Saw through the bone at a slightly more proximal level. Tie vessels and cut nerves as in other amputations (35.3), but at the level of the amputation. The muscles should retract proximal to the skin edge, but remain distal to the bone. The final stump resembles an inverted cone.

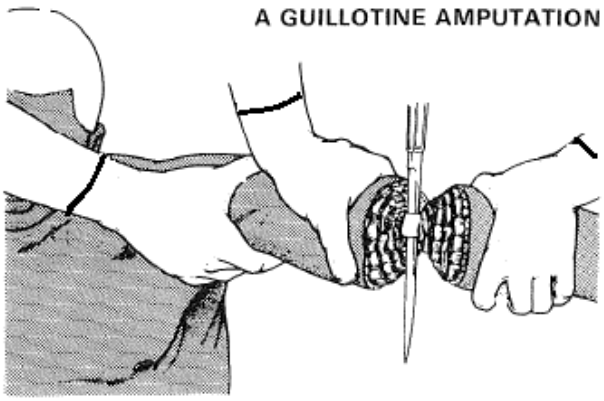

Fig. 60-2 A GUILLOTINE AMPUTATION. This is a quick procedure only indicated in extreme situations. *A revision is almost always necessary later. Beware injury to your or your assistant's fingers from the knife!* Use a saw for the bone!

If you perform the amputation too distally, you may miss dead muscle; if too proximally, you remove more length than necessary. Retraction of the blood vessels makes control of bleeding more difficult.

In addition, wound closure is made more complicated because of retraction of the skin, particularly if the amputation is at mid-calf or mid-thigh level.
The resultant significant oedematous muscle swelling always requires stump revision in order to fit a prosthesis.

MANAGEMENT OF AN OPEN STUMP
You may occasionally see a guillotine stump from a machete injury. The further management of a traumatic or surgical amputation depends on how clean and how fresh it is. Simple skin grafting the stump wound rarely gives a good result.

If the guillotine amputation stump is infected, take the patient to theatre for a debridement to remove any remaining necrotic tissue. You may have to repeat this several times.
Leave the wound open. In the process, try to create flaps for closure, so that you can achieve this when the wound is clean.

If the guillotine stump is on the leg or upper arm, is <48h old and is clean, re-amputate the clean stump at the correct level, salvaging all viable soft tissue. Leave the stump open, and perform a delayed primary closure 5days later.

If the guillotine stump is on the leg or upper arm, is >48h old and is clean, dress it every 2–3days and keep the limb elevated. Perform a secondary amputation after 2wks when the inflammatory oedema has subsided. Again, leave the stump open and perform delayed primary closure another 5days later.

If the guillotine stump is on the forearm, finger or toe, dress it every 2–3days and keep the limb elevated. *Don't try any V-Y or similar flaps, as their results are no better and often worse than letting the wound granulate on its own.*

MTHULISI (45yrs) was an ambulance driver at a Mission Hospital. One night he leant out of his cab to open a rusty gate to drive into someone's homestead. Unfortunately, he cut his hand deeply, but continued his work to bring a patient to hospital. He put a rough cloth round the wound to stop the bleeding and went to sleep as it was already late & dark.
His daughter, a trainee nurse at the hospital found him comatose in his bed 48h later. His right forearm was discoloured in its distal ⅓, he had a temperature of 39°C and was severely hypotensive.
The gravity of the situation was explained to the nurse, who was uncertain about giving her consent as she was under 21 years old. Her mother lived over 20km away, accessible only on foot. It was agreed that the nurse come to theatre to witness the status of the tissues on incision of the forearm, and then to give her consent if she agreed the soft tissue damage was irremediable. The greenish discolouration and smell of gas gangrene were undeniable (and unforgettable).
A damage control guillotine amputation was performed just below mid-forearm level. The wound healed on its own, and the patient recovered fully. He was then employed in the hospital garden, a job he always coveted!
LESSON: Acting quickly in an emergency may be life-saving.

60.4 Amputation of lips, nose, ears, breast & genitalia

INTRODUCTION
Traumatic amputation of lips, nose, ears, breasts and genitals are very mutilating injuries, but in themselves not usually life-threatening. They may either occur as isolated injuries or as multiple mutilation.

The 1° goal is always to save the patient's life, especially in a severely injured patient, by following the ABC algorithm (41.1).
This is particularly important in patients with trauma to their face, as this may compromise the airways.

Patients with severe injuries to their genitals may also suffer from severe bleeding.

Mutilation of lips, nose, breasts, and genitalia are not only cosmetic issues, but may also affect speech, breathing, breast-feeding and sexual function. This may have drastic psychological consequences.

Try to save and reconstruct whatever you can in order to allow your patient the best possible quality of life. If you can, once you have stabilized such patient, try to get specialist help.

If the injury was caused by an animal (or human) bite, or dirty knife, infection is almost inevitable. Primary repair may end disastrously, especially if an elaborate flap breaks down. A delayed primary repair is best. Dress the wound and plan this after 3-5days. Administer broad spectrum prophylactic antibiotics.

LIP AMPUTATION

The face is an exquisitely complex anatomic area, with distinct characteristics for each individual person. Deformity, therefore, is a fundamental issue. Even more important than aesthetic concerns are, however, the essential functions of breathing, chewing, swallowing, and talking.

TREATMENT

Inspect the mouth and pharynx for any loose or broken teeth or bone fragments, or continuing bleeding. This is necessary even in a conscious patient.

Avulsion of a lip segment can involve epidermis, dermis, underlying perioral facial musculature, and labial mucosa.

N.B. Pay attention to a possible delayed oedema formation that may block the airway.

Check the teeth occlusion in case you need to immobilize the mandible or maxilla.

There are 5 general methods of managing avulsed tissue:

(1) Debridement alone,

(2) Debridement and excision of the avulsed tissue with 1° or 2° closure of the wound, directly or with V-Y plasty, or rotation flaps (53.2)

(3) Debridement and excision of the avulsed tissue & free grafting of the excised portion,

(4) Debridement and excision of the avulsed tissue and split- or full-thickness skin grafting to close the wound,

(5) Debridement and excision of the avulsed tissue and a pedicle flap to close the wound.

For a partial or full-thickness avulsion of the lips, a primary re-approximation may be successful but is unpredictable. This depends on whether the patient is young and fit, and has no co-morbidity. It depends also on your dexterity and experience, and on your having fine instruments.

N.B. Skin grafting does not give very good aesthetic results.

Often, it is best to perform plastic procedures in a staged fashion. Sometimes even more sophisticated reconstructive surgery is necessary.

NOSE & EAR AMPUTATION

Traumatic auricular defects, especially partial defects, are relatively frequent, because of the prominent position of the ear on the side of the head and the delicate skin cover of the complex cartilaginous framework.

The loss or partial loss of an ear does not usually result in loss of hearing. Likewise, the loss of all or part of the nose does not result in significant loss of smell. Therefore, its reconstruction is necessary only for aesthetic reasons. However, this is very important for the nose as this contributes a central element to individual facial appearance.

TREATMENT

The reconstruction of a traumatic deformity of a nose or an ear is a challenging procedure. It differs in every case and requires tailor-made reconstruction. You can try replantation for amputations of the external ear and some full-thickness-skin avulsions of the nose, but success is unpredictable.

Repair is possible by skin grafts, Z-plasty, V-Y-plasty or local rotation flaps (53.9). You can replace a small defect of the nasal *ala* with a segment from the pinna.

BREAST AMPUTATION

Traumatic amputations to the breast are rare. The loss of a breast is hugely traumatizing for the victim, especially if she is of reproductive age. However, breastfeeding from the unaffected breast should be possible and is usually sufficient.

Very occasionally, the wrong breast is removed surgically!

TREATMENT

Unless a simple repair is possible, you will need to treat this as any other large wound by either skin grafting or local flaps (46.2). Breast reconstruction needs specialized techniques.

GENITAL AMPUTATION

The penis or scrotum may be amputated by a circular saw, or in motorcycle crashes or by animal (or human) bites. It is occasionally self-inflicted or the result of a punishment.

In males, penoscrotal injury may be associated with other abdominal or pelvic injuries and these take precedence. There may be brisk bleeding.

An isolated injury to the external genitals is usually not life threatening.

If scrotal skin is lost in a degloving injury, close the scrotum (and so cover the testes) using the remaining scrotal skin. A minimum of 20% of the original scrotal skin gives enough cover for the scrotal contents. *Make sure your debridement is adequate*. Irrigate the wound thoroughly before primary closure.

If the amount of remaining scrotal skin is insufficient, use local flaps, or bury the testes (temporarily) in each thigh.

If one or both testes are hopelessly crushed, document the injury by a photo and obtain consent for orchidectomy from the patient or the family. Try to avoid a bilateral testicular amputation whenever possible. Remember to tie off the vas deferens, as well as the vessels.

If the penis is partially amputated, try a primary reapproximation by meticulous repair of the urethra and the fascia, followed by stabilization with a Foley´s catheter. Strap the penis to the lower abdominal wall, and keep the patient on bed rest for 10days. *Don't allow any traction on the catheter;* it may be best to leave the drainage bag on the patient's bed (57.2).

In females, by far most amputations are carried out through forced social convention. In many countries, this practice is illegal, but is still carried out clandestinely. Sadly, there are >200 million girls and women alive today in 30 countries mainly in Africa, the Middle East and Asia who have sustained female genital mutilation (FGM, 57.6).

60.5 Prosthetic fitting

INTRODUCTION
An amputee is a patient for life. Your major focus is on restoring ability to resume a similar lifestyle to before. This is very important, as most of your patients will usually be young working people.
Although social support will usually depend on the family, there are in every country or at least in the capital or provincial capital, a rehabilitation centre, which offers a prosthetic service of some kind.

Whether the patient can obtain a prosthesis or not may well depend also on the family's financial means.

It is very important that you consult with your nearest physical rehabilitation centre. Its available technology and skills are fundamental in considering the sort of amputations which would be suitable for your patients. You should have a mutually agreed 'amputation policy' at your hospital to guide you.

If there is any uncertainty, perform a standard leg or foot amputation (35.3), and for the arm, always aim instead for the longest possible stump.

But even if your patient has received a well-functioning prosthesis, this needs replacing on a regular basis. Also a high percentage of patients will develop anatomic complications in the stump and additional psychological problems that must be dealt with.

GENERAL CONSIDERATIONS
Not every patient is suitable for a prosthesis. Assess each case on its individual merits, asking yourself about the possibility, usefulness and dangers of fitting a prosthesis. Many people are unaware of the extra physiological demands of walking or working with a limb prosthesis. The more proximal the amputation, the heavier the prosthesis and the greater the energy expenditure will be.

Take this into consideration in the elderly and in those with neurological deficits.

The quality of the amputation procedure itself and a lack of proper postoperative care may lead to problems that delay or even rule out the fitting of a prosthesis. The earlier the patient gets the prosthesis, the more he will benefit from it both physically and psychologically.

N.B. The quality of the stump is more important than its length.

Fitting of a prosthesis also needs careful observation and *is not just a one-off event.* Firm bandaging helps decrease oedema and maintain the stump in good shape.

If you can obtain a temporary or interim prosthesis, fit it immediately after the sutures have been removed. If the wound is healing primarily without any problems, you can even start using an interim prosthesis even a few days before suture removal.

Usually a temporary prosthesis is not manufactured from expensive material because it does not last very long (approximately 2months).
It permits amputees to leave hospital walking even before the stump has acquired its final shape, and is ready for permanent prosthesis fitting. The interim prosthesis should be worn for only short periods daily. The aim is to enhance the resilience of the stump gradually. An interim prosthesis may also be worn in case of delayed wound healing in a below-knee amputation with a long posterior flap, as the load then compresses the anterior wound, and also helps to reduce oedema.

N.B. Delayed wound healing should not delay mobilization of the patient, as long-time immobility impedes the rehabilitation process in the long run.

An ideal stump should be free of oedema, wounds or infection, contractures and muscle weakness; it should have no redundant muscle mass, no projecting spur of bone, be free from any tenderness, a fully mobile scar, neither adherent nor infolded, not exposed to pressure, without a stump neuroma.
Its length should not be too long or too short, with a good range of movement at the proximal joint.
These are the results of good wound aftercare and good physiotherapy. *Get patients to take care of their own bandaging!*

A 'permanent' prosthesis is not really permanent. It needs a regular follow-up and prosthetic maintenance. Child prostheses are expected to last up to 6months (depending on the child's growth). Adult prostheses are expected to last up to 3yrs (depending on the adult's activities).

BILATERAL AMPUTATION
Everyone with bilateral lower limb amputations needs a wheelchair but most bilateral below-knee amputees should become reasonably mobile if well fitted with prostheses.

You can fit bilateral above-knee amputees with shortened prostheses called 'stumpies' or 'stubbies' (60-3) They have a regular socket, no knee joint and no shank. These prostheses are most effective for amputees with short stumps. They are useful till the amputee gains confidence before managing 'normal length' prostheses.
They allow some degree of independence in the initial phase. Shortened prosthesis are much easier to make, they do not have jointed knees and only need sockets with simple boots on. You can keep them in place with cords over the shoulder.

'STUMPIES' FOR BILATERAL ABOVE-KNEE AMPUTATIONS

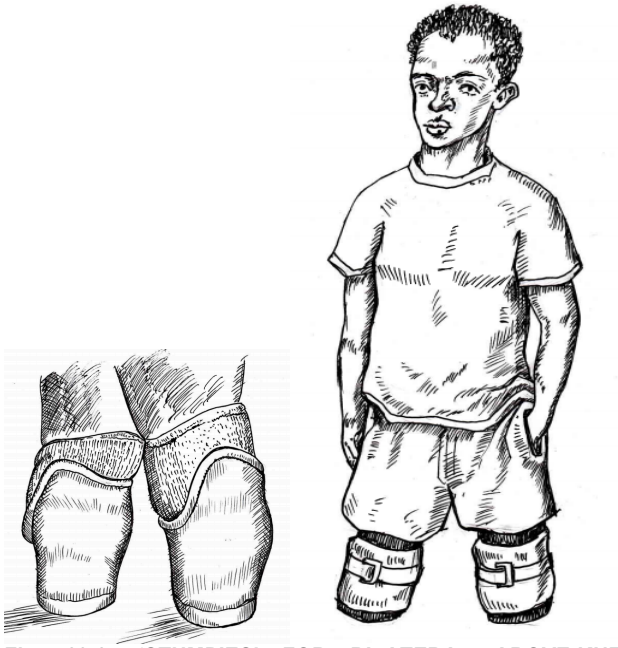

Fig. 60-3: 'STUMPIES' FOR BILATERAL ABOVE-KNEE AMPUTEES. These may be for temporary or permanent use

PRINCIPLES OF PROSTHETIC TECHNOLOGY
An important distinction is between the interim & the permanent prosthesis.

Prostheses are of 2 designs: shell & modular. In the former, the wall of the prosthesis assumes both load-bearing and shaping functions. It is made with thick-walled fittings made of wood or hard foam. Its disadvantage exists in this hard outer surface and the lack of adjustment possible in axis, length and fit.

N.B. The best prostheses are made by amputees themselves!

In the past 30yrs, the modular design has become standard. It imitates the physics of the human skeleton in its tubular skeletal construction. Its interchangeable load-bearing elements can be assembled easily and quickly. This allows axis and length corrections without much effort. It is possible to mould the foam shell also for better cosmesis.

In LMICs, the modular polypropylene system developed by the Red Cross is readily available. Polypropylene waste residues produced during production can be recycled and used again, which makes this system very economical.

But there are also other, simpler modern prosthesis costing about US$30, such as those developed by BMVSS Jaipur foot (35-23), which a mechanic can mend (www.jaipurfoot.org).

In addition, there are the traditional prosthesis, such as a pylon, a peg leg, or elephant boot. When well made these last longer than any of the others, and are better than a modern prosthesis for working in paddy fields.

THE VARIOUS TYPES OF PROSTHESES FOR LOWER LIMB AMPUTATION

HIP DISARTICULATION PROSTHESES
It is rare to be able to get any hip disarticulation prosthesis. Discuss this with your local orthopaedic technician or regional centre.

ABOVE-KNEE PROSTHESIS
N.B. If possible, perform a knee disarticulation rather than an above-knee amputation, especially in children.
There are also different types of prostheses: most are held in place by suction or auxiliary suspension such as a pelvic or Silesian belt.

PELVIC & SILESIAN BELTS

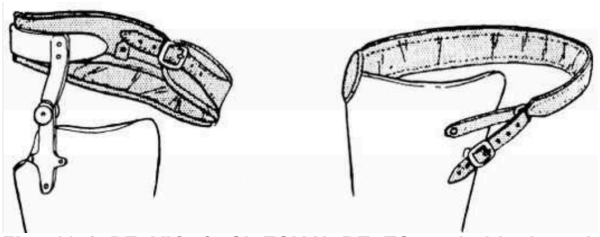

Fig. 60-4 PELVIC & SILESIAN BELTS to hold above-knee prostheses. *After Wilson AB Jr: Limb Prosthetics, New York, Demos, 6th ed, 1989*

These are made of leather, cotton or nylon webbing. The belt is worn around the waist above the iliac crest and is attached to the lateral and anterior surfaces of the prosthesis (60-4). Amputees must learn to tighten the belt sufficiently to prevent the stump moving up & down inside the prosthesis.

However, excessive tightening, especially if done with inadequate weight-bearing through the prosthesis, can rotate the socket internally and produce uncomfortable pressure on the groin or the anterior superior iliac spine. A permanent prosthesis may use Silesian suspension alone or in combination with suction to improve suspension and limit rotation (60-4).

A suction socket achieves adhesion by creating a vacuum between the stump and the prosthesis. As the amputee puts on the prosthesis, air is expelled from the socket through a one-way valve.

The negative pressure around the stump holds the prosthesis in place until the user releases it by opening the valve. With this type of adhesion, control of the prosthesis is very efficient.

Therefore, and whenever the stump conditions allow (*e.g.* distal end contact), technicians should advocate the use of adhesion devices. For initial fittings and when the stump volume alters, it is best that you secure the socket adhesion with a pelvic belt.

ABOVE_KNEE PROSTHESIS

Fig. 60-5 ABOVE-KNEE PROSTHESIS. This is held in place by suction & an auxiliary suspension Silesian belt.
After https://musculoskeletalkey.com/transfemoral-prostheses/

AMPUTATION ACCORDING TO GOTTSCHALK (GRADE 3.3)

For very short transfemoral amputations, when the adductor longus loses its attachment and the adductor brevis cannot resist the tension and forces of the abductors, the stump tends to turn into abduction, flexion and external rotation.
If you can, fix the *adductor magnus* laterally to the femoral shaft and the *quadriceps* to the dorsal end of the femur with strong transosseous sutures. This prevents abduction and flexion of the stump.

EFFECTS OF FEMORAL STUMP LENGTH

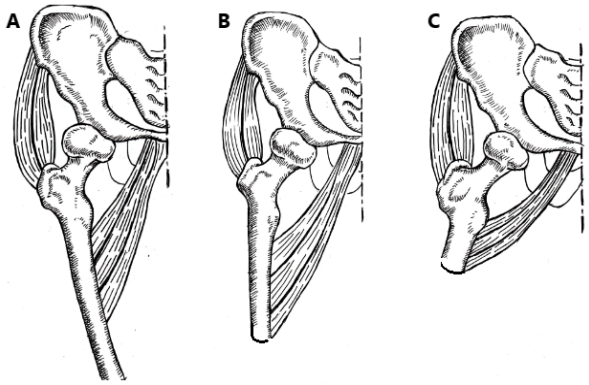

Fig. 60-6 EFFECTS OF FEMORAL STUMP LENGTH. A, the longer the femoral stump (distal $^1/_3$), the less energy consumption, as the leverage is best, with better muscular balance & preservation of adductor strength. B, medium-length stump (middle $^1/_3$) gives adductors reduced strength, with increased flexion & abduction. C, a short stump (proximal $^1/_3$) causes severe imbalance with the stump flexed & abducted and needs great energy expenditure; also prosthetic fitting is very difficult.

KNEE DISARTICULATION PROSTHESES
The features of a stump after knee disarticulation are a long, very stable, strong lever arm with end load capacity and with a much lower muscle imbalance than classic thigh stumps. Knee disarticulation gives a full end-bearing stump.

Knee disarticulation prostheses are relatively simple but efficient devices. The full weight is borne on the intercondylar fossa and provides almost ideal proprioception. The long lever arm provides excellent control of the prosthesis. It is usually worn with a soft socket (inner liner), which adheres to the stump through supracondylar suspension. To make the prosthesis easier to put on, the socket is usually fitted with an opening panel. Depending on the knee component used, the functionality and cosmetic appearance of the knee disarticulation is often poor. The position of the disarticulated knee usually does not match the unamputated knee. Though this may seem a big difficulty, in practice, it is not so. However, the proximal segment of the prosthetic leg may be too long when sitting, leaving the distal part dangling off a chair.

BELOW-KNEE PROSTHESES
Various types of below knee prostheses in both shell or modular design exist. The socket is held in place by (1) suspension or thigh corset, or (2) adhesion with a silicone liner or knee sleeves, or suction with a valve.

The most common types of sockets in LMICs are:
(1) patellar-tendon-bearing,
(2) supracondylar,
(3) supracondylar-suprapatellar.
Some of these prostheses may be re-inforced by a fork strap and cuff or a thigh corset.

EFFECTS OF TIBIAL STUMP LENGTH

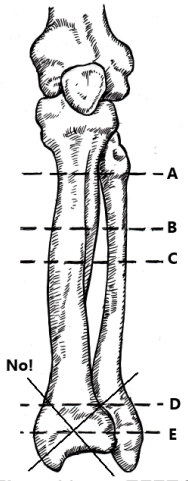

Fig 60-7 EFFECTS OF BELOW-KNEE AMPUTATION LENGTHS. The ideal site is 2-14cm distal to the tibial tuberosity. In very tall patients it might be ≤18cm. The longer the stump, the better the lever. A, a very short stump (the level of the tibial tubercle). B,C the most adequate length with the best muscle action. D, a common error is to amputate in the lower ⅓. *After Giannou C, Baldan M, Molde, Å. War Surgery, ICRC Geneva 2013*

The lower leg stump is not completely end- bearing. This means that most of the load needs to be absorbed by the complete stump surface and only partially by the end of the stump. The prosthesis shaft must therefore encompass the entire stump with the best possible fitting.

The minimum length for a tibial stump is 5cm, the ideal length is 15cm. A very short below-knee amputation (*e.g.* at the level of the tibial tubercle) should have the fibula removed (35.7), otherwise this will swing out and cause pain. A very short stump does not give adequate control or mobility.

FOOT PROSTHESES

There are many beneficial aspects of a Chopart or Syme´s amputation over a lower leg amputation, such as the long lever, the lower energy consumption, and the full distal end contact and full weight-bearing which give an ideal floor proprioception. For short distances (such as in and around the house), the patient can even walk without a prosthesis.

However, because of the unique aspects of the ankle-joint disarticulation, Symes prostheses are challenging to manufacture. So before planning such, it is wise to consult your local orthopaedic technician.

To relieve pressure on sensitive stump ends and because of the short distance to the ground, a special foot has to be used. Prosthetic adhesion occurs through supramaleolar suspension.

PARTIAL FOOT PROSTHESIS

Not everyone needs a prosthesis after partial foot amputation. But the shorter a foot stump is, the more will be the benefit. The main function of partial foot prostheses is the restoration of ground support surface as well as the forefoot lever.

For hindfoot amputations, use prostheses with soft sockets having an inner liner.

Fitting options may include: (1) orthopaedic shoes, (2) custom-made insoles with a toe filler, (3) custom-made or prefabricated ankle-foot orthoses with a toe filler, (4) free ankle-foot prosthesis and (5) cross-ankle foot prosthesis.

ARM PROSTHESES

An arm prosthesis is rarely available, and may be of little use. Unlike lower limb prostheses, which are remarkably efficient at enabling an amputee to walk, even the most sophisticated upper limb prosthesis is a very poor substitute for the human hand and can at best serve as a basic holding device. So, you should discuss this issue with the patient in order to avoid disappointment or even irritation. *N.B. Every cm in the arm counts!*

Bilateral upper limb amputees are of course completely reliant on their prostheses, and this will pose a great challenge.

A unilateral upper limb amputee will normally be able to carry out most daily activities with only one hand. Most will only tolerate a prosthesis if it gives an advantage over not wearing one. This advantage may be functional, *e.g.* using tools or driving a vehicle, or it may be cosmetic.

They generally have a PVC or silicone cover which is usually available in many different color shadings.

Functional prostheses are usually powered by the patient's own body movements. Thus, for example, moving the shoulder in a certain way will pull on a cable and cause it to open, close, or bend (60-8). These prostheses are usually unsuitable for fine precision activities or writing. Most prostheses work with a single hook, some even have a mechanical hand. But you should be able to attach any kind of tool to the prosthesis, such as a sickle.

FUNCTIONAL ARM PROSTHESES

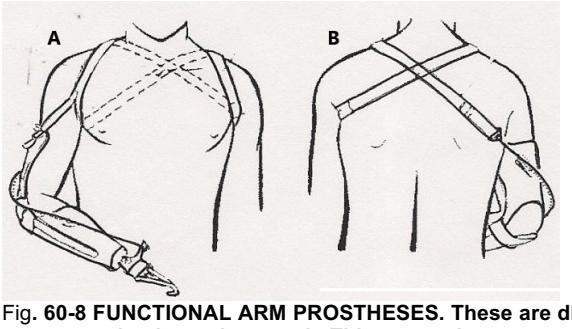

Fig. **60-8 FUNCTIONAL ARM PROSTHESES. These are difficult to get, maintain and control. This type shows control by movements of the opposite shoulder using cables.** *After http://www.upperlimbprosthetics.info/index.php?*

Other devices may help a unilateral upper limb amputee. With a simple opposition plate (60-9), a patient with an amputated thumb may hold objects. It consistS of a metal plate attached to a leather or plastic socket over the hand or, in the case of a weakened wrist, over the wrist joint. This simple prosthesis is worn when needed.

THUMB OPPOSITION PLATE

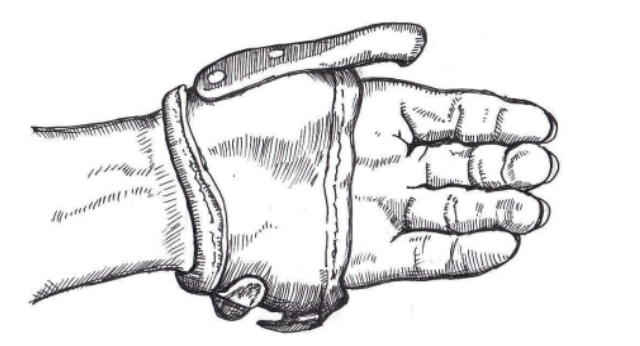

Fig 60-9 SIMPLE OPPOSITION PLATE. This allows a patient to hold objects. *After Giannou C, Baldan M, Molde, Á. War Surgery, ICRC Geneva 2013*

60.6 Anti-personnel landmine amputation

INTRODUCTION

Anti-personnel mines (APM) are a specific type of explosive device with special clinical effects. There are 2 types of APM: blast and fragmentation mines. Fragmentation mines cause wounds the same as described in 46.15 and are set off by a person hitting a tripwire. A blast mine detonates when someone steps on it (pressure mine) or handles one and constitutes a very localised explosion, causing massive destruction of soft tissue and bones. Stepping on an APM causes a traumatic amputation, whose level depends on the amount of explosive material and the size of the body of the victim, child or adult. Handling a mine will cause amputation of the fingers or hand and injuries to the face and chest in survivors. Infection is the great danger in all survivors of APM! *Apply the rules of septic surgery!*

It is a common mistake to underestimate the soft tissue damage. A blast mine creates an 'umbrella effect', propelling the tissues upwards and outwards. and then downwards. The deeper muscle layers (*soleus*) suffer more damage than the more superficial ones (*gastrocnemius*). There is a much bigger soft tissue injury than you would expect from an initial evaluation. In addition, the explosion pushes dirt, grass and leaves, and stones up into the injured tissues. To get a good idea of the level for surgical amputation, grab hold of the edges of the wound and pull them up to look into the depths of the amputated limb.

Your objective is to change a dirty and contaminated traumatic amputation into a clean surgical one that will heal as quickly as possible without becoming infected.

UMBRELLA EFFECT OF A LANDMINE

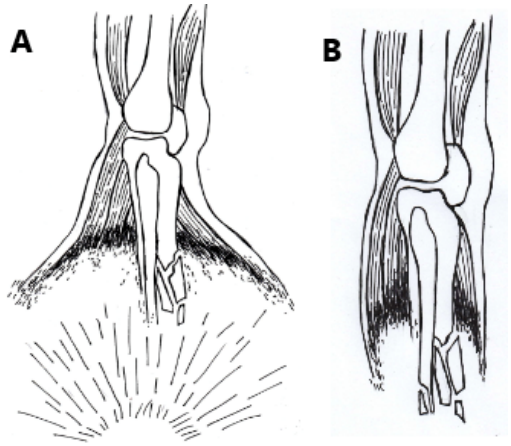

Fig 60-10: UMBRELLA EFFECT: A, note the skin and muscles being pushed up and out, & then collapse inwards (B). The deeper tissue planes suffer greater damage than the more superficial ones. *After Giannou C, Baldan M, Molde, Á. War Surgery, ICRC Geneva 2013*

SEPSIS IS THE GREAT DANGER IN SURVIVORS

Remember that a victim often has multiple injuries; fragments even from a blast mine can penetrate the perineum or abdomen, and the blast effect can thrombose vessels high up the limb or cause lung injury. Always examine the complete patient according to the standard ABCDE algorithm (41.1).

Make sure you have counselled the patient or the decision-makers properly (*e.g.* the military chief) if the patient is unconscious and obtained consent for the amputation. Always try to get consent also for a higher amputation, as the soft tissue injury in war wounds is often worse than you first think.

TWO-STEP SURGICAL PROCEDURE

Never close an amputation stump in war wounded in the initial operation! The risk of infection and septicaemia is very high. Leave the stump open, cover it with a bulky absorbent dressing and leave it untouched until DPC after approximately 4-5 days (60.1).