

CLINICAL PRACTICE

The treatment of hand injuries

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SUMMARY

A major hand injury can completely change a person's life. The consequences of the injury can be reduced by proper assessment, appropriate treatment and careful follow-up. Whenever experienced help is available then it should always be sought. This article describes the management of hand injuries. In Papua New Guinea the worst disasters occur when injuries are missed on initial assessment and the patient is not referred to a surgeon. Another common cause of poor outcome is failure to splint the hand in the correct position.

Introduction

In the human hand has a multitude of functions. Hand injuries can reduce temporarily or permanently some or all of these functions and this can be of major significance to the life of a person. Proper diagnosis and treatment of all hand injuries is, therefore, of extreme importance.

Assessment

As with all other injuries, the diagnosis of the structures which have been damaged is made by a combination of the history, examination and special investigations.

History

The important points concerning the history are:

1. How long ago did it occur?
2. How did it happen? For example, was it a sharp cut, a blunt crush, a burn, or a combination of these?
3. Were there any special circumstances? For example, was there a contaminated wound, a contaminated knife, a burn from electricity or a chemical burn?

It is also important to establish the age and occupation of the patient, what are his or her hobbies, any previous injuries and whether the

hand injured is the dominant or nondominant hand.

Examination

The purpose of the examination is to discover what structures have been damaged and, if possible, to find the extent of the damage to all of the structures.

Before the examination takes place it must be remembered that removal of the dressings can lead both to pain and to bleeding. In severe injuries, in burns and in children it can be very helpful, as well as kind, to give adequate analgesia. This can be by tablet, injection or breathing Entonox; local anaesthetic injections should not be given at this stage because they will interfere with the examination for nerve damage. Prophylactic antibiotics are not required except in very special circumstances, and they have been shown to lead to increased complications. Tetanus prophylaxis, however, should always be given if the patient has not had recent tetanus vaccination. It must also be remembered that injured hands swell and any rings should be removed as soon as possible. In the case of severe contamination or of chemical burns early washing of the injuries can be a help and prevent further damage.

Skin

Skin can be cut, crushed, degloved or burnt. Burns of the hand will be treated later in a

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separate section. The important thing to discover about the skin is whether it is viable and whether all the skin is present. Nonviable skin is particularly likely when there has been a degloving injury, e.g. being run over by a car, or when a flap of skin, particularly if distally based, has been raised. The best test for viability of skin is capillary return when after pressing the skin with a finger a flush of blood returns rapidly. This can sometimes be difficult to see in pigmented skin and if in doubt the quality of colour of the bleeding following a small pin-prick with a hypodermic needle can be assessed. Although it would seem obvious if skin is missing this is frequently not the case because of the elasticity of the skin, and this must be allowed for during the examination.

Tendons

It is sometimes possible to see the ends of divided tendons, particularly of the extensors on the back of the hand. However, the primary examination of tendon injury is by testing for movement. The profundus tendon is attached to the distal phalanx and, therefore, lack of flexion of the distal interphalangeal joint indicates division of this tendon. Testing for superficialis damage is more difficult as it can be masked by a working profundus tendon. The superficialis tendons of injured fingers should be examined in a position which prevents the profundus tendon from bending the finger. Occasionally tendon ruptures can occur as a closed injury, but with the exception of a mallet finger, where the extensor tendon to the distal phalanx is injured, these are a rare occurrence.

Nerves

Damage to nerves can be the most difficult to diagnose by inexperienced doctors. This is particularly true in children, drunks and patients who are being uncooperative. The best method of examination in normal people is by lightly stroking each side of each finger and asking the question "Does that feel normal?". It is important not to ask the question "Can you feel that?", as the answer will often be yes because the feeling is being picked up by the nerve on the other side of the finger.

It is important to know the distribution of the main nerves in the hand, so that the findings

can be correlated with the injury. When nerve damage is suspected at the wrist, median nerve involvement can be tested by the function of the abductor pollicis brevis muscle, and ulnar nerve involvement can be tested by the functions of the interosseus muscles.

Blood vessels

If the injured hand is still bleeding it is absolutely essential that an arterial clamp is not put on blindly. This can severely damage other structures and, in particular, nearby nerves. First aid is always by pressure and elevation to control bleeding and then exploration comes later under a tourniquet.

Damage to vessels can be diagnosed by the survival or lack of survival of distal circulation. Guides to this are colour, capillary return, pulse or, in the fingers, lack of the normal fullness of the pulps. Venous bleeding is normally obvious and not of major significance. If a digit or part of a hand has no circulation then it is obviously an urgent case to try to restore circulation. In an area without microsurgical skills, the only thing that can sometimes be done for a finger without circulation is to reduce fractures, dislocations etc and hence unkink an artery which is blocked for mechanical reasons. If the whole hand is without circulation because of an injury at the wrist then one of the vessels in the wrist can be repaired as a matter of urgency by normal careful suturing using nonabsorbable 6/0 sutures.

Bones

Injuries to the bones of the hand can either be closed or compound. On examination, pain and deformity are normally obvious and an X-ray is by far the most useful diagnostic tool. X-rays should always be taken in two dimensions to get a full indication of the extent of the damage. As with arterial damage, severe deformity or dislocation should be straightened immediately to relieve further pain and damage (1).

Special investigations

The use of an X-ray has already been discussed. In the acute stages of hand injury there is no other use for special investigations although very rarely a pulse oximeter applied to a finger will tell if there is sufficient arterial blood supply available.

Treatment

The treatment of major hand injuries is a very specialized branch of surgery (2). If therefore the doctor first seeing the hand injury has no or little experience and there is available an experienced surgeon within a reasonable time, then it has been shown that suture of the wounds only, and transfer of the patient for such help within two to three days gives improved results. Before suturing, cleaning of the wound should be done.

Before treatment commences it is important to know the age, occupation, hobbies and dominant hand of the patient. These four factors can considerably influence what is the best treatment for the same injury. An example of this is that a person using a typewriter would have a completely different operation from a person working as a labourer or in the fields. It must always be remembered that the more complicated the treatment, the longer is going to be the time that the person is going to be off work or not carrying out his normal functions and the greater will be the demand for specialists, physiotherapy, splinting etc. After the decision to operate, the next decision is whether this should be done under a general anaesthetic or a local anaesthetic. Normally a general anaesthetic or brachial block is preferred for major injuries where a tourniquet is essential. The operation is in five parts: anaesthesia, debridement, treatment, closure and splinting, and dressing.

Anaesthesia

For finger injuries a local anaesthetic ring block is appropriate and a small tourniquet made out of rubber tube or a finger from a surgical glove is very adequate.

Debridement

Debridement means removal of all foreign and dead tissue. Only when an adequate debridement is carried out will results be ideal. With inexperienced surgeons the debridement is the part of the operation that is often the least well done. Under the anaesthetic and with a tourniquet inflated the exact extent of the injuries can be confirmed and the dead tissue all excised.

Treatment plan

Following debridement the treatment plan has to be decided. The normal order of treatment is fixation of the bones, repair of tendons, repair of nerves, and closure of the wound. If a fracture is unstable or involves a joint surface then internal fixation is recommended, which can be done either by interosseus dental wire or by K wires. A dirty wound, providing it is adequately debrided, is not a contraindication to putting metal into the bones of a hand as would be the case with a leg or arm.

Tendons

Extensor tendon repair is relatively simple and can be carried out using a nonabsorbable suture usually 3.0 or 4.0 in size. A simple figure of eight or square suture is all that is necessary to give end to end apposition.

The repair of flexor tendons is very much more difficult particularly when they are in zone two, i.e. in the proximal half of the fingers or distal palm. Even in the best hand units these injuries can do poorly and the chances of a successful repair in inexperienced hands must always be weighed against the option of fusing joints which may give a more functional result. If joints are being fused then the angle for the fusion of any joint can be found by putting one's own hand at rest in the position of function.

There are many different forms of repair of flexor tendons. The best results are given by either the Kleinert or Bunnell methods (Figures 1a and 1b) but these need highly skilled physiotherapy and adequate follow-up. There are two simple methods which have been found to work adequately in nonspecialist hand centres. These are the Becker method and the running epitendinous method (Figures 2a and 2b).

There has been, in the past, a debate as to whether one or two tendons should be repaired. In general if there is a sharp cut then both tendons should be repaired and only if there is considerable crushing injury with tatty tendons should a tendon be discarded. If only one tendon is repaired then, of course, the profundus tendon running to the terminal phalanx is the preferred option.

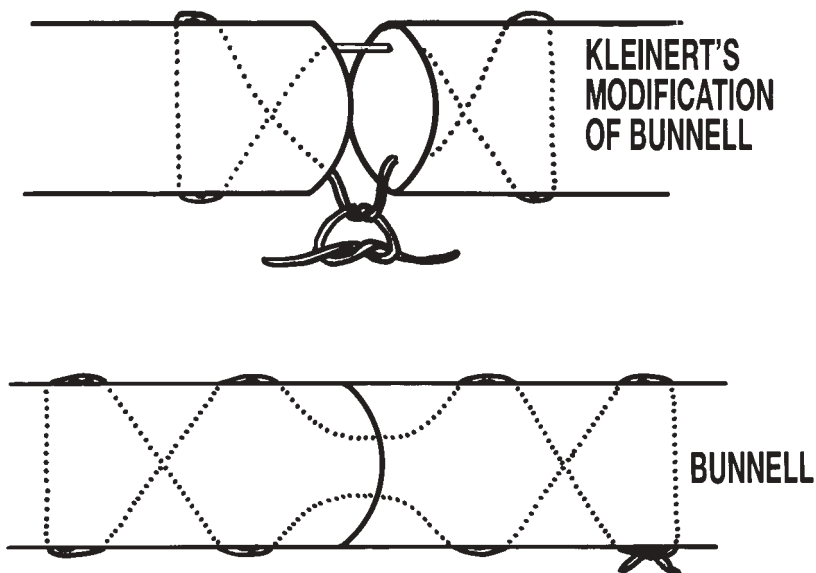


Figure 1. Methods for the repair of flexor tendons in the hand: best methods for use in specialized centres.
1a. Kleinert method (Kleinert's modification of Bunnell's method).
1b. Bunnell method.

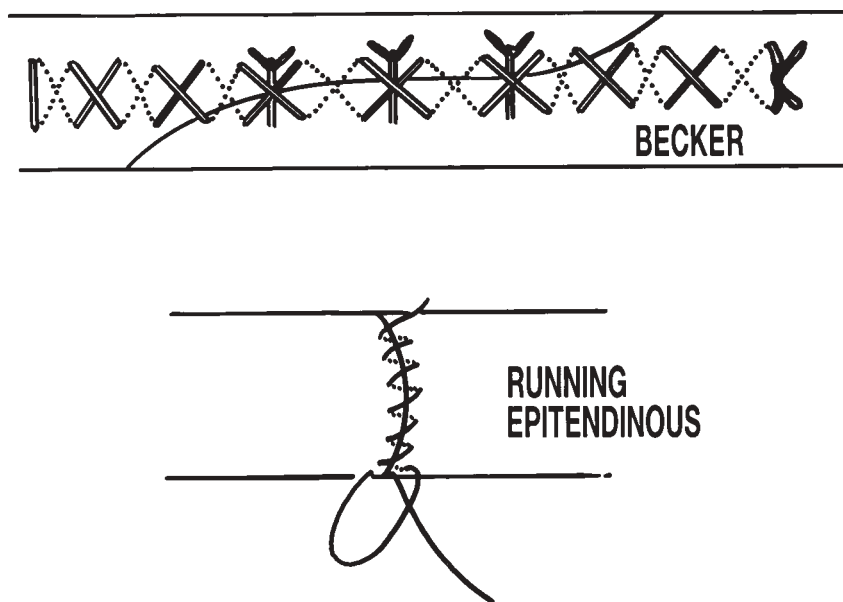


Figure 2. Methods for the repair of flexor tendons in the hand: simple methods for use in nonspecialist hand centres.
2a. Becker method.
2b. Running epitendinous method.

Nerves

Primary nerve repair almost always gives better results than secondary nerve repair. Although less than ideal, suturing of the nerves with a 6.0 nylon suture requiring only one or two sutures will give a far better result than not repairing them at all. In the wrist the median and ulnar nerves may require four or five sutures and as much care as possible should be taken to orientate them into their original positions so that the motor and sensory components on each side have a better chance of joining.

Skin

The options for closing skin wounds on the hand are exactly the same as anywhere else on the body. In order of preference these are direct closure, skin graft or skin flap. Where direct closure is not possible then some other form of skin cover is essential. Without skin cover then improper healing or no healing will happen and late contractures will occur. With practice and an adequate graft knife split skin grafts can be taken from the forearm or thigh as appropriate and applied to the wounds providing that one is not trying to graft on to cortical bone, cartilage or tendon. None of these structures will take a skin graft because of inadequate blood supply. If a proper split skin graft knife is not available then reasonable quantities of skin can be taken with a large number 23 blade. This process is made easier if subcutaneous local anaesthetic is injected to make the donor area of skin firm. Dressing of a donor site is the same as a partial thickness burn, which is discussed later.

The alternative to a split skin graft is to use a full thickness graft, which for small defects can be taken from the wrist crease and for large defects from the groin. Full thickness grafts have the advantage that they do not need the special equipment of a graft knife but the disadvantage is that they are less likely to take. However, they can be very useful particularly on the palm of the hand as they do not subsequently contract. If a full thickness graft is being taken then it should be completely defatted on the under surface before being sutured neatly into place.

When one is considering a skin graft the surgeon must ask himself whether he has the knowledge and the experience to carry out a

flap. A skin flap that fails not only fails to give cover to the affected finger but also leaves a defect on the area from where the flap is taken. If it is thought that it is not possible to carry out a flap then amputation may be a preferred option. The commonest flap used on a hand is a cross-finger flap to give cover to tendon or bones of an adjacent finger. The flap is raised on the back of the finger leaving the paratenon of the extensor tendon in place; this is essential, or the skin graft that is necessary to cover the defect will not take. The flap is sutured into its new position and the defect is skin grafted. The flap is divided from its donor site three weeks later. There are a variety of other flaps described of which the most useful flap for major injuries, particularly of the back of the hand, is the groin flap. Again separation is three weeks later.

Dressings and splintage

The purpose of dressings is to keep the wound clean and dry, and the purpose of splintage is to protect the repairs of bones, tendons etc until reasonable healing has occurred. Where possible a hand should be put into the position of prospective function (Figure 3c). The metacarpophalangeal (MCP) joints should always be in 90 degrees flexion so that the ligaments are at full stretch and therefore less likely to shorten if they should fibrose. The interphalangeal joints should be immobilized in extension. In this position all the structures around the interphalangeal joints are maximally stretched and full movement should be regained. It should be noted that all the joints are in the exact opposite of the position obtained in a claw hand. Exception to dressing in this position should only be made for a specific purpose, e.g. if an extensor tendon is repaired then the MCP joint is kept straight. Similarly if a flexor tendon has been repaired then the wrist is flexed rather than extended. Dressing is normally by gauze, padding and crepe bandage and splintage is very adequately carried out by ordinary plaster of Paris.

Postoperative treatment

When the tourniquet has been released and the patient recovered from the anaesthetic then the hand should be elevated as much as possible to reduce swelling and discomfort. This is best done in some form of roller towel or sling whilst the patient is in bed on the ward

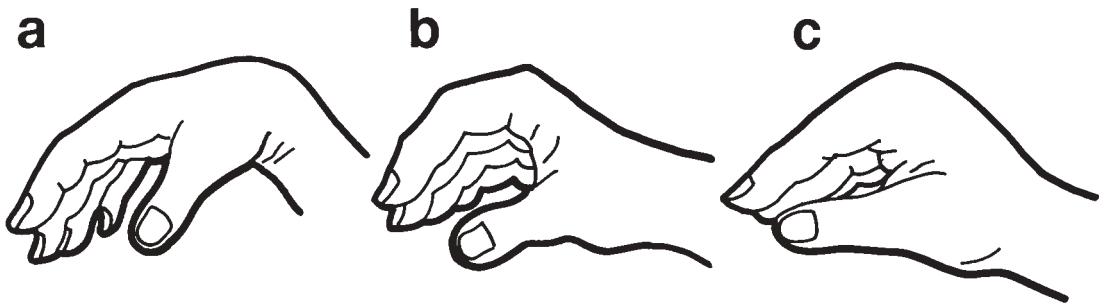


Figure 3. Hand positions. 3a. Hand in relaxed position. 3b. Position of function. 3c. Position of hand in a splint.

and by a high triangular sling when the patient is ambulant. Unless there are special circumstances it is normally best to keep the operative dressing in place for the whole of the two weeks before the first dressing. At the first dressing two weeks later the skin sutures should be removed. Although skin, nerves and vessels will heal in two weeks, extensor tendons take between three and four weeks and flexor tendons between four and six weeks to heal; bones take a minimum of eight weeks. In these situations splintage or support should be maintained for this period of time.

Where physiotherapy and occupational therapy are available they are extremely useful in the subsequent treatment of hand injuries. Where they are not available then the treatment is the responsibility of the surgeon carrying out the operation. The final goal is to obtain a good range of movement with adequate grip and power. If a normal range of active movement has not been obtained six to eight weeks after tendon repairs then stretching of the joints is necessary by active splinting.

It must be remembered that repaired nerves do not grow at all for one month and then grow at approximately one inch a month (1 mm per day). Warning about this should be given to the patient and early return of sensation should not be expected either by the surgeon or the patient. After return of sensation, improvement will occur for approximately one year.

Complications

All surgical procedures may have complications and all surgeons have to deal with complications. When they occur they should be

discussed with the patient and treated aggressively.

Infection

Infected wounds should be treated on the hand as elsewhere. If pus is present then it must be drained. If there is spreading infection then aggressive antibiotic therapy is necessary.

Skin loss

Skin loss can occur because of inadequate debridement, infection or insufficient blood supply. If skin loss is apparent after the first wound dressing then the dead eschar may either be excised and the defect grafted or a small area can be treated with dressings until healing has occurred. However, if bone or tendon is exposed beneath the area of dead skin then aggressive treatment is necessary to preserve the underlying structures.

Tendons

Two complications can occur with tendons: either they can rupture or they can become stuck. If tendon rupture has occurred then secondary suture is possible but should be left to the realm of the expert as the results are relatively poor. However, it is better to carry out an early secondary tendon repair than a late tendon graft, where the results are appalling without the very special facilities of a hand unit.

If tendons have become stuck and remain stuck after adequate physiotherapy then a tenolysis can be carried out. However, to make a tenolysis valuable good passive movement of the joints affected is essential before the operation.

Nerves

If protective sensation, i.e. the ability to tell the difference between sharp and blunt, has not returned after a suitable length of time, then reexploration of the nerve is indicated. Secondary nerve repair and nerve grafting have a relatively good outlook compared to secondary tendon work. If a nerve graft is needed then the median or lateral antebrachial cutaneous nerves of the forearm are the appropriate size for a digital nerve and a sural nerve in two or three cables is suitable for the median or ulnar nerve.

Special problems

Fingertip injuries

By far the commonest injury seen in a hand unit is the injury to a fingertip. These are often extremely poorly treated. It has been well shown in children up to the age of twelve that the best treatment is conservative by weekly dressings until healing has occurred. This gives the best functional and cosmetic results to an injured fingertip in that age group. In an adult a decision has to be made between terminalizing the finger and carrying out some form of repair to keep as much length of the digit as is possible. In general terms the thumb should be kept as long as possible but in a workman terminalization of fingers is frequently the treatment of choice. It means that two weeks after removal of the sutures he is back to work with a good functioning and sensate finger.

Burns of the hand

With a few special differences the treatment of burns to the hand is similar to burns treatment on other parts of the body. It is essential, therefore, to decide whether the burn is partial thickness and will heal itself with adequate dressings in ten days, or is a deep burn and requires some form of operative treatment. The major difference of partial thickness burns is that wherever possible adequate mobility should be maintained. This means that the blister should first be removed. An excellent way of maintaining mobility is by putting the hand in a plastic bag with a small amount of Flamazine or other antiseptic cream. The bag collects a lot of fluid from the hand and needs changing daily for the first few days. Full healing will be expected to occur in ten

days. For smaller areas on the hand treatment with an antiseptic paraffin gauze, e.g. Bactigras, is to be preferred but Betadine and gauze is very adequate. As with all burns the dressing should be changed and the burn reassessed on the first or second day after the injury. If it is still partial thickness it should be redressed and then the dressing left intact for a further ten days until full healing has occurred. Daily dressings are contraindicated as any new epithelium forming is pulled off, and they are also painful.

The next depth of burn is the deep dermal burn which, if it is possible, is best treated by a tangential excision and split skin graft. This is a difficult technique to learn from the books and a demonstration is the best method. However, a good tangential excision and split skin graft will give a fully functioning hand to what would otherwise become very scarred if granulation is allowed to occur and is treated later by a split skin graft. Basically the technique is by using a split graft knife to shave off the outer layers of dead skin until bleeding is obtained and then a thin split skin graft is applied to this. The dressing is held in place with the hand in the position of prospective function (Figure 3c) for ten days before inspection.

Full thickness burns of the hand do extremely badly. Where possible they are treated by early surgery of excision and either full thickness grafting, particularly on the palm, or by flap repair.

The important principle is that early aggressive treatment leads to less scarring and better function. If there is a considerable extent of burn of a patient then the hands and face are the areas which get priority for early surgery.

Bites

Bite wounds can be disastrous and they are a major concern for surgeons. Depending on the inoculum, complications such as stiffness, chronic osteomyelitis, necrotizing fasciitis, amputation, septicaemia or even death can occur.

Bites can be caused by dogs, cats and many venomous creatures such as snakes and spiders. In Papua New Guinea the commonest cause of bite injury is human (3). Over a period of six

years (1986-1992), Ollapallil et al. accumulated a series of 95 human bite patients; in 72 cases there were injuries involving the fingers (3).

Dog bites are less likely to become infected unless there is a major soft tissue injury or joint involvement. Clinically the hand reveals puncture wound marks with erythema and cellulitis with or without purulent drainage. Cultures often grow *Streptococcus pyogenes*, *Staphylococcus aureus* and *Pasteurella multocida*.

Human bites deserve special consideration because they can cause severe morbidity. The adult mouth contains anaerobes which can cause severe infections. In comparison, the bites of children, whose oral microflora is more aerobic in nature, are relatively innocuous. Cultures usually grow *Staphylococcus aureus*, alpha and beta haemolytic *Streptococcus pyogenes* and occasionally *Eikenella corrodens* (4). The wounds are often over metacarpophalangeal joints and communicate with them, especially when a punch has occurred.

Thorough irrigation and debridement with

exploration for possible metacarpophalangeal joint involvement is mandatory. No bite should be sutured primarily or closed primarily. Antibiotics are used even for superficial wounds. Flucloxacillin or a third-generation cephalosporin is recommended until culture reports come back.

Postoperatively rest and elevation are very important and the wound should be inspected regularly for induration, swelling and spreading cellulitis at an early stage. Signs of spreading infection are an indication for more radical treatment: antibiotic change, surgical intervention, or both.

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