



PART I

of the Injured Hand

This is the first of nine articles on the initial management of upper extremity injuries. The purpose of this series is to acquaint emergency medical personnel, emergency department physicians, nurses, and others interested in the care of these types of injuries with the techniques of management of these patients, starting at the scene of the accident.

The immediate and early care of a patient with an upper extremity injury can often make the difference between a patient who returns to work in optimal time or a patient who has prolonged disability and undue permanent impairment of function.

Site of Injury: Initial Care. An old but appropriate dictum in caring for trauma patients is "do no harm." Lack of care, delay of care, or maltreatment can result in further damage to an injured upper extremity. At the site of accident or point of initial care wounds should be covered with clean, or preferably, sterile dressings, and the extremity (or at least the injured part) appropriately immobilized. The more extensive the injury the greater the need to immobilize injured parts. This often can be achieved by basic techniques and with minimal equipment. Simple splints are usually sufficient to place tissues at rest and to restore parts to an anatomical or near anatomical position.

In automobile and other vehicle accidents the proper removal of accident victims can reduce the hazard of further injury. When fractures of the arm and forearm are suspected, splinting should be accomplished before the victim is removed. This can be achieved by strapping the entire upper extremity next to the body.

Splints should be continued during transportation to relieve pain and prevent further damage. Intravenous fluids may be given to maintain hydration and antibiotics administered to treat or prevent infection. The use of pain-relieving drugs should be avoided as long as possible—preferably until the patient has been evaluated by the staff who will render definitive care. Exceptions to this are when there is a severe injury and several hours will pass before reaching a facility

with available and appropriate personnel. Patients with injuries that will require surgical care should not be fed, but hydration should be maintained by intravenous replacement with lactated Ringer's solution, 500 ml/hr.

When bacterial contamination presents a potential problem or when there is extensive tissue damage, antibiotics (Keflin, 1 gram per 6 hours) should be administered prior to and during transport. Before a patient is referred for definitive care of an upper extremity injury, arrangements should be made with the surgical staff who will care for the patient. This will insure the availability of appropriate personnel for the anticipated procedures. This is especially important in amputations where replantation is contemplated. Patients and families should not be promised that a particular procedure or method of care will be performed. This often cannot be determined until a detailed examination is completed. In the case of amputations, this may mean the evaluation of small vessels under an operating microscope.

It is a rare circumstance when bleeding from open wounds and amputation stumps cannot be controlled with pressure dressings. The use of clamps and other instruments should be avoided in open wounds to prevent unnecessary damage to nerves, tendons and vessels that may not already be traumatized. Vessels in open amputation stumps will usually retract, and bleeding is rarely a problem. Dressings with mild pressure will usually stop bleeding from vessels that do

not retract or seal. If the patient has an amputation and replantation is being considered, the amputated part should be placed in a moistened cloth, preferably cotton gauze sponges moistened with saline. The wrapped part should be sealed in a plastic bag and the bag placed on ice (Figure 1). Amputated parts should never be warmed or placed directly on ice, nor should dry ice be used. The survival of amputated parts can be significantly improved with appropriate pre-replantation hypothermia.

The Emergency Department: Assessment and Diagnosis. Proper diagnosis of the extent of an upper extremity injury is impossible without *complete assessment* of the injured part. This assessment and diagnosis is a prerequisite for appropriate treatment.

Except in circumstances where the extent of an injury is obviously limited to specific structures, all tissues should be considered and evaluated. The skin and subcutaneous tissue can usually be considered as a unit. Avulsion of skin suggests deeper tissue damage and the possibility of vascular injury. A major problem in avulsion injuries is inadequate venous drainage. Avulsion injuries with the flap attached distally are more likely to have a problem with venous drainage than when there is proximal attachment. With complete avulsion of skin and subcutaneous tissue, wound closure is often best accomplished by removing the subcutaneous tissue and reapplying the skin as a graft.

Vascular injury may occur in relatively small and often innocuous-appearing



Figure 1: This amputated thumb has been properly transported. It was placed in saline-moistened gauze and sealed in a plastic bag. The bag was cooled on ice, and the amputated part was transported with the patient.

wounds. Vascular injuries should be suspected in all lacerations near an artery or vein and in avulsion injuries, where vessels may be torn at a distance from the open wound. Complete arterial or venous interruption to a part may be difficult to diagnose immediately after injury, and

early care and detailed examination is important. In the case of partial interruption of the arterial supply or venous drainage to a part, the subsequent vascular insufficiency may not be apparent for days or weeks until activity or weather changes produce symptoms.

Proper treatment of a vascular injury is dependent upon a correct diagnosis. It is difficult and often impossible to make a correct diagnosis of a vascular injury without exploring a wound completely. This cannot be achieved without adequate instruments (these include small tissue forceps, hemostats and vascular clamps) and anesthesia.

Injuries to tendon and peripheral nerves in the upper extremity should be suspected in any wound which is not confined to the cutaneous tissues. Sensory and motor examinations distal to the site of injury are helpful but are often difficult in children and uncooperative patients. If the examination cannot be properly performed or is inconclusive, wound exploration in the operating room may be necessary.

Bone and joint injury should be suspected in vehicle accidents as well as crushing and avulsion injuries. Certain obvious angulatory and rotational deformities are indicative of fractures and dislocations; however, confirmation by radio-

graphs is necessary for precise diagnosis. Multiple views may be required to demonstrate certain fractures or joint injuries.

The possibility of foreign material within the hand must be evaluated. In addition, many injuries include thermal or chemical damage; the circumstances of these injuries must be carefully documented. After all the tissues have been evaluated and the complete diagnosis made, a plan of treatment can be outlined.

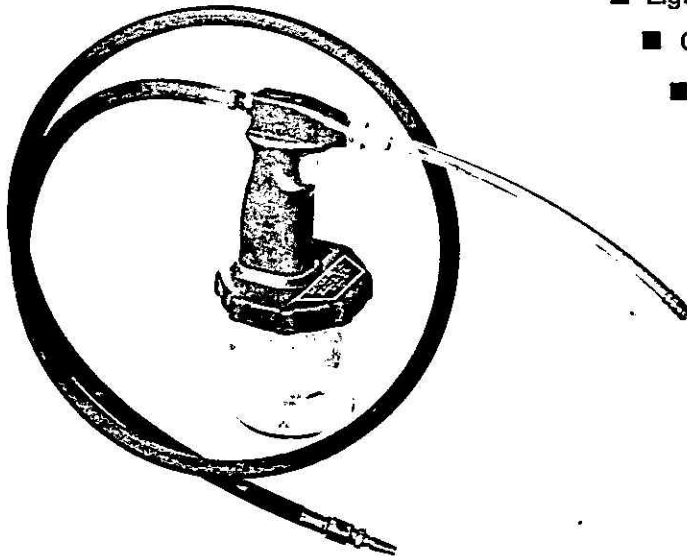
The Emergency Department: Plan of Treatment. The initial assessment in the emergency department determines the need for additional fluids, antibiotics, tetanus prophylaxis, or other resuscitation measures.

At the facility where definitive care can be rendered, plans should be made to:

- Replant amputated parts when indicated;
- Revascularize by arterial and venous repair important structures such as digits and large segments of tissue;
- Debride devitalized tissue;
- Reduce and hold fractures and dislocation;
- Close wounds by suture, flaps or grafts as indicated;
- Continue or start anti-infective measures (antibiotics and tetanus prophylaxis);
- Repair tendons and nerves.

The repair of tendons should be per-

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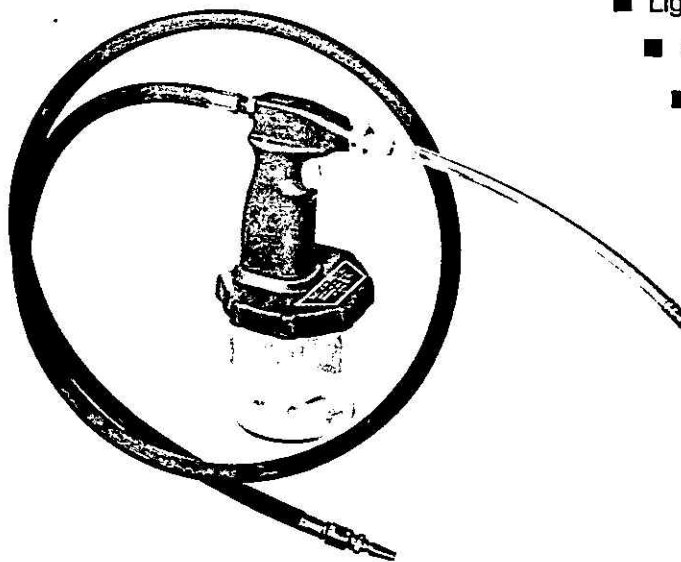
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formed as soon as possible after injury unless there is contamination or tissue damage that precludes wound closure. By opening tissue planes in contaminated wounds the hazard of wound sepsis is increased.

Peripheral nerves should be repaired primarily or soon after injury unless wound conditions are unfavorable. In extensive injuries where tissue healing will be slow and scar formation unavoidable the primary repair of nerves will allow nerve regeneration to proceed along with the healing of other tissues.

Many upper extremity injuries are complex and require management by a surgeon capable of repairing all tissues in a coordinated fashion. He must also be able to undertake the long-term reconstructive surgery and rehabilitation of these patients.

Long-Term Goals: Rehabilitation. Rehabilitation or return to work should be considered from the time of injury until this goal has been achieved. Whenever possible patients should have surgical procedures on the upper extremity without formal hospital admission.

Patients should be encouraged and instructed to return to work, using the non-injured extremity fully, and the injured extremity as much as possible within the limitations of the healing process. Employers and insurance carriers must be educated to the value of organizing modified employment for the injured. Change of occupation or duties should be allowed and encouraged. An employee will more likely return to his regular work or occupation if he has been at his place of employment in a productive capacity during a period of injury.

In the series to be published, the methods for precise diagnosis of individual tissue injuries and the methods for treating those injuries will be detailed. The next article will concern cutaneous injuries including lacerations, skin loss and fingertip trauma. This is followed by a discussion of penetrating wounds with particular reference to foreign bodies and high-pressure injection injuries. Three separate articles will deal with tendon injuries, nerve injuries, and fractures and dislocations. Hand infections are discussed in the sixth article, followed by a paper devoted to thermal and chemical injuries. The final article will describe the management of mutilating hand injuries and includes a lengthy discussion of the new and exciting field of replantation.

As these articles are read, the basic goals of hand injury care should always be borne in mind: *proper emergency care, accurate diagnosis, appropriate surgery, and coordinated rehabilitation.*

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