

Approach to mutilating hand injuries

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ABSTRACT

Mutilating hand injuries are a challenge to manage due to the complex nature of the injury and the variety of structures that are damaged. Good results can only be achieved by careful planning and meticulous management. The ultimate desired outcome is achievement of a normal function of the hand and upper limb. Mutilating hand injuries occur in a variety of settings and the extent of injury and the prognosis varies according to the aetiology of the injury. The management approach focuses on the attention to the repair and reconstruction of individual parts of the hand including the bones, vessels, nerves, tendons and skin cover. Consistent results can be achieved by early aggressive management of damaged structures followed by regular physiotherapy which are the keystones for restoration of form and function of the mutilated hand.

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1. Introduction

The hand is one of the most used parts of the body other than the feet. It undergoes maximum physical use at any time and is hence subject to trauma more than any other part of the body. It is endowed with special properties of the skin which grant added protection from physical, chemical and environmental agents. A mutilating injury to the hand occurs as a result of transmission of high-energy forces to the hand which are often seen in industrial accidents, agricultural injuries commonly by thresher machine, household injuries often by kitchen equipment like entrapment in mixer grinder, gunshot accidents or road traffic accidents in which the hand may be run over by an automobile.¹ The hand can have any spectrum of injury ranging from clean cut lacerations or amputations to crush injury.² Crush injuries by virtue of their pathology cause more damage to the hand than clean cut injuries. The tissues are traumatised, oedematous and have a poorer prognosis and longer healing period than clean cut injuries which heal faster with better recovery of functions. The third spectrum are the avulsion injuries which occur due to industrial accidents, agricultural equipment accidents and commonly by machine belts. These type of injuries lead to severe scarring and often poor function. The

aim of management is to restore sufficient function making the patient return to work early.³ This article highlights the approach to the management of a mutilated hand.

2. What is a mutilating hand injury

There are several definitions for mutilating hand injury. The word mutilating comes from Latin which means “to cut or lop off”. This term hence designates an injury to the hand with significant loss of tissue, function and aesthesia. It is also important to understand the ‘acceptable hand concept’.⁴ An acceptable hand is defined as one which has three fingers of near normal length with near normal PIP joint motion and good sensibility along with a functioning thumb. All those hand injuries which make the hand not acceptable therefore can be categorised into mutilating hand injuries.

3. Assessment and initial decision making

Assessment of the patient with a mutilating hand injury begins with the ATLS workup of airway, breathing and circulation. Successful management of a mutilating hand injury depends largely upon the accurate initial assessment of the injured hand.

a) Obtaining a patient history: The patient history can be the most important criteria in arriving at an accurate diagnosis. The history should be detailed as regards the patients current

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complaint and also other elements like patient's demographics, medical history, allergies, hand dominance, medications and socioeconomic status should also be recorded. The mechanism of injury is probably the most important as it points to the severity of the injury. The time of injury and the interval between the injury and the patient's presentation should be determined. Greater the interval the poorer is the prognosis in these cases (Fig. 1).

- b) Physical examination of the hand: Accurate diagnosis of hand injuries depends on a careful physical examination. The examination should start from the neck and shoulder region and then proceed distally towards the hand. The following eight elements inspection, palpation, measurement of range of motion, stability assessment, musculotendinous assessment, nerve assessment, vascular assessment and specific tests should be performed in all the cases in order to make a complete assessment. The inspection should include examination for discoloration, deformity, trophic changes, swelling, skin creases and amputated parts if any. The palpation should identify abnormal skin temperature, areas of tenderness, crepitus, effusion and should confirm the findings of inspection. The range of motion assessment should be done for both contralateral healthy limb and the injured limb. Stability assessment is important for the joints near the injured area. This should be followed by musculotendinous assessment which includes examination for posture, motion and power of individual muscles of the hand. It may not be possible to examine the injured muscles due to pain and swelling but it is important to have a baseline record of the injury status at the time of presentation. This should be followed by nerve assessment including both motor and sensory function. Vascular assessment of the injured hand is critical for determining the treatment approach and also for the prognosis and includes assessment of both arterial and venous insufficiency. The vascular assessment is done according to the colour, capillary refill, pressure, temperature and palpable pulse of the injured part. The lacerations in the fingers need assessment regarding the depth, associated tendon and bony injury (Fig. 2). The Allen's test is helpful for determining if there is an intact circulatory connection between the radial and ulnar arteries in the hand. If there are amputated parts then they should also be examined and preserved properly.⁵
- c) Emergency room investigative workup: At this time blood work of the patient should be sent. Radiographs of the hand, Doppler examination and angiography may also be used for assessment.



Fig. 1. Showing a mutilated hand following a cracker blast injury with amputation of index finger and partial loss of middle finger, ring finger, little finger and thumb tip with unhealthy raw areas.



Fig. 2. A 32-year-old male suffered a sharp laceration across the palm with incomplete amputation of the thumb at the level of base of proximal phalanx.

Arteriography in the mutilated hand may delay revascularisation and should be used in selective cases.

4. Priorities

The priorities in the management are to salvage the hand, restore maximum function and cosmesis and to return the patient to normal life and functioning status. A stable and opposable thumb of adequate length is recommended.⁶ The patient should have atleast one^{7,8} and preferable two digits for pinch with the thumb.^{9,10} The digits should have adequate length and mobility to reach the thumb. The reconstructed hand should have good sensation and good skin cover.

5. Management

The following are the surgical treatment modalities for management of the mutilated hand.

5.1. Debridement

The first surgical step in the management of mutilated hand is surgical debridement. It helps in eliminating all non-viable tissues and provides an optimum environment for wound healing. It is important to recognise devitalised tissues and one should be frugal in debridement as often some apparently non-viable tissues may regain vascularity in the next 24–48 h. The debridement should preferably be performed under loupe or operating microscope and the end point of debridement is visualisation of bleeding tissue. The soft tissue components of skin, subcutaneous tissue and muscles should be debrided until bleeding is observed. Slough and grossly non-vital tissues which have turned black in colour should be excised. Small bone fragments which have become detached from the soft tissues should be debrided. Contused and cut nerves should be debrided till healthy fascicles are visible. Once debridement has been done the wound should be copiously irrigated and washed with normal saline. Further debridements after a gap of 24–48 h can be done if the wound does not show healthy and healing margins.¹¹

5.2. Provisional revascularisation

Provisional revascularisation is a method to temporarily provide arterial blood to the amputated part before the processes of debridement and skeletal stabilisation. It is meant to offset the

delay till the time vessel continuity is restored between the amputated part and the injured stump. Many different shunts are available such as Javid, Ishihara or other segments having plastic tubing, another option is to rapidly perform reversed vein grafting between the arterial ends to re-establish arterial inflow.

5.3. Skeletal stabilisation

Skeletal stabilisation is one of the key components of surgical treatment of the mutilated hand. Skeletal stabilisation allows proper alignment of the hand, helps in restoring vascular continuity and aids in reduction of oedema and eventual tissue healing. Hand fractures can be fixed using external fixators which are the choice of treatment especially in contaminated situations. Internal fixation using Kirshner wires or even miniplating is a good method and it avoids the risk of neurovascular injury during pin placement, does not restrict the circumferential access to the extremity and does not limit rehabilitation (Fig. 3). Treatment of bone defects should be accomplished using primary bone grafting which is suitable for defects up to 4 cm. For larger defects, vascularised bone grafts should be considered. The goal of skeletal fixation is to achieve stable anatomical alignment and fixation.

5.4. Vascular reconstruction

Restoration of vascular supply is the definitive step in the management of the mutilated hand. The traumatised vessels should be debrided to obtain healthy appearing vessels in preparation for microvascular anastomosis. Reversed vein graft is a good option in situations where the artery has to be resected due to intimal injury or damage to the media. The superficial palmar arch should be reconstructed using branched vein grafts. Flow through flaps should also be considered in situations where there are dual demand of both coverage and vascular repair.

5.5. Musculotendinous reconstruction

Tendons are frequently damaged in the mutilated hand and need immediate repair to restore form and function of the hand. In clean cut injuries primary tendon repair is the goal whereas in crush injury, primary repair of the tendon is deferred. Immediate tendon repair should be attempted wherever feasible and use of tendon grafts from palmaris, plantaris or local tendons should be done. Tendon transfers are also indicated for muscle deficits that cannot recover. These transfers are performed as a primary procedure (Fig. 4).



Fig. 3. A fracture of the proximal phalanx of the middle finger being treated by open reduction and internal fixation by miniplating.

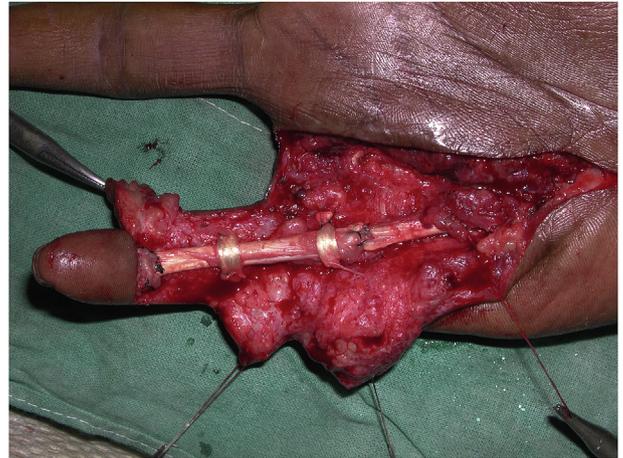


Fig. 4. A defect of the long flexor in the zone II region being reconstructed by a tendon graft in the little finger.

5.6. Reconstruction of nerves

The nerve injury is important to manage as it decides the ultimate prognosis and recovery.^{11,12} The treatment of nerve injury is dependent upon the type of injury. Contused nerves are left intact in that they are likely to recover with time. Lacerated nerves should be debrided to healthy nerves showing normal fascicular structure and these ends should be repaired without tension. Mobilisation can be done for a distance of not more than 2 cm to allow repair but nerve grafting is preferable for larger defects to avoid tension. For contaminated wounds, staged nerve repair is recommended. The nerve ends are tagged with fine non-absorbable suture and are left for later repair at a later stage. The common donor nerves are sural, saphenous, sensory branch of the radial nerve, medial or lateral antebrachial cutaneous nerves and the posterior interosseous nerve.

5.7. Skin and soft tissue reconstruction

Once all the damaged vital structures have been repaired and reconstructed then the last priority is to provide a stable and definitive skin cover over the hand if it is deficient after injury. The options for skin coverage vary from the simplistic split-thickness skin graft to flap cover which can be both pedicled and free (Fig. 5). The skin cover should provide a gliding surface for the underlying tendons to move along with the movements of the



Fig. 5. A compound defect in the mid palm and distal wrist resurfaced by a free radial artery forearm flap.

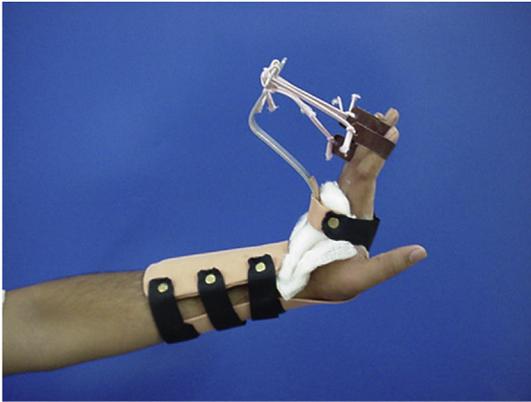


Fig. 6. Early physiotherapy and rehabilitation helps in faster recovery.

hand. Flaps are recommended when the tendons or underlying vasculature is exposed. The various flap options are radial forearm flap, lateral arm flap and the groin flap. The various flaps used as free flaps include gracilis, rectus abdominis, latissimus dorsi or serratus anterior.

6. Postoperative management

The postoperative management is equally important as the intra-operative management. Splinting the hand is very crucial to regain optimum joint mobility, reduce oedema and prevent contractures. Hand elevation is necessary to reduce oedema and it also helps in reducing pain. In addition to this, maintaining optimum hydration is required to have an adequate urine output. Regular dressing evaluations for healing of grafts and flaps is required to achieve consistent results. Early and proactive physiotherapy is important to quickly regain the function and range of motion of the hand. It helps in reducing oedema and stiffness of the hand after injury (Fig. 6).

7. Conclusion

Management of the mutilated hand is complex and demands multidisciplinary team approach, expertise and immediate intervention. The primary determinants of the quality of eventual function are the severity of nerve injury and the need for

emergency fasciotomy. Early and aggressive combined surgical treatment and rehabilitation efforts have shown consistently good results in the management of mutilated hand.

Author's contribution

Dr. Rajiv Agarwal - Conceptualization; Formal analysis; Investigation; Methodology; Roles/Writing - original draft; Writing - review & editing.

Dr. Devisha Agarwal- Formal analysis; Investigation; Methodology; review & editing.

Dr. Mallika Agarwal- Formal analysis; Investigation; Methodology; review & editing.

Conflicts of interest-

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