Skeletal Fixation in a Mutilated Hand

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KEYWORDS

• Hand fracture • Mutilating injury • Wrist arthrodesis • Kirschner wire • Bone loss

KEY POINTS

- Hand fracture fixation in mutilating injuries is characterized by multiple challenges due to possible skeletal disorganization and concomitant severe injury of soft tissue structures.
- The effects of skeletal disruption are best analyzed as divided into specific locales in the hand: radial, ulnar, proximal, and distal. Functional consequences of injuries in each of these regions is discussed.
- Preventing contracture of the first web and extension contracture of the finger MCP joints is of paramount importance. Measures like prophylactic first web pinning, positioning during flap inset are elaborated.
- Given the myriad combinations of skeletal and soft tissue injuries possible, pointers like "make the hand look like a hand" or "more mutilation, more conservation" help simplify management.
- Although a variety of implants are now in vogue, K-wire fixation has stood the test of time and is especially useful in multiple fracture situations. Segmental bone loss is quite common in such injuries, which can be safely reconstructed in a staged manner.

Much of the intricate adaptability of the hand depends on the stable polyarticular skeleton being covered with pliable and sensate soft tissue. The goal of fracture fixation in severe injuries of the hand is to provide a backdrop stable enough for immediate reconstructive procedures. On the other hand, all soft tissue procedures must be planned with a view to achieve rapid and solid fracture healing in good position. Two factors that we have found detrimental to hand function in mutilating hand injuries are contracture of the first web and contracture of the metacarpal phalangeal (MCP) joints of the fingers. Their genesis lies less in the fracture pattern and more in the positioning after fixation. Planning only for fracture fixation gives a good radiograph, albeit of a nonfunctional hand. The goal is to achieve the best possible function under the circumstances. Setting course for such a defined goal should integrate the fixation plan with other procedures, such as flaps, nerve grafting, or tendon transfer. It is quite surprising how often the initial skeletal fixation turns out to be suboptimal for some future reconstruction. So, each milestone in the roadmap to salvage should be familiar to the entire team involved.

CHALLENGES IN FRACTURE FIXATION IN MUTILATED INJURIES

The mutilated hand differs from other closed injuries, or even most open fractures, in many ways. First, mutilating injuries may present with a disorganization of the skeleton. Before fracture fixation is considered, components that can be salvaged have to be identified.[1,2] These then need to be positioned for best possible function.

Second, mutilating injuries also present with joint disruption apart from the fractures. Restoring stability to these joints, while preserving motion, is

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quite a challenge. When ligaments and musculotendinous structures heal, it is very difficult to achieve the balance between pliability and strength they possess before injury. Bone healing, on the other hand, provides a wider latitude to restore normal function. Hence, a mutilated hand demands a determined effort to repair the soft tissues also along with the fractures, as early and as well as possible.

Third, the viability of a digit is influenced by the presence or absence of a fracture. We have observed that the prognosis of finger survival in degloving injuries is better when there are no phalangeal fractures. The addition of a fracture to this scene often results in a nonviable distal digit.

Finally, these fractures have a high incidence of nonunion or delayed union[3–5] as compared with closed or simple open fractures. Given the possibility of compromised hand function in these patients, a nonunion or delayed union is relatively more disabling and delays rehabilitation. In addition, access for secondary procedures for these nonunions is difficult due to precarious viability, scarring, and higher risk of neurovascular injury. For all the previously mentioned reasons, primary management of fractures in all major crush situations demands experience and patience.

EFFECTS OF SKELETAL DISRUPTION

Any fracture immediately introduces abnormal planes of movement to the adjacent soft tissues. When the soft tissues themselves are also significantly injured, the increased mobility compounds the insult. Partially injured vessels and nerves may suffer further injury if fractures are not splinted or fixed quickly enough. In addition, a fracture also represents injury of the attached muscle(s) and ligaments. The mobile tendinous units in the fingers undergo length changes in phalangeal fractures, with potential for eventual loss of motion of joints. Specific effects of skeletal injury in the hand are discussed as per specific regions: radial or ulnar and proximal or distal.

Radial Component

The thumb, index, and middle rays have been called the "dynamic tripod"[6] or the "dynamic tridactyl."[7] Precision grip capability is almost completely decided by the functional integrity of these rays. Injuries in which these are relatively spared or reliably reconstructed carry a better prognosis as regards eventual performance of fine activities. The most important problem to be addressed is the maintenance of the anteposed position of the thumb (Fig. 1). A thumb stiff in abduction is more useful than one stuck in adduction and extension.

Ulnar Component

The ring and little rays, along with the hypothenar eminence, are determinants of power grip activities by virtue of their more mobile metacarpals.[8]

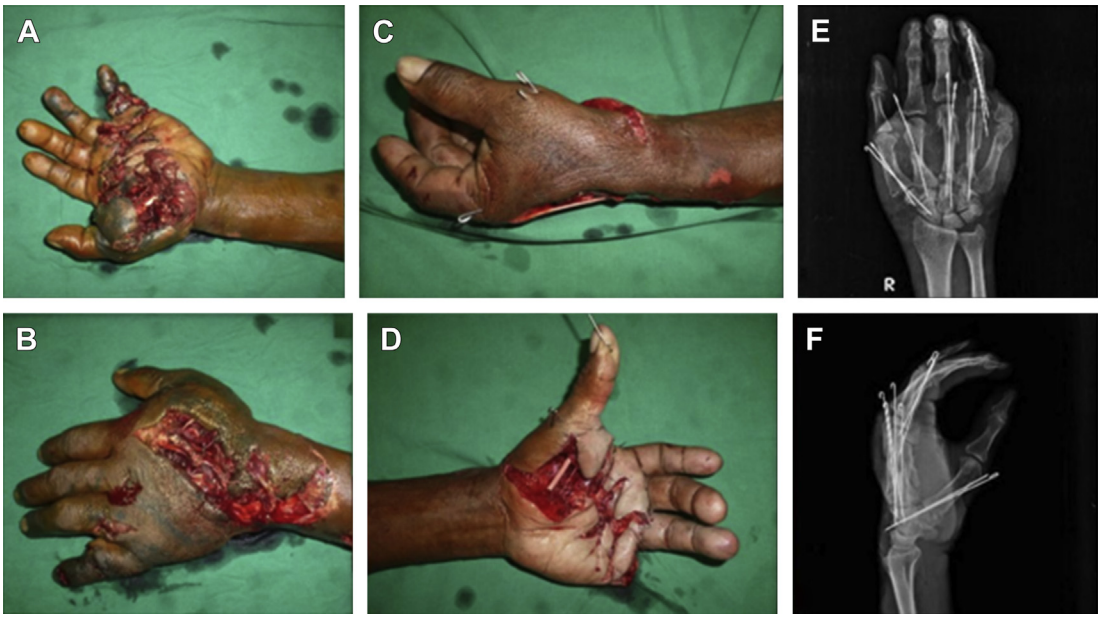

Fig. 1. (*A*, *B*) Preoperative clinical pictures of a press machine injury, with thenar wound. (*C*, *D*) After debridement and fracture fixation, demonstrating the abducted thumb. (*E*, *F*) Postoperative radiographs.