Management of Major Traumatic Upper Extremity Amputations

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KEYWORDS

• Trauma • Amputation • Upper extremity • Revision amputation • Management

KEY POINTS

- Initial management of the acute traumatic upper extremity amputation begins with the principles of advanced trauma life support including achievement of hemostasis, a thorough neurovascular examination, imaging, appropriate care for the amputate, debridement of devitalized tissue, antibiosis and tetanus prophylaxis, and fracture stabilization.
- Care for the traumatic amputee should be multidisciplinary to provide medical, surgical, rehabilitative, social, and psychological support.
- Replantation, when indicated, should be performed by a replantation specialist at a replantation center.
- Revision amputation should aim to preserve the maximum length of the limb and motion in the major joints, allowing for maximal function.
- Initial postoperative care should focus on preparation of the stump for prosthesis wear and minimizing complications.

INTRODUCTION

A major traumatic amputation of the upper limb, which includes injuries proximal to the carpus, is a rare but significant life-altering event. According to the National Trauma Databank, 0.09% of persons hospitalized after trauma sustained a major upper limb amputation[1] and 34,000 people are living with a major amputation in the United States alone.[2] Most of these injuries occur as the result of blunt trauma, with motor vehicle collisions being the most common mechanism. However, penetrating and blast injuries that result in upper limb amputation are becoming more prevalent with the US military's involvement in Iraq and Afghanistan during the past 14 years.[3–5]

Appropriate management of traumatic upper limb amputation is imperative to reduce associated morbidity and mortality while allowing the amputee to reestablish meaningful function in the effected limb. This article reviews contemporary management of traumatic upper limb amputations, with specific focus on initial management, tissue debridement, revision amputation, and postoperative complications.

INITIAL MANAGEMENT

Upper extremity amputations are usually the result of high-energy mechanisms; as such the initial evaluation begins with the principles of advanced trauma life support. Securing the airway and

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cervical spine are of utmost importance, followed by lung ventilation. An oft encountered component of advanced trauma life support primary survey with major amputations is control of hemorrhage, which results from laceration or rupture of the major vessels. A tourniquet is used if necessary to prevent lethal exsanguination; however, hemostasis is preferably achieved with elevation and application of a compression dressing. Blind clamping of vessels in the trauma bay is not recommended because collateral damage to intact vessels and nerves may occur. Resuscitation should begin with intravenous crystalloid fluids, but it may be necessary to infuse packed red blood cells if there is significant blood loss. Broad-spectrum antibiotics and tetanus prophylaxis are initiated in the trauma bay as soon as possible. Typically, at least a first-generation cephalosporin is used for infection prophylaxis, although an aminoglycoside should be added if there is significant contamination. Penicillin is added if there is concern for *Clostridium* infection from farm or vegetative contamination. If the patient's immunization status is unknown or overdue, tetanus prophylaxis is required.

Once the patient is acutely stabilized and resuscitation efforts initiated, care is directed toward a thorough history and physical examination. The history should focus on injury and patient factors that are helpful when formulating a treatment plan. Injury factors include the mechanism, timing, location, and additional injuries. Patient factors include hand dominance, prior occupation, baseline functional level, and medical history (especially diabetes mellitus, peripheral vascular disease, and prior injury to the affected extremity). Although not a contraindication to replantation, patients with diabetes, peripheral vascular disease, and smokers have lower success rates.[6] Physical examination should focus on the remaining portion of the affected extremity, taking note of the level of injury and the amount and type of contamination. Active and passive motion of the proximal joints should be noted to aid with preoperative planning for a future prosthesis. The remaining muscle groups should be palpated and evaluated for compartment syndrome. A local anesthetic is particularly useful before ranging the limb to reduce the effect pain inevitably has on the examination. The amputate should undergo a thorough examination for additional sites or injury distal to the amputation. Significant additional injuries can preclude a replantation attempt. A thorough secondary examination is essential to identify additional injuries to other extremities or the axial skeleton.

Orthogonal radiographs of the residual limb and amputate are obtained to further characterize the bony injury to each. In particular, segmental injuries to the amputate may prohibit successful replantation and favor revision amputation.

REPLANT OR REVISION AMPUTATION

When a traumatic upper extremity amputation occurs, definitive treatment should focus on ultimately providing the patient with the highest level of function possible. The initial decision making should differentiate an injury that can be successfully replanted from one that requires a revision amputation. One must keep in mind the complexity of motion in the human upper extremity; therefore, a replanted "bad hand" may provide more function than is possible with a prosthesis following revision amputation. When the expected function of a replanted extremity is less than that of an amputation with or without a prosthesis, or the patient is not a candidate for replantation, the decision should be made to perform a revision amputation.

Graham and colleagues[7] compared late functional outcomes between major upper extremity amputation and replantation at an average of 7.3 years postinjury. Functional outcomes were determined using the Carroll Standardized Evaluation and Integrated Limb Function, which assesses one's ability to perform simple and complex tasks. Twenty-two major upper extremity replantations were compared with 22 similar level amputees with prostheses, and the functional abilities of the replantation group were significantly better than the prosthesis group.

Proper care of the amputate precludes any discussion regarding the ability to perform a successful replantation. It should be wrapped with sterile saline-soaked gauze to prevent desiccation and then placed into a sealed, impermeable plastic bag. This bag should then be immersed into ice water to help preserve the tissues, which is particularly important if the amputate contains a large amount of muscle because of its high metabolic demand.

The decision to perform a major upper extremity replantation depends on patient factors and the injury pattern. If the amputation is one injury of a polytrauma situation, the patient may not be able to tolerate a lengthy replantation procedure or may not be able to effectively participate in postreplantation rehabilitation. If the patient is hemodynamically unstable, extremity injuries should be treated in a damage control manner and avoid attempted replantation. In general, a smaller zone of injury, such as that from a sharp amputation, results in a more successful replantation. The amount of soft tissue damage that occurs with a