

A Case Report: Saving a Severely Crushed Hand by Implantation into the Abdomen

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Abstract:

Crush hand injuries are rare however they represent devastating and challenging events. They are usually caused by a compressive force, resulting from a high-energy mechanism such as a motor vehicle or industrial accidents, leading to damage of multiple tissue types, including skin, soft tissues, blood vessels, nerves and bones. The objective of this case study is to highlight the management plan to save a severely crushed hand with a high risk of amputation.

It is a case report of a 45-year male patient that was referred to our tertiary trauma centre with a severe crushing injury of his left hand and distal forearm following RTA. After proper resuscitation and investigations, the patient was operated; washout, debridement of all necrotic tissues, and amputation of the completely devitalized index finger and thumb was performed. Fractured bones were stabilized, and then coverage of the big raw area with the underlying bones exposed was managed by implanting the patient hand into his abdomen that was kept for 4 weeks before separation. **Results:** The results were marvelous and the taken flap was completely viable; the hand was saved with a fairly good functional outcome, and the patient is being followed for 18 months up till now.

Implantation of a crushed hand into the abdomen is not a so popular procedure for reconstruction; however, it was the best option to save a severely crushed hand as in our case study. The primary aim of management is to save life, limb and then restore limb function in that order.

Key words: abdomen; crush; compartment; flap; hand; implantation

Introduction

Crush hand injuries are rare however they represent devastating and challenging events. Such injuries result in major health care costs from lack of productivity and disability and its incidence is expected to rise with rapid industrialization. They are usually caused by a compressive force, resulting from a high-energy mechanism such as a motor vehicle or industrial accidents, leading to damage of multiple tissue types, including skin, soft tissues, blood vessels, nerves and bones. The degree of damage is directly proportional to the amount of force applied per square inch surface area and the duration of compression [1].

Proper assessment by an experienced hand surgeon is essential to get a fairly good functional outcome and acceptable cosmetic results. The aim of management of crush hand injuries is to provide the hand with the basic hand functions most importantly: functioning pincer mechanism and sensation for grasping [2, 3].

Crush syndrome with its systemic sequelae may develop in cases of prolonged compression of a more proximal part of the limb with bigger muscle bulk resulting in acute renal failure due to myoglobinuria that can be prevented in such cases by alkalization of urine [4].

Case report

It is a case study of a 45-year male patient that was referred from another hospital to our tertiary trauma centre at 1 am 6 hours after the accident with a severe crushing injury of

hand and distal forearm following RTA. The patient was managed according to ATLS; he was hemodynamically unstable when he presented to us. Examination of his limb showed a severely crushed left hand with severe contamination: completely devitalized index finger and thumb, different levels of injury of the remaining 3 fingers, and a severe injury with soft tissue loss of the lateral aspect of the forearm (Fig.1).



Figure 1: preoperative photo at emergency department.

Primary patient survey revealed no other associated major injuries; he was properly resuscitated and we started IV broad spectrum antibiotics empirically until the results of the culture and sensitivity test appear (*Imipenem 500 mg/8 H; Linezolid 600 mg/ 12 H, and Metronidazole 500 mg/ 8 H*) together with *tetanus prophylaxis*. Imaging studies revealed fracture both radius and ulna, carpal and metacarpal, and some phalangeal bones (Fig.2). To prevent the risk of crush syndrome with its serious sequelae due to the extensive muscle necrosis, we gave the patient *intravenous sodium bicarbonate bolus of 1 mEq/kg to alkalinize the urine (pH \geq 7.5)*, together with adequate postoperative hydration.



Figure 2: X-ray showing multiple bony fractures

Procedure: after proper assessment of the case we put a management plan and the patient was operated; washout, thorough debridement of all necrotic tissues, and amputation of the gangrenous index finger and thumb was performed. Fractured bones were stabilized using wires and external fixator, injured tendons were repaired, and fortunately there were no major vascular or neurological injuries, and then coverage of the big raw area with the underlying bones exposed at the lateral aspect of both the hand and distal forearm was challenging. We decided to manage by implanting the patient hand into his abdomen so we fashioned the abdominal flap to be tailored to the hand that was put inside its pocket to be separated later in a second session





Figure 3: the abdominal flap fashioned to be tailored to the hand



Figure 4: the hand implanted into its abdominal pocket.

The patient had an uneventful postoperative course; he was followed by regular wound dressings, appropriate antibiotic coverage, blood transfusion, good hydration and nutrition and keeping his hemoglobin, serum albumin and renal function within normal levels, and the patient was taught to keep moving his fingers while his hand was implanted in the abdomen to prevent joint stiffness and muscle atrophy. *The taken abdominal flap was completely viable with good healing and coaptation with the hand, and no evident wound infection (Fig.4).* The patient was hospitalized for 4 weeks then we decided to go for the second operation; the full thickness flap was successfully separated and

tailored to the hand and distal forearm, and we repaired the abdominal wound after making undermining of the edges to achieve primary closure without tension with suction drainage. We also had to do some de fattening of the taken flap to decrease its thickness and a small skin graft taken from the thigh was needed to cover a small residual raw area.



Figure 5: the abdominal flap was viable and the patient could move his fingers.

Results: the first postoperative dressing was made one week after the second surgery; *the results were marvelous, and both the separated abdominal flap and skin graft were completely viable and well taken with good healing and no wound infection (Fig.5).* The hand was saved with a fairly good functional outcome and



the remaining 3 fingers were well perfused and moving with no much stiffness to get more benefit by the physiotherapy by a hand therapist. The patient was satisfied and he was happy to use his hand in the normal daily activities and exercises, also he got a help by a psychotherapist (Fig.7). The definitive orthopedic management of the multiple bony fractures was conducted later on a third session, and with advancement of technology it would be prepared to replace the amputated index and thumb with prosthesis to restore the hand function almost completely, and the patient is *being followed for 18 months up till now*.



Figure 6: the patient could do exercises.



Figure 7: the patient can do normal daily activities.

Discussion

Crush injuries of the upper extremity can be devastating and the outcome of reconstruction critically depends on the early proper management of such injuries in the operation room with thorough understanding of the underlying mechanisms of injury. Assessment by *an experienced hand surgeon* starts in the emergency department with precise evaluation of the vascularity,

categorization of damaged structures and assessment of salvageability. Early limb revascularization and thorough debridement of all devitalized tissues are essential in the management plan [5].

Due to complexity of such crush injuries, it is important to consider both short term tactics and long-term strategies for management of each component of the multiple tissue types involved in such mangling injuries: *neurovascular injuries, soft tissues, and fractures in that order of priority* [6].

Compartment syndrome is one of the serious complications of crush injuries; increased compartmental pressure causes capillary bed collapse, decreased tissue perfusion, and cell death; reversible muscle damage occurs after 4 hours of compression and it becomes irreversible by 8 hours resulting in significant functional morbidity (*hand contracture*). Early recognition is crucial to initiating timely treatment and minimizing functional loss. *Emergency fasciotomy* is the definitive treatment for hand acute compartment syndrome [7].

Our hands are vital for everyday life; whether we are brushing teeth, opening a door, operating tools, holding a fork, grasping a steering wheel, or wearing clothes, we want to perform such daily tasks effortlessly and without pain. The goal of the reconstructive hand surgery for management of crush injuries is to restore both the function and appearance of the hand as much as possible. Implantation of the hand into the abdomen as a reconstructive surgery is by no means new, but it is uncommon; this procedure was first described by doctors in 1900, and was used regularly during the Second World War to treat injured soldiers. In our case study of such severe crush injury, it was the best option for reconstruction as there was marked soft tissue loss with the underlying bones and tendons exposed so that skin grafting to cover was not appropriate and we needed full thickness abdominal flap to replace the significant soft tissue loss. Moreover, such injuries are associated with severe contamination with high incidence of infection and subsequent muscles and tendons dehiscence with tissue necrosis; the abdominal flaps with their good vascularity are more resistant to infection.

Conclusion

Implantation of a crushed hand into the abdomen is not a so popular procedure for reconstruction; however, it is the best option to save a severely crushed hand as in our case study, with phenomenal results and minimal complications. The primary aim of management is to save life, limb and then restore limb function in that order.

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Ethical statement:

The study protocol was approved by the Local Medical Ethics Committee. Informed consent was obtained from all individual participants in the study.

Declaration of competing interest:

No benefits have been received from a commercial party related



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