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PUSHING THE BOUNDARIES - BONE GRAFTING IN HAND TRAUMA - A CASE REPORT

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Abstract: *The hand and upper extremities are one of the most common sites of complex trauma. Hand trauma causes both functional and psychological effects on patients. The most important aspects of hand trauma reconstruction are functionality, preserving the integrity of component parts, and low morbidity of donor sites in cases where grafting is necessary. This paper offers a re-examination of open hand fractures and soft tissue defects and new ways to reconsider the strategies to approach a mangled hand and upper extremity by using a "damage control" approach and a different perspective on donor sites*

INTRODUCTION

The hand is one of the most complex parts of the body in terms of functionality but also the most susceptible to trauma. Injuries to the hand are common in domestic and industrial accidents, falls, war, and ballistic trauma and can have both functional and psychological effects.

Complex trauma can result in significant injuries affecting both bones, nerves, vessels, and overlying skin.(1)

Due to the accumulation of functional elements per square centimetre, any injury causes considerable damage in the event of amputation of its parts or soft tissue defects making the reconstruction process challenging. Because of the unique anatomy, a thorough knowledge of the intimate relationship between neurovascular structures and skeletal anatomy is required. Another turning point is choosing the donor site in case of replacing an element, especially bone grafts.

In the case of bone grafting, there are important characteristics that need to be considered, such as structural integrity and osteointegrative proprieties of the graft. The autogenous bone graft represents the gold standard regarding histocompatibility, osteogenicity, and osteoconductivity.(2)

Autologous bone graft sources in hand trauma surgeries include the iliac crest, distal radius, toe phalanx, metacarpal, distal femur, scapula, proximal ulna, and fibula but the most common source is the iliac crest.

The difference between an autologous cortical bone graft and a cancellous bone graft is the osteoinductive and osteogenic properties. **Cortical bone graft**, because of its dense matrix, results in slow vascularization, low perfusion, and incorporation and results in poorly osteogenic option for large defects.(5,6) On the other hand, when using **cancellous bone grafts**, a portion of the donor osteocytes survives. This, combined with graft porosity and local cytokines, promotes angiogenesis, stem-cell recruitment, and the potential to differentiate into osteoblasts.(3)

In other words, the cancellous graft can be fully vascularized within two days after the surgery, new bone formation is observed in 6-8 weeks, and complete turnover by one year.

AIM

The purpose of this article is to present different donor areas for bone grafting. In other words, when the situation allows it, we can use whatever is available for an optimal result and low morbidity of the donor site.

CASE REPORT

In the Plastic Surgery Clinic in Timișoara within the "Pius Brinzeu" County Emergency Clinical Hospital, which treats both chronic cases and emergencies, we had a patient with hand trauma with a different treatment option.

The case concerns a 25-year-old policeman who suffered a domestic accident resulting in a complete amputation of the first phalanx of fingers IV and V and a near-complete amputation of the first phalanx of finger III at the dominant hand. The mechanism of the accident was a combination of crushing and torsion, so preserving the fourth and fifth fingers was no longer possible, the remaining viable part being only the skin at the volar level. In the case of the third finger, even if the second and the third phalanx were viable, the defect in the proximal phalanx showed a 70% bone defect and intense contamination with vegetal particles (figure no. 1).

The first intention in the surgical management under regional anesthesia was intense cleaning of the wound and damage assessment. The soft tissue defect, compromised vascularization, and multiple fractures were the reasons we decided to perform debridement of bony fragments, necrotic skin, flexor tendons, nerve endings, and nail matrix for the fourth and fifth fingers. The bone fragment of the middle phalanx of the fifth finger, measuring 1.7 cm, remained intact after the trauma and was preserved for bone grafting. After cortical bone fragments were removed from the bone graft, obtaining a cancellous bone graft was fixed with a Kirschner wire at the defect site.

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Figure no. 1. Initial clinical aspect and Rx of hand trauma

After several measurements, there was still a 0.4 cm intraarticular defect of the first phalanx of the third finger, which was covered by the remaining fragment of metacarpal V fracture and fixed with a metal cerclage (figure no. 2). In this way, the integrity of both the third finger and the proximal phalanx joint was preserved.

Figure no. 2. Bone graft harvested from the second phalanx of the fifth finger and post-operatory Rx of the hand

The defect on the dorsal part of the hand was covered with viable skin remaining after the removal of bone and tendon fragments from the fourth and fifth fingers. Given the mechanism of the accident and the possibility of necrosis, the excess skin was retained for several days until the second surgery (figure no. 3). Splints on volar side were used for the third finger.

Figure no. 3. Postoperative result with skin preservation and Penrose drainage

After the first week, part of the skin that used to cover the dorsal face of the hand became necrotic, and the defect was successfully covered using the skin reserve (figure no. 4).

Figure no. 4. Clinical aspect after five days with partial skin necrosis

Postoperatively, the patient was compliant, following the treatment with oral antibiotics, anticoagulants, and anti-inflammatories. After two weeks, the soft tissue parts were healed. The patient also received psychokinetic therapy after one week and the splint was removed.

After six weeks, the patient underwent an X-ray showing callus and bone neoformation in the proximal phalanx of the third finger. After the removal of the osteosynthesis material, the patient is able to perform flexion, extension, and fine movements. In the future, other surgeries will be performed for aesthetic purposes (figure no. 5).

Figure no. 5. Postoperative clinical aspect after six weeks

DISCUSSIONS

Considering the importance and function of the hand, operative management needs to take into account patient factors such as premorbid functional state, profession, motivation, medical comorbidities.(8)

In choosing the donor site area, we had to consider the benefits versus the risks. The major concern regarding the iliac crest as a donor site is the morbidity associated with the procedure. The complication rate associated with iliac crest harvesting is 2.8% to 37.9%.(4) Possible complications include superficial sensory nerve damage, hematoma, infection, and persistent donor site pain.

Furthermore, a different surgery for harvesting the bone graft would increase surgical time and hospitalization.(7)

A fracture should be kept in a steady, reduced position for at least 4 weeks before mobilising the adjacent joints. This can be achieved by several possible methods of splinting. In this case of a proper, stable fixation, achieved by open reduction and

internal fixation with a cerclage and a Kirschner wire , the hand can be mobilized more quickly and a postoperative timeframe of 1 week is recommended. This helps to avoid soft tissue adhesions and joint stiffness, which are inevitable with prolonged immobilisation.(9)

Hand trauma is best approached in a holistic manner, taking into account the particularities of soft tissue and bone injury but also the rehabilitation process, patient will to respect the postoperatory indications along with the medical, psychological and social factors of the patient.(10)

CONCLUSIONS

In the case of complex hand injuries, it is important to consider several aspects before emergency surgery, such as the risk of infection, the biological condition of the patient, possible bone defects or discontinuity of vascular elements, and then decide how to manage the case. Normally, in this case, a bone grafting from the iliac crest or amputation of the finger would be performed. An important element described in this review article is to try to use any biological element available.

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