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Septic Nonunion Of Radius and Ulna. Treatment with Calcium Sulphate Beads Impregnated With Antibiotic, Plate Fixation and Iliac Crest Autograft

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ABSTRACT

Introduction: Forearm fractures are common in young adults after direct trauma, such as traffic accidents, falls from height, and sports activities. Septic nonunion is defined as the failure of fracture consolidation and persistence of infection for 6-8 months. Factors contributing to its development include inadequate initial reduction, unstable fixation, early limb mobilization. In septic nonunions, influencing factors also include open fractures, extensive soft tissue damage, highly comminuted fractures, and patient-specific characteristics such as comorbidities.

Clinical case: A 43-year-old male, was admitted to the hospital due to severe pain and functional limitation in his left forearm. The current condition began while riding his motorcycle, he collided with an animal on the road, lost his balance, fell and suffered a discrete trauma to his left forearm, causing deformity, intense pain and a skin wound on the back of the forearm with bone exposure. He was initially treated in a first-level medical unit where mechanical lavage and wound closure were performed. Later he is sent to our unit. Surgical intervention was performed by open reduction of the left radius and ulna with a DCP plate in the radius and ulna.

Operative and postoperative course without complications. At 5 months of follow-up, he reported pain, edema, functional limitation and deformity. New radiographic studies are performed where loosening of osteosynthesis hardware, data of oligotrophic nonunion in the diaphyseal area of the radius and data of hypertrophic nonunion in the diaphyseal area of the ulna are observed.

Discussion: The therapeutic approach to septic non-unions presents a challenge for orthopedic physicians. Various management sequences have been described in the literature, with the gold standard being the eradication or reduction of the infectious load at the fracture site. Autografts play an important role in tendon, ligament and bone reconstruction surgery. calcium sulphate beads (Stimulan®) impregnated with vancomycin were used, specifically designed to fill dead space. Their ability to absorb antibiotics allows for effective, localized concentration maintenance, while promoting bone formation upon absorption.

KEYWORDS: Ulna, radius, septic non-union, Plate fixation, iliac crest autograft, calcium sulphate beads.

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INTRODUCTION

Forearm fractures are common in young adults after direct trauma, such as traffic accidents, falls from height, and sports activities (1).

The forearm is considered as the medial radio-ulnar articulation, wich along the proximal radio-ulnar joint and the distal radio-ulnar joint, form a triarticular complex. Conversely to the cylindrical PRUJ and DRUJ, the MRUJ may be considered as a particular kind of syndesmosis, a joint in which the bony surfaces are connected by an interosseous ligament. It has 3 basic functions: pronosupination, longitudinal load transfer and muscular insertion site. The affection of any of the 3 joints, has repercussions on the other ones (2).

The treatment of choice for displaced fractures of the radius and ulna in adults is open reduction with internal fixation. Closed reduction is designed for those patients who cannot undergo surgery,and unsatisfactory results may be obtained up to 71% of the time. For contaminated open fractures as in our case and fractures with substantial soft tissue deterioration, external fixators may be recommended [3]. The objective of treating diaphyseal forearm fractures is to provide axial and rotational stability. While rigid fixation with plates and screws is one of the most accepted implants for treating such fractures, it has certain disadvantages such as soft tissue damage, disruption of periosteal circulation, and irritation of the skin adjacent to the ulna (4).

Septic nonunion is defined as the failure of fracture consolidation and persistence of infection for 6-8 months. Factors contributing to its development include inadequate initial reduction, unstable fixation, early limb mobilization. In septic nonunions, influencing factors also include open fractures, extensive soft tissue damage, highly comminuted fractures, and patient-specific characteristics such as comorbidities (5).

Bone infection presents a challenging condition to treat. The gold standard of treatment involves surgical debridement followed by long-term antimicrobial therapy to achieve a minimum effective concentration at the infectious focus (6).

CLINICAL CASE:

A 43-year-old male, who was admitted to the hospital due to severe pain and functional limitation in his left forearm. The current condition began while riding his motorcycle, he collided with an animal on the road, lost his balance, fell and suffered a discrete trauma to his left forearm, causing deformity, intense pain and a skin wound on the back of the forearm with bone exposure. He wasinitially treated in a first-level medical unit where debridement, irrigation and wound closure were performed. Later he is sent to our unit.

During the physical examination, he was conscious, oriented, with pain in the left hemithorax ondeep inspiration, left upper extremity with a wound on the back of the forearm approximately 7 cm long, with well-contoured edges, with no evidence of bleeding at this time or active infection.Right upper extremity with notable edema at the level of the hand and forearm, with pain on palpation and mobilization of the wrist, hand, thenar and hypothenar region.

A polytrauma radiographic series was performed. The anteroposterior and lateral radiograph of the left forearm shows a spiral fracture trace in the shaft of the radius and ulna, with dorsal displacement, with no signs of injury in the distal or proximal radioulnar joint, the rest of the structures with no signs of other acute bone injuries. A patient is admitted with the diagnosis of open fracture of the shaft of the left radius and ulna Gustilo and Anderson type II, AO 2r2a2/2u2a2

After 7 days of intravenous antibiotic administration, a second surgical intervention was performed by open reduction of the left radius and ulna with a DCP plate inthe radius and ulna (Figures 3 & 4). Operative and postoperative course without complications. At five months of follow-up, he reported pain, edema, functional limitation and deformity. New radiographic studies are performed where loosening of osteosynthesis hardware, data of oligotrophic nonunion in the diaphyseal area of the radius and data of hypertrophic nonunion in the diaphyseal area of the ulna are observed.

A third surgical intervention is performed where osteosynthesis hardware is removed, purulent exudate is observed at the radius fracture site, cultures are taken, then debridement and scarification of non-union is performed. A external fixation was assembled and calcium sulphate beads impregnated with antibiotic were placed (stimulan). The surgical procedure was performed without complications, he remained hospitalized for intravenous antimicrobial management and was subsequently discharged with oral antimicrobial management.

A fourth surgical intervention was performed two months later, a right iliac crest graft was taken to treat the residual bone defect of the radius and ulna. Open reduction was performed with internal fixation to the left radius with a 2.5 mm Trilock XL plate and reconstruction plate for the ulna.

After definitive intervention, a weekly follow up was performed in the first month, then a monthly follow up until 6 months. During his follow up, adequate clinical and radiological evolution was observed. Thepatient is currently functional to perform day-to-day activities without limitations. The last physical examination revealed left wrist with flexion of 60°, extension of 40°, ulnar deviation of 30°, radial deviation of 40°, complete supination and 10° lag in pronation, without distal neurovascular compromise. In the last radiographic control, a consolidated fracture was observed, as well as integration of grafts, osteosynthesis hardware in adequate position without signs of fatigue.

Figures 1, 2. Forearm x-rays where bone disruption is observed at the diaphyseal level of the radius and ulna, oblique type, with displacement of the distal radio-ulnar joint.

Figures 3, 4. Immediate post-surgical AP and lateral radiographs of the forearm showing management of the fractures with osteosysthesis hardware (two dynamic compression plates)

Figures 5, 6. AP and lateral forearm radiographs. Five-month follow-up where data of hypertrophic nonunion in the diaphyseal area of the radius and ulna is observed, associated with hardware loosening.

Figures 7, 8. AP and oblique forearm radiographs. Placement of external fixator, centralmedulla k-wire and placement of calcium sulphate beads impregnated with antibiotic (stimulan).

Figures 9, 10. AP and lateral forearm radiographs. Osteosynthesis of the radius and ulna plusplacement of iliac crest autograft is observed in both fracture sites.

Figures 11, 12. AP, lateral and oblique forearm radiographs. Three months of evolution of definitive surgical intervention. Consolidation of both fractures, restoration of radial height and alignment of bothbones.

Figures 13-16. Clinical figures of the patient, three months after definitive intervention showing left wrist with 60° flexion, 40° extension, complete supination and 10° restriction in pronation.

DISCUSSION

The therapeutic approach to septic non-unions presents a challenge for orthopedic physicians. Various management sequences have been described in the literature, with the gold standard being the eradication or reduction of the infectious load at the fracture site. Initially, this is achieved through surgical debridement and proper scarification in one or more surgical stages, followed by prolonged antimicrobial regimens targeted at the isolated pathogen. Once evidence suggests that the infection is no longer active, reconstruction of the bone defect is undertaken. (7)

Autografts play an important role in tendon, ligament and bone reconstruction surgery. Enthusiasm for the use of autografts in reconstructive orthopedic surgery has increased over the past decade, with an increase in the use of autografts in a variety of procedures. There is a wide variety of pathology and procedures that involve the use of various types of autografts in orthopedic reconstructive surgery of the elbow and forearm such as the iliac crest used in our patient [5].

In this case, calcium sulphate beads (Stimulan®) impregnated with vancomycin were used, specifically designed to fill dead space. Their ability to absorb antibiotics allows for effective, localized concentration maintenance, while promoting bone formation upon absorption. External fixators maintained reduction, with weekly monitoring using acute phase reactants (10).

Compared to other options like poly-methyl methacrylate beads and bioactive glass, the antibiotic impregnated calcium sulphate beads have been shown to fully dissolve (marked by absence on X-rays) within 3-12 weeks, removing the need for a follow-up procedure and the possibility of biofilm formation.(11)

Pharmacokinetic studies also show its superiority. As AICS dissolves, 100% of its loaded antibiotic is released, compared to around 10% in PMMA, leading to much higher local concentrations for more prolonged periods. Local antibiotic concentrations with AICS being much higher than the minimum inhibitory concentration (MIC) for the implicated pathogen, systemic levels remain far from those potentiating toxicity (11).

After three months of monitoring and antibiotic therapy without clinical or acute phase reactant abnormalities, definitive surgery was performed to correct the bone defect using a 2.7mm locking compression plate plate for the radius and a 3.5 mm dynamic compression plate for the ulna. Cancellous autologous graft from the iliac crest was used for bone defect repair. Ring et al. reported a 100% success rate using plate fixation and autologous cancellous bone graft, recovering an average bone defect of 2.2 cm in diaphyseal fractures of the radius and ulna with bone defects (12).

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