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Ilizarov technique in management of nonunited fracture of both bones of the forearm

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Abstract Nonunited fracture of the forearm, although not a common problem, is associated with marked disability. Nonunion can due to infection secondary to open fracture or can be a complication of surgical open reduction and internal fixation. Nonunion can also result from improper management or technique that is not suitable for the type of injury. This study reviews 11 patients with nonunited fractures of the shafts of the radius and ulna. Average duration of nonunion was 18 months. Nine patients presented with active infection or a history of infection in the form of open discharging wound with or without exposed bone, while two had no history of infection. Patients were managed by surgical debridment, removal of dead bone and hard wear, if any, and application of Ilizarov external fixation frame followed by acute shortening by compressing the fracture site. Three weeks later, gradual lengthening started to regain the normal length. Eradication of infection and sound union was achieved in all cases, with good hand, wrist, and elbow function on final follow-up. Limitation in pronation and supination ranges of movement were found in all cases. This could be due to multiple surgeries, long duration of management, the external fixation wires that crossed the distal and proximal radio-ulnar joints, or loss of the normal radial and ulnar bowing during lengthening. Ilizarov technique and external fixation represent an option in the management of resistant nonunion of diaphysial fractures in the forearm.

Key words Nonunion • Fracture • Forearm • Ilizarov

Introduction

Nonunited fracture of the forearm is associated with great deal of disability. This condition is not common, and the incidence ranges between 2.7% [1] and 9.3% [2]. The disability can be due to the loss of proper hand function, pain, chronic infection if present, bony angulation and associated skin problems. To regain proper hand function, the patient needs proper alignment of the fracture and sound healing besides normal neurological and vascular status of the upper limb [3]. Good muscle and tendons in both the forearm and hand are mandatory; this requires proper tension within the muscle and tendons and proper alignment with minimal scarring around [4].

The problem of nonunited fracture of the forearm can be secondary to open fracture or neglected fracture in adults [5]. It can also be a complication to surgical management, and infection following open reduction and internal fixation of forearm fractures [6].

Management of nonunion depends on if there is associated infection or not and if there is associated shortening or deformity [7]. Depending on the condition, the treatment can be in the form of multiple debridments, open reduction and internal fixation [8], free bone graft [9], vascularised bone graft [10], uniplanar external fixation [11], or circular

external fixation with or without osteogenesis procedures (e.g. segment transfer or limb lengthening) [12]. The management can be a combination of more than one technique.

In this study, I present 11 cases of nonunited fractures to the shafts of both bones of the forearm, managed by Ilizarov external fixation.

Materials and methods

Nonunited fractures of the forearm bones were observed in 11 patients (10 men) of mean age 31 years (range, 22–59 years). All fractures were diaphysial fractures to both bones of the forearm. Six patients had type 22-A3 fractures according to the AO classification, three patients had type 22-B3, and two patients had type 22-C3. The average duration of nonunion was 18 months (range, 10–24 months).

At time of presentation six patients had infected nonunion with discharging sinus and skin problems, while three others had a history of infection managed previously by multiple surgeries in the form of hard wear removal, irrigation and debridment, and/or external fixation with no sign of active infection at the time of presentation. Two patients presented with nonunion without history of infection. The average number of surgeries before presentation was 4 (range, 2–9). These surgeries were in the form of open reduction, internal fixation, external fixation with uniplanar fixation, irrigation and debridment, free bone graft, or closed reduction and above-elbow cast.

Eight patients had a history of open fracture, while three had closed fracture at the time of injury. All patients were investigated using plain radiographs and blood investigation including sedimentation rate and C reactive protein. These investigations were used for follow-up of fracture healing and treatment of infection.

At time of presentation five cases had retained hard wear in the forearm with associated infection in the form of discharging sinus. This hard wear was in the form of small DCP plates in three cases, intramedullary Rush pins in one case, and combination of both techniques in one case. The rest of the cases had external fixation of the fracture at time of presentation in the form of above-elbow cast or uniplanar external fixation. Seven patients had bone loss either at time of trauma or during the debridement procedures carried out before presentation (Fig. 1a, b).

Management was in the form of surgical debridment with removal of dead bone and infected tissues, acute shortening of both bones of the forearm followed by acute compression of the freshened fracture edges. Primary closure of the wound was done in ten cases, while delayed primary closure (after 48 hours) was done in one case. Fixation and compression of the fracture employed the Ilizarov external fixation frame. After complete healing of the wounds (3–5 weeks), gradual distraction at the fracture site was done (Fig. 2). The aim of distraction is to regain the proper length of the forearm bones that is needed for proper function of the long flexors and extensors of the hand. The injured side is lengthened until it reaches a length equal to that of the normal side. The average length of infected bone removed was 3 cm (range, 2–4 cm), while the average length achieved was 4 cm (range, 2–5 cm). Lengthening rate was 1 mm per day. Physical rehabilitation of the hand and elbow was from the first postoperative day to get the best hand function. The average duration of frame application was 120 days (range, 90–200 days) (Fig. 3a, b).

The external fixation frame was removed after radiological consolidation of the newly formed bone. The average duration of follow-up was 30 months (range, 24–42 months). Physical therapy was used after removal of the external fixation frame to regain range of movement and muscle strength.

Fig. 1a, b *Plain radiographs of a patient with infected nonunited fractures of both bones of the forearm of one year duration*. **a** Anteroposterior view. **b** Lateral view

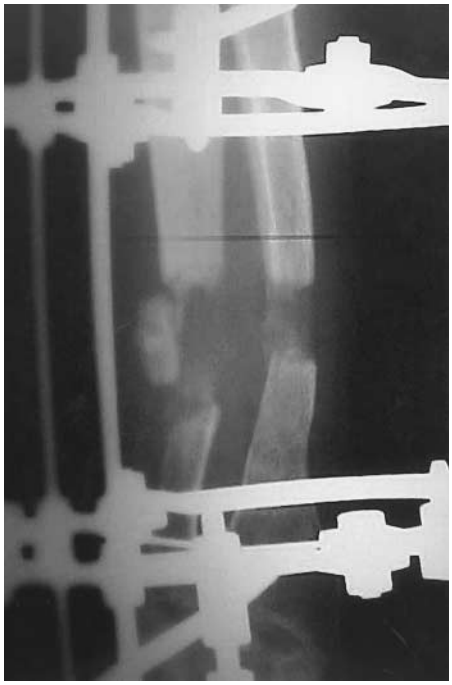

Fig. 2 Radiograph after removal of dead bone, eradication of infection, stabilisation and lengthening using the Ilizarov external fixation frame. New bone formation is seen

Fig. 3a, b *Final follow-up radiographs show proper alignment and relation between the radius and ulna, with healed fracture, and no infection*. **a** Anteroposterior view. **b** Lateral view

Results

All 11 patients had complete healing of the fracture in both bones of the forearm. Infection was cured in all cases. Regarding range of movement, there was limitation of pronation and supination compared to the normal side. The average range of motion on the normal side was 0–70 in supination and 0–80 in pronation, while on the injured side it was 0–30 and 0–35 respectively. Regarding wrist and elbow ranges of movement, there were no differences between the normal and injured sides on final follow-up.

On final follow-up, radiological assessment showed proper relation between the radius and ulna in both the distal and proximal radio-ulnar joints. On the other hand, there was loss of normal radial bowing on anteroposterior radiograph-

ic assessment, and loss of ulna bowing on lateral radiographs. This was found in the lengthened segment, and this may partially explain the limited pronation and supination.

In cases with infected nonunion, cure of infection occurred in all cases. This was in the form of complete healing of the wounds, no systemic nor local sign of infection, and the low sedimentation rate on final follow-up blood investigation. Plain radiographs and the regained hand and forearm function proved sound healing of the fractures.

Ten patients had full-time jobs before injury. Nine patients were able to return to the same job. One patient needed job modification.

No case of neurological nor vascular complication was encountered in this study.

Discussion

Ilizarov external fixation is a demanding procedure especially in an anatomical area with many nerves, vessels and tendons as in the forearm. Proper planning before surgery regarding the frame design and the sites of placement of pins and tensioned wires helps to decrease risks to a minimun.

Distraction osteogenesis after removal of dead bone is useful in these problems. This helps to eradicate infection and restore proper length and alignment. This can lead to the final aim, which is proper function.

This technique may be considered an alternative to vascularised grafting with the advantages of avoiding donor site morbidity and the versatility during follow-up. This technique needs a cooperative patient with meticulous follow-up to achieve its goal.

Limitation of pronation and supination on final follow-up in this group of patients may be due to the multiple surgeries and long immobilization before presentation. This also can be due to transfixing the distal and proximal radioulnar joints with tensioned wires of the Ilizarov frame. Loss of radial and/or ulnar bowing in the distraction osteogenesis could also be a factor in limitation of pronation and supination. On the other hand, elbow and wrist ranges of movement were equal to those of the normal side on final follow-up.

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