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Case Report

Treatment of forearm diaphyseal defect by distraction compression bone transport and continued distraction for radial head reduction: A case study

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ABSTRACT

Treatment of infected forearm nonunion and defects represents a difficult task for the operating surgeons. Conventional methods like composite and vascularized fibular grafts and the induced membranes filled with cancellous autografts or the Masquelet technique have been reported to be useful and successful, but sometimes it is difficult to predict the outcome and cannot address simultaneous deformities or the need to apply gradual distraction for reduction of a chronically dislocated radial head. Ilizarov technique has an answer for such conditions. We report a 43 years old man with infected ulnar defect and dislocated radial head as a result of infected Monteggia fracture: the patient was successfully treated by Ilizarov bone transport after failed attempts by bone spacer and fibular graft.

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Introduction

The forearm is no longer viewed as two separate bones connecting to the proximal and distal radio-ulnar joints (PRUJ and DRUJ respectively), but rather a complex joint mechanism that possess a range of motions mainly the supination and pronation.¹ The forearm also serves as a force transmitter and provides attachment for muscles that move the wrist and hand. The forearm also works as a joint so integrity of these structures is vital for a comprehensive function and synergistic effect. The middle radio-ulnar joint has a very important biomechanical characteristic.^{1,2} It is important to have an intact forearm for PRUJ and DRUJ to function normally. The forearm bones linked by interosseous membrane which could be designated as the middle radio-ulnar joint are not independent of the forearm and cannot function if the forearm is either locked, unstable or destroyed.^{2,3}

Monteggia fracture-dislocation represents a complex situation where we assume ulnar reduction will lead to radial head reduction as well, however this is not usually the case and some radial heads remain chronically dislocated even after proper ulnar reduction and fixation.^{4,5} There is dearth of information with regard to

chronic osteomyelitis of one or both forearm bones and their treatment strategies. The Masquelet,⁶ fibular grafts and Ilizarov technique⁷ are most frequently used for this condition whether in the forearm or any other anatomical location. However, the versatility and ability to control bone regeneration and simultaneous deformity correction is well known as an advantage of using Ilizarov technique. To the best of our knowledge we report the first case in literature to have such treatment strategy for treatment of complicated infected Monteggia fracture with ulnar defect and chronically dislocated radial head.

Case report

Case description

With our institutional review board (IRB) and ethical committee approval we shared a 43 years old man presented to our institute with infected left forearm nonunion. He had road traffic injury 4 years ago which resulted in open Monteggia fracture of the left forearm. The patient presented with ulnar nonunion and plate fixation and accompanied dislocated radial head.

The patient reported primary surgical treatment of the wound at his hometown with plate osteosynthesis of the left ulna which was complicated by plate breakage (the patient lost the original radiograph); the fracture was then re-plated (Fig. 1A). Six months later the patient was referred to our center in the department of bone

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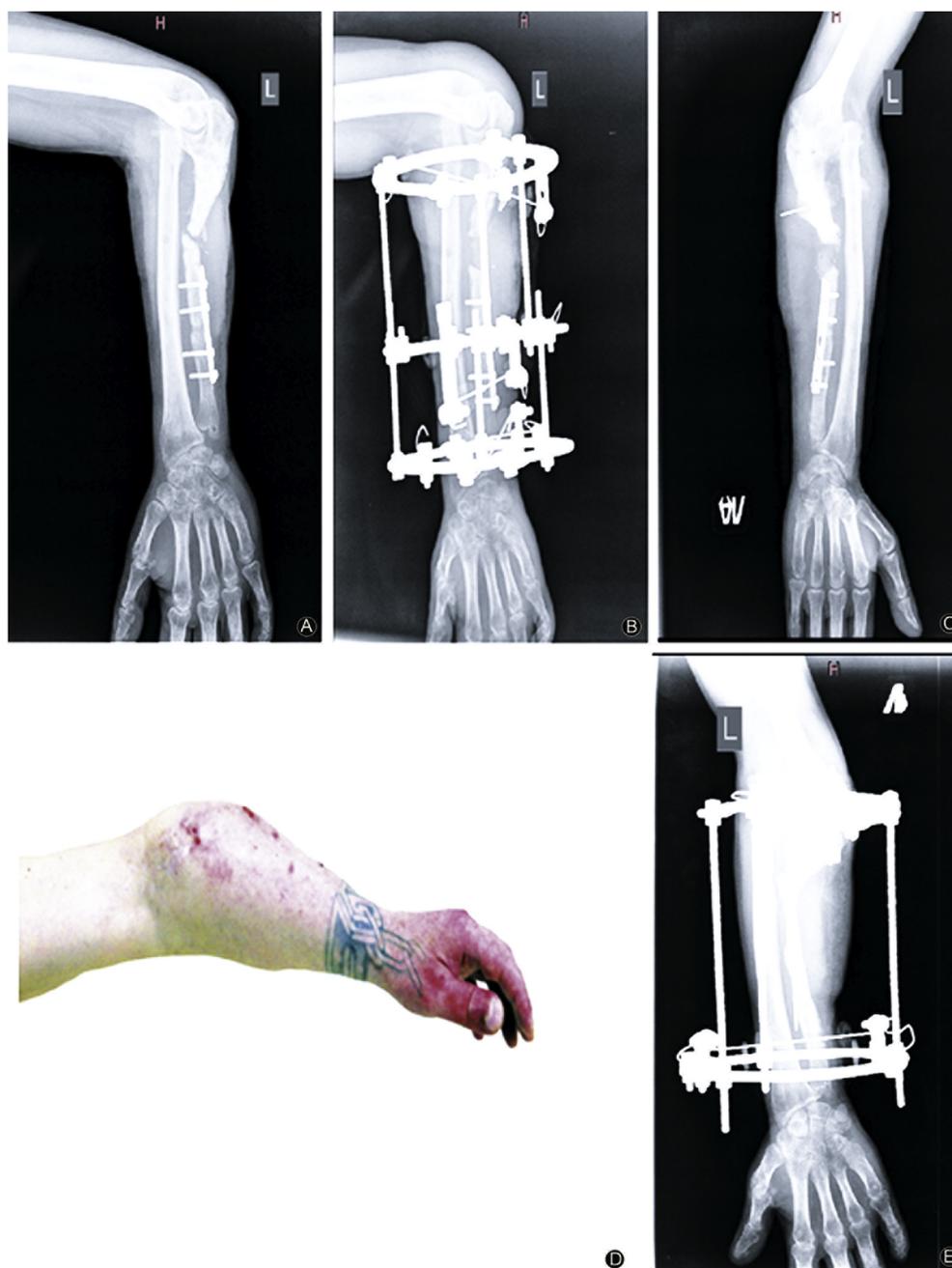


Fig. 1. An 43 years old man with mismanaged Monteggia fracture. (A) First presentation after 6 months showing re-fixation of the fracture with plate; (B) Resection of the nonunion and application of spacer supported by Ilizarov frame; (C) Frame removal with failed osseointegration and dislocated radial head; (D) Left forearm with discharging sinuses; (E) Spacer removal and fixation of fibular graft aiming for union. The radial head is notably displaced.

reconstruction where swab was taken and the result showed *Staph Aureus*. The nonunion was resected and a spacer was applied to fill the 2.5 cm defect. An Ilizarov frame was applied for support and compression for osseointegration (Fig. 1B). Intravenous (IV) Cefazolin was given for 10 days according to culture and sensitivity results. Six months later the frame was removed due to cessation of the discharge, but clinical examination proved failed osseointegration and radial head remained dislocated (Fig. 1C). Six weeks later the patient had discharging sinuses from his forearm (Fig. 1D); seven months later the spacer was removed and after debridement the defect size increased to 3.3 cm and a fibular graft was applied and fixed by K-wire and supported and compressed by Ilizarov frame (Fig. 1E). After taking swab, the patient received IV antibiotics

for 10 days according to culture and sensitivity results. Unfortunately, three months later the patient presented again with purulent discharge on the wires and a sinus opened in the area of the postoperative wound.

Treatment strategy and surgical technique

Three months later the frame was removed because of deep infection of all wires and the patient was referred to the infection department with a plaster cast. The patient had discharging sinuses on his left forearm with elbow contracture and flexion of 70° and extension lag of 30° and very limited supination and pronation. We started by taking wound swab for culture and sensitivity test,

which identified staphylococcus aureus as the causative microbe was sensitive to cefazolin. The patient received 1 g IV cefazolin every 8 hours for three weeks.

Surgical treatment started by debridement with removal of the infected fibular graft and K-wire at the same time. Following IV antibiotics, we did osteotomy at the distal ulna which was fixed by Ilizarov frame aiming for proximal ulnar transport (Fig. 2A). The frame consisted of half ring at the elbow to facilitate flexion and extension and two full rings at the very proximal ulna which was oriented in such a way to correct the forearm varus deformity and reduce the radial head at the end of distraction and another one at

the very distal part of the ulna. Since fixation of the frame will usually take a long time, the wires were passed through the ulna only to allow for supination and pronation. Distraction started at day 7 after osteotomy at a rate of $\frac{1}{4} \text{ mm} \times 4 = 1 \text{ mm}$ every day for 33 days to gain 3.3 cm bone regeneration and achieve docking at the distal ulnar fragment. Three rings with wires passing through the ulna were added at the beginning of bone transport to stabilize the ulnar transported fragment and to have more control at the docking and compression site (Fig. 2B). After 4 weeks from docking and primary bony consolidation and union we did another osteotomy at the distal ulna and continued distraction for 15 days at

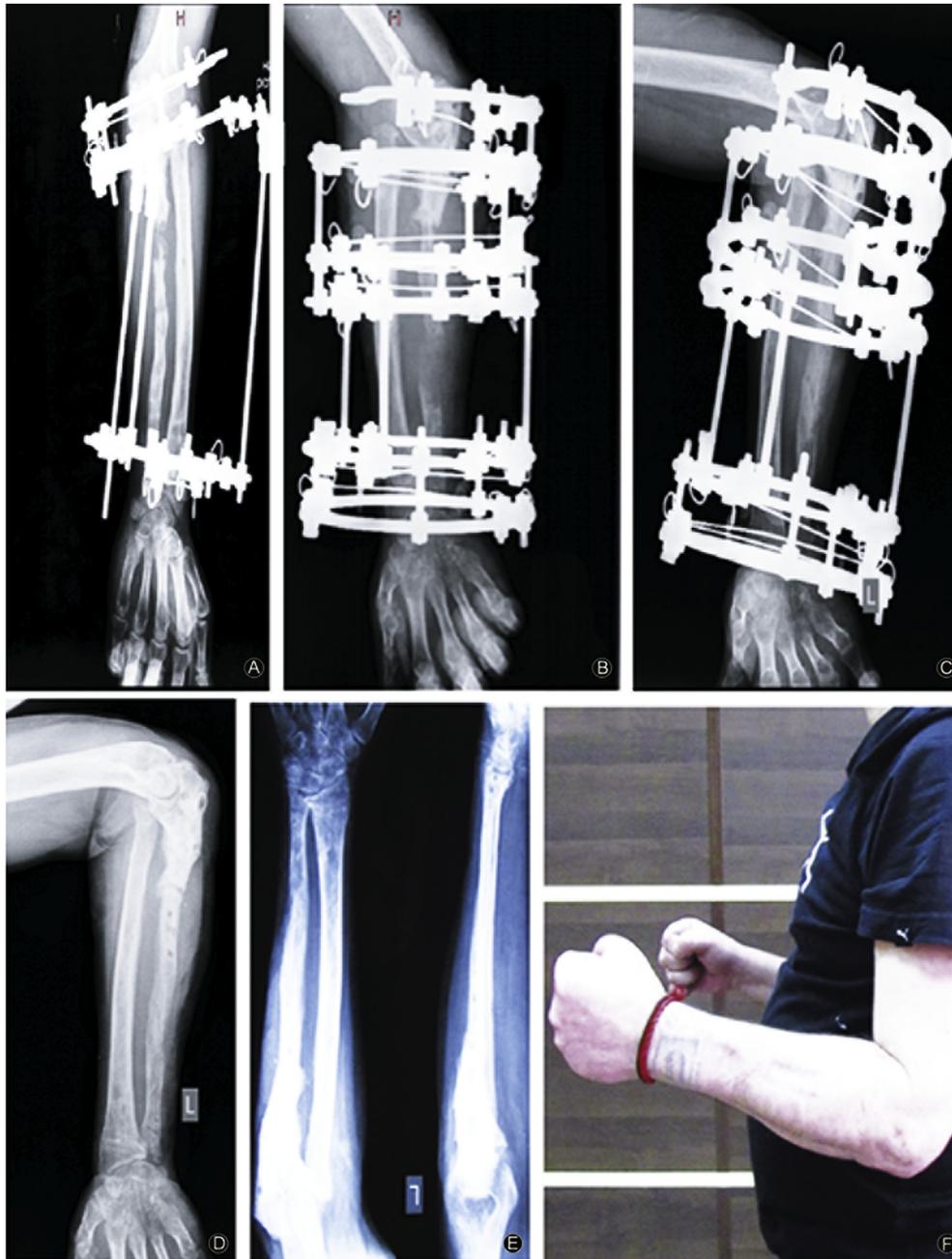


Fig. 2. Treatment at the infection department. (A) Removal of the old frame debridement and fixation by new Ilizarov frame; (B) Addition of three rings and wires through ulna to help stabilize ulnar fragment during bone transport and radial head reduction; (C) At 4 months follow-up, the regeneration starts to consolidate; (D) Union at docking site with reduction of radial head after frame removal; (E) One and half year follow-up showing full consolidation of the ulna with no signs of infection; (F) Clinical appearance with deformity correction and normal range of motion and hand grip.

the same rate to achieve radial head reduction, so at the end of distraction we had 4.8 cm of new bone regeneration (Fig. 2C). The frame was maintained for a period of 8 months for full consolidation (Fig. 2D). Laboratory findings were normal; white blood cells (WBC) count and C-reactive protein turned back to normal. The patient maintained physiotherapy with range of motion activity at the elbow joint and also increasing supination and pronation with the help of visits to physiotherapy department. The patient also started to exercise to regain his hand and forearm power.

Outcome

At final follow-up the patient had improved clinical outcome with elbow flexion of 135° and extension of 0°, supination of 65° and pronation of 75° which were very close to normal range of elbow motion. The patient had also regained full length of his left forearm and radiography showed anatomical bony alignment of radius and ulna except for minimal radial head subluxation which did not affect the overall function of the left elbow (Fig. 2E and F).

Discussion

There is no doubt that treatment of chronic osteomyelitis represent a difficult task as there is no consensus on the best treatment strategy and many centers and experts have developed their own treatment modality.⁸ For such cases it is important to restore the forearm function and to stop the infection process simultaneously. The main options range between palliative and reconstructive.⁹ With over 30 years of experience at a single institute, we adopted the reconstructive strategy with debridement, sequestrectomy, anti-infective chemotherapy and bone transport using the Ilizarov technique being our main treatment tools.

Our case presented with ulnar proximal diaphyseal defect on top of an established infection. Our treatment strategy included debridement, species specific IV antibiotics for three weeks and bone transport using distraction compression Ilizarov technique, the technique also represent continuation of bone transport to simultaneously reduce radial head. The main technique options other than Ilizarov are the Masquelet technique and plastic procedures like fibular grafts. Masquelet technique which combines induced membranes and cancellous autografts has the advantage for filling bone defects but is difficult to predict the outcome, especially in post-infective defects.¹⁰ We think the most suitable method for this patient is bone transport using Ilizarov technique primarily because it helps address bone defects and secondly by continuing distraction after bone docking, the force of distraction is transmitted through the interosseous membrane from the ulna to the radius to help radial head to assume its anatomical position.

A comparison between nonvascularized fibular graft and Ilizarov bone transport in the treatment of tibial bone defects showed that both techniques are effective to address this complex problem with the earlier has the chance of early external fixator removal; however, it has a limitation in patients with severe infections and requires long bracing to address stability and union.¹¹ It is worth mentioning that IV injection of antibiotics will not work if there is not enough debridement or there is instability, which might have contributed to failure, like the first two operations in the first

department in our center. On the other hand Ilizarov bone transport technique enables early weight bearing and is very stable during treatment process; it can also address large bone defects and has the ability to generate soft tissues as well through the concept of distraction histogenesis.

Other main alternative techniques have the disadvantage of donor site morbidity and once failed it will be very exhaustive to repeat the surgical procedure for the patient; while when using Ilizarov technique this can be avoided by cleaning the docking site before final compression of the transported bone segment. The main disadvantage of Ilizarov technique is pin tract infection which can be solved by meticulous dressing and keeping the site clean. Another disadvantage is the lengthy duration of treatment which can be outweighed by the benefits patients gain after treatment.

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Nil.

Ethical statement

The institutional review board and ethical committee have approved this study.

Conflicts of interest

All authors declare that they have no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cjtee.2019.04.005>.

References

- Dumontier C, Soubeyrand M. The forearm joint. In: Bentley G, ed. *European Surgical Orthopaedics and Traumatology*. Berlin: Springer-Verlag Berlin Heidelberg Springer; 2014:1509–1524.
- LaStayo PC, Lee MJ. The forearm complex: anatomy, biomechanics and clinical considerations. *J Hand Ther*. 2006;19:137–144.
- Bakri K, Moran SL. Initial assessment and management of complex forearm defects. *Hand Clin*. 2007;23:255–268.
- Stitgen A, McCarthy JJ, Nemeth BA, et al. Ulnar fracture with late radial head dislocation: delayed Monteggia fracture. *Orthopedics*. 2012;35:e434–e437. <https://doi.org/10.3928/01477447-20120222-35>.
- Chen HY, Wu KW, Dong ZR, et al. The treatment of chronic radial head dislocation in Monteggia fracture without annular ligament reconstruction. *Int Orthop*. 2018;42:2165–2172. <https://doi.org/10.1007/s00264-018-3943-6>.
- Masquelet AC, Begue T. The concept of induced membrane for reconstruction of long bone defects. *Orthop Clin N Am*. 2010;41:27–37. <https://doi.org/10.1016/j.joc.2009.07.011>.
- Ilizarov GA, Green SA. *Transosseous Osteosynthesis—Theoretical and Clinical Aspects of the Regeneration and Growth of Tissue*. Berlin: Springer-Verlag; 1992.
- Stevanovic M, Gutow AP, Sharpe F. The management of bone defects of the forearm after trauma. *Hand Clin*. 1999;15:299–318.
- Walter G, Kemmerer M, Kappler C, et al. Treatment algorithms for chronic osteomyelitis. *Dtsch Arzteblatt Int*. 2012;109:257–264. <https://doi.org/10.3238/arztebl.2012.0257>.
- Giannoudis PV, Faour O, Goff T, et al. Masquelet technique for the treatment of bone defects: tips-tricks and future directions. *Injury*. 2011;42:591–598. <https://doi.org/10.1016/j.injury.2011.03.036>.
- Abdelkhalek M, El-Alfy B, Ali AM. Ilizarov bone transport versus fibular graft for reconstruction of tibial bone defects in children. *J Pediatr Orthop B*. 2016;25:556–560. <https://doi.org/10.1097/BPB.0000000000000334>.