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Masquelet technique for infected distal radius fractures with gaps in paediatric age group

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ABSTRACT

The management of infected nonunion with bone loss is always challenging. The Masquelet technique is an excellent option available for us today. However, there are few reports of its use in the paediatric age group and no reports of its use especially in infected distal radius fractures or nonunion. We report on two children with infection and significant bone loss after open fractures of the distal radius which we have treated successfully using a modified Masquelet technique.

Introduction

The principles of induced membrane osteogenesis are well established today, and the cement spacer with added antibiotics serves to deliver high local concentration of antibiotics with minimum systemic side effects [1,2]. There are some reports of its use for infected distal radius fractures or nonunion in adults, but not for similar cases in the paediatric age group [3–7] [Table I]. In this study, we report on two similar cases of infected distal radius fractures with large bone gaps resulting from sequestration of a segment of bone which have been successfully treated using this technique [Table II].

Case 1

An eleven-year-old boy fell from a tree and injured his left distal forearm (Fig. 1.a). He was diagnosed as fracture both bones distal forearm and was initially treated in his home town with lavage, close reduction and K-wire fixation (Fig. 1.b). The child developed discharge from the wound within 3–4 days of surgery. He was treated with antibiotics but the discharge persisted and K-wire removal was done after 35 days. As the infection did not settle down even after K-wire removal, he was referred to us 3 months after the injury. On examination there was gross stiffness of wrist and fingers with seropurulent discharge on the radial aspect above the wrist (Fig. 1.e). Xray's showed ununited fracture of the radius with a large sequestrated segment of radius (Fig. 1.c). The ulnar fracture had united. A sinogram was also done which clearly delineated the sequestrated segment (Fig. 1.d). After preoperative evaluation by the anaesthesiologist, he was taken up for surgery. Thorough debridement was undertaken, with excision of the 6.7 cm sequestrated segment of the radius. Tissue from multiple layers was taken for culture and sensitivity and histopathological examination. An antibiotic

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Table I
Similar studies of Masquelet technique in bone gap of radius pathology in adult vs our study in paediatric age group.

Study	Number of cases/sites	Mean size of bone gap	Graft to fill bone gap in second stage	Problem in union
Luo et al. [9]	4 cases/radius	5.8 cm	Autograft	No
Devis et al. [10]	4 cases/radius	3.8 cm	Allograft	50%
Micev et al. [11]	1 case/radius	4.5 cm	Allograft, demineralised bone and autograft	100%
Dhar et al. [5]	5 cases/radius	4.8 cm	Autograft	No
Walker et al. [6]	7 cases/radius	4.9 cm	Autograft	No
Bourgeois [13]	6 cases/radius	6.4 cm	Autograft	17%
Giannoudis et al. [7]	11 cases/(7 radius + 4 forearm)	3.2 cm	Autograft	No
Perna et al. [12]	7 cases/radius with or without ulna	1.8 cm	Autograft	No
Our study[a]	2 case/distal radius	7.5 cm	Autograft	No

[a] Paediatric age.

Table II
Case characteristics.

Case	Age in years/ gender	Mechanism of injury	Bones involved	Time from injury to presentation in months	Fixation time elapsed between both surgical stages	Bone gap	Time to consolidation (months)
1	11/M	Fall from tree	Distal radial shaft	3	46 days	6.7 cm	5
2	14/M	Fall from tree	Distal radial shaft	3	48 days	8.2 cm	5

impregnated cement block (20-gram PMMA with 2-gram vancomycin) was placed in the defect overlapping the two ends of the bone gap (Fig. 2a). An above elbow cast was applied. Patient was discharged from hospital after the second dressing on the fifth day and encouraged to do finger movements, and shoulder movements. The cast was changed to a below elbow cast at two weeks when the sutures were removed and the elbow mobilised. Patient was on intravenous antibiotics for 7 days and then on oral antibiotics for a further 5 weeks based on the culture and sensitivity reports. The postoperative period was uneventful. Patient underwent serial CRP and ESR testing during the follow up. After forty-six days of primary surgery, the wound and sinuses were well healed, the inflammatory markers had settled, and there were no clinical signs of active infection. At this stage the second stage surgery was performed. The cement block was removed carefully preserving the induced membrane (Fig. 2.c), the medullary canal on the proximal fragment was opened and the bone defect filled with a long strut graft from the ipsilateral iliac crest along with cancellous bone chips. The strut graft was used to improve the stability of the fixation because of the small distal fragment. A long T shaped locking plate was used for internal fixation. Post-operatively it was supported in a POP slab for three weeks followed by a mobilization of the wrist and fingers. Subsequent follow ups showed that the fracture was well healed by five months. His wrist and finger flexion improved significantly and at the two years follow up he had a satisfactory clinical and radiological outcome (Fig. 3).

Case 2

A fourteen-year boy sustained an open fracture of his left distal radius and ulna following a fall from tree three months before he presented to us. He was treated elsewhere initially by debridement of the radial side and open reduction and nailing of the ulna. He was given an above elbow cast for four weeks. On removal of the cast, he was found to have a discharging wound on the radial side, which was treated with antibiotics and dressings. As the discharge persisted, he was referred to us for further treatment three months after the initial injury. On examination, there was gross stiffness of the fingers and wrist. There was a persistent seropurulent discharge from a sinus on the volar radial aspect just above the wrist. The initial post injury X-ray was not available and the first available X-ray was after the ulnar fixation (Fig. 4a). The X ray at presentation showed a large sequestrated segment extending from the shaft to the distal radius metaphysis (Fig. 4b). After suitable counselling and preoperative assessment, he was taken up for surgery. There was a large 8.2 cm long sequestered segment of the radius (Fig. 4c) and significant infected granulation tissue present. A through debridement was done. Samples for culture and sensitivity were taken from various layers. A twenty-gram cement block impregnated with two-gram vancomycin was inserted (Fig. 4d). As there was no evidence of infection on the ulnar side, the ulnar nail was left in situ (Fig. 4e). At this stage an above elbow POP cast was applied. Wound inspection through a window in the cast was done at 48 h and five days, which showed satisfactory progress and the sutures were removed at 14 days postop. He was called for review after four weeks. He was treated with i.v. antibiotic for seven days and continued with oral antibiotic for a further five weeks based on culture and sensitivity reports. Patient underwent serial CRP and ESR testing during the follow up visits. After 48 days of surgery, he presented to us for his second stage surgery. At this stage there were no clinical signs of infection and his inflammatory markers were normal. Second stage surgery was performed with removal of the antibiotic cement block carefully to preserve the induced membrane (Fig. 5a), medullary canal was opened and filled with autologous cortico-cancellous strut graft from the iliac crest along with autologous cancellous bone chips. The fracture was fixed with a long locking T plate (Fig. 5b). The cortico-cancellous strut graft was used instead of just cancellous bone graft to provide additional stability as the distal radius segment was small. The ulnar nail was removed and a sleeve resection of the distal ulna was performed to correct the radioulnar relationship (Fig. 5c, d). Postoperatively he was supported in a POP slab for

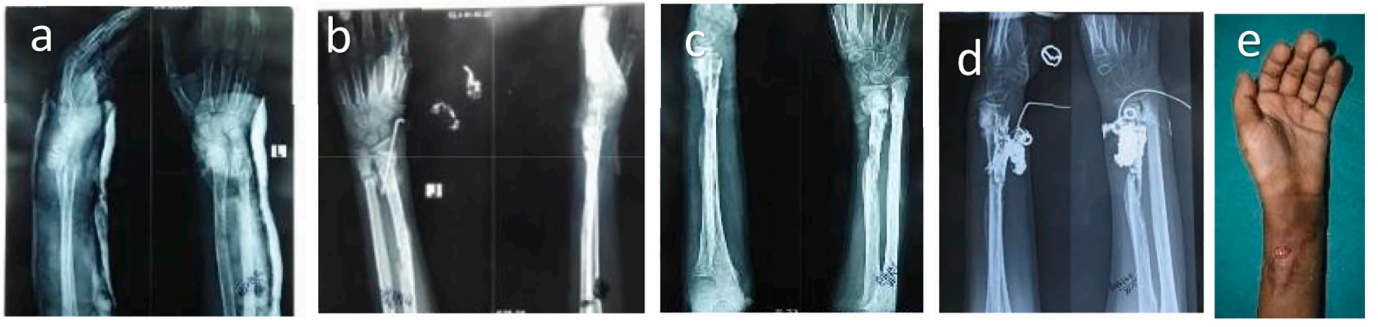

Fig. 1. (a) Patient presented with first lateral and anteroposterior (AP) view taken after slab application on day one after injury (b) AP and lateral view taken after lavage, close reduction and K-wire fixation. (c) Preoperative lateral and AP view after 3 months, (d) Sinogram showing sinus tract extending to distal radius. (e) Clinical photographs showing sinus on lateral side on volar aspect of distal forearm.

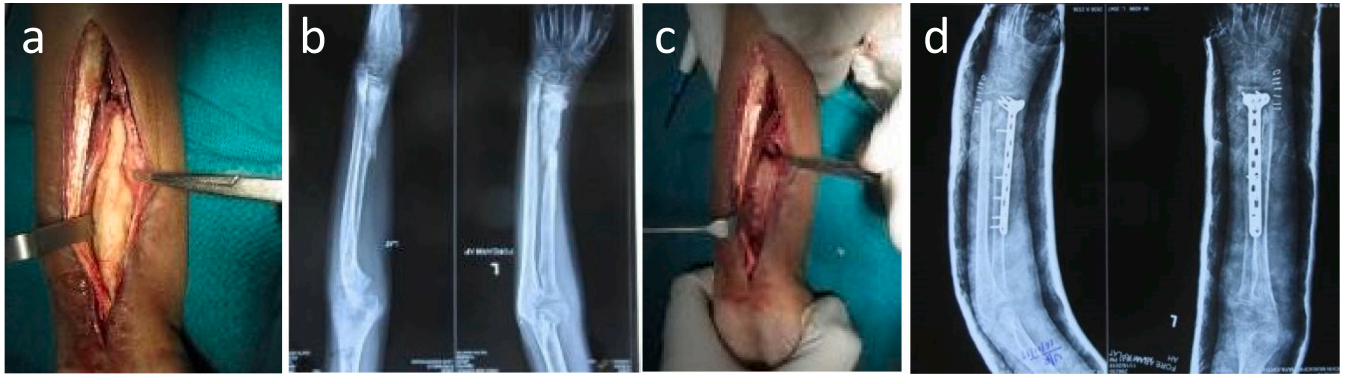

Fig. 2. (a) Bone gap filled with antibiotic impregnated bone cement after debridement and excision of sequestrated part of radius in stage one, (b) Lateral and AP view after stage one. (c) Induced membrane formation after removal of cement spacer in stage two, (d, e) immediate Postoperative AP and lateral view after stage two.

Fig. 3. Clinical photographs at 2 years follow up (a) healed scar and significant wasting of volar muscles (b, c, d, e) showing almost comparable palmer flexion (60 degree) and supination (80 degree) and loss of dorsiflexion (0 degree) and pronation (30 degree) (f) lateral and AP radiographs at 2 years follow up.

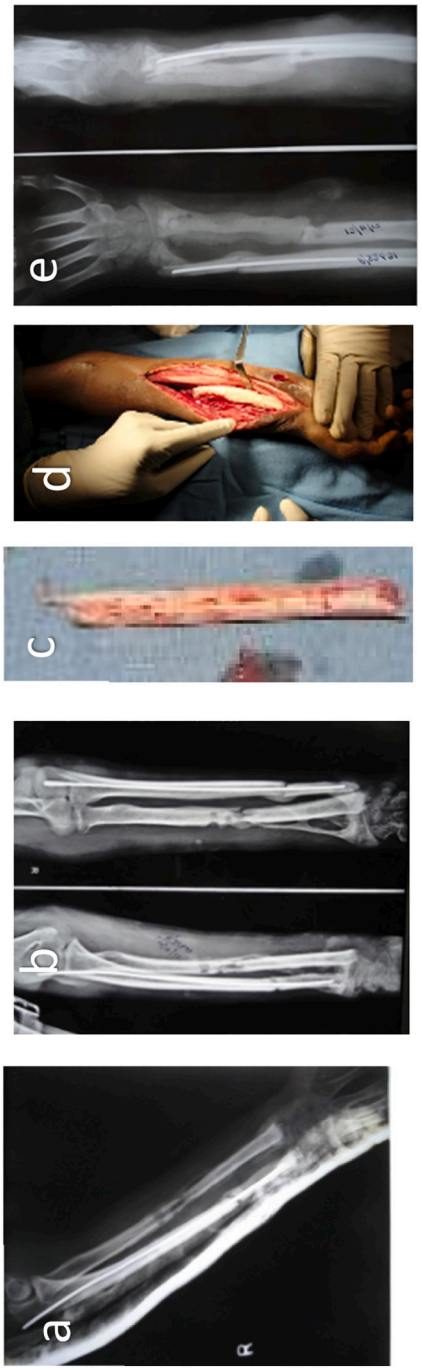

Fig. 4. (a) First available X-ray: after ulnar fixation. (b) Preoperative lateral and AP view. (c) Excised sequestrated segment of the radius. (d) Bone gap filled with the antibiotic impregnated bone cement. (e) Postoperative AP and lateral view.

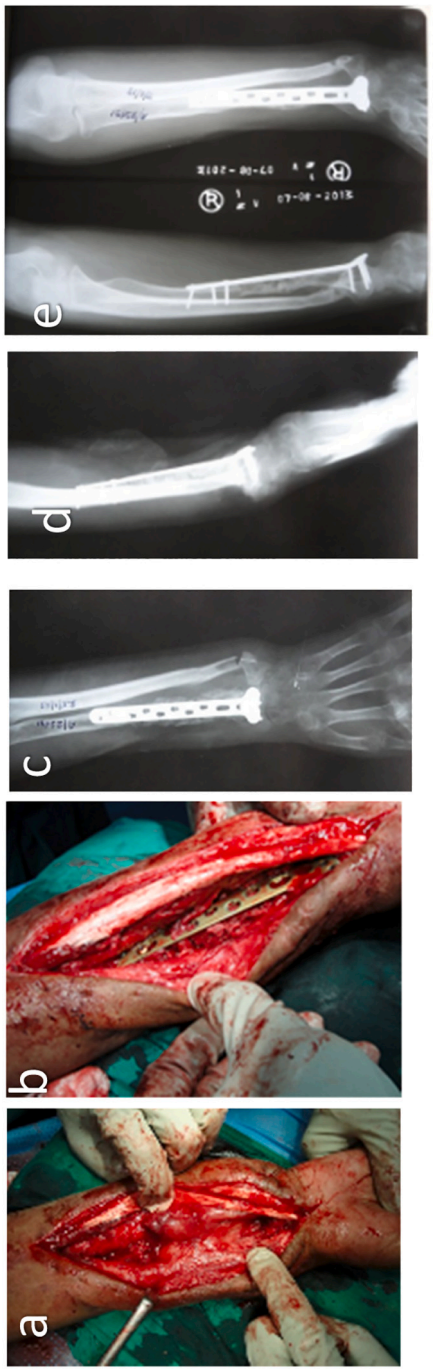

Fig. 5. (a) Bone gap with well-formed induced membrane after removal of cement spacer in stage two. (b) Impaction of iliac strut bone graft in bone gap and fixed with plate and screws, cancellous graft placed in mainly at the junction of strut graft and native bone on both sides. (c, d) Immediate postoperative AP, lateral view (e) Lateral and AP view after two months.

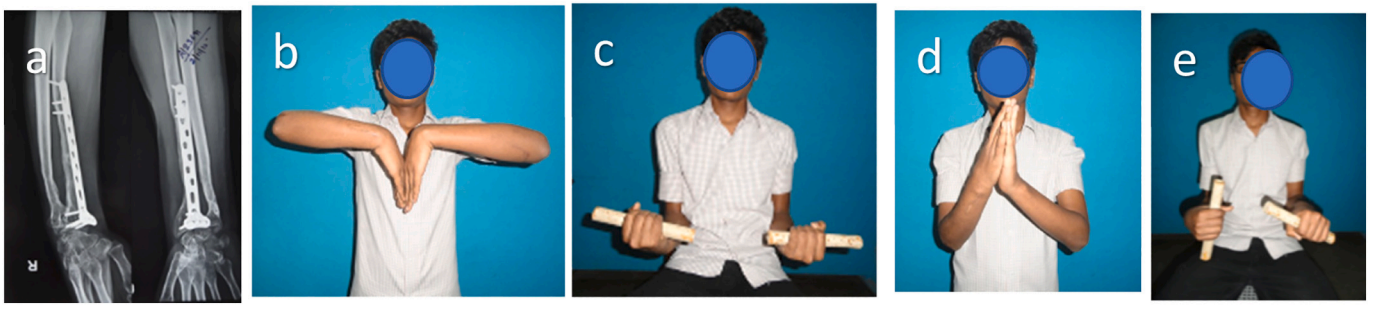

Fig. 6. (a) Radiographs during follow up at 3 year (b, c, d, e). Clinical photographs during follow up at 3 year showing satisfactory range of motion. Comparable palmer flexion (70 degree) and supination (90 degree) and loss of dorsiflexion (5 degree) and pronation (20 degree).

three weeks after which he was allowed mobilization. Subsequent follow-up showed the fracture to heal and the function to improve significantly (Fig. 6).

Discussion

There are no reports in the literature of the use of the Masquelet technique in the treatment of bone gaps of the distal radius of infected nonunion in children. We were able to successfully treat these two children using a modified Masquelet technique. In stage one thorough debridement with removal of all necrotic and nonviable bone and soft tissue is critical to the success of this method. We have used a vancomycin impregnated cement spacer to fill the bone gap to deliver adequate concentration of local antibiotic and also to stimulate an induce membrane, which would promote osteogenesis. Kawakami et al. successfully used cement beads instead of spacer for the same purpose [8]. Luo et al. used gentamycin impregnated cement, and 2 patients suffered reinfection [9].

In the second stage we used a cortico-cancellous strut graft, as the distal fragment in both the cases was small and there was large bone gap. Devis et al. and Micev et al. reported problem in union after using allograft alone or mixed with bone graft substitutes and autograft [10,11]. Allende [4] reported one case of distal radius infected atrophic nonunion with bone gap of 2 cm in 56-year-old female and five cases in which bone gap was in radial diaphysis managed using similar technique. Unlike us he used external fixator along with cement spacer in stage one in case of distal radius pathology. He also used autograft and volar locked distal radius T plate as we had used in both of our cases. We were successful in achieving in union in mean duration of 5 months in both the cases like Giannoudis et al. and Perna et al. [7,12]. Although there was some residual stiffness of the wrist in both cases at the last follow up, considering the fact that they came late with pre-existing gross stiffness of the wrist and fingers, the result achieved were satisfactory. We were able to achieve a functional range of motion in both the cases.

Conclusion

Infected distal radius fractures with bone gaps are a difficult problem especially in the paediatric age group. The induced membrane osteogenesis (Masquelet technique) is an effective way to treat such problem. Meticulous debridement in stage one, and preservation of induced membrane in stage two are key to successful outcomes. Impacted autogenous strut graft in the large bone gap may have helped in improving the stability of the fixation and reduced the risk of fixation failure.

Role of the funding

None.

Consent

Written informed consent was obtained from the patients and their guardians for publication of this case report.

Any meeting at which the work was presented, wholly or in part

None.

Consent taken from patients and his guardian (father) for publication

Yes.

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None.

Declaration of competing interest

None.

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