

Use of surgical glue for Mason type III radial head fractures

A case report

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Abstract

Rationale: A Mason type III radial head fracture, which is characterized by comminuted fragments of the radial head, is a severe injury. Open reduction and internal fixation (ORIF) is an alternative treatment method; however, the technique of using an on-table reduction in combination with surgical glue is rarely reported.

Patient concerns: A 48-year-old man was admitted to our department with complaints of elbow pain after falling down. Elbow radiography and computed tomography (CT) demonstrated characteristics of fractures before the operation.

Diagnosis: Radiographic images showed a Mason type III radial head fracture.

Interventions: The patient underwent ORIF at our hospital. During the operation, the technique of on-table reconstruction combined with surgical glue was used.

Outcomes: The patient recovered well and was able to participate in his usual work.

Lessons: Mason type III radial head fractures could be treated with ORIF, and a satisfactory result could be anticipated, thus avoiding a radial head replacement or resection. Anatomical reduction of a comminuted radial head could be obtained via an on-table reconstruction and application of surgical glue.

Abbreviations: CT = computed tomography, ORIF = open reduction and internal fixation.

Keywords: fracture reduction, radial head fracture, surgical glue

1. Introduction

Radial head fractures account for about one-third of elbow fractures and 2% to 4% of fractures in adults.^[1] The mechanism of injury typically involves a fall on an outstretched arm with the forearm in a pronated position.^[2,3] Mason originally proposed the classification of radial head fractures in 1954.^[4] The classification was modified by Johnston in 1962,^[5] and by Broberg and Morrey in 1987.^[6] A type III fracture refers to a comminuted, displaced fracture involving the entire radial head.

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The appropriate method for treating Mason type III radial head fractures is still a matter of controversy. Surgical treatment options include open reduction and internal fixation (ORIF), radial head arthroplasty, and radial head resection.^[1,7,8] A radial-head excision may result in some adverse effects, including proximal migration of the radius, decreased strength, elbow and wrist degenerative arthritis, cubitus valgus, and posterolateral rotatory instability of the elbow.^[7,9] Because the radial head plays an important role in maintaining the stability of the elbow, many investigators recommend preservation of the radial head, either by ORIF or radial head arthroplasty.^[1,10,11]

In the present study, we report a case of a Mason type III fracture treated with on-table reconstruction and an application of surgical glue, which obtained a satisfactory result. The study was approved by the institutional ethics committee in Shanghai Pudong Hospital with an ethics approval number of WZ-2018-001.

2. Case report

A 48-year-old man was admitted to our hospital, with a complaint of right elbow pain, after falling down with the wrist and hand in extension. Physical examination revealed palpable swelling and pain around the radial head. There was no tenderness in the olecranon and the medial aspect of the elbow. Motion of the right elbow was limited due to the pain. The patient denied pain of the wrist or paresthesia of the right hand. The elbow radiography and computed tomography (CT) demonstrated a Mason type III radial head fracture (Fig. 1A–D).

The patient underwent ORIF 2 days after injury, and general anesthesia was applied. The patient lay in a supine position, with



Figure 1. (A) Preoperative anteroposterior x-ray image of the elbow. (B) Lateral x-ray image. (C, D) The CT scan showed comminuted fragments of the radial head.

tourniquet on the upper arm. The arm was placed over the chest on a bolster to support the extremity. The Kocher approach was adopted to expose the radial head. The annular ligament and capsule were longitudinally dissected. Intraarticular hematomas were irrigated. The fracture fragments of the radial head were explored and retrieved. Radial head reconstruction was performed precisely on the operation table. The comminuted fragments were bonded with surgical glue (n-butyl-2-cyanoacrylate; Compont Medical Devices Co., Ltd., Beijing, China) to restore the configuration of the radial head. The surgical glue is a colorless transparent liquid stored in a vial. A straw was used to remove the glue from the vial and apply it to the fracture fragments to bond them together (Fig. 2A). The radial head was

fixed temporarily with 1-mm Kirschner wires (Fig. 2B), which were also guide wires. Two interfragmentary screws, which were headless Bold cannulated compression screws (General Care Int'l, Shanghai, China), were used followed by removal of the Kirschner wires (Fig. 2C). The reduced radial head was then reimplanted in situ. Definitive fixation was achieved using a low-profile mini-plate (DePuy Synthes, Suzhou, China), which was placed on the safe zone so as to not interfere with the rotational movements of the forearm (Fig. 2D). Intraoperative fluoroscopy was used to confirm that the fracture was well reduced and secured (Fig. 3). The wound was irrigated, and the capsule and annular ligament were repaired with absorbable sutures. Stability and range of motion of the elbow were carefully checked. At the

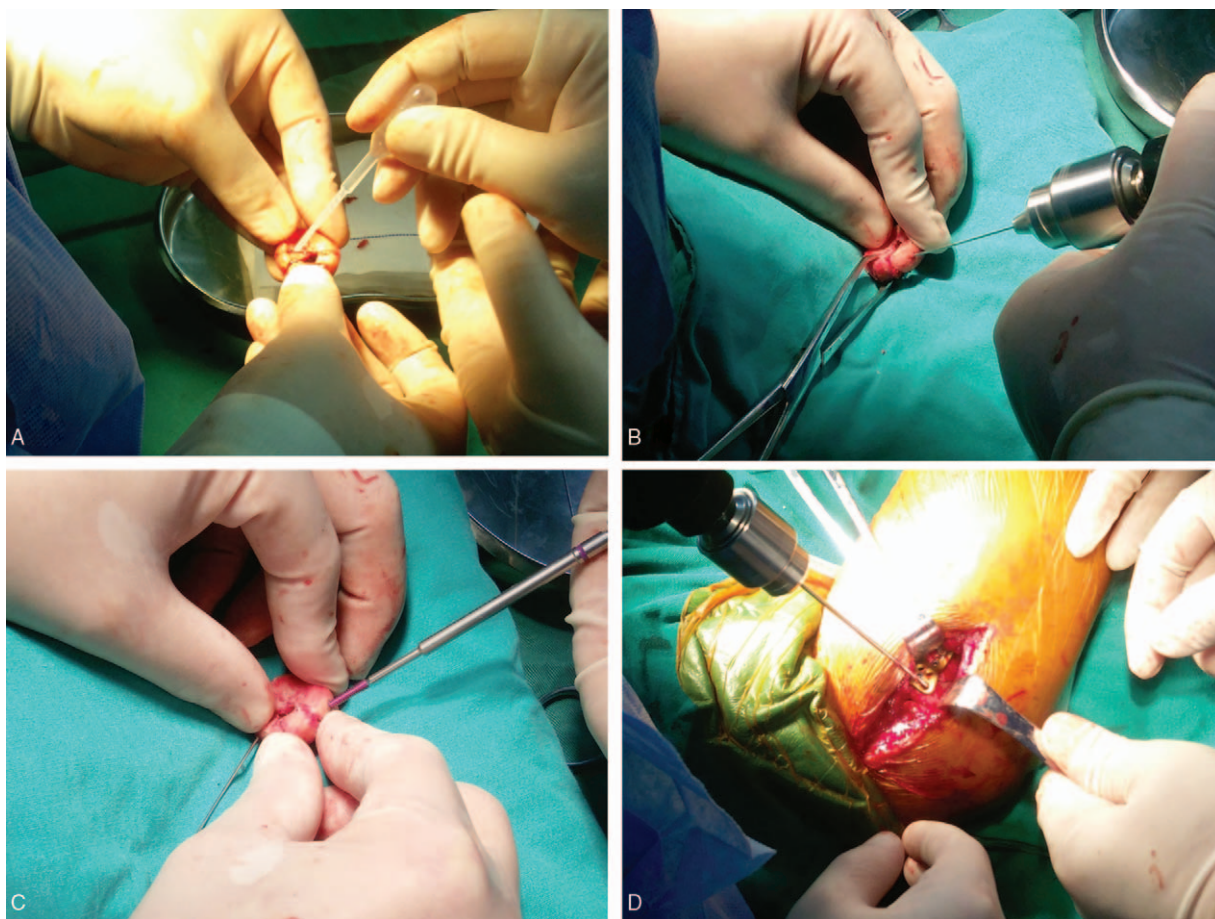


Figure 2. (A) The comminuted fragments of the radial head were reassembled and bonded with surgical glue. (B) Temporary fixation with K-wires. (C) The Bold screw was used to secure the fixation. (D) Definitive fixation using a low-profile mini-plate.

end of the procedure, the distal radioulnar joint was examined clinically as well as under fluoroscopy to exclude an Essex-Lopresti lesion.

Above-elbow plaster was applied for a week followed by a removable splint for 3 weeks. Free active motion and forearm

rotation were initiated. A postoperative CT (Fig. 4A–D) was used to evaluate the reduction quality after the surgery. The fracture received anatomic reduction. Anteroposterior and lateral views of the elbow radiography were taken at the follow-up. Bone union was achieved at 12 weeks (Fig. 5A–D). In the 4th month, the patient was participating in usual work and completely pain free. The latest follow-up was 2 years after the operation (Fig. 6A, B). The patient was satisfactory with the result.

3. Discussion

A Mason type III radial head fracture, characterized by comminuted fragments of the radial head, is a severe injury. A fracture displacement of more than 2 mm has been regarded as a criterion for surgical intervention.^[1,2,12] Methods of treatment for this kind of fracture include ORIF, radial head resection, and arthroplasty. In current literature, there is no definitive answer as to which one is the optimal method.

Crönlein et al^[1] reported 24 patients with Mason type III-IV fractures, who received ORIF with anatomically preshaped low-profile locking plates. At follow-up survey, patients rated their satisfaction for elbow function as highly satisfied in 17 cases and satisfied in 3 cases. The authors concluded that ORIF should be preferred before radial head resection or replacement in complex radial head fractures on the basis of the importance of the radial



Figure 3. Intraoperative fluoroscopy showed anatomical reduction and solid fixation.

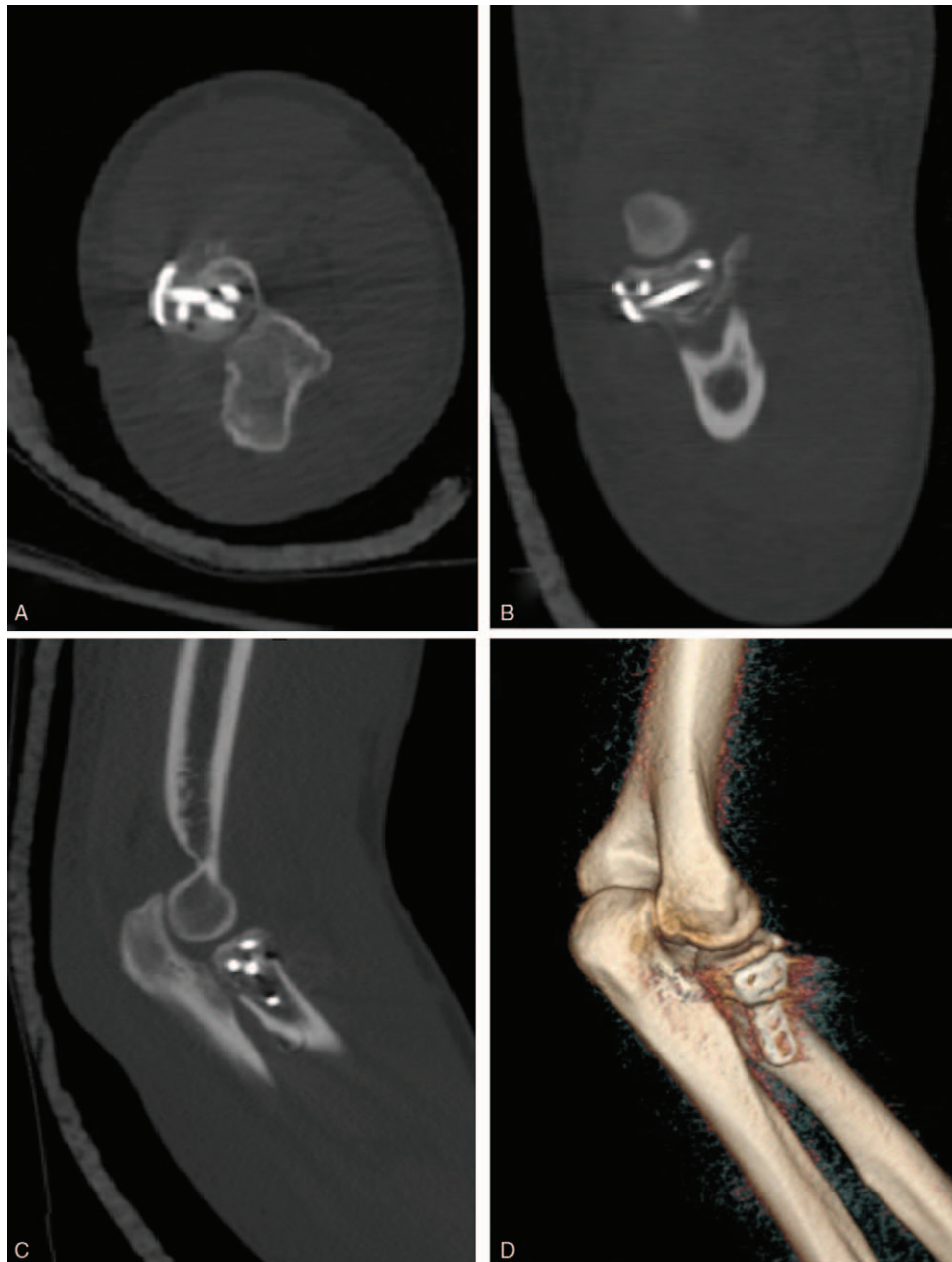


Figure 4. A postoperative CT was used to evaluate the reduction quality. (A) Axial view. (B) Coronal view. (C) Sagittal view. (D) 3-D reconstruction.

head for elbow stability. In a previous study reported by Ikeda et al,^[13] 3 fractures were classified as Mason type III and 7 as type IV, and all of the 10 fractures were treated with ORIF using low-profile mini-plates. According to the Broberg and Morrey functional elbow index, the mean score was 90.7 points, and the outcome was excellent in 3 patients, good in 6, and fair in 1. They thought ORIF was applicable to severely comminuted radial head fractures, which otherwise would require excision. Akman et al^[8] retrospectively compared the clinical results of 34 patients with Mason type III fractures. Nineteen patients received ORIF, and 15 patients underwent radial head resection. They did not find a statistically significant difference between the ORIF and resection groups regarding the clinical and radiological out-

comes. However, in another study by Meena et al,^[14] radial head resection produced better functional results than ORIF in treating Mason type III fractures. As a result, the authors recommended radial head excision in Mason type III fractures. However, their study was a short-term study with a follow-up of only 12 months. The ORIF group had longer immobilization time. In addition, only screws or wires were used in the ORIF group, with no use of mini-plates. These factors might affect the final results. Lópiz et al^[7] performed a retrospective study, in which 25 Mason type III fractures were analyzed. Eleven patients were treated with radial head resection, and 14 patients received radial head arthroplasty. The authors recommended radial head excision due to the good function of the elbow post-excision and a high

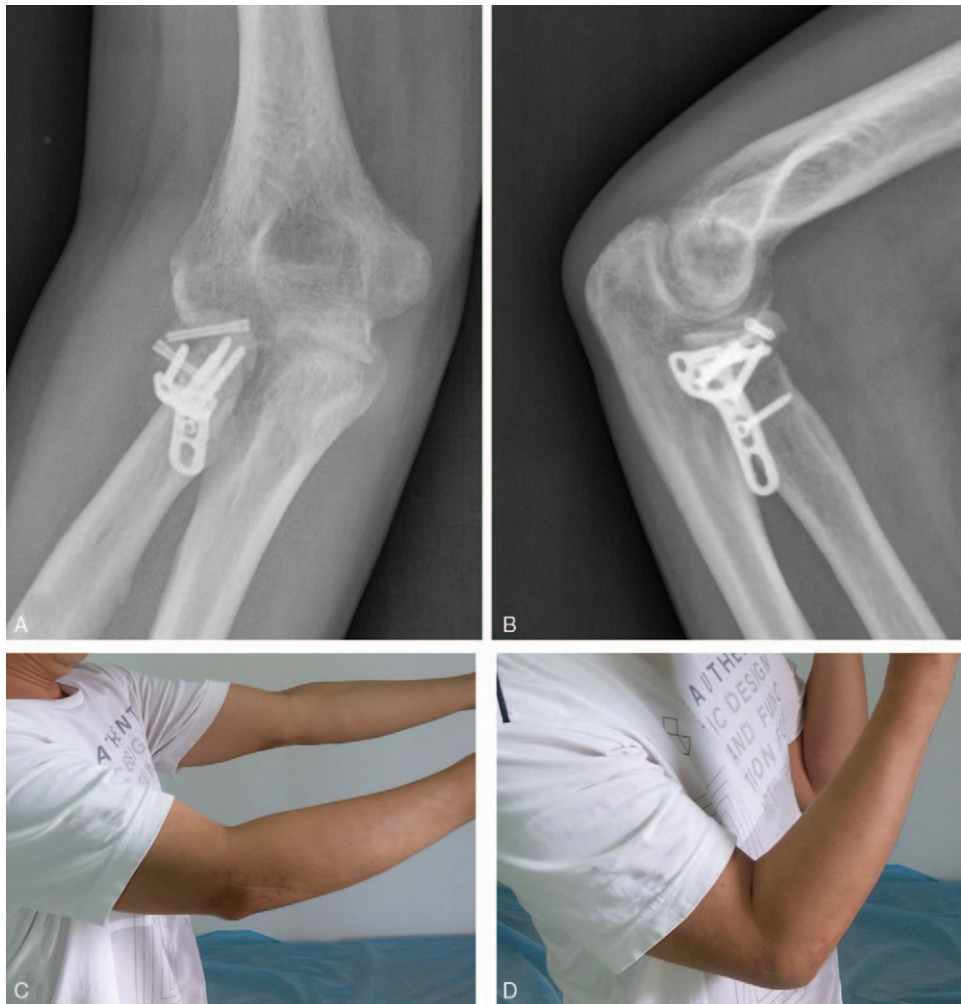


Figure 5. (A, B) Three-month follow-up radiographs showing fracture union. (C, D) Function evaluation.



Figure 6. (A, B) Two-year follow-up radiographs.

complication rate with radial head arthroplasty. Zwingmann et al^[15] performed a meta-analysis regarding the clinical results achieved after different operative treatment methods of radial head and neck fractures. A total of 841 studies were identified and there were 302 patients in 33 studies with Mason type III fractures. ORIF, with a success rate of 92%, demonstrated the best results for the treatment of type III fractures and seemed to be superior to resection (81%) and arthroplasty (79%). However, another 2 meta-analyses revealed that radial head arthroplasty had a better outcome than ORIF for Mason type III fractures.^[16,17]

The radial head is an important stabilizer of the elbow and forearm articulations.^[18] It resists proximalization of the radius in the axial loading of the forearm and acts as a secondary valgus stabilizer by resisting the valgus forces.^[3,12] If the medial collateral ligaments were disrupted, the radial head would be the main stabilizer against the valgus forces. Concurrently, at the elbow, approximately 60% of the axial load was transferred by the radial column. Removal of the radial head will make the elbow unstable and change the kinematics of the elbow. It can also lead to proximal migration of the radius and concurrent derangement of the distal radioulnar joint. Meanwhile, 100% of the load will be transferred to the ulnar column, which will make the ulnohumeral joint prone to degeneration.^[10,12] On the basis of these factors, the radial head should be preserved as much as possible even if the fracture is comminuted. With the development of locking plates, the possibilities of ORIF in complex fractures were extended. In our opinion, for Mason type III radial head fractures, ORIF is still the first choice. Even though a possible poor outcome has occurred, the patients still have the chance to receive a radial head arthroplasty.

Because of the limited space, it is occasionally difficult to reduce the Mason type III fractures via a normal reduction method. On-table reconstruction will make the reduction of the fractures easier. This technique was first described by Businger et al,^[9] and produced good functional outcome. In their study, 2 patients with Mason type III and 4 patients with Mason type IV radial head fractures were treated with on-table reconstruction and fixation using low-profile mini-plates. In another study by Kiran Kumar et al,^[11] 6 patients with Mason type III fractures were treated by an on-table reconstruction technique. The results were rated as excellent in 2 patients, good in 3 patients, and fair in 1 patient. In our case, we also used the on-table reconstruction technique and received a satisfactory result. However, in the process of a fracture reduction, we used the surgical glue to bond the comminuted fragments, which was not mentioned before.

Surgical glue has now been widely used in wound closure, plastic surgery, ophthalmologic surgery, oral and maxillofacial surgery, and vessel embolism in cases of tumor and hemorrhage.^[19–22] However, its application in orthopedic surgery as a bone adhesive, especially for force-bearing bones, is rarely reported. Surgical glue can roughly be divided into 2 groups: synthetic and biological adhesives.^[23] As a widely used type in the clinical practice, fibrin glue belongs to the latter. Cyanoacrylate, however, is almost the most commonly used synthetic adhesive, which was invented by Ardis in 1949 and first used in surgery in 1959 by Coover.^[24,25] In our case, we used the n-butyl-2-cyanoacrylate, as a modified form of cyanoacrylate, which is bioabsorbable and biocompatible.

The studies of Shermak et al^[25] and Amarante et al^[26] showed that cyanoacrylate created a foreign body reaction in tissues and was resorbed, but had no toxic effect. An experimental study by

Akcal et al^[27] showed that cyanoacrylate did not adversely affect fracture healing. For the clinical utilization of cyanoacrylate, several studies received favorable results. Mehta et al^[28] used n-butyl cyanoacrylate to fix mandibular fractures in 10 patients, and fracture union occurred uneventfully in all but 1 case. Yilmaz and Kuyurtar^[24] fixed a talar osteochondral fracture with cyanoacrylate. After 3 months, magnetic resonance imaging showed an anatomically reduced and intact chondral surface, and the clinical result was excellent. Gul et al^[29] used butyl-2-cyanoacrylate to fix osteochondral fractures of the patella and the medial femoral condyle in a 29-year-old man, and the follow-up showed successful healing of the fractures and an excellent clinical outcome. Foresta et al^[30] treated comminute fractures of the anterior wall of the maxillary sinus associated with fractures of the orbital-maxillary complex using n-butyl-2-cyanoacrylate in 25 patients and achieved a good outcome with no complications. Delay on the recovery time of the fracture, displacement of fragments, or pseudoarthrosis was not observed.

In our case, n-butyl-2-cyanoacrylate, as a useful adjunct to plate and screw fixation, was used to hold the comminuted fragments of the radial head in their original anatomical position and osseous union was obtained. The glue provided a simple and quick method to pre-assemble small fragments, which are difficult to fix by conventional means, and facilitated definitive fixation of the fracture. Further investigation using surgical glue as the definitive fixation of bone fractures in orthopedic surgery would be worthwhile and interesting.

4. Conclusion

Mason type III fractures of the radial head can be successfully treated with on-table reconstruction along with the use of surgical glue. Surgical glue facilitated the reduction of comminuted fragments. We believe our method is a reliable and useful treatment option for Mason type III fractures.

5. Consent for publication

Informed written consent was obtained from the patient for publication of this case report and accompanying images.

Author contributions

Methodology: Jia-qian Zhou.

Resources: Da-wei Chen, Wan-kun Hu.

Supervision: Jia-qian Zhou.

Writing – original draft: Da-wei Chen, Wan-kun Hu.

Writing – review & editing: Jia-qian Zhou.

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