

The Use of Phalangeal Plate as “Hook Plate” to Treat Unstable Distal Radius Fracture Fragments with External Fixation

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Abstract

Background: To study the functional outcome of AO type C3 distal radius fracture using external fixation and modified radial flexor carpi approach with contoured phalangeal plate as “hook plate” to treat small comminuted and unstable fracture fragments.

Method: Between June 2016 and October 2017, seven patients presenting with AO type C3 distal radius fracture were treated using modified radial flexor approach and external fixation. Radiographic assessment were based on preoperative and postoperative X-ray and CT imaging during follow-up visits. The grip strength, range of active motion and pain were recorded. Mayo wrist score and Gartland and Werley score were obtained to evaluate functional outcome.

Results: The mean follow-up was 2 years. All patients achieved articular congruity and bone healing. The average Gartland and Werley score was 2.86 which indicated excellent outcome with minimal impairment to daily life. The average Mayo score was 87.5 which overall was a good score, 3 patients (42.9%) had excellent score and 4 patients (57.1%) had good score. No complications such as radioulnar instability and implant failure occurred.

Conclusion: Our results suggest rapid functional outcome and range of motion at the wrist with minimal complications. This technique is effective and addresses the challenges in treating unstable AO type C3 distal radius fracture. Installing the external fixator first provides adequate reduction and enhances stability while the bent phalangeal plate serves as a buttress to grab and fix small fracture fragments.

Introduction

Distal radius fracture is the most common fracture site of the human skeleton⁶ and often occur in young people resulting from high energy injury caused by severe trauma. However, complex distal radial intra-articular fractures (AO type C3) are relatively rare and account for about 5% of all distal radius fracture⁹. Joint surface comminution is the main manifestation followed by avulsion of bone mass at the edge of the joint surface especially with displacement of metacarpal and ulnar bone mass. Treatment of these displaced and unstable fracture remains a challenge. The application of open reduction and closed reduction depends on the nature of the fracture articular surface. Treatment goal focus on extra-articular reduction and restoration of radial length and maintenance of volar tilt^{5,3}. On the other hand, incongruity of the intra-articular distal radius fracture has been associated with development of arthritis^{2,4}.

Surgical methods and instruments such as the clamp needle, volar plate and rotary Kirshner wire series have been used to fix the distal bone fragments mainly on the metacarpal and ulnar side which have achieved good results but still have corresponding drawbacks. Example, for fragments less than 5mm the method of fixation is limited. On the other hand, the traditional palmar anatomic locking plate provide good support at the comminuted fragments but however does not exceed the watershed. Moreover, the distal fractures are often far from the watershed and cannot be well fixed.

Recognizing the limits and complications mentioned above, we report new technique and modification in the treatment of AO type C3 distal radius fracture. We first installed external fixator then used small phalangeal plate contoured as a “hook plate” to provide additional buttress for small fragments with ligament repair to achieve good functional outcome. This technique provides better choice for treatment of displaced, unstable and comminuted fracture of the distal radius.

We believe the use of the external fixation with the proposed modification of the plate in the treatment of comminuted distal radius fracture will produce good clinical and radiographic outcome in these patients.

Materials And Method

This study was approved by our hospital ethic committee board and informed consent was obtained from all individual participants. Between June 2016 and October 2017, seven patients presenting with AO type C3 distal radius fracture were treated at our hospital. The study included six men and one female with a mean average age of 45 years (range 24–65 years). Four patients had injury on the right hand and three patients on the left hand, all of them were closed injuries. The cause of injury were falls (n = 4) and traffic accident (n = 3). In all the subjects preoperative X-ray and CT radiographic images (Fig. 1) were taken followed by manipulative reduction and immobilized with cast.

Surgical treatment involved using external fixator first then followed by contoured phalangeal plate in form of a hook. The fractures were reduced by anterior modified radial flexor carpal approach combined with posterior approach depending on the fracture morphology. The average follow-up was 26 months. The external fixator was maintained for 6 weeks. To access the functional outcome of the surgery we used Mayo wrist score and the Gartland and Werley wrist score, compared at 3 months and 12 months consecutively postoperation. We reviewed radiograph for fracture healing during follow-up (3–24 months).

Surgical Technique

After the induction of anesthesia and placement of arm tourniquet, a standard external fixator (Orthofix® Bussolengo, VR, Italy) was placed across the radiocarpal joint with incision at the base of the second metacarpal and dorsal side of the radius (away from the estimated placement area of the plate) with enough traction distance. The external fixator stents were placed at an oblique angle of 45° to each other. Manual manipulative reduction was done and alignment confirmed by intraoperative fluoroscopy.

Then through the modified radial flexor carpi approach about 4 cm incision was made at the wrist joint space. The distal radius bone was exposed along the radial side of the flexor carpi tendon. The ulnar side was explored to the distal radioulnar joint about 3cm from the articular surface. The fracture fragments were exposed and soft tissues cleared and irrigated. Temporal fixation of the radius styloid process and bone fragments were done with the help of Kirschner wire. Depending on the fracture site, appropriate phalangeal plate (Synthes Inc, Oberdorf, Switzerland) length was contoured to form a hook (Fig. 2A). The

contoured plate was placed on the fractured site and screw applied at the proximal end for eccentric compression and fixation. Here the radius styloid process fracture fragments are conveniently fixed with the “hook plate”. Verification for the placement of the plate on fluoroscopy is made (Fig. 2D). Additional contoured plate is placed when needed. In subjects where preoperative CT confirmed dorsal ulnar bone fragments, a dorsal incision approach was used to access the fragments.

Postoperative Evaluation

After surgery, patients were closely followed up. The external fixator was maintained for 6 weeks, during this time passive and active finger movement was encouraged. After removal of the external fixator, wrist joint movement was emphasized for four weeks. Pain, grip strength and range of active motion were measured and recorded. Postoperative X-ray and CT imaging (Fig. 3) was used to observe articular surface recovery, palmar inclination, ulnar deviation and radial shortening on each visit. Mayo wrist score and Gartland and Werley wrist score were evaluated.

Results

The average follow-up was 25 months. All patients achieved anatomic reduction and fracture healing. No complication such as implant failure and wound infection occurred. Six patients recovered well and returned to their normal daily job and life style during the two-year follow-up. One patient could not return to previous job due to injury to the spine that resulted in paraplegia. In general, wrist motion was significantly improved and was similar to the uninjured wrist. Five patients had their internal fixations removed. All the seven patients were satisfied with the current wrist function and had a good range of motion (Fig. 4). However, one patient had flexion and stretch sensation of the thumb due to scar formation at the radius point where the external fixator was placed. The Mayo wrist score reached 87.5% and that of the Gartland and Werley score was excellent at the end of the study (Table 1).

Table 1
Presentation of Mayo wrist score and Gartland and Werley score at 3 month and 12 months of follow-up.

Patients	Sex	Age	Mayo wrist scores		Gartland and Werley score	
			3 months	12 months	3 months	12 months
			1	Male	46	60
2	Male	37	55	90	16	2
3	Female	65	55	85	18	3
4	Male	43	60	92.5	12	2
5	Male	50	52.5	82.5	16	5
6	Male	58	52.5	80	15	5
7	Male	24	75	95	8	1

Discussion

AO type C3 distal radius fracture involves the articular joint with fracture of the volar lunate facet, die punch, dorsal ulnar and radial styloid fragments¹. The fracture line is often located between the tendon and bone space which manifest with the disruption of the articular bones and connecting ligaments. However, it is difficult for precise reconstruction and repair of the associated ligament and also restore the volar-ulnar and dorsal-ulnar bone fragments resulting to palmar subluxation and dislocation of the radioulnar joint. For distal radius fragments, open reduction and external fixation with volar hook plate and screws have been proposed¹ to provide good stability but however for fragments less than 5mm the use of this plate is limited.

In this study, we propose technical modification by using phalangeal plate bent at one end to form a hook that provides buttress for fragments and fix tendon-bone junction edge of distal radius fracture with the aid of external fixator. The first installation of the external fixator does not only provide adequate reduction but also allows easy access to the fragments without disruption of the surrounding ligaments. The secured external fixator also enhanced stability at the distal dorsal fragments to resist displacement. Our patients achieved articular congruity and had satisfactory wrist function and range of motion compared to the uninjured wrist. Final follow-up in our study showed no decompression of the median nerve. Our patients had a mean Gartland and Werley wrist score of 2.86 at the end of the study indicating excellent outcome with minimal to no impairment to their daily life. 6 patients (85.7%) reported fair results while 1 patient (14.3%) had a good score at 3 months. However, at 12 months of follow-up, the wrist score was good for 3 patients (42.8%) and excellent for 4 patients (57.2%). On the other hand, objective evaluation of the wrist using Mayo score for the first 3 months saw an average score of 58.6

indicating a poor outcome (poor in 6 patients;85.7%, satisfactory in 1 patient;14.3%), however at 12 months of the study an average score of 87.5 was reported which showed an overall good functional outcome with 3 patients (42.9%) having an excellent score and 4 patients (57.1%) having a good score.

The short-term functional recovery and score were significantly low in the 3 months after surgery. This could be attributed to the long term placement of the external fixator which provided discomfort in the patients but however a close follow-up and rehabilitation training was emphasized after its removal. It has been reported that patients treated with the combined volar plate and external fixation have about 14% complication rate⁸ and 19% hardware tendon irritation⁷. However, our study with this new modified technique with external fixation and the use of contoured phalangeal plate reported no complication by the end of the 2 year follow-up. The advantage of this technique include (i) as a form of buttress plate provides palmar support to prevent dislocation of the wrist joint. (ii) The distal bending hook can grab and stabilize fragments well and maintain the position of bone block. In this way has a good offset position for the longitudinal and lateral tension to avoid displacement and (iii) because the plate has a small notch and the front is bent it helps avoid local sharp protrusion that directly irritates the surround tendons and soft tissues. It is advisable to avoid the use of large plates as this requires extensive separation of the proximal soft tissues and also avoid further dissection of the pronator muscles to reduce postoperation functional impact. The number of patients in this study is limited. Randomized controlled studies to observe the prognosis of these type of fracture patients is needed.

Conclusion

In a summary, the results from this study provide useful information and modified technique in treating AO type C3 distal radius fracture. The use of this surgical approach and fixation is effective and provides better option to overcome the challenges in treating these types of unstable comminuted fractures.

Declarations

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Contributions

Xiangfeng Zhang: first author, carried out study proposal, member of surgical team, recorded and analyzed patients' progress before and after surgical intervention.

Edem Prince Ghamor-Amegavi: second author, member of surgical team, recorded and analyzed patient's progress before and after surgical intervention, research online articles relating to the study.

Hejia Hu: third author, member of surgical team, collected research data and analyzed literature study

Corresponding author

Correspondence to Gang Feng, chief surgeon who over looked the successful new surgical procedure carry out, review literature and analyzed follow-up results.

Ethics declarations

Ethics approval and consent to participate

This study was approved by our hospital ethic committee board and in compliance with ethical standards.

Consent for publication

Written informed consent was obtained from each patient for this publication and accompanying images.

Availability of data and materials

Yes.

Competing interests

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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Figures



Figure 1

Case illustration; a 37-year-old man with comminuted AO type C3 left distal radius fracture with distal volar lunate facet/volar rim fragment(A). Oblique x-ray shows intra-articular displacement and comminution (B). CT scan image indicates the small fragment(C) and loss of volar inclination and dorsal comminution (D).

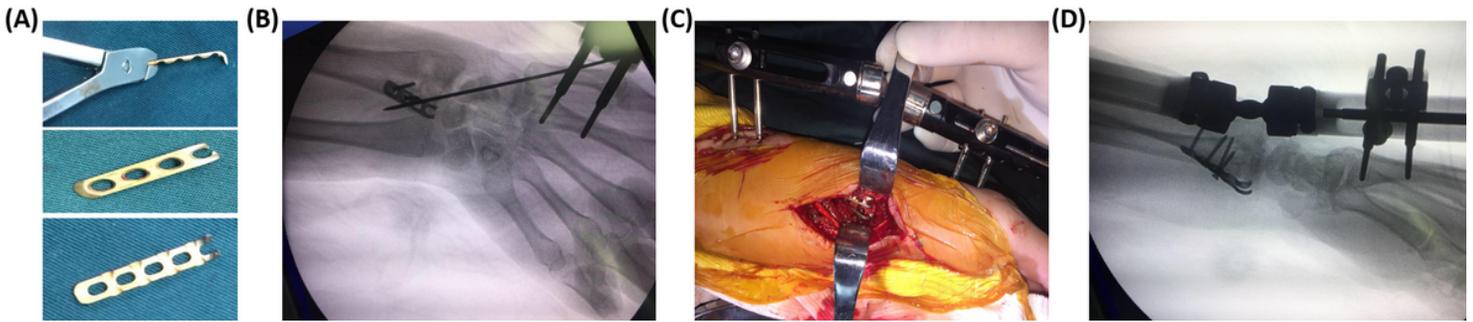


Figure 2

Surgical procedure. Phalangeal plate contoured into a “hook plate” (A). Temporal fixation of fragments with K-wire (B) followed with internal fixation with plate and screw (C & D).

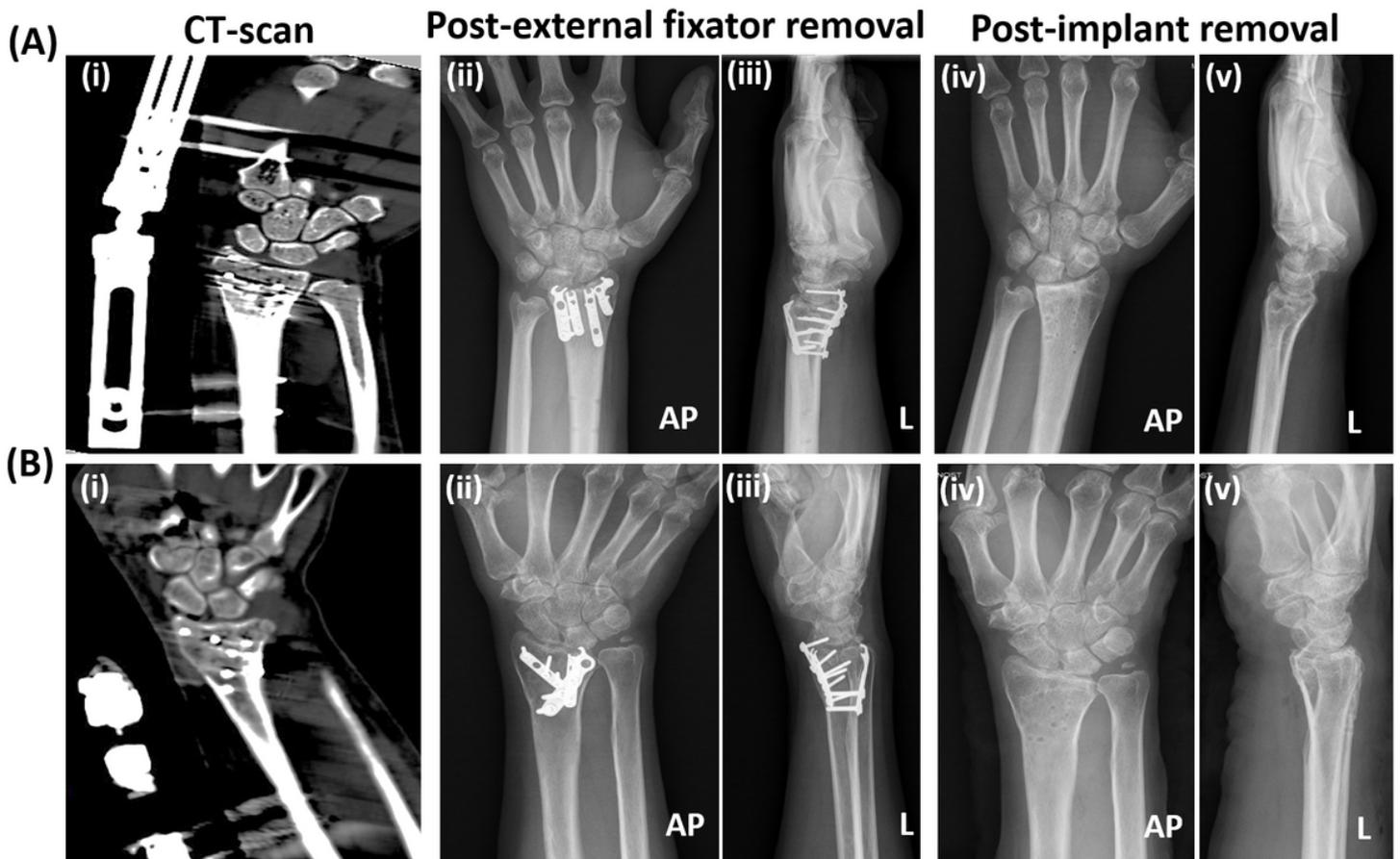


Figure 3

Postoperative radiographic follow-up of two patients (A and B) after treatment with external fixator and “hook” plate. Images indicated articular congruity, restoration of radial length and stabilization of the fracture fragments. CT: Computed Tomography, AP: Anterior-Posterior and L: Lateral.

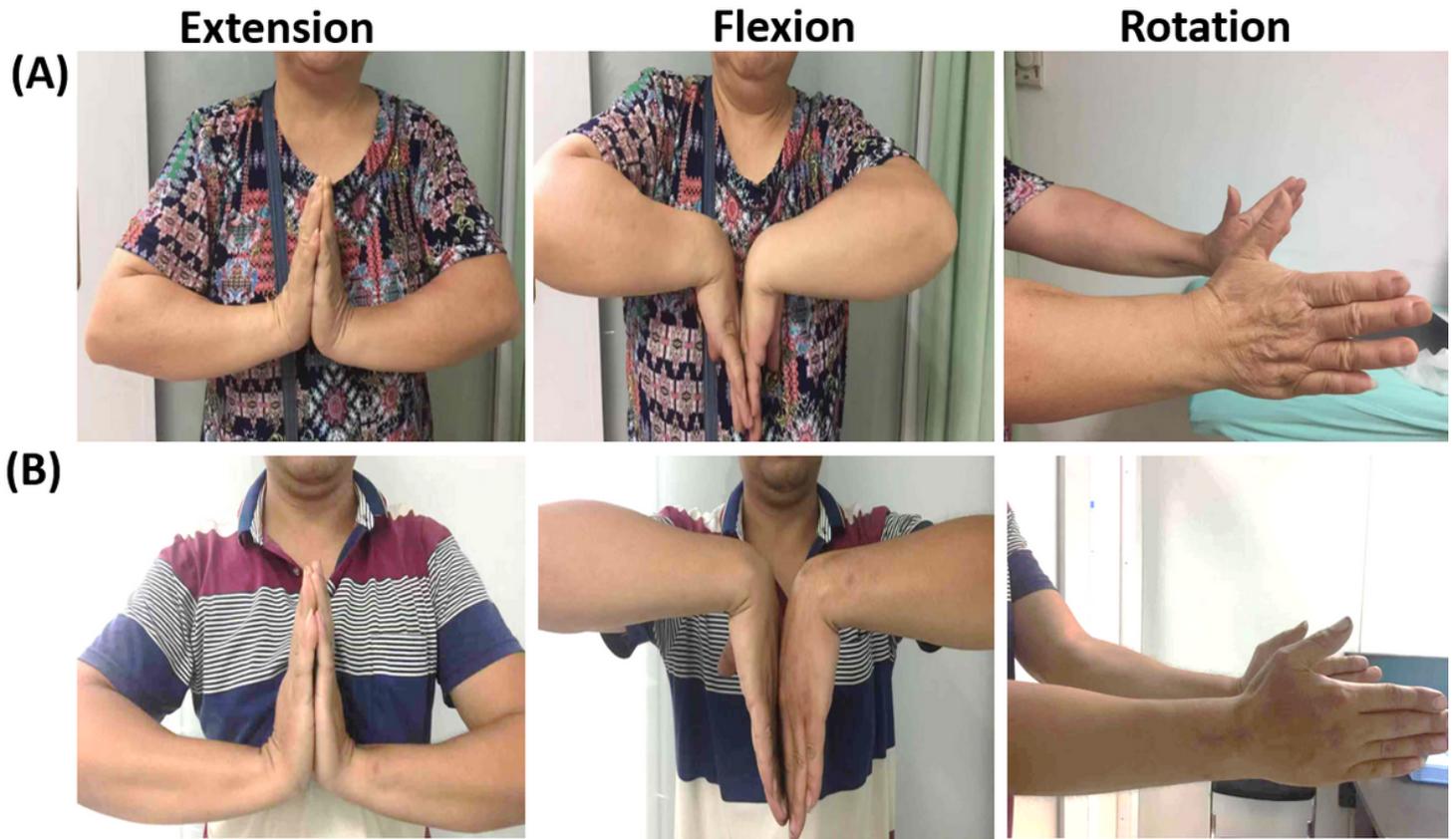


Figure 4

Functional outcome at final follow-up, the patients (A: female, B: male) had a virtually normal range of motion (flexion, extension and rotation) at the treated wrist joint compared to the contralateral normal wrist.