ISSN: 0975-3583,0976-2833 VOL15, ISSUE 09, 2024

Original Research Article

A STUDY ON Z- CORRECTIVE OSTEOTOMY IN MALUNITED EXTRA ARTICULAR FRACTURES OF DISTAL RADIUS

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ABSTRACT

BACKGROUND: Dorsally angulated malunions of the distal radius have historically been corrected with an opening wedge osteotomy fixed with a dorsal plate. Multiple techniques for corrective osteotomy have been developed in recent years. **AIMS & OBJECTIVE:**This study aimed to evaluate the clinical value of corrective osteotomy combined with volar and dorsal plate fixation in patients with malunion of extra-articular fractures of the distal radius.

MATERIAL AND METHODS: Fifteen patients with extra-articular distal radius malunions (13 dorsal and 2 volar) underwent z-corrective osteotomy and volar plate fixation without bone grafting. Correction and maintenance of each deformity was evaluated in terms of various radiographic indices; grip strength; range of motion; Disabilities of the Arm, Shoulder, and Hand scores; and Mayo wrist scores.

RESULTS: The mean radial height was corrected from -1.3 mm to 4.7 mm. The mean ulnar variance improved from 4.1 mm to -0.2 mm. The sagittal radial tilt and radial inclination were restored from a mean of -17.7° (dorsal) to 3.3° (volar) and from 12.0° to 15.2°, respectively. The Disabilities of the Arm, Shoulder, and Hand and Mayo wrist scores improved from means of 34 and 54 preoperatively to 24.6and 73.3, respectively, at 6 months and further to 20.4 and 77.4, respectively, at the last follow-up. There were no nonunion or tendon-related problems. The mean pain score decreased from 4.3 preoperatively to 1.2 at 6 months and 0.8 at the last follow-up. The mean grip strength improved from 5.4 kg preoperatively to 15.4 kg at 6 months and 19.5 kg at the last follow-up. There was a statistically significant improvement in range of motion at the wrist. **CONCLUSION:** The z-osteotomy provides correction of deformity in all 3 planes, along with restoration of radial height. It also maintains a broad area of bone contact between the 2 osteotomized bone fragments, facilitating bony union.

KEY WORDS: Colles' fracture; Z-osteotomy; distal radius; malunited.

INTRODUCTION:

The incidence of distal radius fractures is approximately 0.27% [1].They are twice as frequent in women, and 73% are caused by falls. Two age peaks of fracture incidence occur in the second decade and sixth through eighth decades [2]. Among the different fracture patterns, Colles' fractures are the most frequent, representing approximately 60% of distal radius fractures [3]. Complications are neither infrequent nor negligible. An incidence of as much as 7.9% has been reported for compression neuropathy, 6.5% has been reported for posttraumatic arthritis, and 5.3% has been reported for malunions occurring in as much as 76% patients after nonoperative treatment [4,5,6]

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Distal radius corrective osteotomies are considered for patients with painful malunions and have been recommended for younger or more active individuals with angulations greater than 25° [7]. Surgery generally is considered contraindicated when there are dystrophic changes, inadequate bone quality, osteoarthritic changes, or fixed carpal mal-alignment [8]. Corrective osteotomy of the distal radius allows reestablishment of normal anatomic relationships in the distal radioulnar joint (DRUJ) and radiocarpal joint. Osteotomy of the distal radius can improve motion, function, and comfort level in patients with symptomatic malunited fractures of the distal radius. It is common to use a structural corticocancellous bone graft interposed in the osteotomy site to help restore alignment. This requires thorough preoperative planning and precise shaping of the bone graft to ensure insertion of the bone graft into the osteotomy produces the planned correction [9, 10, 11].

AIMS AND OBJECTIVE:

This study aimed to evaluate the clinical value of corrective osteotomy combined with volar and dorsal plate fixation in patients with malunion of extra-articular fractures of the distal radius.

MATERIAL AND METHODS:

Study subjects:

This was a prospective study conducted after acquiring clearance from the ethical committee of I.Q City Medical College and Hospital, Durgapur, West Bengal with informed consent from all the patients. Patients with distal radius malunions presenting to the orthopedic outpatient department were screened, and those with symptomatic extra-articular malunions (dorsal or volar) who were between the ages of 20 and 60 years were selected for the study.The potential study group for this

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analysis included 15 patients who were identified during the study period of August 2020 to December 2021. Patients were contacted and invited to participate in this study.

Inclusion criteria:

Patient with a symptomatic deformity of the distal radius who underwent distal radius corrective osteotomy at this institution.

Exclusion criteria:

Patients with pre-existing intracarpal arthrosis and without at least 6 months of follow-up were excluded.

Surgical Technique:

A volar approach to the distal radius was performed. A 5-cm longitudinal incision was made over the flexor carpi radialis tendon proximal to the wrist flexion crease. The radial artery was identified, and its superficial branch at the distal portion of the incision was preserved. The pronator quadratus was released along its radial and distal borders, and the brachioradialis and radial septum were released. After exposure, the distal portion of the small five-hole plate from DePuy (Warsaw, IN) was provisionally held to the distal radius with K-wires. Fluoroscopy images were taken to assure appropriate position of the plate and for planning of the osteotomy. The position of the plate and osteotomy were marked but the distal holes were not predrilled. The plate was then removed and an osteotomy was performed. It was attempted to place the osteotomy at the site of deformity and roughly perpendicular to the shaft of the radius. After the osteotomy was completed, the dorsal periosteum was further released, and the fragments were distracted initially using a small osteotome as a lever followed by a small lamina spreader to allow creep of the soft

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tissues. The plate was then fixed to the distal fragment to allow appropriate correction of volar tilt and radial inclination. Once the plate was fixed to the distal fragment in appropriate position, the lamina spreader was reinserted for distraction, and the proximal portion of the plate was held to the radial shaft using a tenaculum. Fluoroscopy was then used to assess plate position, and adjustments to radial inclination and height were made. The oval hole in the proximal portion of the plate was filled with a 3.5-mm cortical screw.The remaining proximal 3.5-mm screws were then placed. The pronator quadratus was sutured back into place covering the plate, and the skin closed with a running absorbable subcuticular suture. All patients were placed into a well-padded, above-elbow splint and were discharged to home on the same day.

Fig :1- Distal radius Malunion in adults.

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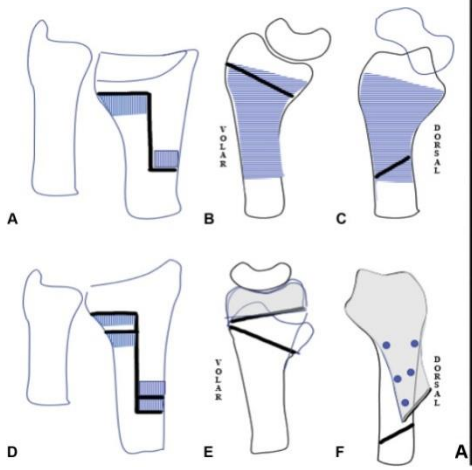

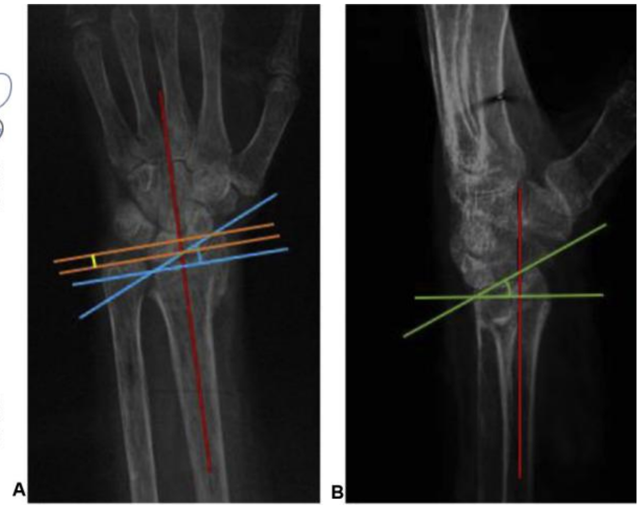

Fig :2 & fig:3 Z-corrective osteotomy in mal-united extraarticular fractures

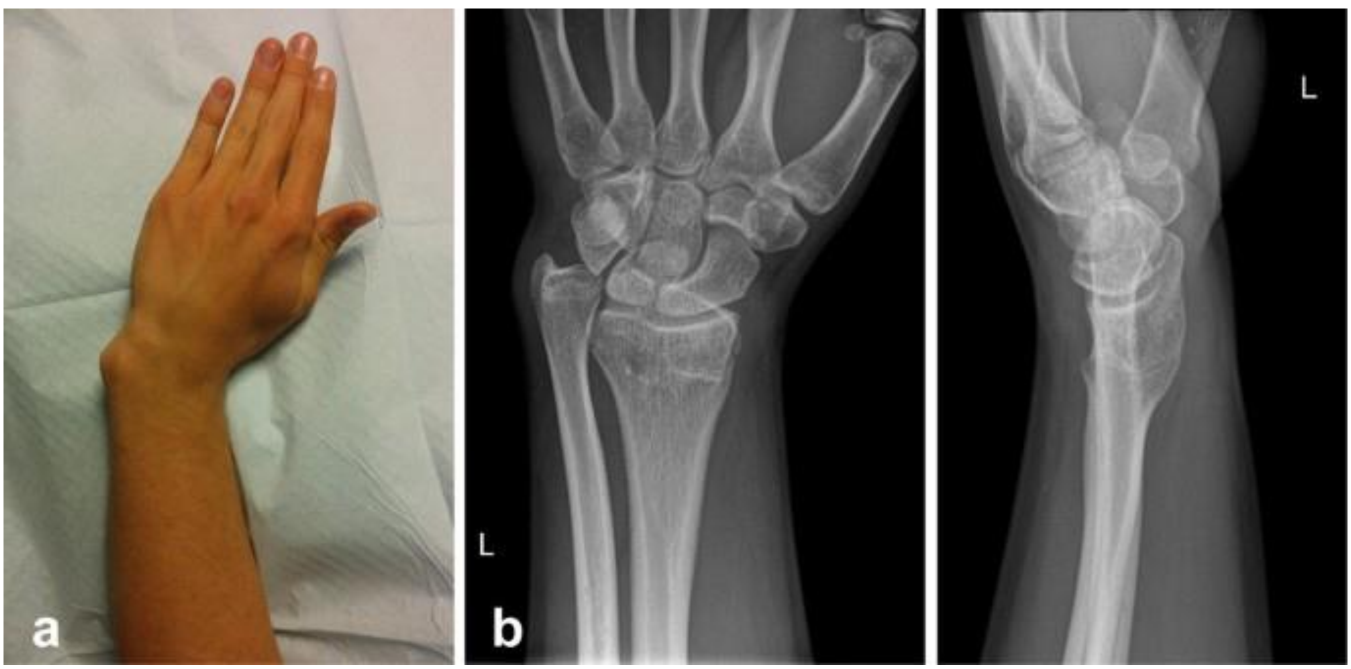

Fig : 4 Corrective osteotomy of distal radius malunions

Each patient in the study group underwent clinical evaluation consisting of history, physical examination of extremities, and radiographic examination with PA, lateral and ulnar variance views. Additionally, functional outcomes were calculated with the Mayo Wrist score.

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The Mayo Wrist scoring system allows for a total count of 100 points in four categories. Range of motion, grip strength, and pain were measured. Range of motion was reported as both the absolute measurement and that compared with the contra lateral side. Maximal grip strength on the operated side was measured with a Jamar™ (Chicago, IL) dynamometer and was reported as a percentage of maximal strength of the opposite side. The pain scale and satisfaction score were self-reported and graded.

STATISTICAL ANALYSIS:

There was a statistically significant improvement in range of motion at the wrist.

RESULTS:

Clinical Examination:

Preoperative examination revealed patients' average range of motion (ROM) to be 20° of wrist flexion and 42° of wrist extension. Pronation and supination averaged 45 and 55°, respectively. The latest postoperative examination revealed an average of 60.5° of wrist extension, 58.5° of wrist flexion, 68.4° of pronation, and 70.5° of supination. Radial and ulnar deviation averaged 17.5° and 24.5°. Grip strengths measured improved from an average of 41 to 80.4 lb.

Radiograph:

There were six patients with dorsally angulated malunions. Preoperative radiographs revealed an average of 24.3° (range, 5–49°) of dorsal tilt. Postoperative radiographs revealed that their average measurement was 2.5° volar tilt. Two patients had excessive volar tilt preoperatively. One patient suffered a malunion of a Smith-type fracture and had a volar tilt of 24°; the other patient had a severe Madelung's deformity with 50° of volar tilt. The volar tilt in these two patients was

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corrected to 13 and 25°, respectively. All patients in this study were initially ulnar positive; the average was 4.1 mm of positive ulnar variance (range, 2–7 mm). Postoperatively, the average positive ulnar variance was less than 1 mm. In addition, radial inclination was corrected. Preoperatively, radial inclination averaged 18.5°; postoperatively, radial inclination measurements averaged 23.6°.

Functional Outcomes

Subjective outcome measurements are reported. DASH, SF-12, and Mayo Wrist scores averaged 10.8, 81, and 82.5, respectively. Postoperatively, the Mayo wrist scores of all patients in the study were above 80 and, therefore, classified as "good" under the Mayo Wrist scoring system.

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Fig: 4 (a) preoperative radiographs of a patient with dorsally angulated malunion of the distal radius. (b) post-operative radiograph

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DISCUSSION:

Malunion of the distal radius may result in biomechanical abnormalities in the radio-ulnar, radiocarpal, and midcarpal articulations [12, 13, 14]. For the distal radius, normal radiographic values are typically cited as 11° of volar tilt, 22° of radial inclination, neutral ulnar variance, and a congruent radiocarpal articulation [15, 16]. The acceptable ranges of these parameters are typically cited as up to 15° of dorsal radial tilt or 20° of volar tilt, a 15° change in radial inclination, 4 mm of ulnar variance, and 2 mm of articular step-off. When the deformity exceeds these parameters, wrist dysfunction follows certain patterns. With increasing dorsal angulation, biomechanical studies have demonstrated increasing force concentration on the radioscaphoid, radiolunate, and ulnocarpal articulations [15]. Clinically, patients may develop dorsal carpal subluxation or an adaptive DISI pattern [14]. Both abnormal dorsal angulation of the distal radius, as well as ulnar variance, may affect the distal radioulnar joint and wrist pronation/supination [17,18,19]. In addition, increasing ulnar positivity results in ulnocarpal impaction and degenerative changes on the ulnar side of the wrist [20,21].For dorsally angulated fractures, techniques involving a dorsal approach and fixation may improve radiographic parameters as well as pain and function, but there are well-documented complications associated with the use of plates on the dorsal surface of the wrist [22,23,24,25,26]. Recently, Keller et al. reported on a series of 49 patients who underwent dorsal plating of the distal radius. At a mean follow-up of 32 months, patients had an average DASH score of 14.4 with good motion and grip strength. However, 37 of the 49 patients had undergone plate removal, and of the 12

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patients who did not undergo plate removal, one patient suffered a rupture of the extensor indicis proprius [27]. Other authors have argued that extensor tendon complications are the result of the profile of the dorsal plate. In 2006, Kamath et al. [28] reported on a series of 30 patients who underwent dorsal plating with a low profile plate. At a mean follow-up of 18 months, patients had an average DASH score of 15 without need for plate removal, although two patients had undergone screw removal and one patient underwent extensor pollicis tenolysis. Simic et al. [29] reported on 60 patients who underwent dorsal plating with a low-profile plate. At a mean follow-up of 2 years, the average DASH score was 11.9 and only one patient underwent removal of hardware. Low profile dorsal plates may reduce some of the extensor tendon morbidity; however, studies in both canine and rabbit models indicate a reactive, inflammatory response to both stainless steel and titanium plates, which increases with time [30,31].The volar approach is potentially less morbid, but traditionally, volar plating has been performed on malunions with excess volar angulation [32,33,34]. Locking plates offer mechanical advantages for treating acute fractures of the distal radius [35,36], and these properties make them attractive for corrective osteotomy as well. To our knowledge, this is the largest series of corrective osteotomy and volar locked plating to treat dorsally angulated and complex deformities of the distal radius. Malone et al. described four cases of dorsally malunited fractures in which they used a volar fixed angle plate. They used autogenous iliac crest bone graft in only 50% (two) of their cases, but the severity of the deformity that they addressed was less than that reported in this paper [37]. Prommersberger and Lanz [38] have published on a radiovolar approach to treat distal radius malunions [39]. They began using a fixed angled device in 2000 and have reported their technique [40] In both Malone's and Prommersberger's reports, low morbidity associated with the volar approach were documented.

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CONCLUSION:

The z-osteotomy provides correction of deformity in all 3 planes, along with restoration of radial height. It also maintains a broad area of bone contact between the 2 osteotomized bone fragments, facilitating bony union and eliminating the need for bone grafting.

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