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# Radial lengthening osteotomy versus ulnar shortening osteotomy in malunited distal radius fracture

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**Abstract**
Impaired function and pain after malunion of distal radius fractures may be caused by derangements of the radiocarpal, ulnocarpal, and radioulnar joints. The aim of this study is to compare the two surgical methods of treating symptomatic dorsal malunited extra-articular fractures of the distal radius who underwent corrective osteotomy using a volar locking plate with additional bone grafting and ulnar shortening osteotomy. Our study comprises patients who presented with pain and impaired function after malunited fracture of the distal radius. Preoperative symptoms with pain from the distal radioulnar (DRU) joint, with or without limited motion, pain from the radiocarpal (RC) joint with limited motion, or disability from both joints, were improved in 8 patients with a significant increased range of wrist motion, 4 cases had improved wrist motion but persistent pain after the osteotomy.

**Keywords:** radial, ulnar, osteotomy, plating, grafting, malunion

## Introduction

Fractures of the distal radius are extremely common injuries and the outcome differs depending on the type of fracture. Normally stable distal radius fracture is treated non- operatively with a favorable result. On the other hand, unstable fracture easily becomes malunited with inadequate treatment. Distal radius malunion is the most common complication of distal radius fractures and can occur in up to 11% of operatively treated fractures and 23% of conservatively managed fractures. The most common deformity following a malunited extra-articular fracture of the distal radius is the loss of the normal palmar tilt of the articular surface in the sagittal plane, and loss of length relative to the ulna. Malunion is a recognized cause of suboptimal function after distal radius fracture. The objective findings and subjective complaints of a symptomatic malunion have come to be better appreciated as patients of all ages have demanded high levels of function after this common injury. Furthermore, advances in the understanding of the biomechanics of the hand-wrist- forearm unit have led to improvements in surgical techniques for restoring the normal anatomic relationships, resulting in better function for patients with a malunion. A wrist with a normal motion has about 120° of wrist flexion and extension, 50° of wrist radial and ulnar deviation, and 150° of forearm rotation. The radius carries 80% of the axial load through the wrist, and the distal ulna only 20%. Malalignment of the distal radius due to an osseous deformity affects the normal load transmission, causing a limitation in the extension-flexion arc of motion. Multiple techniques for corrective osteotomy have been developed in recent years with the same aims: to improve the radiographic parameters and improve motion, pain and grip Strength. Authors such as Fernandez have described the traditional treatment of osteotomy and dorsal plating with bone graft for angulated malunions. These techniques guarantee good restoration of the anatomy and relieve pain, but have sometimes been associated with irritation or rupture of extensor tendons. Volar fixed- angled plates have added a new approach to the treatment of distal radius fractures thanks to the low morbidity of the surgical approach and the strength of the final construct, allowing early mobilization and return to function.

Ulnar shortening osteotomy (USO) was described first by Milch to treat radial shortening after distal radius fractures. The indications for USO have expanded to include treatment of other etiologies of ulnar-sided wrist pain. However, USO continues to be a useful treatment method for distal radius malunion or shortening. The aim of this study is to compare the two surgical methods of treating malunited distal end radius fracture and symptomatic dorsal malunited extra-articular fractures of the distal radius who underwent corrective osteotomy using a volar locking plate with additional bone grafting and ulnar shortening osteotomy respectively.

## Objectives

The aim of this study is to compare the functional and surgical outcomes of two surgical methods for treating malunited and symptomatic dorsal malunited extra- articular fractures of the distal radius who underwent corrective radial lengthening osteotomy using a volar locking plate with bone grafting to the ones who underwent ulnar shortening osteotomy.

## Materials and Methods

Our study comprises 12 patients in a period between January 2020 to June 2021 who presented with pain and impaired function after malunited fracture of the distal radius. They were treated with opening wedge lengthening osteotomy of the radius with bone grafting and shortening osteotomy of the ulna. Osteotomy of the radius was performed in 8 patients, 4 patients were operated by shortening osteotomy of the ulna. The grafts were taken from the iliac crest in all patients. It is our routine practice to evaluate all patients clinically at 2 weeks, 8 weeks and 6 months. The clinical assessment included the analysis of passive range of motion (ROM), Post-operative functional outcome based on DASH score and pain during activities of daily living. Ours is a prospective study.

## Patient Selection

The patients of malunited distal radial fractures were assessed pre operatively by radiological evaluation along with the clinical examination, further they were assessed intraoperatively as well and as per the recommendations in Study by Graham and Hasting and were planned for the suitable surgery.

**Table 1**

| Group | Radial measurement | Radioulnar length | Druj reducible by radial osteotomy | Acceptable Druj articular surface | Reconstruction indicated |
|---|---|---|---|---|---|
| 1 | Unacceptable | Unacceptable | Yes | Yes | Distal Radial Osteotomy |
| 2 | Acceptable | Unacceptable | N.A | Yes | Ulnar Shortening Osteotomy |
| 3 | Unacceptable | Unacceptable | No | Yes | Distal Radial Osteotomy with Ulnar Shortening Osteotomy |
| 4 | Unacceptable | Unacceptable | No | No | Distal Radial Osteotomy with Distal Ulnar Ablation |

## Surgical Techniques

For ulnar osteotomy the patient is placed supine on the operating table and a well- padded tourniquet is used on the upper arm. The procedure is completed on a hand table either with an assistant holding the elbow flexed or by extending the arm and placing bumps underneath the elbow with the forearm supinated. The ulna is exposed using the interval between the flexor carpi ulnaris (FCU) and ECU muscles. Care is taken to protect the dorsal sensory branch of the ulnar nerve. Retractors are placed volarly and dorsally to protect the soft tissues and the jig is applied to the ulna, allowing for parallel osteotomies. Preoperative imaging is reviewed to measure the amount of ulna that must be excised to recreate normal ulnar length with the sigmoid notch. A standard 3.5 mm six- or seven-hole compression plate that allows lag screw fixation and compression is used as part of the jig for fixation of the osteotomy. Prior to fixation of the osteotomy, fluoroscopy is used to confirm appropriate shortening and alignment of the ulna, relative to the radius and sigmoid notch.

For the radial osteotomy and grafting followed by plating in all patients, a volar approach to the distal radius was performed. A longitudinal incision along the flexor radialis carpi was made. The radial artery was preserved and dislocated radially. The pronator quadratus was released using an “L” incision from the radial insertion. After exposure of the volar margin of the distal radius, the distal portion of the plate was held against the distal radius with K-wires. At this stage fluoroscopy was necessary to identify the correct positioning of the plate on the volar surface of the radius and for planning the level of the osteotomy. The plate was then removed after marking the position of the plate and the line of the osteotomy. Once the plate was removed and the osteotomy was performed, the fragments were distracted using a small osteotome as a lever to correct the deformity in lateral view under fluoroscopy.

Cortico cancellous graft from the illiac crest was taken and inserted in the gap of osteotomy to maintain the radial length. The plate was then fixed to the radius on the distal fragment, allowing the correct volar tilt and radial inclination. Once the plate was fixed on the distal radius fragment, the oval hole of the plate was used to center the proximal axis of the plate and a screw was inserted to hold the plate to the radial shaft. In this way the preformed shape of the distal part of the plate helps to correct the dorsal tilt, and under fluoroscopy the surgeon can correct the radial inclination and radial lengthening. The remaining cortical screws were inserted to complete the implant. The pronator quadratus was sutured back into place, covering the plate. Wrist and forearm range of motion is evaluated for joint congruity.

Following osteotomy stabilization and wound closure, the patient is placed into a padded plaster or fiberglass splint. A home-based therapy regimen of wrist and finger range of motion is initiated, and patients are restricted to lifting, pulling, and torsional activity against resistance. Serial radiographs are obtained, commensurate with osseous healing. Weight bearing is not advanced until signs of osseous healing are observed radiographically, typically at 10–12 weeks postoperatively.

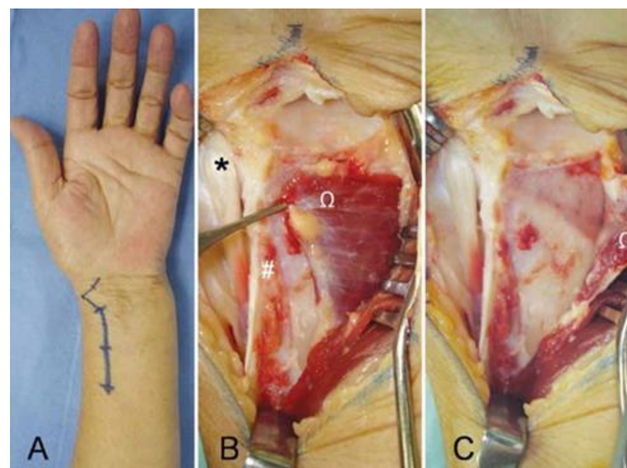


**Fig 1:** Photographs Showing: A) Surgical incision marking for distal radius osteotomy, B) Photograph showing part of pronator quadratus (Ω) after soft tissue dissection, C) Reflected part of pronator quadratus (Ω) and underlying malunited bone.

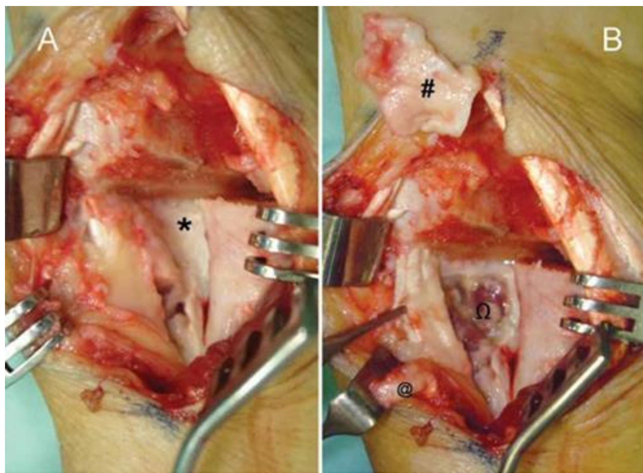


**Fig 2:** A) & B) Distal radius after shortening osteotomy along with the malunited extra bone piece (#)

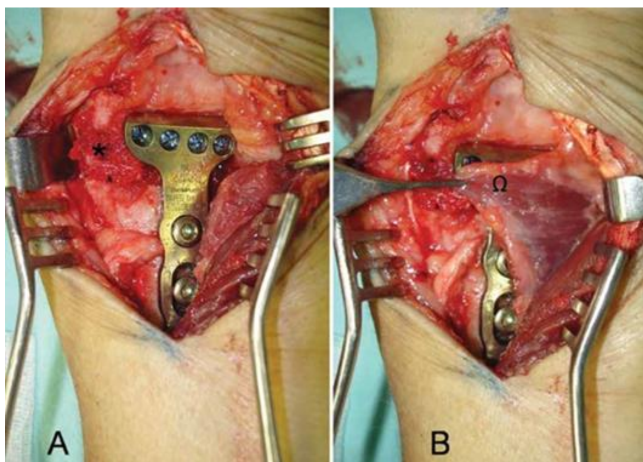


**Fig 3:** A) & B) Intraoperative photographs after bone grafting and volar plate fixation

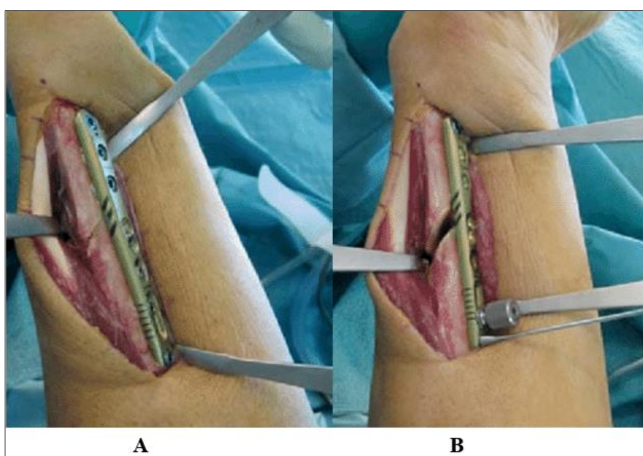


**Fig 4:** A) & B) Intraoperative photographs after ulnar shortening osteotomy and fixation with locking plate.

Pre and postoperative DASH score (Mean) of patients who underwent Radial Osteotomy with bone grafting and volar plating v/s the group which underwent ulnar shortening osteotomy

**Table 2**

| Procedure | Preoperative DASH score (Mean) | Postoperative DASH score at 6 months (Mean) |
|---|---|---|
| Radial osteotomy with bone grafting | 53.8 | 22.4 |
| Ulnar shortening osteotomy | 55.4 | 25.3 |

## Results & Discussion

There was significant increases in the supination (a mean of about 50°) of the wrist after distal radius osteotomy with bone grafting and volar plating. Meanwhile the flexion, extension by a mean of 30° and pronation at the wrist also increased post operatively by a mean of 20°. On the other hand there was an increase in the supination by a mean of 20° and flexion - extension arc by a mean of 20° of the patients who underwent ulnar shortening osteotomy but the mean results were less as compared to the results of radial lengthening osteotomy with bone grafting and volar plating. The pain in patients with radial osteotomy was also minimal which persisted in patients who underwent ulnar shortening osteotomy. However the mean DASH score reduction in both the procedures was at a mean score of 30. The problem of obvious visible deformity was resolved in almost all the patients post operatively.

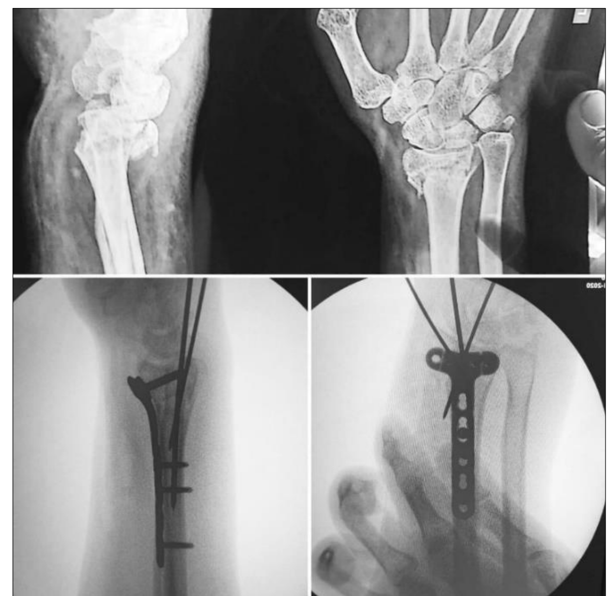

**Fig 5:** A pre and intra operative image of patient that has undergone radial lengthening osteotomy with bone graft with volar plating

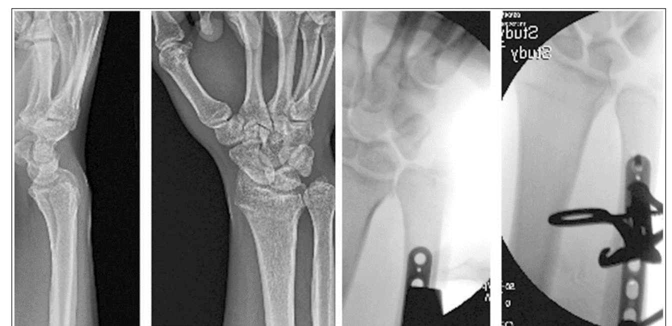

**Fig 6:** Pre and intraoperative photos of ulnar shortening osteotomy in malunited distal radius fracture

**Fig 7:** Post-Operative photos of patient who underwent radial osteotomy with bone grafting and volar plating wrist for malunited distal radius fracture showing significantly normal ROM at wrist joint at 6 months.

## Conclusions

Many studies have demonstrated that corrective osteotomy which restores anatomical configuration can effect an improvement in wrist function, forearm rotation, grip strength and pain. Usually, an opening wedge osteotomy using dorsal plates and bone grafting has been performed for malunited distal radius fractures. However, when dorsal plates are used, a high incidence of plate removal has been reported because of painful hardware, tendon rupture and/or irritation. There are several advantages to using a volar approach in the treatment of a malunited distal radius fracture. If the dorsal compartments are not disturbed, the volar cortex can be fixed directly with a volar plate. Moreover, according to Malone *et al*, the rigid characteristics of the volar locking plates are strong enough to avoid the requirement of structural bone grafting, although the problems of future collapse persists especially in old age patients.

Donor site morbidity, especially at the iliac crest, has been well described and minor complications such as persistent pain at the harvest site, superficial sensory nerve injury, superficial hematoma or seroma and superficial infection have been reported. Moreover, a volar approach is easier than a dorsal approach and the reduction of the volar cortex is simple because of less comminution and the advantage of direct vision. The present study showed that a corrective osteotomy using a volar locking plate with the use of bone grafting could effectively produce a significant improvement in wrist function in patients treated for extra-articular distal radius malunion. We obtained an excellent correction of deformity based on radiographic parameters, with low morbidity and no non-unions, hardware failure or need for hardware removal.

Ulnar shortening osteotomy however was beneficial in deformity correction and maintaining distal radius parameters well but had inferior results as far as Post-Operative pain and ROM is considered. Thus with this study we conclude that distal radius lengthening osteotomy is better than ulnar shortening osteotomy in malunited distal radius fracture in terms of relief of Post-Operative pain and better ROM at the wrist joint.

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None

**Conflicts of interest**

There are no conflicts of interest.

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