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Corrective distal radius osteotomy following fracture malunion using a fixed-angle volar locking plate

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Abstract

Post-traumatic distal radius deformity may cause severe morbidity, and corrective osteotomy is often necessary to realign the functional axis of the wrist to correct symptomatic malunion. The aim of this retrospective study was to review the short-term results of a single surgeon's series of distal radius corrective osteotomies following fracture malunion using a fixed-angle volar locking plate for 20 patients (26 women) of an average age of 57 (range 19–83) years. At short-term follow up (average 14 months, range 12–15 months), no complications were noted and radiological union was confirmed in all cases at an average of 3 months. The average post-operative Disability of the Arm, Shoulder and Hand score was 13.48 (range 0–48.33) and an objective improvement was noted in movements at the wrist joint. A statistically significant improvement was achieved in ulnar variance, radial inclination, dorsal tilt, and supination.

Keywords

Corrective, osteotomy, distal radius, DASH, radiographic outcomes

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Introduction

Distal radius fractures are a significant cause of morbidity and account for approximately 15% of all extremity fractures (Sanders et al., 1996). They are one of the most common presentations to the emergency department, and patients range from the elderly with their associated increased risk of falls and osteoporosis, to young adults involved in high-impact trauma (Ruch, 2006).

The majority of these fractures are treated non-operatively (Finsen et al., 2012) and heal with no symptoms or morbidity. However, 6% to 80% of patients may progress to malunion (McKay et al., 2001) and can present with symptoms such as reduced function, stiffness, or pain in the joint (Viegas, 2006). This wide range of reported complications is thought to be due to a lack of standardization in the reporting of complications from distal radius fractures. McKay and colleagues (2001) studied a cohort of patients with distal radius fractures and devised a scoring system for patients to report complications of distal radius fractures. They concluded that there was no correlation between the rate of complications reported by the surgeon and patients (McKay et al., 2001).

In the malunited distal radius fracture, restoring alignment is possible by open and closing wedge osteotomies (Peterson et al., 2008), the use of bone graft or biomaterials, and fixation (Lozano-Calderón et al., 2007). Although osteotomy has been used for the last hundred years to treat distal radius malunion (Cooney et al., 1980), the debate remains as to whether a dorsal or volar approach should be used. Volar plating of dorsally angulated distal radius fractures has become increasingly popular over recent years due to the large area of the volar side of the wrist and the possibility for using the pronator quadratus to cover the plate, and hence reduce contact with flexor tendons (Koh et al., 1997).

The aim of this study was to retrospectively evaluate the results of a single surgeon's corrective osteotomy and fixed-angle volar plating of distal radius fracture malunion. We compared pre- and post-operative

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Table 1. Pre- and post-operative radiological measurements.

	Ulnar variance, °		Radial inclination, °		Dorsal tilt, °	
	Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op
Average	3.69	–0.067	17.25	22.67	26.13	–3.69
Range	0–6	–3 to 2	8–24	16–26	10–42	–12 to 6
SD	1.88	1.22	5.12	3.18	8.37	6.23
p value	< 0.001		< 0.001		< 0.001	

radiographic measurements and range of movements, as well as patient-perceived disability using the Disability of the Arm, Shoulder and Hand (DASH) scoring (Hudak et al., 1996) at a minimum of 12 months post-operatively.

Methods

A total of 20 patients (16 females, 4 males) with an average age of 57 (range 19–83) years presented to our clinic with symptomatic post-traumatic distal radius malunion. These patients were all concerned about weakness and fatigue on activities involving supination and pronation. Thirteen patients had injured their dominant right hand. The indication for osteotomy was pain and functional limitation affecting their work or activities of daily living. Patients with radiographic evidence of anatomical deformity without these symptoms were excluded.

All patients underwent corrective osteotomy using a fixed-angle volar locking plate (DVR; DePuy Orthopaedics, UK), performed by the senior author (ES). A volar-extended approach was used in all cases (Orbay et al., 2004). The pronator quadratus muscle was lifted off the underlying periosteum. A fixed-angle volar locking plate was first fixed distally and held in place temporarily with Kirschner wires. Fluoroscopy was used to allow for planning of the osteotomy and to ensure appropriate positioning of the plate. Pronation of the proximal radius allowed the dorsal periosteum to be elevated. Corrective osteotomy was undertaken at the site of the deformity parallel to the dorsally angulated joint using an osteotome only. Once the position was adequate and the anatomical angles were restored, the plate was fixed into position distally using locking screws and pegs, and then proximally (Figure 1). No bone graft or bone substitutes were used. Pronator quadratus was sutured back into its original position covering the plate. The wound was closed in layers. A bulky pressure dressing was applied, but no splints were used in any of the cases.

Post-operatively, all patients began active forearm and wrist movement within 1 week of surgery.

Post-operative follow up was routinely arranged at 1, 3, 6, and 12 months after surgery. Patients were followed up for an average of 14 (range 12–15) months, with repeat radiographs taken at approximately 1 and 3 months follow up. Radiological union was said to have occurred when three of the four cortices showed evidence of bony bridging. Absence of clinical tenderness was used to define clinical union.

The senior author (ES) undertook radiological analysis of the pre- and post-procedure radiographs. The parameters measured were ulnar variance, radial inclination, and dorsal tilt. Pre- and post-procedure wrist flexion and extension, pronation and supination, and radial and ulnar deviation were measured using a goniometer, and values expressed in degrees by the senior author (ES). The values were compared and statistical significance tested using the *t* test; $p < 0.05$ was considered statistically significant.

All patients were asked to fill out the DASH questionnaire 12 months post-operatively. This questionnaire generates a score between 0 and 100 of perceived disability; a higher score indicates a higher perceived disability.

Results

At short-term follow up of an average of 14 (range 12–15) months, no complications were noted in any cases. Radiological union was confirmed in all cases at an average of 12 (range 10–16) weeks follow up. All patients regained functional improvement in the wrist, and activities were no longer restricted by pain. Patients reported a good post-operative DASH score (average 13.48, range 0–48.33). Wrist alignment significantly improved, as demonstrated by measurements on plain radiographs (Figure 2). Pre- and post-operative radiographic measurements are summarized in Table 1. A statistically significant improvement was noted in ulnar variance ($p < 0.0001$), radial inclination ($p < 0.0001$), and dorsal tilt ($p < 0.0001$).

Although we felt there was clinical improvement in the subjective range of wrist movements at the wrist joint as measured using a goniometer, this was not

Table 2. Pre- and post-operative wrist movements.

	Volar flexion, °		Extension, °		Pronation, °		Supination, °		Radial deviation, °		Ulnar deviation, °	
	Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op
Average	54.17	70	69.17	75	57.14	67	40.71	81	19.17	20	34.17	35
Range	30–70	70–85	40–75	75–75	30–70	55–70	30–70	75–85	15–20	20–20	30–35	35–35
SD	18	70	14.29	0	17.04	6.70	13.36	5.48	2.04	0	2.04	0
p value	0.18		0.22		0.18		0.02		0.36		0.37	

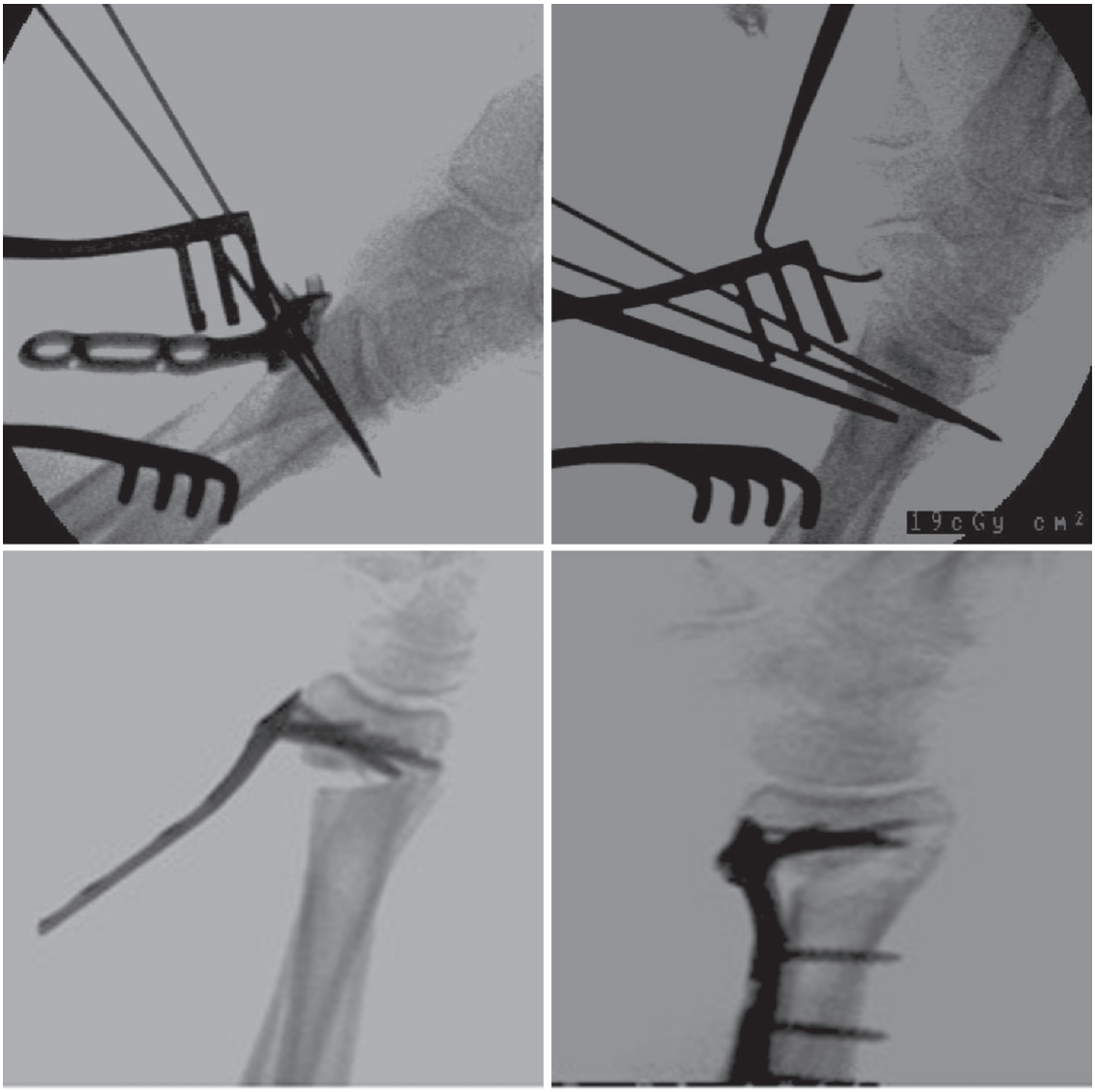

Figure 1. Radiographs demonstrating method of osteotomy and volar plate insertion.

statistically significant. This is summarized in Table 2. The difference in pre- and post-operative measures was only statistically significant for supination (p = 0.02).

Discussion

We found corrective osteotomy of the distal radius with a fixed-angle volar locking plate, no bone graft,

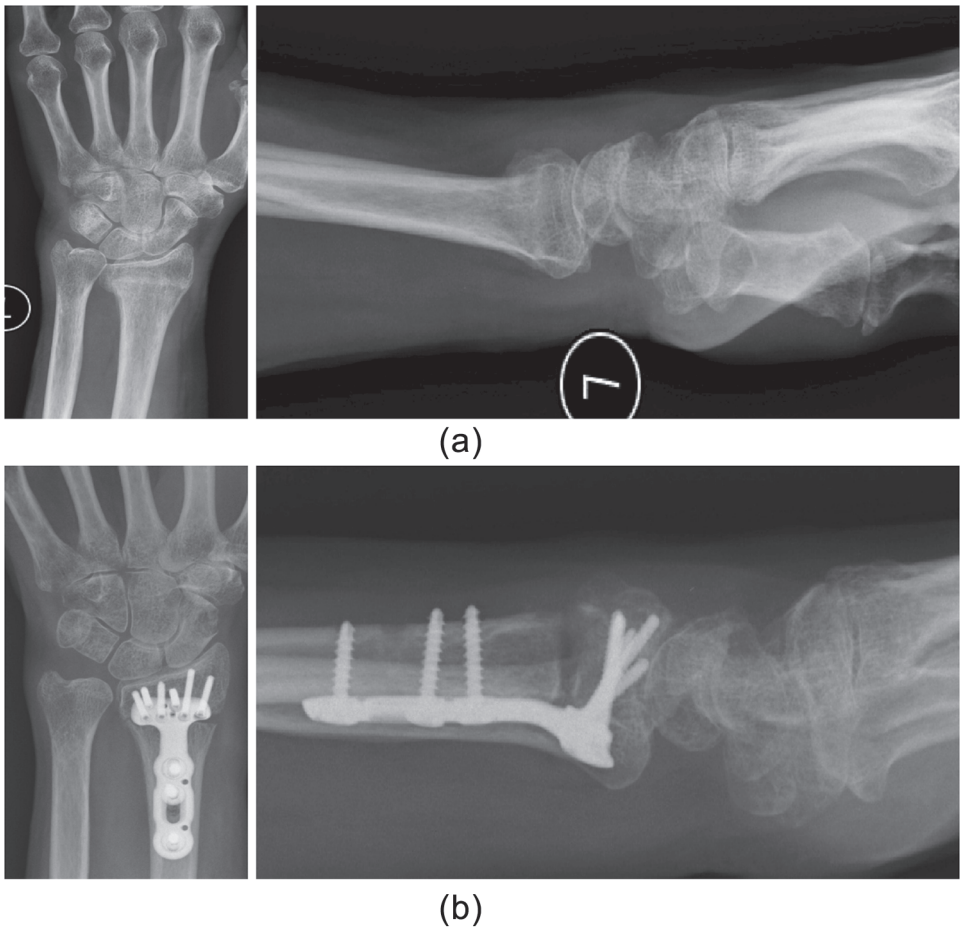

Figure 2. (a) A patient's presentation radiograph. (b) Radiograph 3 months post-operatively.

and immediate mobilization to be a safe and reliable surgical technique. There is no donor site morbidity, pre- and post-operative radiological measurements improved, and patient-rated outcome measures demonstrated good function. All patients noted a functional improvement and activities of daily living were no longer restricted by pain; the DASH score points to this effect.

The distal radius is one of the most common fracture sites of the body with malunion being its most common complication (Cooney et al., 1980). Malunited distal radius fractures may be associated with complications as a result of increased load across the distal radioulnar joint (Henry, 2007). These include pain, stiffness, decreased grip strength, limitations to movement, and median nerve symptoms (Dée, 2000). Bronstein et al. (1997) reported a 47% reduction in forearm pronation and 29% reduction in supination with radial shortening of just 10 mm. Additionally, Saito et al. (2013) described distal radioulnar joint instability with dorsal angulation of the distal radius.

Corrective osteotomy is now described as the current preferred management of symptomatic distal radius malunion (Farshad et al., 2013; Jupiter et al., 1996; Ring, 2005), and the benefit of using the volar approach with a volar fixed-angle plate is to avoid scarring and damage to the extensor tendons (Cooney et al., 1980; Henry, 2007). Fixed-angle internal fixation has the additional benefit of immediate mobilization as compared with external fixation, thus reducing capsular stiffness (Henry, 2007; Smith et al., 2005).

The patients in our series noticed an improvement in their wrist function as well as a reduction in pain post-operatively, as assessed using the DASH score. Although we were unable to score patients pre-operatively in this retrospective study, they commented that their ability to carry out activities of daily living improved after their operation, even though there was only a statistically significant improvement in supination.

It should be noted that the patient with the highest DASH score was referred a year after internal fixation of a left distal radius fracture undertaken at a different centre. This patient subsequently developed

compartment syndrome and required fasciotomy. A corrective osteotomy with volar plate insertion was undertaken at our centre and the patient made an excellent recovery. Although the pain improved and a radiological improvement from pre-corrective osteotomy was noted, the functional outcome remained poor, which resulted in a high DASH score (48.33).

In conclusion, this retrospective case series demonstrates that corrective osteotomy of the distal radius with a fixed-angle volar locking plate, no bone graft, and immediate mobilization is a safe and reliable surgical technique.

Conflict of interests

None declared.

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