

CORRECTIVE OSTEOTOMY OF MALUNITED FRACTURE DISTAL RADIUS (SHORT TERM FOLLOW UP)

By

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ABSTRACT

Background: Malunion distal radius involving shortening of the radius may result in disruption of the distal radioulnar joint, chronic pain, loss of both supination and pronation, and cosmetic deformity. Shortening often accompanies dorsal angulation, and a relatively positive ulna variance is produced. With malunion caused by extra-articular fractures, pain may develop in the distal radioulnar joint secondary to abnormal stresses resulting from radial shortening and occasionally from disruption of the distal radioulnar ligaments.

Objective: To evaluate the locked plate fixation after corrective osteotomy of malunited distal radius without using graft (short term follow up).

Patients and Methods: Between 2018 and 2020, 20 patients were treated for malunited distal radius fracture by open wedge distal radial osteotomy. Follow-up included review of patient records and patient contact and all are done at Al-Azhar University Hospitals. All Patients undergoing general /local and radiological examinations. All patients have been treated by open wedge & Volar Locked plates and followed up postoperative by for clinical assessment including range of motion, and pain.

Results: All patients reported improvement in work abilities. 14 patients gradually returned to their work within 3 to 7 months. However, 2 cases chosed to return to modified duties. Pain relieved in 13 wrists. The remaining 7 patients reported mild pain which had been improved significantly.

Conclusion: Outcome scores as well as pre- and postoperative range of motion and grip strength tests document significant by improved in function. This allowed earlier return to normal activities with no recorded complications.

Keywords: Malunited distal radius, Corrective osteotomy

INTRODUCTION

Distal radius fracture, also known as wrist fracture, is a break of the part of the radius bone which is close to the wrist. The wrist joint is one of important joints of upper extremity and most of functions of upper extremity is done by this joint, such as writing and most of manual work by fracturing of the distal radius (*Evans and Jupiter, 2019*). In younger people, these fractures typically occur during sports or a motor vehicle collision. In

older people, the most common cause is falling on an outstretched hand. Fractures of the distal radius are among the most common fractures treated by orthopedic surgeons (*Koo et al., 2013*). In the healed distal radius fracture, the discrepancy from actual alignment to anatomic alignment is malunion. Minimal malunion of the distal radius may be asymptomatic or cause mild to moderate clinical problems (*Yang et al., 2014*). With the increasing magnitude of distal radius

malunion, weakness, carpal instability, post-traumatic arthritis, ulnar carpal abutment, and other problems can occur, resulting in significant disability (*Evans and Jupiter, 2019*). Malunion of the distal radius should be scrutinized and treated with corrective osteotomy when clinically indicated (*Koo et al., 2013*).

The presented study aimed to evaluate the locked plate fixation after corrective osteotomy of malunited distal radius without using graft (short term follows up).

PATIENTS AND METHODS

Between 2018 and 2020, 20 patients were treated for malunited distal radius fracture by distal radial osteotomy and fixed angle plate without using graft. Follow-up included review of patient records and patient contact and all were done at Al-Azhar University Hospitals. All patients gave written consents.

All patients undergo general, regional, local and radiological examinations. All patients have been followed up postoperative for clinical assessment including range of motion, pain, deformity and grip strength. All patients have been treated by open wedge and volar locked plates. Malunited distal radius dorsal angulations more than 10 degrees. decrease radial inclination less than 11 degrees. Shortening more than 2 mm, less than 20ys intra articular arthritic radio carpal / radio ulnar were excluded.

All patients had their initial fracture care elsewhere and were treated by a variety of standard methods.

All osteotomies were done to correct the malunion at the extra-articular site.

Patients who were selected for osteotomy had pain, decrease of wrist and finger or function and/or were dissatisfied with the appearance of their wrist.

Subjective assessment included pain, limitation of movement and ability to perform daily activity. Moderate or severe pain during daily activities or at rest in the radio-carpal or distal radio-ulnar joint and hand weakness were present in different grades in all cases.

Grip strength (was measured by Jamar dynamometer), flexion-extension arcs of the radio carpal joint and pronation supination arcs were measured pre and postoperative by standard postero-anterior and dead lateral radiographs of both wrists were used for measuring radial inclination angle, radial length and palmar tilting angle preoperatively and postoperatively compared to other side in pre-and postoperative assessment. The Fernandez point scoring system was used in assessment with T-plate fixation (*Çalbiyi and Ipek, 2018*).

Patient's Demographics:

Age and sex, there were 4 patients (20%) 20-30 years, 7 patients (35%) 30-40 years, 5 patients (25%) 40-50 years and 4 patients (20%) 50-60 years. As regard sex, there were 12 male (60%) and 8 female (40%) in the studied patients.

Affected side, Right side was affected in 11 patients (55%) while the left side was affected in 9 patients (45%).

The modified Henry approach used the plane between flexor carpi radialis tendon and the radial artery. The flexor carpi radialis tendon was palpated before making the skin incision to the radial side. The radial artery and palmar cutaneous

branch of the median nerve were at risk during this approach.

The skin incision was along the radial border of the flexor carpi radialis tendon. The incision depended between the flexor pollicis longus and the radial artery. The pronator quadratus muscle was elevated using an L-shaped incision, and incised on its radial border, exposing the distal radius.

The degrees of shortening and radial inclination were measured. The osteotomy was opened on the dorsoradial than dorsoulnar side in order to restore the radial inclination using laminar spreader to preserve the volar ulnar contour.

Postoperatively, the forearm was immobilized in a cast for 6 weeks. A range of motion exercises were begun immediately after cast removal, but activities against resistance and manual work were not permitted until radiological union had occurred. 6-9 months later after osteotomy, plates were removed to avoid soft tissue complication in dorsal plating.

The final evaluation for each case was based on subjective, objective and

radiological criteria according to Fernandez scoring system.

The pronator quadratus was placed over the plate. The tendon sheath was closed, but care was taken to avoid catching the cutaneous branch of the median nerve and the skin was closed.

Statistical analysis:

Statistical analysis was done by SPSS v20 (IBM[®], Chicago, IL, USA). Normality of data (Parametric or not) was checked with Shapiro-Wilks test and histograms and all our data were normal distributed. Quantitative data were presented as mean and standard deviation (SD) and were compared by student's t-test with ROC curve test if significant and is used to detect sensitivity and specificity. all SD were less 0.5 mean so it is not abnormal to need Mann Whitney (U) test. Qualitative data were presented as number and percent and were compared by the Chi-square (X²) test. A P value <0.05 was considered statistically significant.

RESULTS

The mean overall functional score (Fernandez point score system) was 17 (range, 14-19) points. Very good results were achieved in 12 cases (60%), good in 6 cases (30%) and fair in 2 cases (10%).

All patients reported improvement in work abilities. 14 patients gradually returned to their pre-fracture jobs within 3 to 7 months of the radial osteotomy. However, two cases choose to return to modified duties. Pain relieved completely in 13 wrists, at the radiocarpal joint, all of which only underwent the radial

osteotomy. The remaining 7 patients reported that mild pain had improved significantly, but not completely with nearly complete subsidence of pain after plate removal. Seventeen patients were pleased with their outcome. Three were moderately satisfied and had occasional aches on strenuous activity at the radiocarpal joint with complete release of pain after plate removal and arthroscopic debridement TFC in 2 patients. The remaining one still unsatisfied.

Table (1): Comparison of pre and post-operative

States		Before (N = 20)		After (N = 20)		P-value
Flexion-extension of radio-carpal joint	Mean \pm SD	97.5 \pm 5.5		123.5 \pm 10.04		< 0.001
	Median	98.5		126.5		
Degree	80° – 100°	10	50%	2	10%	0.002
	101° – 129°	10	50%	11	55%	
	Of at least 30°	0	0%	7	35%	
Rotation of the forearm						
Degree	Mean \pm SD	108.5 \pm 9.4		153.9 \pm 11.2		< 0.001
	Median	107.5		156.5		
Score	< 120°	9	45%	0	0%	< 0.001
	120° – 139°	7	35%	4	20%	
	140° – 159°	4	20%	6	30%	
	160° – 180°	0	0%	10	50%	
Grip strength						
Degree	Mean \pm SD	41.2 \pm 12.5		94.3 \pm 3.8		< 0.001
	Median	41.5		93		
Score	< 40%	5	25%	0	0%	< 0.001
	40 – 64%	15	75%	0	0%	
	At least 80% of that of the uninvolved hand	0	0%	20	100%	
Pain						
At radio carpal joint	Severe	10	50%	0	0%	< 0.001
	Moderate	10	50%	0	0%	
	Mild	0	0%	15	75%	
	No pain	0	0%	5	25%	
At radio ulnar joint	Severe	10	50%	0	0%	< 0.001
	Moderate	10	50%	0	0%	
	Mild	0	0%	8	40%	
	No pain	0	0%	12	60%	
Total score						
Total score	Poor	20	100%	0	0%	< 0.001
	Fair	0	0%	2	10%	
	Good	0	0%	6	30%	
	Very good	0	0%	12	60%	
Radiographic parameters						
Radial tilt	Mean \pm SD	19 \pm 3.6		8.8 \pm 2.3		< 0.001
	Median	19		9.5		
Radial inclination	Mean \pm SD	12.3 \pm 7.4		25 \pm 0.7		< 0.001
	Median	12		25		
Radial length	Mean \pm SD	5.8 \pm 1.9		10.8 \pm 0.9		< 0.001
	Median	10.5		10.5		

MW: Mann-Whitney U test and Fisher's exact test.

Complications: There were two superficial wound infections. Two screws were malposition in different two patients and one case develop carpal tunnel syndrome.

DISCUSSION

Malunion of distal radius may result in biomechanical abnormalities in radio-ulnar, radio-carpal and mid-carpal articulations (*Ali et al., 2018*). For the distal radius, normal radiographic values are 11° volar tilt, 22° of radial inclination, neutral ulnar variants, and congruent radiocarpal articulation (*Graham, 2016*). 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 radio-scaphoid, radio-lunate and ulnocarpal articulations (*Graham, 2016*).

Clinically, patients may develop dorsal carpal sub laxation or an adaptive DISI pattern (*Ali et al., 2018*). Both abnormal dorsal angulations of the distal radius, as well as ulnar variance, may affect the distal radioulnar joint and wrist pronation/supination (*Kamath et al., 2011*).

In addition, increasing ulnar positivity results in ulnocarpal impaction and degenerative changes on the ulnar side of the wrist. In this study, patients with malunited distal radius fracture were managed by corrective osteotomy and fixation by open wedge and volar locked plates without bone graft. The mean overall functional score (Fernandez point score system) (Range was, 14/19). Very good results were achieved in (60%),

good in 30 % and fair in 10 %. All patients reported improvement in work abilities. 70% patients gradually returned to their work within 3 to 7 months of the radial osteotomy. However, 10% chosed to return to modified duties. Pain was relieved in 13 wrists. The remaining patients reported that mild pain had improved significantly.

Keller and Steiger (2010) reported on a series of 49 patients who underwent volar plating of the distal radius. At a mean follow-up of 32 months, patients had an average Fernandez point score of 14.4 with good motion and grip strength. However, 37 of the 49 patients had undergone plate removal, and of the 12 patients who did not undergo plate removal, one patient suffered from persistent pain.

Kamath et al. (2011) reported on a series of 30 patients who underwent volar plating with a low profile plate. At a mean follow-up of 18 months, patients had an average Fernandez point score of 15 without need for plate removal, although two patients had undergone screw removal.

Simic et al. (2010) reported on 60 patients who underwent dorsal plating with a low-profile plate. At a mean follow-up of 2 years, the average Fernandez point score was 13 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 (*Nazzal et al., 2011* and *Cohen et al., 2012*).

The volar approach is potentially less morbid, but traditionally, volar plating has been performed on malunions with excess volar angulation. Locking plates offer mechanical advantages for treating acute fractures of the distal radius (*Koh et al., 2011*), 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 (*Malone et al., 2013*).

In the present work all patients reported improved function and pain relief from their preoperative condition. This surgical technique allowed excellent correction of deformity based on radiographic parameters, with low morbidity and no nonunion, hardware failure, or need for hardware removal.

Outcome scores as well as pre- and postoperative range of motion and grip strength tests document significant improvements in function. The volar approach and locking plate was an extremely effective technique for addressing symptomatic and even severe deformities of the distal radius.

CONCLUSION

Corrective osteotomy of malunited distal radius is now widely accepted in the

allowed earlier return to normal activities with no recorded complications and adopted as the standard techniques in many orthopedic centers worldwide.

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الجراحة التصحيحية لعظمة الكعبرة رديئة الالتحام (متابعة قصيرة المدى)

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خلفية البحث: الإعوجاج الناجم عن الإلتئام الخاطئ للكسور أسفل عظمة الكعبرة من أهم مضاعفات الناجمة عن كسور أسفل عظمة الكعبرة، ولذلك فإن معالجة ذلك الإعوجاج يعد من الأهمية القصوى لدى المرضى وذلك لما يؤثر عليهم من الألام بمفصل الرسغ ومحدودية الحركة في ذلك المفصل.

الهدف من البحث: تقييم علاج كسر اسفل عظمة الكعبرة خاطيء الالتحام بواسطة الشق العظمي المفتوح لأسفل عظمة الكعبرة والتثبيت بواسطة شريحة ذاتية الغلق (متابعة قصيرة المدى).

المرضى وطرق البحث: تمت تلك الدراسة علي 20 مريضاً بين عامي 2018 و2020، وتم علاج المرضى من كسر نصف القطر البُعدي الخبيث عن طريق فتح العظم الشعاعي البعيدة. تضمنت المتابعة مراجعة لسجلات المرضى والاتصال بالمريض وكل ذلك يتم في مستشفيات جامعة الأزهر. وقد خضع جميع المرضى لفحوصات عامة / محلية وإشعاعية.

نتائج البحث: أبلغ جميع المرضى عن تحسن في قدرات العمل. عاد 14 مريضاً تدريجياً إلى عملهم في غضون 3 إلى 7 أشهر، وهناك حالتين إختاروا العودة إلى وظائف أخرى. وتم تخفيف الألم في 13 معصماً. وأفاد المرضى السبعة المتبقون أن الألم الخفيف قد تحسن بشكل ملحوظ.

الاستنتاج: نجح الشق العظمي المفتوح في تصليح شقي الإعوجاج من إنحناء خاطئ لأسفل عظمة الكعبرة وقصور أسفل عظمة الكعبرة. كما نجح التثبيت الداخلي بشريحة حرف T في ضمان الألتئام الكامل للكسور مع ضرورة التوصية برفع الشريحة بعد 6 الي 9 شهور من الألتئام الكامل للكسور.

الكلمات الدالة : عظمه الكعبرة شئنة الالتحام – الجراحة التصحيحية .