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Corrective osteotomy is an effective method of treating distal radius malunions with good long-term functional results

M.A.M. Mulders[a,*], P.N. d'Ailly[a], B.I. Cleffken[b], N.W.L. Schep[b]

[a] Trauma Unit, Department of Surgery, Academic Medical Center, University of Amsterdam, P.O. Box 22660, 1100 DD Amsterdam, The Netherlands
[b] Department of Surgery, Maasstad Hospital, P.O. Box 9100, 3007 AC Rotterdam, The Netherlands

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ABSTRACT

Introduction: Malunion occurs in approximately 23% of non-operatively treated and 11% of operatively treated distal radius fractures. The decision whether to correct a malunion is primarily based on functional impairment and wrist pain. The purpose of this study was to assess the long-term functional outcomes of corrective osteotomies for symptomatic malunited distal radius fractures.
Methods: All consecutive corrective osteotomies of the distal radius performed in one centre between January 2009 and January 2016 were included. The primary outcome was the functional outcome assessed with the Disability of the Arm, Shoulder and Hand (DASH) and the Patient-Rated Wrist Evaluation (PRWE) score. Secondary outcomes were range of motion, grip strength, pain as indicated on the Visual Analogue Scale (VAS) before and after corrective osteotomy, radiological parameters, time to union and complications. Additionally, we aimed to determine if there were any difference in graft versus no graft usage.
Results: A total of 48 patients were included. The median age was 54.5 years (IQR 39–66) and 71% was female. The median time to follow-up was 27 months. The median DASH and PRWE score were respectively 10.0 (IQR 5.8–23.3) and 18.5. (6.5–37.0). Except for pronation and supination, range of motion and grip strength of the injured wrist were significantly less compared to the uninjured side. Palmar and dorsal flexion and radial and ulnar deviation of the injured wrist were significantly less compared with the uninjured side. VAS pain scores decreased significantly from 6.5 preoperative to 1.0 postoperative. The median time to union was 23 weeks (IQR 12–29.5). Eighteen patients (38%) had a complication for which additional treatment was required. Except for a significant difference in radial inclination and length after the corrective osteotomy in favour of graft usage, there were no significant differences between graft an no graft usage.
Conclusions: Corrective osteotomy is an effective method of treating symptomatic distal radius malunions with good long-term functional results, measured with the DASH and PRWE score, and improvement in radiographic parameters and pain scores. Additionally, no differences in functional outcomes were found between graft and no graft usage.

Introduction

Fractures of the distal radius account for up to 17% of all extremity fractures [1]. Standard treatment of both displaced and non-displaced distal radial fractures consists of closed reduction and cast immobilisation [2,3]. However, fracture redislocation following closed reduction has been reported in up to 64% of patients [4–6]. If left untreated, this may result in a symptomatic malunion of the distal radius [3,7].

Malunion occurs in approximately 23% of conservatively treated patients and in 11% of operatively treated patients and may cause considerable disability [8,9]. Commonly reported symptoms are functional impairment, loss of grip strength and pain [10]. Moreover, patients are frequently unsatisfied with the aesthetics of the wrist due to the malunion.

The decision whether to surgically correct distal radial malunions is primarily based on functional demand and wrist pain. Contra-indications for surgery are poor overall health, severe osteoporosis and advanced arthrosis [1,11]. Over the years, several surgical techniques have been developed for correcting malunions

* Corresponding author at: Academic Medical Center, Trauma Unit, Department of Surgery, Meibergdreef 9, 1105 AZ Amsterdam, The Netherlands.
E-mail address: m.a.mulders@amc.nl (M.A.M. Mulders).

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of the distal radius. Open wedge osteotomies are preferred over closed wedge osteotomies because they improve radial length and can be used to correct angular deformities in multiple directions [1]. Finally, bone grafting could be considered when performing open wedge corrective osteotomies to the distal radius. Bone grafting has been claimed to provide structural stability by filling the gap in open wedge osteotomies and can be either autogenic, allogenic or bone substitutes [12]. However, other studies have shown that bone grafting is not necessary to achieve union following open wedge osteotomy [11,13–15].

Long-term outcomes of corrective osteotomies have been studied infrequently and only in small populations [11,14,16–18]. Additionally, conclusions are mainly based on radiological outcomes rather than functional outcomes. However, the correlation between radiological and functional outcomes is still a topic of debate [19–22]. Consequently, if one aims to evaluate the treatment effect of a corrective osteotomy of the radius, patient reported outcome measures may be more appropriate [23,24]. Therefore, the purpose of this study is to assess the long-term functional outcomes of corrective osteotomies for symptomatic distal radius malunions.

Methods

This study is a retrospective cohort study of 48 consecutive adult patients with a corrective osteotomy for a symptomatic distal radius malunion between January 2009 and January 2016. Both initially non-operative and operative treated patients were included. The setting was a Dutch teaching hospital with 554 beds and a total of 40.064 emergency room visits according to its annual report in 2014. Patients undergoing an ulnar shortening osteotomy were excluded. The primary outcome was the functional outcome assessed with the Disability of the Arm, Shoulder and Hand (DASH) and Patient-Rated Wrist Evaluation (PRWE) score. Secondary outcomes were range of motion and grip strength compared to the uninjured wrist, pain as indicated on the Visual Analogue Scale (VAS) before and after corrective osteotomy, radiological parameters including radial inclination, radial length, ulnar variance, dorsal and volar angulation, time to union and complications. Additionally, we aimed to determine if there was any difference in functional outcomes, radiological parameters, time to union and complications for patients where a bone graft was used and for patients without grafting.

To characterize the study population, demographic characteristics were collected from the hospital's medical files. Demographic characteristics included age at time of corrective osteotomy, sex, diabetes, osteoporosis or osteopenia diagnosed by dual-energy X-ray absorptiometry (DEXA scan), corticosteroid use and smoking status. In addition, fracture side, arm dominance, mechanism of injury, initial treatment (non-operative versus operative), usage of graft and type of graft, complications and additional surgeries after corrective osteotomy, were collected. The type of graft was divided in autogenic, allogenic or demineralised bone matrix. If the initial treatment of the distal radius fracture included surgery, type of surgery was specified including K-wires, external fixation and volar or dorsal plating.

The follow-up period was determined as the time between the corrective osteotomy and the last outpatient visit and had to be at least six months.

DASH and PRWE questionnaire

All patients were asked to complete a digital form including the DASH and the PRWE questionnaire. The DASH is a 30-item, self-report questionnaire designed to measure physical function and symptoms in patients with any or several musculoskeletal disorders of the upper limb. The final DASH score is calculated by summing and averaging the responses. It ranges from 0 to 100, with a higher score indicating greater disability. The DASH-score of the general population is 10.1 with a standard deviation of 14.68 [25].

The PRWE is a 15-item questionnaire and allows patients to rate their levels of wrist pain and disability from 0 to 10. It is more specific to the wrist than the DASH and studies show it is the most responsive instrument for evaluating the outcome in patients with distal radius fractures [23,26,27]. The final score of the PRWE is the sum of pain and functional scores and also ranges from 0 to 100, with a higher score indicating more pain and less functionality. For both questionnaires the Dutch language version has been structurally validated [28–30].

Additional to these questionnaires patients were asked about their current occupation and if they had noticed improvements in wrist functionality, pain or aesthetics of the wrist after corrective surgery. Occupation was categorized by type: white collar, blue collar, domestic (household), unemployed, disabled, retired and unknown. Non-responders were asked a second time after 4 weeks.

Clinical evaluation

All included patients were invited to the outpatient clinic to measure range of motion of the wrist and grip strength. Range of motion was measured using a goniometer and included pronation and supination, radial and ulnar deviation, and dorsal and palmar flexion. Grip strength was measured as the mean of three measurements using a Baseline Hydraulic Hand dynamometer (Fabrications Enterprises Incorporated, White Plains, New York, USA) with the elbow flexed at 90° and the forearm in neutral rotation. Both range of motion and grip strength were presented as the percentage of the uninjured side. Moreover, patients were asked to indicate their pain on a Visual Analogue Scale (VAS) pre- and postoperatively.

Furthermore, all patients were asked if they experienced a reduction in symptoms after the corrective osteotomy.

Radiographic outcomes

Radiographs of the wrists were collected using the Picture Archiving and Communication System (PACS) of our hospital. Posteroanterior (PA) radiographs were used to evaluate radial inclination, radial length and ulnar variance. Lateral radiographs were used to evaluate dorsal and volar angulation. Measurements were performed before and after corrective osteotomy. All fractures were classified based on the initial fracture radiographs in type A, B and C fractures according to the AO/OTA classification system. Additionally, the presence of a concomitant fracture of the distal ulna or the ulnar styloid process and time to union was determined. Time to union was defined as the time between the corrective osteotomy and bridging of the fracture site by bone or callus.

Statistical analysis

Descriptive statistics was performed to show patient characteristics and surgical details. All normally distributed data were shown in means with standard deviation (SD). Non-normally distributed data were shown in medians with interquartile range (IQR). Normality was specified by plotting the data distribution in a histogram.

Paired Students *t*-Test was used to compare radiographic parameters before and after corrective osteotomy and range of motion and grip strength of the injured compared to the uninjured

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