Full Length Article

JHS(E)

The Journal of Hand Surgery
(European Volume)
2016, Vol. 41E(5) 516–520

DOI: 10.1177/1753193415624669
jhs.sagepub.com
SAGE

The correlation of initial radiographic characteristics of distal radius fractures and injuries of the triangular fibrocartilage complex

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Abstract

Our purpose was to determine the correlation of initial radiographic parameters of a distal radius fracture with an injury of the triangular fibrocartilage complex. In a prospective study, 85 patients with surgically treated distal radius fractures were included. Wrist arthroscopy was used to identify and classify triangular fibrocartilage complex lesions. The initial radial length and angulation, dorsal angulation, ulnar variance and distal radioulnar distance were measured. Wrist arthroscopy identified a triangular fibrocartilage complex lesion in 45 patients. Statistical analysis did not identify a correlation with any single radiographic parameter of the distal radius fractures with the associated triangular fibrocartilage complex injuries. The initial radiograph of a distal radius fracture does not predict a triangular fibrocartilage complex injury.

Level of evidence: III

Keywords

Distal radius fracture, triangular fibrocartilage complex, associated lesion, wrist arthroscopy

Date received: 19th April 2015; revised: 22nd July 2015; accepted: 16th September 2015

Introduction

An injury of the triangular fibrocartilage complex (TFCC) is the most frequent soft tissue injury associated with distal radius fractures. The reported incidence ranges from 49%–78% (Geissler et al., 1996; Lindau et al., 1997, 2000; Pechlaner et al., 2002; Shih et al., 2001; Varitimidis et al., 2008). An ulnar styloid fracture often accompanies these fractures (up to 70% cases) (Lidstrom, 1959). Although some authors recommend internal fixation of the fractures of the ulnar styloid or immobilization in maximum stability position, the published evidence suggest that these methods do not improve the outcome (Chen et al., 2013; Kramer et al., 2013; Scheer and Adolfsson, 2011; Souer et al., 2009; Zenke et al., 2009).

Distal radius fracture pathomechanics were simulated on 63 cadaveric wrists (Nakamura and Makita, 2000). In 45% of cases, distal radioulnar joint (DRUJ) instability was found. It resulted from a complete or partial laceration of the TFCC at its ulnar insertion: either an ulnar styloid fracture (68% of the cases with DRUJ instability) or an ulnar avulsion of its ligamentous insertion (29%); in only one case there was a radial TFCC tear.

Radial shortening of 5–7 mm could stretch the dorsal and the palmar radioulnar ligament and result in ligament tears as more than 20° of dorsal angulation has been associated with DRUJ incongruence and altered kinematics of the TFCC (Schneppendahl et al., 2012). An in vivo study by Chen et al. (2015) showed that the ulnotriquetral ligament was substantially stretched with 10° to 20° dorsal angulation of the distal radius. In biomechanical studies, 10° and 20° of dorsal angulation (Saito et al., 2013) and 10° of volar angulation (Bessho et al., 2015) are related to distal radioulnar instability.

Fujitani et al. (2011) performed a prospective study examining the association between DRUJ instability and age, gender, involvement of the dominant hand,

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the mechanism of injury, the fracture pattern, the presence of an ulnar styloid fracture and fracture displacement. They identified only one risk factor, an increase of the DRUJ gap distance by 1 mm; this was associated with a 5-fold increased risk of radioulnar ligament tear. Bombaci et al. (2008) considered the association between the severity of the bone injury (based on the Frykman classification) and TFCC tears; type VI and VIII fractures were more frequently associated with TFCC lesions.

Wrist arthroscopy has proven to be the most reliable method for diagnosis and treatment of the associated soft tissue lesions of the distal radius fractures. It is better than arthrography (Smith et al., 2012; Weiss et al., 1996) and magnetic resonance imaging (Rominger et al., 1993).

Although common, DRUJ and TFCC injuries cannot be detected on radiographs but can result in chronic pain and disability (Knirk and Jupiter, 1986; Lindau et al., 2000; Zimmerman and Jupiter, 2014).

The aim of this study was to determine whether there was a correlation between the initial radiographic characteristics of distal radius fractures and associated TFCC tears.

Methods

Patients

This clinical study was designed as a prospective study of patients with distal radius fractures. All patients gave their informed consent prior to inclusion in the study. All the operations were performed by the authors of the study.

The inclusion criteria were distal radius fractures in adults aged 16–65 years needing operative treatment of the fracture. Surgical fixation was indicated for distal radius fractures with postreduction radial shortening >3 mm, dorsal angulation $>10°$ or intra-articular displacement >2 mm (Lichtman et al., 2010). The exclusion criteria were fractures in patient with unfused epiphyses; concomitant carpal or hand fracture on initial radiographs; bilateral distal radius fractures; previous wrist fractures on either side; and contraindications for wrist arthroscopy (local infection, compartment syndrome and problems positioning for vertical traction).

We measured patient demographics.

Diagnostic wrist arthroscopy

Arthroscopic examination followed a standardized protocol (DelPinal et al., 2010; Geissler, 2005). To examine the integrity of the TFCC, the 'trampoline test' and 'hook test' were used (DelPinal et al., 2010; Geissler, 2005). The arthroscopic findings of the TFCC were classified according Palmer's classification system (Palmer, 1989). Following arthroscopic inspection of the radiocarpal and midcarpal joints (interosseous scapholunate and lunotriquetral ligaments were assessed to identify a tear; distal radius articular surface was examined for fracture configuration), we performed definitive fixation of the distal radius fractures with internal or external fixation. Patients with concomitant carpal ligament injuries were then excluded as we wished to assess the association between fractures of the distal radius and TFCC injuries and not other carpal injuries.

We performed wrist arthroscopy on 128 patients; 85 met the inclusion criteria and were evaluated.

Group assignments

Patients were divided into two groups by arthroscopic findings: those with an associated TFCC injury (injured group) and patients with no TFCC lesion (intact group). Patients with arthroscopically diagnosed degenerative TFCC lesions were excluded from the study.

Radiographic evaluation

Both authors assessed fracture alignment on standard wrist posteroanterior and lateral radiographs: initial radiographs after injury, as well as radiographs of the uninjured side after inclusion in the study. We measured the following radiographic parameters: radial length (mm), radial angulation (degrees), ulnar variance (mm), DRUJ distance (mm) on the posteroanterior radiograph and dorsal angulation (degrees) on the lateral radiograph (Medoff, 2005; Pouge et al., 1990). The presence of a distal ulnar fracture was noted. They were grouped as ulnar styloid tip, ulnar styloid base or ulnar head (Scheer and Adolfsson, 2012). The fractures were classified using the AO classification (Muller at al., 1991); fracture type and subtype was confirmed with the arthroscopic assessment of the radial articular surface as well.

Statistical analysis

Data are presented as means, percentages and standard deviations. Spearman's rank correlation was used to test correlation of the presence of associated TFCC lesion with the results from the radiographic measurements. A two-sample *t*-test was used to evaluate between-group differences in results, as well as the difference of means of the radiological findings of the groups (with confidence

Table 1. Characteristics of the evaluated patients.

	All (n = 85)	TFCC lesion (n = 45)	TFCC intact (n = 40)	p
Age	51 (18–65)	53 (18–65)	49 (28–65)	0.1905
Sex				
Female	57 (67%)	32 (71%)	25 (63%)	
Male	28 (33%)	13 (29%)	15 (38%)	
Injured side (R/L)	38/47	22/23	16/24	
Mechanism of injury				
Fall on outstretched hand	54	30	24	
Fall from a height	23	12	11	
Crush injury	6	3	3	
Wrist overdistension	2	0	2	
AO classification				0.873
A2	3 (4%)	3 (7%)	0	
A3	21 (25%)	11 (24%)	10 (25%)	
B1	0	0	0	
B2	2 (2%)	1 (2%)	1 (3%)	
B3	1 (1%)	0	1 (3%)	
C1	14 (17%)	7 (16%)	7 (18%)	
C2	15 (18%)	9 (20%)	6 (15%)	
C3	29 (34%)	14 (31%)	15 (38%)	
Intra-articular distal radius fracture				0.594
Yes	61 (72%)	31 (69%)	30 (75%)	
No	24 (28%)	14 (31%)	10 (25%)	
Ulnar fracture				0.364
No	31 (36%)	13 (29%)	18 (45%)	
Yes	54 (64%)	32 (71%)	22 (55%)	
Styloid tip	20 (37%)	12 (38%)	8 (36%)	
Styloid base	30 (56%)	16 (50%)	14 (64%)	
Ulnar head	4 (7%)	4 (13%)	0	
Initial dorsal angulation, mean (SD)		20 (17.54)	20 (18.20)	1.000
Loss of dorsal angulation, mean (SD)		27 (16.17)	29 (16.93)	0.5238
Initial ulnar variance, mean (SD)		2 (2.25)	2 (2.07)	0.6117

TFCC: triangular fibrocartilage complex; R/L: right/left; SD: standard deviation; AO: Arbeitsgemeinschaft fur Osteosynthese fragen.

interval 95%). A p value of <0.05 was considered statistically significant.

The study was approved by the Ethical committee of the Ministry of Health of our country, as well as our Medical Faculty.

Results

The arthroscopic exploration identified TFCC lesion in 45 patients (53%); in 40 patients (47%) the TFCC was intact. The mean age of the patients in this study was 50 years (range 18 to 65); the majority were women (57/85). The characteristics of the patients evaluated in this study are divided in groups are shown in Table 1, presented as a number and percentage. According to Palmer's classification, there was a central TFCC perforation diagnosed (Type IA) in six patients, an ulnar lesion (IB) in nine patients, a distal lesion of the ulnolunate or ulnotriquetral ligaments (IC) in four patients and radial TFCC tears in 26 patients (ID).

There was no significant difference in the characteristics of the two groups: age of the patients (p = 0.1905); severity of the injury on the AO classification (p = 0.873); the presence of an intra-articular fracture (p = 0.594); or the presence of an ulnar styloid fracture (p = 0.364). There was no significant difference in the radiographic characteristics of the distal radius fractures between the two groups: initial dorsal angulation (p = 1.000); loss of dorsal angulation (p = 0.5238); and initial ulnar variance (p = 0.6117).

The association of a TFCC tear with the initial radiographic characteristics of the distal radius fractures is shown in Table 2. The correlation of the type of TFCC lesion with the initial radiographic characteristics is shown in Table 3. On statistical analysis, we found no correlation of the tested radiographic

Table 2. Correlation of the presence of associated TFCC lesion with the radiographic characteristics of the fracture of the distal radius.

TFCC lesion	Correlation coefficient	*P* value
Intra-articular fracture	0.050	0.682
Associated ulnar fracture	0.113	0.350
Type of ulnar fracture	−0.134	0.267
AO classification	−0.023	0.851
Initial dorsal angulation	−0.062	0.610
Initial dorsal angulation SD	0.207	0.086
Initial dorsal angulation </⩾ 10°	−0.029	0.810
Loss of dorsal angulation	−0.109	0.371
Initial ulnar variance	0.069	0.568
Ulnar variance difference	−0.016	0.898
Ulnar variance </⩾ 3 mm	−0.134	0.268
Ulnar variance </⩾ 2 mm	−0.017	0.888
Loss of radial length	−0.025	0.836
Loss of radial length </⩾ 3 mm	−0.009	0.944
Loss of radial angulation	0.013	0.913
DRUJ distance difference	−0.173	0.151
DRUJ distance </⩾ 2 mm	0.211	0.082

TFCC: triangular fibrocartilage complex; DRUJ: distal radioulnar joint; AO: Arbeitsgemeinschaft fur Osteosynthese fragen.

Table 3. Correlation of the type of the TFCC lesion with the radiographic characteristics of the distal radius fracture.

Type of TFCC lesion according to Palmer	Correlation coefficient	*P* value
Ulnar fracture	0.109	0.367
AO classification	−0.113	0.353
Loss of dorsal angulation	−0.122	0.315

TFCC: triangular fibrocartilage complex; AO: Arbeitsgemeinschaft fur Osteosynthese fragen.

parameters with the presence of the TFCC lesion, nor with the type of TFCC lesion.

Discussion

In this study, we have found no correlation with a TFCC tear and the severity of the fracture (expressed with the AO classification); and intra-articular extension of the distal radius fracture. The associated ulnar fracture does not correlate with the presence of a TFCC tear. There was no correlation of the associated TFCC injury and the radiographic characteristics of the distal radius fractures. We found no positive correlation with any measured parameter and the presence or absence of a TFCC tear.

Other studies have shown that there was no correlation and no predictive value of an ulnar styloid fracture and a TFCC tear (Haugstvedt et al., 2006; Lindau, 2005; Lindau et al., 1997, 2000; Richards et al., 1997).

In a laboratory cadaver study, Viegas et al. (1990) demonstrated that following a distal radius fracture with an intact ulnar styloid and TFCC, the distal radius fracture can only shorten to a limited extent. Only when ulnar styloid was cut through its base (detaching the TFCC), did the distal radius fracture displace more than 4 mm, tilt radially beyond 0° and dorsally >10°. This has important clinical implications, since it suggests that a distal radius fracture with shortening or dorsal tilt beyond the above values will have a TFCC tear and DRUJ instability. This supposition is supported by the observation of Richards et al. (1997). They found a relationship between the initial displacement of distal radius fracture and the presence of a TFCC injury; TFCC injury was associated with significantly greater shortening (average ulnar variance 4.6 mm) and dorsal angulation (average 24°) of the radius at the time of injury compared with fractures where the TFCC was intact (ulnar variance 2.5 mm and dorsal angulation 12°) (Richards et al., 1997). A further corollary is that in order to restore proper tension of the TFCC, the distal radius should be reduced to, at worst, 2 mm of shortening, 10° of radial tilt and 0° of dorsal tilt (Richards et al., 1997). The increase in DRUJ distance has previously been identified as an independent risk factor for DRUJ instability in distal radius fractures (Fujitani et al., 2011). The results of this study did not confirm a significant correlation of any of the initial radiographic characteristics of the distal radius fractures and the presence of a TFCC tear.

A limitation of this study is its relatively small number of patients. All patients with arthroscopically diagnosed TFCC injury were grouped as one group for statistical calculations. This could not exclude the possibility that if separate TFCC injury types were analysed the results would have been different. Studies with a larger series of patients are needed to enable TFCC types grouping.

In conclusion, the present study provides evidence that initial radiography of the distal radius fracture has no predictive value for associated TFCC tears. TFCC tears occur in about half of patients whose distal radius fracture is appropriate for surgical treatment on current accepted criteria.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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