



Effect of ulnar styloid fracture on outcomes after conservative treatment of distal radius fracture

Radius distal uç kırığının konservatif tedavisi sonrasında ulnar stiloid kırığının sonuçlar üzerine etkisi

Sualp Turan, MD.,¹ Deniz Çankaya, MD.,¹ Serdar Yılmaz, MD.,¹ Dilek Karakuş, MD.,²
Abdurrahim Dündar, MD.,¹ Güzelali Özdemir, MD.¹

¹Department of Orthopedics and Traumatology, Ankara Numune Training and Research Hospital, Ankara, Turkey

²Department of Physical Therapy and Rehabilitation,

Ankara Physical Therapy and Rehabilitation Training and Research Hospital, Ankara, Turkey

ABSTRACT

Objectives: This study aims to investigate the effect of accompanying ulnar styloid fracture (USF) on clinical outcomes and hand-wrist muscle strength in conservatively treated active patients after displaced distal radius fracture (DRF).

Patients and methods: The retrospective study, which was conducted November 2012 and September 2016, included 56 patients (34 males, 22 females; mean age 28.8 years; range 20 to 40 years) with displaced DRF treated with closed reduction and casting. Patients were divided into three groups according to ulnar styloid status as group A (intact ulnar styloid), group B (USF non-union), and group C (healed USF). Grip strength, quick-disabilities of the arm, shoulder and hand (DASH) score, and joint range of motions were evaluated; the results were combined with measurements of isokinetic muscle strengths of hand-wrist region. Magnetic resonance imaging was performed to evaluate the accompaniment of distal radioulnar joint injury and triangular fibrocartilage complex (TFCC) lesion.

Results: There were no significant differences between the groups regarding joint range of motion, grip strength, and quick-DASH scores. However, the peak torque and total work of supination was better in group A compared to group B ($p=0.008$ and $p=0.006$, respectively). According to the magnetic resonance imaging findings, of the 10 patients with detected TFCC lesion, four were in group C, five in group B, and one was in group A.

Conclusion: Results of this study suggest that USF should not be the focus of attention during initial treatment of DRF and surgical intervention might be considered in case of an accompanying TFCC lesion.

Keywords: Cast; closed reduction; distal radius fracture; isokinetic evaluation; ulnar styloid.

ÖZ

Amaç: Bu çalışmada ayrılmış radius distal uç kırığı (RDUK) sonrası konservatif tedavi edilen aktif hastalarda eşlik eden ulnar stiloid kırığının (USF) klinik sonuçlar ve el-bilek kas gücü üzerindeki etkisi araştırıldı.

Hastalar ve yöntemler: Ekim 2012 - Eylül 2014 tarihleri arasında yapılan bu retrospektif çalışmaya kapalı redüksiyon ve alçı ile tedavi edilen ayrılmış RDUK'li 56 hasta (34 erkek, 22 kadın; ort. yaş 28.8 yıl; dağılım 20-40 yıl) dahil edildi. Hastalar ulnar stiloidin durumuna göre; grup A (sağlam ulnar stiloid), grup B (kaynamayan USF) ve grup C (iyileşmiş USF) olmak üzere üç gruba ayrıldı. Kavrama gücü, hızlı-kol, omuz ve el için engellilik (DASH) skoru ve eklem hareket açıklıkları değerlendirildi; sonuçlar el-bilek bölgesi izokinetik kas kuvvetlerinin ölçümleriyle birleştirildi. Distal radyoulnar eklem yaralanmasının ve triangular fibrokıkırdak kompleks (TFCC) lezyonunun eşlik edip etmediğini değerlendirmek amacıyla RDUK'ye manyetik rezonans görüntüleme uygulandı.

Bulgular: Gruplar arasında eklem hareket açıklığı, kavrama gücü ve hızlı-DASH skorları yönünden anlamlı bir farklılık yoktu. Ancak, supinasyonun pik tork ve toplam iş değerleri grup A'da grup B'ye kıyasla daha iyiydi (sırasıyla, $p=0.008$ ve $p=0.006$). Manyetik rezonans görüntüleme bulgularına göre, TFCC lezyonu tespit edilen on hastanın dördü grup C'de, beşi grup B'de ve biri grup A'da idi.

Sonuç: Bu çalışmanın bulguları RDUK'nin ilk tedavisinde USF'ye odaklanılmaması gerektiğini ve eşlik eden TFCC lezyonu olması halinde cerrahi girişimin düşünülebileceğini önermektedir.

Anahtar sözcükler: Alçı; kapalı redüksiyon; radius distal uç kırığı; izokinetik değerlendirme; ulnar stiloid.

Distal radial fractures (DRF) are among the most common orthopedic injuries, accounting for one-sixth of all fractures and often result from a fall onto an outstretched hand.^[1,2] Ulnar styloid fractures (USF) are injuries commonly associated with patients who have DRF.^[2-4] Studies on the clinical relevance of USF have produced conflicting results, and comparative studies were generally about surgically treated patients.^[2,3] It is still not clear whether USF accompanied with DRF affect the clinical outcome and whether surgical treatment is necessary for USF.^[5] The data from the literature is contradictory as to whether USF results in instability, disability and pain in the wrist^[6,7] or has no adverse effect.^[2,3,8,9]

The triangular fibrocartilage complex (TFCC) consists of ligament, structures that contribute to distal radioulnar joint (DRUJ) stability as well as ulnocarpal stability.^[1,4,10] and the secondary attachment of these structures is the ulnar styloid. The function of the wrist can be objectively evaluated with muscle strength measurements in a dynamic fashion. The TFCC lesions are commonly seen in wrist injuries and magnetic resonance imaging (MRI) has been shown to be a reliable diagnostic tool for TFCC and other ligamentous injuries.^[11]

We aimed to investigate the effect of USF on the wrist in active patients after displaced DRF in conservatively treated patients. We asked whether (i) there is any functional difference and muscle strength alteration between intact ulnar styloid and the healed and non-union of USF and (ii) whether the accompanying TFCC injuries diagnosed in MRI have any impact on functional scores and isokinetic testing results?

PATIENTS AND METHODS

This retrospective study using prospectively collected data revealed the effect of USF on wrist function in patients treated with closed reduction and casting after DRF. The study was approved by the ethics committee of Ankara Numune Training and Research Hospital and informed consent was obtained from all study participants. The study was conducted in accordance with the principles of the Declaration of Helsinki. Some data on this cohort of patients has previously been published as a short report letter^[12] and data of new patients who completed a one-year follow-up has been included in the present study. In the previous short-letter, there were 68 patients and we could only find MRI results for 38 of them. These MRI results were reevaluated regarding the presence of DRUJ injury and TFCC lesion. Eighteen new

patients with DRF were included in the study with their MRI examinations and prospectively collected data of wrist motion, grip strength, quick-DASH (Disabilities of the Arm, Shoulder and Hand) scores and isokinetic performances. The MRI results were examined specifically with the intention to evaluate DRUJ injury and its impact over functional scores and isokinetic testing results. All of the patients evaluated in this study had displaced extra-articular DRF, namely, type A fractures according to Association for Osteosynthesis/Association for the Study of Internal Fixation (AO/ASIF) classification. Intra-articular fractures were excluded from the study so as not to conflict with the functional results. Exclusion criteria were previous injuries or surgeries on either side; bilateral fractures; intra-articular fractures; non-displaced fractures; Smith's fracture; fractures treated with surgical treatment; malunited fracture; a pre-existing severe illness; multiple trauma; systemic disease; pathological fractures; open fractures; patients presenting more than a week after injury; uncooperative patients during isokinetic testing; and bone and joint diseases, which could interfere with rehabilitation.

We evaluated patients with regular follow-ups of between 12-24 months because a similar follow-up period is required for evaluation during isokinetic testing as an improvement might be expected in that amount of time. We selected patients between 20-40 years of age so who could reliably cooperate and complete the isokinetic testing. The patients were subdivided into three groups according to ulnar styloid status in this retrospective study: group A: intact ulnar styloid, group B: ulnar styloid non-union and group C: healed ulnar styloid fracture. Stability of the DRUJ was assessed by identifying any dislocation with either anteroposterior stress of the distal ulna (the piano key sign) or forearm rotation. All of the patients were also evaluated with MRI for TFCC injury. None of the patients had instability as it was previously defined.

Patients were treated with closed reduction in the emergency room under local anesthesia and under sedation. After the reduction, a circular well-molded short arm cast was applied to the wrist up to 30° flexion and 15°-20° ulnar deviations with a plaster of paris cast. Follow-up radiographies were obtained weekly thereafter. The patients were encouraged to begin elbow and metacarpophalangeal joint motion and the cast was removed six weeks post-fracture according to fracture healing. The outcome assessments were performed between 12-20 months after fracture. An independent physiotherapist

TABLE I
The demographic data of patients with distal radius fracture

Demography	Group A			Group B			Group C			p
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	
Gender										0.478
Male	18			9			7			
Female	8			8			6			
Age (years)			27.8±3.70			29.2±5.59			28.2±5.54	0.639
Hand dominance		65.4			52.9			69.2		0.605
Follow-up			14.9±1.68			14.7±1.58			13.9±2.34	0.249

SD: Standard deviation.

who was not involved in this study performed the functional testing. Grip strength was measured using a Jamar® hand dynamometer (Therapeutic Equipment Corp., Clinton, NJ, USA) with the elbow flexed at 90° and neutral rotation. The range of motions (ROMs) of both wrists were determined using a goniometer. The grip strength and ROM of the wrist were recorded as the percentage of the unaffected side. The functional outcome was evaluated with the 'quick disabilities of the arm, shoulder and hand' (quick-DASH) questionnaire, which yielded a score that ranged from 0 to 100 points, where a lower score denoted less impairment. Standard antero/posterior and lateral radiographies were obtained in the follow-up period. Isokinetic testing was performed using a Biodex System 3 Pro isokinetic test device (Biodex Corp., Shirley, NY, USA). The test was performed at a speed of 60 degree/second. The non-fractured arm was tested first, and all of the results were expressed as a percentage on the normal side. Magnetic resonance imaging examination was performed with the 1.5 Tesla GE Excite MRI device (GE Medical Systems, Milwaukee, Wisconsin, USA)

using a wrist coil. An experienced musculoskeletal radiologist interpreted all the MRI results for TFCC injury, DRUJ instability, ulnar impaction syndromes and arthritis.

Categorical variables between the two groups were analyzed using the chi-square test, Mann-Whitney U-test, and Student's t-test when appropriate. Differences between the groups were compared using analysis of variance (one-way ANOVA). Significant differences were further analyzed by post hoc analysis using the Bonferroni method. Pearson's correlation analysis was used to investigate relationships between isokinetic values and clinical variables, which included ROM, grip power and quick-DASH scores. P values <0.05 were considered statistically significant.

RESULTS

Age, gender and hand dominance were recorded for each patient (Table I). There were no significant differences between groups in any of the wrist motion, grip strength and quick-DASH scores (Table II). However, the isokinetic evaluation peak

TABLE II
Clinical outcomes (Grip strength, Range of motion and Quick-DASH) between the patient groups according to ulnar styloid process fracture and union

Clinical results	Group A	Group B	Group C	p
	Mean±SD	Mean±SD	Mean±SD	
Grip strength	90.3±7.07	86.4±8.72	90.9±8.16	0.207
Supination	91.6±8.29	89.3±7.61	90.1±7.67	0.648
Pronation	90.3±7.45	88.1±8.87	90.2±8.69	0.674
Flexion	89.4±6.69	85.8±12.43	87.5±6.21	0.417
Extension	91.1±6.51	87.9±9.88	87.2±8.36	0.270
Radial deviation	91.3±6.46	87.5±9.69	89.2±6.39	0.269
Ulnar deviation	93.2±6.56	91.3±8.42	90.6±10.23	0.587
Quick-DASH	16.8±6.68	19.5±7.04	19.4±3.07	0.273

SD: Standard deviation; DASH: Disabilities of the Arm, Shoulder and Hand.

TABLE III

Abnormal magnetic resonance imaging findings after minimum one-year follow-up after distal radius fracture				
Magnetic resonance imaging findings	Group A	Group B	Group C	Total
Distal radioulnar joint instability	1	-	-	1
Partial triangular fibrocartilage complex injury	1	4	5	10
Ulnar impaction syndrome	-	1	-	1
Ganglion cyst	5	4	4	13

torque and total work values for supination was different between groups ($p=0.008$ and $p=0.006$, respectively). The peak torque of supination ($p=0.020$ and $p=0.044$, respectively) and total work for supination ($p=0.005$ and $p=0.012$, respectively) was better in patients with intact ulnar styloid patients (group A) compared to patients with a fractured ulnar styloid (group B and C).

Abnormal MRI findings were listed in Table III. During MRI evaluation, one patient was found to have DRUJ instability despite having no abnormalities in the clinical examination and radiographic evaluation. She generally used her dominant hand in daily life and had a sedentary life. Therefore she did not want to have any operation on her hand. In addition, in 10 patients partial TFCC lesions were found on coronal images, but the patients voiced no complaints and no abnormalities were found showing instability on axial sections (Figure 1a-c). Abnormal MRI findings of 10 patients were distributed to the four patients in the healed group and five patients in the non-healed group. There was one TFCC lesion in a patient with intact ulnar styloid. So, the isokinetic test measurements seemed to be affected from the pathological findings which were reported from the MRI. Furthermore, ulnar impaction syndrome was seen in one patient (Figure 2a-c).

Isokinetic testing results are shown in Table IV. Percentage decreases of flexion and supination torque were significantly correlated with percentage decreases in grip strength in group B ($r=0.475$, $p=0.022$ and $r=0.406$, $p=0.021$) and C ($r=0.883$, $p<0.001$ and $r=0.618$, $p=0.024$), but not in group A ($r=0.338$, $p=0.059$ and $r=0.221$, $p=0.225$), respectively. In addition, decreases in flexion work were significantly correlated with percentage decreases in grip strength in group C ($r=0.601$, $p=0.030$). We found no significant correlation between range of motion and isokinetic testing.

DISCUSSION

Debate continues regarding the effect of the USF on the outcome of treatment after DRF. To the best of our

knowledge, this is the first study evaluating wrist function and muscle strength with a combination of clinical tests, isokinetic evaluation and MRI after DRF. Forearm rotation is an essential part of upper extremity function and influenced by DRF and supination is important for clinical scores



Figure 1. (a) Partial triangular fibrocartilage complex lesion seen after distal radial fracture with an intact ulnar styloid in a 32-year-old female patient. Pre-reduction anteroposterior and lateral radiography showed displaced radial fracture. (b) The fracture healed after 14 months follow-up and can be seen on the anteroposterior and lateral radiography. (c) Partial triangular fibrocartilage complex lesion was seen on a fat suppressed T₂-weighted fast spin echo image. Fluid signal was seen around the ulnar styloid process and triangular fibrocartilage complex was shown with a red arrow. No instability was seen on T₂-weighted axial image.

in the function of the upper limb.^[13] The DRUJ is an essential component for forearm rotation. Ploegmakers et al.^[13] highlights the importance of the strength of supination in the performance of daily activities and the strength of supination might be affected by the ulnar styloid fracture in the role of DRUJ.

Most of the studies have documented that USF did not affect outcomes and that the presence,

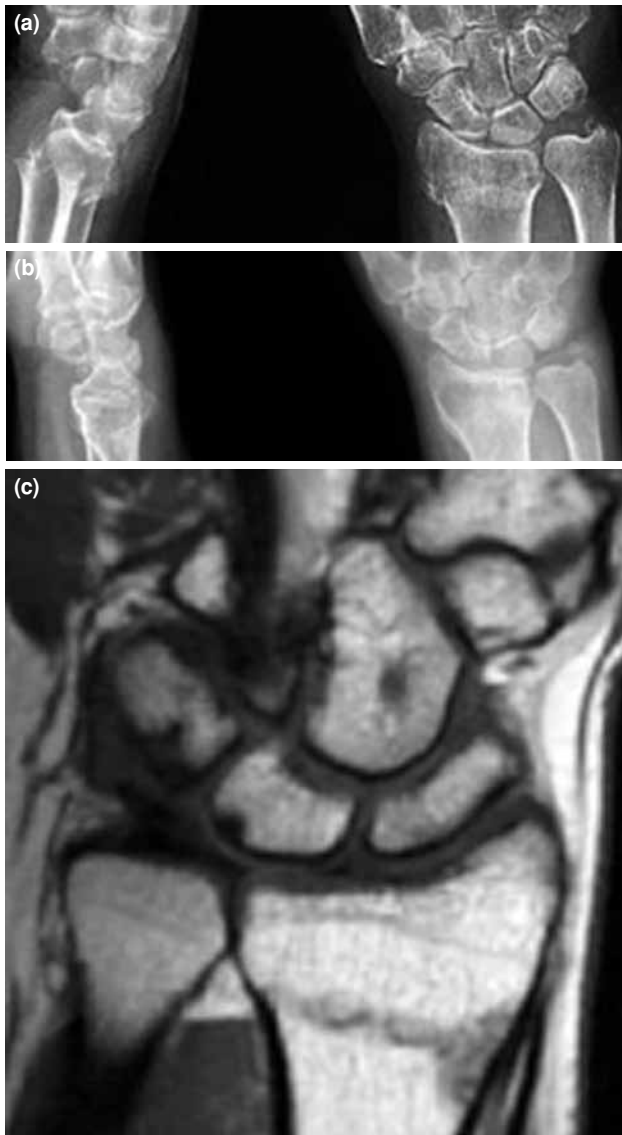


Figure 2. (a) Ulnar impaction syndrome was seen in a 34 year-old male patient after distal radial fracture associated with ulna styloid fracture. Pre-reduction anteroposterior and lateral radiography showed displaced radial fracture. (b) The fracture healed after 16 months and can be seen on anteroposterior and lateral radiography. (c) Cystic changes were seen on lunate and triquetrum bones on T₁-weighted coronal image showing ulnar impaction syndrome.

displacement, or level of USF did not have any effect on the outcome.^[2,3,8] In contrast, some other studies have demonstrated that accompanying USF was a predictor of poor results after DRF.^[6,14] In these studies, the authors generally thought that the poor outcomes of USF were caused by DRUJ injury. Actions that stress the DRUJ, such as forearm rotation, ulnar deviation, or DRUJ translation can cause pain in cases of TFCC injury and soft tissue damage after DRF. However, radioulnar stress test and physical examination were reported to have poor results in diagnosing TFCC.^[15] Although all the patients included in the present study had a normal physical examination, one patient had instability and 10 patients had partial TFCC injuries detected on MRI.

The poor results obtained after DRF accompanied by USF were attributed to DRUJ injury arthroscopically by some authors.^[2,6,14,16] Lindau et al.^[16] found higher TFCC injuries arthroscopically in accompanied USF. Symptomatic USF was suggested to be associated with TFCC tears and the importance of treatment after diagnostic arthroscopy was emphasized.^[17] Primary repair of the displaced ulnar styloid is recommended as a means of stabilizing the DRUJ and preventing the disability associated with chronic DRUJ instability.^[17,18]

We found no correlation between the fracture and union of the ulnar styloid with the functional outcome, which was in agreement with most of the previous studies, but we found some differences using isokinetic testing. Patients with accompanying USF had lower muscle strength in supination after DRF, and the union of the USF did not improve the findings. The most common abnormality after DRF was ganglion cysts found in the MRI, and partial TFCC lesions was seen mainly in USF patients regardless the presence of the union. These findings suggested that the lower isokinetic muscle strength in supination of USF patients seemed to be affected by the TFCC lesions.

There are some limitations to the present study. First, the sample size was too small to extract reliable baseline values. The three groups that were compared in this study did not match. Although the evaluation was made 1-2 years after the fracture, it is possible to improve the outcomes in a longer follow-up time period. The present study lacked an arthroscopic evaluation of the DRUJ that may have provided diagnosis of a patho-anatomical basis for loss of the rotational strength of the forearm. We did not obtain any pre-injury strength data in the study group. Although the groups were equally

TABLE IV

Isokinetic testing values and statistical comparisons between the patient groups according to ulnar styloid process fracture and union

Isokinetic muscle strength	Group A		Group B		Group C		p: Intergroup difference					
	n	Mean±SD	n	Mean±SD	n	Mean±SD	One-way ANOVA			Post hoc (Bonferroni)		
							F	p	A vs B	B vs C	A vs C	
Number of patients	26		17		13							
Peak torque												
Supination		89.4±13.61		75.2±18.15		75.6±18.17	5.277	0.008	0.020	1.000	0.044	
Pronation		85.4±15.54		86.9±21.90		88.9±19.88	0.158	0.855	1.000	1.000	1.000	
Flexion		86.2±15.25		86.8±13.31		81.4±14.57	0.609	0.548	1.000	1.000	0.947	
Extension		88.8±16.57		94.0±14.76		82.1±15.96	2.059	0.138	0.896	0.142	0.664	
Total work												
Supination		93.8±16.62		77.1±18.27		77.4±11.26	7.396	0.006	0.005	1.000	0.012	
Pronation		90.0±15.56		91.5±20.14		91.4±13.19	0.055	0.254	1.000	1.000	1.000	
Flexion		92.5±18.01		94.2±13.54		94.6±22.21	0.079	0.412	1.000	1.000	1.000	
Extension		93.3±14.29		93.9±10.71		85.2±10.89	2.232	0.673	1.000	0.186	0.192	

SD: Standard deviation.

distributed according to hand dominance, the hand strength differed by the dominant hand.

In conclusion, USF did not affect the outcome, except for in the case of muscle strength, in supination in extra-articular DRF patients. Although supination is more important for upper extremity function, there were no differences between the united and nonunion of USF. Initial TFCC lesion seems to lead to poorer isokinetic performance in USF patients and healing of fracture does not influence isokinetic outcome. The main clinical relevance of this study is that the USF should not be the focus of attention during initial treatment and surgical intervention might only be considered in case of accompanying TFCC lesion.

Declaration of conflicting interests

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

Funding

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

REFERENCES

- Nakamura T, Iwamoto T, Matsumura N, Sato K, Toyama Y. Radiographic and Arthroscopic Assessment of DRUJ Instability Due to Foveal Avulsion of the Radioulnar Ligament in Distal Radius Fractures. *J Wrist Surg* 2014;3:12-7.
- Wijffels MM, Keizer J, Buijze GA, Zenke Y, Krijnen P, Schep NW, et al. Ulnar styloid process nonunion and outcome in patients with a distal radius fracture: a meta-analysis of comparative clinical trials. *Injury* 2014;45:1889-95.
- Kim JK, Yun YH, Kim DJ, Yun GU. Comparison of united and nonunited fractures of the ulnar styloid following volar-plate fixation of distal radius fractures. *Injury* 2011;42:371-5.
- Gogna P, Selhi HS, Mohindra M, Singla R, Thora A, Yamin M. Ulnar styloid fracture in distal radius fractures managed with volar locking plates: to fix or not? *J Hand Microsurg* 2014;6:53-8.
- Atik OŞ. Do not treat the radiograph, treat the patient! *Eklem Hastalık Cerrahisi* 2015;26:125.
- Belloti JC, Moraes VY, Albers MB, Faloppa F, Dos Santos JB. Does an ulnar styloid fracture interfere with the results of a distal radius fracture? *J Orthop Sci* 2010;15:216-22.
- Sammer DM, Chung KC. Management of the distal radioulnar joint and ulnar styloid fracture. *Hand Clin* 2012;28:199-206.
- Ozasa Y, Iba K, Oki G, Sonoda T, Yamashita T, Wada T. Nonunion of the ulnar styloid associated with distal radius malunion. *J Hand Surg Am* 2013;38:526-31.
- Buijze GA, Ring D. Clinical impact of United versus nonunited fractures of the proximal half of the ulnar styloid following volar plate fixation of the distal radius. *J Hand Surg Am* 2010;35:223-7.
- Scheer JH, Adolfsson LE. Radioulnar laxity and clinical outcome do not correlate after a distal radius fracture. *J Hand Surg Eur* 2011;36:503-8.
- Fotiadou A, Patel A, Morgan T, Karantanas AH. Wrist injuries in young adults: the diagnostic impact of CT and MRI. *Eur J Radiol* 2011;77:235-9.
- Yilmaz S, Cankaya D, Karakus D. Ulnar styloid fracture has no impact on the outcome but decreases supination strength after conservative treatment of distal radial fracture. *J Hand Surg Eur Vol* 2015;40:872-3.
- Ploegmakers JJ, The B, Bruttly M, Ackland TR, Wang AW. The effect of a Galeazzi fracture on the strength of pronation and supination two years after surgical treatment. *Bone Joint J* 2013;95:1508-13.
- Meyer H, Krämer S, O'Loughlin PF, Vaske B, Krettek C, Gaulke R. Union of the ulnar styloid fracture as a function

- of fracture morphology on conventional radiographs. *Skeletal Radiol* 2013;42:1135-41.
15. Scheer JH, Adolfsson LE. Radioulnar laxity and clinical outcome do not correlate after a distal radius fracture. *J Hand Surg Eur Vol* 2011;36:503-8.
 16. Lindau T, Hagberg L, Adlercreutz C, Jonsson K, Aspenberg P. Distal radioulnar instability is an independent worsening factor in distal radial fractures. *Clin Orthop Relat Res* 2000;376:229-35.
 17. Protopsaltis TS, Ruch DS. Triangular fibrocartilage complex tears associated with symptomatic ulnar styloid nonunions. *J Hand Surg Am* 2010;35:1251-5.
 18. Argintar E, Mantovani G, Pavan A. TFCC reattachment after traumatic DRUJ instability: a simple alternative to arthroscopic management. *Tech Hand Up Extrem Surg* 2010;14:226-9.