Effects of Ulnar Styloid Fractures on Unstable Distal Radius Fracture Outcomes: A Systematic Review of Comparative Studies

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J Wrist Surg 2018;7:172–181.

Abstract

Purpose In this literature review, functional outcomes such as Disability of Arm, Shoulder and Hand (DASH) score and the visual analog scale (VAS) of pain along with clinical outcomes such as range of movement and grip strength of treated distal radius fractures (DRF) accompanied with ulnar styloid fractures (USF) will be compared with those with isolated DRF.

Materials and Methods We analyzed articles from MEDLINE, Embase, and CINAHL that met our predetermined inclusion and exclusion criteria as per the Preferred Reporting Items for Systematic Reviews and Meta-analysis statements. This resulted in the identification of 464 articles with 18 potentially eligible studies of which 6 were included at the full-text screening stage. The primary outcomes were wrist pain, range of motion, functional outcome and satisfaction, such as VAS, and the DASH questionnaire along with radiological assessment and incidence of complications.

Results These studies involved 796 participants with DRF and 806 wrists with DRF; 444 (55%) of DRF had an associated USF. Three studies did not report any statistically significant difference in DASH scores between the DRF patients with or without USF. Two studies reported worse DASH scores in the group with associated USF. Wrist pain was reported to be statistically significantly worse in patients with associated USF in two studies. Grip strength did not exhibit a statistically significant difference in any groups in four studies. On assessing the range of motion of the wrist and forearm, only one study reported a statistically significant difference in flexion at 2 years follow-up, with less flexion in patients with USF.

Conclusion This review suggests that there is no significant correlation between a USF and the functional and clinical outcomes of DRF treatment, albeit wrist pain and less flexion were reported in some studies to be associated with USF. There is a need for more robust evidence from large randomized controlled trials to specifically look at the effects of fixation versus nonfixation of USF on DRF, or large prospective cohort studies assessing DRF with and without USF, with a minimum of 12 months follow-up.

Level of Evidence Level II—therapeutic.

Keywords
- radius
- fracture
- ulnar styloid
- DRUJ stability

received
June 12, 2017
accepted
September 5, 2017
published online
October 11, 2017

DOI https://doi.org/10.1055/s-0037-1607214.
ISSN 2163-3916.

Distal radius fractures (DRF) are the most common fracture seen in the northern hemisphere,[1–3] and appropriate management based on the best evidence is essential in providing good clinical care to the patient. More than 50% of ulnar styloid fractures (USF) can be associated with DRF.[4–6] Untreated basal USF result in high rates of nonunion and are linked to instability of the distal radioulnar joint (DRUJ).[7] A small percentage of patients (8–10%) require surgical treatment to stabilize the DRUJ, such as fixation of the ulnar styloid or repair of the triangular fibrocartilage complex (TFCC).[8,9] DRUJ instability often leads to chronic loss of function and loss of motion with poor clinical outcomes;[10] some studies attribute the poor treatment results of DRF to an accompanying untreated USF.[11–14] A significant percentage (10–37%) of patients with DRF who will complain of ulnar-sided wrist pain that will affect their quality of life and subsequently require further investigation and intervention.[12,14]

The frequency quoted for nonunion of USF associated with DRF ranges from 14 to 76%.[4,13,15] The union rate of USF associated with DRF following stable internal fixation of the DRF with volar locking plates ranges from 27 to 63%.[16–19] Importantly, it has also been shown that even if the USF is not united, it has no adverse effects on wrist function and there are no significant differences in the functional outcomes, pain scale, wrist movements, or grip strength.[16,17]

The effects of USF in the presence of DRF are not clear and the evidence in the literature is conflicting. Ulnar-sided wrist injury and DRUJ instability are major contributors to poorer treatment outcomes of DRF, thus, some investigators advise primary repair or fixation of styloid fractures to prevent this;[9,14,19,20] on the contrary, treatment of the USF associated with DRF remains controversial as some authors conclude that fractures involving the tip or waist of the ulnar styloid can be treated nonsurgically, and internal fixation may be required if there is displacement of the base of the styloid.[9,10,20] Conversely, others conclude that USF do not cause poor wrist function or DRUJ instability.[17,18,21]

In this systematic review, we will present the findings of all the recent relevant individual studies so that the existing evidence is more accessible to decision makers[22] in deciding whether an USF affects the treatment results of an unstable DRF. We hypothesize that the presence of an USF does not affect DRF treatment or outcomes.

Materials and Methods

Before undertaking this systematic review, we searched the Database of Abstracts of Reviews of Effects (DARE)[23] and the Cochrane Database of Systematic Reviews.[24] The search terms used were "ulnar styloid fracture," "distal radius fracture," and "wrist fracture." This showed that there has been no previous review of this type.

An electronic search was performed via the Evidence Search website[25] and databases: MEDLINE (U.S. National Library of Medicine's bibliographic database from 1950 to the present), EMBASE (Excerpta Medica Database produced by Elsevier from 1980 to the present), and CINAHL (Cumulative Index to Nursing and Allied Health Literature from 1981 to the present). The key search terms and outcomes as of January 2014 are shown in ►**Supplementary Table S1** (available in the online version) .

Furthermore, scanning was undertaken of the reference lists of the relevant articles of both the selected studies and the reviewed articles that were identified by the database searches to identify additional studies to include in the systematic review.[22,26] The U.S. National Institutes of Health clinical trials website,[27] the World Health Organization International Clinical Trials Registry Platform,[28] the current controlled trials website,[29] the UK Clinical Research Network,[30] and the Cochrane Central Register of Controlled Trials for clinical trials[24] were searched for clinical trials relevant to the review subject. To further reduce the publication bias, a search was performed for studies not published in peer-reviewed journals, that is, gray literature, such as unpublished studies that were unlikely to be identified if the search was restricted to electronic bibliographic databases. A wider search was conducted to capture any relevant study; the sites searched included Open Gray,[31] the National Technical Information Service,[32] and the British Library for report literature,[33] although no articles were found to be related to the review topic. In addition, the major databases of conferences abstracts, BIOSIS Previews,[34] and the British Society for Surgery of the Hand website[35] were searched for relevant studies on USF for conference proceedings and ongoing or completed studies. The health care focus search engine Trip database[36] was also employed to search for the key terms.

Study Selection

This process was undertaken in two stages: the first stage was to screen the titles and abstracts of the citation lists obtained from searching the relevant databases which was done independently by two reviewers (an orthopaedic surgeon and hand surgeon). In the second stage, the full article of all the studies selected as relevant by any of the reviewers were then assessed against the inclusion criteria. Any disagreement between the assessors was discussed and resolved by consensus; if necessary, a third person (a resident orthopaedic surgeon) was consulted to resolve the discrepancy. The studies deemed ineligible to be included in the review at the second stage of the selection of the studies were all listed, along with the reason for the exclusion (►**Supplementary Table S2**, available in the online version).

Population, Intervention, Comparison, and Outcome

The recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-analysis statements on systematic review were followed[37,38] (►**Fig. 1**). The inclusion and exclusion criteria are summarized in ►**Table 1**.

Participants included both female and male adults, aged 18 years and older, with unstable DRF associated with a USF. Unstable DRF were defined in the published literature[39,40] as any fracture within the distal end of the radius requiring a procedure to correct unacceptable displacement or angulation. The procedure could be manipulation under anesthetic, open reduction and internal fixation with plate and screws,

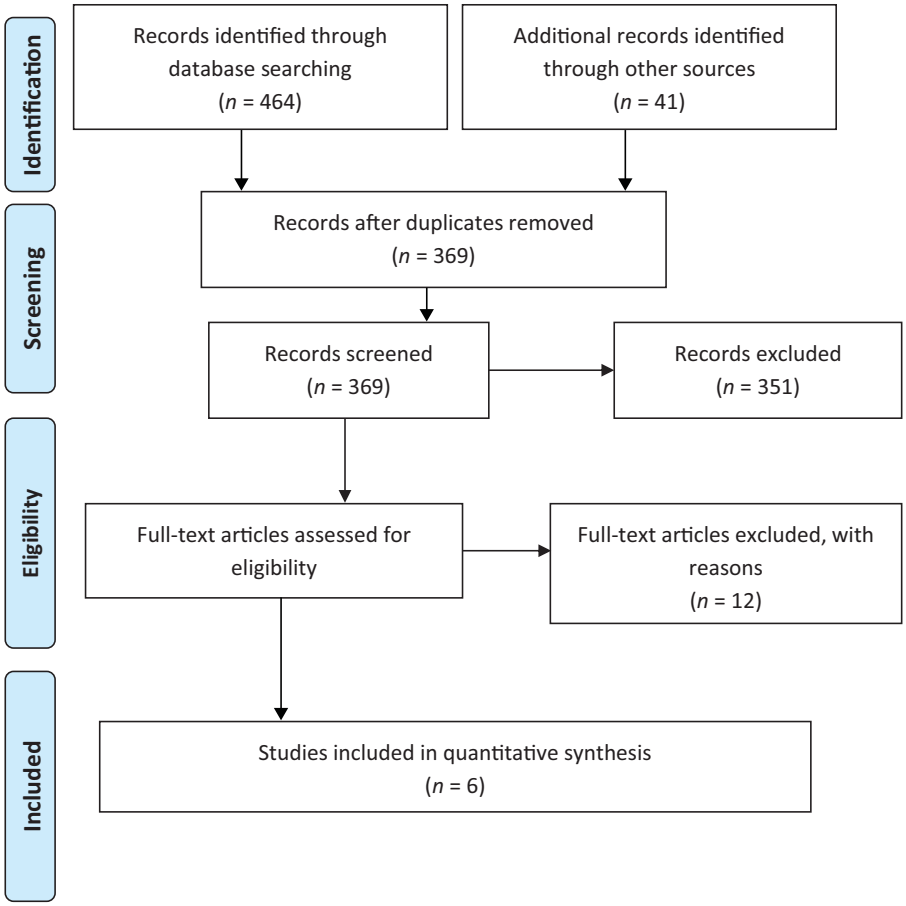

Fig. 1 The Preferred Reporting Items for Systematic Reviews and Meta-analysis flow chart showing the search results.

Table 1 Inclusion and exclusion criteria

PICOs	Inclusion criteria	Exclusion criteria
Population	• Adults $\geq$ 18 y • Male and female • Injury: unstable DRF associated with USF • Treatment: DRF treated with ORIF, external fixation, percutaneous pinning or MUA, and plaster	• Skeletally immature • Undisplaced DRF does not require an intervention • Acute dislocation/subluxation of DRUJ
Intervention	• Surgical fixation of USF	
Comparison	• No surgical treatment for USF	
Outcomes	• Functional and satisfaction outcomes include DASH, VAS, and ulnar-sided wrist pain • Range of motion of wrist and forearm • Postoperative complication • Radiological assessment	
Study types	• RCTs, CCSs, quasi-randomized trials, and comparative observational studies	• Case reports, case series, and any study that does not include a comparison between surgical fixation and no surgical treatment for USF
Language	• English publications	• Non-English language literature
Subjects	• Human subjects	• Cadaveric and animal studies

Abbreviations: CCS, case control study; DASH, Disability of Arm, Shoulder and Hand; DRF, distal radius fractures; DRUJ, distal radioulnar joint; MUA, manipulation under anesthetic; ORIF, open reduction and internal fixation; PICOs, population, intervention, comparison, and outcomes; RCT, randomized controlled trial; USF, ulnar styloid fractures; VAS, visual analog scale.

such as volar locking plates, percutaneous pinning, or external fixation. A minimum of 6 months follow-up was necessary for those included.

All the studies compared two groups of DRF, one associated with USF and the other without USF, and there was no intervention or specific treatment for the USF in both the groups. Surgical interventions were only for the DRF.

Outcome Measures

Several outcome measures were reviewed (►**Table 1**), functional and satisfaction outcomes were based on validated scores such as the Disability of the Arm, Shoulder and Hand (DASH) score,[41–45] along with clinical outcomes such as wrist pain, grip strength, and range of motion. These were measured in the early postoperative period and at the final follow-up or review. All the studies assessed the patients for the range of motion using a goniometer and compared it with the unaffected side, and the grip strength was measured using a Jamar dynamometer. Radiological evaluations were reported in all the studies mainly to assess the union rate of the ulnar styloid. Wrist and ulnar-sided wrist pain were measured using a visual analog scale (VAS) by all studies except for Kim et al.[17] The outcomes were measured and data were taken at different periods of time across the studies; all studies collected data at the final follow-up or review time (►**Table 2**).

Six articles were identified that met the inclusion criteria and were included in the systematic review (►**Table 2**). They included a randomized controlled trial (RCT),[46] case–control study,[21] and four comparative cohort observational studies (3*x* prospective and 1*x* retrospective).[17–19,47] Altogether, the total number of patients with DRF included in the review was 796 and the number of wrists with DRF was 806; 444 (55%) of DRF had an associated USF (►**Table 3**).

Quality Assessment

The Grading of Recommendations Assessment, Development and Evaluation (GRADE)[48] tool (►**Supplementary Table S3**, available in the online version) was used to assess the appropriateness of the study design in regard to the aims of the study, the risk of bias, the choice of outcome measures, statistical issues, quality or reporting, and external validity.[22] The assessment of the methodology and quality of the studies using a prepiloted form (►**Supplementary Table S4**, available in the online version) was conducted by two reviewers independently. ►**Table 4** summarizes the results of the quality assessment conducted on all the included studies.

Results

Functional Outcomes

Five studies used the DASH score as the functional outcome and reported it at the final follow-up. Three studies reported that the associated USF did not affect the functional outcome, DASH score of the treated DRF. In the study by Kim et al,[17] the authors did not report any statistically significant difference ($p = 0.46$) between the group of DRF patient without USF and the other two groups with USF (basal of styloid fracture and nonbase USF), and did not find any significant statistical difference ($p = 0.48$) between minimally displaced USF and displaced USF. Souer et al,[21] at 24 months review, did not report any significant difference in the functional outcomes between the patients with USF (DASH $= 6.7 \pm 6.7$) and those without USF (DASH $= 7.6 \pm 12.9$). The authors also did not report any significant difference between the displaced (DASH $= 6.7 \pm 11.1$) and minimally displaced USF (DASH $= 9.7 \pm 15.4$) patients. Zenke et al[18] did not report any significant difference ($p > 0.05$) in the DASH scores between the two groups.

Two studies reported that the DRF patients with associated USF had worse DASH scores than the patients with isolated DRF.[19,46] In the RCT study,[46] the authors compared the group with DRF without USF with the group of DRF patients with USF. They reported the group that had DRF associated with USF had the worst DASH score at 24 months review, which was significantly different ($p = 0.04$). In the retrospective cohort study,[19] the authors reported significantly better mean DASH scores in DRF patients without USF ($p = 0.045$), but did not report any significant difference between patients with union USF and nonunion USF ($p = 0.856$).

Chen et al[47] used the Patients-Rated Wrist Evaluation Questionnaire Hong Kong (PRWE-HK) version to measure the functional outcome. At the final follow-up, the authors did not report any significant difference ($p = 0.452$) in the score of the functional outcome PRWE-HK between USF and non-USF patients.

Visual Analog Scale for Pain

Five studies reported the VAS for the pain at their final follow-up (►**Table 5**).

Range of Motion of the Wrist and Forearm

All the studies reported that they measured the wrist joint range of movement of their patients at the final follow-up (►**Table 6**).

Grip Strength

All the studies reported the grip strength of the injured side, which was measured and compared with the unaffected side (►**Table 7**).

Radiographic Evaluation

Five studies reported on the healing of the ulnar styloid in radiographic evaluation outcomes (►**Table 8**).

Complications

Two studies reported complications in relation to DRF treatment alone. Chen et al[47] had eight patients who developed superficial pin track infections, which were resolved after local wound cleaning and treatment with antibiotics, while one patient had numbness in the first web space and one patient developed malunion of DRF. Zenke et al[18] reported 10.2% of the patients had complications; three with tendon injury (two extensor pollicis longus and one flexor pollicis longus), two with nerve palsy (one carpal tunnel syndrome and one superficial palmar branch nerve), one patient with

Table 2 Studies included in the systematic review

Study PICO	Zenke et al (2009)	Souer et al (2009)	Belloti et al (2010)	Kim et al (2010)	Krämer et al (2012)	Chen et al (2013)
Country of study	Japan	U.S.	Brazil	South Korea	Germany	China
Population	118	152	91	138	200 DRF 191 Pt	106
Number	68 USF (57.6%)	76 USF (50%)	61 USF (67%)	76 USF (55%)	101 USF (50%)	62 USF (58%)
Age (y)	64.1 (25–94)	55 (18–83)	57.2 (45–72)	49 (17–88)	55.5 (18–81)	51.1 (38–65)
Type of injury	Unstable DRF ± USF	DRF ORIF ± USF	Unstable DRF ± USF	Unstable DRF ± USF	DRF at least 6 mo	Unstable DRF and stable DRUJ
Inclusion criteria	Patients with DRF treated with ORIF	DRF treated with ORIF within last 10 d and age ≥ 18 y	Age ≥ 40 y, unstable reducible DRF	Unstable DRF	Previous DRF treated at least 6 mo ago, age ≥ 18 y	Unstable DRF and stable DRUJ
Exclusion criteria	Ipsilateral upper limb injury, nonunion previous USF or DRF, systematic multiorgans or head injuries, previous surgery for distal ulna fracture or previous surgery in the last 2 wk	Previous ORIF, local tumor, hyperparathyroidism, osteogenesis imperfecta, multiple traumatic injuries, coenrollment in another study, history of alcohol or drug abuse	Volar angulation of DRF (Smith's fracture), volar or dorsal intra-articular DRF (Barton's fracture), open fracture, bilateral, unable to reduce, previous injury to wrist, local degenerative disease, and refusal to consent	Stable DRF treated nonoperative, preexisting severe illness, refused surgery, skeletally immature, previous wrist fracture, bilateral, open fracture, and ulnar head or neck fracture	Not reported	Not reported
Intervention	ORIF of DRF	ORIF of DRF	Ex Fix DRF	ORIF DRF	ORIF/Ex Fix/K.WIRE/MUA	Ex Fix for DRF
Comparison	No USF	No USF	Pinning DRF	No USF	Union vs. nonunion USF	No USF
Outcomes	DASH Grip strength ROM Pain Radiographic	DASH Gartland Grip Strength ROM Pain VAS Radiographic	DASH VAS pain Grip strength ROM Radiographic	DASH Mayo Grip strength ROM Radiographic DRUJ stability	DASH Pain VAS ROM Grip strength Radiographic DRUJ stability	PRWE-HK Pain VAS ROM Grip strength Radiographic
Time of data collection	1, 4, and 6/52 and 4, 6,12 and 24/12	6 and 24 mo	1 and 4/52 and 6 and 24 mo	Time of final review ≥ 12/12	At last review ≥ 6/12	3/12 and final review 12–24/12
Follow-up (mo)	6–38 (14.9)	24	24	19 (12–36)	20 (6–49)	15 (12–24)
Type of study	Prospective cohort comparative	Case–control study	Randomized controlled trial	Cohort prospective	Retrospective comparative cohort study	Cohort prospective study

Abbreviations: DASH, Disability of Arm, Shoulder and Hand; DRF, distal radius fractures; DRUJ, distal radioulnar joint; MUA, manipulation under anesthetic; ORIF, open reduction and internal fixation; PICOs, population, intervention, comparison, and outcomes; PRWE-HK, Patients-Rated Wrist Evaluation Questionnaire Hong Kong; pt, patient; RCT, randomized controlled trial; ROM, range of motion; USF, ulnar styloid fractures; VAS, visual analog scale.

Table 3 Demographic data of the included studies

Character	Result
Number of included studies	6
Total number of patients	796
Total number of DRF	806
Total number of DRF associated with USF	444
Total male patients	202
Total female patients	361
Number of patients where gender not reported	243 (Belloti et al, 2010; Souer et al, 2009)
Range of age	18–94 y
Mean age	55.32 y

Abbreviations: DRF, distal radius fractures; USF, ulnar styloid fractures.

flexor tendonitis, and five patients had metal work-related problems; no infections were reported.

Discussion

The overall aim of this systematic review was to evaluate the effect of USF on the results of treatments for DRF. USF are commonly associated with DRF, and the rate of USF associated with DRF in this systematic review was 55%, which is consistent with previously published rates ranging between 50 and 67%.[9,13,14,16,49]

Regarding the functional outcomes, previous studies[49–51] have not shown any statistical difference if there is a concomitant USF. Sammer et al[49] reported that USF did not affect the subjective outcomes measured by the Michigan Hand Outcomes Questionnaire. Chen et al[47] used a different functional outcome measure, the PREW-HK, and they reported that the presence of associated USF did not affect the functional outcome of the treatment of DRF. Two studies reported worse DASH scores in the group with associated USF.[19,46] In the previous studies, there were not any reports of worse functional outcomes in DRF associated with USF.

Wrist pain was reported to be statistically significantly worse at the final follow-up in patients with an associated fracture of the ulnar styloid affecting the DRUJ in two of the included studies.[18,47] A previous study[16] did not report any statistically significant difference, among patients with DRF, between patients with healed USF, and patients with nonunion of USF. Pain in the wrist mainly occurs on the ulnar side and can be explained by concurrent injuries to the TFCC and soft tissues. In a study of arthroscopically assisted reduction of intra-articular fracture of the distal radius, Geissler and Freeland[52] found TFCC lesions in 4 of 25 patients with associated USF and 3 of 35 patients without USF.

Regarding grip strength at final follow-up, there was no statistically significant difference between healed and nonunion USF[17] and between displaced and undisplaced USF.[19] In assessing the range of motion of the wrist and forearm, only Souer et al[21] reported a statistically significant difference in flexion at 2 years follow-up, with less flexion in patients with USF ($p = 0.02$). There were no statistical significant differences in measurements of the rest of the wrist and forearm movement at 2 years follow-up. Previous studies[15,16,50,51] did not report any significant difference in assessing the motion between healed USF and nonunion USF or any significant difference in wrist movement between repaired and nonrepaired USF.

Radiographic evaluations were reported the rate of USF union ranged between 22.95 and 54% in the five studies. In regard to the radiological evidence of healing of the USF at the final follow-up, 138 patients out of 367 (37.6%) with associated USF exhibited a union of USF in these studies. Previous evidence[51] shows a rate of union consistent with this result, with a union rate of USF treated nonoperatively being 35.7%.

DRUJ instability was reported to be statistically significantly higher in the DRF patients with associated USF ($p = 0.032$) in one study, but they did not find any statistically significant difference between the tip of the styloid fracture and the base of the USF ($p = 0.525$). On the contrary, Kim et al[17] did not report any significant difference in the rate of DRUJ instability between patients with and without USF.

Quality of Evidence

There were different types of studies included in this systematic review as further described in detail in ►**Table 4**.

In the RCT study,[46] eight patients were reported lost to follow-up. However, there were no details of how and when the patients were lost, and the authors did not include them in the study analysis. In the study by Kim et al,[17] the authors reported that four patients were lost to follow-up. Two were excluded after the initial reduction of the DRF, and none of them was included in the study analysis. Therefore, this increased the attrition bias in these studies. Only one of the observational studies[21] reported that the authors assessed the participants of the selected matched groups for potential confounders. In addition, the studies included a wide range of ages; DRF in the young tend to be due to high-energy injuries in comparison to low-energy fractures associated with osteoporosis in the elderly. The potential effects of these variations on outcomes have not been scrutinized further.

The sample size and power calculation were done in only two studies[17,20] and the sample size in both were compatible with the power analysis. The other four studies did not report whether they had performed the power calculation.

Strengths and Limitations of the Review

This systematic review was based on a comprehensive search performed with no limitation in regard to time or type of study. All the included studies were assessed for quality by two assessors using the validated GRADE approach. Therefore, there is a lower likelihood of publication bias.

The limitations of this review are that the search was limited to English language studies only. The studies

Table 4 Summary of the quality assessment of all the included studies

Study	Zenke et al	Souer et al	Bellotti et al	Kim et al	Kramer et al	Chen et al
Selection bias: Randomization Allocation concealment	Unclear Nonrandomized	Unclear Nonrandomized	Unclear Randomized	Unclear Nonrandomized	High Nonrandomized	Unclear Nonrandomized
Performance bias	Unclear One intervention to all patients. Not reported if patients were blinded to either associated USF or not	Unclear One intervention to all participants	Low Not possible to blind the patients to the type of intervention	Unclear One intervention to all participants	Unclear Retrospective cohort Not reported if the patients were aware of the presence of USF	Unclear One intervention to all participants
Measurement bias	Unclear Not reported	Unclear Not reported	Unclear Not reported	Low The assessor unaware of the radiographs	Unclear Not reported	Unclear Not reported
Attrition bias	Unclear Not reported	Low	High 8 patients lost to follow-up not included in the final analysis	High 4 lost to follow-up and 2 lost initial reduction of the fracture all not included in analysis	Low	Unclear Not reported
Reporting bias	Low The proposal of the study is not available nor reported. All prespecified outcomes are reported	Low The proposal of the study is not available nor reported. All prespecified outcomes are reported	Low The proposal of the study is not available nor reported. All prespecified outcomes are reported	Low The proposal of the study is not available nor reported. All prespecified outcomes are reported	Low The proposal of the study is not available nor reported. All prespecified outcomes are reported	Low The proposal of the study is not available nor reported. All prespecified outcomes are reported
Confounding bias	Unclear Not reported	Low Assessment was done and reported	Low RCT	Unclear Not reported	Unclear Not reported	Unclear Not reported

Abbreviation: RCT, randomized controlled trial.

Table 5 Summary of the VAS results from five studies

Study	Belloti et al (2010)	Chen et al (2013)	Kramer et al (2010)	Souer et al (2009)	Zenke et al (2009)
VAS	**No USF = 1.2 ± 1** **USF = 1.9 ± 2.0**	No USF = 0.9 ± 1.4 Tip USF = 0.8 ± 1.0 Base USF= 0.5 ± 0.9	No USF = 16% USF = 27%	**No USF = 0.7 ± 0.9 R**[a] **= 0.9 ± 1.3 M**[b] **USF = 0.8 ± 1.6 R** **= 1.1 ± 1.6 M**	No USF= 6% Tip USF= 0% Base USF = 4.9%
p-Value	**0.03**	0.555	0.048	**NR**	NR

Abbreviations: NR, not required; USF, ulnar styloid fractures; VAS, visual analog scale
[a]R = pain at rest.
[b]M = pain at motion.
Note: Columns in bold are for statistically significant studies.

Table 6 Range of motion of wrist and forearm in degrees

		Flexion	Extension	Ulnar deviation	Radial deviation	Supination	Pronation
Belloti et al (mean loss of motion ± SD)	No USF	6 ± 10	6 ± 9	5 ± 6	2 ± 2	5 ± 11	5 ± 11
	With USF	7 ± 9	6 ± 9	4 ± 5	2 ± 4	5 ± 9	4 ± 7
	p-Value	0.79	0.80	0.46	0.15	0.85	0.76
Chen et al (mean of movement ± SD)	No USF	57 ± 9	51 ± 8	35 ± 8	22 ± 6	82 ± 14	81 ± 2
	Tip USF	56 ± 8	53 ± 10	39 ± 11	23 ± 6	81 ± 10	81 ± 9
	Base USF	58 ± 10	52 ± 9	36 ± 11	22 ± 6	83 ± 13	83 ± 9
	p-Value	0.558	0.721	0.331	0.624	0.583	0.78
Kim et al (mean arc of motion ± SD)	No USF	Flex-Ext arc = 104 ± 13		NR	NR	Supin-Pron arc = 159 ± 18	
	Less displaced	Flex-Ext arc = 106 ± 18		NR	NR	Supin-Pron arc = 161 ± 25	
	More displaced	Flex-Ext arc = 101 ± 14				Supin-Pron arc = 154 ± 23	
	p-Value	0.42				0.75	
Kramer et al (mean loss of movement)	No USF	−11.67	7.58	**−2.74**	−4.88	NR	NR
	Healed USF	−15.00	12.58	**−5.00**	−4.88	NR	NR
	Nonunion USF	−14.26	16.03	**−6.91**	−5.88	NR	NR
	p-Value	0.423	0.097	**0.031**	0.843	NR	NR
Souer et al (mean range of motion ± SD)	No USF	59 ± 17.2	63 ± 13.5	36 ± 10.2	23 ± 8.6	81 ± 13.7	85 ± 8.2
	With USF	54 ± 16.5	61 ± 15.4	32 ± 9.9	23 ± 8.9	80 ± 13.9	83 ± 13.2
	p-Value	0.02	NR	0.05	NR	NR	NR
Zenke et al	There was no report of the actual measurement of the movement, but the authors did not report any statistical significant difference between the two groups ($p > 0.05$)						

Abbreviations: Flex-Ext, flexion–extension; Supin-Pron, supination–pronation; NR, not required; SD, standard deviation; USF, ulnar styloid fractures.
Note: Columns in bold are for statistically significant results.

included in this review are mostly observation studies and only one was a RCT, which increases the risk of bias.

Implication for Practice and Further Research

The results of the studies were inconsistent and based on these outcomes, they do not allow clear treatment recommendation to be developed. Within the results, there was no strong evidence to support the view that USF do affect the treatment outcomes of unstable DRF. In fact, most of the studies showed no significant difference in the functional outcomes and VAS wrist pain between the two groups. Interestingly, none of the studies investigated the exact cause of the wrist pain in those patients who experienced pain. The cause of this could be due to something other than USF and maybe worthy of further investigation.

There is a need for more robust evidence from large RCTs or large prospective cohort studies with a longer follow-up to look at fixation versus nonfixation of USF in the context of an associated DRF to see whether this affects outcome scores and functional outcomes between the two.

Table 7 Summary of the grip strength results at final follow-up

	Belloti et al (2010) (mean ± SD loss of GS compared with uninjured side)	Chen et al (2013) (mean ± SD of the GS in the affected side)	Kim et al (2010) (mean ± SD of the GS in the affected side)	Kramer et al (2012) (percentage of GS loss in comparison to unaffected side)	Souer et al (2009) (mean ± SD of the GS in the affected side at 6 and 24 mo)	Zenke et al (2009) (percentage of GS compared with unaffected side)
No USF	5 ± 5 kg	25.2 ± 7.1 kg	24 ± 4 kg	**9%**	**25 ± 12.9 kg 71%** **31 ± 12.8 kg 93%**	90.8%
With USF	6 ± 5 kg				**25 ± 12.6 kg 79%** **33 ± 16.3 kg 94%**	
Tip USF		25 ± 5.5 kg				94.7%
Base USF		26.6 ± 8.5 kg		**32%**		92.5%
Healed USF				**31%**		
Nonunion USF						
Minimally displaced			24 ± 4 kg			
Displaced USF			23 ± 6 kg			
p-Value	0.75	0.576	0.64	**0.001**	**0.03 at 6 mo**	>0.05

Abbreviations: GS, grip strength; SD, standard deviation; USF, ulnar styloid fractures.
Note: Columns in bold are for statistically significant studies.

Table 8 Summary of radiographic evaluation of the union of USF

	Belloti et al	Chen et al	Kim et al	Kramer et al	Zenke et al
Tip of USF	22.9%	30%	38%	54%	**40.7%**
Base of USF		24%	45%		**26.8%**
p-Value		0.603	0.74		**<0.05**
Total number	14/61	16/62	31/76	55/101	**22/68**

Abbreviation: USF, ulnar styloid fractures.
Note: Columns in bold are for statistically significant studies.

Conclusion

In conclusion, on current evidence and as per our hypothesis, the presence of an USF does not affect DRF treatment and outcomes.

Conflict of Interest

None.

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