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Original article

Scapholunate, lunotriquetral and TFCC ligament injuries associated with intraarticular distal radius fractures: Arthroscopic assessment and correlation with fracture types

Les lésions scapho-lunaires, luno-triquétrales et du TFCC dans les fractures articulaires de l'extrémité distale du radius : évaluation par arthroscopie et corrélation avec les différents types de fractures

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ABSTRACT

The aim of this study was to evaluate the prevalence of arthroscopic scapholunate (SL) and/or lunotriquetral (LQ) laxity and triangular fibrocartilaginous complex (TFCC) injuries in patients who have an intraarticular fracture of the distal radius and to correlate these lesions with fracture type. Fifty-seven intraarticular radius fractures, whether or not they were associated with an ulnar styloid fracture, were evaluated and treated by arthroscopy. Scapholunate and lunotriquetral ligament injuries were classified according to the EWAS classification. TFCC lesions were assessed according to Palmer's classification. Each injury was documented through preoperative X-rays and a CT scan. Fracture type and soft tissue injury were not significantly associated one to another. Arthroscopic examination revealed at least one soft tissue injury in 39 intraarticular fractures of the distal radius (68.4%). Twenty-five percent of arthroscopic SL laxities (including severe EWAS 3 injuries) were not detected on standard radiographs. Arthroscopic SL laxity was present in 8 of 11 cases (72.7%) of radial styloid fracture and in 15 of 25 cases (60%) of fractures with at least one radial styloid component. There was no association between LQ integrity and fracture type. Ulnar styloid fractures (base or tip) and TFCC lesions were significantly correlated ($P < 0.0001$). The prevalence of soft tissue lesions secondary to intraarticular fractures of the distal radius was 68.4%. However, there was no statistically significant relationship between the different types of radius fractures and soft tissue injuries. On the other hand, ulnar styloid fracture was predictive of TFCC injury.

Mots clés :
Arthroscopie
Fracture de l'extrémité distale du radius
Lésions ligamentaires
Ligament luno-triquétral
Ligament scapho-lunaire
TFCC

RÉSUMÉ

Le but de l'étude était d'évaluer la prévalence des laxités arthroscopiques scapho-lunaires et/ou luno-triquétrales et des lésions du complexe fibrocartilagineux triangulaire (TFCC) dans les fractures articulaires de l'extrémité distale du radius et de corréler ces lésions aux différents types de fracture. Cinquante-sept fractures articulaires de l'extrémité distale du radius, associées ou non à une fracture du processus styloïde ulnaire, ont été opérées sous arthroscopie. Les lésions scapho-lunaires et luno-triquétrales étaient évaluées selon la classification EWAS. Les lésions du TFCC étaient évaluées selon la classification de Palmer. Chaque fracture était documentée par un bilan préopératoire radiographique et tomodensitométrique. Il n'existait pas de relation statistiquement significative entre les différentes fractures et les lésions ligamentaires. Dans 39 cas (68,4 %), il existait au moins une lésion ligamentaire. Vingt-cinq pour cent des laxités arthroscopiques scapho-lunaires (dont des lésions sévères EWAS 3) n'avaient pas été détectées lors du bilan radiographique préopératoire. Une laxité arthroscopique

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scapho-lunaire était associée dans 8 cas sur 11 (72,7 %) à une fracture cunéenne pure et dans 15 cas sur 25 (60 %) à une fracture avec au moins une composante cunéenne. Il n'existait pas d'association entre les lésions luno-triquétrales et les différents types de fracture. Les fractures du processus styloïde ulnaire et les lésions du TFCC étaient associées de manière statistiquement significative ($p < 0{,}0001$). La prévalence des lésions des parties molles consécutives à une fracture articulaire de l'extrémité distale du radius est de 68,4 %. Il n'existe pas de relation statistiquement significative entre les différents types de fracture et les lésions ligamentaires. A l'inverse, la fracture du processus styloïde ulnaire est prédictive d'une lésion du TFCC.

1. Introduction

Soft tissue injury is frequently associated with intraarticular fractures of the distal radius [1–14]. The incidence of scapholunate (SL) injury ranges from 18 to 95%, lunotriquetral (LT) injury from 0 to 52%, and triangular fibrocartilaginous complex (TFCC) injury from 6 to 67%. Untreated soft tissue injury can lead to carpal dissociation, instability [15,16] and osteoarthritis in the long term [15,17].

Arthroscopy is a useful tool for managing wrist fractures [18]. It makes it easier to check reduction and improve fixation; additionally, soft tissue damage can be precisely assessed. Concomitant soft tissue injuries are in fact difficult to evaluate and therefore easily missed during the initial clinical or radiographic assessment [19,20]. These often adversely affect the long-term results in younger persons because they may be a source of persistent pain and/or disability despite the fracture having healed [15,21].

The aim of this study was to assess the prevalence of arthroscopic SL or LT laxity and TFCC injuries in patients who have an intraarticular fracture of the distal radius and to correlate these lesions with the different types of fracture.

2. Material and methods

The authors retrospectively reviewed 57 intraarticular fractures of the distal radius, with or without an ulnar styloid fracture, in patients who underwent arthroscopically assisted surgical treatment from January 2013 to April 2017. The inclusion criteria were a displaced intraarticular distal radius fracture or the presence of an interfragment gap larger than 2 mm [18] documented by preoperative X-rays and CT scan, managed by arthroscopically assisted surgical treatment and the availability of operative records with ligament testing recorded (SL complex, LT and TFCC). The exclusion criteria were age under 18 and over 65, and prior surgery or prior fracture on the ipsilateral wrist. The radiocarpal assessment was performed through standard 3–4 and 6R portal portals, and the midcarpal assessment through the midcarpal radial (MCR) and midcarpal ulnar (MCU) portals. The TFCC was tested using the trampoline effect, hook test and ghost sign, and lesions were assessed according to Palmer's classification [22]. SL and LT ligament injuries were classified according to the EWAS classification [23]. Since SL and LT stability does not depend solely on the SL and LT interosseous ligament but on a ligament complex, arthroscopic testing was performed to evaluate the laxity of the SL and LT joints. TFCC lesions were debrided and reinserted depending on their stage [1,10,11]. Depending on severity, SL arthroscopic laxity or LT arthroscopic laxity was treated either by immobilization, percutaneous pinning, capsulodesis, or reinsertion using suture anchors by arthrotomy.

Fractures were classified after CT examination using the Doi classification [24]. The Doi system, which is based on preoperative 3D CT scanning, classifies intraarticular fractures into 2-, 3- and 4-part types (Table 1).

For statistical analysis, categorical data were compared with the Fisher exact test. Monte Carlo simulation was applied to calculate Chi^2 probability. The difference was considered significant at $P < 0.05$.

3. Results

The study population consisted of 57 consecutive patients. There were 23 women and 34 men. Mean age at surgery was 43 years (range, 18–64 years). Twenty-six fractures (out of 44 where this information was documented) involved the dominant hand.

Fixation was performed in 32 cases with a volar plate, 14 with plate and K-wires, 9 with K-wires, 1 using a screw and 1 by external fixation, plate and K-wires. All intraarticular radius fractures fell within the 8 types described by Doi (Table 1), based on CT analysis [24]. In 27 cases, there was an accompanying fracture of the ulnar styloid process.

Among 57 intraarticular radius fractures, 25 (44%) were associated with arthroscopic SL laxity, 3 (5%) with arthroscopic LT laxity, and 16 (28%) with traumatic TFCC injury. The SL joint had an isolated arthroscopic laxity in 19 cases (33.4%), the LT joint had an isolated arthroscopic laxity in 2 cases (3.5%) and the TFCC had an isolated traumatic injury in 10 cases (17.5%). Two type 2c degenerative TFCC isolated lesions were reported (3.5%) but not entered into the statistical analysis as we considered only acute traumatic injuries. There was a combined SL + TFCC injury in 5 cases (8.75%) and a combined SL + LT + TFCC injury in 1 case (1.75%). No ligament was injured in 18 cases (31.6%). The different soft tissue injuries that we observed are listed in Table 2.

In 25 patients, SL joint laxity was suspected due to a visible gap on standard preoperative radiographs. In 17 of these 25 patients (68%), the lesions were confirmed by arthroscopy. In 32 patients for whom radiographs did not suggest any SL abnormalities, arthroscopic instability was discovered in 8 patients (25%) (Table 3): one EWAS stage 1, three EWAS stage 2 and four EWAS stage 3 injuries. Table 4 presents the associations between the different types of fractures and soft tissue injury. There was no statistically significant relationship between the different types of radius fractures and soft tissue injury: fracture and SL arthroscopic laxity ($P = 0.315$, CI 99%: 0.298–0.332); fracture and LT ligament injury (extremely rare); fracture and TFCC injury ($P = 0.583$, CI 99%: 0.565–0.601). When analyzing the group of fractures with involvement of the lunate fossa (types E, F and G), we found no relationship with soft tissue injuries ($P > 0.9999$). When grouping together all the fractures with at least one radial styloid component (types A, B, C and G), no statistically significant relationship was found with SL arthroscopic laxity ($P = 0.791$, CI 99%: 0.777–0.806), even though in 60% of cases (types A, B, C and G), SL arthroscopic laxity was also present.

Table 1
Types of intraarticular distal radius fractures analyzed on CT scan.

Type	Doi classification [24]	Description	Visual representation
A	2-part fracture, vertical line	Isolated radial styloid fracture	
B	2-part fracture, horizontal line	Anterior margin styloid fracture: horizontal fracture line with a styloid fragment and an anterior scaphoid fossa fragment	
C	2-part fracture, horizontal line	Posterior margin styloid fracture: horizontal fracture line with a styloid fragment and a posterior scaphoid fossa fragment	
D	2-part fracture, palmar rim	Palmar rim fracture: a fragment which is neither from the styloid nor the lunate fossa	
E	2-part fracture	Palmar lunate fracture: anterior fragment of the distal radioulnar joint Anterior lunate fossa injury	
F	2-part fracture	Dorsal lunate fracture: posterior fragment of the distal radioulnar joint Posterior lunate fossa injury	
G	3-part fracture	Pure styloid fracture + anterior or posterior lunate fossa fragment	
H	4-part fracture	Central depression, comminution	

Table 2
Types of soft tissue injury.

Ligament	Injury stage	N
Scapholunate complex: $n = 25$	EWAS 1	5
	EWAS 2	12
	EWAS 3	7
	EWAS 4	1
Lunotriquetral: $n = 3$	EWAS 2	1
	EWAS 3	2
TFCC: $n = 18$	2c	2
	1b	10
	1b + 1d	1
	partial 1d	5

TFCC: triangular fibrocartilaginous complex; EWAS: European wrist arthroscopy society.

Ulnar styloid fractures and TFCC injury are shown in Table 5. This is the only association that was significantly correlated ($P < 0.001$, CI 99%: 0.0000–0.0002). It was noteworthy that all 1d lesions were associated with both styloid fracture (base or tip) and a lunate fossa fragment. In two cases where the ulnar styloid was not fractured, a type 1b TFCC lesion was present.

4. Discussion

There was no statistically significant correlation between the different types of radius fractures and soft tissue injuries, although arthroscopic SL laxity was present in 8 of 11 cases (72.7%) of isolated radial styloid fractures and in 15 of 25 cases (60%) of fractures with at least one radial styloid component. Arthroscopic

Table 3
Comparison between preoperative radiographic observations and arthroscopic assessments for scapholunate complex integrity.

	Arthroscopic SL laxity	No arthroscopic SL anomaly	N
Visible SL gap on preoperative radiographs	17	8	25
No SL anomaly on preoperative radiographs	8	24	32
N	25	32	

SL: scapholunate; N: number.

Table 4
Associations between types of intraarticular distal radius fractures and soft tissue injury.

Distal radius fracture type (Doi classification)	SL intact N (%)	SL injury N (%)	LT intact N (%)	LT injury N (%)	TFCC intact N (%)	TFCC injury N (%)
A	3 (27.3)	8 (72.7)	10 (90.9)	1 (9.1)	9 (81.8)	2 (18.2)
B	5 (71.4)	2 (28.6)	7 (100)	0	3 (42.9)	4 (57.1)
C	1 (50)	1 (50)	2 (100)	0	2 (100)	0
D	2 (100)	0	2 (100)	0	2 (100)	0
E	3 (60)	2 (40)	5 (100)	0	4 (80)	1 (20)
F	2 (33.3)	4 (66.7)	6 (100)	0	5 (83.3)	1 (16.7)
G	8 (66.7)	4 (33.3)	11 (91.7)	1 (8.3)	8 (66.7)	4 (33.3)
H	8 (66.7)	4 (33.3)	11 (91.7)	1 (8.3)	8 (66.7)	4 (33.3)

SL: scapholunate; LT: lunotriquetral; TFCC: triangular fibrocartilaginous complex; N: number.

Table 5
Associations between presence and absence of ulnar styloid fracture and TFCC injury.

Ulnar styloid process	TFCC intact	Type 1b injury	Type 1d injury	Type 1b + 1d injury
Fractured	13	8	5	1
Intact	28	2	0	0

TFCC: triangular fibrocartilaginous complex; N: number.

examination revealed at least one soft tissue injury in 39 intraarticular fractures of the distal radius (68.4%). But it would be excessive to affirm with certainty that all SL and LT injuries are secondary to the trauma. Conversely, for TFCC injuries, only non-degenerative lesions were taken into account.

A number of authors have proposed classification systems for distal radius fractures [25–29] but none are precise enough when it comes to the status of intraarticular fragments. The principal purpose of any classification is to provide guidelines for treatment as well as to make it easier to evaluate and compare outcomes [24,30]. All our patients underwent a CT scan, which enabled us to study the fracture as a 3D reconstruction. We prefer using the Doi radiological classification [24] when searching for a correlation between soft tissue injury and bone injury.

Our study comprised a series of 57 articular fractures and is the only study with a population whose age ranges from 18 to 65 years. In the literature, the incidence of soft tissue injuries associated with intraarticular radius fracture is consistent with our findings (Table 6). However only two other studies [8,31] specifically sought to correlate soft tissue injuries with different fracture types and one of them was a radiological study [31]. Both concluded there was no correlation. Levy et al. [8] carried out arthroscopic examination of 32 wrists with no age restriction, 6 weeks postoperatively when the fixation material was removed. Klempka et al. [31] studied the prevalence of ligament injuries, but these authors used MDCT arthrography and the AO classification. According to them, a nonsignificant trend was found between SL arthroscopic laxity and fracture type: type C was associated with slightly more (non-significant) major SL lesions (9.0%) compared to type B (4.3%). There was no association seen between LT integrity and fracture type because very few arthroscopic LT laxities were associated with intraarticular fractures of the radius. Indeed, we documented only 3 cases (5%) of LT injuries. Conversely, a significant correlation was found only for the ulnar TFCC segments.

Table 6
Publications reporting the frequency of soft tissue injury associated with intraarticular distal radius fractures assessed by arthroscopy.

	Patients N	SL N (%)	LT N (%)	TFCC N (%)
Richards et al. [1]	88	27 (31)	6 (7)	31 (35)
Christiaens et al. [2]	20	6 (30)	0	6 (30)
Doi et al. [3]	25	16 (64)	7 (28)	4 (16)
Hardy et al. [4]	18	5 (28)	0	1 (6)
Hattori et al. [5]	25	5 (20)	3 (12)	8 (32)
Khanchandani & Badia [6]	27	8 (30)	1 (4)	17 (63)
Kordasiewicz et al. [7]	27	11 (41)	0	16 (59)
Levy et al. [8]	32	10 (31)	–	3 (9)
Mathoulin [9]	27	10 (37)	4 (15)	7 (26)
Mehta et al. [10]	31	23 (74)	16 (52)	15 (48)
Ruch et al. [11]	56	26 (46)	2 (4)	30 (54)
Ruch et al. [12]	15	5 (33)	4 (27)	10 (67)
Varitimidis et al. [13]	20	9 (45)	4 (20)	12 (60)

N: number.

In our study, 25% of arthroscopic SL laxities (including severe EWAS 3 injuries) were not detected during standard radiographic examination [1,32]. Richards et al. [1] also found that 60% of SL tears had normal preoperative radiographs (SL gap 2 mm or less); conversely, only 50% of patients with 3 mm or more SL gap on preoperative radiographs had an SL tear.

In our patients, TFCC injury was associated in 16 of 57 cases (28%) with intraarticular fracture of the radius and in 14 of 27 cases (52%) with ulnar styloid fracture. In our study, as in others [33–35], there was a statistically significant correlation between ulnar styloid fractures and TFCC injury ($P < 0.001$). It was noteworthy that stage 1d TFCC injury was always associated with both styloid fracture and with a lunate fossa fracture fragment (6 cases) [1,35]. However, ulnar styloid fracture is not a satisfactory indicator of TFCC tear in younger patients [36]. Indeed, TFCC tears have been found without an ulnar styloid fracture [33,35–37], therefore arthroscopic assessment is required. Whether for SL, TL or TFCC injuries, arthroscopy appears essential for the documentation of ligament injuries since they are not radiologically predictable before surgery. The main question is how to identify those injuries that will become symptomatic [1,16,18]. We do not know if all soft tissue injuries revealed by arthroscopy need to be treated [11,38]. We consider arthroscopy fundamental to gain more knowledge of these injuries [18,32].

The limitations of this study are typical of one with a retrospective design although all the operative reports captured the ligament testing and preoperative radiographs and CT scans were available for all patients. The results are applicable only for intraarticular radius fractures indicated for surgery.

5. Conclusion

The prevalence of soft tissue lesions responsible for dissociative instability or TFCC injury secondary to intraarticular fracture of the distal radius was 68.4%, and 72.7% of pure radial styloid fractures were associated with arthroscopic SL laxity. However, there was no statistically significant relationship between the different types of radius fractures and soft tissue injuries. On the other hand, ulnar styloid fracture was predictive of TFCC injury.

Disclosure of interest

The authors declare that they have no competing interest.

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