Arch Orthop Trauma Surg (2016) 136:425–432
DOI 10.1007/s00402-015-2357-9

HANDSURGERY

1-Year outcome of concomitant intracarpal lesions in patients with dislocated distal radial fractures: a systematic assessment of 78 distal radial fractures

Renata Gologan[1] · V. M. Ginter[1] · A. Haeffner[2] · U. Obertacke[1] · U. Schreiner[1]

Received: 31 July 2015 / Published online: 30 November 2015

Abstract
Introduction Ligamentous lesions are concomitant to dislocated distal radius fractures in a high percentage. The purpose of this study was to evaluate the relevance of intracarpal lesions.
Methods Seventy eight of an original cohort of 104 distal radius fractures (74 %) were studied over a follow-up period of one year after surgery with complete data (X-rays, CT, MRI, follow-up X-rays and questionnaire).
Results Most of our radius fractures (AO 23 type: A 39, B 9, C 30) present additional lesions: 97 %. One-year evaluation showed an average Castaing score of 4.5 ± 2.5 points, means a "good" result of a scale of 0–27. Fifty five of seventy eight had an "excellent" or "good" result (<6 points). No patient had more than 12 points ("fair").
Conclusions The dislocated distal radial fracture implies severe and complex injury to the whole wrist, mostly concerning intracarpal concomitant lesions (MRI). Surgical therapy of dislocated radius fractures followed by 6 weeks relief through thermoplastic splint seems to be sufficient to achieve good 1-year results. MRI-detectable carpal lesions at the time of the radial fracture are common, but only a few of them seem to decompensate later, give symptoms and became of therapeutic relevance.

Keywords Distal radius fracture · Concomitant ligament lesions · Intracarpal lesions · Outcome distal radius fracture

✉ Renata Gologan
renata.gologan@umm.de

[1] Orthopädisch-Unfallchirurgisches Zentrum, Universitätsmedizin Mannheim, Medizinische Fakultät Mannheim der Ruprecht-Karls-Universität Heidelberg, Theodor-Kutzer-Ufer 1-3, 68167 Mannheim, Germany

[2] Alameda County Medical Center, Oakland, CA, USA

Introduction

Distal radial fractures are the most common fractures requiring orthopedic intervention and surgery for dislocated fractures has been done for many years [1–3].

However, even with the development of modern implants which allow early mobilization, long-term outcome has not significantly improved [1, 2, 4, 5]. Concomitant lesions to ligaments and capsule or cartilage might be contributing to this problem. Studies using arthroscopy of the wrist were able to demonstrate a high percentage (74–98 %) of mostly ligamentous lesions concomitant to dislocated radial fractures [6–9]. The recently published study of 104 patients with dislocated distal radial fracture who underwent computer tomography (CT) and magnet resonance imaging (MRI) of the wrist prior to surgery demonstrates that all, but one patient demonstrated concomitant intracarpal osseous or ligamentous lesions (radio-carpal fracture, distal radio-ulnar fracture, acute TFCC lesion, rupture of the scapholunate ligament (SL) and radioulnar (RU) ligament) [10]. The prognostic relevance for early diagnosis (and treatment) of such concomitant lesions seems uncertain [11, 12]. Even very early publications failed to demonstrate ongoing symptoms due to ligamentous lesions after a period of regular follow-up [13, 14]. It is agreed that dislocated radial fractures are to be seen as combined injuries of the distal radio-ulnar functional unit [6, 7, 11, 15, 16].

What remains open to discussion is

- What relevance do intracarpal lesions (concomitant to dislocated fractures of the distal radius) have after open reduction and plate fixation of the radial fracture and after a typical period of convalescence.
- Whether there are distinct patterns of primary concomitant lesions, which can predict long-term outcome.

This study intends to address these questions with a standardized follow-up at 1 year postoperatively after distal radial fracture and operative treatment.

Methods

103 Consecutive patients with a total of 104 dislocated distal radial fractures were prospectively included into the study before undergoing surgery.

The indication for operative treatment was a comminuted fracture zone in combination with tilting of $\geq 20°$ and radial shortening of ≥ 5 mm on the initial X-ray according to the guidelines of the German society for trauma (DGU) for distal radius fractures [16].

Inclusion criteria were a dislocated radial fracture with indication for surgery, age >18 years, and an informed consent to allow examination for the duration of the study. Exclusion criteria were patient's refusal to participate in the study, need for immediate surgery (e.g., open fractures), multiple fractures of various body regions (polytraumata) or serial fractures of the upper arm, and preexisting functional impairment of the involved upper extremity. The study was approved by the Ethics Committee of the Ruprecht-Karls-University Heidelberg, Medical Faculty Mannheim on 11/26/2004, reference number 225/04. CT and MRI were reported by a single, senior radiologist with special qualification for musculoskeletal imaging.

Operation was done by surgeons of our department, including the authors of the present study. Orthopedic surgeons in training were supervised by senior surgeons.

The operating surgeon had access to the CT images while both, the surgeon and the physician doing the follow-up exam were blinded for the MRI results.

The first results of this study were nearly almost detectable concomitant lesions of carpal structures (Table 1).

Follow-up of these patients was possible for 78 of the 104 fractures (74 %) 1 year after surgery with complete data (X-rays, CT, MRI, follow-up X-rays, and questionnaire). Three of the remaining patients lost to follow-up had passed away (not on account of the trauma), two had moved away, and four refused a repeat examination. 17 patients were unable to reach at the time of the scheduled follow-up.

The follow-up group consisted of 49 women and 28 men with an average age of 59.3 years (range 19–85 years). Patients included in the follow-up group had 39 fractures type A (AO classification), nine fractures type B, and 30 fractures type C. 76/78 patients had at least one additional radiocarpal lesion independently from the primary type of fracture (Fig. 1). The exact number of additional lesions related to fracture type is presented in Fig. 2.

We contacted patients by mail 1 year after surgery for a follow-up exam. This follow-up exam took place an average of 13.9 ± 6.5 months postoperatively. Follow-up comprised a questionnaire (Castaing Score, Fig. 2), physical exam with documentation of all findings (pain scale, ROM, wrist circumference, and X-ray of the wrist in 2 planes). The scoring system of Castaing (Table 2) comprises wrist function, radiographic data and subjective condition obtained from the patient. Depending on the number of points scored, the outcome is classified as excellent (0), good (1–5), sufficient (6–11), fair (12–15), poor (16–25), or very poor (>25).

Results

Post-operative evaluation after 1 year showed an average Castaing score of 4.5 points ±2.5, means a "good" result of a scale of 0–27. No patient had more than 12 points ("fair"). 55/78 had an "excellent" or "good" result (<6 points). Only 1 out of the 78 fractures had a single additional lesion, both a lesion of the triangular fibrocartilage complex (TFCC). These patients resulted both with a Castaing score of 3 and 4, respectively ("good"). Patients demonstrating the worst outcomes with 11–12 points ("adequate–fair", $n = 4$) had all suffered a combination of four lesions (radio-carpal fracture, distal radio-ulnar fracture, acute TFCC lesion, rupture of the scapholunate ligament (SL) and radioulnar (RU) ligament). However, three patients with the same pattern of additional lesions were found to have very favorable outcomes of 1 point ("excellent", $n = 3$) and four points ("good", $n = 1$).

Table 1 Gologan et al. [10] concomitant lesions in 104 dislocated distal radial fractures

	RC joint	DRU joint	PSU	Carpal fractures*	TFCC lesions	SL-lig. lesions	RU-lig. lesions
CT scan	87/104	84/104	67/104	17/104			
MRI					77/104	19/104	35/104

RC distal radial fracture involving the radiocarpal joint surface, *DRUJ* distal radial fracture involving the distal radioulnar joint, *PSU* processus styloideus ulnae fracture, *TFCC* lesions of the triangular fibrocartilage complex, *SL* lesion of the scapholunate ligament, *RU* lesion of at least one radioulnar ligament

* for example: scaphoid, lunatum, triquetrum and carpla bones

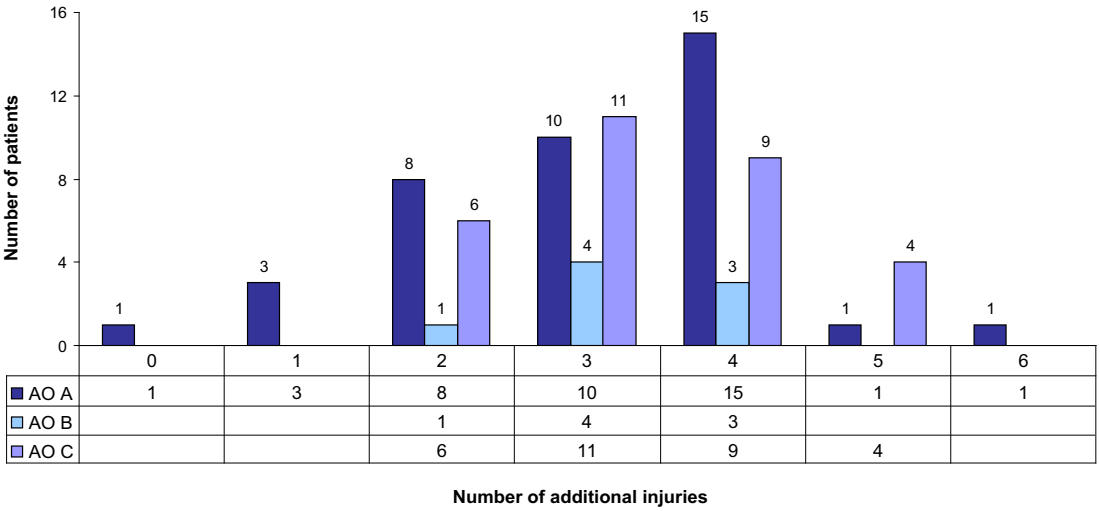

Fig. 1 Number of simultaneously lesions (from zero to six additional lesions) related to fracture type: AO 23, A, B, C

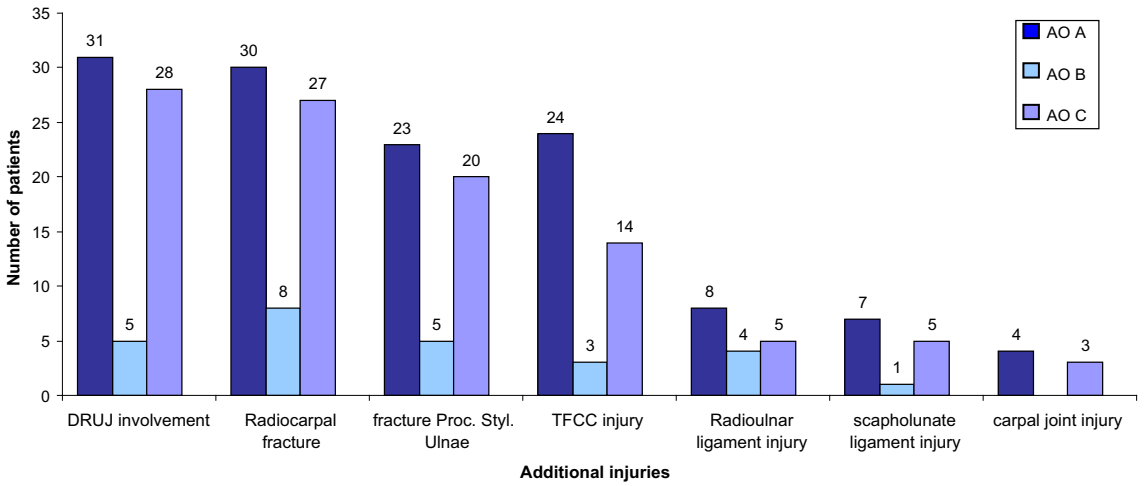

Fig. 2 Detailed description of additional lesions related to fracture type: AO 23, A, B, C

Table 2 Castaing score [22]

Wrist function (points 0–3)	Radiographic data (points 0–3)	Subjective condition (points 0–9)	Outcome
Normal (0)	Normal (0)	No disorders (0)	Excellent (0)
Dorsalflexion 45–25° (1)	Dorsal tilt 5–10° (1)	All grips possible, rare complaints (1)	Good (1–5)
Dorsalflexion 24–15° (2)	Dorsal tilt 11–20° (2)	All grips possible, often complaints upon exertion (2)	Adequate (6–11)
Dorsalflexion <15° (3)	Dorsal tilt >20° (3)	Some grips impossible (3)	Fair (12–15)
Palmarflexion <45° (1)	Palmar tilt 10–20° (1)	Several grips impossible, manual activities restricted (4)	Poor (16–25)
Ulnarflexion 30–15° (1)	Palmar tilt >20° (2)	Several grips impossible, manual activities markedly restricted (6)	Very poor (>25)
Ulnarflexion <15° (2)	Arthrosis signs+ (1)	Useless hand (9)	
Radialflexion restricted (1)	Arthrosis signs++ (2)		
Pro/sup 130–90° (1)	Ulna advance 2–4 mm (1)		
Pro/sup <90° (2)	Ulna advance >4 mm (2)		

Furthermore, patients with 0–2 points ("excellent–good") also demonstrated up to four additional carpal lesions. Number of additional injuries in related to fracture type (AO) is showed in Figs. 1 and 2. 55/78 were satisfied (no complains, or rare complains), 15/78 could do all movements, but complained often pain, 8/78 were unsatisfied. Subjective dissatisfaction could not be objectively quantified. Satisfied and unsatisfied patients had dorsal extension of $\geq 40°$ or pronation of $>40°$. Patients with a pronation $<40°$ had a tendency to Castaing scores >6 ("adequate" or worse). Furthermore, no association was observed between subjective outcome and objective findings of dorsal extension or palmar flexion as well as radial or ulnar abduction. 8 out of 78 patients reported to be sensitive to temperature and weather changes, 3 out of 77 patients suffered from carpal tunnel syndrome, another four had recurrent pain in the distal distribution of the radial nerve (radial dorsum of hand and digit 1–3).

Discussion

Dislocated distal radial fractures are nowadays considered to represent an extensive injury of the radiocarpal complex [6, 10]. Several studies have evaluated the extent of additional lesions to non-osseous structures in the setting of dislocated distal radial fractures and have concluded the ubiquitous existence of associated lesions to structures which are not amenable to visualization on plain films [9–11, 17–21]. MRI, CT, and cinematography were used in addition to plain films for diagnostic purposes. These can confirm high percentage of additional lesions to ligaments and other bony structures which had been missed on regular X-rays (Fig. 3).

It remains open to discussion:

- How do these lesions influence the final outcome after conventional treatment of dislocated distal radial fractures?
- Do these lesions require extra attention in addition to ORIF and immobilization?

The previously published study analyzed the outcome of 104 consecutive patients with dislocated distal radial fracture undergoing MRI and CT evaluation for additional injuries [10]. At least one additional lesion (osseous, ligamentous, or TFCC) was found in 102 patients (Table 1).

The patients were examined for SL or RU instability. We found no relevant instability though the SL or the RU joint shows hematoma or the SL distance seems widened.

All patients underwent surgery with ORIF with early functional mobilization and additional thermoplastic splint to give discharge to the joint for 6 weeks in individually fitted forearm (thermoplastic) splints. We have now reached 78 patients (74 %) of these 104 to undergo repeat evaluation 1 year postoperatively.

Clinical and radiographic outcomes evaluated by Castaign Score showed 71 % of patients with excellent or good results. No poor or very poor results were found. Those four patients with the worst outcome (adequate/fair) were found to have four additional lesions. However, other patients with similar extent of lesions (four additional lesions) had also demonstrated good and excellent results. A correlation of the extent of additional lesion and final outcome can therefore not necessarily be deducted.

Most scoring systems comprise only subjective measures. The Gartland-Werley Score not only includes subjective criteria (residual deformity, pain, compromise of range of motion, and restriction of activity), but also includes objective data (loss of ROM) and complications (osteoarthritis, median nerve complications, poor finger function due to cast). 0–2 points represent an "excellent" outcome, 3–8 points represent a "good" outcome, 9–20 points represent a "fair" and >20 points a "poor" outcome. However, the point system allows different investigators significant variation regarding the distribution of points for deformity and signs of osteoarthritis.

The Castaing Score is another system which is frequently used to evaluate post-operative outcomes, including subjective and objective measures. It includes subjective discomfort with activity as well as objective findings of ROM and radiographic changes of angulation [22–26].

More recent studies of dislocated distal radial fractures [27, 28] with similar post-operative interval (12, 13, 17 months) and similar interventions (ORIF with palmar plate and forearm splinting for 4 weeks) have also shown promising results with good functional outcome. However, additional lesions have not been documented or presented. This makes one believe that current means of intervention (ORIF and immobilization) are sufficient measures to achieve good 1-year outcomes despite the presence of additional lesions; a more extensive diagnostic evaluation with extended imaging of the wrist might be unnecessary [29, 30]

This is further supported in a study by Frank demonstrating 55 % of dislocated distal radial fractures to have additional ligamentous lesions. The functional 1-year outcome did not depend on differences in surgery.

Tang's study with only 20 SL ruptures as seen on imaging (SL-dissociation on X-ray) out of 424 patients with distal radial fractures has more controversy, and all patients had persistent complaints postoperatively due to SL rupture. Eight patients underwent repeat surgery. When the current literature is taken into account, one has to consider that only a small percentage of existing primary lesions are actually visualized on plain films. These could be considered "primary decompensated lesions"

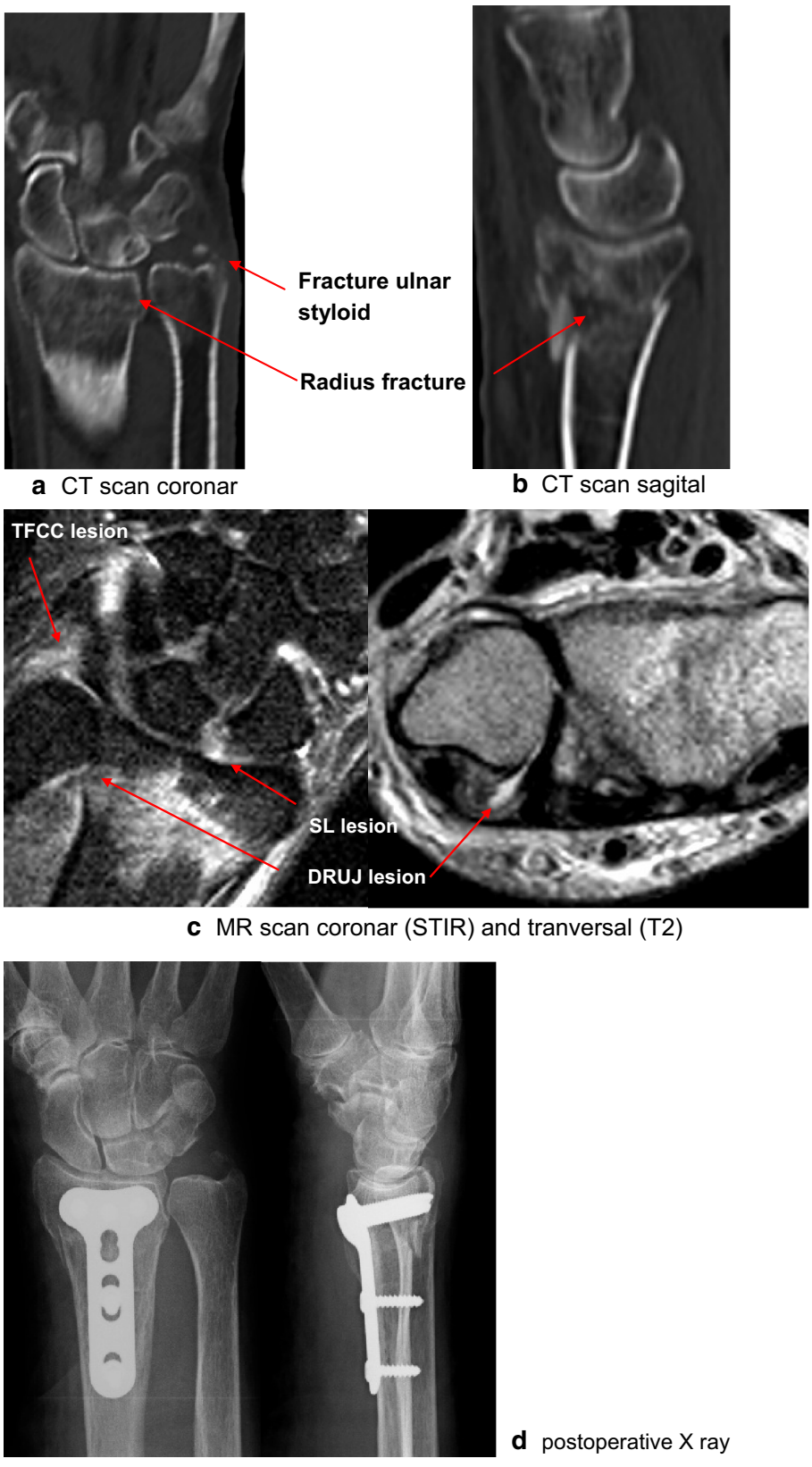

Fig. 3 78-year-old female patient, AO C1 fracture, multiple carpal lesions, Castaing score 3 (good result). **a** coronary CT layer. **b** sagittal CT layer. **c** coronary (STIR) and transversal MRI layer (T2). **d** Post-operative X-ray

Table 3 Overview of studies with short-term post-operative results after dislocated distal radial fracture

Study, year	Patients (*n*)	Follow-up (months)	Method/score	Intervention (*n*)	Additional injuries (*n*)	Complications (*n*)	Outcome
Jakob et al. [36]	74	12	ROM, functional disability, grip strength	Plate (52) K-wire (4) Ext fix (5) Conservative (12)	No data available	Plate dislocation (4) EPL rupture (5) CRPS (4) Arthritis (5)	97 % (71/74) Very good = full capabilities in work life and daily activities
Forward et al. [37]	51	12	Gartland and Werley	Arthroscopy Casting Plate	SL rupture (44)	No data available	47/51 very good/good
Rozental [28]	45	12	ROM DASH	Casting and pins Palmar plate	No data available	Pin infectionen (3) Tendinitis de Quervai (1), EPL tendinitis (1)	Dash ≤10
Figl et al. [27]	80	12	Castaing DASH	Plate and thermoplastic splint	No data available	CRPS (2) CTS (1) N. med. paresthesias (5) Thenar paresthesias (3)	79/80 Very good/good
Frank et al. [38]	66	12	ROM DASH Mayo	Plate K-wire Ext fix	SL (36) TFCC PSU Scaphoid fracture Ulnar fracture	none	DASH 23 Mayo 72
Gologan et al. [10]	78	12	Castaing	Palmar plate with 6 weeks immobilization	TFCC (41) SL rupture (13) RU rupture (17)	CTS (3) Screw dislocation (1) N. rad. paresthesia (4)	71 % (55/78) Very good/good

K-wire Kirschner wire, *Ext fix* external fixation, *SL* scapholunate, *CTS* carpal tunnel syndrome

where conservative approaches immediately bear only very limited chance of success. Radiographically identified additional lesions appear to have more significant impact on future outcome than those not visualized on initial imaging.

Table 3 shows an overview of studies with short-term post-operative results after dislocated distal radius fracture including data for their peri- and post-operative management, additional injuries, complications and outcome. The effect of additional lesions on future functional outcome cannot be estimated in the current study since 97 % already present radial fractures with additional lesions. This ought to be taken into account for all dislocated distal radial fractures. MRI-detectable carpal lesions at the time of the radial fracture are common, but only a few of them seem to decompensate later [7, 31, 32], give symptoms and became of therapeutic relevance [30, 33–35]. The presented means of therapy with open reduction and plate, followed by 6 weeks relief through thermoplastic splint appear adequate for a good functional outcome after 1 year even for complex lesions to the wrist [10, 16, 36]. The nearly ubiquitous presence of additional injuries cannot be prognostically rated nor do these lesions appear to persist after above mentioned intervention.

Our follow-up of 1 year is probably too short to make a definitive statement. Future evaluations after five-year interval will be done.

Compliance with ethical standards

Ethics Committee of the Ruprecht-Karls-University Heidelberg, Medical Faculty Mannheim on 11/26/2004, reference number 225/04.

Conflict of interest Renata Emiliana Gologan, Vera Maria Ginter, Astrid Haeffner, Udo Obertacke, Ute Schreiner declare that they have no conflict of interest.

References

1. Chen NC, Jupiter JB (2007) Management of distal radial fractures. J Bone Joint Surg Am 89:2051–2062
2. Poigenfürst L (1980) Brüche am distalen Unterarmende. Einteilung der Bruchformen und Indikation. H Unfallheilkunde 148:53–59
3. Fernandez DL, Jupiter JB (2002) Fractures of the distal radius—a practical approach to management. In: Fractures of the distal radius 2. Aufl. Springer, New York
4. Arora R, Lutz M, Hennerbichler A, Krappinger D, Espen D, Gabl M (2007) Complications following internal fixation of unstable distal radius fracture with a palmar locking-plate. J Orthop Trauma 21:316–322
5. Campbell DA (2000) Open reduction and internal fixation of intra articular and unstable fractures of the distal radius using the AO distal radius plate. J Hand Surg (Br) 25:528–534
6. Fischer M, Denzler C, Sennwald G (1996) Carpal ligament lesions associated with fresh distal radius fractures: arthroscopic study of 54 cases. Swiss Surg 2:269–272
7. Lindau T, Arner M, Hagberg L (1997) Intraarticular lesions in distal fractures of the radius in young adults. A descriptive arthroscopic study in 50 patients. J Hand Surg [Br] 22:638–643
8. Herbert TJ, Faithfull RG, McCann DJ, Ireland J (1990) Bilateral arthrography of the wrist
9. Pilný J, Kubes J, Hoza P et al (2007) Scapholunate instability of the wrist following distal radius fracture. Acta Chir Orthop Traumatol Cech 74(1):55–58
10. Gologan R, Ginter VM, Ising N, Kilian AK, Obertacke U, Schreiner U (2014) Unfallchirurg 117(1):48–53. doi:10.1007/s00113-012-2264-2.German
11. Laulan J, Bismuth JP (1999) Intracarpal ligamentous lesions associated with fractures of the distal radius: outcome at one year. A prospective study of 95 cases. Acta Orthop Belg 65:418–423
12. Tang JB, Shi D, Gu YQ, Zhang QG (1996) Can cast immobilization successfully treat scapho—lunate dissociation associated with distal radius fractures? J Hand Surg (Am) 21:583–590
13. Ehalt W (1935) Die Bruchformen am unteren Ende der Speiche und Elle. Arch OrthopUnf Chir Z5:397–465
14. Bacorn RW, Kurtzke JF (1953) Colles' fracture: a study of two thousand cases from the New York State workmen's compensation board. JBJS 35-A:643–658
15. Pechlaner S, Gabl M, Lutz M, Krappinger D, Leixnering M, Krulis B, Ulmer H, Rudisch A (2007) Distal radius fractures-aetiology, treatment and outcome. Handchir Mikrochir Plast Chir 39:19–28
16. Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften. S2e Leitlinie: Distale Radiusfraktur vom 10.02.2015. http://www.awmf.org/uploads/tx_szleitlinien/012-015l_S2e_Distale_Radiusfraktur_2015-02.pdf
17. Court-Brown CM, Caesar B (2006) Epidemiology of adult fractures: a review. Injury 37:691–697
18. Cole RJ, Bindra RR, Evanoff BA, Gilula LA, Yamaguchi K, Gelberman RH (1997) Radiographic evaluation of osseous displacement following intra-articular fractures of the distal radius: reliability of plain radiography versus computed tomography. J Hand Surg (Am) 22:792–800
19. Rose S, Frank J, Marzi I (1999) Diagnostic and therapeutic significance of arthroscopy in distal radius fracture. Zentralbl Chir 124:984–992
20. Rappold G, Leixnering M, Pezzei C (2001) Carpal injuries associated with distal radius fractures. Diagnosis and therapy. Handchir Mikrochir Plast Chir 33:221–228
21. Kordasiewicz B, Pomianowski S, Orlowski J, Rapala K (2006) Interosseous ligaments and TFCC lesions in intraarticular distal radius fractures—radiographic versus arthroscopic evaluation. Ortop Traumatol Rehabil 8:263–267
22. Castaing J (1964) Les fractures récentes de l'extrémité inférieure du radius chez l'adulte. Rev Chir Orthop Reparatrice Appar Mot 50:581–696
23. Gartland John J, Werley Charles W (1951) Evaluation of healed Colles fracture. JBJS 33-A(4):895–907
24. Changulani M, Okonkwo U, Keswani T, Kalairajah Y (2008) Outcome evaluation measures for wrist and hand: which one to choose? Int Orthop 32(1):1–6 **(Epub 2007 May 30. Review)**
25. Seifert J, Müller C, Schauwecker HH (1998) Studying minimally invasive osteosynthesis methods for distal radius fractures. Intrafocal vs. conventional wire osteosynthesis. Unfallchirurgie 24(1):18–24
26. Gruber G, Zacherl M, Giessauf C, Glehr M, Fuerst F, Liebmann W, Gruber K, Bernhardt GA (2010) Quality of life after volar plate fixation of articular fractures of the distal part of the radius. J Bone Joint Surg Am 92(5):1170–1178
27. Figl M, Weninger P, Liska M, Hofbauer M, Leixnering M (2009) Volar fixed-angle plate osteosynthesis of unstable distal radius

fractures: 12 months results. Arch Orthop Trauma Surg 129(5):661–669
28. Rozental TD, Blazar PE, Franko OI, Chacko AT, Earp BE, Day CS (2009) Functional outcomes for unstable distal radial fractures treated with open reduction and internal fixation or closed reduction and percutaneous fixation. A prospective randomized trial. J Bone Joint Surg Am 91(8):1837–1846
29. MacKay BJ, Montero N, Paksima N, Egol KA (2013) Outcomes following operative treatment of open fractures of the distal radius: a case control study. Iowa Orthop J 33:12–18
30. Gliatis JD, Plessas SJ, Davis TR (2000) Outcome of distal radial fractures in young adults. J Hand Surg (Br) 25:535–543
31. Schädel-Hopfner M, Bohringer G, Junge A, Celik I, Gotzen L (2001) Arthroscopic diagnosis of concomitant scapholunate ligament injuries in fractures of the distal radius. Handchir Mikrochir Plast Chir 33:229–233
32. Schädel-Hopfner M, Iwinska-Zelder J, Bohringer G, Braus T, Klose KJ, Gotzen L (2001) MRI or arthroscopy in the diagnosis of scapholunate ligament tears in fractures of the distal radius? Handchir Mikrochir Plast Chir 33:234–238
33. Spies CK, Prommersberger KJ, Langer M, Müller LP, Hahn P, Unglaub F (2015) Instability of the distal radioulnar joint: treatment options for ulnar lesions of the triangular fibrocartilage complex. Unfallchirurg 118(8):701–717
34. Spies CK, Müller LP, Oppermann J, Hahn P, Unglaub F (2014) Instability of the distal radioulnar joint—an overview of clinical and radiological procedures regarding their efficacies. Handchir Mikrochir Plast Chir 46(3):137–150
35. Hohendorff B, Eck M, Mühldorfer M, Fodor S, Schmitt R, Prommersberger KJ (2009) Palmar wrist arthroscopy for evaluation of concomitant carpal lesions in operative treatment of distal intraarticular radius fractures. Handchir Mikrochir Plast Chir 41(5):295–299
36. Jakob M, Rikli DA, Regazzoni P (2000) Fractures of the distal radius treated by internal fixation and early function. A prospective study of 73 consecutive patients. J Bone Joint Surg Br 82(3):340–344
37. Forward DP, Lindau TR, Melsom DS (2007) Intercarpal ligament injuries associated with fractures of the distal part of the radius. J Bone Joint Surg Am 89(11):2334–2340
38. Frank J, Pralle H, Lehnert M, Marzi I (2010) Begleitverletzungen distaler Radiusfrakturen. Unfallchirurg 113(10):796, 797–803