Carpal Injuries Associated With Distal Radius Fractures: Arthroscopic-Tomographic Correlation

Agustina Laboranti, Mateo Lazzari, Gabriel O. Pérez Lloveras, Franco G. Casen Infante, Tomás M. Rognoni, Raúl A. Posse, Macarena Otero Consoli, Francisco Colombato, Franco Casserá, Martín Caloia
Hand and Upper Limb Reconstructive Surgery Department, Hospital Universitario Austral, Buenos Aires, Argentina

ABSTRACT

Introduction: Distal radius fractures are among the most common fractures. Associated intercarpal injuries have been reported in up to 70% of cases. If undiagnosed or untreated, these injuries can negatively impact functional outcomes. The aim of this study was to establish a correlation between computed tomography (CT) and arthroscopy in diagnosing intercarpal injuries associated with distal radius fractures. **Materials and Methods:** We retrospectively analyzed 146 patients (aged 18–65 years) with distal radius fractures who underwent arthroscopically assisted surgery. Preoperative radiographs and CT scans of the wrist were evaluated. Triangular fibrocartilage complex (TFCC) injuries, ligament and osteochondral injuries, and carpal bone fractures were assessed based on pre-established imaging criteria, with arthroscopy serving as the diagnostic gold standard. The diagnostic accuracy of CT for these injuries was determined. **Results:** For TFCC injuries, CT demonstrated a sensitivity of 84%, specificity of 65%, positive predictive value (PPV) of 77%, and negative predictive value (NPV) of 10%. For scapholunate ligament injuries, sensitivity was 61%, specificity 62%, PPV 60%, and NPV 63%. For osteochondral injuries, sensitivity was 55%, specificity 87%, PPV 22%, and NPV 97%. **Conclusion:** There was no statistically significant correlation between CT and arthroscopy for the preoperative diagnosis of intercarpal injuries associated with distal radius fractures.

Keywords: Distal radius fracture; computed tomography; arthroscopy; associated injuries; intercarpal ligaments.
Level of Evidence: II. Diagnostic study

Lesiones del carpo asociadas a fracturas del radio distal: correlación artroscópico-tomográfica

RESUMEN

Introducción: La fractura del radio distal representa una de las fracturas más frecuentes. La prevalencia de lesiones intercarpianas asociadas llega al 70%. Estas lesiones impactan en los resultados funcionales cuando pasan desapercibidas durante el diagnóstico y el tratamiento. El propósito de este estudio fue establecer una correlación entre la tomografía computarizada y la artroscopia para diagnosticar lesiones intercarpianas asociadas a fracturas del radio distal. **Materiales y Métodos:** Se evaluó retrospectivamente a 146 pacientes de 18 a 65 años, con fractura del radio distal, operados con asistencia artroscópica y estudiados con radiografías y tomografía computarizada prequirúrgicas. Se evaluaron las lesiones del fibrocartílago triangular, ligamentarias y osteocondrales, y las fracturas de los huesos del carpo, según criterios imagenológicos prestablecidos, tomando como patrón de referencia diagnóstico a la artroscopia. Se determinó la precisión diagnóstica de la tomografía para estas lesiones. **Resultados:** Para lesiones del fibrocartílago triangular, la sensibilidad fue del 84%; la especificidad, del 65%; el valor predictivo positivo, del 77% y el valor predictivo negativo, del 10%. Para lesiones del ligamento escafolunar, la sensibilidad fue del 61%; la especificidad, del 62%; el valor predictivo positivo, del 60% y el valor predictivo negativo, del 63%. Para lesiones osteocondrales, la sensibilidad fue del 55%; la especificidad, del 87%; el valor predictivo positivo, del 22% y el valor predictivo negativo, del 97%. **Conclusión:** No hubo una correlación estadísticamente significativa entre la tomografía computarizada y la artroscopia para el diagnóstico prequirúrgico de lesiones intercarpianas asociadas a una fractura del radio distal.

Palabras clave: Fractura de radio distal; tomografía computarizada; artroscopia; lesiones asociadas; ligamentos intercarpianos.
Nivel de Evidencia: II. Estudio diagnóstico

Received on March 29th, 2024. Accepted after evaluation on July 23rd, 2024 • Dr. AGUSTINA LABORANTI • aguslaboranti@gmail.com https://orcid.org/0000-0002-7136-937X
How to cite this article: Laboranti A, Lazzari M, Pérez Lloveras GO, Casen Infante FG, Rognoni TM, Posse RA, Otero Consoli M, Colombato F, Casserá F, Caloia M. Carpal Injuries Associated With Distal Radius Fractures: Arthroscopic-Tomographic Correlation. *Rev Asoc Asoc Argent Ortop Traumatol* 2025;90(1):34-42. https://doi.org/10.15417/issn.1852-7434.2025.90.1.1939

INTRODUCTION

Distal radius fractures (DRFs) account for approximately 25% of fractures in the pediatric population and 18% in elderly patients.[1] The classic literature reports an increasing incidence of DRFs across all age groups, with a stable trend in recent years.[2] This trend, along with the high healthcare costs associated with treating the injury and its complications, highlights the importance of comprehensive and timely diagnostic and therapeutic management.[3]

Approximately 16% of patients with DRFs report persistent wrist and hand pain even one year after injury, which is attributed to a multifactorial etiology.[4] Cheng et al. associated this chronic pain with factors such as ulnar impaction due to poor reduction, lack of ulnar styloid consolidation, triangular fibrocartilage complex (TFCC) injuries with or without distal radioulnar instability, intercarpal ligament injuries, and chondral damage.[5] Ligament injuries have been reported in up to 70% of cases.[6] The scapholunate ligament (SLL) is the most important intercarpal ligament; its injury causes instability, leading to a specific pattern of osteoarthritis and residual chronic pain.

Diagnosing these lesions before surgical treatment is challenging. This difficulty arises from the inability to perform a thorough clinical evaluation due to pain and soft tissue edema. Additionally, literature reports diagnostic limitations of both radiography and computed tomography (CT) in detecting such injuries. Although radiographic signs, such as widening of intercarpal joint spaces, distal radioulnar joint incongruity, or disruption of Gilula's lines, may suggest associated soft tissue injuries, radiographs have been found to be moderately reliable for diagnosing ligament injuries and are better for ruling out rather than confirming them.[7]

Gradl et al. reported a specificity and sensitivity of 84% and 69%, respectively, for radiographs in diagnosing scapholunate ligament injuries concomitant with intra-articular DRFs.[8] Suzuki et al. evaluated the intra- and interobserver reliability of radiography and CT for detecting carpal ligament injuries associated with DRFs, using arthroscopy as the confirmatory method.[9] They found moderate intraobserver and poor interobserver reliability for radiographs, in contrast to the acceptable results obtained with coronal CT slices. However, current evidence is insufficient to accurately determine the extent of these injuries and guide therapeutic management.

Although alternative imaging methods such as CT with intra-articular contrast, MRI, or stress radiographs exist, they are not routinely used due to their costs and the need for contrast administration.

The aim of this study was to determine whether a correlation exists between CT and arthroscopy in diagnosing lesions associated with DRFs. As a secondary objective, we sought to establish the incidence of carpal injuries in this type of fracture.

MATERIALS AND METHODS

A retrospective, observational cohort study was conducted. Data analysis was performed using the PECTRA® system, accessing medical records, imaging studies, and surgical reports. Radiographs and CT scans with multiplanar reconstruction were reviewed, with specific measurements performed to detect potential carpal injuries based on clearly established criteria. These findings were then compared with those documented in surgical reports.

A total of 269 patients with DRFs who underwent open reduction and internal fixation with an anatomical locking plate and arthroscopic assistance between January 2012 and December 2022 were retrospectively analyzed. All surgeries were performed by the same expert-level surgeon, according to J.B. Tang's classification, alongside the institution's Upper Limb Surgery team.[10]

Patients aged 18 to 65 years were included. Preoperative imaging included standard wrist radiographs (anteroposterior, lateral, and oblique views) and CT scans in neutral rotation. CT images were obtained at 1 mm intervals and reconstructed in sagittal, axial, coronal, and 3D views. Patients with pathological fractures, bilateral fractures, severe osteoporosis, previous ipsilateral wrist conditions (trauma, fractures, or rheumatic diseases), or open fractures were excluded (Table 1). Stress radiographs were not performed to rule out partial or occult ligament injuries (predynamic instability).

Based on the inclusion criteria, 146 patients were selected: 72 men and 74 women, with a mean age of 46.9 years. All fractures were classified according to the AO classification and analyzed for CT signs of associated injuries (Figure 1).

Table 1. Summary of initial characteristics

n = 146	
Age	49.6 (19-65)
Sex	Male 72 (49%) Female 74 (51%)
Evaluation	Radiographs in three projections: anteroposterior, lateral, and oblique
	Computed tomography with multiplanar reconstruction
Treatment	Reduction and osteosynthesis with anatomical volar locking plate
	Arthroscopic assistance

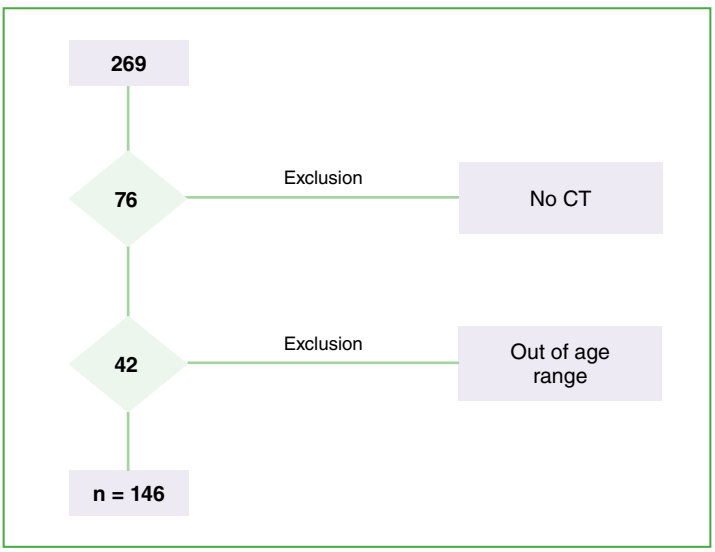

Figure 1. Selection of patients according to the inclusion criteria.

The institutional protocol, which evaluates injuries from ulnar to radial and from proximal to distal, was used for assessing associated lesions. TFCC injury was defined as a fracture at the base or apex of the ulnar styloid, a fracture of the lunate facet of the radius, or distal radioulnar joint incongruity (Figure 2).

Lunotriquetral ligament injury was assessed based on the presence of fracture or avulsion at the lateral or medial aspects of these bones, respectively. Scapholunate ligament injury was diagnosed if the narrowest distance between the scaphoid and lunate exceeded 2.0 mm on coronal CT slices, and the scapholunate angle measured >60° on sagittal slices (Figure 3).[11]

Additionally, carpal fractures and osteochondral lesions were evaluated (Table 2).

The validity of CT as a diagnostic tool for the different injuries was determined by analyzing its sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for each lesion, using the Easy R® software (version 4.2.1).

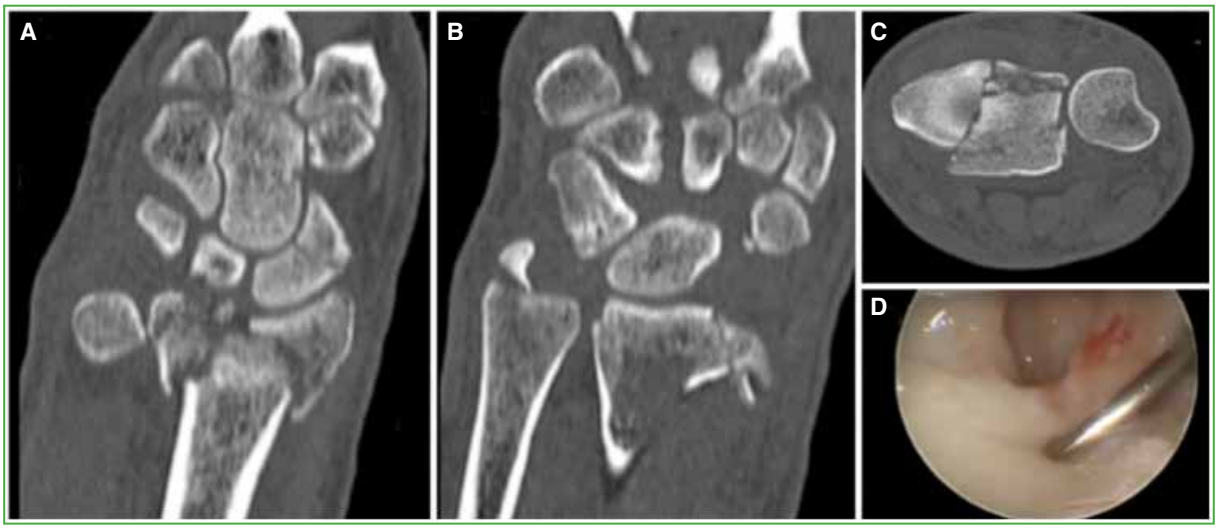

Figure 2. TFCC injury. **A.** Computed tomography of the wrist, coronal section. Radial lunate facet fracture and scaphoid fracture. **B.** Wrist computed tomography, coronal section. Fracture of ulnar styloid. **C.** Distal radioulnar subluxation and radial lunate facet fracture. **D.** Arthroscopic view through portal 3-4-R. Injury at the level of the triangular fibrocartilage in its dorsal portion.

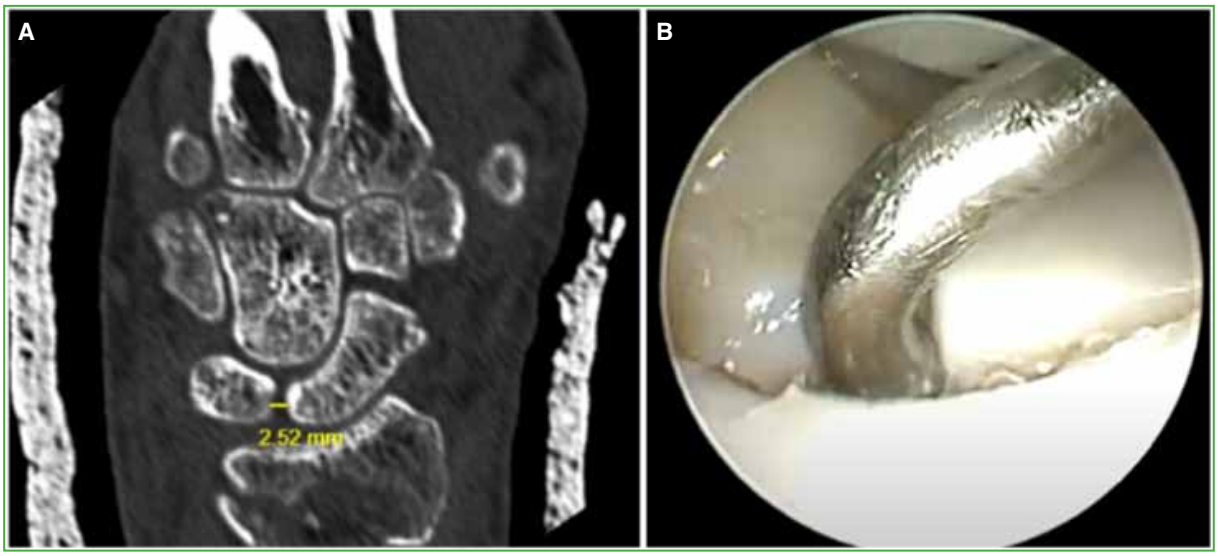

Figure 3. Scapholunate ligament injury. **A.** Computed tomography of the wrist, coronal section. Scapholunate distance> 2 mm. **B.** Arthroscopy. Introduction of the probe through the scapholunate ligament observing the scapholunate ligament injury.

Table 2. Tomographic and arthroscopic evaluation of associated lesions.

Injury	Tomography	Arthroscopy
TFCC injury	Fracture of the lunate facet	Evaluation according to Palmer's classification
	Distal radioulnar dislocation or subluxation	
	Fracture of the styloid process	
Scapholunate lesion	Scapholunate distance >2 mm in coronal slice	Evaluation according to Geissler's classification
	Scapholunate angle >60°.	
Lunotriquetral lesion	Avulsion of the semilunate or triquetral in its articular facet.	Macroscopic visualization of the ligament and avulsion of the articular facet of the lunate or triquetral bone.
Associated carpal bone fracture	Fracture lines involving carpal bone	Direct visualization of fracture lines involving carpal bone.
Osteochondral injury	Bone surface defect	Direct visualization of the osteocartilaginous defect of the articular surface of the carpal bones.

TFCC = triangular fibrocartilage complex.

Surgical Technique

All patients underwent the same surgical procedure. They were positioned in the dorsal decubitus position under a plexus anesthetic block, with a hemostatic cuff inflated to 250 mmHg. The first stage involved open reduction and internal fixation via the Henry volar approach, modified by Orbay, using an anatomical volar locking plate for the distal radius.[12] The limb was then positioned in a traction tower, with the shoulder at 90° of abduction, the elbow at 90° of flexion, and the forearm in a neutral position. Standard arthroscopic portals were used (3-4R, 6R, radial and ulnar midcarpal), and diagnostic and therapeutic arthroscopy was performed. If SLL injuries were identified, the Geissler classification was applied.[13] TFCC injuries were classified and treated according to Palmer's concepts and, in cases of type Ib injuries, treatment followed Atzei's criteria, distinguishing between stable and unstable Ib lesions.[14,15] Immobilization with a plaster cast was maintained for 2 to 4 weeks, depending on the severity of the injury.

RESULTS

In this series, 50% of the patients were women and 49% were men, with an average age of 46.9 years. Regarding fracture type frequency according to the AO classification, 100 fractures were classified as 2R3C (68%), while 23 were 2R3A and 23 were 2R3B (16% each).

The diagnostic accuracy of CT with multiplanar reconstruction was assessed by comparing its findings with those from intraoperative arthroscopy.

TFCC injury: Arthroscopy confirmed this injury in 115 patients. On CT evaluation, 128 patients were diagnosed with TFCC lesions, while 18 were not. Of the 128 positive cases on CT, 99 were true positives and 29 were false positives. Among the 18 negative CT cases, only 2 were true negatives, while 16 were false negatives. From these data, the sensitivity was 84% (CI 76–96%), specificity was 65% (CI 8–21%), PPV was 77% (CI 68–84%), and NPV was 10% (CI 1–32%).

Scapholunate ligament (SLL) injury: Arthroscopy identified 71 cases of SLL injury. CT detected 72 cases with ligament injuries and 74 without. Of the 72 CT-positive cases, 44 were true positives, while 28 were false positives. Among the 74 CT-negative cases, 47 were true negatives and 27 were false negatives. The sensitivity was 61% (CI 49–73%), specificity was 62% (CI 50–73%), PPV was 60% (CI 47–71%), and NPV was 63% (CI 51–74%).

Osteochondral injury: Nine patients were diagnosed with this injury by arthroscopy, while CT identified 23 cases. Of these, 5 were true positives and 18 were false positives. Among the 123 CT-negative cases, 4 were false negatives, and 119 were true negatives. Sensitivity was 55% (CI 21–86%), specificity was 87% (CI 80–92%), PPV was 22% (CI 7.5–43%), and NPV was 97% (CI 92–99%).

Lunotriquetral injury: Arthroscopy detected only 2 cases of this type of injury, making it insufficient to evaluate the diagnostic accuracy of CT.

Carpal bone fractures: Arthroscopy identified 5 carpal bone fractures, whereas CT detected 16 cases. Additionally, 7 patients had radiocarpal ligament injuries diagnosed arthroscopically, which were not assessed by CT. The results are detailed in Table 3.

In this series, only 9 patients had no carpal injury associated with the fracture, indicating a high overall incidence of carpal injuries, at 92% (Table 4).

Table 3. Outcomes.

Injury	Arthroscopy	CT	Sensitivity	Specificity	PPV	NPV
TFCC	With injury: 115 Without injury: 31	With injury: 128 99 TP 29 FP Without injury: 18 2 TN 16 FN	84% (CI 76-96%)	65% (CI 0.8-21%)	60% (CI 47-71%)	10% (CI 1-32%)
SLL	With injury: 71 Without injury: 75	With injury: 72 44 TP 28 FP Without injury: 74 47 TN 27 FN	61% (CI 49-73%)	62% (CI 50-73%)	60% (CI 47-71%)	63% (IC 51-74%)
OCI	Injury: 9 Without injury: 135	With injury: 23 5 TP 18 FP Without injury: 123 119 TN 4 FN	55% (CI 21-86%)	87% (CI 80-92%)	22% (CI 7.5-43%)	97% (IC 92-99%)

CT = computed tomography; PPV = positive predictive value; NPV = negative predictive value; CI = confidence interval; TFCC = triangular fibrocartilage complex; SLL = scapholunate ligament; OCI = osteochondral injury; TP = true positive; FP = false positive; TN = true negative; FN = false negative.

Table 4. Incidence of associated injuries

Injury	Patients	Incidence
Triangular fibrocartilage complex	115	78.7%
Scapholunate ligament	70	48%
Osteochondral injury	9	6%
Radiocarpal ligament	7	4.8%
Carpal bone fracture	5	3.5%
Lunotriquetral lesion	2	1.36%

DISCUSSION

A large number of publications establish a close relationship between DRF and associated injuries, which have a predictive value for short- and long-term functional outcomes.

The complex anatomy of the carpus makes it difficult to diagnose associated injuries using plain radiographs. Failure to detect them can lead to complications such as carpal instability and biomechanical alterations, which may result in persistent pain and functional impairment.[16]

The use of arthroscopic assistance in the treatment of DRF has highlighted the high incidence of associated intercarpal injuries, including the TFCC and radiocarpal and intercarpal ligaments. The importance of repairing unstable injuries and identifying acute lesions, which may be treated with postoperative immobilization, has been emphasized. Injuries to the interosseous carpal ligaments and TFCC that are accessible via arthroscopy have been extensively evaluated.

A high incidence of associated ligament injuries has been reported. Linscheid et al. were pioneers in describing scapholunate instability, which remains the most common type of associated carpal instability.[17] Several authors have observed SLL injuries in 53.7% of cases, TFCC injuries in 82%, lunotriquetral ligament injuries in 27.1%, and osteochondral lesions in 32% of DRF cases treated with open reduction and internal fixation. Additionally, extrinsic carpal ligament injuries were described in 74%.[18-21] In our series, similar results were obtained for TFCC (78.7%) and SLL (48%) injuries, whereas the incidence of radiocarpal and chondral injuries was considerably lower, at 4.8% and 6%, respectively.

Richards et al. reported the low accuracy of radiographs as a diagnostic tool, noting that in 60% of cases where a ligament tear was confirmed arthroscopically, the scapholunate distance appeared normal on preoperative radiographs.[20] Although MRI and MR angiography have greater sensitivity for detecting ligament injuries than radiographs, they do not precisely define the extent of ligament damage, the quality of the affected tissue, or the presence of associated chondral lesions—information that is crucial for surgical planning and technique selection.[22]

The aforementioned studies correlate arthroscopic and radiographic findings. However, Suzuki was the first to evaluate the correlation between arthroscopy and CT. In a series of 88 wrists, they compared arthroscopic findings of the scapholunate interval with preoperative CT measurements and concluded that measuring the scapholunate distance on the central coronal CT slice was reproducible, with high intra- and interobserver agreement, for diagnosing low- and high-grade SLL lesions confirmed by arthroscopy.[9] The present study found that an increased scapholunate distance on coronal CT had a positive predictive value (PPV) of 60%, meaning that 3 out of 5 patients with this imaging finding actually had the lesion.

Radiocarpal and lunotriquetral ligament injuries had a low incidence in this series, rendering specificity and sensitivity values insignificant.

Regarding the frequency and distribution of injuries, Heo et al. evaluated a series of 223 patients with DRF and found that 20.6% had associated carpal fractures, with the triquetrum being the most frequently affected bone.[23] Other studies report that scaphoid fractures have the highest incidence, ranging from 0.75% to 6.5%, which aligns with the 4.1% observed in our series.[24,25]

Similar to the previously mentioned series, the incidence of carpal fractures in this study was 13% (19 patients). Among them, 14 cases were diagnosed solely by CT, 3 by arthroscopy, and only 2 were identified by both methods. This demonstrates the superior diagnostic accuracy of CT compared to arthroscopic visualization, which may be attributed to the lack of routine use of specific portals for viewing different regions of the carpus.

CONCLUSIONS

The prevalence of lesions associated with DRF has been reported to be high, with up to 80% of TFCC and 50% of SLL injuries. While our findings are consistent with these values, no significant correlation was found between CT imaging and arthroscopic findings. The authors consider arthroscopy to remain the gold standard for diagnosing intercarpal lesions, with its primary advantage being the ability to treat these injuries during the same surgical procedure. However, disadvantages include increased surgical time, additional costs, and the need for an experienced surgeon. The importance of CT for evaluating fractures and joint injuries is emphasized; however, it should only be considered a preliminary tool for suspected intercarpal injuries. We recommend MRI or arthroscopy as more reliable diagnostic methods.

Conflict of interest: The authors declare no conflicts of interest.

M. Lazzari ORCID ID: https://orcid.org/0009-0006-8609-5777
G. O. Pérez Lloveras ORCID ID: https://orcid.org/0009-0005-4227-0484
F. G. Casen Infante ORCID ID: https://orcid.org/0009-0008-9108-9755
T. M. Rognoni ORCID ID: https://orcid.org/0009-0000-4720-1318
R. A. Posse ORCID ID: https://orcid.org/0000-0003-2202-4268
M. Otero Consoli ORCID ID: https://orcid.org/0009-0006-2297-5257
F. Colombato ORCID ID: https://orcid.org/0009-0004-8747-7887
F. Casserá ORCID ID: https://orcid.org/0009-0005-0566-7124
M. Caloia ORCID ID: https://orcid.org/0000-0002-8103-3036

REFERENCES

1. Nellans KW, Kowalski E, Chung KC. The epidemiology of distal radius fractures. *Hand Clin* 2012;28(2):113-25. https://doi.org/10.1016/j.hcl.2012.02.001
2. Melton III LJ, Amadio PC, Crowson CS, O'Fallon WM. Long-term trends in the incidence of distal forearm fractures. *Osteoporos Int* 1998;8(4):341-8. https://doi.org/10.1007/s001980050073
3. Kelsey JL, Praemer A, Nelson LM, Felberg A, Rice DP. *Upper extremity disorders: Frequency, impact and cost*. New York: Churchill Livingstone; 1997.
4. Lee Y-K, Kwon T-Y, Lee H-S. Arthroscopic treatment of chronic wrist pain after distal radius fractures. *Medicine (Baltimore)* 2020;99(38):e22196. https://doi.org/10.1097/MD.0000000000022196
5. Cheng HS, Hung LK, Ho PC, Wong J. An analysis of causes and treatment outcome of chronic wrist pain after distal radial fractures. *Hand Surg* 2008;13(01):1-10. https://doi.org/10.1142/S0218810408003748
6. Kwon BC, Baek GH. Fluoroscopic diagnosis of scapholunate interosseous ligament injuries in distal radius fractures. *Clin Orthop Relat Res* 2008;466(4):969-76. https://doi.org/10.1007/s11999-008-0126-6
7. Desai MJ, Kamal RN, Richard MJ. Management of intercarpal ligament injuries associated with distal radius fractures. *Hand Clin* 2015;31(3):409-16. https://doi.org/10.1016/j.hcl.2015.04.009
8. Gradl G, Neuhaus V, Fuchsberger T, Guitton TG, Prommersberger KJ, Ring D. Radiographic diagnosis of scapholunate dissociation among intra-articular fractures of the distal radius: Interobserver reliability. *J Hand Surg* 2013;38(9):1685-90. https://doi.org/10.1016/j.jhsa.2013.05.039
9. Suzuki D, Ono H, Furuta K, Katayama T, Akahane M, Omokawa S, et al. Comparison of scapholunate distance measurements on plain radiography and computed tomography for the diagnosis scapholunate instability associated with distal radius fracture. *J Orthop Sci* 2014;19:465-70. https://doi.org/10.1007/s00776-014-0533-3
10. Tang JB. Re: Levels of experience of surgeons in clinical studies. *J Hand Surg Eur Vol* 2009;34(1):137-8. https://doi.org/10.1177/17531934097321
11. Özkan S, Mudgal CS, Jupiter JB, Bloemers FW, Chen NC. Scapholunate diastasis in distal radius fractures: Fracture pattern analysis on CT scans. *J Wrist Surg* 2020;9(04):338-44. https://doi.org/10.1055/s-0040-1712505
12. Orbay JL, Badia A, Indriago IR, Infante A, Khouri RK, Gonzalez E, et al. The extended flexor carpi radialis approach: A new perspective for the distal radius fracture. *Tech Hand Up Extrem Surg* 2001;5(4):204-11. https://doi.org/10.1097/00130911-200112000-00004
13. Geissler WB, Freeland AE, Savoie FH, McIntyre LW, Whipple TL. Intracarpal soft-tissue lesions associated with an intra-articular fracture of the distal end of the radius. *J Bone Joint Surg Am* 1996;78(3):357-65. https://doi.org/10.2106/00004623-199603000-00006
14. Palmer AK. Triangular fibrocartilage complex lesions: A classification. *J Hand Surg* 1989;14(4):594-606. https://doi.org/10.1016/0363-5023(89)90174-3
15. Atzei A, Rizzo A, Luchetti R, Fairplay T. Arthroscopic foveal repair of triangular fibrocartilage complex peripheral lesion with distal radioulnar joint instability. *Tech Hand Up Extrem Surg* 2008;12(4):226-35. https://doi.org/10.1097/BTH.0b013e3181901b1
16. Vigler M, Aviles A, Lee SK. Carpal fractures excluding the scaphoid. *Hand Clin* 2006;22(4):501-16. https://doi.org/10.1016/j.hcl.2006.07.007
17. Linscheid RL, Dobyns JH, Beabout JW, Bryan RS. Traumatic instability of the wrist. *J Bone Joint Surg Am* 1972; 54(8):1612-32. PMID: 4653642
18. Lindau T, Arner M, Hagberg L. Intraarticular lesions in distal fractures of the radius in young adults. *J Hand Surg* 1997;22(5):638-43. https://doi.org/10.1016/s0266-7681(97)80364-6
19. Abe Y, Tsubone T, Tominaga Y. Plate presetting arthroscopic reduction technique for the distal radius fractures. *Tech Hand Up Extrem Surg* 2008;12(3):136-43. https://doi.org/10.1097/BTH.0b013e3181670fe3
20. Richards RS, Bennett JD, Roth JH, Milne K. Arthroscopic diagnosis of intra-articular soft tissue injuries associated with distal radial fractures. *J Hand Surg* 1997;22(5):772-6. https://doi.org/10.1016/S0363-5023(97)80068-8

21. Ogawa T, Tanaka T, Yanai T, Kumagai H, Ochiai N. Analysis of soft tissue injuries associated with distal radius fractures. *Sports Med Arthrosc Rehabil Ther Amp Technol* 2013;5(1). https://doi.org/10.1186/2052-1847-5-19
22. De Santis S, Cozzolino R, Luchetti R, Cazzoletti L. Comparison between MRI and arthroscopy of the wrist for the assessment of posttraumatic lesions of intrinsic ligaments and the triangular fibrocartilage complex. *J Wrist Surg* 2022;11(01):28-34. https://doi.org/10.1055/s-0041-1729757
23. Heo YM, Kim SB, Yi JW, Lee JB, Park CY, Yoon JY, et al. Evaluation of associated carpal bone fractures in distal radial fractures. *Clin Orthop Surg* 2013;5(2):98-104. https://doi.org/10.4055/cios.2013.5.2.98
24. Trumble TE, Benirschke SK, Vedder NB. Ipsilateral fractures of the scaphoid and radius. *J Hand Surg* 1993;18(1):8-14. https://doi.org/10.1016/0363-5023(93)90237-W
25. Rutgers M, Mudgal CS, Shin R. Combined fractures of the distal radius and scaphoid. *J Hand Surg Eur Vol* 2008;33(4):478-83. https://doi.org/10.1177/1753193408090099