



Original Article

DOI: https://doi.org/10.23950/jcmk/13943

# Incidence and functional outcome of inter-carpal ligament injuries associated with fractures of distal radius

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Received: 2023-07-25. Accepted: 2023-10-03



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J Clin Med Kaz 2023; 20(6):55-59

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#### Abstract

**Introduction:** Although the prevalence of intercarpal ligament injuries with distal radius fractures ranges from 0.5 to 75 percent, these injuries are often missed by the untrained eye. Currently, wrist arthroscopy is considered gold standard for diagnosis and treatment, but in Indian setting it is an impractical proposition. Scapho-lunate and luno-triquetral injuries can be identified on X rays easily by Gilula's arc, scapholunate distance and angle, carpal height ratio etc. The aim of this study is to estimate the prevalence of intercarpal ligament injuries in distal radius (DER) fractures and determine their functional outcome at one year.

**Material and methods:** The study was conducted over 18 months at VMMC and Safdarjung Hospital. Patients with distal radius fractures were subjected to wrist X rays in 100% magnification and earlier mentioned parameters were measured. Patients who needed surgery were operated for fracture DER. Immediate post-operative X rays and X rays at 1 year were compared with that of the contralateral wrist. Patients' clinical outcomes like range of motion, grip strength, quick DASH score and pain on VAS were measured at one year to assess the clinical outcome.

**Results:** The study population was of 103 patients. Prevalence of intercarpal injuries in patients with DER fractures was 11.7%. Out of these 12 patients, 50% had broken Gilula's arc, 66.6% had increased scapho-lunate distance and 42% had increased scapho-lunate angle. Carpal height ratio was significantly less in patients with intercarpal ligament injuries at one year. Similarly, functional outcome was worse in these patients at one year.

**Conclusion:** Intercarpal injuries are associated with worse outcomes in patients with fracture DER. These injuries can reliably diagnosed on X rays using the parameters mentioned. Since the prevalence is quite high, we should learn to diagnose them early, so that patients can be explained about the prognosis of their injury.

Keywords: intercarpal ligament, distal radius fracture, scapho-lunate

## Introduction

Distal Radius Fractures (DRF) are one of the commonest injuries encountered in clinical practice [1] and one sixth of all fractures managed in the emergency department. The incidence is 20-40 per 10000 persons per year [2,3].

There has been an increasing concern regarding the incidence of various soft tissue injuries that are associated with DRF, their association with the type of fracture, treatment of these injuries and their effect on the final outcome of the patient. The prevalence of intercarpal ligament injuries and distal radius fractures ranges from 0.5-75% [4,5,6]. The incidence of these injuries is higher with intraarticular DRF [4,7]. But there is scarcity of studies documenting their incidence and outcome in Indian population.

There are 2 types of ligaments in the wrist; extrinsic and intrinsic. Extrinsic ligaments connect the forearm bones with the carpals while intrinsic ligaments are the functional inter carpal stabilizers. The intercarpal ligament injuries commonly associated with distal radius fractures are scapholunate ligament and lunotriquetral ligament. Scapholunate ligament injuries cause Dorsal Intercalated Segment Instability (DISI deformity) while Lunotriquetral ligament injuries cause Volar Intercalated Segment Instability (VISI deformity).

The association of the intercarpal ligament injuries has shown to affect the future outcome of the injury in terms of range of motion at the wrist joint, grip and pinch strength, pain in wrist as well as the ability in doing daily activities [8]. Therefore, there is a need for diagnosing these injuries early to know their natural history opt for early treatment. Presently wrist arthroscopy is considered the gold standard procedure for their diagnosis and treatment [9,10].

We have studied these injuries using radiographs of wrist due to our limited resources. Our study has tried to identify these injuries and their future outcome at 1 year on X-rays in the Indian diaspora. We aim to help understand these injuries so that early diagnosis is possible in a limited resource setting.

### Material and methods

Our study was conducted over a period of 18 months in Central Institute of Orthopedics, Safdarjung Hospital, New Delhi. We included all the patients coming to our emergency with unilateral distal end radius fractures, both intra-articular and extra-articular, between the age of 18-50 years. All these patients were explained about the study and patients were enrolled after taking written informed consent. All the patients were subjected to preoperative X-ray of bilateral wrist: PA & Lateral views in 100% magnification. Radiographic parameters visualized were:

1) Gilula's Arc- 3 uniform arcs were visualized on the PA view of the wrist to assess carpal alignment. First arc outlines the proximal articular surface of scaphoid, lunate and triquetrum. Second arc outlines the concave distal surface of scaphoid, lunate and triquetrum. Third arc outlines the proximal surface of capitate and hamate. Any disruption of these arcs is suggestive of abnormality at that site [11] (Figure 1).



**Figure 1** - Post op X- Ray: PA view B/L wrist at 1 year showing broken Gilula's arc (Arc1) as compared to the uninjured side.

2) Scapholunate distance- it is the distance between scaphoid and lunate measured at a midpoint between first and second Gilula's arc [12]. Distance > 2 mm is suggestive of SL dissociation leading to Terry Thomas Sign on the PA view (Figure 2A and 2B).

3) Scapholunate Angle: it is the angle between the long axis of scaphoid and mid axis of lunate on lateral view. Angle >60 degree indicates DISI while angle <30 degree suggests VISI [13] (Figure 3A and 3B).

4) Carpal Height Ratio (CHR): it is measured by dividing carpal height by the length of the third metacarpal on the PA view. Carpal height is measured from articular surface of base of 3rd metacarpal to the distal articular surface of radius and 3rd



Figure 2A - X- Ray showing normal SL (<2 mm) Distance on PA view



Figure 2B - X- Ray showing increased SL Distance (>2 mm) on PA view.



Figure 3A - X- Ray B/L wrist: Lateral view showing increased SL Angle (DISI).



Figure 3B - X-Ray B/L wrist: Lateral view showing decreased SL Angle (VISI).

metacarpal length was measured along its longitudinal axis from distal to proximal articular surface. Normal value ranges from 0.45-0.63 [14] (Figure 4A and 4B).



Figure 4A -X-Ray at 1 year showing CHR on affected side (0.46).





All patients were then evaluated for swelling and skin condition and those patients who were found to have healthy skin were managed by surgical intervention for distal radius fractures by either of the following methods:

1) ORIF with plating

2) K wire pinning

3) External fixator

Repeat X-Rays of bilateral wrist: PA & Lateral view in 100% magnification were taken at post op day 1, at 6 weeks and at 1 year. X-rays were visualized for various radiographic parameters and were compared with contralateral wrist between immediate post-operative day 1 x-ray and at 1 year.

The patients were also evaluated for functional and clinical outcomes for bilateral wrist joints with normal wrist acting as a control at one year. Parameters assessed were;

1) Range of Motion: It is the extent of osteokinetic motion available for movement activities, functional or otherwise, with or without assistance [15]. It is assessed using a Goniometer. Movements assessed included wrist flexion-extension, supination-pronation and radial deviation-ulnar deviation.

2) Grip Strength: It is the measure of maximum force generated by one's forearm muscle. It is measured using the Hand Dynamometer of the bilateral side for comparison. An average of 3 readings was taken.

3) Visual Analog Scale: It is used to measure severity of pain at the wrist joint of the affected side while doing day-to-day activity as compared to the opposite normal side. It consists of a numerical rating scale with numbers marked at regular intervals from 0 to 10 with 0 representing no pain and 10 representing severe debilitating pain [16].

4) Quick DASH Score: It is a self-reported outcome measure for physical function and symptoms in persons with any or multiple musculoskeletal disorders of the upper limb on a 5-point Likert scale [17,18]. It consists of 11 questions for which the patient selects an appropriate number according to his/her function level [19]. It cannot be measured if more than 1 question is missing. Quick DASH Scoring Formula= ([(sum of n responses)/n] -1)(25), where n is the number of answered questions. Higher score indicates more disability and vice-versa.

The entire study was conducted after taking the Institutional Ethics Committee (IEC) approval from our Institution (IEC/VMMC/SJH/Thesis/ 2020-11/CC-201).

#### **Results**

The study population consisted of 103 patients out of which 71 were males and 32 were females with a mean age of 28.13+/-5.56 years (range 20 to 50 years).

The radiographic parameters were evaluated in all the patients at the time of presentation which showed that the incidence of intercarpal ligament injuries associated with distal radius fractures was 11.7% (12 out of 103 patients) (Table 1). These 12 patients consisted of 9 men and 3 women. The Gilula's arc was broken in 6 out of 12 patients, 8 patients had increased scapholunate distance. The scapholunate angle was abnormal in 5 out of 12 patients with 4 patients having SL angle > 60 degree while 1 patient having SL angle < 30 degree (Table 2).

Table 1	Incidence of Ligament injury in study subjects (n=103)			
Ligament injury		No.	%	
Absent		91	88.3	
Present		12	11.7	

normal side at post treatment 1 year.	Table 2	Comparison of different radiological and functional parameters between subjects with ligament injury side and				
		normal side at post treatment 1 year.				

	Ligament injury	Ligament injury		P value
	Absent (n=91)	Present (n=12)		
Gilula's line				
Broken	0	6 (50%)	0	< 0.001
Unbroken	91 (100%)	6 (50%)	103 (100%)	
Scapholunate distance				
<2	91 (100%)	4 (33.3%)	103 (100%)	< 0.001
>2	0	8 (66.7%)	0	
Scapholunate angle	49.78±10.67	60.92±16.79	50.88±10.42	0.03
Carpel height ratio	0.53±0.11	0.49±0.02	0.53±0.04	< 0.01
Quick DASH score	30.39±8.06	76.97±6.53	0.40±1.30	< 0.001
Grip strength	19.12±4.42	10.92±4.27	26.38±4.16	< 0.001
VAS score	1.15±1.39	3.50±1.83	0.0±0.0	< 0.001

Table 3 Comparison of Carpal height ratio between

both groups.							
	Ligament injury	P value					
Carpal height ratio	Absent (n=91)	Present (n=12)	intergroup				
Post -treatment at day 1	0.53±0.11	0.53±0.03	0.56				
Post -treatment 1 year	0.53±0.11	0.49±0.02	<0.01				
P value between post & 1 year	0.76	<0.01					

Carpal height ratio (CHR) was measured in all the patients at 1 year. The mean carpal height ratio in patients without ligament injuries was  $0.53\pm0.11$  at day and it was unchanged in one year. It was  $0.53\pm/-0.03$  at post op day 1 and  $0.49\pm/-0.02$  at 1 year in patients with associated ligament injuries. The difference in the values in two groups was significant at 1 year (p value <0.01) (Table 3).

Functional outcome was significantly poor in patients with associated ligament injuries. The mean Grip Strength measured at 1 year was 10.92+/-4.27kg and 19.12+/-4.42kg in patients with and without ligament injury, respectively and that on the

Journal of Clinical Medicine of Kazakhstan: 2023 Volume 20, Issue 6

normal side was 26.38+/-4.14 kg which showed a significant reduction of grip strength with a p value<0.001. Range of motion was assessed at 1 year and was compared to the opposite normal wrist which also showed significant reduction in patients with ligament injury which affected their normal daily activities.

Clinical outcomes were assessed using quickDASH score and VAS score at 1 year time. The quickDASH score was 76.97+/-6.53 and 30.39+/-8.06 in patients with and without ligament injuries, respectively. The patients also had a poorer VAS score of 3.50+/-1.83. Both quickDASH and VAS score had a significant difference in both groups with a p value <0.001 signifying that the patients had restricted and painful daily activities.

### Discussion

The purpose of this study was to estimate the incidence of intercarpal ligament injuries associated with distal radius fractures and determine the functional outcome at one year.

Age: The mean age associated with intercarpal ligament injuries in distal radius fractures was 32.5+/-8.5 in our study. While the mean age of patients with distal radius fractures was 28.13/-5.56 years.

Sex: The intercarpal ligament injuries were found more commonly in males (75%) than females due to the predominant male population being affected.

Incidence: In our study, the incidence of intercarpal ligament injuries was found 11.7% in patients with distal radius fractures on X-rays. In the study by Rosenthal et al [4] the incidence of intercarpal lesions was found to be 7.4% on X-rays which is similar to our study. Laulan et al [8] took all patients with intra and extra articular distal radius fractures and found the incidence to be 43% on X-rays. The incidence of various intercarpal ligament lesions on radiographs was found between [8] 1-32% [10,20]. Later arthroscopic studies showed the incidence ranging from 7-64% in association with DRF [9,21-24]. All the patients with intercarpal ligament injuries were diagnosed early at the immediate post op period. The incidence of these lesions increases with intra-articular distal radius fractures. These lesions can be detected on radiographs with proper understanding of intercarpal alignment, angles and measurements on initial presentation.

Radiographic parameters: Of the patients diagnosed with an associated intercarpal ligament injury, the Gilula's arc was broken in 50% patients, SL angle was affected in 41.7% patients while the SL distance was abnormal in 66.7% patients. Out of 12 patients, 7 had more than one parameter affected. Also, no significant change in affected parameters was seen at 1 year follow up that was present at post op day 1.

At 1 year, the mean CHR showed significant reduction in 41.67% patients with ligament injury from 0.55+/-0.3 to 0.47+/-0.21 which shows significantly affected carpal height. The mean CHR in patients without ligament injuries was 0.53+/-0.11 at post op day1 and at 1 year. Laulan et al [8] also showed similar progression in CHR reduction using revised CHR measurement [25] method in 61% of cases with intercarpal ligament lesions with rCHR value decreasing from 1.56+/-0.07 at post op day 1 to 1.51+/-0.09 at 1 year follow up.

Functional outcome: All range of motions i.e., wrist flexion and extension, radial and ulnar deviation, supination and pronation were significantly affected in patients with ligament injuries as compared with the contralateral normal wrist and also with the patients without ligament injuries. In patients with intercarpal ligament lesions in our study, average wrist flexion was 20.5+/-6.36 and 82.81+/-4.64 degrees, wrist extension was 16.83+/-3.97 and 74.56+/-4.35 degrees, radial deviation

was 10.08+/-3.23 and 30.06+/-2.94 degrees, ulnar deviation was 20+/-4.71 and 34.96+/-4.61 degrees, pronation was 17.92+/-5.31 and 69.64+/-5.28 degrees and supination were 25.17+/-7.69 and 81.60+/-5.64 degrees on affected and the normal side respectively. Similar results of poor wrist function were seen by Tang et al [20] in all patients with ligament injuries. In contrast to our study, Forward et al [21] showed no significant difference in ROM of affected and normal wrist.

The grip strength in the affected wrist was 10.92+/-4.27 kg which was significantly lower than in patients without ligament injury (19.12+/-4.42 kg) and that on the normal side 26.38+/-4.14 kg. Kaspinova et al [26] also found poor grip strength in patients with associated ligament injuries using hydraulic hand dynamometer. This was in contrast with results shown by Laulan et al [8] And Forward et al [21] in their studies.

Clinical outcome: The quick DASH score was also significantly higher in patients with ligament injuries 76.97+/-4.27 as compared to those without associated ligament injury showing that these patients had more difficulty in doing day-to-day activities. Similar results were seen by Kaspinova et al [26] where patients with associated ligament injury had greater disability with high Dash score.

The subjective pain was assessed using VAS score which showed significant pain in patients with associated ligament injuries at 1 year with mean value of 3.50+/-1.83 compared to 1.15+/-1.39 in patients without ligament injuries. Similar results were seen by Forward et al21 with VAS score of 1.1 in patients with ligament injuries. In contrast with this, Laulan et al [8] 86% showed no wrist pain, 12% had pain after strenuous activities and 2% had severe pain.

### Conclusion

In this study, "Incidence and functional outcome of intercarpal ligament injuries associated with fractures of the distal radius" by evaluating the result and statistics we concluded that patients with intercarpal ligament injuries associated with distal radius fractures had poor functional and clinical outcome at 1 year.

Following advantages were seen with our study:

Intercarpal ligament injuries associated with distal radius fractures can be diagnosed on x rays.

X-rays can be done as a routine procedure in all patients and are inexpensive.

Abnormality of Radiographic parameters such as Gilula's arc, SL distance, SL angle, and carpal height ratio can help in early diagnosis of intercarpal instabilities.

Arthroscopy of wrist to diagnose intercarpal ligament injuries cannot be carried out routinely.

Patients with intercarpal ligament injuries had poor functional outcome evaluated by ROM and Grip strength.

These patients also had poor clinical outcomes evaluated as high VAS score for pain and high quick DASH score suggesting more disability.

It is important to diagnose these injuries early on X rays because when left alone, the outcome is generally unsatisfactory.

**Disclosures:** There is no conflict of interest for all authors.

Acknowledgements: Authors acknowledge the contribution of Aryaman Jaiman, MBBS Student, Agartala Government Medical College, Agartala, Tripura, India, 799006 for his assistance with statistical analysis, grammar editing, and plagiarism detection.

Funding: None.

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