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# EVALUATION AND CHARACTERIZATION OF CONCURRENT CARPAL BONE FRACTURES IN DISTAL RADIUS FRACTURES

**Manu Jacob Abraham[1], Reddy Ravikanth[2]**

[1] - Postgraduate student, Department of Orthopedics, St. John's Medical College, Bangalore
[2] - Postgraduate student, Department of Radiology, St. John's Medical College, Bangalore

**Corresponding Author:**
Reddy Ravikanth, MBBS
Post-graduate student
Department of Radiology,
St. John's Medical College,
Bangalore – 560034
Email: ravikanthreddy06@gmail.com
Mob: +91-9035144252

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**Abstract:**

***Background:*** Aim of the study was to evaluate the incidence and characteristics of carpal bone fractures occurring concurrently with distal radius fractures.

***Methods:*** We retrospectively analyzed 260 patients with distal radius fractures who were treated between May 2013 – May 2016 at St. John's Medical College Hospital, Bangalore. AP, lateral and oblique radiographs of the wrist were examined and CT was done to rule out carpal bone fractures. We evaluated the frequency and characteristics of carpal bone fractures occurring concurrently with distal radius fractures with the AO classification and patient factors age and gender.

***Results:*** 66 cases (25.3%) had simultaneous carpal bone fractures of one or more bones in the 260 distal radius fractures we encountered. Fall on an outstretched hand with extended wrist was the commonest mechanism of injury.The distribution of carpal bone fractures were 30 cases in the triquetrum, 18 in the lunate, 14 in the scaphoid, 7 in the hamate and 5 in pisiform.Hamate was the only carpal bone fractured in the distal row of carpals.

***Conclusion:*** The incidence of concurrent carpal bone fractures in distal radius fractures was significant. Almost all carpal fractures had no or minimal displacement. Suspicion of carpal fractures occurring concurrently with distal radius fracture should be high. CT should be considered for the diagnosis as misdiagnosed or untreated carpal bone fractures may have a poor surgical outcome with complications

**Key-words:** *Radius, carpal, fracture, AO, malunion, CT*

## Introduction:

The wrist is a complex joint with bony structures, including the distal radius, distal ulna, and eight carpal bones and a ligament complex that divides extrinsic and intrinsic ligaments.

Distal radius fractures are the commonest in the upper extremity.[1] An estimated 17% of fractures seen acutely in the emergency departmentaccount or distal radius fractures.Indications for surgical intervention and method of treatment remains subjective despite the high frequency of these fractures. Closed reduction, cast immobilization, percutaneous K-wire fixation, external fixation, intramedullary fixation, open reduction and internal fixation are the various methods of treatment. However studies have not been done relating the association of distal radius fractures with ulnar fractures.[2] Rapid restoration of function, with attention given to the prevention of chronic disability is the goal in treating distal radius fractures. Full evaluation is required rather than simple fracture detection and description. Potential fracture complications and consequentimplications can be assessed with CT.

Avulsion fractures of the carpal bones with injuries to extrinsic and intrinsic ligaments of the wrist have been commonly noted in association with distal radius fractures. Due to the compact placement with overlap of bones, carpal bone fractures are frequently missed on plain radiographs. Unsatisfactory clinical outcomes may result if misdiagnosed or untreated. Scaphoid bone fracture has been frequently documented with distal radius fractures.

Carpal bone fractures may be untreated, because they are frequently missed on initial radiographs, which leads to persistent pain, subsequent wrist dysfunction and eventually affects the outcome of distal radius fracture treatment.[3] The purpose of this study was to evaluate the frequency, distribution and characterization of carpal bone fractures associated with distal radius fractures.

## Materials And Methods:

Retrospective evaluation of 260 patients who underwent operative treatment for distal radius fractures after being diagnosed with plain radiographs and CT between May 2013- May 2016 done and reviewed. All patients underwent pre-operative CT evaluation. Suspected carpal instability and distal radius fractures that had a fracture-dislocation on plain radiographs and CT were excluded from the study.

They were total of 100 males and 160 females with mean age of 44 years (Range 16 – 72). All patients with distal radius fractures underwent AP, lateral and oblique plain radiographs of the wrist prior to and after reduction with CT in neutral forearm rotation was performed and images reviewed. The mechanism of injury was fall on outstretched hand (160 cases), road traffic accidents (52 cases) and fall from height (48 cases).

Frequency and location of concurrent carpal bone fractures on CT images were assessed for in all distal radius fractures. Arbeitsgemeinschaftfür osteosyntheses (AO) classification was used for the classification of distal radius fracturesand the frequency of associated carpal bone fractures checked for each AO classification. Subtypes of carpal bone fractures were classified according to Vigler et al, the distal radius fractures were divided into two groups: Distal radius fractures with and without carpal bone fractures. Differences in age and sex between the two groups were compared with the chi-square test. The mechanism of injury was divided into a low-energy group including fall on an outstretched hand and a high-energy group including fall from height and road traffic accident. The frequency of associated carpal bone fractures between the two groups was compared with the t -test. Fisher's exact test was used to compare the frequency among AO types.

## Results:

66 cases were associated with carpal bone fractures among the 260 distal radius fractures evaluated. They were 30 males and 36 females with a mean age of 41.5 years (Range 18-65 years). The mechanisms of injury included fall on an outstretched hand (45 cases), fall from height (15 cases) and road traffic accidents (6 cases). The distribution of carpal bone fractures were 30 cases in the triquetrum, 18 in the lunate, 14 in the scaphoid, 7 in the hamate and 5 in pisiform. Among the 66 distal radius fractures with carpal bone fractures, fractures of triquetrum were the commonest, and most carpal bone fractures were identified in the proximal row. Only single carpal bone fracture occurred in 50 cases, two in 10 cases, three in 4 cases and four in 2 cases.

All distal radius fractures were classified according to the AO classification. The frequency of associated carpal bone fractures were checked for each AO classification. Type A3 was complicated in two of 50 cases, type B1 was complicated in two of 15 cases, type B3 was one of 16 cases, type C1 was one of 15 cases, type C2 was 24 of 86 cases and type C3 was 24 of 70 cases. Type C2 and

C3 are a result of high-energy trauma and were commonly identified in these fracture subtypes. The incidence of carpal bone fractures is 30.7% in these two types as against 5.0 % in all other types combined together if we go by the current study.

Despite the relatively high frequency of associated carpal bone fractures in AO types C3 or C2, no difference was found among AO types (p= 0.20).No significant difference was observed in the frequency of associated carpal bone fractures between the low energy and high energy groups separated by the mechanism of injury (p=0.88). Observations on age (p=0.39), sex (p=0.34) between patients with distal radius fractures and carpal bone fractures (66 cases) and those without carpal bone fractures (194 cases) showed no significant differences.

**Discussion:**

Eight carpal bones form the wrist joint and stability among carpal bones is maintained by extrinsic and intrinsic ligaments.[4] Frequently, carpal bone fractures have been misdiagnosed on radiographs which can lead to complications resulting in malunion, non-union, avascular necrosis, carpal instability and traumatic arthritis. Current study showed concurrent carpal bone fractures in 28.4% of distal radius fractures that have been surgically treated with majority of cases diagnosed on CT.

CT should be considered if clinically warranted, because 30% of wrist fractures are not detected on plain radiographs as suggested by Welling et al.[5] Compared to scaphoid, other carpal bone fractures have lower sensitivity of detection on plain radiographs. The frequency of carpal bone fractures of all hand injuries ranges from 8% to 19%.70% of all carpal bone fractures involve the scaphoid and the remaining carpal bones account for about 30%. Fractures of the triquetrum and lunate was higher than scaphoid in the current study and proximal row carpal bones were commonly fractured in 89.4% cases.

Majority of triquetral fractures occur onthe dorsal surface and lesscommonly involve the body of the triquetrum.[6] Impingement from the ulnar styloid, shear forces, or avulsion from strong ligamentousattachments are the factors that cause fractures of dorsal surface of thetriquetrum. The body fracturestypically in atransverse pattern. Lunate injuries are commonlyassociated with a fall on an outstretchedwrist, with compression force also involved. The position of the carpus atimpact determines the specific type of injury. Perilunate dislocations are associated with avulsion injuries of the volar pole of thelunate or the proximal radial corner ofthe triquetrum.[7] Hamate is reported to be the only injured bone in the distal carpal row. These injuries typicallyheal or become asymptomatic with castimmobilization. Displaced intraarticularfractures of the hamate may involve thefourth or fifth carpometacarpal joints, requiringopen reduction and fixation withKirschner wires. Pisiform fractures often occur in the setting of direct blow to the wristwith resulting vertical or transverse fracture(linear or comminuted) or a compressioninjury. Scaphoid is the most frequent site of carpal fracture and intercarpal ligamentinjury.[8] Scaphoid bone fractures with simultaneous distal radius fractures accounting for 0.75-6.5% has been reported in many studies.

Stable internal fixation of scaphoid and distal radius fractures is performed for early mobilization of the wrist joint to avoid complications like scaphoid nonunion.The complication rate of distal radius fractures varied between 6-80%. Carrigan andPretell-Mazzini reported concurrentdistal radius fractures with carpal bone injuries in children. Emphasis was laid on ruling out carpal bone fractures because of the similar mechanism of injury for both fractures.(9)Type C2 and C3 injuries were a result of high velocity trauma and should be carefully assessed with high suspicion as approximately one-third of them have associated carpal bone fractures. CT is warranted to assess fracture comminution, displacement and complex intraarticular extension.CT evaluation of radiocarpalarticular step-off and gap displacement-factors is crucial in predicting thedevelopment of radiocarpal osteoarthritis.[9]

Kiuru et al recommended the need for CT when findings on plain radiographs are equivocal and also to assess complex wrist fractures, because only plain radiographs may miss occult fractures, which usually occur in small carpal bones.[10] In the current study, only 14 of 66 distal radius fractures with simultaneous carpal bone fractures were detected on plain radiographs and the rest on CT scans.

All carpal bone fractures were conservatively managed except for the 6 waist fractures of scaphoid. Immobilization of all distal radius fractures using a locking plate was done for 4 weeks. Closed reduction and castor percutaneous pin immobilization were sufficient for treatment; Intraarticular fragments wound require open reduction and internal fixation.[11] CT may imply avulsion fractures with ligament

damage or instability of the wrist joint.

Current study focused on the frequency, distribution and characterization of concurrentcarpal bone fractures with distal radius fractures. Limitation of this study was, distal radius fractures with simultaneous carpal bone fractures were surgically treated with various methods such as volar plate fixation (39 distal radius fractures), dorsal plate fixation (eight distal radius fractures), external fixation (eleven distal radius fractures), and percutaneous K-wire fixation (eight distal radius fractures). They did not have much significance to evaluate the clinical outcomes because these fractures were not treated by one surgical method with the same postoperative protocol.

**Table 1: Number of carpal bones fractured**

| Number of carpal bones involved | Number of fractures (%) |
|---|---|
| One | 50 (75.7%) |
| Two | 10 (15.1%) |
| Three | 4 (6.0%) |
| Four | 2 (3.0%) |

**Table 2: Involvement of proximal and distal row of carpal bones**

| Row of carpal bones | Frequency (%) |
|---|---|
| Proximal | 59 (89.4%) |
| Distal | 7 (10.6%) |

**Table 3: Mechanism of injury in distal radius and carpal bone fractures**

| Mechanism of injury | Frequency of distal radius fractures |
|---|---|
| Low energy injury | 160 |
| High energy injury | 150 |
| | Frequency of carpal bone fractures |
| Low energy injury | 45 |
| High energy injury | 21 |

**Table 4: Carpal bone involvement with Arbeitsgemeinschaftfür osteosyntheses type of fracture**

| Characteristic | Carpal bone fracture (-) | Carpal bone fracture (+) | Total |
|---|---|---|---|
| Number of patients | 194 | 66 | 260 |
| Age (yr), Mean (Range) | 44 (16-72) | 41.5 (18-65) | 44 (16-72) |
| Sex (Male : Female) | 78 : 116 | 30 : 36 | 102 : 158 |
| Injury causes | | | |
| Slip down | 120 | 45 | 165 |
| Fall down | 30 | 15 | 45 |
| Road traffic accident | 44 | 6 | 50 |
| Fracture type (AO) | | | |
| A1 | 0 | 0 | 0 |
| A2 | 4 | 0 | 4 |
| A3 | 48 | 4 (7.7%) | 52 |
| B1 | 13 | 4 (23.5%) | 17 |
| B2 | 0 | 0 | 0 |
| B3 | 15 | 1 (6.2%) | 16 |
| C1 | 14 | 1 (6.6%) | 15 |
| C2 | 62 | 24 (27.9%) | 86 |
| C3 | 46 | 24 (34.2%) | 70 |

(A0 - Arbeitsgemeinschaftfürosteosyntheses)

**Table 5: Frequency of fractures of each carpal bone that complicated 260 distal radius fractures**

| Carpal Bone | Number of fractures (%) | Subtype | Number of fractures |
|---|---|---|---|
| Scaphoid | 14 (5.4) | Palmar tubercle | 2 |
| | | Around waist | 6 |
| | | Distal pole | 6 |
| Lunate | 18 (6.9) | Type 1 – Palmar pole | 6 |
| | | Type 2 – Osteochondral grip | 2 |
| | | Type 3 – Dorsal pole | 10 |
| | | Type 4 – Sagittal oblique body | 0 |
| | | Type 5 – Transverse body | 0 |
| | | Type 6 – Comminuted | 0 |
| Triquetrum | 30 (11.5) | Type 1 – Dorsal cortex | 15 |
| | | Type 2 - Body | 12 |
| | | Type 3 – Palmar cortex | 3 |
| Pisiform | 5 (1.9) | Type 1 - Transverse | 0 |
| | | Type 2 - Sagittal | 4 |
| | | Type 3 - Comminuted | 1 |
| | | Type 4 – Pisotriquetral impaction | 0 |
| Trapezium | 0 | | |
| Trapezoid | 0 | | |
| Capitate | 0 | | |
| Hamate | 7 (2.7) | Type 1 – Hook | 5 |
| | | Type 2 – Body including dorsal cortex | 2 |

**Conclusion:**

Concurrent fractures of distal radius and carpal bones are common and complex entities. A thorough understanding of fracture dynamics and treatment options would be necessary for complete evaluation of the wrist joint. Carpal bone fractures are frequently associated with distal radius fractures due to similar mechanism of injury such as fall on an outstretched hand with an extended wrist. We conclude that fractures of proximal row of carpal bones are frequently associated with distal radius fractures. If undetected on plain radiographs, CT must be warranted as misdiagnosed or untreated fractures of carpal bones may result in complications affecting the final outcome. If distal radius fractures associated with carpal bone fractures are conservatively managed, then no additional intervention is required for carpal bones, except in scaphoid fractures due to risk of infarction. However, if distal radius fractures associated with carpal bone fractures are surgically managed and early immobilization is planned, then misdiagnosed or untreated fractures of carpal bones may result in complications.

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