

# Presence of an Associated, Untreated Ulnar Styloid Fracture, Adversely Affect the Outcome in Distal Radius Fracture: A Paradigm Worth Pondering

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## Abstract

**Background:** Yet the unresolved question of the relationship between concomitant ulnar styloid fracture and the final outcome of distal radius fracture needs further evaluation.

**Methods:** This study was carried out for 4672 patients of fracture distal radius, recruited in an ongoing longitudinal study to evaluate the radiological and functional outcomes treated by one surgeon at Government Hospital institute between 1986 to 2011. The right wrist was injured in 2986 (63.9%). There were 3236 (69.3%) men and 1436 (30.7%) women, with a mean age of 59 years (range 8 to 98 years). In intact styloid group, 1948 (72.8 %) were men and 726 (27.2%) women, in fractured styloid group 1386 (69.4%) were men & 612 (30.6%) women.

**Results:** 2674 (57.2%) patients had intact ulnar styloid and 1998 (42.8%) distal radius fracture with concomitant ulnar styloid fracture. This was again divided into two groups: 1426 (71.4%) had an ulnar styloid base fracture and 572 (28.6%) belong to the ulnar styloid tip fracture group.

224 (8.4%) patients with intact styloid and 346 (17.3%) with ulnar styloid fracture presented with ulnar side wrist pain. 264 (9.9%) had acute or chronic distal radioulnar joint instability with intact styloid, as compared to 746 (37.3%) with ulnar styloid fracture group. The mean volar tilt was 11.90 (60 to 180) in the intact styloid and 12.60 (70 to 190) in the fracture styloid group. The respective values for the base and tip group were 11.60 (50 to 170), 12.40 (60 to 180) at final follow-up. The mean ulnar variance was observed - 0.4 to 0.6 in the intact styloid group and 0.2 to 0.4 in the fracture styloid group at the final follow-up ( $p < 0.0001$ ). The grip strength was 92.2% in the intact styloid group and 82.4% in the fracture ulnar styloid group. The hand performance was rated as excellent in 1020 (38.1%), good 1318 (49.3%), fair 204 (7.6%), poor 132 (4.9%) in intact styloid group as compared to fracture ulnar styloid group, excellent 582 (29.1%), good 684 (34.2%), fair 513 (25.7%) and poor in 219 (10.9%).

**Conclusion:** This large sample series report concludes a very distinctly unsatisfactory final outcome uniformly, in fracture ulnar styloid group of distal radius fractures, even in spite of adequate treatment by five different modalities of treatment, which were compared very rigorously. The great influence of ulnar styloid fracture in distal radius fracture is once again well established and this study reinforced categorically the previously published articles by the same author in the past.

**Keywords:** Distal radius fracture; Ulnar styloid fracture outcome; Ulnar wrist pain; Distal radioulnar joint instability.

## Introduction

Every sixth admission being distal radius fracture is one of the most common injuries seen in orthopaedic casualty room at Sindhudurg District Hospital [1]. Various factors affecting the final outcome of distal radius fractures are visualized in many published articles [2, 3]. Out of this, one factor being concomitant ulnar styloid fracture and its clinical significance in association with

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distal radius fracture is not clear with controversial opinions on data in the literature [4,5].

Nearly half a century ago, Frykman thought of the importance of fractured ulnar styloid and state "Less satisfactory anatomical end results are obtained, regardless of nature of distal radius fracture, where there is also a fracture of the distal ulna" [6].

A number of studies have suggested that a strong relationship exists between ulnar styloid fracture and final outcome of distal radius fracture [7, 8, 9]. In contrast, many have reported no correlation between ulnar styloid fracture and final outcome [10, 11, 12]. Thus, yet the unresolved question of the relationship between concomitant ulnar styloid fracture and the final outcome of distal radius fracture needs further evaluation. The present authors have already reported twice, way back in 2005 and 2007 regarding the predictive value of ulnar styloid fracture in distal radius fracture and its poor outcome [13]. Once again in this prospective review of a very large series of distal radius fracture, an ongoing study by the authors since 1986 to 2011 treated by both conservative and operative methods, it is reattempted to determine and highlight the importance of a relationship with associated ulnar styloid fracture affecting on final outcome [14].

### Patients and Methods

This exclusively devoted prospective study of distal radius fracture has been started at Government Hospital Devgad, Kudal, Oros by the author from 1986 to 2011. Separate stringent protocols were prepared and attached to each indoor case paper of fracture distal radius patient [15]. This was mainly being done to know about the usefulness and comparison of various fracture geometry, investigation modalities, different methods of treatments, with appropriate evaluation, final outcomes, complications and highlight salient

**Table 1: Classification of distal radius fractures**

Frykman Classification,							
I	II	III	IV	V	VI	VII	VIII
615	462	702	508	664	504	693	524
-13.20%	-9.90%	-15.00%	-10.90%	-14.20%	-10.80%	-14.80%	-11.20%

**Table 2: Treatment method wise distribution of distal radius fractures (n=4672)**

		Below elbow cast	Above elbow cast in supination	Pins & plaster	External fixation	Open reduction & internal fixation
Ulnar styloid fracture group	Fracture base styloid	282(19.8%)	296(20.8%)	288(20.0%)	258(18.1%)	302(21.2%)
	Fracture tip Styloid	128(22.4%)	106(18.5%)	98(17.1%)	116(20.3%)	124(21.7%)
Intact styloid group		532(19.9%)	506(18.9%)	548(20.5%)	560(20.9%)	528(19.7%)

characteristics of long term follow up studies [16].

This study was carried out for 4672 patients of fracture distal radius, recruited in an ongoing longitudinal study to evaluate the outcomes treated by one surgeon at Government Hospital institute Devgad, Kudal, Oros, Sindhudurg between 1986 to 2011, are included in this report. Govt. hospital Devgad, Kudal (1986 to 1999) and District hospital, Oros (2000 to 2011) Sindhudurg were the only public hospitals in the whole of the district, wherein conservative and surgical intervention procedures for distal radius fracture patients were performed free of cost at this facility with full-time orthopaedic surgeon services.

All patients were reviewed at a mean follow up of 56 (range from 28 months to 136 months) months, in the outpatient Orthopaedic department of Govt. hospital. The patients were called upon for examination accordingly by sending postcards and telephonic messages.

Bilateral fracture distal radius, upper arm injuries, compound fractures, were excluded from this study group. Frykman classification system has been adopted which was found to be quite comprehensive and well suited for this study purpose.

The right wrist was injured in 3254 (69.6%). There were 3236(69.3%) men

and 1436(30.7%) women, with a mean age of 59 years (range 8 to 98 years). In intact styloid group, 1948(72.8%) were men and 726(27.2%) women, in fractured styloid group 1386(69.4%) were men and 612(30.6%) women.

At final follow up visit, the deformity was assessed by radiographs with measuring the volar tilt angle, radial inclination and degree of ulnar variance as described by Goldfarb with the modified technique of Steyer's & Blair [17]. All these radiological parameters were measured by the senior technician in the radiology department with no knowledge of patients regarding anatomical and functional results. A senior doctor from radiology independently double-checked the radiological parameters.

The range of movements of wrist and forearm with ulnar wrist pain, grip strength along with disability of arm, shoulder and hand outcome score with activities of daily living were recorded. The DASH questionnaire (30 items measuring disability and symptoms related to upper extremity) is scored from 0 to 100, with a higher score indicating higher disability [18].

942 (20.2%) patients were treated with a below-elbow cast with the forearm in pronation, and wrist in palmar flexion, ulnar deviation [19], 908 (19.4%) with above elbow cast with the forearm in supination, and wrist in palmar flexion

and ulnar deviation with a change of cast at the end of two weeks to below elbow with the forearm in supination and wrist in a neutral position, 934 (20.0%) with pins & plaster, 934 (20.0%) with an external fixator [20] and 954 (20.4%) with open reduction internal fixation with volar plating. No surgical intervention was done for ulnar styloid fracture.

The indications for surgical intervention were, dorsal angulation >150, radial inclination angle >200, ulnar variance contralateral >2mm, compared with another side, intraarticular step off >2 mm, with an ulnar styloid fracture.

The patients also completed a health status questionnaire at the final follow up clinical examination at the hospital. This questionnaire has eighteen items, produces functional daily living activities component score, each normalized to mean of 50 standard deviations of 10 compared to the rural Indian population, with a higher score indicating better quality of life [21].

### Results

2674(57.2%) patients had intact ulnar styloid and 1998(42.8%) distal radius fracture with a concomitant ulnar styloid fracture. This was again divided into two groups: 1426(71.4%) had an ulnar styloid base fracture and 572(28.6%) belong to the ulnar styloid tip fracture group.

In ulnar styloid base fracture group, the gap distance at fracture site was >2mm in 944(66.2%) and <2mm 482(24.1%), whereas tip group >2mm 346(60.5%) <2mm in 226(39.5%). There was no significant difference in age between groups (Chi-square test).

The ulnar wrist pain improved gradually with time. At final follow up, 224(8.4%) patients with intact styloid and 346(17.3%) with ulnar styloid fracture presented with ulnar side wrist pain. There was a statistically significant difference between the two graphs ( $p < 0.05$ ).

**Table 3: Ulnar wrist pain during follow up in intact and fracture ulnar Styloid groups as per five treatment modalities (n=4672)**

	Method of treatment	Ulnar wrist pain		
		At 3 Month	At 6 Month	At 12 Month
Intact Ulnar Styloid	Below elbow cast	42(7.9%)	39(7.3%)	48(9.0%)
	Above elbow cast	26(5.1%)	24(4.7%)	31(6.1%)
	Pins and plaster	46(8.4%)	43(7.8%)	51(9.3%)
	Ext. fixation	44(7.9%)	40 (7.1%)	49(8.6%)
	Open reduction and internal fixation	40(7.6%)	36(6.8%)	45(8.5%)
Fracture Ulnar Styloid	Below elbow cast	79(19.3%)	76(18.5%)	86(20.9%)
	Above elbow cast	46(11.4%)	42(10.4%)	48(11.9%)
	Pins and plaster	72(18.7%)	68(17.6%)	76(19.7%)
	Ext. fixation	62(16.6%)	58(15.5%)	64(17.1%)
	Open reduction and internal fixation	68(15.9%)	64(15.0%)	72(16.9%)

**Table 4: Ulnar wrist pain during follow up in ulnar styloid fracture base and tip groups compared with five treatment modalities (n=1998)**

	Treatment Method	Ulnar wrist Pain		
		At 3 months	At 6 months	At 12 months
Ulnar Styloid fracture base group	Below elbow cast	52(18.4%)	49(17.4%)	59(20.9%)
	Above elbow cast	40(13.5%)	38(12.8%)	36(12.2%)
	Pins and Plaster	49(17.0%)	48(16.7%)	55(19.1%)
	Ext. fixation	44(17.1%)	41(15.9%)	48(18.6%)
	Open reduction and internal fixation	54(17.9%)	49(16.2%)	62(20.5%)
Ulnar Styloid fracture tip group	Below elbow cast	18(14.1%)	14(10.9%)	18(14.1%)
	Above elbow cast	12(11.3%)	11(10.4%)	11(10.4%)
	Pins and plaster	17(17.3%)	17(17.3%)	22(22.4%)
	Ext. fixation	15(12.9%)	14(12.1%)	14(12.1%)
	Open reduction & internal fixation	16(12.9%)	16(12.9%)	21(16.9%)

There was a significant relationship between ulnar wrist pain and non-union of ulnar styloid fracture, 742(52.1%) base groups and 334(58.4%) ulnar styloid tip fractures united radiologically with bridging trabeculae at the fracture site.

Incidence of non-union of ulnar styloid both tip and base was lowest in patients treated conservatively with above elbow full cast with a forearm in supination as compared with the other four methods of

treatment modalities.

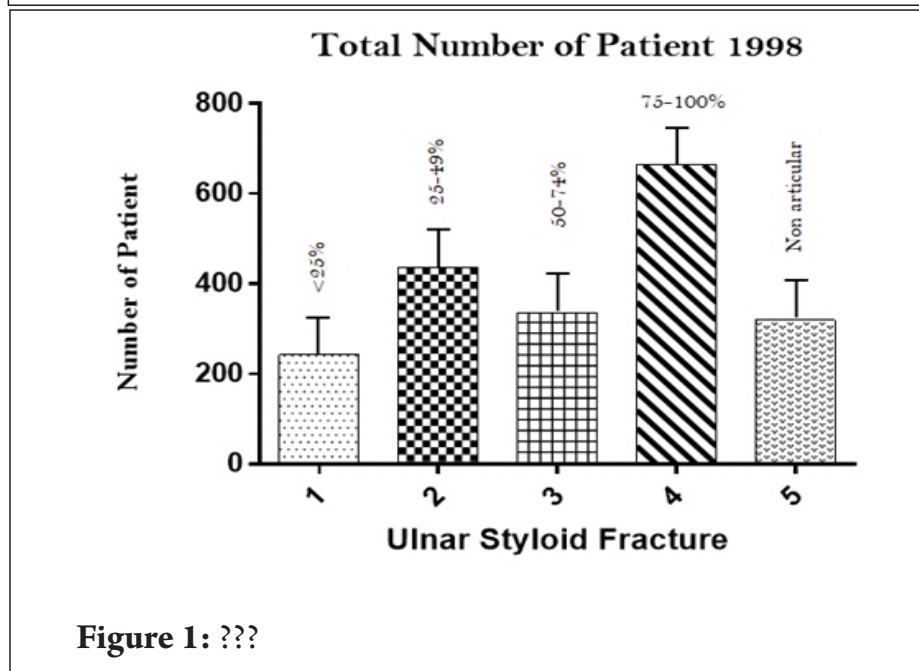
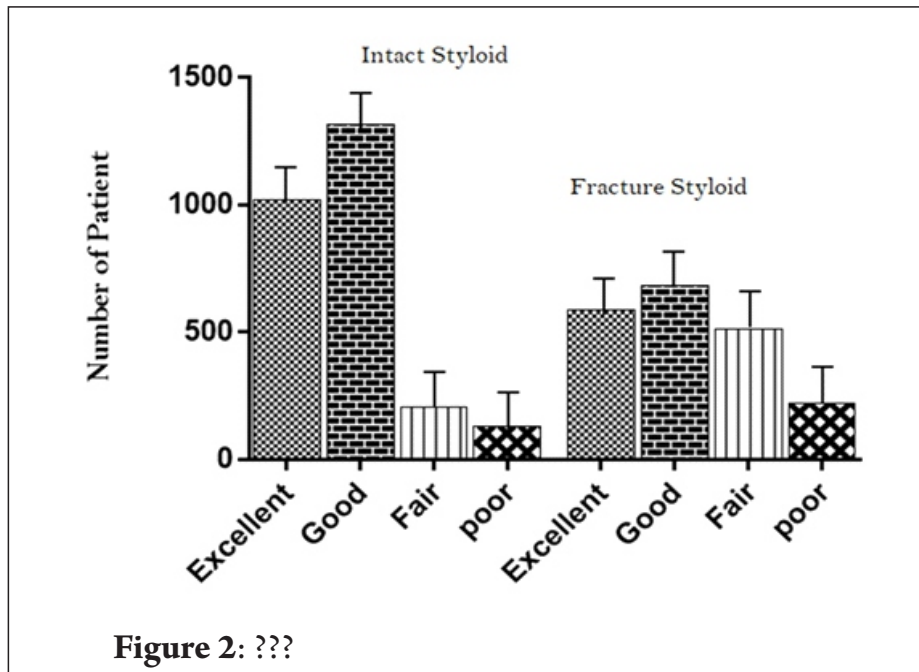
Of 1998 ulnar styloid fractures, 242(12.1%) involved less than 25% of intact styloid, 437(21.9%) involved 25% to 49% of intact styloid, 336(16.8%) involved 50% to 74% of intact styloid, 664(33.2%) involved 75% to 100% of intact styloid and 319(15.9%) involved non articular component of ulnar head in continuity with ulnar styloid. These findings represent a non-random distribution ( $p < 0.0001$ ).

Table 5: Ulnar wrist pain					
	Group	Ulnar Wrist Pain			
		Treatment method	At 3 Months	At 6 Months	At 12 Months
United ulnar styloid fracture	Base fracture	Below elbow cast	26(17.8%)	24(16.4%)	36(24.7%)
		Above elbow cast	19(10.4%)	18(9.9%)	21(11.5%)
		Pins & plaster	14(10.1%)	13(9.4%)	24(17.4%)
		Ext. fixation	20(14.1%)	18(12.7%)	29(20.4%)
		Open reduction & internal fixation	19(14.2%)	18(13.4%)	29(21.6%)
	Tip fracture	Below elbow cast	8(14.8%)	7(12.9%)	11(20.4%)
		Above elbow cast	10(10.2%)	10(10.2%)	8(8.1%)
		Pins & plaster	10(16.1%)	9(14.5%)	13(20.9%)
		Ext. fixation	9(13.2%)	8(11.8%)	12(17.6%)
		Open reduction & internal fixation	8(15.4%)	8(15.4%)	13(25.0%)
Nonunion ulnar styloid fracture	Base fracture	Below elbow cast	13(20.3%)	12(18.8%)	16(25.0%)
		Above elbow cast	1(5.5%)	2(11.1%)	2(11.1%)
		Pins & plaster	12(19.7%)	11(18.0%)	11(18.0%)
		Ext. fixation	9(18.8%)	8(16.6%)	8(16.6%)
		Open reduction & internal fixation	7(14.9%)	7(14.9%)	9(19.1%)
	Tip fracture	Below elbow cast	26(17.7%)	25(17.0%)	35(23.8%)
		Above elbow cast	11(11.5%)	11(11.5%)	12(12.5%)
		Pins & plaster	38(22.9%)	25(15.1%)	25(15.1%)
		Ext. fixation	22(17.3%)	28(22.1%)	34(26.8%)
		Open reduction and internal fixation	24(16.2%)	22(14.9%)	21(14.2%)

264 (9.9%) had acute or chronic distal radioulnar joint instability with intact styloid, as compared to 746(37.3%) with ulnar styloid fracture group. Both the size of ulnar styloid fracture and its displacement were statistically significant risk factors in the development of distal radioulnar joint instability. (Odds ratio 4.6, p > 0.005). Statistical analysis indicated distal radius fracture with a concomitant ulnar styloid fracture are more complicated by distal radioulnar joint instability than those with an intact ulnar styloid group (odds ratio 2.95, p < 0.001). Ulnar styloid fracture base group is associated with a greater incidence of distal radioulnar joint instability than ulnar styloid tip group. (Odds ratio 3.4, p = 0.06). Ulnar styloid fracture with gap distance at fracture site > 2 mm is associated more with distal radioulnar joint instability than in < 2 mm displacement ulnar styloid group (odds ratio 7.6, p = 0.006). Frykman type III & IV group involving radiocarpal joint did not generate a statistically significant difference in radioulnar joint instability (p > 0.3) as compared to Frykman type V & VI involving distal radioulnar joint and type VII & VIII involving both radiocarpal and distal radioulnar joints (p > 0.002). The relationship between radiological parameters and disability, multiple linear regression analysis with daily living activities score, as a dependent continuous, variable, adjusting for age, sex and Frykman type of the radiographic variables, volar tilt and ulnar variance were found to be statistically significant on daily living activities score. Whereas radial inclination was not statistically significant (average change per unit – 0.312, 95% CI – 0.84 – 0.52, p = 0.462). The two significant radiological parameters were further analysed as dichotomized categorical variables (volar tilt ≤ 100 or > 100 and ulnar variance ≤ 0 or ≥ 1mm). Results were expressed as means. Differences were evaluated using Mann Whitney test for

Table 6: Union of ulnar styloid fracture treatment method wise					
Fracture type	Below elbow cast	Above elbow cast	Pins & plaster	External fixation	Open reduction & internal fixation
United fracture base group	146(19.7%)	182(24.5%)	138(18.6%)	142(19.1%)	134(18.1%)
United fracture tip group	54(16.2%)	98(29.3%)	62(18.6%)	68(20.4%)	52(15.6%)

Table 7: Nonunion of ulnar styloid fracture					
Fracture type	Below elbow cast	Above elbow cast	Pins & plaster	External fixation	Open reduction & internal fixation
Nonunion fracture base group	147(21.5%)	96(14.0%)	166(24.3%)	127(18.6%)	148(21.6%)
Nonunion fracture tip group	64(26.9%)	18(7.6%)	61(25.6%)	48(20.2%)	47(19.7%)



age, duration of follow up, grip strength movements. A p-value of 0.05 was considered significant. It was assessed for reliability with intra-class correlation coefficient & its 95% confidence interval for volar tilt, it was 0.88(0.86 to 0.89), for ulnar variance 0.92(0.92 to 0.94) indicating high reliability. The mean volar tilt was 11.90(60 to 180) in intact styloid and 12.60(70 to 190) in fracture styloid group. The respective values for base and tip group were 11.60(50 to 170), 12.40(60 to 180) at final follow up. The mean ulnar variance,

the loss of correlation occurred at final follow up, the change being - 0.4 to 0.6 in an intact styloid group and 0.2 to 0.4 in fracture styloid group, 0.2 to 0.9 in a base group and -0.3 to 1.2 in tip group. The reliability was assessed with intra-class correlation coefficient and its 95% confidence interval for volar tilt, it was 0.88 (0.86 to 0.89), for ulnar variance 0.92 (0.90 to 0.94) indicating high reliability (p < 0.05). At the final follow up, the grip strength was 92.2% in intact styloid group and 82.4% in the fracture ulna group. 79.1%

in the base group and 83.1% in tip fracture group which were statistically highly significant. (Mann Whitney U Test, p > 0.004).

A significantly greater loss of wrist movements was seen in styloid fracture group than intact styloid 94.2% (p > 0.0001) (values are given in percentage of expected normal of the uninjured wrist).

The hand performance was rated as excellent in 1020(38.1%) good 1318(49.3%), fair 204(7.6%), poor 132(4.9%) in an intact styloid group as compared to fracture ulnar styloid group, excellent 582(29.1%), good 684(34.2%), fair 513(25.7%) and poor in 219(10.9%).

**Discussion**

The association of ulnar styloid fracture with distal radius fracture is reported in the literature between 50 to 65 % [22]. In this large series of the study, the rate of this fracture is 42.8%. Similarly, the association of ulnar styloid fracture with distal radius fracture in previously published reports by the same author from the same institute was 46.2% [23]. The ulnar styloid plays a crucial role in wrist biomechanics [24]. The palmar and dorsal radioulnar ligaments are inserted in the fovea of ulnar styloid, thus stabilising the distal radioulnar joint. In addition, this acts as a strut to stabilise extensor carpi ulnaris and ulnocarpal ligaments. Due to this anatomical importance, the potential exists for ulnar wrist pain in ulnar styloid fractures [25]. In the middle of the last century, the literature with many reports suggests the concomitant ulnar styloid fracture did not affect the final outcome [26, 27, 28]. Numerous subsequent studies did not find any correlation between ulnar styloid fracture and outcome in distal radius fracture, support these conclusions [29, 30]. In these above-cited reports, all patients were treated by only one modality of treatment.

In this present study, the association of

styloid fracture is very distinctly reported with unacceptable outcome categorically in all five large series of different types of treatment modalities. This also strongly suggests and proves the association of ulnar wrist pain with ulnar styloid fracture, both tip and base group. This ulnar wrist pain is also documented very distinctly in non-union ulnar styloid than in united fracture ulnar styloid in both tip and base group which coincide with the reports of other investigators in the literature [31]. Similar findings were also noted in the previous study, published by the present author in the past, reconfirming again that presence of ulnar styloid fracture was found to be a significant independent predictor of distal radius fracture outcome [32]. The possible speculations for sources of ulnar wrist pain with distal radius fracture in this series are ulnar styloid base or tip fracture, displaced or undisplaced, with triangular fibrocartilage complex injury, irritation from a non-union fragment of extensor carpi ulnaris tendon sheath and distal radioulnar joint instability which are in concurrence with the published literature [33]. Thus, imaging in the form of MRI can help to identify soft tissue changes following trauma, as the cause of ulnar sided wrist pain [34]. Spence et al. have reported on MRI scan that soft tissue injuries are documented with an ulnar styloid fracture in 47.6% cases [35]. In this study, ulnar styloid fractures were not treated by surgical intervention. There are studies in the literature, with open reduction and fixation of ulnar styloid does not affect the final outcome [36].

Shaw et al., however, reported, based on the biomechanical study, primary repair of ulnar styloid fracture as a means of stabilising the distal radioulnar joint. But they have not commented on final outcome [37]. Kazemian et al. in their report, all patients treated by locking plates found, no adverse effect on final outcome of distal radius fracture. Here only minimally displaced ulnar styloid

fractures are considered [38]. Downing demonstrated that there was no significant difference in wrist function, with a concomitant ulnar styloid fracture in distal radius fracture [39]. No mention has been made in this report as regards the radiological and other clinical parameters. Ekenstam et al., who reported again, no difference in outcome for fracture ulnar styloid associated with distal radius fracture. This study has only considered extra-articular fractures of the distal radius [40].

A number of authors have emphasized the positive correlation between ulnar styloid fracture and distal radioulnar joint instability [41]. Hauck et al. in their report noted the instability of distal radioulnar joint much more so in fracture base of ulnar styloid which includes the insertion of radioulnar ligaments than the ulnar styloid tip fracture group. They recommended open reduction and internal fixation of ulnar styloid base fractures including non-unions and not tip fracture group. But they did not compare the outcome results with untreated ulnar styloid fracture group [42]. Stoffelen et al. prospectively evaluated and concluded that ulnar styloid fracture correlates statistically with poor outcomes. They also pointed out from their series; all patients with distal radioulnar joint instability had concomitant ulnar styloid fractures [43]. Kaukaen reported ulnar styloid fractures contributed poor results in distal radius fractures treated operatively [44]. Similarly, Oskarsson et al. evaluated concomitant ulnar styloid fracture was a more important predictor of functional outcome [45]. Nakamura et al. reported, fracture ulnar styloid leads to instability of the distal radioulnar joint and treated their cases with fixation of ulnar styloid and repair of triangular fibrocartilage complex [46]. This finding is consistent with this current study, that acute or chronic distal radioulnar joint instability was seen more frequently in the ulnar styloid fracture group than in intact

styloid. Similar findings and conclusions were noted in the previously published study by the same author regarding the instability of distal radioulnar joint with associated ulnar styloid fracture further demonstrating the importance of ulnar styloid in stabilizing the distal radioulnar joint. It is also noteworthy to observe that instability of distal radioulnar joint was seen more frequently in ulnar styloid base fracture than tip fracture group and in nonunion of ulnar styloid than in united concomitant fracture ulnar styloid group. The above-cited all these published reports from the literature, conclusions are based on only one method of treatment modality.

The superiority of this present large series being, treated by five different modalities of treatments, both operative and non-operative with stringent comparison protocols concluded that the presence of ulnar styloid fracture was found to be a significant independent predictor of final outcome.

The limitation of this study being, there was no control group, wherein ulnar styloid fracture was treated surgically. In this investigation report, data was not collected beyond 56 (range from 28 months to 136 months) months after treatment. It is possible that after this period, significant clinical and radiological changes would have occurred if patients were followed for a further long-term period [47]. However, the clinical and radiological parameters approached normal range and appeared relatively stable by this period, suggesting further significant changes are unlikely [48]. Another lacuna being about unawareness of soft tissue injury as CT scan and MRI investigations were not performed in this study [49].

The major strength of this report is a single institutional prospective study being a very large series of cases, treated by five different, treatment modalities and compared and concluded by one surgeon. To the best of our knowledge with a thorough search from the

literature, no clinical studies of which we are aware, that this is the only prospective large scale study that compares the final outcome of distal radius fractures with intact and concomitant ulnar styloid fracture treated by five different modalities of treatments with stringent comparison protocols for achieving a meaningful outcome result by one surgeon.

### Conclusion

Incidence of non-union of ulnar styloid both tip and base was lowest in patients treated conservatively with above elbow full cast with a forearm in supination as compared with the other four methods of treatment modalities.

This large sample series report concludes very distinctly unsatisfactory final outcome of distal radius fracture associated with ulnar styloid fracture uniformly, even in spite of adequate

treatment by five different modalities of treatment, which were compared very rigorously. Thus, the presence of ulnar styloid fracture serves as a marker for more severe osseous and soft tissue injuries and predicts inadequate radiographic and clinical outcome. The great influence of ulnar styloid fracture in distal radius fracture is once again well established and this study reinforced categorically the previously published articles by the same author in the past.

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