

## Manipulating Dorsally Displaced Distal Radius Fractures in the Emergency Department. What are the Variables and Results?

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### Abstract

**Introduction:** We are seeing increasing numbers of wrist fractures as the population ages, and pressure is being felt in orthopaedic and emergency departments.

**Method:** 2 independent observers retrospectively measured radial tilt, volar/dorsal tilt and radial height at presentation, after manipulation and on final radiographs over a 6-month period. Our primary outcome was quality of reduction based on operator grade and specialty. Our secondary outcome was the effect of block technique used.

**Results:** Out of 210 fractures, 63 required manipulation. The quality of reduction was expressed as the divergence from a) 22° radial tilt, b) 11° volar tilt and c) 11mm radial height. There was no clinically relevant difference in the quality of reduction produced by emergency and orthopaedic personnel. No statistically significant difference was found between Bier's and haematoma blocks either.

The initial manipulation produced the single greatest improvement in reduction for both surgically and non-surgically managed patients. This was the definitive treatment in 32 (51%) patients.

**Conclusion:** Most wrist fractures can be manipulated safely within the emergency department, regardless of the manipulator's specialty or the type of block used.

**Keywords:** X-Ray, Treatment; Trauma Extremity; Musculoskeletal Fractures and Dislocations; Hand Injury

### Introduction

Wrist fractures are the commonest orthopaedic injury and we are seeing a lot more of them as a result of an ageing population [1]. Pressure is being felt in accident and emergency departments (ED) as well as orthopaedic trauma units across the country [2-5] and this is blurring the delineation of roles in the management of this injury [6].

Wrist fractures come in many different configurations and the dorsally displaced distal radial variant, of which the "Colles' fracture" is an example, is by far the commonest in adults [7,8]. The latter tends to result from low energy trauma and there is often an associated ulnar fracture, typically involving the styloid process [9]. Volarly displaced fractures, such as those described by Barton and by Smith, tend

to involve a more severe mechanism of injury [10,11]. Dorsally displaced distal radius fractures can usually be safely manipulated in a safer and more comfortable position at presentation [12]. This can be done under different types of anaesthesia ranging from local, through conscious sedation to general [13]. The most popular methods are the haematoma block and Bier’s block. Some people advocate delaying the initial manipulation to a fracture clinic for a senior orthopaedic doctor to undertake it. The increasing popularity of Bier’s blocks in ED for the manipulations may be an additional factor adding to the time and resource pressures felt. We wanted to know if the grade or specialty of the manipulating clinician made a difference to the quality of the overall reduction and also, if the type of block used did.

**Method**

We retrospectively analysed all dorsally displaced fractures of the distal radius, which underwent manipulation at our hospital ED from September 2013 to February 2014. We gathered data from the radiological and clinical letter databases of our hospital. We excluded open fractures, volar-angulated ones and those that did not require any manipulation. All manipulations were undertaken using a haematoma or Bier’s block.

A haematoma block involved injecting a small volume of short acting local anaesthetic such as Lidocaine, in an aseptic fashion, directly into the fracture site via a dorsal approach. A Bier’s block involves an intravenous injection of a very short acting local anaesthetic such as Prilocaine into a distal vein with a double cuff tourniquet preventing systemic distribution, thereby producing regional anaesthesia to the whole forearm. It usually requires monitoring and the presence of 2 doctors who are able to deal with the consequences of local anaesthetic toxicity [14].

Two independent observers (AD and DB) measured the following parameters of displacement at initial presentation, after initial manipulation and at final radiological review: radial tilt, volar/dorsal tilt, and radial height. A standard method of angle and length measurement was agreed between the observers and senior author. An inter- and intra-observer variability assessment was conducted. The quality of reduction was expressed in terms of the divergence of the absolute values either way from pre-agreed normal values set at 22° radial tilt, 11° volar tilt and 11 mm radial height [5,15-17]. This value was always expressed as a positive to prevent any overcorrection being misinterpreted as a very good one. The greater the value therefore, the greater the divergence from “normal” and hence the poorer the reduction.

Our primary outcome measure was the improvement in parameters of displacement from the initial manipulation. Statistical analysis was undertaken using GraphPad Prism (Version 5.0b, GraphPad software Inc.). Shapiro-Wilk normality test showed data was not normally distributed therefore nonparametric statistical test were used. Mann Whitney U test was used for two-variable comparison and Kruskal-Wallis one-way analysis for variance was used for multi-group comparison. 2x2 categorical contingency table analysis was done using Fisher’s exact test. Pearson’s coefficient for inter-observer variability was based on measurements from all 63 patients, whereas a subset of repeated values for 5 patients (45 measurements) was used for each observer’s intra-observer variability.

**Results**

210 distal radius fractures were seen in ED, of which 63 (13 male: 50 female) were manipulated. The mean age was 56.7 [SD 21.2] and most fractures resulted from a simple fall. 22 fractures (35%) were intra-articular. There were 52 (83%) distal ulnar fractures associated with the radial injury. No complications related to manipulation or block technique used were recorded.

The average time from initial diagnosis to first check radiograph was 154 minutes [SD 86], with ED staff at 125 minutes, compared with 166 minutes for orthopaedic staff. The average time from initial ED attendance to fracture clinic was 10.6 days [SD 10.3], while the time from presentation to surgery, when required, was 5.2 days [SD 4.2].

Pearson’s coefficient for inter-observer and intra-observer variability was > 0.88 for all parameters except radial height (0.79) (Table 1).

	Inter-observer	Intra-observer 1	Intra-observer 2
Radial Tilt	0.90	0.90	0.89
Volar Tilt	0.97	0.96	0.93
Radial Height	0.79	0.91	0.94

**Table 1:** Inter and intra observer variability.

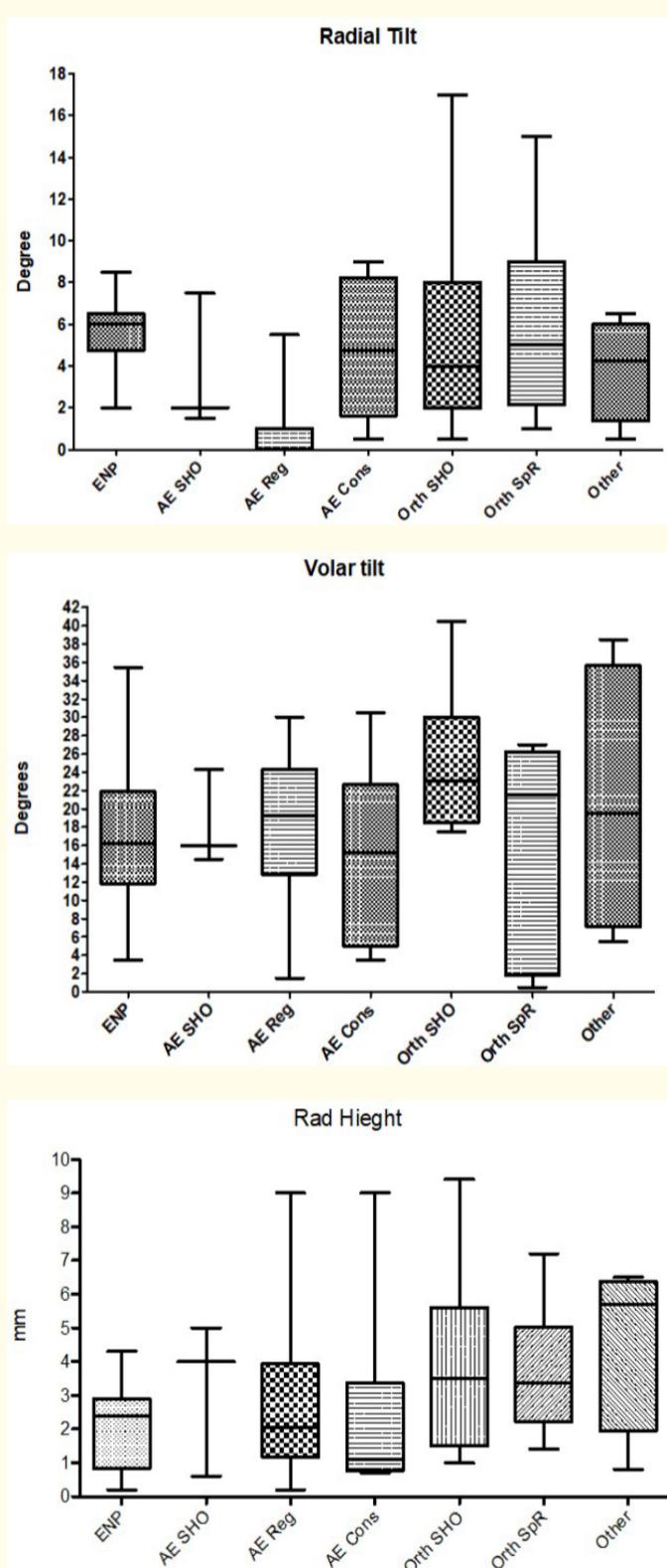
**Effect of Manipulations**

Initial manipulations completed by ED personnel were slightly better compared to the ones done by the orthopaedic staff. This reached statistical significance for volar tilt and radial height restoration, even though the magnitude of this difference is unlikely to be of clinical significance (Table 2).

Divergence	A&E reduction		Ortho reduction		P value
	Mean	SD	Mean	SD	
Radial Tilt (deg)	5.0	2.9	5.3	4.4	0.73
Volar Tilt (deg)	17.4	8.1	22.1	9.2	0.04
Radial Height (mm)	2.6	2.2	4.0	2.5	0.02

**Table 2:** Quality of reduction (the smaller the figure, the better the reduction).  
ED versus Orthopaedics performed reduction.

Among the manipulator grades, there was a statistically significant improvement, albeit very small again, in radial tilt when done by ED registrars compared to extended nurse practitioners, orthopaedic junior doctors and registrars (Dunn post-test;  $p < 0.0001$ ). There was no difference in volar/dorsal tilt or radial height restoration between the grades ( $p = 0.309$  and  $0.167$  respectively) (Figure 1).



**Figure 1:** Quality of reduction by specific manipulator groups for each parameter. The value on the y-axes represents the divergence from an anatomical reduction (ENP: Extended Nurse Practitioner; AE: Emergency Department; Orth: Orthopaedic).

There were some differences between the ED and orthopaedic manipulation groups. The group manipulated by orthopaedics tended to be younger with a higher male to female ratio- typical of the higher energy injuries, which are more likely from the outset to be treated surgically. Indeed, 76% of orthopaedic manipulations were treated surgically compared to 37% completed by ED staff (Table 3). No Bier's blocks were used by orthopaedic staff, compared to about a third in the A&E group. However, there was no significant difference in terms of the original fracture displacements, irrespective of the above, making the two groups comparable.

	A&E group	Orthopaedic group	P value	
Age	66.4	43.8	0.00	
Sex (m:f)	5:33	7:14	0.09	
Pre-manipulation divergences (mean [SD])	Radial tilt (deg)	11.6 [9.5]	13.2 [12.3]	0.95
	Volar tilt (deg)	36.6 [13.4]	40.1 [11.5]	0.18
	Radial height (deg)	5.5 [3.4]	6.4 [3.3]	0.38
% Intra-articular	37	29	0.58	
% Extra-articular	63	71		
% Haematoma blocks	58	100	0.00	
% Biers' block	32	0		
% Surgically treated	37	76	0.01	
% Conservatively treated	63	24		
Minutes from initial to check radiograph* (mean [SD])	125 [47]	166 [74]	0.02	

**Table 3:** Pre-manipulation fracture characteristics for A&E and orthopaedic groups.

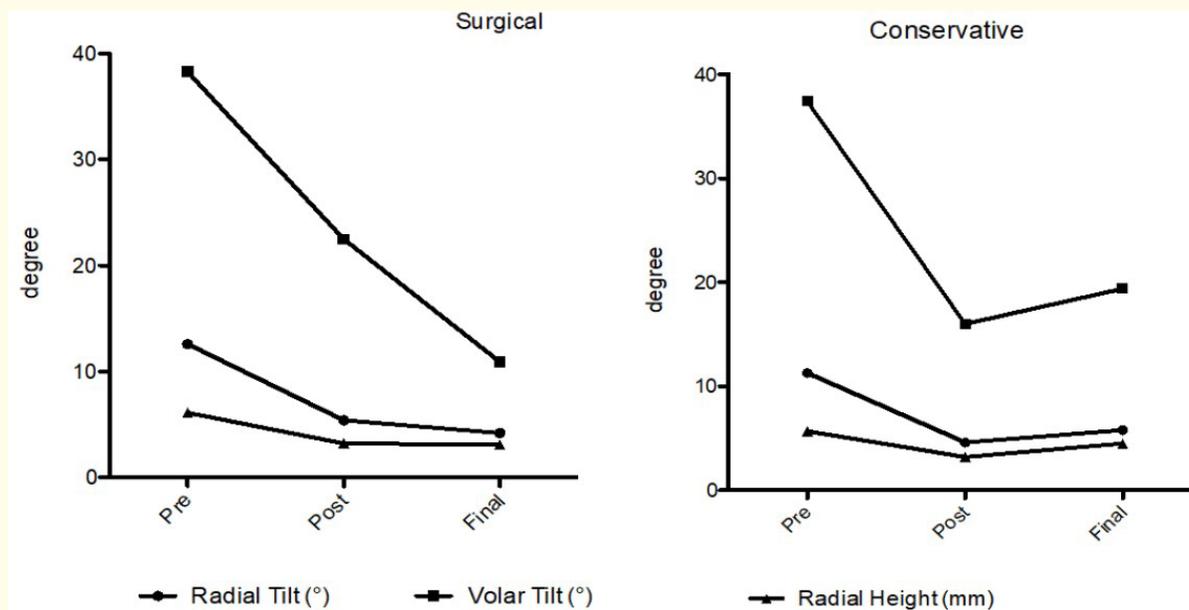
\*excluding outliers

Manipulations undertaken under Bier's block were equivalent to those under haematoma block, with no statistically significant difference demonstrable (Table 4).

As a whole, we found that the initial manipulation in ED resulted in the greatest magnitude of reduction throughout the patient episode. Thereafter, the conservatively managed patients underwent a slight loss of reduction until final radiographic follow up. This was much smaller in magnitude than the initial improvement. The surgically managed patients achieved a further improvement in reduction, but again smaller in magnitude than the initial one (Table 5) (Figure 2).

	Improvement after initial manipulation			Change between initial manipulation and final radiographs			
	Mean	SD	P value	Mean	SD	P value	
Radial Tilt (deg)	9.5	10.4	< 0.001	All	5.0	3.75	0.875
				Surgical	1.2	4.6	
				Conservative	-1.3	4.4	
Volar Tilt (deg)	37.8	12.7	< 0.001	All	3.9	11.9	0.012
				Surgical	11.6	9.4	
				Conservative	-3.5	9.0	
Radial Height (mm)	5.92	3.4	< 0.001	All	-0.6	2.7	0.213
				Surgical	0.1	2.5	
				Conservative	-1.3	2.8	

**Table 5:** Effect of different stages of treatment (positive values signify improvement, while negative ones represent loss of reduction).



**Figure 2:** Trend from pre-manipulation to final position in surgically compared to conservatively managed patients. Y-axis represents deviation from standard.

## Discussion

Effective fracture reduction can be completed within ED by both emergency and orthopaedic staff. This is well reported in the literature [6,18]. For about half of all patients, this was the definitive treatment.

While the debate is currently quite lively with regards to the definitive management of these fractures (operative or non-operative [4,5,19,20]; volar locking plates or K-wires [21-23]; external fixation or not [24,25], there is little literature on the best form of early management [6,18,26]. The main area where there has been an interest is in the best type of blocks used for the manipulation [27,28].

While the literature suggests superior results for Bier’s blocks [14,29], we didn’t find a significant difference between a simple haematoma and a Bier’s block. Orthopaedic staff in our hospital tended to prefer haematoma blocks for its expediency and ease, while the ED staff favoured a Bier’s block for its alleged safety [18]. While not challenging this practice, we believe that at times where significant pressures are being felt in the department, for example, during the winter spikes in injuries resulting from falls on the ice, a switch to haematoma blocks could prove useful. Infection is often quoted as a reason for avoiding hematoma blocks. However we could only find 1 case report documenting this rare complication [30].

Our study brought up an unexpected finding in the detection of a prevalence of around 83% of distal ulnar fractures associated with fractures of the distal radius. This is much higher than we originally thought and many of these were very subtle avulsions of the tip of the ulnar styloid. They only became visible once we magnified the images to improve the accuracy of our radiographic measurements, something we don’t routinely do when assessing these images in our day-to-day practice. The implication of this is that the tip of the ulnar styloid, however subtle the fracture, can be a significant source of pain to the patient when subjected to a simple haematoma block reduction of the distal radius. This could explain why Bier’s blocks are reported as being more effective in the literature. Based on this finding, we believe that a haematoma block could be made more effective by injecting some extra local anaesthetic around the ulnar styloid at the same time as the radial fracture site is injected. This theory remains to be tested formally in a trial.

Currently, there is no evidence to determine who the best-qualified person is to undertake the initial manipulation. The answer to that is likely to be unit dependent, as every unit has different training standards and levels of experience among its staff. Our study suggests that ED staff, especially senior ones, are as good as, if not better than the average orthopaedic junior doctor at manipulating these fractures. One of the reasons is that the orthopaedic doctor typically undertaking this manipulation is a relatively junior one. ED staff who frequently undertake manipulations in our hospital, on the contrary, tend to be a consultant, registrar or extended nurse practitioners. This group is more experienced, has greater exposure to the procedure and is more familiar with the department. Orthopaedic registrars could potentially achieve similar results, but unfortunately they often aren't available at the time of referral. Having a permanent orthopaedic registrar based in ED has significant cost and staffing implications [31]. An alternative would be to defer the initial manipulation to an orthopaedic clinic or directly to theatre if one knows that the patient will definitely require an operation anyway. The problem with this is that it creates a delay from the time of the initial presentation to the first manipulation or definitive surgery. Our data shows that the time from manipulation in ED to being seen in fracture clinic is of the order of 10 days. Delay till definitive theatre treatment in our hospital was of the order of 5 days. We anticipate that leaving a fracture until clinic or surgery would cause significant problems directly for the patient and also to the outcome of our intervention. Unfortunately there are no studies that have looked specifically at the complications of delayed first manipulation of distal radius fractures. The evidence in relation to ankle fractures is abundant though and is strongly in favour of early reduction [32-37]. The benefits are outlined in terms of ease of reduction, outcome of final treatment, length of stay, hence hospital costs and patient care [38]. In our experience, delaying manipulation of a distal radius fracture results in prolonged pain, swelling and potential nerve compromise for the patient. The reduction also becomes harder to undertake due to swelling and stiffness, potentially compromising the outcome. The conversion rate to surgery, we anticipate, would be increased as a result.

We recognise the following limitations to our study. It was a retrospective analysis without a preliminary power calculation. The measurement of the parameters was undertaken by 2 doctors of differing seniority. However this was showed not to be an issue, based on the good inter-observer reliability. Our final radiographic assessment may not reflect the position of the fracture at the final clinic review, which often took place a few weeks later. A radiograph was not routinely taken at that stage, as it is assumed that these fractures do not displace further once they have achieved initial stability. Our study has focused largely on the radiological outcomes of one of the commonest fractures seen. Emerging literature increasingly suggests that radiological outcome is not the best indicator of patient satisfaction and function [39]. Further work to look into functional outcomes would help improve the interpretation of our results.

In summary, we have demonstrated that the manipulation of dorsally displaced distal radius fractures can be safely completed at presentation in the emergency department by both ED and orthopaedic personnel and using either Biers' or haematoma block. An awareness of this could help address staffing and resource issues within the department at times of increase pressure, such as the winter crisis.

### Conclusion

Most wrist fractures can be manipulated safely within the emergency department, regardless of the manipulator's specialty or the type of block used.

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