



Demographics, fracture patterns and treatment strategies following wrist trauma

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The objective of this study was to determine the percentage of radiographs which showed a fracture of the wrist. Secondary, the fracture characteristics and the received treatment were determined. Additionally, the percentage of operatively treated patients with a distal radius fracture was compared between the hospitals. A retrospective cohort study was performed in three Dutch hospitals in all consecutive adult patients with wrist trauma who presented at the ED. A fracture of the wrist was defined as a fracture of the distal one-third part of the radius, the distal one-third part of the ulna or any carpal bone. Fracture classification according to the AO/OTA classification, the amount of displaced fractures, and the received treatment were recorded. Out of 1740 patients with wrist trauma, 49% sustained one or more fractures of the wrist. The distal radius was most frequently fractured (61%). Almost half of the distal radius fractures was extra-articular (AO/OTA type A2-3) and 61% of fractures was displaced. Of all patients who sustained a distal radius fracture, 14% was treated operatively. Significantly more patients were treated operatively in the academic hospital in comparison to the teaching and non-teaching hospital.

Keywords : wrist trauma ; fracture ; distal radius ; operative ; treatment.

INTRODUCTION

A traumatic injury of the wrist is one of the most common reasons for patients to visit the emergency department (ED). Although, the incidence of wrist injury is unknown, it is recognized that distal radius fractures are the most common fractures with an overall incidence rate, ranging between of 20 to 37 per 10,000 person years in Europe to 125 per 10,000 person years in the United States (2,4,5,8). Moreover, the age-specific incidence has increased over the past 50 years (3,9).

Up till now, it is unknown how many patients who present at the ED with a trauma of the wrist, actually sustained a fracture of the wrist. Moreover, the incidence of distal radius fractures is increasing, consequently it is also important to know the fracture characteristics and patterns since this influences the choice of treatment. Both the

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a-priori chance of a fracture and the treatment may influence functional outcomes, resource allocation, and healthcare costs.

Therefore, the primary aim of this study was to determine which percentage of radiographs, requested due to suspicion of a wrist fracture, indeed showed a fracture of the wrist. Secondary, the fracture characteristics and patterns and the received treatment were determined. Additionally, the percentage of operatively treated patients with a distal radius fracture was compared between the hospitals.

MATERIALS AND METHODS

A retrospective cohort study was conducted in three Dutch hospitals: one academic hospital, one teaching hospital and one non-teaching hospital. All consecutive patients who underwent a radiograph of the wrist following wrist trauma were included. To rule out the seasonal variation on the incidence of fractures among patients with acute trauma of the wrist, all consecutive patients visiting the ED during one year were included.

Patients younger than 18 years of age, patients who sustained a trauma of the wrist more than three days (> 72 hours) before presentation at the ED and patients who were referred with radiographs from another hospital or had returned for reassessment of the same injury were excluded. The medical charts of all the included patients were evaluated.

Wrist trauma was defined as a high or low energetic trauma involving the wrist, for example a fall on the outstretched hand, or a motor vehicle accident. A fracture of the wrist was defined as a fracture of the distal one-third part of the radius, the distal one-third part of the ulna and all carpal bones. It was assessed whether the radiologist reported a fracture of the distal radius and/or carpus. Demographic data included gender, age, injured side and trauma mechanism. Fracture characteristics included fracture classification according to the AO/OTA classification, presence of a concomitant fracture of the ulnar styloid process and the amount of displaced fractures that underwent open or closed reduction. Additionally, the received treatment (operative or conservative) was noted.

Statistical analysis

User-defined missing values were treated as missing. Normality of continuous data was tested by inspecting the normality plots. Normally distributed data were presented as mean and standard deviation (SD) and non-normally distributed data were presented as median and interquartile range (IQR). Categorical data was presented as numbers with corresponding percentages. Univariate analysis was performed to test the difference in the primary and secondary outcome measures between patients with a distal radius fracture and patients without. Continuous data were tested using a Mann Whitney U-test (non-parametric data). Chi-square analysis was used for statistical testing of categorical data. Multivariable logistic regression was used to determine if the difference in operative treatment of distal radius fractures between the three hospitals was significant, controlled for the confounders age and AO/OTA classification. In all tests, a p-value of less than 0.05 was considered to indicate statistical significance. All analyses were performed using SPSS version 23 (Chicago, Illinois, USA).

RESULTS

A total of 1740 patients were included. The median age was 51 years (IQR 34 to 65 years) with a range of 18 to 97 years. Acute wrist trauma occurred more often in women than in men. Most patients sustained a fall on the outstretched hand (Table I).

Of all patients, 847 (49%) patients had one or more fractures of the wrist. The median age of patients who had a wrist fracture significantly differed from patients who did not have a fracture; it was higher in patients who sustained a fracture of the wrist (58 years versus 43 years). Additionally, female patients had significantly more fractures of the wrist compared to male patients. There was no significant difference in the incidence of fractures between the three hospitals (Table II).

There was a major increase of patients presenting with a trauma of the wrist during December and January and a slight increase from June till September. The ratio between wrist fractures and wrist trauma remained stable over the year (Figure 1).

Table I. — Characteristics of the 1740 included patients

	N (%)
Age (years); median (IQR), range	51 (34-65), 18-97
Female patients	1107 (63.6)
Injured side (right)	885 (50.9)
Hospital	
Academic hospital	497 (28.6)
Teaching hospital	801 (46)
Non-teaching hospital	442 (25.4)
Trauma mechanism	
Fall on outstretched hand (FOOSH)	1246 (71.6)
Fall (during ice skating)	110 (6.3)
Fall from height	29 (1.7)
High energetic trauma	29 (1.7)
Pain and swelling without trauma	29 (1.7)
Punch	28 (1.5)
Ball versus hand	8 (0.5)
Miscellaneous	217 (12.5)
Missing	44 (2.5)

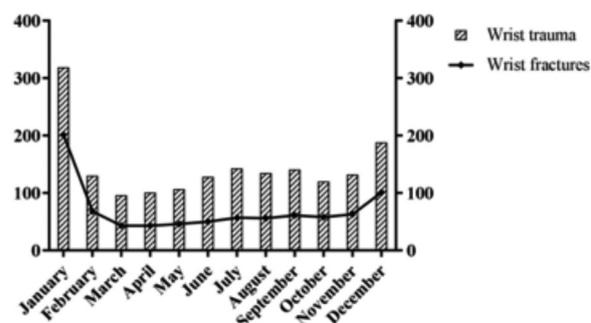


Fig. 1. — Incidence of wrist trauma and fractures presented per month.

Fracture characteristics

In total, 1152 fractures were found in 847 patients. The distal radius was most frequently fractured after wrist trauma, in 707 patients (61.4%). From all distal radius fractures, 47% of those fractures was an extra-articular fracture (AO/OTA type A2-3). Fourteen patients sustained an isolated fracture of the distal ulna or ulnar styloid process (AO/OTA type A1). In 227 patients (32%) a distal radius fracture was accompanied by a fracture of the ulnar styloid process. An antebrachial fracture was found in 45 patients (Table 3). Moreover, 61% of patients had a displaced fractures which required open or closed reduction.

A total of 152 patients (18%) sustained a fracture of the carpal bones. The triquetrum and scaphoid

Table II. — Patient's age, sex and hospital type, specified for wrist fracture: yes or no

Wrist fracture	Yes (N=847)	No (N=893)	P-value
Age (years); median (IQR), range	58 (44 – 69), 18 – 97	43 (28 – 59), 18-96	< 0.001*
Number of female patients (%)	578 (68)	531 (59)	< 0.001*
Hospital			
Academic hospital	257 (30)	240 (27)	0.28
Teaching hospital	380 (45)	421 (47)	
Non-teaching hospital	210 (25)	232 (26)	

* Significant

were the most frequent fractured carpal bones. In 26 patients (17%) a carpal bone fracture was combined with a fracture of the distal radius or other carpal bones. Nine patients sustained multiple fractures of the carpal bones (Table III).

Most distal radius fractures were seen in the teaching hospital, followed by the academic hospital and the non-teaching hospital. The distribution of the fracture classifications was significantly different among the three hospitals ($p = 0.006$) (Figure 2).

Treatment of distal radius fractures

Of all patients who sustained a distal radius fracture, a total of 102 patients (14.4%) were treated operatively. Significantly more patients were treated operatively in the academic hospital in comparison to the teaching hospital and non-teaching hospital (academic hospital: 25.6%; teaching hospital: 7.3%; non-teaching hospital: 13.4%; $p < 0.001$). This difference was statistically significant in multivariable logistic regression, corrected for the confounders age and AO/OTA classification. Additionally, younger patients and AO/OTA type C fractures were significantly more often treated operatively (type A: 5.4%; type B: 7.5%; type C: 35.7%; $p < 0.001$) (Table IV, Figure 2).

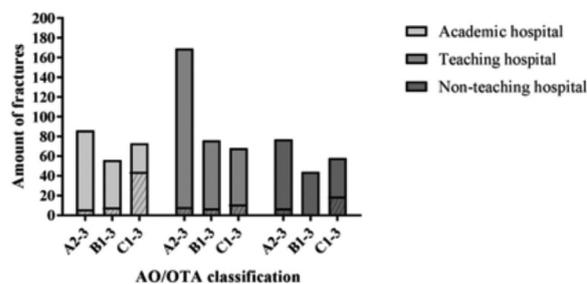


Fig. 2. — Distribution of 707 distal radius fractures for each hospital. Shaded area shows the amount of fractures which are treated operatively

DISCUSSION

This study demonstrates that half of the wrist radiographs in patients with a trauma of the wrist does not show a fracture. Of all fractures in the wrist, the majority are fractures of the distal radius (61%), more specifically AO/OTA type A2-3 fractures. Moreover, patients who were treated in the academic hospital and who sustained an AO/OTA type C were more likely to be treated operatively.

The a priori change of having a fracture of the wrist (49%) is much higher compared with the a priori change of having a significant malleolar fracture following ankle trauma, another frequent extremity trauma, which is 9.3% in the study of Stiell et al. (11). Taking these figures into account one may

Table III. — Fracture characteristics of 1152 fractures in 847 patients

	N (%)
Distal radius fractures, AO/OTA-classification	
A2-3: extra-articular	332 (28.8)
B1-3: partially articular	176 (15.3)
C1-3: complete articular	199 (17.3)
Distal ulna fractures	
A1: Isolated distal ulna fracture	14 (1.2)
Antebrachial fracture	45 (3.9)
Associated fracture of the ulnar styloid process	227 (19.7)
Carpal bone fractures	
Scaphoid (navicular bone)	73 (6.3)
Triquetrum	72 (6.3)
Other carpal bones	14 (1.2)
Total count of fractures	1152

Table IV. — Difference in operative treatment between hospitals, corrected for confounders age and AO/OTA classification

	OR	95% CI		P-Value
		Lower	Upper	
Academic hospital vs. teaching hospital	0.288	0.163	0.509	<0.001*
Academic hospital vs. non-teaching hospital	0.423	0.237	0.756	0.004*
Teaching hospital vs. non-teaching hospital	0.680	0.357	1.297	0.242
AO-class A vs. B	1.158	0.545	2.461	0.703
AO-class A vs. C	8.826	4.981	15.639	<0.001*
AO-class B vs. C	0.131	0.068	0.253	<0.001*
Age	0.980	0.966	0.995	0.010*
Nagelkerke R square = 0.286				
* Significant				

argue that with an a priori change of almost 50% of having a wrist fracture a standard radiograph of the wrist following trauma is mandatory. However nowadays, governments aim to limit their healthcare expenses, and therefore every effort should be undertaken to make healthcare more efficient and to reduce costs. With a growing population of elderly, an increase in wrist trauma patients over the last 50 year has been seen (3,9). Therefore, even a small reduction in negative radiographs may be cost-effective.

The results of this study are consistent with previous studies showing a marked excess of fractures in females in the occurrence of acute wrist fractures. This may be explained by the fact that women live longer compared to men and that osteoporosis is more frequent in women (5). As expected a fall on outstretched hand was the most common trauma mechanism in acute wrist injuries (1). Moreover, the distribution of the fracture characteristics was consistent with the literature (4,6).

Furthermore, this study shows a noticeable difference between the three hospitals in the percentage of patients treated operatively for a distal radius fractures. This difference is statistically significant, even after correction for fracture severity and age, indicating that there is no broad consensus on operation indication. This phenomenon was

also seen in a study of Walenkamp et al., who determined the variation in surgical treatment of distal radius fractures in the Netherlands (12). This study showed that although the operative rate was the highest in the academic hospital, the differences in operative rates between the hospitals could not be explained by hospital type, percentage of females, age of the patient, the socioeconomic status or the number of patients presenting in each hospital. However, the variation in treatment strategies could be explained by surgeon and patient preferences (7,8,10). Although an operatively treated distal radius fracture is more expensive than a non-operatively treated distal radius fracture, there does not seem to be a financial motivation since patients who were treated in the academic hospital were more likely to be treated operatively.

In addition, Walenkamp et al. stated that the variation could possibly be explained by the difference in fracture patterns between the hospitals, suggesting that academic hospitals have a larger number of severely injured patients resulting in more comminuted fractures. However, in our study we corrected for fracture severity and still found a higher operative rate in the academic hospital compared to the teaching and non-teaching hospital.

An important limitation of this study is the lack of follow-up. First, for patients who did not undergo radiographic examination. Therefore the exact

percentage of wrist fractures of the total population of patients following wrist trauma presenting at the ED is not known. In other words the a priori change of a wrist fracture in this patient category is not exact. However, in all hospitals included in this study there was a very low threshold to perform a radiograph in a patient with wrist trauma. Therefore, we assume that the a priori change of a wrist fracture is approximately 49%. Second, for patients who did not receive treatment or initially conservative treatment, there may be a possibility that some of these patients eventually received operative treatment due to a redisplacement of the fracture, malunion or non-union.

CONCLUSION

Of all patients, 49% who present at the ED with a trauma of the wrist actually sustained a fracture of the wrist. The distal radius is most often fractured. Significantly more patients with a distal radius fracture are treated operatively in an academic hospital in comparison to a teaching and non-teaching hospital. This indicates a lack of consensus on the treatment of distal radius fractures and we should aim to minimise the variation in treatment strategies.

REFERENCES

1. **Altizer LL.** Colles' fracture. *Orthop Nurs.* 2008 ; 27 : 140-5.
2. **Angermann P, Lohmann M.** Injuries to the hand and wrist. A study of 50,272 injuries. *J Hand Surg Br* 1993 ; 18 : 642-4.
3. **Bengner U, Johnell O.** Increasing incidence of forearm fractures. A comparison of epidemiologic patterns 25 years apart. *Acta Orthop Scand* 1985 ; 56 : 158-60.
4. **Bentohami A, Bosma J, Akkersdijk GJM et al.** Incidence and characteristics of distal radial fractures in an urban population in The Netherlands. *Eur J Trauma Emerg Surg* 2014 ; 40 : 357-61.
5. **Brogren E, Petranek M, Atroshi I.** Incidence and characteristics of distal radius fractures in a southern Swedish region. *BMC Musculoskelet Disord* 2007 ; 8 : 48.
6. **Brogren E, Hofer M, Petranek M et al.** Relationship between distal radius fracture malunion and arm-related disability: a prospective population-based cohort study with 1-year follow-up. *BMC Musculoskelet Disord* 2011 ; 12 : 9.
7. **Chung KC, Shauver MJ, Yin H et al.** Variations in the use of internal fixation for distal radial fracture in the United States medicare population. *J Bone Joint Surg Am* 2011 ; 93 : 2154-62.
8. **Fanuele J, Koval KJ, Lurie J et al.** Distal radial fracture treatment: what you get may depend on your age and address. *J Bone Joint Surg Am* 2009 ; 91 : 1313-19.
9. **Melton LJ 3rd, Amadio PC, Crowson CS, O'Fallon WM.** Long-term trends in the incidence of distal forearm fractures. *Osteoporos Int* 1998 ; 8 : 341-8.
10. **Neuhaus V, Bot AG, Guitton TG, Ring DC.** Influence of surgeon, patient, and radiographic factors on distal radius fracture treatment. *J Hand Surg Eur* 2015 ; 40 : 796-804.
11. **Stiell IG, Greenberg GH, McKnight RD et al.** A study to develop clinical decision rules for the use of radiography in acute ankle injuries. *Ann Emerg Med* 1992 ; 21(4) : 384-90.
12. **Walenkamp MM, Mulders MA, Goslings JC, Westert GP, Schep NW.** Analysis of variation in the surgical treatment of patients with distal radial fractures in the Netherlands. *J Hand Surg Eur* 2016 [Epub ahead].