



## ■ TRAUMA

# Patterns of injury and treatment for distal radius fractures at a major trauma centre

**J. L. Francis,  
J. M. Battle,  
J. Hardman,  
R. E. Anakwe**

From St Mary's  
Hospital, Imperial  
College Healthcare NHS  
Trust, London, UK

## Aims

Fractures of the distal radius are common, and form a considerable proportion of the trauma workload. We conducted a study to examine the patterns of injury and treatment for adult patients presenting with distal radius fractures to a major trauma centre serving an urban population.

## Methods

We undertook a retrospective cohort study to identify all patients treated at our major trauma centre for a distal radius fracture between 1 June 2018 and 1 May 2021. We reviewed the medical records and imaging for each patient to examine patterns of injury and treatment. We undertook a binomial logistic regression to produce a predictive model for operative fixation or inpatient admission.

## Results

Overall, 571 fractures of the distal radius were treated at our centre during the study period. A total of 146 (26%) patients required an inpatient admission, and 385 surgical procedures for fractures of the distal radius were recorded between June 2018 and May 2021. The most common mechanism of injury was a fall from a height of one metre or less. Of the total fractures, 59% (n = 337) were treated nonoperatively, and of those patients treated with surgery, locked anterior-plate fixation was the preferred technique (79%; n = 180).

## Conclusion

The epidemiology of distal radius fractures treated at our major trauma centre replicated the classical bimodal distribution described in the literature. Patient age, open fractures, and fracture classification were factors correlated with the decision to treat the fracture operatively. While most fractures were treated nonoperatively, locked anterior-plate fixation remains the predominant method of fixation for fractures of the distal radius; this is despite questions and continued debate about the best method of surgical fixation for these injuries.

**Cite this article:** *Bone Jt Open* 2022;3-8:623–627.

**Keywords:** Distal radius fracture, Trauma, Epidemiology, Major trauma centre

## Introduction

Hand and wrist injuries make up a considerable proportion of the trauma workload.<sup>1,2</sup> Of these, distal radius fractures are common injuries which have been shown to occur in a bimodal distribution, with peaks in young males and elderly females.<sup>2,3</sup> In elderly patients, distal radius fractures are often low-energy, isolated injuries such as falls from standing height and fragility fractures. In a younger demographic, these fractures often

occur as high-energy injuries, and possibly as part of polytrauma.<sup>2,4,5</sup>

The organization of trauma systems into hub and spoke models, where trauma units feed into major trauma centres, has been widely recognized as an advance in trauma care that has resulted in improvements in trauma patient care and outcomes.<sup>6</sup> This means that the most critically injured patients are transported directly to major centres with pooled trauma expertise and resources. In

Correspondence should be sent to  
Raymond E Anakwe; email:  
raymond.anakwe@nhs.net

doi: 10.1302/2633-1462.38.BJO-  
2022-0027.R1

*Bone Jt Open* 2022;3-8:623–627.

many cases, distal radius fractures will not be the most critical patient injury and, in some circumstances, definitive treatment may need to be deferred.

We undertook a study to examine the patterns of injury and treatment for adult patients presenting with distal radius fractures to a major trauma centre serving an urban population of 3.9 million people.

## Methods

In this retrospective cohort study, we identified all adult patients who were referred to our major trauma centre for treatment of a distal radius fracture between June 2018 and May 2021. Patients were identified by examining the hospital electronic record system, and using diagnostic, injury, and discharge codes. All adult patients aged 16 years or over were included in the study. The study was approved by our institutional review board.

The patient record for each identified case was used to confirm the diagnosis and to establish patient demographics, mechanism, and patterns of injury, as well as the treatment and fracture management given. The original injury radiographs were independently reviewed and classified by two of the authors (JMB, JLF) using the Orthopaedic Trauma Association (OTA) classification.<sup>7</sup> Where there was disagreement, the senior author (REA) reviewed the images and adjudicated.

The time period of this study included the first wave of the COVID-19 pandemic, which resulted in a national 'lockdown' in the UK from 23 March 2020. The aim of this lockdown was to reduce social movement and virus transmission in the community. Non-essential travel was therefore restricted until there was a phased lifting of social restrictions. We further examined the presentations and treatment of patients during this period to identify any patterns or variations from the norm.

**Statistical analysis.** Patient and injury characteristics were described using means and frequencies. Histograms were used to confirm the normality of continuous variables. The chi-squared test was used to examine categorical variables, and the independent-samples *t*-test for continuous variables. One-way analysis of variance (ANOVA) tests were performed separately to examine for differences between time periods and fractures treated using different methods. Binomial logistic regression analysis was performed to examine for independent predictors of inpatient admission or selection for operative management. Variables were selected following initial testing with chi-squared and Spearman's rank testing. A *p* value of < 0.05 was considered significant. GraphPad Prism v 8.4.2 was used to conduct the statistical analysis (USA).

## Results

Over the study period, we treated 571 patients with distal radius fractures at our major trauma centre. Of these, 336 patients (59%) were female, and the mean patient

age was 54 years (standard deviation (SD) 20; 16 to 99). 184 patients were aged 65 years and over.

A total of 152 patients (27%) were admitted to hospital for at least one night; of these, 36 (24%) had sustained open injuries and 11 (7.3%) had sustained polytrauma injuries characterized by an Injury Severity Score (ISS)<sup>8</sup> of 16 or greater, and 36 (24%) had sustained multiple injuries as well as a distal radius fracture. The likelihood of inpatient admission increased with age (odds ratio (OR) 1.03 for every year of age increase (95% confidence interval (CI) 1.01 to 1.04); *p* < 0.001, binomial regression analysis). Females were 2.5 times more likely to be admitted than males (95% CI 1.43 to 4.22; *p* < 0.001, binomial regression analysis).

Of those patients aged 65 years and over, 82% (*n* = 150) were female, with the most common mechanism of injury being a fall from a height of one metre or less (75%; *n* = 112). Most of these were isolated injuries (87%; *n* = 97) and closed (92%; *n* = 103), however 32% (*n* = 58) of all patients in this age group were admitted to hospital as an inpatient. Overall, 314 (55%) fractures were classified as extra-articular (Type A), while 257 (45%) were intra-articular; 337 (59%) were treated nonoperatively, while 180 (76%) of those patients treated surgically received locked anterior-plate fixation. Of the patients aged 65 years and over who received operative management, 56% were admitted to hospital (*n* = 30), a significant proportion of whom sustained isolated distal radius fractures (*n* = 22).

In the younger patient group aged 35 years or younger, 69% were male (*n* = 86). The proportion of distal radius fractures sustained due to a fall from a height of one metre or less was lower (26%; *n* = 22) than for the older patient group. In comparison, high-energy mechanisms such as road traffic accident, pushbike/scooter accident, or sports accident were much more prevalent (14% (*n* = 12), 15% (*n* = 13), and 17% (*n* = 15) respectively). Again, most injuries sustained were isolated (89%; *n* = 76) and closed (94%; *n* = 81) (Table I). A larger proportion of patients were managed operatively (43%; *n* = 37) compared to patients aged 65 years and over. Of the 86 patients in this younger age group, 18% (*n* = 16) were admitted to hospital overnight as an inpatient.

The pattern of fracture types seen and treated are summarized in Table II. A total of 234 distal radius fractures (41%) were treated operatively. Of these, 180 fractures (77%) were treated using locked anterior-plate fixation. Of patients aged 65 years and over who were managed operatively, 69% (*n* = 37) received locked anterior-plate fixation. Five patients (2.2%) underwent more than one procedure for their fracture, for example where staged external fixation was used before definitive locked anterior-plate fixation for open injuries, or where the soft-tissues were in poor condition.

**Table I.** Injury patterns and mechanisms.

Mechanism of injury	n (%)
Assault or altercation	9 (1.6)
Crushed between object/barrier	2 (0.4)
Fall from 1 m or less	312 (55.0)
Fall from 1 to 2 m	59 (10.0)
Fall from 2 to 5 m	37 (6.5)
Fall from 5+ m	25 (4.4)
Impact with stationary object/barrier	2 (0.4)
Low-energy bump with object/barrier/person	3 (0.5)
Other	5 (0.9)
Pushbike/scooter accident	34 (6.0)
Road traffic accident	46 (8.1)
Sports accident	37 (6.5)
Total	571

In all, 64 patients suffering distal radius fractures did so as part of multiple injuries or polytrauma. Within this cohort, 53% of patients (n = 34) were treated operatively, with 47% of these patients (n = 16) treated with locked anterior-plate fixation. In total, 11 of these patients were defined as polytrauma injuries resulting in an ISS of 16 or more. Within this cohort, 100% were admitted and 91% (n = 10) had operative fixation of their distal radius fracture. Most of these fractures were Type C injuries (55%; n = 6).

In comparison, 507 patients sustained isolated wrist injuries. In this group, 39% of patients (n = 198) were treated with surgery. Of the total 507 patients, 5% (n = 25) sustained open injuries; 82% of patients presenting with isolated wrist injuries who received operative management were treated with locked anterior-plate fixation (n = 164), while only 12% received Kirschner-wire fixation (n = 24) (Table III).

Figure 1 indicates the impact the COVID-19 pandemic had over time on the numbers of patients being treated for distal radius fractures. There was an increase in the mean numbers of referrals per month from 13 (SD 4.1) to 20 (SD 1.7) (t = -27.95; p < 0.001, independent-samples t-test) when the periods before and after the start of the first UK lockdown (1 June 2018 to 22 March 2020 vs 23 March 2020 to 30 May 2021, separated by the dotted line) were compared.

Similarly, when comparing these time periods there was a significantly higher proportion of patients discharged than admitted after the start of the first lockdown ( $\chi^2 = 8.50$ ; p < 0.001, chi-squared test). Also, a lower proportion of patients were operated on after the start of the first lockdown ( $\chi^2 = 10.59$ ; p < 0.001, chi-squared test).

**Binomial logistic regression model.** A logistic regression was carried out to assess the effect of several independent variables on the requirement for inpatient admission, and the decision to manage the distal radius fracture surgically.

**Table II.** Fracture type/Orthopaedic Trauma Association classification.

AO fracture type	n (%)
A	315 (55)
B	106 (19)
C	150 (26)

Chi-squared testing was used to select independent variables to be included in the logistic regression analysis. Age, sex, OTA fracture classification, the presence of bilateral distal radius fractures, open fractures, multiple injuries, or polytrauma with an ISS scored at 16 or greater were all considered for their effects on the decision to have surgery, and the need or decision for inpatient admission.

The overall model was statistically significant when compared to the null model ( $\chi^2 (9) = 200.750$ ; p < 0.001). When considering the decision to admit patients to the hospital, the explained variation based on our model ranges from 30% to 43%, and correctly predicted 84% of cases. Open injuries (p < 0.001), age (p < 0.001), sex (p = 0.001), bilateral distal radius fractures (p < 0.001), and multiply injured patients (p < 0.001) were all predictive of inpatient admission.

When considering the decision to manage distal radius fractures with surgery, the overall model was statistically significant when compared to the null model, ( $\chi^2 (13) = 70.110$ ; p < 0.001). The explained variation based on our model ranges from 12% to 16%, and correctly predicted 65% of cases. Age (p = 0.008), open fractures (p < 0.001), and fracture complexity (p < 0.001) were predictive of the decision to manage a distal radius fracture surgically. Type C fractures were most likely to be selected for surgery (OR 1.85 (95% CI 1.22 to 2.78); p = 0.004). Polytrauma patients with an ISS of 16 or greater, and those who had sustained Type B2, C3, or bilateral distal radius fractures, were not shown to be more likely to have surgery using our model.

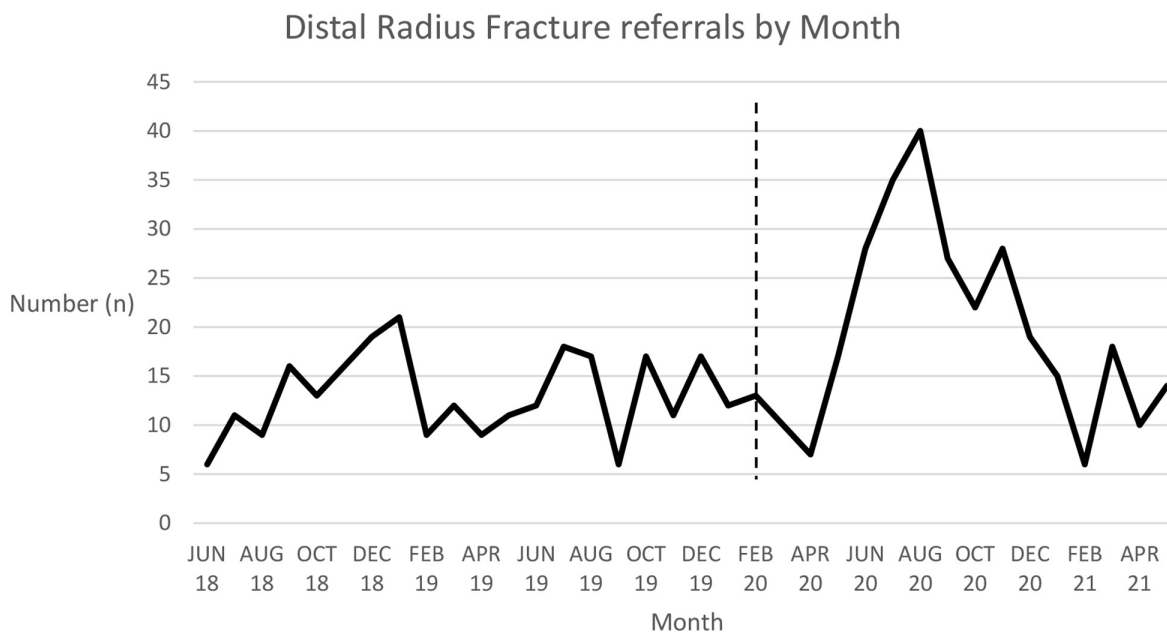
## Discussion

The epidemiology of distal radius fractures presenting to our urban major trauma centre replicated the classical bimodal distribution that has been reported in the literature.<sup>2,3</sup> Within our patient cohort, many young males and elderly females sustained distal radius fractures following high-energy injuries and low-energy injuries, respectively. In patients aged 65 years and over, most fractures were simple, isolated injuries, resulting from falls from a height of one metre or less. In keeping with the literature, most elderly patients received nonoperative management for their distal radius fracture.<sup>9</sup>

Our study highlights that at our major trauma centre, locked anterior-plate fixation is the preferred method of surgical fixation for distal radius fractures. This is an area of continuing debate and discussion.<sup>10,11</sup> When surgery is offered, patients with fractures of the distal radius are increasingly treated with day-case surgery, which is recognized to

**Table III.** Fracture type and management.

Management, n (%)	A2	A3	B1	B2	B3	C1	C2	C3	Total
Nonoperative cast/splint	145 (68)	49 (48)	42 (81)	22 (79)	12 (46)	33 (51)	29 (40)	5 (38)	337
Manipulation under anaesthetic	7 (3.3)	0	2 (3.8)	0	0	1 (1.5)	0	0	10
Kirschner-wire fixation	14 (6.6)	11 (11)	2 (3.8)	1 (3.6)	0	2 (3.1)	3 (4.2)	0	33
Locked anterior plating	47 (22)	41 (40)	5 (9.6)	4 (14)	14 (54)	27 (42)	34 (47)	8 (62)	180
Dorsal distal radius plating	0	1 (1.0)	1 (1.9)	1 (3.6)	0	1 (1.5)	2 (2.8)	0	6
Combined dorsal and locked anterior plating	0	0	0	0	0	0	2 (2.8)	0	2
External fixation	0	0	0	0	0	1 (1.5)	2 (2.8)	0	3
Total	213	102	52	28	26	65	72	13	571

**Fig. 1**

Fractures of the distal radius treated each month.

be efficient and safe.<sup>12</sup> While our study reflects this, several patients required inpatient admission – elderly patients were more likely to require this. These admissions were related to a number of factors, including lack of social support, acute exacerbations of chronic medical conditions, reduced or impaired mobility, and medical issues requiring input from the orthogeriatric department, affecting bed pressures in a busy major trauma centre. Comparatively, the younger patient group who were admitted as inpatients almost exclusively required inpatient admission, because they presented as a result of polytrauma and suffered multiple injuries requiring additional treatment from multiple teams. Polytraumatized patients and those with open fractures were more likely to require inpatient admission and to undergo surgery. The fracture pattern and complexity did not show any relationship with the likelihood of requiring inpatient admission ( $\chi^2 = 2.0035$ ;  $p = 0.157$ ).

Our study showed that Type C fractures were most often selected for operative management, which seems intuitive. More complex intra-articular fracture patterns were selected

for surgery, reflecting the established literature.<sup>10,11,13</sup> It is important to recognize, however, that even for patients treated at a major trauma centre, nonoperative treatment remains a viable treatment option for selected fractures; in fact, this treatment option was selected for the majority of patients in our study.

A mean of 16.1 (SD 7.7) distal radius fractures were treated in our major trauma centre each month over the study period, with a mean of 6.44 (SD 2.95,  $n = 232$ ) treated surgically each month over the same time period. While locked anterior plating was the preferred operative strategy, most fractures were treated non-operatively. The number of patients treated each month increased considerably following the national lockdown instituted in response to the COVID-19 pandemic, particularly in the six months between June and December 2020 (Figure 1). While there were more referrals, a higher proportion of patients were treated non-operatively, with fewer patients receiving operative management or requiring inpatient admission.

Our study has a number of limitations and leads to a number of questions. The increase in the number of patients treated for a distal radius fracture during the national lockdown could be the result of a number of factors. Reduced social mobility would be expected during these periods, but also, large numbers of people were not engaged in their usual employment or activities, and there was an anecdotal increase in the number of people undertaking an hour of outdoor daily exercise. In addition, the referral patterns and presentations to neighbouring and referring hospitals may have changed during this period. It is not possible to be definitive about this within the scope of this study, and these questions present viable avenues for further research.

Any retrospective study is open to bias. Our study relied on coding and automated searches of trauma and patient databases. This potential for bias was mitigated with manual clinical validation of the clinical records, and an inclusive case definition for the study group. Nevertheless, we recognise the potential for bias remains.

Our study also represents the experience of one major trauma centre, which may not be widely representative. Despite this, we believe that it is important to examine and report these data which describe new and developing patient pathways, as well as injury and treatment patterns.

In conclusion, the epidemiology of distal radius fractures treated at our major trauma centre replicated the classical bimodal distribution described in the literature. Patient age, open fractures, and fracture classification were factors correlated with the decision to treat the fracture operatively. While most fractures were treated non-operatively, locked anterior-plate fixation remains the predominant method of fixation for distal radius fractures.



### Take home message

- The epidemiology of distal radius fractures treated at our major trauma centre reflects that reported in the literature.
- Even in a major trauma setting, most distal radius fractures can be treated nonoperatively and where surgical fixation is required, locked anterior plate fixation is the preferred method of treatment.
- 32% of patients aged 65 years or older who sustained a distal radius fracture required inpatient admission, often for social or non-clinical reasons.

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#### Author information:

- J. L. Francis, MB ChB, Junior Clinical Fellow
- J. M. Battle, MBBS, Junior Clinical Fellow  
The Hand and Wrist Service, Department of Trauma & Orthopaedic Surgery, St Mary's Hospital, Imperial College Healthcare NHS Trust, London, UK.
- J. Hardman, FRCS (Tr&Orth), Consultant Hand, Wrist and Elbow Surgeon, Department of Trauma and Orthopaedic Surgery, Torbay and South Devon NHS Foundation Trust, Torbay, UK; Department of Trauma & Orthopaedic Surgery, Royal Devon and Exeter NHS Foundation Trust, Exeter, UK.
- R. E. Anakwe, FRCS Ed(Tr&Orth), Consultant Hand, Wrist and Elbow Surgeon, The Hand and Wrist Service, Department of Trauma & Orthopaedic Surgery, St Mary's Hospital, Imperial College Healthcare NHS Trust, London, UK; Department of Surgery and Cancer, Imperial College, London, UK.

#### Author contributions:

- J. L. Francis: Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing.
- J. M. Battle: Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing.
- J. Hardman: Methodology, Writing – original draft, Writing – review & editing.
- R. E. Anakwe: Methodology, Conceptualization, Supervision, Writing – review & editing.
- J. L. Francis and J. M. Battle contributed equally to this work.

#### Funding statement:

- The authors received no financial or material support for the research, authorship, and/or publication of this article.

#### ICMJE COI statement:

- No competing interests or conflicts of interest.

#### Acknowledgements:

- J. M. Battle and J. L. Francis contributed equally to this study and are recognized as joint first authors.

#### Ethical review statement:

- Ethical approval was not required according to Health Research Authority guidance. The study was approved by our Clinical Audit and Effectiveness Group as a clinical audit.

#### Open access funding

- The open access fee for this study was funded by the academic institution.

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