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ORIGINAL RESEARCH

Do instability markers predict satisfactory reduction and requirement for later surgery in emergency department patients with wrist fracture?

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Abstract

Objective: Research suggests that the presence of instability markers in patients with displaced distal radial fractures is associated with poorer outcome. Our aims were to determine whether the presence of previously defined instability markers could predict the likelihood of successful ED reduction and requirement for a secondary procedure after ED reduction.
Methods: Retrospective cohort study performed by medical record review. Adult ED patients coded as having an isolated wrist fracture and having fracture reduction in ED were eligible for inclusion. Data collected included demographics, history of osteoporosis, mechanism of injury, radiological features on X-rays and performance of a secondary procedure. Outcomes of interest were the rate of successful fracture reduction in ED (against defined radiological criteria), the rate of secondary procedures and the association between the number of defined instability risk factors and successful reduction and performance of a secondary surgical procedure. Analysis was by χ^2 test, receiver operating characteristic curve, logistic regression analyses.
Results: Three hundred and nineteen patients were studied; median age 62 years, 77% female. Sixty-five per cent of patients had satisfactory fracture reduction in ED (95% CI 59%–70%). Eighty-six patients underwent a secondary procedure to reduce/stabilise their fracture (28%, 95% CI 23%–33%). Younger age, lack of satisfactory ED reduction and increased number of instability factors were independently predictive of the performance of a secondary procedure.
Conclusion: Instability risk factors are common in patients with wrist fractures requiring reduction in ED. The number of instability factors is not a strong predictor of the performance of secondary procedures.

Key words: *emergency department, fracture, instability, surgery, wrist.*

Key findings

- Instability risk factors are common in ED patients with wrist fractures.
- About a quarter of patients who undergo reduction of wrist fractures in ED require a secondary procedure.
- The number of instability risk factors is not a strong predictor of requirement for a secondary procedure.

Introduction

Wrist fractures are common presentations to EDs. Some can be treated with simple cast immobilisation while others require manipulation or stabilisation surgery. In patients requiring intervention, in some Australasian ED current practice is for ED staff to perform a reduction (usually under deep sedation/anaesthesia – e.g. propofol) with follow up in outpatients rather than consideration of primary reduction in theatre or primary surgical stabilisation. An unknown proportion of these patients undergo a secondary procedure (re-manipulation, stabilisation surgery) at later follow up.

A UK study[1] explored the significance of the number of defined instability markers in distal radial fractures for predicting outcome and found that four or more of the defined instability markers were globally associated with a poorer outcome. The defined instability markers are shown in Table 1. Patients with four or more markers who underwent surgery did better than those treated with manipulation alone. However, in patients with three or fewer markers, non-operative management yielded equally good outcomes. This study challenges current ED practice and it may well be that there are a group of patients that would have better outcomes if

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TABLE 1. *Instability markers*[1]

Marker
Age ≥60 years
Dorsal angulation >20%
Intra-articular fracture
Associated ulna fracture
Dorsal comminution
Radial shortening
Osteoporosis

referred directly for surgery, avoiding a second procedure and its associated inconvenience, cost and risks.

The objectives of this study were to determine whether the presence of previously defined instability markers could predict the likelihood of successful ED reduction and requirement for a secondary procedure after ED reduction.

Methods

This was a retrospective cohort study performed by medical records review conducted in the ED of two community teaching hospital EDs in Melbourne, Australia. We identified all adult patients (aged ≥18 years) with an isolated wrist fracture treated with manipulation/reduction in ED between November 2011 and June 2015 who were subsequently discharged for outpatient follow up from an ED patient management database. Exclusion criteria were age <18 years, hospital admission at the index visit for whatever reason, presence of an open fracture, patients who did not have fracture manipulation/reduction in the ED, those that did not have an isolated distal radial fracture (miscoding), absence of X-rays on the hospitals' radiology system or, for the secondary procedures outcome, loss to follow up. The decision that a fracture required ED reduction was a clinical one made by the duty ED consultant/senior registrar, sometimes in consultation with the duty orthopaedic registrar.

Data were collected onto a specifically designed data collection form by trained researchers (AG, AW, JC, PR and SK). The form defined all data points and measurements. The researchers were not blinded to the study hypothesis. Data collected included demographics, injury mechanism, fracture characteristics before and after ED reduction, presence of instability markers and performance of a secondary procedure.

Outcomes of interest were the rate of successful fracture reduction in ED (against defined radiological criteria), the rate of secondary procedures and the association between the number of defined instability risk factors and successful reduction and performance of a secondary surgical procedure. Successful reduction was defined radiologically as volar tilt within 10°, radial length within 2 mm, radial incliniation within 5° and articular step <2 mm as in the previous study.[1]

Analysis was by descriptive statistics, χ^2 test analysis of proportions, receiver operating characteristic (ROC) curve analysis and multivariate logistic regression. Inter-rater agreement for data extraction was collected for 10% of cases for the items: eligibility, age, gender, known osteoporosis and performance of a secondary procedure.

Prior to undertaking this study, the rate of successful ED reduction, rate of secondary procedures and instability risk factor score distribution was unknown. For the successful ED fracture reduction endpoint, we estimated that the overall rate of successful reduction would be about 70%, that patients with <4 instability markers would have a success rate of about 75% compared to about 50% for those with ≥4 markers. We acknowledge that this was an educated guess. On this basis, estimated sample size would be 58 per group ($P = 0.05$, power = 0.8). Given the number of potential influences, we recognised that the sample size for the rate of secondary procedures would need to be considerably larger. If one estimates an overall rate of about 20% with the group with ≥4 instability markers having twice the intervention rate of the group with ≤3 instability markers (say 30% *vs* 15%), 121 patients would be required per group ($P = 0.05$, power = 0.8). In the previous study approximately 40% of patients had ≥4 instability markers. Being conservative, we aimed to collect data on a minimum of 250 patients.

The study was approved by the institutional ethics review panel. Patient consent for data collection was not required.

Results

There were 319 patients who met inclusion criteria and had follow-up data. Sample derivation is shown in Figure 1. Characteristics of the patients, the fractures and outcome are summarised in Table 2. Median age was 62 years and 78% of patients were female.

Two hundred and six patients had a satisfactory ED reduction according to the defined criteria (65%, 95% CI 59%–70%). Patients with less than four instability markers were more likely to have a satisfactory ED reduction than those with ≥4 (80% *vs* 55%; $P < 0.0001$).

During follow up, 86 patients underwent a secondary procedure to reduce/stabilise their fracture (28%, 95% CI 23%–34%). In patients with <4 risk factors, the rate of secondary procedure was 21% (95% CI 14%–30%) compared with a rate of 32% (95% CI 26%–40%) in patients with four or more defined risk factors ($P = 0.048$, χ^2). Patients who did not achieve satisfactory ED fracture reduction were more likely to require a secondary procedure (relative risk 1.99, 95% CI 1.39–2.85). Multivariate logistic regression showed that younger age, higher number of instability markers and lack of satisfactory ED reduction were all independent predictors of performance of a secondary procedure (Table 3).

The number of instability risk factors was not a strong predictor of the performance of a secondary procedure (area under the ROC curve 0.53). A cut-off of ≥4 instability markers was 73% sensitive for identifying patients who had a secondary procedure performed (63/86, 95% CI 63%–81%) (Fig. 2). Inter-rater agreement of data collection was 100% for items eligibility, age, gender, known

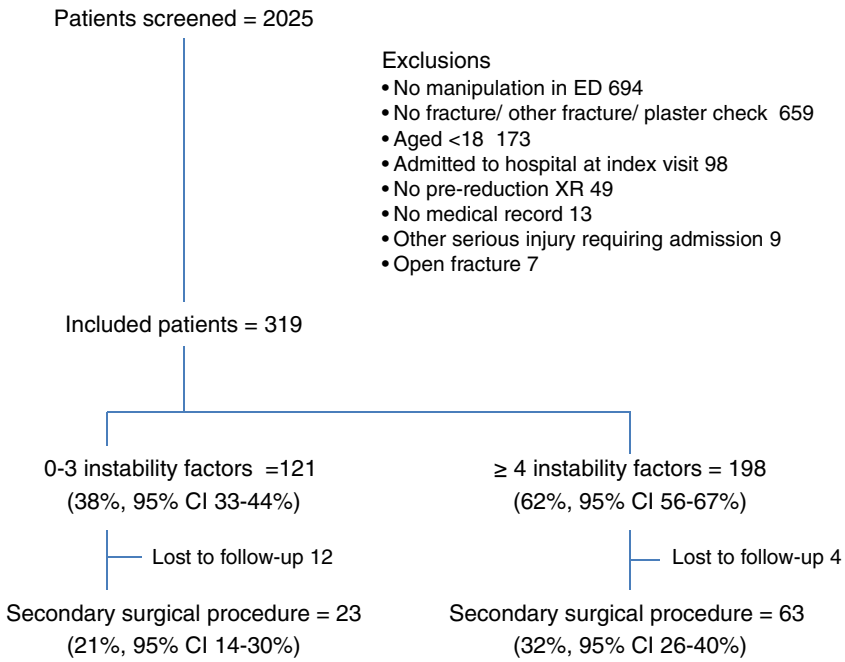

Figure 1. *Sample derivation.*

TABLE 2. *Characteristics of the sample*

Variable	
Age, median (IQR) (years)	62 (48–74)
Patients aged ≥60 years, *n* (%)	181 (57)
Gender female, *n* (%)	245 (77)
Known osteoporosis, *n* (%)	34 (11)
Mechanism of injury	
Fall <30 cm, *n* (%)	232 (72)
Fall 30–100 cm, *n* (%)	47 (15)
Fall >100 cm, *n* (%)	18 (6)
Other, *n* (%)	22 (7)
Fracture characteristics	
Dorsal angulation >20°, *n* (%)	164 (51)
Intra-articular fracture, *n* (%)	211 (66)
Associated ulnar fracture, *n* (%)	197 (52)
Dorsal comminution, *n* (%)	248 (68)
Intra-articular step, *n* (%)	36 (11)
Radial tilt, *n* (%)	51 (16)
Number of risk defined factors, median (IQR)	4 (3–5)
≥4 defined risk factors, *n* (%)	198 (62)
Satisfactory reduction, *n* (%)	206 (65)
<4 instability markers	97/121 (80)
≥4 instability markers	109/198 (55)

osteoporosis and performance of secondary procedure.

Discussion

Our study found that the defined risk factors for fracture instability were common, with almost two-thirds of patients having four or more defined instability risk factors. We also found that the number of risk factors was a weak predictor of patients undergoing a secondary reduction/stabilisation procedure.

There have been a number of attempts to identify and validate risk factors for early and late instability in distal radius fractures. Some have focused on radiological features of the fracture[2] while others have incorporated radiographic features and patient characteristic such as age and presence of osteoporosis.[3–6] Radiological features associated with re-displacement are radial shortening,[2,5,6] dorsal tilt,[2,5,6] radial inclination[2] and comminution.[5] Patient characteristics associated with re-displacement include age[3–6] and patient independence.[5] Lafontaine *et al.* defined five instability makers (four radiological criteria and age) that have become known as the Lafontaine criteria.[4] That seminal study demonstrated that the higher the number of instability factors the higher likelihood of a worse initial reduction and poor radiological result at union. MacKenney *et al.*[5] derived a range of formulae for predicting early and late displacement, but they are complex and unwieldy. It should be noted that these studies for the most part, focused on radiological outcome rather functional outcome. There is at least some evidence to show that good functional outcome can be achieved with poor radiological features.[7]

Our motivation in doing this study was to determine if instability risk factors could identify a subset of patients who should be referred for primary operative intervention from ED rather than have fracture reduction in ED and outpatient follow up. If this was true, these patients could avoid the inconvenience and risks of a second procedure and the health system could avoid the associated costs.

TABLE 3. *Predictors of secondary procedure*

Variable	Secondary procedure	*P* value
Univariate analysis		
Age		
≤70	69/202, 34%	0.0002
>70	17/101, 19%	
Instability markers		
<4 instability markers	23/109, 21%	0.048
≥4 instability markers	63/194, 32%	
Satisfactory ED reduction		
Yes	46/196, 23%	0.024
No	40/110, 36%	
Multivariate analysis		
Variable	Odds ratio (95% CI)	
Age (older age)	0.994 (0.991–0.995)	<0.001
Number of instability markers	1.066 (1.029–1.089)	0.0006
Failure of satisfactory ED reduction	1.14 (1.025–1.212)	0.016

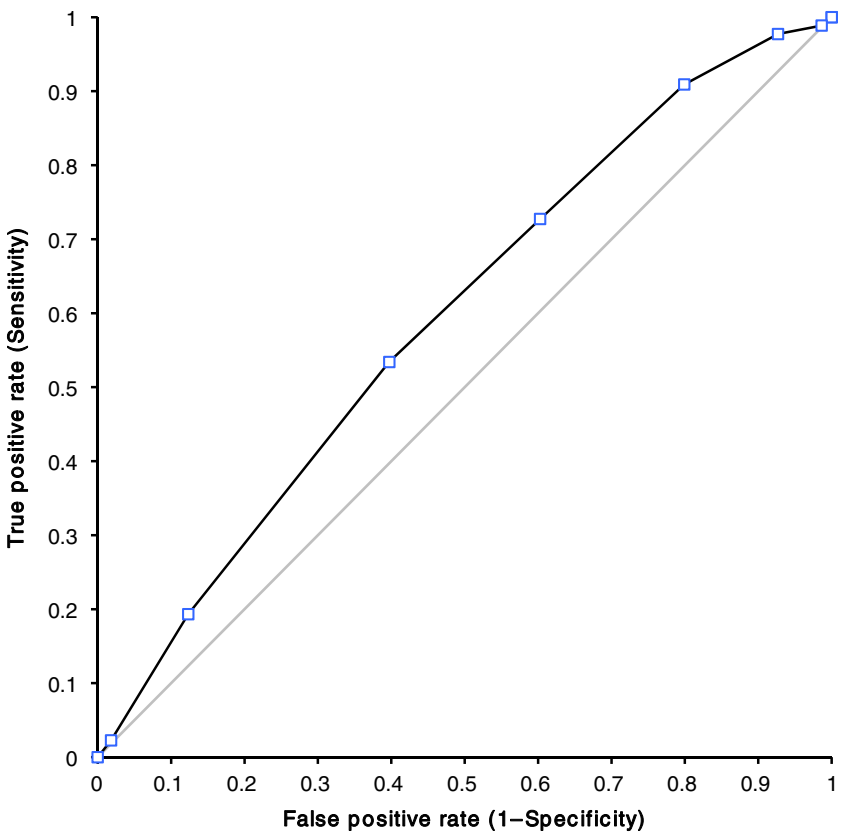

Figure 2. *ROC curve analysis of number of risk factors as a predictor of secondary surgical procedure. (——), No discrimination; (—□—), number of risk factors.*

Unfortunately the predictive performance of the instability score was weak and thus our results do not support its use for this purpose.

That 28% of patients underwent a secondary procedure after an ED manipulation is similar to the rate reported by Bhattacharyya *et al.*[1] Along with radiological features of the fracture and displacement, in deciding to undertake a secondary procedure treating surgeons may consider other factors such as patient age, co-morbidity and surgical risk, activity, hand dominance, soft tissue or neurological compromise, employment and independence as well as patient preference. The preference of the surgeon and health insurance status may also be factors. This injects an element of subjectivity into decision-making that is hard to quantify and is poorly researched. Access to operating time may further complicate the issue. Combined these factors are likely to result in some variation in the rate of secondary procedures between hospitals and regions.

This study has some limitations that should be considered when interpreting the results. Data were collected by retrospective chart review methods and thus is subject of the weaknesses of that methodology, especially missing data. This study was conducted at one health service so the results may not be generalisable to other health services or regions. Due to the retrospective design of the study and missing data, it was not possible to collect data on patient's functional outcome or accurate data on some potential confounders such as identity of individual surgeon making the decision for a secondary procedure, return to work pressures, etc. In addition, while sample size calculations were based on best available data, the proportion of patients with ≥4 instability markers was much higher than anticipated, which may have resulted in the study being under-powered for the secondary procedure outcome. We defined whether an ED fracture reduction was satisfactory based on radiological criteria; this may be open to question but allowed accuracy in classification.

Conclusion

Instability risk factors are common in patients with isolated wrist fractures requiring reduction in ED. The number of instability factors is not a strong predictor of the performance of secondary procedures.

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Competing interests

A-MK is a member of the editorial board for *Emergency Medicine Australasia*.

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