Running head: Instability markers in wrist fractures

Amar Winayak MBBS BSc Hons

Department of Emergency Medicine, Western Health

Alyza Gossat MBBS

Department of Emergency Medicine, Western Health

Jenny Cooper MBBS

Department of Emergency Medicine, Western Health

Peter Ritchie MBBS MPH FACEM

Department of Emergency Medicine, Western Health

Wei Lim FRANZCR

Medical Imaging Department, Western Health

Sharon Klim BN

Joseph Epstein Centre for Emergency Medicine Research @ Western Health

Anne-Maree Kelly MD FACEM

Department of Medicine, Melbourne Medical School – Western Precinct, The University of

Melbourne and Joseph Epstein Centre for Emergency Medicine Research @ Western Health

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Address for correspondence:

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Instability markers in wrist fractures

Prof AM Kelly

JECMR, Sunshine Hospital, Furlong Road, St Albans 3021

Email: anne-maree.kelly@wh.org.au

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 emergency department (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 Chi Square, receiver operator characteristic curve (ROC), logistic regression analyses.

Instability markers in wrist fractures

Results: 319 patients were studied; median age 62,77% female. Sixty-five per cent of patients had satisfactory fracture reduction in ED.(95% CI 59-70%). 86 patients underwent a secondary procedure to reduce/ stabilize their fracture (28%, 95% CI 23-33%). Increasing 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: fracture, instability, wrist, emergency department, surgery

INTRODUCTION

Wrist fractures are common presentations to emergency departments (ED). Some can be treated with simple cast immobilization while others require manipulation or stabilization 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 stabilization. An unknown proportion of these patients undergo a secondary procedure (re-manipulation, stabilization surgery) at later follow-up.

A UK study¹ 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 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 emergency department (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 ED in Melbourne, Australia. We identified all adult patients (aged ≥ 18) 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 , hospital admission at the index visit for whatever reason, presence of an open fracture, patients who did not have fracture manipulation/reduction in ED, those that did not have an isolated distal radial fracture (miscoding), absence of xrays 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 was collected onto a specifically designed data collection form by trained researchers (AG, AW, JC, PR, 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

Instability markers in wrist fractures

degrees, radial length within 2mm, radial inclination within 5 degrees and articular step <2mm as in the previous study¹.

Analysis was by descriptive statistics, Chi Square 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 recognized 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 approx. 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 summarized in Table 2. Median age was 62 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 $\geq$ four (80% vs 55%; $p < 0.0001$).

During follow-up, 86 patients underwent a secondary procedure to reduce/ stabilize 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 ($p = 0.048$, Chi Square). 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%). Inter-rater agreement of data collection was 100% for items eligibility, age, gender, known 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/stabilization 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 fracture² 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 inclination² and comminution.⁵ Patient characteristics associated with re-displacement include age³⁻⁶ and patient independence.⁵ Lafontaine et al defined five instability makers (4 radiological criteria and age) which 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 al⁵ derived a range of formulae for predicting early and late displacement however 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

Instability markers in wrist fractures

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. 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 was 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 generalizable 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,

Instability markers in wrist fractures

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.

FUNDING AND CONFLICTS OF INTEREST

This project was supported by departmental funds only. The authors have no conflicts of interest to declare.

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Instability markers in wrist fractures

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Table 1: Instability markers¹

Marker
Age ≥ 60 years
Dorsal angulation $>20^\circ$,
Intra-articular fracture
Associated ulna fracture
Dorsal comminution
Radial shortening
Osteoporosis

Table 2. Characteristics of the sample

Variable	
Age (years, median IQR)	62,48-74
Patients aged ≥ 60	181, 57%
Gender (female, N, %)	245, 77%
Known osteoporosis (N, %)	34, 11%
Mechanism of injury	
Fall <30cm (N, %)	232, 72%
Fall 30-100cm (N, %)	47, 15%
Fall >100cm (N, %)	18, 6%
Other (N, %)	22, 7%
Fracture characteristics	
Dorsal angulation >20 degrees (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	206, 65%

Instability markers in wrist fractures

< 4 instability markers	97/121, 80%
≥4 instability markers	109/198, 55%

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

Instability markers in wrist fractures

Failure of satisfactory ED reduction	1.14 (1.025-1.212)	0.016
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Figure 1. Sample derivation

Figure 2. ROC curve analysis of number of risk factors as a predictor of secondary surgical procedure

Fig. 2

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Author/s:

Winayak, A;Gossat, A;Cooper, J;Ritchie, P;Lim, W;Klim, S;Kelly, A-M

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