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ORIGINAL STUDY

The value of manipulation of displaced distal radius fractures in the emergency department

Robert W. Jordan, Rahil Naeem, Saqiba Jadoon, Kuntrapaka Srinivas, Gunaratnam Shyamalan

From the Birmingham Heartlands Hospital, Birmingham, UK

The aim of this study was to report the success of maintaining reduced distal radius fractures with cast immobilisation and analyse risk factors for redisplacement. A retrospective analysis of distal radius fracture manipulated between April 2011 and 2013 was conducted. Age, gender, fracture classification, ulna fracture, dorsal comminution and volar alignment were recorded. Reduction and redisplacement were measured using Sarmiento's modification of Lidstrom's system. 110 patients were included ; mean age 62.8 years and 83.4% female. The AO classification was used to grade initial fractures A2 (44%), A3 (25%), C1 (20%) and C2 (10%). 86.4% of cases were improved following manipulation, although 48.4% redisplaced and 27.4% required surgical intervention. The radial length (60%) was harder to maintain than dorsal alignment (44%) in cases of redisplacement. Successful alignment of the volar cortices was associated with a statistically significant reduction in redisplacement (p = 0.024). Manipulation of distal radius fractures is initially beneficial but half of cases redisplace.

Keywords : distal radius fracture ; wrist fracture ; manipulation ; closed reduction ; redisplacement.

INTRODUCTION

Distal radius fractures are common injuries (*8, 16,18*) with 70,000 occurring each year in the UK (*15*). Two thirds occurring between 50 and 79 years and 80% in patients over 80 years (*6*). Historically distal radius fractures are treated non-operatively (*21*) which avoids the surgical risks of infection, tendon rupture, hardware problems and nerve compression (*9*). A number of radiographic standards have traditionally been used to measure the success of treating distal radius fractures. An intra-articular step of over 2mm, greater than 20 degrees of angulation or more than 5mm of radial shortening have been reported as unacceptable by surgeons (*1*). Sarmiento's modification of Lidstroms system combines radial length, radial inclination and angulation into one score and is illustrated in Table I (*17*). The importance of radiographic outcomes is controversial with Foldhazy *et al* reporting a positive association with functional outcome (*10*). However Arora *et al* demonstrate similar functional outcomes following both plate fixation and non-operative treatment

■ Robert W. Jordan, Specialist Registrar.
University Hospitals Coventry & Warwickshire, West Midlands, UK.
■ Rahil Naeem, Specialist Trainee.
■ Saqiba Jadoon, Specialist Trainee.
■ Kuntrapaka Srinivas, Consultant Surgeon.
■ Gunaratnam Shyamalan, Consultant Surgeon.
Birmingham Heartlands Hospital, Birmingham, UK.
Correspondence : Mr R. W. Jordan, Birmingham Heartlands Hospital, Bordesley Green East, Birmingham B9 5SS, UK.
E-mail : Robert.jordan@doctors.org.uk

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Table I. — Sarmiento's modification of Lidstroms system (*17*)

Dorsal angle	Loss of radial length (mm)	Loss of radial tilt	Score for each measurement
Neutral	< 3	0-4	0
1-10	3-6	5-9	1
11-14	7-11	10-14	2
> 15	> 12	> 15	4

Scoring : Excellent 0, Good 1-3, Fair 4-6 and Poor 7-12.

despite a higher prevalence of mal-union after non-operative treatment (*2,3*). A recent Cochrane meta-analysis concluded that it remains unclear whether surgery gives a better long term outcomes than non-operative treatment (*11*).

Distal radius fractures have a tendency to redisplace following closed reduction (*5,19,20*) with particular difficulty maintaining the radial length (*5,10*). Wadsten *et al* reported that 87% of reduced fractures redisplace. However redisplacement has not been demonstrated to be directly associated with patient outcomes (*5,22*). No agreement currently exists over the optimal technique to maintain reduction in unstable fractures (*4,7*). Risk factors for redisplacement include dorsal comminution, intra-articular extension, volar displacement, age, activity level, lifestyle, co-morbidities and osteoporosis (*5,12,19,22*). The aim of this study was to analyse risk factors associated with redisplacement in distal radius fractures managed by closed manipulation.

PATIENT AND METHODS

A retrospective analysis of all patients aged over 18 years that were treated for a distal radius fracture at our Emergency department between April 2011 and April 2013 was performed. Patients were included if a manipulation was performed in the Emergency Department and initial treatment was non-operative. The procedure was performed under either haematoma block, where local anaesthetic is injected into the fracture site, or Bier's block, that involves injection of local anaesthetic intravenously under tourniquet. The decision to manipulate and which anaesthetic to use was made by the treating physician who also performed the procedure. This individual was a member of the Emergency Department team and their level of seniority varied. Manipulation was not performed under fluoroscopy and repeat plain radiographs were obtained after casting. A below elbow cast was used and wrist positioned in flexion and ulna deviated. The original cast was kept for six weeks and only changed if concerns regarding swelling or the skin were raised. Open fractures, patients taken directly to theatre without manipulation and those followed up at another centre were excluded from the study.

Patient's age and gender were collected from electronic records. The fracture was graded according to the Association for the study of internal fixation classification (AO) (14). Initial radiographs were assessed for the presence of an associated ulna fracture or dorsal comminution. Dorsal or volar angulation, radial inclination and radial length were measured and graded according to Sarmiento's modification of Lidstrom's system (*17*) on initial, post manipulation and follow up radiographs taken at 3 months. A successful reduction was defined as an improvement of at least one level in this score, e.g. from poor pre-operatively to good post-manipulation. Redisplacement was defined as a decline in the Lidstrom's score, e.g. from good post-manipulation to poor at three months follow up. Successful reduction of the volar cortex after manipulation was also assessed and examples are illustrated in Figures 1 and 2. Need for further surgical intervention during the first three months follow up was also recorded. Separate subgroup analysis was performed according to age ; the study group was divided into those patients under the age of 55 years and those 55 years and over.

Statistical analysis was performed using IBS SPSS Statistics 22.0 and risk factors for redisplacement were evaluated using the Pearson Chi-squared test. The study was registered locally but ethics committee approval was not sought as the study was retrospective and involved no patient contact.

RESULTS

During the study period 110 patients underwent attempted closed reduction of a distal radius fracture under a haematoma or Bier's block in the Emergency Department. During the same time period 56 patients underwent volar plate fixation and 120 percutaneous wire fixation for distal radius fractures. The mean age of the study population was 62.8 years and 83.4% were female. The initial fractures were classified according to AO as A2 (44%), A3 (25%), C1 (20%) and C2 (10%).

The scores according to Sarmiento's modification of Lidstrom's system (*17*) at initial presentation,

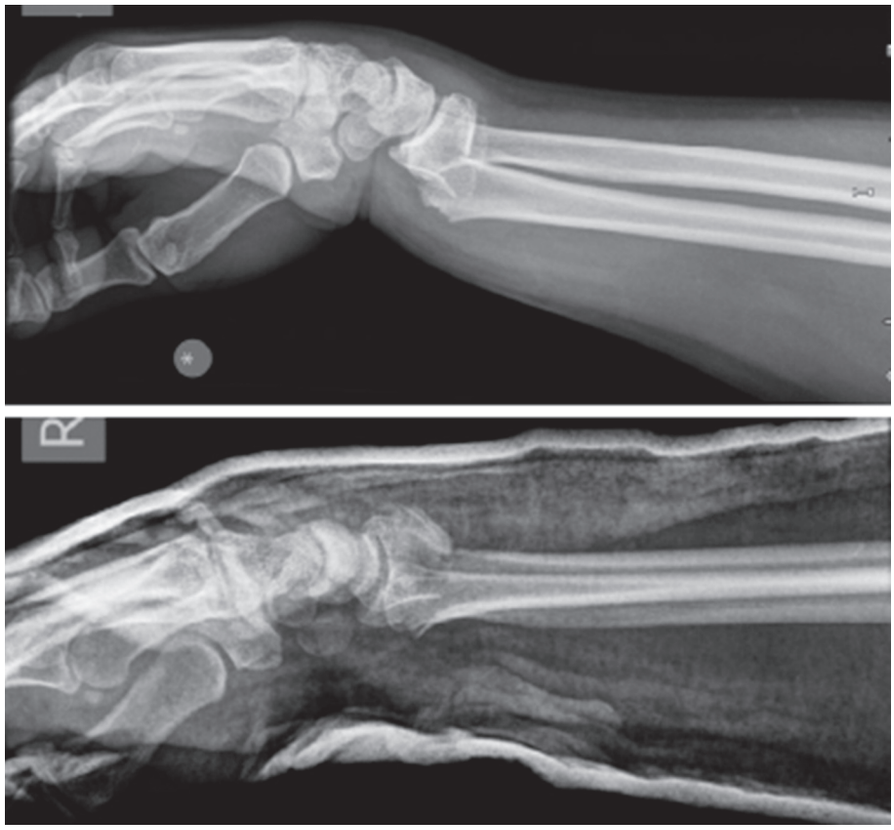

Fig. 1. — An example of failure to reduce the volar cortex

Table II. — Radiographic scores according to Sarmiento's modification of Lidstrom's system *(17)*

Lidstrom's Score	Initial (%)	Post manipulation (%)	Follow up (%)
Excellent	0	14.5	6.4
Good	10.9	64.5	48.2
Fair	40	17.3	26.4
Poor	49.1	3.6	19.1

post manipulation and follow up are reported in Table II. In 95 patients (86.4%) an improvement in radiographic measurements was achieved following manipulation, although 48.4% of these cases redisplaced during follow up. When analysed separately, correction of dorsal angle was lost in 44% and radial length in 60% of cases. 27.4% required further surgical intervention in the form of plate fixation or percutaneous wire fixation. The risk factors for redisplacement studied are reported in Table III. Although age, female gender, ulna fracture, dorsal comminution were more common in the redisplacement group these did not reach statistical significance. The association between the failure to achieving reduction of the volar cortex and redisplacement was statistically significant ($p = 0.024$).

79 manipulations (71.8%) were performed in patients over the age of 55 years with the remaining 31 cases (28.2%) under the age of 55 years. The proportion of cases achieving radiological improvement were similar between the age groups ; 87.3% over 55 years and 83.9% under 55 years. The proportion of cases suffering a redisplacement at three months was higher (50.7%) in the older age group that those under 55 years (42.3%) but this did not reach statistical significance. The risk factors for redisplacement in each group are described in

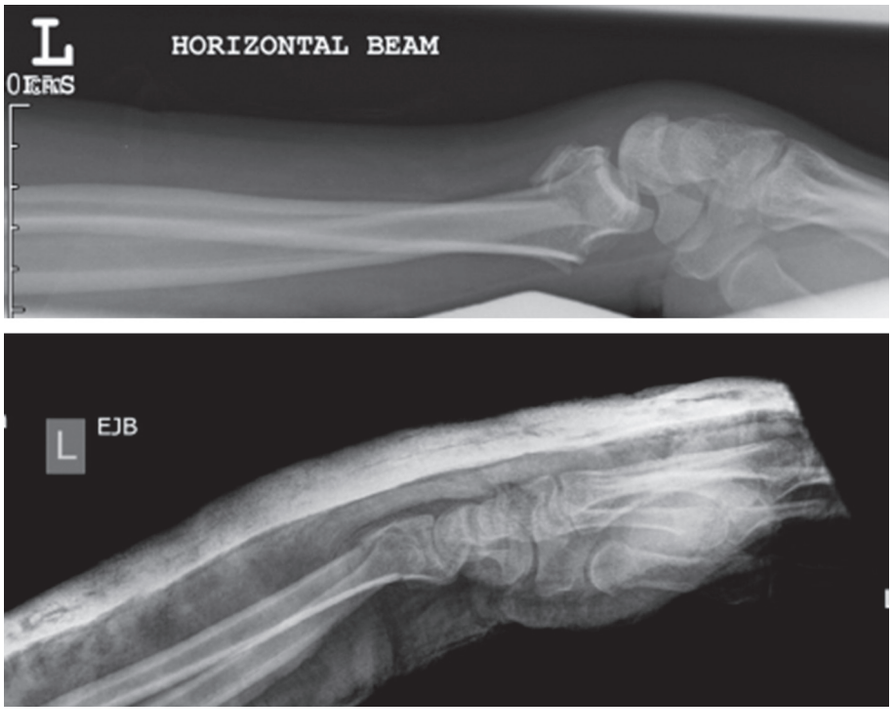

Fig. 2. — Example of successful reduction of volar cortex

Table III. — Presence of risk factors for redisplacement in both groups

		Undisplaced group (n = 49)	Redisplaced group (n = 46)	P-value
Age (years)		60.8	65.1	0.860
Gender	Female	81.6%	86.9%	0.763
AO Classification	A2	40.8%	45.7%	0.837
	A3	28.6%	23.9%	
	C1	20.4%	17.4%	
	C2	8.2%	13.0%	
Ulna fracture	Yes	67.3%	78.3%	0.203
Dorsal comminution	Yes	57.1%	60.9%	0.628
Volar cortex reduced	Yes	71.4%	45.7%	0.024
Initial Lidstroms score	Excellent	0%	0%	0.545
	Good	4.1%	4.3%	
	Fair	44.9%	39.1%	
	Poor	51.0%	56.5%	

Table IV. — Presence of risk factors for redisplacement in different age groups

Risk Factor		Over 55 year (n = 79)	Under 55 years (n = 31)
Gender	Female	96.2%	51.6%
AO Classification	A2	46.8%	35.5%
	A3	29.1%	16.1%
	C1	16.5%	29%
	C2	6.3%	19.4%
Ulna fracture	Yes	73.4%	64.5%
Dorsal comminution	Yes	64.6%	38.7%
Volar cortex reduced	Yes	46.8%	83.9%
Initial Lidstroms score	Excellent	1%	0%
	Good	3.8%	25.8%
	Fair	38%	45.2%
	Poor	57%	29%

Table IV. Those in the older age group had a higher proportion of females, dorsal comminution and associated ulna fractures. However the younger group had more intra-articular fractures (C1 and C2).

Of the 95 cases successfully reduced by manipulation, 59 were performed under haematoma block and 36 under Bier's block. The rate of redisplacement was higher after haematoma block (52.5%) than after Bier's block (41.7%) but this difference did not reach statistical significance. The majority of the manipulations were performed by senior doctors (65.5%) and this groups had a lower redisplacement rate (45.8%) than those performed by junior doctors (50%) but again this difference did not reach statistical significance.

DISCUSSION

Closed reduction has been the traditional treatment for distal radius fracture (*21*) and is indicated for minimally displaced and reducible fractures. Manipulation is commonly employed to improve fracture position and measurement of radiographic indices are used to judge success. The aim of manipulation is to restore the radial length, dorsal angulation and the articular surface. The data presented reports an improvement in 86.4% of patients following manipulation and suggests manipulation in the Emergency Department is initially worthwhile. However a 48.4% redisplacement rate demonstrates that the ability to maintain reduction is currently unsatisfactory, despite this figure being favourable to that reported in the literature (*19*). Maintenance of radial height has been identified as a particular problem in previous studies (*5,10*) and the failure in nearly two thirds of cases to maintain height in this study supports this finding. These results would suggest that the main aim of manipulation should be to correct the volar or dorsal angulation as this is more likely to be successfully maintained at follow up. Improvements in techniques to hold reduction and identify factors that predict redisplacement should be the focus of future research.

Multiple risk factors for redisplacement have been reported and include ; dorsal comminution, intra-articular extension, volar displacement, age, activity level, lifestyle, co-morbidities and osteoporosis (*5,12,19,22*). Despite a higher prevalence of those factors measured in the redisplaced group the only factor to reach statistical significance was achieving alignment of the volar cortex. Although achieving volar alignment is not commonly described, the lower rate of redisplacement seen after is logical given the inherent stability of a successful reduction and hitching of the volar cortices. Further

research to confirm the importance of this factor is required. A previous study has reported that manipulation performed under a Bier's block and by a senior health professional are more likely to be successfully (*13*). This is supported by data from this study although these findings did not reach statistical significance. A physician's ability to achieve alignment of the volar cortex would be enhanced by performing the reduction under both a Bier's block and fluoroscopic control. The authors would therefore advocate the use of Bier's block where expertise is available and the use of fluoroscopy in the Emergency Department to optimise the success of volar cortex reduction which has been shown to reduce the rate of redisplacement.

The study does have a number of limitations ; firstly the study only recorded radiographic outcomes and does not address whether the patients perceived an improvement. Arora *et al* reported that functional outcomes were independent to radiographic measurements (*2*,*3*) and this suggests redisplacement does not necessarily result in a poorer outcome. The follow up of three months was sufficient to measure redisplacement and need for early surgical intervention, however it does not address the long term risk of arthritis or elective intervention for ongoing symptoms. The lack of a formal protocol for manipulation of distal radius fractures resulted in individual doctors deciding on the appropriateness of intervention and the method of analgesia used. This process is at risk of bias and a protocol for manipulation would provide a consistent treatment policy. The study did not include patients with type B fractures as these patients were referred directly to the orthopaedic team without undergoing manipulation in the Emergency Department. These individuals either had surgery in view of the unstable nature of the injury or were deemed to be medically unfit for surgery and any manipulation was done by the orthopaedic team after admission.

CONCLUSION

Manipulation of distal radius fractures in the Emergency Department is beneficial in improving radiographic indices in the vast majority of patients. However nearly half of cases redisplace and 27.4% require surgical intervention. Achieving alignment of the volar cortex was the only statistically significant risk factor for redisplacement and should be considered when assessing stability of these fractures.

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