



Outcomes Following Type C Distal Humeral Fracture Fixation Using Two Different Osteosynthesis Techniques

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SUMMARY

Background. Distal humeral fractures are notorious injuries, and they require surgical fixation. The reliability of reconstruction devices has been a subject of debate. Our primary outcome was to detect differences, if any, between two different groups of patients using the patient-reported outcomes measurement information system (PROMIS) Global-10 form and to compare it with the Mayo elbow performance score (MEPS) results. Other secondary outcomes included the difference in union time between patients who received a reconstruction plate vs those who received a pre-contoured anatomical plate.

Material and methods. It is a prospective randomised study which included a total of 30 cases equally distributed into two groups.

Results. The mean PROMIS and MEPS scores for group A were 31.5 SD 6.6 and 77.7, respectively, compared to 33.7 SD 6.66 and 73, respectively, for the other group. Time to union was 13.4 weeks for group A and 12.6 weeks for the other group. There was no statistically significant difference between the groups regarding union and function. However, reconstruction plates were more cost effective. The correlation between the MEPS and PROMIS G scores in both groups was statistically significant.

Conclusion. 1. Recon plates continue to be a cost-effective method of treatment in simple intra-articular fractures. 2. PROMIS is a valuable tool to be used along with other scores in future studies.

Key words: PROMIS, bone union, MEPS score, reconstruction plates, locking plates, distal humerus fracture

BACKGROUND

Despite a low incidence, intra-articular fractures of the distal humerus have notorious and unpredictable outcomes [1,2]. The complex anatomy and various options of surgical treatments add up to expectation uncertainty [3].

Achieving anatomical reduction and sound fixation has been associated with risks, which depend on the ability to reduce the fracture intraoperatively, available bone stock and neurovascular structures [6]. The pre-contoured locking plate system has been introduced to overcome these challenges [4,5].

Reconstruction plates have been compared with locking plates in several biomechanical studies [6,7]. Moreover, there has been no agreement regarding the superiority of one system over the other. The surgeon's preference and experience often dictate the implant of choice [8-10].

The aim of this research was to detect differences in patient-related outcomes following the use of two different plate fixation systems. Secondary outcomes were clinical and radiological bone union, Mayo performance score, range of motion and implant-related complications.

MATERIAL AND METHODS

This study was conducted as a prospective randomized study using the closed envelope technique between April 2016 and April 2018. Patients who had sustained Type C intra-articular fractures of distal the

humerus were included. Inclusion criteria were age 20-60 years and no comminution. Exclusion criteria comprised open fractures, nerve or vascular injury, diabetics and rheumatoid patients, and the presence of associated injuries.

Two groups were formed. Group A had their fracture fixed using an anatomical locking plate system and the orthogonal method of fixation, Group B were fitted with a reconstruction plate system in the same orthogonal fashion.

Patients were assessed preoperatively in our clinic, including a history, skin examination, neuro-vascular status, and radiographs and CT of the elbow (Fig. 1).

Both groups were operated on in a single center by two upper limb specialists. The approach used was triceps sparing. Patients were followed up at 2, 6, 12 and 24 weeks (Fig. 2). Assessment comprised the patient's range of motion. Patient-reported outcome measurement information system (PROMIS G) allowed assessment of the patients' general and mental health (Tab. 1). The Mayo elbow performance score was administered at 12 months. Assessment of the radiological union was also performed.

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). Qualitative data were described using numbers and percentages. The Kolmogorov-Smirnov test was used to verify normality of the distribution. Quantitative data were described using ranges (minimum and maximum), means, standard deviations and

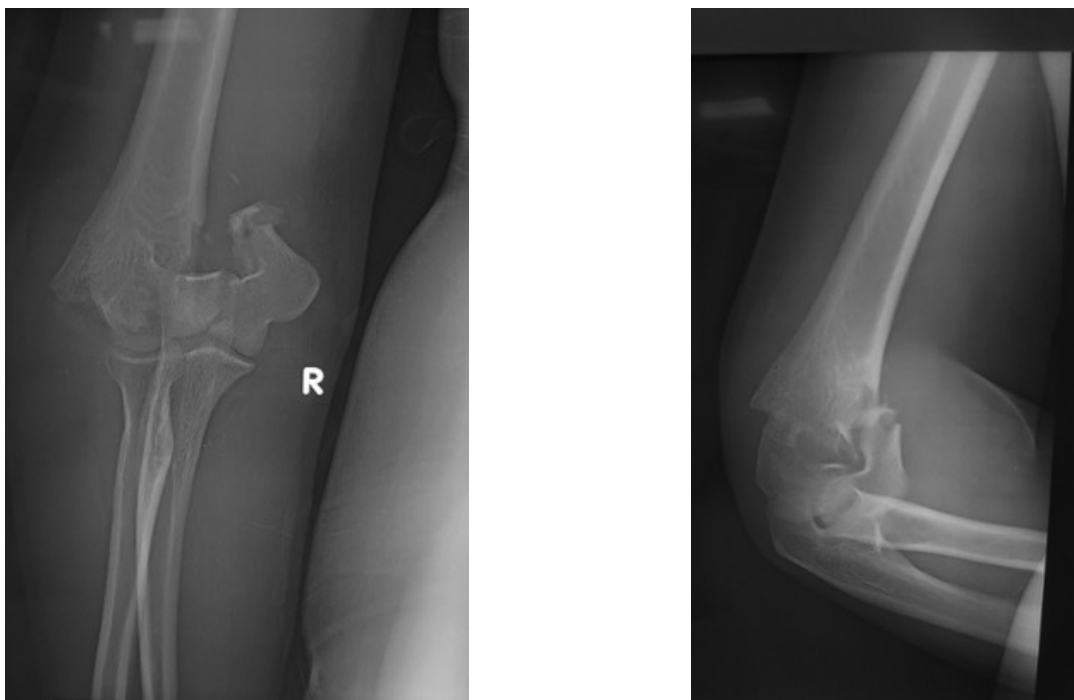


Fig. 1. Pre-op radiographs of Type C AO distal humerus fracture

Tab. 1. PROMIS G

Please respond to each item by marking one box per row		Excellent	Very good	Good	Fair	Poor							
Global 01	In general, would you say your health is:	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1							
Global 02	In general, would you say your quality of life is:	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1							
Global 03	In general, how would you rate your physical health?	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1							
Global 04	In general, how would you rate your mental health, including your mood and your ability to think?	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1							
Global 05	In general, how would you rate your satisfaction with your social activities and relationships?	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1							
Global 09	In general, please rate how well you carry out your usual social activities and roles. (This includes activities at home, at work and in your community, and responsibilities as a parent, child, spouse, employee, friend, etc.)	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1							
		Completely	Mostly	Moderately	A Little	Not At All							
Global 06	To what extent are you able to carry out your everyday physical activities such as walking, climbing stairs, carrying groceries, or moving a chair?	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1							
In the past 7 days		Never	Rarely	Sometimes	Often	Always							
Global 10	How often have you been bothered by emotional problems such as feeling anxious, depressed or irritable?	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1							
		None	Mild	Moderate	Severe	Very Severe							
Global 08	How would you rate your fatigue on average?	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1							
Global 07	How would you rate your pain on average?	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	<input type="checkbox"/> 9	<input type="checkbox"/> 10	
		No Pain			Worst Imaginable Pain								

Scoring:

Re-code Global07. The recoded score ranges from 1 to 5.

(0 No pain =5; 1, 2, or 3 =4; 4, 5, or 6 =3; 7, 8, or 9 =2; 10 worst pain imaginable =1)

After recoding, the

Global Physical Health score = SUM responses to G03 + G06 + G07 + G08.

Global Mental Health score = SUM G02 + G04 + G05 + Global10.

medians. Significance of the results was judged at the 5% level. and Spearman’s correlation method was used to detect correlation.

RESULTS

Forty-three patients were considered, of whom 30 patients were included, 11 were excluded and two patients declined participation (Fig. 3). Patient demographic data were as follows: mean age of the patients was 39.5 years and 42 years, respectively, for the anatomical and conventional groups. The study included 17 males, with 8 patients (53.3%) and 9 patients (60.0%), respectively, in the anatomical and conventional groups, and 13 females, with 7 (46.7%) patients and 6 (40%) patients in the anatomical and conventional groups, respectively.

The mechanism of the trauma was a high-velocity injury in 26 patients and a fall on an outstretched hand in 4 patients. Mean time to surgery was 8 days in Group A and 7 days in Group B. Time to union was 12 weeks (SD 3.4) in Group A while in Group B it was 13.3 (SD 2.6). The range of movement at 12 months (mean±SD of the arc of motion) was 123.3±11.3 and 114.3±13.3 in the anatomical and conventional groups, respectively.

At one year from surgery, the PROMIS G score was 31.5 (SD 6.6), PROMIS PHYSICAL HEALTH was 12.8 (SD 2.9) and PROMIS MENTAL HEALTH was 12 (SD 2.5) in Group A. In group B, PROMIS G was 33.7 (SD 6.66), PROMIS PHYSICAL HEALTH was 12 (SD 2.9) and PROMIS MENTAL HEALTH was 12.8 (SD 2.6).



Fig. 2. Post-op radiographs. A. Pre-contoured plate, B. Recon plate

Tab. 2. Summary of results

	Group A n 15	Group B n 15
Mean Age	39.5	42
Sex	M 8 F 7	M 9 F 6
Handedness	Dominant 14	Dominant 13
Range of movement	123.3±11.3	114.3±13.3
MEPS	77.7±22.7	73.0±21.7
PROMIS G	31.5 SD 6.6	33.7 SD 6.66

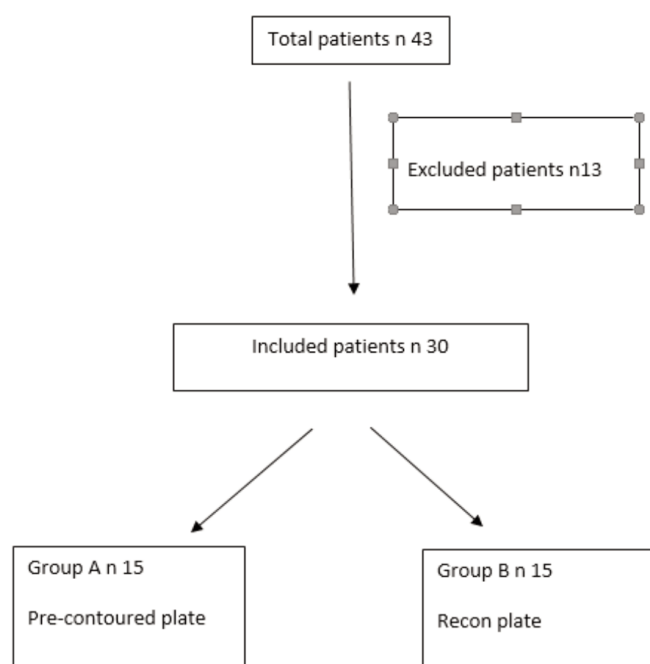


Fig. 3. Flowchart of patient selection

MEPS was 77.7 and 73.0 in the anatomical plate and conventional groups, respectively, at 12 months. In the anatomical plate group, 5 patients (33.3%) had a fair outcome and 10 patients (66.7%) had a good outcome, while in the conventional group, 7 patients (46.7%) had a fair outcome, and 8 patients (55.3%) had a good outcome. There was no significant difference between the groups regarding the Mayo score.

Spearman's correlation coefficient between Group A's MEPS & PROMIS G was 0.81341 p (2-tailed) = 0.00023. The association between the two variables would be considered statistically significant. Spearman's correlation coefficient between Group B's MEPS & PROMIS G was 0.59874, p (2-tailed) = 0.01836. The association between the two variables would be considered statistically significant.

Complications encountered comprised one case of transient ulnar nerve palsy in each group which resolved in six months' time and one case of superficial infection which was controlled with antibiotics.

DISCUSSION

This study reported a patient related outcome following elbow fractures and compared it to the Mayo score. We also used two different plate systems for fixation to assess whether there is any difference in outcomes between the two. We also had a comprehensive view of the patients' both physical and mental health by using PROMIS G.

Distal humerus fracture management presents numerous dilemmas in treatment as per review article by Ring et al. in 2000 [11,12]. We minimised the confounding factors, including patient- and surgeon-related factors. We conducted this study in otherwise healthy adult patients, and we randomised the allocation of plate fixation into two equal groups. Moreover, two expert upper limb specialists performed the surgery with a uniform approach.

The para-triceptal technique provides for excellent results according to Singh et al. (2019). Nevertheless, a meta-analysis in 2017 concluded that olecranon osteotomy had superior results to its triceps counterpart, but it added more morbidity [13-15]. The plate fixation was used in an orthogonal fashion which is equal in terms of outcomes to parallel ones, as shown in Shin et al. in 2010 [16].

A systematic review in 2018 highlighted that commonly used patient-related outcomes were the MEPS, DASH and VAS pain scores. Most studies have been inconclusive regarding a uniform measure and there is considerable variability in the literature regarding the procedures and patients and treatment strategies which affects the levels of evidence [17].

A few years ago, there were some concerns regarding loss of fixation and radiographic changes when comparing locked and non-locked systems. However, this factor did not affect the clinical outcome, as noted by Berkes et al. in 2011 [18]. In our study, there were no radiographic differences or metal work com-

plications in either group, which relates to advances in the engineering of medical implants and the experience of the surgeons.

Our study did not show any differences regarding the patients' scores between precontoured and recon plates. The PROMIS has been validated and used in several conditions [19-22]. This outcome does not include the range of motion and it shed lights on the mental health of the patients, which provides for a holistic assessment at follow-up visits.

Huang et al in 2004, acknowledged the use of the recon plate as producing good outcomes. They had 15 patients with Type C1 out of 40 cases included. Moreover, there were mixed results due to case-mixes [23]. In 2020, extra-articular Type A fractures managed with two different implants (locking vs non-locking) was assessed using MEPS, showing a statistically significant difference [24].

In 2008, Griener et al. used both the DASH and MEPS scores to assess the outcome. They had patients with a mixture of injuries who were all treated using locked plate systems to a good outcome in general according to both scores [25]. In 2017, the same evaluation tool was assessed in a slightly larger cohort of cases with both Type B and C AO distal humerus fractures treated with a locked contoured plate system, with the results comparable to other studies [26].

Shields et al in 2021, pointed out the importance of handedness on the outcomes, as injury in the non-

dominant limb had a negative influence on pain and function in cases with a long rehabilitation period [27].

Bhashyam et al in 2020 assessed PROMIS Global retrospectively in distal humerus fractures, adding a valuable tool in understanding the recovery of patients [28].

Our results did not show any difference in outcomes between two groups of patients with similar characteristics. Our reflection about the PROMIS global and its physical and mental health subscales, as this tool is independent of the range of motion, is that it truly reflects the patients' outcomes following treatment.

Regarding the positive correlation between the MEPS and PROMIS, it reflects on the necessity of having more than one valid scoring system to appreciate treatment results, as one may do well in one system but fail on the other.

From our experience, the pre-contoured plate is quite handy to use, but at the same time, recon plates required more time for pre-bending. Both systems did not affect the union rate or the outcomes.

CONCLUSIONS

1. Recon plates continue to be a cost-effective method of treatment in simple intra-articular fractures.
2. PROMIS is a valuable tool to be used along with other scores in future studies.

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