

Midterm clinical and radiological outcomes of the surgical treatment of complex AO type C distal humeral fractures with two different double plate fixation techniques

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Abstract

Introduction: The aim of this retrospective, case series was to report the clinical and radiological outcomes of plate fixation of AO Type C distal humeral fractures and to compare the two techniques, the double plate parallel fixation with the double plate orthogonal fixation.

Case Series: Twenty-six consecutive patients had their AO type C distal humeral fracture treated either with the orthogonal (group A: 15 patients; mean age 53.5 years, range 21-96) or the parallel (Group B: 11 patients; mean age 56.5 years, range 17-86) plate fixation. The patients were assessed clinically with the use of Mayo elbow performance index (MEPI), and the grading system of Jupiter as well as radiographically.

Twenty four patients (14 from group A and ten from group B) were available for follow-up. The mean follow-up for group A was 48.8 months and for group B, 33 months. According to MEPI, seven elbows were graded as excellent, five as good, one as fair, and one as poor in group A, whereas, in group B, six elbows were graded as excellent, and four as good. According to the Jupiter score, in group A the result was considered excellent in four cases, good in six, fair in three, and poor in one case, while three elbows were graded as excellent and seven as good in group B. Statistical analysis did not reveal any significant differences between the two groups in any of the parameters tested.

Conclusions: Our results provide further evidence that double plate fixation is an adequate treatment option with satisfactory mid-term results for these fractures and indicate that both configurations are equally effective. HIPPOKRATIA 2017, 21(1): 38-42.

Keywords: Distal humeral fractures, AO type C, plate fixation, parallel plate technique, orthogonal plate technique

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Introduction

Elbow fractures constitute about 7 % of adult fractures, with distal humeral fractures accounting for almost half of them. Their number has more than doubled in women older than 60 years within two and a half decades¹. Open reduction and internal fixation in anatomical position is currently the treatment of choice for these demanding fractures^{2,3} even in elderly osteoporotic patients⁴. Double plate fixation, with the placement of a separate strong plate on each column, is indicated in such fractures. Plates should be applied either at a 90° angle to one another (orthogonal plate fixation), as initially described by the AO/ASIF group, or at 180° to each other (parallel plate fixation), as later proposed by O’Driscoll⁵.

In the literature, several papers exist reporting satisfactory results with both techniques without any clear evidence of any possible superiority of the one method over the other. Through the years several modifications of these basic techniques have been proposed, and a variety of implants has been used^{2,5-7}.

The purpose of this study was to present the mid-term clinical and radiological results in a case series and to compare the treatment outcomes of these two techniques; the orthogonal and the parallel plate fixation. We retrospectively reviewed a series of consecutive patients with complex (AO type C) distal humeral fractures treated with both techniques in our institution.

Case series

Twenty-six consecutive patients with AO type C distal humeral fracture were treated in our institution from January 2006 to June 2009. Group A consisted of 15 patients (eight men, seven women) treated with the orthogonal plate technique (Figure 1), while the remaining 11 patients (six men, five women) constituting group B were treated with the parallel plate technique (Figure 2). Table 1 presents patients’ and fractures’ demographic data. There was no statistically significant difference among the two groups regarding patients’ age, sex, cause of injury, frequency of dominant hand involvement, specific fracture



Figure 1: Preoperative radiographs (a: frontal view, b: lateral view) of an AO Type C intraarticular distal humeral fracture. Postoperative radiographs (c: frontal view, d: lateral view) after internal fixation with the orthogonal plate technique.

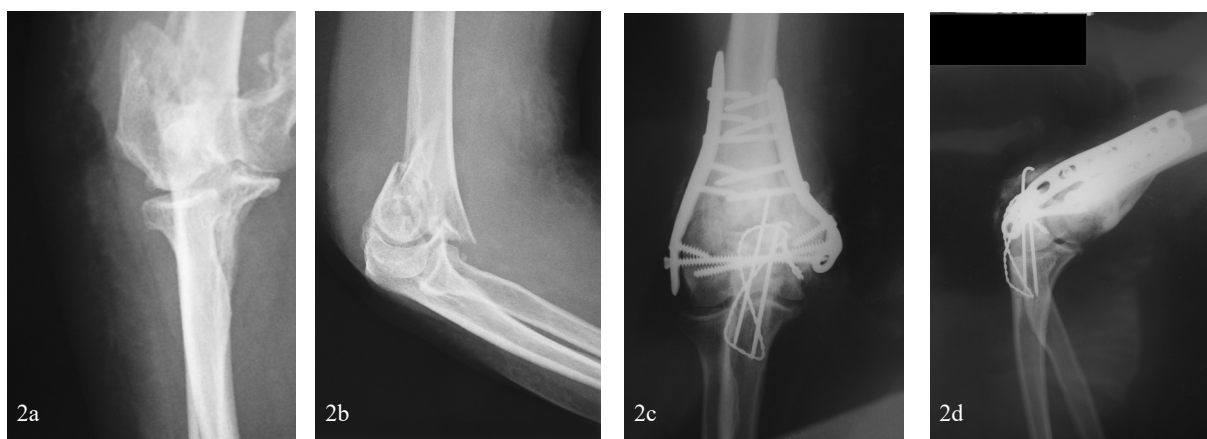


Figure 2: Preoperative radiographs (a: frontal view, b: lateral view) of an AO Type C, intraarticular, distal humeral fracture. Postoperative radiographs (c: frontal view, d: lateral view) after internal fixation with the parallel plate technique.

Table 1: Demographic data of the 26 consecutive patients with AO type C distal humeral fracture treated in our institution with either the orthogonal plate technique (group A) or with the parallel plate technique (group B).

	Group A (orthogonal)	Group (parallel)	Total
Number of pts (men, women)	15 (8, 7)	11 (6, 5)	26 (14, 12)
Mean age (range)	53.5 (21-96)	56.5 (18-86)	54.8 (18-96)
Dominant limb injured	12/15	9/11	21/26
High energy trauma (fall, traffic accident)	9/15	6/11	15/26
AO classification of fractures			
C1 type	3	2	5
C2 type	5	4	9
C3 type	7	5	12
Grade I open fractures (Gustillo/Anderson class. ¹²)	1	2	3
Radial nerve injury	0	1	1

subtype (C1, C2, C3) according to the AO classification, comorbidities, and presence of an open fracture. All 26 patients underwent surgery within 72 hours following their admission. Patients with open fractures were submitted to surgical debridement and definite fracture fixation within 24 hours after injury. Medical comorbidities that prevented early surgical intervention were responsible for the delays in fracture treatment. The study protocol was approved by our hospital's Ethical Committee.

Surgical technique

An intraarticular chevron-type transolecranon osteotomy was performed in all cases and was fixed with tension band wiring upon procedure completion. The ulnar nerve was constantly identified and protected but not routinely anteriorly transposed. The implants used in group A (orthogonal) were the 3.5 mm dynamic compression plates, 3.5 mm reconstruction plates, and in a few cases the Mayo Clinic Congruent Elbow Plates (Acumed,

Hillsboro, OR, USA) (Figure 1). In the parallel fixation group (Group B) the Mayo Clinic Congruent Elbow Plate was used in all cases (Figure 2). No locking screws were used in either group of patients. All fractures were operated by two experienced, specialized hand surgeons.

Postoperative Management

In most cases, the elbow was immobilized in extension with an anterior slab for approximately seven days postoperatively to reduce postoperative edema. In four cases no slab was applied. Following slab removal, a physiotherapy regime including active and passive motion was commenced in all cases. All patients were encouraged to perform active movements with their hand and elbow but were instructed to abstain from lifting, pushing or pulling heavy loads during the first six postoperative weeks. During this period, neither external protection such as a cast or a brace nor a continuous passive motion machine was used by any patient. In cases that range of motion failed to improve as expected postoperatively, a formal physiotherapy regime including active and passive elbow exercises was implemented.

Patients' Evaluation

The mean follow-up time was 48.8 months (range 24-58) for patients in group A and 33 months (range 24-50) for group B. This difference in the follow-up duration is explained by the fact that the parallel plate technique was introduced later than the orthogonal plate technique that had been routinely used in our institution for a longer period. Two patients, one from each group, were lost to follow-up and subsequently excluded from the study. The remaining 24 patients were evaluated clinically and radiographically at six weeks, three months, six months, one year postoperatively, and once annually afterward.

The overall results were rated with the use of Mayo elbow performance index (MEPI) and the system of Jupi-

ter which grades a result as excellent, in the lack of pain, combined with an elbow extension measuring at least 15° and an elbow flexion of at least 130°.

Postoperative radiographs were evaluated for fracture union, alteration in implant positioning, heterotopic ossification, and the development of arthritic changes. Heterotopic ossification was classified according to the Brooker classification⁸, which was modified to refer to the elbow joint.

The following parameters were statistically analyzed and compared between the two groups: pain, elbow extension, elbow flexion, elbow arch of motion, clinical result rated by the MEPI and the Jupiter evaluation systems.

Statistical Analysis

Normality of data was initially assessed with the Shapiro-Wilk test. The comparison of quantitative variables between groups was performed with Mann-Whitney U test. The association between qualitative variables was assessed with the Fisher's exact test since the expected cell counts were less than five. All reported p values are two-tailed with $p < 0.05$ considered as significant. Analyses were conducted using the Statistical Package for the Social Sciences (SPSS) for Windows, version 15.0 (SPSS Inc., Chicago, IL, USA).

Clinical Evaluation (Table 2)

At the time of the latest follow up visit, ten elbows were pain-free, two mildly painful, and two moderately painful in group A, whereas in group B, eight patients were pain-free and two reported a mild ache. Elbow extension loss averaged 21.4° (range 0°-30°) in group A, and 17° (range 0°-30°) in group B. Mean elbow flexion was 118.5° in group A (range 100°-140°) and 120° (range 100°-140°) in group B. The total flexion-extension arch of motion averaged 95.7° (range 70°-130°) in group A,

Table 2: Clinical and radiological evaluation of the 26 consecutive patients with AO type C distal humeral fracture treated in our institution with either the orthogonal plate technique (group A) or with the parallel plate technique (group B).

	Group A (parallel)	Group B (orthogonal)	Total
Mean follow-up in months (range)	48.8 (24-58)	33 (24-50)	
Lost from follow-up	1/15	1/11	2/26
Level of pain at last follow-up:			
none	10/14	8/10	18/24
mild	2/14	2/10	4/24
moderate	2/14	0/10	2/24
Elbow extension loss (range)	21.4° (0°-30°)	17° (0°-30°)	19.6° (0°-30°)
Elbow flexion (range)	118.5° (100°-140°)	120° (100°-140°)	119.1° (100°-140°)
Total flexion-extension arch of motion	95.7° (70°-140°)	103° (70°-130°)	98.7° (70°-140°)
Patients with moderate instability	2	2	
MEPI score in points (range)	85.4 (55-100)	86.5 (75-100)	85.8 (55-100)
excellent	7/14	6/10	13/24
good	5/14	4/10	9/24
fair	1/14	0/10	1/24
poor	1/14	0/10	1/24
Jupiter grading system			
excellent	4/14	3/10	7/24
good	6/14	7/10	13/24
fair	3/14	0/10	3/24
poor	1/14	0/10	1/24
Heterotopic ossification (Brooker 1 or 2)	3/14	2/10	5/24

and 103° (range 70°-140°) in group B. Two patients in each group displayed a moderate instability, which did not require further surgical treatment. The final postoperative range of motion was achieved at six months postoperatively and remained unchanged afterward.

At the most recent follow-up, the mean MEPI score was 85.8 points (range 55-100) (Group A: 85.4 points, Group B: 86.5 points). According to this score, 22 of the 24 elbows (91.66 %) were graded as good or excellent. In group A, seven elbows were graded as excellent, five as good, one as fair, and one as poor, whereas, in group B, six elbows were graded as excellent, and four as good.

According to the Jupiter grading system, in group A the result was excellent in four cases, good in six, fair in three, and poor in one case, while in group B, three elbows were graded as excellent, and seven as good. Statistical analysis performed did not reveal any statistically significant differences between the two groups in any of the parameters tested.

Radiographic Evaluation (Table 2)

All fractures healed primarily in both groups within three months, with the exception of one fracture in group A, which was complicated by infection in the form of elbow bursitis and required removal of the tension band wire at eight months postoperatively. Alteration of implant position that did not require further treatment was evident in one case in group B. All olecranon osteotomies performed for surgical approach united uneventfully.

Heterotopic ossification developed in three cases in group A and two cases in group B. All of them were classified as either Brooker stage 1 or 2, thus not requiring surgical excision.

Discussion

The main challenge faced when treating the complex AO type C distal humeral fractures is to obtain an anatomic reduction of the articular surface and sufficient stability to allow early and intense rehabilitation without risking a fixation failure^{9,10}. Double plate fixation, with the placement of a separate strong plate on each column, is indicated when treating these demanding fractures. Plates should be applied either at a 90° or 180° angle to one another⁵.

According to clinical studies reporting on the results of surgical treatment of the complex distal intraarticular fractures, good results were obtained both by using the parallel plate configuration, as well as with the orthogonal configuration^{2,5-7,11,12}. A study comparing the parallel and orthogonal plating systems concluded that although more patients had failed to achieve bony union in the perpendicular plating group, both configurations could provide adequate stability and anatomic reconstruction of the distal humerus fractures⁶. Two review papers pointed out that both systems were acceptable for achieving a stable fixation and that the controversy regarding the most reliable plate configuration still remained^{5,13}.

Luegmaier et al proposed the use of a Y-shaped recon-

struction plate for treating AO type C distal humeral fractures¹⁴. Greiner et al reported satisfactory results when using angular stable fixation of these complex fractures with anatomically preshaped plates¹⁵. A recent paper pointed out the importance of adequate orientation of the condyles to the shaft for achieving satisfactory clinical results³. Another study concluded that long-term results were similar to the short-term results, suggesting that the results are durable¹⁶. Ali et al reported the most important determinant of nonunion after surgery for distal humeral fracture, to be the adequacy of fixation¹⁷. On the contrary, Claessen et al concluded that patients' factors like obesity, diabetes mellitus, and radiographic osteoarthritis, rather than technical factors were associated with reoperation for loosening or breakage of implants and nonunion¹⁸.

There are several biomechanical studies in the literature, which aim to elucidate the most efficient configuration for plating distal humeral fractures. These studies tend to indicate the superiority of parallel plate configuration over orthogonal plate configuration¹⁹⁻²¹, but as discussed above, this is not directly supported by existing clinical data.

The orthogonal plate technique had been widely accepted and routinely used in our institution, before the introduction of the Mayo Elbow Congruent Plate System. The newer parallel configuration technique was used in our institution simultaneously with the longer applied perpendicular configuration technique. Both hand surgeons have applied both techniques in this series of patients.

Our clinical results are considered satisfactory and very similar to those reported in studies where newer implants with locking screws are used^{2,7}, which indicate that there are other, more important, factors than implant type in determining the outcome.

The current study has several advantages: only complete intraarticular AO type C fractures were included, only two experienced hand surgeons were involved, and no locking screws were used in any of the two groups. In this aspect, the almost complete absence of implant failure reflects the effectiveness of the fixation methods. As indicated by Korner et al in their biomechanical study⁹, the use of locking plates and screws would further enhance the fixation stability, especially in osteoporotic bone.

The study also has several limitations. First of all, it is a retrospective, case series. Moreover, patients' cohort was quite inhomogeneous regarding patients' age, while different implants were used when the orthogonal fixation was applied. Finally, the number of patients is relatively small and one could argue that although differences found were not significant, the study has not adequate power to detect less than gross outcome differences. The small differences found by both outcome scores (MEPI and Jupiter) were in favor of parallel plating method and may implicate a possible superiority of that technique, which failed to reach statistical significance.

An interesting finding in this series, is that all transolecranon osteotomies healed uneventfully, in accordance to some² but contrary to other studies²², where complications related to transolecranon osteotomy were reported in 9 of 29 cases. This fact further supports the belief that chevron-type transolecranon osteotomy, when performed correctly is a reliable approach not contributing to procedure's morbidity.

Our study is a case series reporting the treatment outcomes of intraarticular AO type C distal humeral fractures by use of two different double plating techniques and also providing some data comparing the orthogonal and the parallel fixation methods. Our results are in agreement with other existing clinical studies and indicate that both configurations are suitable for treating these fractures successfully, with no clear superiority of one configuration over the other. Further comparative studies with larger patients' numbers and adequate study design are required, to detect subtle differences and finally establish the best surgical technique for treating these demanding fractures.

Conflict of Interest

The authors declare no conflict of interest.

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