Osteosynthesis of Complex Fractures of the Distal Humerus. Our Experience

Fabián E. Muñoz, Emmanuel J. L. Rosso Guiñazu
Orthopedics and Traumatology Service, Policlínico Neuquén, Neuquén, Argentina

ABSTRACT

Objective: To describe the results obtained in the treatment of distal humerus fractures by open reduction and internal fixation (ORIF) and to reflect whether the approach used had an impact on the functional outcome. **Materials and Methods:** We carried out a retrospective case study of 19 patients with a diagnosis of complex distal humerus fracture who were treated with ORIF from 2015 to 2021. Periodic radiographic controls were performed and the functional outcome was evaluated using internationally known scales such as the DASH and Mayo Elbow performance Score (MEPS), then the variables obtained were extrapolated using statistical software. **Results:** A 100% consolidation rate was achieved; in 7 patients (37%), the Alonso Llames approach was used and in 12 cases (63%), we performed an olecranon osteotomy. The average DASH was 11.31, which determined mild disabilities. The MEPS obtained was excellent in 1 patient (5.26%), good in 10 (52,6%), fair in 7 (36.84%), and poor in 1(5.26%). When comparing the results obtained through the different approaches a P = 0.4197 was obtained in the ANOVA test and P =0.4723 in the Mann-Whitney/ Wilcoxon Two sample Test. **Conclusions:** We conclude that ORIF is effective in the treatment of complex fractures of the distal humerus, allowing the surgeon to obtain good post-surgical results. In this series, the average DASH was 11.31, with excellent and good results in 57% of the patients. We found no statistically significant difference regarding the choice of one approach or the other.
Key words: Osteosynthesis; distal humerus fracture; Alonso Llames; olecranon osteotomy.
Level of Evidence: IV

Osteosíntesis de fracturas complejas de húmero distal. Nuestra experiencia

RESUMEN

Objetivo: Describir los resultados obtenidos en el tratamiento de las fracturas de húmero distal mediante reducción abierta y fijación interna y reflejar si el abordaje empleado tuvo impacto en el resultado funcional. **Materiales y Métodos:** Se llevó a cabo un estudio retrospectivo de presentación de casos. Se evaluó a 19 pacientes con diagnóstico de fractura de húmero distal compleja tratados con reducción abierta y fijación interna entre 2015 y 2021. Se realizó un control radiográfico periódico y se evaluó el resultado funcional mediante escalas internacionales, como DASH y MEPS. Luego se procedió a extrapolar las variables obtenidas utilizando un programa estadístico. **Resultados:** Se logró la consolidación de todas las fracturas. Se empleó el abordaje de Alonso Llames en 7 pacientes (37%) y la osteotomía de olécranon en 12 casos (63%). El puntaje DASH promedio fue de 11,31, lo que determinó discapacidades leves. El puntaje MEPS obtenido fue excelente en un paciente (5,26%), bueno en 10 (52,6%), regular en 7 (36,84%) y pobre en 1(5,26%). **Conclusiones:** La reducción abierta y la fijación interna son eficaces para tratar las fracturas complejas de húmero distal, permiten lograr buenos resultados posquirúrgicos. En esta serie, el 57% de los pacientes obtuvo resultados excelentes o buenos. No se halló una diferencia estadísticamente significativa con respecto a la elección de un abordaje u otro.
Palabras clave: Osteosíntesis; fracturas de húmero distal, Alonso Llames; osteotomía de olecranon.
Nivel de Evidencia: IV

INTRODUCTION

Distal humerus fractures are infrequent injuries in our field, with a prevalence of 0.5% to 7%,[1,2] and they represent 30% of elbow fractures. In young people, these injuries are usually due to high-energy trauma.[1,2] In the elderly, often women, these injuries are considered low-energy and are generally due to a fall from their own height.

Received on March 20th, 2022. Accepted after evaluation on July 4th, 2022 • Dr. FABIÁN E. MUÑOZ • fabianneuquen@hotmail.com https://orcid.org/0000-0002-1859-3065
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96% of these fractures are of the CAO type,[1,2] which translates into intraarticular compromise and disabling sequelae, even with adequate treatment. The complex local anatomy, bony comminution, osteoporotic bone, and lack of bone stock present the surgeon with multiple challenges in treating these fractures.

Anatomical reduction of the joint surfaces, restoration of the anatomical limb axes, and stable fixation allow for early range of motion, which is key to good surgical outcomes. Early range of motion is very important after open reduction and internal fixation, because the elbow joint capsule is very prone to scarring and prolonged immobilization is associated with poor outcomes.[3]

The objective of this study is to communicate the functional outcomes obtained with two approaches of choice to treat distal humerus fractures, evaluated with standardized scales, such as Disabilities of the Arm, Shoulder and Hand (DASH)[4] and Mayo Elbow Performance Score (MEPS),[5] and reflect whether the approach used had an impact on the postoperative functional outcome.

MATERIALS AND METHODS

A retrospective case report study was conducted. Between 2015 and 2021, 23 patients with a diagnosis of distal humerus fracture were treated in our Service through open reduction and internal fixation; three patients were lost to follow-up. Patients >18 years of age with a follow-up of >1 year and a diagnosis of type B and C distal humerus fracture were included. Patients <18 years old, with open fractures, history of surgery and malunions were excluded.

Records of 20 patients (6 women and 14 men, average age 44 years) were found. The injuries had been caused by traffic accidents and falls from their own height. Eight fractures involved the left elbow and 12 the right elbow. According to the AO/ASIF classification system, 18 were type C and two were type B. Before the injury, they all carried out their daily activities normally. One case in which the Kocher approach was used was not considered; therefore, the sample contained 19 patients (Table 1).

A Chevron olecranon osteotomy approach (Figure 1) was performed for fractures with intra-articular involvement and an Alonso Llames triceps approach (Figure 2) for supracondylar fractures with minimal intra-articular involvement. The ulnar nerve was released and transposed, and plates were placed in both columns in an orthogonal and parallel arrangement, respecting the O'Driscoll criteria.[6] All patients were treated by the same surgical team. In type C fractures, after nailing and reduction of the fragments, and once the intra-articular facet was restored, transverse cannulated screws were placed. For fixation of the olecranon osteotomy, different means of fixation were used (tension band, cannulated screws, Kirschner pins).

Description of the approaches used

Alonso Llames: The patient is placed in the prone or lateral decubitus position. The injured arm is placed on a support that allows at least 90° of elbow flexion. A posterior midline incision is made between the medial and lateral brachial cutaneous nerves, curving laterally around the olecranon. The incision continues 5-8 cm distal to the tip of the olecranon. The fascia overlying the triceps brachii is identified, divided in the midline, and elevated with the dermis and subcutaneous tissue, creating two fasciocutaneous flaps. The dissection continues to the lateral and medial borders of the triceps at their respective interfaces with the posterior aspects of the intermuscular septa. In this way, the triceps muscle is separated from the posterior surface of the intermuscular septa. On the lateral aspect, the radial nerve and its concomitant vessels are identified passing from the posterior to the anterior compartment through the intermuscular septum approximately 10 cm proximal to the elbow.

The posterolateral humeral shaft is approached by elevating the triceps muscle from the posterior periosteum and retracting it medially. Distally and laterally, the dissection can be continued anterolaterally to the anconeus muscle, thus preserving its innervation and blood supply. Medially, the ulnar nerve is identified and exposed proximally in the posterior compartment. When a more proximal exposure of the humerus is required, the ulnar nerve can be followed further until it traverses the intermuscular septum from the anterior compartment.

Table 1. Study population data

Patient	Age	AO/ASIF Classification	Approach	DASH	MEPS
1	42	13C3.1	Olecranon osteotomy	9.16	Good
2	41	13C1.1	Olecranon osteotomy	3.33	Excellent
3	45	13C2.1	Olecranon osteotomy	4.54	Good
4	50	13C2.1	Olecranon osteotomy	13.33	Fair
5	23	13C2.1	Alonso Llames	5.10	Good
6	48	13C3.3	Olecranon osteotomy	15	Fair
7	48	13C3.3	Olecranon osteotomy	10	Fair
8	38	13C2.1	Olecranon osteotomy	4	Good
9	36	13C2.2	Alonso Llames	18.33	Fair
10	35	13C1.1	Alonso Llames	4	Good
11	63	13C1.1	Olecranon osteotomy	1	Fair
12	86	13C1.1	Alonso Llames	6.10	Good
13	28	13C1.1	Alonso Llames	5.5	Good
14	50	13C2.3	Olecranon osteotomy	11	Fair
15	40	13C2.3	Olecranon osteotomy	76.6	Poor
16	40	13C1.1	Alonso Llames	7	Good
17	36	13B3.1	Alonso Llames	4.40	Good
18	54	13C3.3	Olecranon osteotomy	10.33	Fair
19	50	13C3.2	Olecranon osteotomy	6.33	Good

DASH = *Disabilities of the Arm, Shoulder and Hand*, MEPS = *Mayo Elbow Performance Score*.

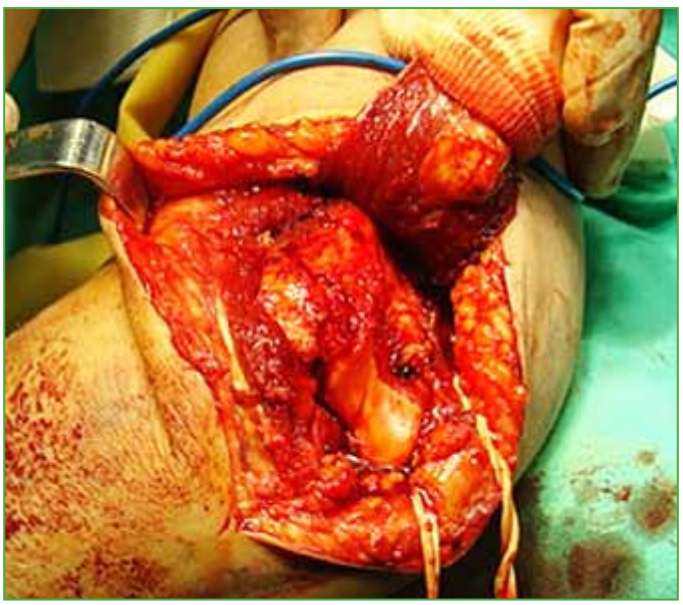

Figure 1. Approach with olecranon osteotomy.

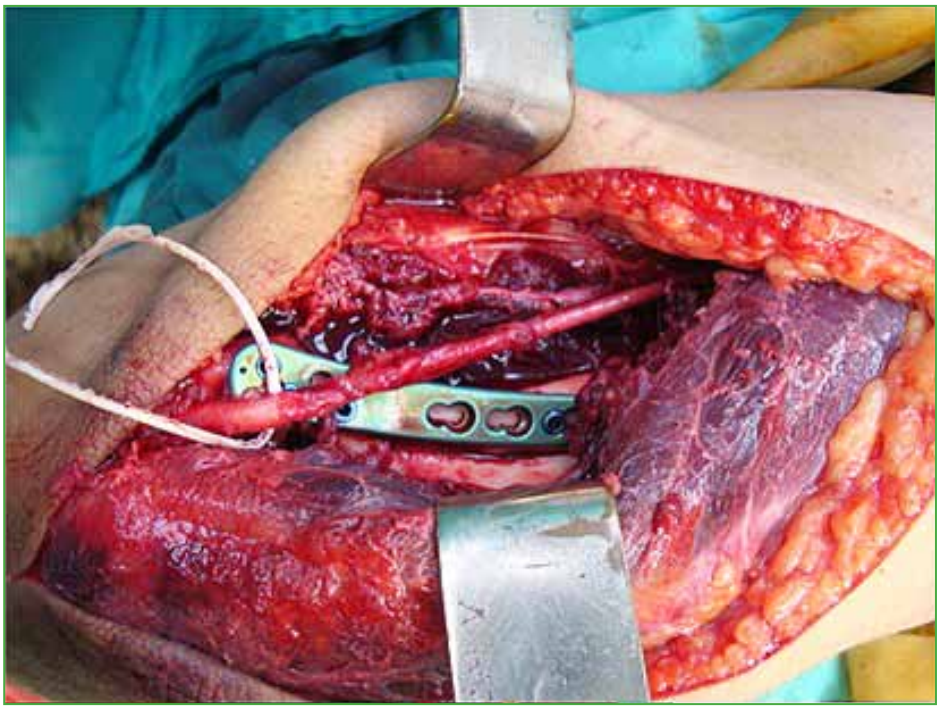

Figure 2. Alonso Llames approach.

Olecranon osteotomy: It is carried out with the patient in ventral decubitus, with a bloodless field, through a "V" osteotomy of the olecranon, in its middle third. The posterior capsule is transected and the olecranon with the triceps muscle and posterior periosteum are lifted proximally, exposing the entire posterior aspect and the distal end joint of the humerus. Prior to olecranon osteotomy or medial column work, the ulnar nerve must be released, mobilized, and protected; once osteosynthesis is completed, the nerve returns to its anatomical position[7] or is transposed.

A long arm cast is placed, with the elbow flexed at 90°, for the first five days after surgery. Then, the cast is removed to begin physical rehabilitation consisting of assisted passive range of motion exercises until the third week; assisted active range of motion exercises until the sixth week; active range of motion without restriction and without weight-bearing from the sixth to the eighth week; and strengthening and weight-bearing exercises from the eighth week (Figures 3 and 4).

Statistical analysis

Continuous variables are presented as median and interquartile range, and categorical variables are presented as proportions. The ANOVA test (parametric test for inequity in population medians) and the Mann-Whitney/Wilcoxon two-sample test were used to compare continuous variables. A p-value <0.05 was considered statistically significant. The EPI Info program, version 7.2.5.0, was used for the statistical analysis.

Figure 3. Clinical case. Pre-surgical tomographic images showing a dislocated complex fracture of the distal humerus.

Figure 4. Clinical case. Post-surgical anteroposterior and lateral control radiographs. Reduction and osteosynthesis of a fracture of the distal humerus.

RESULTS

Of the 19 patients who followed treatment, 100% consolidation of fractures and osteotomies was achieved, without implant failure or material migration. The average consolidation time was 3.5 months, anatomical reduction was achieved in 8 patients; 9 were satisfactory and 2 were poor. In 7 patients (37%), the Alonso Llames approach was used and, in 12 cases (63%), olecranon osteotomy.

The mean DASH[4] score was 11.31 (range 1-76), indicating mild disabilities; the average DASH score of the patients with olecranon osteotomy was 13.7 and that of those with the Alonso Llames approach, 7.20 (Table 2). The MEPS[5] obtained was excellent in one patient (5.26%), good in 10 (52.6%), fair in seven (36.84%) and poor in one (5.26%) (Table 3). The average arc of extension and flexion was 21° (range 0-40°) to 125° (range 100-140°), pronation and supination were 75° (range 60-85°) and 68° (range 60-85°). 60°-80°), respectively.

After extrapolating the data obtained in the DASH functional scale, the statistical analysis of the variables was carried out using the EPI info tool of the CDC. When comparing the results obtained through the different approaches, a value of P = 0.4197 was obtained in the Anova test and a value of P = 0.4723 in the Mann-Whitney/Wilcoxon Two Sample Test. (Tables 4 and 5)

Table 2. Postoperative assessment with the DASH scale

	DASH mean ± SD	Average
Alonso Llames	5.50 ± 5.00	7.204
Olecranon osteotomy:	9.58 ± 20.25	13.718
Total	6.33 ± 16.41	11.318

DASH = Disabilities of the Arm, Shoulder and Hand, SD = standard deviation.

Table 3. Postoperative assessment with the MEPS scale

MEPS	Frequency	Percentage
Excellent	1	5.26%
Good	10	52.63%
Fair	7	36.84%
Poor	1	5.26%

MEPS = Mayo Elbow Performance Score.

Table 4. ANOVA, parametric test for inequity in population median

VARIATION	SC	gl	MC	F-statistic
Between	187.5977	1	187.5977	0.6480
Within	4662.8275	17	274.2840	
Total	4850.4253	18		
p	0.4197			

Table 5. Mann-Whitney/Wilcoxon two-sample test (Kruskal-Wallis test for two groups)

Kruskal-Wallis H	0.5165
Degrees of freedom	1
p	**0.4723**

One patient had a late post-surgical infection with osteomyelitis that required the removal of the osteosynthesis material and infectious treatment, for which the consolidation and rehabilitation time was prolonged; this case had the worst post-surgical evolution with a DASH score of 76.6% and a poor MEPS.

Another patient presented signs compatible with neuropraxia of the ulnar nerve, but did not require other interventions, and evolved favorably, with complete restoration (Figure 5).

Figure 5. Clinical Case. Arc of motion 6 months post surgical treatment.

DISCUSSION

The goal of treatment of distal humerus fractures is to achieve anatomic reduction, with a stable and painless elbow. The surgeon must restore the complex local anatomy to achieve early and complete rehabilitation. The lack of bone stock and the osteoporotic bone make it technically difficult to achieve the objective.

The approach of choice for the resolution of complex fractures of the distal humerus is still a matter of controversy. Currently, there are multiple well-described approaches available to the surgeon, some of the most widely used are: Bryan Morrey, Alonso Llames and olecranon osteotomy.[3] In cadaveric studies, the percentage of exposed joint surface has been quantified and the olecranon osteotomy was found to be superior, most authors advocate the transolecranon approach in AO type C fractures.[1,2,8,9,10] However, the functional outcomes associated with each approach remain uncertain.

In the systematic review by Ljungwuist KL et al.,[3] functional outcomes were reviewed in 133 published complex fractures of the humerus. The authors reported more complications and reinterventions associated with olecranon osteotomy, and concluded that, in the absence of a reference pattern of elbow functional outcomes and in the absence of studies, it is very difficult to recommend one technique over another, since no significant differences were found between one approach and the other.

In our series, the choice of the approach route focused on the involvement of the facet joint. Cases with intra-articular involvement were approached through an olecranon osteotomy, whereas patients with minimal involvement of the facet joint were approached through the paratricipital approach. More complications occurred in the olecranon osteotomy group related to ulnar union, but functional outcomes were satisfactory in most patients.

The management of the ulnar nerve is a subject of controversy, since many authors prefer transposition. In the meta-analysis by Shearin et al., it was concluded that ulnar transposition increased the risk of neuropraxia and the authors proposed in situ decompression as a routine method,[11] advising not to use medial plates when it is mechanically possible. In our series, there was only one case of ulnar neuropraxia that healed spontaneously, we routinely transposed the ulnar nerve.

Reduction and osteosynthesis with double plate is currently the most widely used method, some series report good to excellent outcomes in 65-100% of patients. The traditional method was to apply the plates perpendicular to each other at 90°, this has been challenged by the introduction of parallel column plates that use a medial and lateral configuration, and allow long screws to interdigitate distally, maximizing the stability of the columns.[1,6,8,12,13] In the systematic meta-analysis by Xiaohan et al., it is argued that, although the orthogonal and parallel methods are effective in the treatment of distal humerus fractures, the times of fracture healing are better with the parallel method.[1]

CONCLUSIONS

Technical advances and technological developments in materials such as new implant designs allow the surgeon to achieve good surgical outcomes in the treatment of distal humerus fractures.

The different approaches used have not had statistically significant differences in the functional outcome of the patients. We have noticed a longer healing time in patients treated with olecranon osteotomy, which we infer has to do with the healing of the ulna. This approach allowed the best exposure and visualization of the articular facet of the distal humerus, and although the Alonso Llames approach respects the extensor apparatus, it would be the choice in those fractures that do not compromise the joint.

The surgeon has multiple approaches to treat this pathology. According to our experience, the choice of approach should be the one he or she considers best for the resolution of the fracture. We conclude that the transolecranon approach should be the choice in those fracture lines that present compromise of the articular facet, relegating the tricipital approach to cases without joint compromise.

Conflict of interest: The authors declare no conflicts of interest.

E. J. L. Rosso Guiñazu ORCID ID: https://orcid.org/0000-0003-3987-236X

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