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ORIGINAL ARTICLE

Treatment of proximal humeral fractures using plate osteosynthesis

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KEYWORDS

Proximal humeral fractures;
Plate osteosynthesis;
Humeral fractures treatment

Abstract

Objective: To analyse the results obtained with the structured plate in proximal humeral fractures compared with other types of treatment.

Patients and methods: The results of 61 patients with a proximal humeral fracture, treated by means of osteosynthesis with a structured plate. The fractures were classified according to Neer, analysing the complications found, as well as their treatment.

The majority of fractures were in women (85%); the mean patient age was 64 years (range 20-78), and mainly on the non-dominant (60%). The fractures were in 3-fragments in 65%. Only 75% were treated with a plate, and the rest with bone graft or replacement, Kirschner needle or compression screw.

The mean follow-up time was 20 months (16-32). The influence of the type of fracture, age and sex of the patient were analysed. The clinical assessment included, pain, strength, mobility, daily activity and patient satisfaction.

Results: A total of 80% of patients were satisfied with this treatment, with 77% have good mobility and 78% with no or mild pain. There were 16 (26%) complications, with half of them requiring repeat surgery.

Conclusions: Osteosynthesis with a structured plate is an acceptable technique in proximal humeral fractures, with good results provided that there is rigorous selection of the patients and the technique.

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PALABRAS CLAVE

Fracturas proximales de húmero;
Osteosíntesis con placa;
Tratamiento fracturas de húmero

Tratamiento de las fracturas de tercio proximal de húmero mediante osteosíntesis con placa**Resumen**

Objetivo: Analizar los resultados obtenidos con la placa conformada en las fracturas de tercio proximal de húmero, en comparación con otro tipo de tratamientos.

Pacientes y métodos: Se presentan los resultados de 61 pacientes con fractura de tercio proximal de húmero, tratados mediante osteosíntesis con placa conformada. Las fracturas han sido clasificadas según la clasificación de Neer, estudiando las complicaciones encontradas, así como el tratamiento de las mismas.

La mayoría de fracturas se produjeron en mujeres (85%), la edad media fue 64 años (20-78), con predominio por el lado no dominante (60%). Las fracturas fueron en 3 fragmentos en un 65%. Se trataron solo con placa el 75% en el resto se asoció injerto o sustitutivo óseo, aguja de Kirschner o tornillo a compresión.

El tiempo medio de seguimiento fue de 20 meses (16-32). Se analizaron la influencia del tipo de fractura, la edad y el sexo de los pacientes. La valoración clínica estudió el dolor, fuerza, movilidad, actividad cotidiana y satisfacción del paciente.

Resultados: Un 80% de los pacientes refirió encontrarse satisfecho con este tratamiento, presentando un 77% buena movilidad y un 78% ausencia o dolor leve. Las complicaciones encontradas fueron 16 (26%), requiriendo una nueva cirugía la mitad de ellas.

Conclusiones: La osteosíntesis con placa conformada es una técnica aceptable en las fracturas de la extremidad proximal de húmero, con buenos resultados siempre que la selección de pacientes y la técnica sean rigurosas.

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Introduction

Fractures of the proximal end of the humerus are very common, accounting for up to 10% of all fractures, with an incidence rate of 6.6/1,000 people and year; their incidence increases with age.¹ This is why their treatment is the subject of debate and the reason they pose difficulties in treatment, given the almost systematic association of osteoporosis.² To date, the various existing classifications, apart from causing considerable confusion, fail to help when determining the most convenient treatment. This explains why treatment is as diverse as ever and why the results attained with the different techniques cannot be compared.³

We present a retrospective study of 61 proximal fractures of the humerus all treated in the same way; i.e., using a preformed plate, in an attempt to establish the cases in which this is an advisable indication and at the same time, advising as to which cases should not be candidates for treatment using this method.

Patients and methodology

We conducted a retrospective analysis of the outcomes of treatment by means of osteosynthesis with a plate for fractures of the proximal third of the humerus in a total of 61 cases treated at our department from April 2000 to March 2006.

The inclusion criteria consisted of proximal humeral fractures into 2, 3, and 4 fragments, and fracture-dislocation

into 3 and 4 fragments, in patients in acceptable physical condition, that were independent, cortical [fractures] of the humerus with sufficient density bone. In and of itself, age was not a factor to be taken into consideration. The diagnosis was made by means of simple, antero-posterior and lateral x-ray⁵ in the scapular plane; an axillary radiograph, and a CAT (useful in cases of fragmentation and head impaction, as well as the thickness of the head, so as to assure good anchoring of the screws). All the patients underwent procedures with a deltoid-pectoral approach and osteosynthesis with a preformed plate (Waldemar-Link). Special care was given to avoid damaging the vascularization of the fragments so as to not provoke avascular necrosis of the humeral head.

In terms of gender, there was a predominance of females, 52 cases, which corresponded to 85% with 9 cases in males (15%). The left side was affected in 38 cases (60%) and in

Table 1 Distribution of the number and percentages of the types of fracture observed in the series under study

Types of fracture	n	%
2 fragments	13	23
3 fragments	40	65
4 fragments	4	6
3 fragments with dislocation	3	4
4 fragments with dislocation	1	1
Total	61	100

23, it was the right side (40%). In short, the non-dominant side was involved in 60% of the cases. The mean age was 64 years, (range 20-78). The patients were over the age of 55 in 53 cases and under this age in 8; this points toward the importance of osteoporosis in this type of fracture, as well as the mechanism of production which was of low energy in 88% (54 cases) and high energy in a mere 7 cases.

The types of fractures observed were; 40 cases presented 3 fragments (65%), 13 had 2 fragments (23%), 4 exhibited 4 fragments (6%), 3 cases had fracture-dislocation in 3 fragments (4%), and 1 case of fracture-dislocation had 4 fragments (1%) (table 1). The treatment performed in 45 cases was osteosynthesis with only a preformed plate. In 6 cases, bone replacement was added to the plate. In 5, the plate was supplemented with a PDS suture. In 3 cases, compression screws were added; an autograft was added in another case and in one other case, Kirschner wires were added.

The following epidemiological data were examined: gender, age, handedness, mechanism of production, and type of fracture. Neer's classification⁴ is used to describe the type of fracture; said classification studies the number of fragments (4 possible fragments) and the presence or absence of associated dislocation. It considers displacement when there is a separation of more than 1 cm and angulation is in excess of 45° with respect to the other fragments.

The association of the different types of fracture with age and type of surgical treatment undertaken was studied. Results were studied on the basis of pain, strength, mobility, recovery of daily activities, and the degree of patient satisfaction, according to the Constant-Murley test. Outcomes were also studied according to the type of fracture. Finally, complications were analyzed according to the type of fracture, as well as in terms of whether or not they required surgery.

Results

Fracture types varied according to age. The mean age of the individuals with two-part fractures was 56 years; in the case of 3 fragments, the mean patient age was 66; subjects with 4 fragments had a mean age of 72; the mean age of people presenting fractures-dislocations in 3 fragments was 70 and for those who displayed fractures-dislocations in 4 fragments, the mean age was 77 years. Patients were followed up for a mean time of 20 months, with a range of 18 to 30 months.

In analyzing the treatment dispensed, osteosynthesis with a plate with or without supplements, based on fracture type, we found that the 13 fractures in 2 fragments required

a plate in 10 cases, a plate with bone replacement in 2 cases, and a plate with autograft in another one. The 40 fractures with 3 fragments were resolved only with plates in 34 cases; in 2 cases, plates with bone replacement were needed; in 1, a plate with PDS suture was used, and in 3 fractures, treatment consisted of plates with compression screws. In the 4, 4-part fractures, a plate only was used in one; plates with PDS sutures were used in 2, and a plate with Kirschner wires was used in the remaining 1 fracture. The 3 cases of fracture-dislocation in 3 fragments, two fractures required plates with bone replacement and one case was treated with a plate with PDS suture. The 4-part fracture-dislocation required plating with PDS suture.

Clinical outcomes were assessed on the basis of pain, daily activities, strength, mobility, and the degree of patient satisfaction (table 2).

In terms of the Constant-Murley test, 78% of the patients reported mild pain or none at all (values 10-15). The strength score ranged between 20 and 25 in 59% of the patients. Mobility was rated between 20 and 39 points in 77% of the cases. Seventy-seven percent of the patients recovered their regular daily activity and 80% of the patients who underwent surgery felt satisfied (good or excellent results) at the end of the follow-up period.

Results were good and free of complications in 10 of the 13 fractures in 2 fragments (77%) and in 34 of the 40 fractures in 3 fragments (85%). However, complications appeared in the 4 cases of 4-part fractures (100%), in 2 of the 3 fractures-dislocations in 3 fragments (67%), and in the fracture-dislocation in 4 fragments (100%).

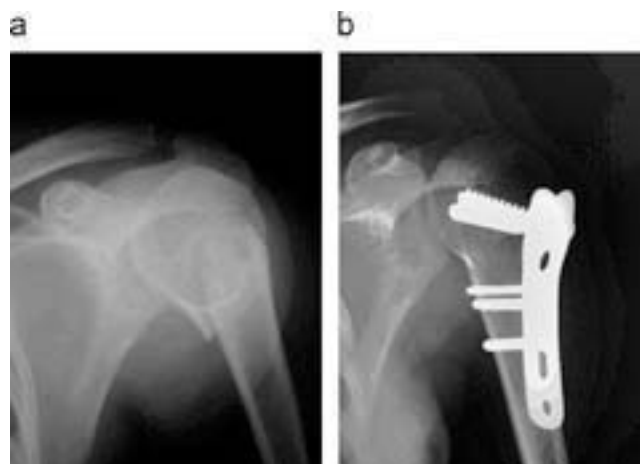


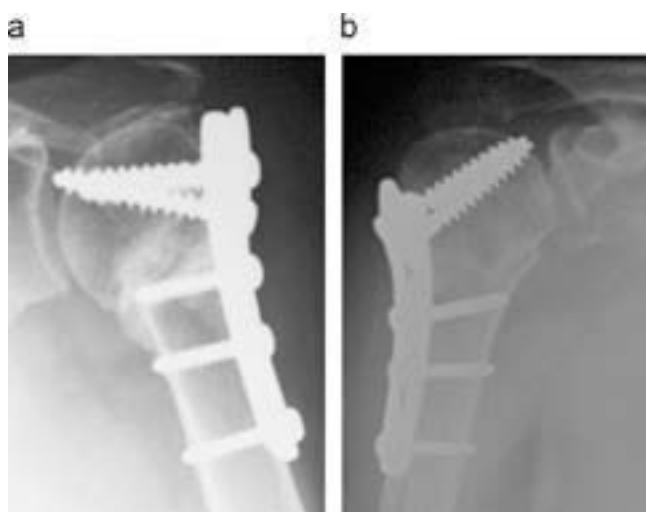
Figure 1 Preoperative (a) and postoperative (b) image of a proximal humeral fracture with stable osteosynthesis in a 34-year old female with a 2-part fracture.

Table 2 Grouping of the overall results and outcomes according to the sections of the Constant-Murley test

Pain	n	%	Strength	n	%	Mobility	n	%	Activities	n	%	Global	n	%
0-4	4	7	0-9	4	7	0-19	14	23	0-7	14	23	Excellent	13	21
5-9	9	15	20-19	21	34	20-29	33	54	8-15	30	49	Good	36	59
10-15	48	78	20-25	36	59	30-40	14	23	16-20	17	28	Fair/ poor	12	20

Table 3 Distribution of the complications observed according to Neer's classification fracture type

Complication	2 fragments	3 fragments	4 fragments	fract-disloc 3 frag	fract-disloc 4 frag	Total
Infection		1				1
Neurological injury				1	1	2
Pseudoarthrosis	1		2	2		4
Südeck's atrophy		1				1
Screw protrusion	1	2				3
High plate	1	1				2
Poor consolidation		1	1			2
Cuff injury			1			1

**Figure 2** Complications due to articular screw protrusions in: a) 69-year old female with a fracture in 3 fragments, and b) 55-year old male with a 2-part fracture.

The outcomes analyzed by age were optimal and complication-free in 7 of the 8 cases of patients under the age of 55 years (88%) and in 38 of the 53 subjects who were older than 55 (71%). On the basis of the gender, the results were good in 7 of the 9 males (78%) and in 38 of the 52 females (73%). Pooling the results of the age and gender parameters, we find poorer outcomes in females over the age of 55 years. There were no complications after a mean follow-up of 20 months in 74% of the patients (fig. 1).

The complications detected consisted of 16 (26%), one infection, 2 neurological injuries, 4 cases of pseudoarthrosis, one case of Südeck's disease, 3 articular screw protrusions, 2 plates implanted too high, 2 defective consolidations, and one case of rotator cuff injury. The number of complications was high overall, mainly in certain types of fracture and in older patients (table 3). The 3 cases of articular screw protrusions were in patients over the age of 55 years and two of them were women who associated significantly diminished bone mass density. In the 3 cases the screws used were 45 mm or longer (fig. 2).

Eight of the 16 complications (50%) required revision surgery 3 cases of pseudoarthrosis, two of which necessitated a partial prosthesis of the shoulder and in the other one, the

plate was removed and a new osteosynthesis with autograft was put into place; three cases presented articular screw protrusion through the head and in two cases the screws were replaced with shorter screws and in the other case, a partial prosthesis of the shoulder was implanted. In the case in which the plate was placed too high, it was removed after the fracture had consolidated and, finally, in another case of poor consolidation of the tuberosities, a partial prosthesis of the shoulder was needed. Conservative treatment was the treatment of choice in the remaining complications.

Discussion

Proximal humeral fractures are very common and although the incidence rate is increasing with age, they are very disabling.⁶ The loss of mobility of the upper limb and pain generally remain as sequelae, which means that treatment should be aimed at achieving the maximum recovery of function possible without pain. There is a host of procedures that seek to attain these aims, albeit many cannot simultaneously achieve anatomical reduction with robust fixation that enables early, safe mobilization, while at the same time they do not stand out as being particularly anatomy-sparing, adding irreversible soft tissue damages that will keep the patient from achieving an acceptable outcome.

The discussion emerges when determining the best treatment for each patient bearing in mind their age and activity, the type of fracture to be treated, and bone quality. There are no studies that are sufficiently homogenous or that have enough cases as to properly answer these questions.³

Thus, in fractures having two fragments, some authors advocate the use of intramedullary pins, since they claim that osteosynthesis with a plate causes more complications.⁷ Robinson et al⁸ speak of the superiority of intramedullary osteosynthesis with respect to plates that are screwed into place in older patients with osteoporosis. However, Court-Brown et al⁹ do not recommend intramedullary fixation with a flexible nail and cerclage of the proximal fragment in 2-part fractures and instead, prefer conservative treatment. Nevertheless, in our series we have seen that treatment with a preformed plate in fractures with 2 fragments offers a good result in 77% of the cases. In fractures consisting of 3 fragments, the recommended treatment is osteosynthesis by means of a plate, given that in the remaining techniques the

assembly tends to fail as a result of the existing osteopenia in these patients.^{10,11} In the case of plates, interarticular penetration of the screws is a possibility with the use of plates, particularly when the screws are locking screws.¹²⁻¹⁴ Experience has shown that cephalic screws should not be more than 45 mm in length in any case. Longer screws, even in males, can protrude when the fracture is impacted. In our revision, the outcomes in fractures with 3 fragments were optimal, with good results and without any complications in 85% of the patients. Naturally, with this type of treatment, cases with osteoporosis must be avoided or when there is shattering of the internal cortical bone of the humerus, although this is usually associated with the osteoporosis.¹⁵

The demographic characteristics in this study did not differ from those published in the literature.^{16,17} Rose et al,¹⁸ in a study of 16 osteosynthesis of the proximal third of the humerus, with a mean follow-up of 12 months, and four surgical revisions due to pseudoarthrosis and 12 good results, relating outcomes with shattering, osteoporosis, smoking status, and 3-part fractures [sic]. Smith et al¹⁹ published a series of 82 cases with 42 complications and 21 surgical reinterventions to rule out 12 incomplete reductions, 9 consolidation delays, and 16 cases in which fixation was lost.

In the 4-fragment fractures, as well as in the fractures-dislocations with 3 and 4 fragments, treatment consisting of osteosynthesis with a plate has not yielded such good results^{3,20} [and we therefore] favour other treatments, preferably hemiarthroplasties. In our study, all the 4-fragment fractures and fractures-dislocation in 4 fragments suffered complications, as well as 67% of the fractures-dislocations in 3 fragments.

Osteosynthesis with a preformed plate is an advisable technique for 2- and 3-part proximal humeral fractures,^{13,21-24} with good or very good results, as long as the technique and the selection of patients are strict.

Osteosynthesis of the proximal end of the humerus must endeavour to get the screws to go to the centre and postero-superior and postero-inferior quadrants, which are the areas that have the greatest bone density of the humeral head,²⁵ in order to achieve firm anchorage.

The complications in our revision, despite that they appear to be quite numerous (26%), are surgically avoidable and the systematic use of bone graft or similar is advised in cases of poor bone density, given that they are older patients with osteoporosis.

The works published that followed conservative treatment or minimally invasive surgical techniques^{26,27} have worse clinical outcomes and a similar rate of complications. The advantages of conservative treatment over surgical treatment in these types of fracture²⁸ flies in the face of most of the works reviewed²⁹⁻³¹ and confirms the technical difficulty and the need for surgical expertise that these types of fracture require; be that as it may, if a stable anatomical reduction is achieved and no further damages are inflicted during surgery, the outcomes will undoubtedly be better than with any other kind of treatment.

Conflict of interest

The authors have not received any economic aid to carry out this work, nor have they signed any kind of agreement

by virtue of which they receive any kind of benefit or fees from any commercial entity. On the other hand, no commercial entity has pay or will pay any foundation, educational institutes, or other non-profit organizations the authors may belong to. The work has been conducted in line with the recommendations of ethical responsibility regarding the protection of humans.

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