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Original Article

Results of open reduction and internal fixation of severe fractures of the proximal humerus in elderly patients☆,☆☆

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ARTICLE INFO

Article history:
Received 22 March 2013
Accepted 20 May 2013

Keywords:
Humeral fractures
Elderly
Fracture fixation, internal
Avascular necrosis

ABSTRACT

Objective: To evaluate clinical and radiological results with open reduction and internal fixation of severe fractures of the proximal humerus in the patients over the age of 60 years.
Methods: Between June 1992 and February 2011, 21 patients with FGEPU over the age of 60 years were treated by open reduction and internal fixation at the Group of Shoulder and Elbow Department of Orthopaedics and Traumatology of Santa Casa de São Paulo Medical School. 18 patients were reviewed.
Results: Two patients had excellent results, 12 good, three regular and one bad. Therefore, we find that 77.7% of these had good and excellent results. All patients were satisfied with the treatment and only three patients did not return to previous activities. Mean postoperative mobilities were 122° elevation (90–150°), 39 lateral rotation (20–60°) and medial rotation of T11 (T5 to sacro iliac joint).
Conclusion: Open reduction and internal fixation of FGEPU may also be indicated for elderly patients and obtained 77.7% of good and excellent results. Statistically ($p < 0.05$), the anatomical reduction of the fracture was found to be important for obtaining good results.

Avaliação dos resultados da redução aberta e da fixação interna das fraturas graves da extremidade proximal do úmero em idosos

Palavras-chave:
Fraturas do humero
Idoso
Fixação interna de fraturas
Necrose avascular

RESUMO

Objetivo: avaliar clinica e radiologicamente os resultados obtidos com a redução aberta e a fixação interna das fraturas graves da extremidade proximal do úmero (FGEPU) na população com idade igual ou superior a 60 anos.
Métodos: entre junho de 1992 e fevereiro de 2011, o Grupo de Ombro e Cotovelo do Departamento de Ortopedia e Traumatologia da Faculdade de Ciências Médicas da Santa Casa de

☆ Please cite this article as: Miyazaki AN, et al. Avaliação dos resultados da redução aberta e da fixação interna das fraturas graves da extremidade proximal do úmero em idosos. Rev Bras Ortop. 2014;49:25–30.

☆☆ Study conducted at Group of Shoulder and Elbow, Department of Orthopaedics and Traumatology of Santa Casa de São Paulo Medical School, Santa Casa de São Paulo, São Paulo, SP, Brazil.

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2255-4971/$ – see front matter
http://dx.doi.org/10.1016/j.rboe.2014.01.002

São Paulo tratou, com redução aberta e fixação interna, 21 pacientes com FGEPU e com idade superior a 60 anos. Desses, 18 foram reavaliados.

Resultados: dois pacientes evoluíram com resultados excelentes, 12 bons, três regulares e um ruim. Portanto, verificamos que 77,7% evoluíram com bons e excelentes resultados. Todos os pacientes estavam satisfeitos com o tratamento e apenas três não retornaram às atividades prévias. As médias de mobilidade pós-operatória foram de 122° de elevação (90°–150°), 39° de rotação lateral (20°–60°) e T11 de rotação medial (T5 a Glúteo).

Conclusão: a redução aberta e a fixação interna das FGEPU podem ser indicadas também para pacientes idosos e obtivemos 77,7% de bons e excelentes resultados. Estatisticamente ($p < 0,05$), a redução anatômica da fratura mostrou-se importante para a obtenção de bons resultados.

Introduction

Fractures of the proximal end of the humerus in four parts and fracture-dislocations in three parts are characterized by loss of joint congruity and severe impairment of vascularity of humeral head.[1,2] The epiphyseal fractures, that compromise the head of humerus, are infrequent, being caused by an impact against the glenoid cavity; these lesions are associated with injury to the humeral head blood supply or their fragments and, therefore, are difficult to treat and its evolution is accompanied by high complication rates.[2,3] Those aforementioned injuries (excluding fractures in four parts impacted in valgus) are called severe fractures of the proximal humerus (SFPU). The four-part fractures impacted in valgus were excluded because, according to Jakob et al.[4] and later Resch et al.,[5] preserve intact the medial periosteum of the anatomical neck, and this is essential for maintaining the vascularization of the humeral head, which would explain the lower rate of osteonecrosis.[5,6]

Some studies have attempted to demonstrate the benefits and disadvantages of the treatment options of four-part fractures and fracture-dislocations in three parts, but what is the best way to treat? This remains challenging and controversial.[7–9] In the literature, there are descriptions of several methods of treatment, including conservative ones, and different types of surgical techniques, such as percutaneous fixation, open reduction and internal fixation with various types of synthesis, and the replacement of humeral head.[10–12]

The natural history of the treatment of these fractures suggests that they can evolve to nonunion, pseudoartrosis and/or avascular necrosis,[13] leading to unsatisfactory results. The occurrence of persistent pain and stiffness, regardless of treatment chosen, is common.[8,9,11,14]

Helmy and Hinterman[15] claim that, in the literature, there is no unanimity of opinion as to the best method of treatment of these fractures. The only apparent consensus is about the importance of an anatomical reduction and of a stable osteosynthesis.[12,16]

In the elderly population, the treatment of these lesions remains even more controversial. Internal fixation of these fractures, especially in patients with osteopenia and in those with comminuted fractures, resulted in high complication rates.[10,16–18] For these patients, hemiarthroplasty remains the treatment of choice, because of the anatomical and technical difficulties in its maintenance[1,4,5,10,19] and of the high complication rates, such as post-traumatic osteonecrosis of the humeral head.[17,20] However, it is known that the functional outcome of hemiarthroplasties for the treatment of fractures is unsatisfactory, as compared with the initial descriptions of Neer.[5,6] Usually, patients develop loss of lift force and decreased range of motion, despite the low incidence of pain.[5,10]

It is important to remember that sometimes the osteonecrosis of the humeral head will not evolve with unfavourable clinical and functional outcomes, especially in the case of an anatomical reconstruction of the fracture and in the absence of a complete collapse of the subchondral bone due to osteonecrosis.[13]

The objective of this study is to evaluate clinically and radiographically the results obtained with open reduction and internal fixation of SFPU in a population aged over 60 years.

Patients and methods

Between June 1992 and February 2011, 21 patients older than 60 years with SFPU were treated with open reduction and internal fixation at the Group of Shoulder and Elbow, Department of Orthopaedics and Traumatology, Faculty of Medical Sciences, Santa Casa de São Paulo. Of these, two died and one is bedridden, so 18 were reassessed. Patients with fractures in two parts, in three parts without associated dislocation, in four-part impacted in valgus and those not classified by Neer were excluded.[20] Also excluded were those patients who were less than 60 years of age and who underwent hemiarthroplasty with postoperative follow-up <12 months. Eight patients were male (44%) and ten females (56%), with a mean age of 68 years (range 60–78). The dominant limb was affected in nine cases (50%) (Table 1).

The mechanisms of injury were: falls from a height in three cases (17%) and falls to the ground in fifteen (83%).

All patients underwent radiographs of the shoulder (trauma series), for diagnosis and classification of fractures; computed tomography was used in ten cases to complement the study.

The fractures were classified according to Neer,[20] as shown in Table 2.

Four patients (22%) had associated injuries: anterior border of the glenoid cavity (case 16) fracture; fracture of the

Table 1 – Demographic data of patients, classification of fractures, associated injuries, fracture reduction and fixation type.

Nr	G	Age	D	Class	ΔT (days)	Associated injuries	Operation	Reduction
1	M	62		E (4P)	3		tw + sut + gr (aut)	anat.
2	F	65	+	4P – vr	5		Philos®	vr
3	F	77	+	E (3P)	7		tw + sut	vr
4	M	75		E (4P)	7	fract. post. border glen.	Philos®	vl (T↑)
5	M	70		E (3P)	19		Philos®	anat.
6	M	62		E (3P)	13		Philos®	vr
7	M	64		4P – vr	21		Philos®	vl
8	M	74	+	4P – vr	3		tw + sut	anat.
9	F	66		4P – vr	4		Philos®	anat.
10	F	77		E (4P)	3	Rotator cuff injury	PhiloS® + gr (sin)	anat.
11	F	65	+	4P – vr	15		Philos®	vr (T↑)
12	F	64	+	4P – vr	19		tw + sut	anat.
13	M	60		4P – vr	9		tw + sut	vl
14	M	69	+	E (3P)	14		tw + sut	anat.
15	F	64		3P – ant. disl.	6	Lesion of Bankart	Interfragmentary screw	anat.
16	F	65	+	3P – ant. disl.	18	fract. Ant. border glen.	Philos®	vr
17	F	72	+	4P – vl	17		tw + sut	vr (T↓)
18	F	78	+	4P – vr	4		tw + sut	vl (T↑)

G, gender, Age, age, D, dominance, class, classification of Neer; Δ*T*, time interval between trauma and surgery, M, male; F, female; E, epiphyseal fracture associated; 3P, fracture into three parts; 4P, fracture into four parts; anat., anatomic reduction; vr, varus deviation, vl, valgus deviation; ant. disl., anterior dislocation associated; fract., fracture;. Glen., glenoid;. post., posterior; ant., anterior; tw, threaded wires, gr (sin), synthetic graft; gr (aut), autograft; sut, suture with transosseous points of greater/lesser tuberosity, T, reduction of greater tuberosity (↓ - low; ↑ - high).
Source: Hospital Medical File.

posterior border of the glenoid cavity (case 4); lesion of the anterior–inferior lip of the glenoid cavity, diagnosed intraoperatively (case 15); and rotator cuff injury (case 10) (Table 1).

The mean time interval between trauma and surgery was 10 days (range 3–21) (Table 1).

The surgical method of choice was open reduction and internal fixation by deltopectoral approach, with the most atraumatic surgical technique possible. The fixation methods varied according to the type of fracture: threaded wires associated with nonabsorbent suture band nr. 5 (Ethibond®) (eight cases), locked plate (Philos®) (nine cases) and interfragmentary screws (one case). Autologous cancellous bone graft from the iliac crest was used in one case (case 1) (Table 1).

In the postoperative period, Velpeau sling immobilization was applied, with permission to exercise only for elbow and wrist for six to eight weeks, depending on the radiographic fracture union. After evidence of consolidation, the patients began passive exercises to gain range of motion (ROM), and at 12 weeks active exercises to gain muscle strength.

The results were evaluated by a score system defined by University of California at Los Angeles (UCLA)[21] and ROM was measured according to American Academy of Orthopaedic Surgeons (AAOS) criteria.[22]

The classification of Ficat et al. and Enneking et al., modified by Neer et al., was used for evaluation of osteonecrosis of the humeral head, when present.[23]

Statistical analysis was performed using the Fisher exact test. The following variables were calculated: end result of UCLA by type of fracture, age, type of reduction, for presence or absence of osteonecrosis, and for presence or absence of arthrosis. Also the following were statistically analyzed: age, depending on the type of fracture and presence or absence of osteonecrosis, as well as the variables "reduction depending on the type of fracture and of fixation", and "osteonecrosis according to the type of fixation and reduction". The analyses were performed with the aid of statistical software Minitab® version 16. A significance level of 5% for all tests of hypothesis was adopted; therefore, the hypotheses with a significance level (p value) <0.05 were rejected.

Table 2 – Distribution of fractures according to Neer classification.

Neer classification		Total
Fract. disl. anterior 3P	w/fract. tub >	2
	w/fract. tub <	–
Fract. 4P	vl deviation of head	1
	vr deviation of head	8
Epifisary	fract. 3P epifisary trait	4
	fract. 4P epifisary trait	3
	Total	18

Fract. disl, fracture-dislocation; 3P, three parts, w/, with; fract. fracture; tub., tuberosity (< - less; > - larger); 4P, four parts; vl, valgus; vr, varus; head, humeral head.
Source: Hospital Medical File.

Results

With an average time of postoperative follow-up of 53 months (range 12–188), it was found that the mean score of UCLA was 29 points (range 19–35; Table 3); two patients evolved with excellent results, 12 good, three regular and one poor. Therefore, 77.7% progressed with good and excellent results. All patients were satisfied with the treatment and only three (16%) did not return to their previous activities.

Table 3 – Results.

Nr	ΔT (months)	E, LR, MR	Complications	Other surgeries	UCLA (total)
1	45	140, 45, T10		RSM	34
2	28	130, 45, T12			29
3	17	90, 30, GL		RSM	26
4	28	100, 20, L2	Necrosis II		28
5	29	120, 30, T7			29
6	29	80, 20, T8	Arthrosis (ecc.) + Necrosis IV	RSM	19
7	36	130, 30, T12			29
8	12	150, 45, T7		RSM	30
9	12	140, 60, T8			29
10	17	150, 60, T12			33
11	29	110, 30, GL	Arthrosis (cent.) + Necrosis III		24
12	188	150, 45, T8		RSM	35
13	183	150, 30, T5		RSM	33
14	109	130, 60, T7		RSM	33
15	107	110, 50, L2	Necrosis II		26
16	29	90, 30, GL			30
17	18	120, 45, L3		RSM	31
18	45	110, 30, L4		RSM	30

ΔT, follow-up time; E, elevation in degrees; LR, lateral rotation in degrees; MR, medial rotation according to vertebral level; T, thoracic vertebra; GL, gluteus; cent., centric; ecc., eccentric, RSM, removal of synthesis material.
Source: Hospital Medical File.

Mean postoperative mobility was 122° of elevation (90–150°), 39° of lateral rotation (20–60°) and T11 of medial rotation (T5-gluteus) (Table 3).

After the analysis of postoperative radiographs, the results of fracture reduction obtained during surgery were: anatomical reduction in eight (44%), varus in six (33%) and valgus in four (23%). The greater tuberosity remained high in three cases (cases 4, 11 and 18) and low in one (case 17). Consolidation occurred in all fractures.

The observed complications were: two cases of transient neuropraxia of the axillary nerve (11%, cases 5 and 6), two superficial infections (11%, cases 17 and 18), one with impingement syndrome associated with malunion of the greater tuberosity (5%, case 18), two with osteoarthritis of the shoulder in association with osteonecrosis (11%, cases 6 and 11), six varus consolidations as a result of unsatisfactory reduction (39%, cases 2, 3, 6, 11, 16 and 17), a poor placement of the implant (5%, case 6), four with osteonecrosis of the humeral head: two of type II (cases 4 and 15), one of type III (case 11) and one of type IV (case 6), which amounted to 22% of patients (Table 3).

The mean UCLA score of the two shoulders that developed arthrosis was 21 (19–24) points, with mean elevation of 95°. In the four cases which developed osteonecrosis of the humeral head, the mean score was 24 (19–29) points and the mean elevation was 105°. In the 12 cases which did not develop osteoarthritis and/or necrosis, the mean score was 30 (28–35) points, with a mean elevation of 130°. In patients in whom we obtained anatomical reduction of the fracture, the UCLA mean score was 31 (28–35) points, with mean elevation of 138°, and

Fig. 1 – Case 5: Radiographs of left shoulder (frontal view), showing a three-part fracture with epiphyseal trait; (a) preoperative, (b) postoperative, 29 months.

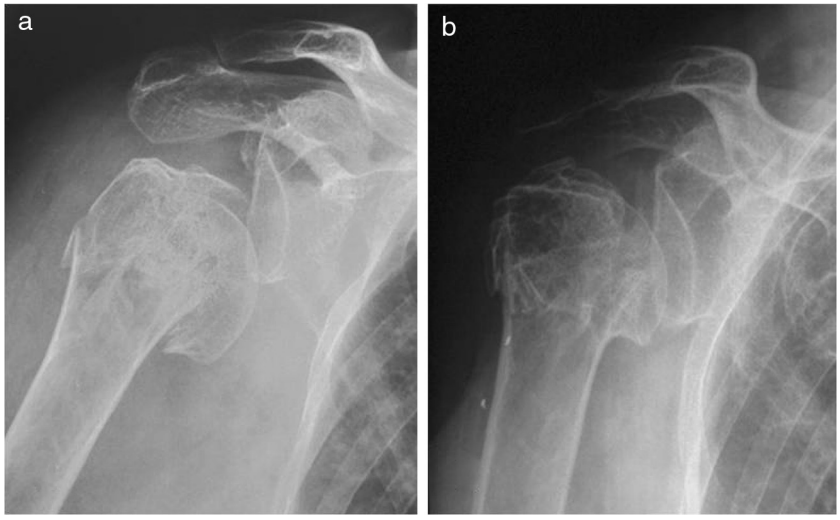

Fig. 2 – Case 3: Radiographs of the right shoulder (frontal view), showing a three-part fracture with epiphyseal trait; (a) preoperative, (b) postoperative, 17 months.

in those without anatomic reduction, the mean score was 27 (18–33) points, with a mean elevation of 111°.

Discussion

In literature there is no consensus regarding the treatment of SFPU.[12] In 1970, Neer et al. published their experience with the treatment of SFPU with use of hemiarthroplasty; these authors obtained good and excellent results in 90% of their patients.[11] These results were not reproduced later by other authors, and high rates of complications and unsatisfactory results were observed.[24–26]

In recent decades, studies have shown that open reduction and internal fixation of SFPU led to satisfactory results in most patients. Age, type of fracture, achieving (or not) the reduction, reduction technique, quality of fixation, evolution with or without osteonecrosis of the humeral head, and evolution with or without arthritis in the shoulder joint are the main prognostic factors in treatment.[12,13,27,28]

The advanced age of patients who underwent open reduction and internal fixation of SFPU (mostly osteoporotic people) is quoted by Gerber et al.[12] as a negative prognostic factor. However, in our study, no statistically significant correlation between age and worse outcomes by UCLA score ($p = 0.23$) was noted, which agrees with the findings of Moonot et al.[29]

The type of fracture, as described in the literature, influences the worst results, especially in the higher rates of complications related to more severe cases.[27] However, in our study we could not correlate statistically fracture severity with worse outcomes ($p = 0.33$).

Studies describe the importance of anatomic reduction of the fracture during surgery; and the best results were obtained in cases in which this objective was achieved and maintained until consolidation[5,13,27] (Fig. 1). However, the achievement of this objective is dependent on factors such as type of fracture and type of fixation.[12] In our study, non-anatomical reduction occurred in 11 cases. This factor influenced statistically in the worst results, when compared with the cases in which anatomic reduction was achieved ($p = 0.03$).

In recent years, studies have demonstrated that the quality of fixation is of utmost importance in the treatment of SFPU, mainly to maintain the reduction achieved during the surgery also in the postoperative period.[12,16] However, in our study, when fixation methods (threaded wires associated with suture band or Philos® plate) were compared, there was no statistically significant difference with respect to the results by UCLA score ($p = 0.33$).

Osteonecrosis of humeral head occurred in four patients (22%), a result slightly below the value reported in the literature.[12,17,20] These four patients had the worst functional results ($p = 0.006$). Three cases were fixed with Philos® plate and one case with threaded wires associated with suture band. In three cases, anatomic reduction was not obtained (Fig. 2). However, with regard to the presence of osteonecrosis, the variables "type of fixation" and "fracture reduction" showed no statistically significant difference ($p = 0.37$ and $p = 1.0$); this is consistent with the findings of Südkamp et al.[16]

In our study, age and type of fracture were also not correlated with osteonecrosis ($p = 0.67$ and $p = 0.26$), which is consistent with the findings of Gerber et al.[12] Our low rate of osteonecrosis of the humeral head can be explained by the group's experience in the treatment of SFPU and by the use of the more atraumatic technique possible. Another explanation would be the difficulty to correctly classify the fractures according to Neer et al. classification,[20] and this could cause a incorrectly greater number of SFPU. The interpretation of images of the proximal humerus fracture and, thus, its classification, are quite controversial.[12]

According to Gerber et al.,[13] in fractures in which anatomic reduction was obtained and the bone healing progressed to osteonecrosis, there is an indication for hemiarthroplasty. However, it is known that patients who develop osteonecrosis may maintain a reasonable function.[30] This was verified in our work, since the four patients who developed osteonecrosis had an average elevation of 105° and an UCLA mean score of

24 points in the final evaluation. So far, none of these patients required arthroplastic treatment.

Conclusion

Open reduction and internal fixation of SFPU may also be indicated for elderly patients. We obtained 77.7% of good and excellent results.

Statistically ($p = 0.03$), an anatomic reduction of the fracture was found to be important for obtaining good results.

Conflicts of interest

The authors declare no conflicts of interest.

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