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ORIGINAL ARTICLE

Radial Head Comminuted Fractures: a Comparative Study Between Resection and Internal Fixation

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PALABRAS CLAVE

Codo;
Fractura;
Cabeza radial;
Tratamiento quirúrgico

Abstract

Introduction: The treatment of radial head fractures continues to be controversial. The open reduction and internal fixation (ORIF) method is expanding due to improvements in the techniques and the implants. However, it can be very demanding technically and is not free of complications. On the other hand, resection shows satisfactory results in the long term in stable elbows, although it is also associated with complications. We compared resection and ORIF in comminuted fractures of the radial head.

Material and Method: A total of 23 patients with type III Mason fractures were included, of which 11 were subjected to resection of the radial head (Group A), and 12 to internal fixation of their fracture (Group B). The mean age was 54 and 45 years, respectively. The fractures were clinically and radiologically evaluated, with a mean follow-up of 80 months in Group A and 76 months in Group B.

Results: The flexion-extension movement range was 121°-(−11°) in Group A and 131°-0° in Group B. The functional results obtained according the Broberg and Morrey scale were: 82 points in Group A and 90.9 points in Group B.

Discussion: Patients with comminuted fractures of the radial head subjected to open reduction and internal fixation have a satisfactory movement range, with greater strength, and therefore, better function. We recommend open reduction and internal fixation in the treatment of these fractures, particularly in young patients.

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Fracturas conminutas de la cabeza radial: estudio comparativo entre resección y fijación interna

Resumen

Introducción: El tratamiento de las fracturas de cabeza radial continúa siendo controvertido. La reducción abierta y fijación interna (RAFI) está en expansión debido a la mejora de las técnicas y los implantes. Sin embargo, puede ser técnicamente muy demandante

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y no está exenta de complicaciones. Por otra parte, la resección muestra resultados satisfactorios a largo plazo en codos estables, aunque también asocia complicaciones. Comparamos la resección y la RAFI en fracturas conminutas de la cabeza de radio.

Material y método: Se incluyeron 23 pacientes con fracturas Mason tipo III, 11 sometidos a resección de la cabeza del radio (Grupo A), y 12 a fijación interna de su fractura (Grupo B). La media de edad fue 54 y 45 años, respectivamente. Las fracturas fueron evaluadas clínica y radiológicamente; con un seguimiento medio de 80 meses en el Grupo A y 76 en el B.

Resultados: El rango de movilidad fue de 121° (-11°) de flexo-extensión en el grupo A y de 131° -0° en el grupo B. Según la escala de Broberg y Morrey los resultados funcionales obtenidos son: 82 puntos en el Grupo A y 90,9 puntos en el Grupo B.

Discusión: Los pacientes con fracturas conminutas de la cabeza del radio sometidos a reducción abierta y fijación interna tienen un rango de movilidad articular satisfactorio, con mayor fuerza y por tanto, mejor función. Recomendamos la reducción abierta y fijación interna en el tratamiento de estas fracturas, sobre todo en pacientes jóvenes.

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Introduction

Isolated fractures of the radial head are frequent in our setting and represent approximately 33% of the fractures in the elbow region in adults.¹⁻⁵ Despite this frequency and their description by Paulus Aegineta (625-690 B.C.) and more recently by Poland in 1898 and Thomas in 1905, their treatment continues to be controversial today, especially with more comminuted and displaced fractures.¹⁻⁵

There is evidence in the literature in favour of both open reduction and internal fixation (ORIF) and also resection of the radial head with good outcomes.⁶⁻¹³ The role of ORIF is expanding due to the improvement in implants and the greater understanding of anatomy and joint biomechanics, although the repair of the most comminuted fractures and those with considerable displacement still represents a challenge for orthopaedic surgeons and they are not free from complications. Placing osteosynthesis material interferes with the congruence of the proximal radioulnar articulation, limiting articular mobility, causing pain, and leading to post-traumatic arthritis of the adjacent joints. On the other hand, resection of the radial head has been a valid therapeutic option with good functional results in fractures without associated lesions; however, there have been descriptions of cases of pain, articular instability, proximal migration of the radius, loss of strength, osteoarthritis or ulna valgus in long-term series.¹²⁻²²

The goal of the present study is to perform a comparative assessment of the patients with comminuted fracture of the radial head without any associated bone or ligament lesions treated by total resection of the radial head versus ORIF, analyzing the clinical and radiological results obtained and possible complications to determine the best treatment method for this kind of lesion.

Material and method

Between December, 1994, and March, 2005, 23 consecutive patients with comminuted fractures and displacement of

the radial head underwent surgery, with complete resection of the radial head being performed on 11 of them (group A) and ORIF on the remaining 12 (group B). All the fractures were classified as type III according to the classification system proposed by Mason⁶ (fig. 1) and the type of treatment was assigned at random after the informed consent had been signed.

Randomization was performed on the basis of a table of random numbers obtained from the Epi Info 5.0 programme. The results were calculated depending on the original assignment group (intent to treat).

Those fractures of the radial head with associated fractures at the level of the ipsilateral elbow (choronoid

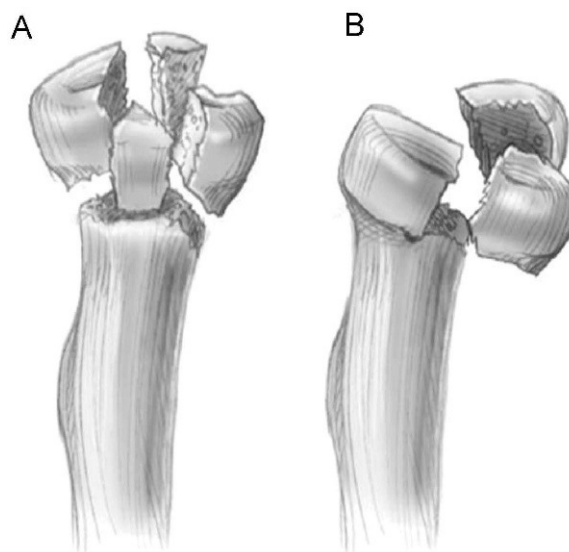


Figure 1 Masson type III fracture of the radial head. A) Fracture of the radial head with more than 3 fragments completely separated from the diaphysis. B) Fracture of the radial head with an impacted or angulated fragment and several fragments separated from the diaphysis.

process, olecranon,...), associated ligament lesions (collateral ligaments or interosteal membrane) and luxation fractures were excluded, in order to be able to compare both types of treatment on an equal footing, as resection has been widely shown to have poor results in this kind of patient.

In both groups, the approach used was the posterolateral approach to the elbow described by Kocher between the anconeus and the extensor carpi ulnaris muscles,²³ placing a post-operative immobilization ferrule for 10 days until the stitches are removed.

Group A: Resection of the Radial Head

Group A included 11 patients, 5 men and 6 women, with a mean age of 54 years (range 34-74 years). The cause of the fracture was a full length-fall in 10 patients and a traffic accident in the remainder, affecting the left hand side in 63.6% on the dominant side in 36.4%. Resection was effected at the level of the annular ligament with a mean surgical delay of 3.7 days (range 0-12 days), with surgery lasting on

average 37.3 min. The mean post-operative follow-up was 80 months (range 15 133 months) (table 1).

Group B: ORIF

Group B included 12 patients, 7 men and 5 women, with a mean age of 45 years (range 18 75 years). The cause of the fracture was a full-length fall in 9 cases, 2 sports accidents and 1 traffic accident. The left side was affected in 25% of cases and the lesion involved the dominant limb in 75% of cases. Osteosynthesis²⁴ was performed with the plates and screws in the Compact Hand set from Synthes® in 4 cases or isolated Herbert® or Acutrack® screws in 8 cases, with a surgical delay of 3.7 days (range 0 9 days) and a mean duration of surgery of 88.8 min. The mean post-operative follow-up was 76 months (range 15 136 months) table 2.

All patients were assessed using the Broberg and Morrey scale^{9,25} measuring pain, stability, articular balance and strength; these results and intra- and post-operative complications were recorded on table 3.

Table 1 Epidemiological results of group A (resection of the radial head)

Case	Gender	Age (years)	Follow-up (months)	Side	Aetiology
1	Female	61	72	Left	Accidental fall
2	Female	59	124	Left	Accidental fall
3	Female	56	128	Right	Accidental fall
4	Female	62	71	Left	Accidental fall
5	Male	34	131	Right	Traffic
6	Female	67	52	Left	Accidental fall
7	Male	39	54	Right	Accidental fall
8	Female	64	27	Right	Accidental fall
9	Male	74	15	Left	Accidental fall
10	Male	35	76	Left	Accidental fall
11	Male	40	133	Left	Accidental fall

Table 2 Epidemiological details for group B (ORIF of the radial head)

Case	Gender	Age (years)	Follow-up (months)	Side	Aetiology
1	Male	55	25	Left	Accidental fall
2	Female	49	50	Right	Accidental fall
3	Female	75	52	Right	Accidental fall
4	Female	57	104	Right	Accidental fall
5	Female	69	15	Right	Accidental fall
6	Male	46	55	Right	Accidental fall
7	Male	24	109	Right	Fall from a height
8	Male	18	123	Right	Sports accident
9	Male	29	36	Left	Sports accident
10	Male	22	136	Right	Accidental fall
11	Male	31	132	Right	Accidental fall
12	Female	70	76	Left	Accidental fall

Pain was measured using an analogue visual scale between 0 and 10 points, with absence of pain being 0 points and maximum pain 10 points.

Stability was tested by the same examiner (independent of the surgeons) as forced varus and valgus movements of the elbow with the forearm in complete supination.

Articular balance was measured by a standard goniometer, placing the forearm in neutral rotation to assess flexion and

extension and with the elbow at a right angle for pronation and supination.

The force of the elbow's flexion and extension and the pronation and supination of the forearm were measured with a Cybex 770-NORM® dynamometer. The strength of the fist was recorded on a JAMAR® dynamometer, standardizing all these measures according to normality tables for age, gender, affected side and dominance¹².

Anteroposterior and lateral X-rays were taken of both elbows and wrists with the forearm in supination to assess bone consolidation, articular congruence, heterotopic calcifications, distal radioulnar variance, carrying angle of the elbow or post-traumatic osteoarthritis. For the measurement of radioulnar variance an anteroposterior projection of the wrist and forearm was made with the volar region of the forearm in contact with the radiographic chassis, with the elbow at 90 degrees of flexion and the shoulder at 90 degrees of abduction-elevation (Palmer's Projection). An imaginary line joining the upper vertex of the sigmoid fossa of the radius to the upper vertex of the ulnar head is used as a reference to know whether there is positive or negative ulnar variance.

Statistical analysis was done with a comparison of both groups, in terms of epidemiological characteristics and functional results, calculating means and standard deviations with the SPSS 17 statistical programme and measuring the significance of inter-group differences (difference was significant if $p < 0.05$).

Results

Both comparison groups present similar epidemiological characteristics, although, the patients in group B are notably younger with predominant involvement of the dominant limb.

All the fractures in group B consolidated in a mean time of 2.7 months (range 2-4 months). This group required the performance of repeat surgery on 3 occasions, 2 to remove the osteosynthesis material and once for a traumatic

Table 3 Broberg and Morrey assessment scale (1986)⁹

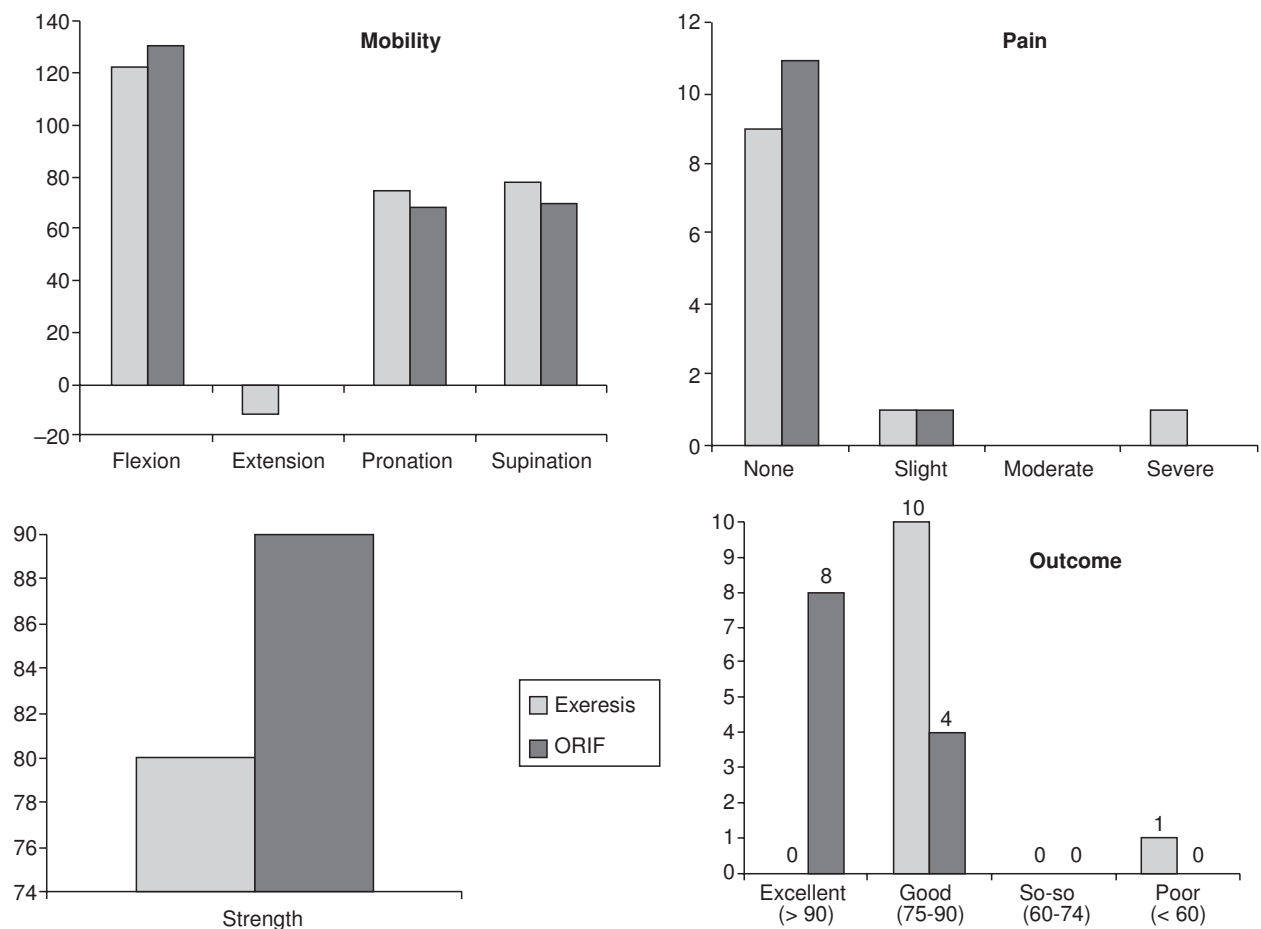
Broberg and Morrey scale: 1986		Excellent: >90
Fractures radial head		Good: 75-89
		So-so: 60-74
		Poor: <60
Data		
Mobility		
Flexion (0.2 x arc)	Max. 27	
Pronation (0.1 x arc)	Max. 6	
Supination (0.1 x arc)	Max. 7	
Strength		
Normal	20	
Slight loss 80%	13	
Moderate loss 50%	5	
Major loss	0	
Stability		
Normal	5	
Slight loss (not limiting)	4	
Moderate loss (limiting activity)	2	
Major loss	0	
Pain		
None	35	
Slight (no NSAIDs)	25	
Moderate	15	
At rest	0	
Total		
Months		

Table 4 Results of group A

Case	Pain	Flexion (degrees)	Extension (degrees)	Supination (degrees)	Pronation (degrees)	Radial lift (mm)	Valgus of the elbow (degrees)	Strength (%)	Stability	Broberg-Morrey (points)
1	Mild	100	-20	70	90	0	20	70	Yes	75
2	No	130	-10	85	80	0	4	90	Yes	90
3	No	130	-10	85	80	0	0	90	Yes	90
4	No	130	-10	85	80	0	8	90	Yes	90
5	No	130	-10	85	90	0	0	90	Yes	90
6	No	120	0	70	60	5	10	80	Yes	80
7	No	130	0	85	80	0	12	90	Yes	90
8	Severe	100	-20	50	30	0	8	40	Yes	55
9	No	130	-10	70	60	0	8	90	Yes	79
10	No	140	-10	85	90	2	0	80	Yes	81
11	No	100	-30	85	80	0	5	80	Yes	82

Table 5 Results of group B

Case	Pain	Flexion (degrees)	Extension (degrees)	Supination (degrees)	Pronation (degrees)	Radial lift (mm)	Valgus of the elbow (degrees)	Strength (%)	Stability	Broberg-Morrey (points)
1	No	130	0	15	75	0	0	90	Yes	88
2	No	100	0	26	24	0	0	80	Yes	76
3	Mild	110	0	80	60	0	0	80	Yes	77
4	No	140	0	80	85	0	0	80	Yes	93
5	No	130	0	80	75	0	0	80	Yes	92
6	No	140	0	80	55	0	0	100	Yes	97
7	No	140	0	80	85	0	0	100	Yes	95
8	No	140	0	80	15	0	0	80	Yes	85
9	No	140	0	80	85	0	0	100	Yes	98
10	No	140	0	80	85	0	0	100	Yes	100
11	No	140	0	80	85	0	0	80	Yes	93
12	No	125	0	65	85	0	0	100	Yes	97

**Figure 2** Comparative diagrams for mobility, pain, fist strength and functional outcome of both groups.

refracture in the early post-operative period when re-osteosynthesis was attempted. All the patients in both groups presented a stable elbow in both varus and valgus tables 4 and 5 and figure 2.

Pain

The mean result on the visual analogue scale for pain in both groups was 0.8 points for the group with resection of

the radial head and 0.3 points for those with ORIF, with no statistically significant differences being found between these two groups.

In terms of pain assessment using Broberg and Morrey's scale⁹ (which establishes 4 categories of patients: free from pain, mild pain not requiring painkillers, moderate pain and severe pain at rest), the following results were obtained:

Group A: 9 patients free from pain, 1 with mild pain and 1 case of severe pain at rest.

Group B: 11 patients free from pain and 1 case of mild pain.

Articular Balance

A mean deficit in extension of 11.8° (range $0-30^\circ$) was obtained in group A, compared with the 0° on average for group B, which turned out to be statistically significant ($p=0.001$). The rest of the mobility ranges in both groups was quite similar, with a mean flexion of 121.8° (range $100-140^\circ$) in group A versus 131.3° (range $100-140^\circ$) for group B ($p=0.540$), a mean pronation of 74.5° (range $30-90^\circ$) in group A versus 67.8° (range $15-85^\circ$) in group B ($p=0.267$),

and supination of 77.7° (range $50-85^\circ$) in group A versus 68.8° (range $15-80^\circ$) in group B ($p=0.140$).

Strength

The mean fist strength lost was 19.1% in group A (range 10-60% of loss) versus 12.5% for group B (range 0-20% of loss), which was statistically significant ($p=0.049$).

Group A obtained a mean loss of 28.6% (range 6.5-40%) of extension force, 17.9% (range 6.2-35%) of flexion force, 26.4% (range 7.1-54.7%) of pronation force, and 38.3% (range 14.3-55.5%) of supination force; group B, on the other hand, lost on average 11.8% (range 2.3-29.7%) of extension force, 21.3% (range 5.5-37.5%) of flexion force, 13.6% (range 0-42.3%) of pronation force, and 7.7% (range 0-30.1%) of supination force.

The loss of force in extension ($p=0.0002$), pronation ($p=0.0046$), and supination ($p < 0.0001$) was greater and statistically more significant in group A than in group B. There were no statistically significant differences between the two groups with respect to flexion force ($p=0.3841$).



Figure 3 Case 5: resection of the radial head, initial X-rays and from the end of the follow-up period, plus clinical images of mobility and strength.

Radiological Parameters

In comparison with the values of the contralateral elbow, an increase was found in the mean elbow carrying angle of 6.8° (range $0-20^\circ$) in group A versus 0° in group B ($p < 0.0001$). The mean increase in the distal radioulnar variance was 0.6 mm in group A (range 0-5 mm) versus 0 mm for group B ($p = 0.0075$).

Variable signs of osteoarthritis and degenerative changes at the level of the elbow were found in both groups without any statistical relationship between their degree and the type of treatment, although there was a tendency towards a larger number of degenerative changes in almost all the patients in group A at the level of both the elbow and the wrist.

Functional Assessment

The mean values on Broberg and Morrey's functional valuation scale⁹ were 82 points (range 55-90 points) in group A versus 90.9 points (range 76-100) for group B ($p = 0.159$). According to this scale, 10 good results were established in group A (scores between 75 and 90) and 1 bad result (score < 60), versus 8 excellent results (score > 90) and 4 good results in group B.

Discussion

There are numerous studies reporting satisfactory long-term functional results with resection of the radial head both as primary treatment and later for the handling of

type III fractures in Mason's classification^{6,7,9,10,11,22,26} (fig. 3). Resection of the radial head has traditionally been associated with long-term complications, including pain in the wrist and forearm, increased deformity of the valgus elbow, degenerative changes and osteoarthritis at the level of the



Figure 5 Case 4: ORIF with a mini-fragments plate, initial images of the fracture and at from the end of the follow-up period.

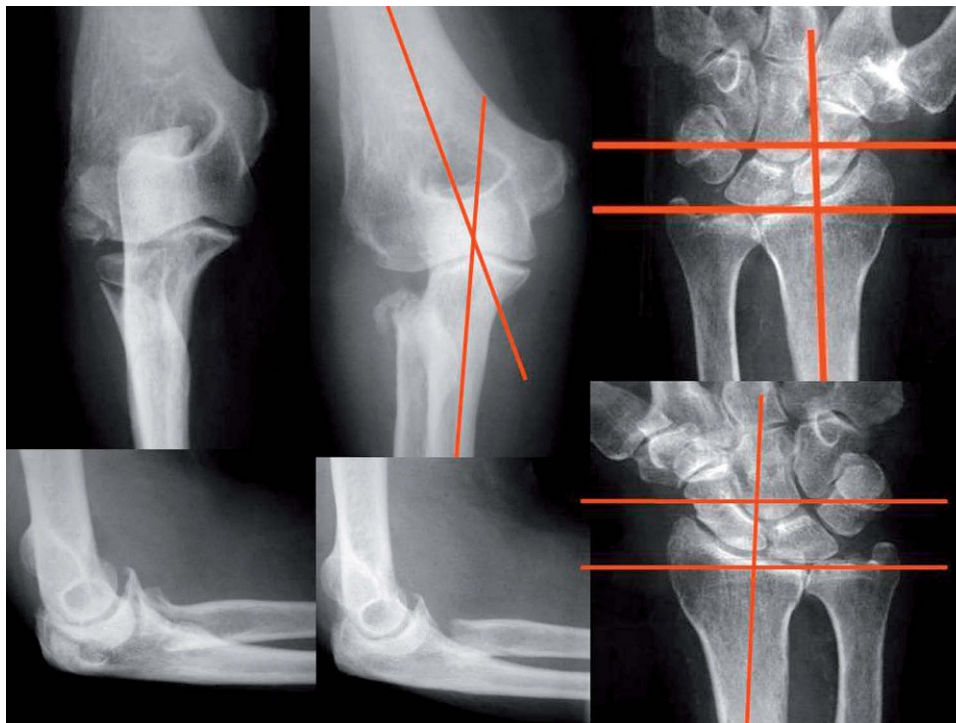


Figure 4 Case 6: resection of the radial head, initial X rays of the fracture and from the end of the follow-up period for the elbow (showing the valgus deviation) and bilateral X rays of the wrists (showing the proximal migration of the radius).

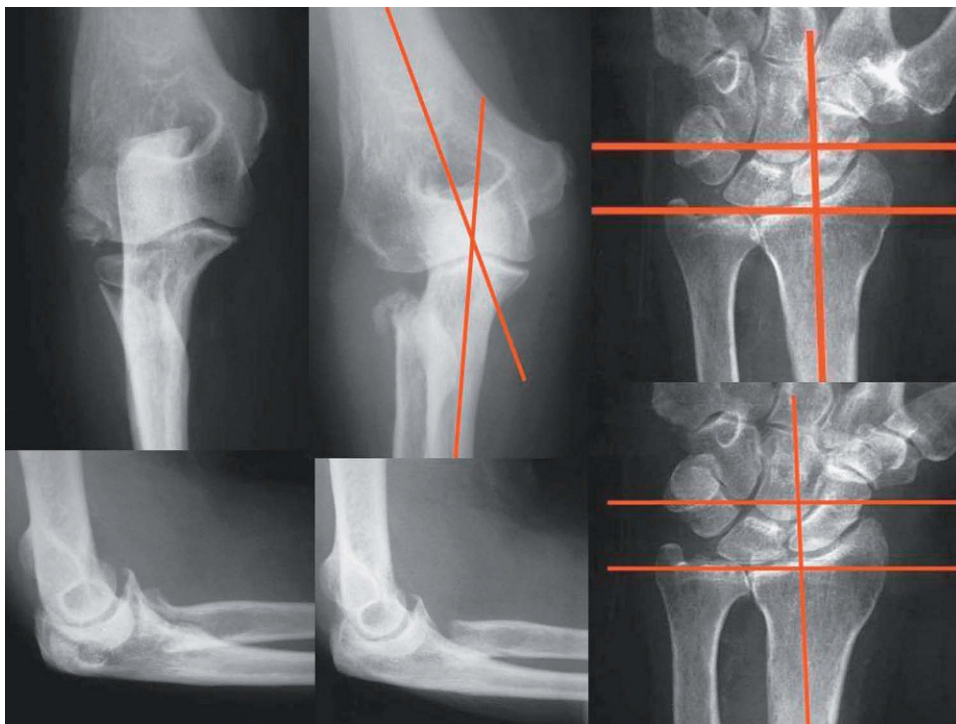


Figure 6 Case 11: ORIF with mini-fragments plate and screws, initial and post-surgical images and from the end of the follow-up period.

elbow and wrist, or a reduction in strength. These complications, however, are not considered important for patients because of their low level of functional impact and the maintenance of acceptable articular mobility.^{6-10,12,19} In our study, most patients associated radiographic changes in the elbow and wrist, but this apparently did not correlate with greater pain or loss of mobility (fig. 4).

Many authors^{10,12,16,18,20} have confirmed an increase of 2-3 mm in the radius, producing an increase in the distal radioulnar variance in a series of patients subjected to resection of the radial head. These changes may give rise to pain in the elbow, the forearm or the wrist, with carpal impaction of the distal ulna, subluxation of the distal radioulnar articulation or stretching of the interosseal membrane^{14,16,18}. Descriptions have also been published of increases from 5° to 20° in the elbow carrying angle^{10,13,16,17-19} (6.8° in our series), which may lead to the onset of ulnar neuropathy due to stretching at this level.

Although the methods to assess strength are not uniformly standardized in previous studies, the loss rates for flexion, extension and pronosupination strength are estimated at around 30%.^{8,9,12,18,27} Our study demonstrated a statistically significant lower degree of force in the elbow extension, in the rotation of the forearm and in the fist strength of patients following resection of the radial head versus those who had had an osteosynthesis put in place; this parameter was the most important long-term clinical complication and was responsible for the lower score on the Broberg and Morrey functional valuation scale in group A.

The main mechanism involved in the loss of strength in this group was possibly the loss of proximal support by the

radius, normally acting as the fulcrum transmitting forces through the radiocapitate joint. Other factors involved might be the better articular balance, valgus joint deviation, functional discomfort and psychological factors.²⁷⁻³³

The importance of the radial head and radiocapitate contact has been proved both in clinical studies and experimentally, especially after fractures of the radial head associated with ligament lesions.²⁷⁻³³ The most common cause of failure in open reduction and internal fixation has been the inability to achieve a stable osteosynthesis allowing early mobilization^{5,30}. The insertion of Herbert or Acutrack screws and low-profile or anatomical mini-plates, together with better understanding of joint biomechanics and anatomy, has allowed an increase in the number of fractures in which stable osteosynthesis can be achieved, reducing the number of resections of the radial head^{24,28-31,34-38} (figs. 5 and 6). Although the repair of fractures with a large degree of comminution is technically very demanding and sometimes impossible, our results warrant an effort to preserve the radial head and, if this were not possible, to perform a prosthetic substitution in functionally demanding patients.³⁹

In our protocol for the treatment of Mason's type III fractures of the radial head, we reserve resection for older patients with low functional demand and comminuted fractures without associated lesions. Osteosynthesis is performed whenever possible and sufficiently stable as to allow early mobilization, as we obtain less force loss and less incidence of elbow varus-valgus deviations or lesions of the distal radioulnar joint. In extremely comminuted fractures (more than 3 fragments), especially if associated with lesions to the ligaments, the interosseal membrane,

olecranon-choronoid fractures, dislocations of the elbow or fractures of the neck of the radius, we prefer to make a prosthetic substitution, as these patients are the ones with greater complications with osteosynthesis and the outcomes become considerably worse.^{40,41}

In conclusion, in type III fractures without associated lesions, ORIF has been shown to be superior to radial head resection fundamentally for the preservation of strength so this must be the treatment of choice, whenever possible, in this type of fracture, reserving resection for comminuted fractures in the elderly with low functional demands.

Conflicts of interests

The authors declare they have no conflict of interests.

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