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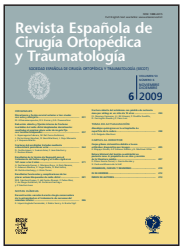

ORIGINAL PAPERS

Functional results and complications of locked distal radius volar plates

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KEYWORDS
Distal radial fracture;
Locked plate;
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Abstract
Introduction and purpose: In the last few years, there has been increased aggressiveness in the treatment of distal radius fractures by means of internal fixation. Locked plates prevent metaphyseal collapse even in the presence of osteoporotic or comminuted bone; they also maintain reduction and allow early motion. Nevertheless, there is as yet not enough evidence as to what may be the best way of treating this fracture. Our purpose is to assess our functional results and the complications that can arise from the use of distal radius locked plates.
Materials and methods: This is a retrospective study of 145 unstable distal radius fractures treated by means of a locked volar plate, with a mean follow-up of 28 months. AO (Association for the Study of Osteosynthesis) and Fernandez' classifications were used to assess the presence of osteoporosis, need for a graft, difference between healthy and fractured hand in terms of mobility, the radiographic measurements and the functional PRWE (Patient-Rated Wrist Evaluation) test and any potential complications. A statistical analysis was carried out.
Results: 95 patients were analyzed. Mean PRWE score was 13 points. A significant relation was found between motion and functional result. A graft was used in 3 patients and there were no cases of pseudoarthrosis or metaphyseal collapses. Eight percent of patients presented with some serious complication (algodystrophy, chronic pain, malunion).
Conclusions: Locked plates can be regarded as an alternative to the treatment of unstable distal radius fractures. They provide good functional results and few complications, they minimize the need for grafting and they allow early mobilization even in the presence of osteoporotic and comminute bone.

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PALABRAS CLAVE
Fractura de radio distal;
Placa bloqueada;
Resultado funcional

Resultados funcionales y complicaciones de las placas volares bloqueadas de radio distal

Resumen
Introducción y objetivos: En los últimos años se está observando un aumento en la intensidad del tratamiento de la fractura de radio distal derivado hacia la fijación interna. Las placas bloqueadas evitan el colapso metafisario aun con el hueso osteoporótico o conminuto, mantienen la reducción y permiten una movilidad temprana. Sin embargo, todavía no hay suficiente evidencia de cuál es el mejor método de tratamiento para esta fractura. Nuestro objetivo es evaluar nuestro resultado funcional y las complicaciones con el uso de las placas bloqueadas de radio distal.
Material y métodos: Estudio retrospectivo sobre 145 fracturas inestables de radio distal tratadas mediante placa volar bloqueada, con un seguimiento medio de 28 meses. Se usó la clasificación AO (Asociación para el Estudio de la Osteosíntesis) y la clasificación de Fernández. Se evaluó la presencia de osteoporosis, la necesidad de injerto, la diferencia de movilidad entre la muñeca sana y la muñeca fracturada y las medidas radiográficas, así como el test funcional PRWE (Patient-Rated Wrist Evaluation) y las complicaciones. Análisis estadístico.
Resultados: Se revisó a 95 pacientes. La puntuación media del PRWE fue de 13 puntos. Se encontró una relación significativa entre la movilidad y el resultado funcional. Se utilizó injerto en 3 pacientes y no hubo casos de seudoartrosis o colapsos metafisarios. El 8% de los pacientes presentó alguna complicación seria (algodistrofia, dolor crónico o consolidación viciosa).
Conclusiones: Las placas bloqueadas se presentan como una alternativa para el tratamiento de las fracturas inestables de radio distal, proporcionan buenos resultados funcionales, pocas complicaciones, minimizan la necesidad de aporte de injerto y permiten una movilización temprana aun con hueso osteoporótico o conminuto.

Introduction

Distal radius fractures are the most common skeletal fractures, accounting for approximately 1/6 of all fractures in the human body; over 40% of these are considered unstable and require some kind of fixation[1].

In the last few years there has been a move towards treating these fractures by means of internal fixation, which allows better fixation of the radiocarpal and radioulnar joints than other kinds of treatment. Fixed-angle plates have been one of the most significant advances in trauma surgery and have become an attractive alternative for repairing these fractures. In addition, locking plates prevent metaphyseal collapse, even in cases where the bone is osteoporotic or comminuted, preserve reduction and allow early motion. Use of a volar approach to place these plates permits good soft tissue coverage, is relatively unaggressive and minimizes complications. However, there is as yet not enough scientific evidence as to what may be the best method to treat distal radius fractures. Our purpose is to evaluate our experience in terms of the functional result achieved and the complications observed with distal radius locking plates.

Materials and Methods

During the period between June 2004 and August 2008 se 145 unstable distal radius fractures were subjected to open reduction and internal fixation with a locked plate at the Trauma Surgery Department of our hospital: a volar approach was used. A retrospective study was carried out of these fractures excluding patients with multiple trauma, those with fractures at other levels or in the same hand, those with bilateral radius fractures and those with grade II and III open fractures.

The total number of patients included in the study was 95. The following variables were studied: age, gender, dominant side, length of evolution and time to surgery. Fractures were classified according to the AO (Association for the Study of Osteosynthesis) and the Fernández grading scales and the need for applying a bone graft was considered. The radial osteosynthesis was performed with 2 kinds of plates: 2.4 mm LCP distal radius plates (SYNTHES®) and the APTUS® adaptive 2.5 mm distal radius plates. An assessment was made of the need of ulnar fixation. Several parameters were radiographically analyzed both in the operated and the healthy wrists: radial height, radial tilt and ulnar variance were evaluated in AP views and palmar tilt in lateral views.

Wrist joint motion was measures both in the healthy and the fractured wrist, evaluating flexion, extension, pronation and supination. For the functional assessment of the wrist, use was made of the PRWE (Patient–Rated Wrist Evaluation) test, considered by recent publications to be more reliable and reproducible than the DASH (Disabilities of the Arms, Shoulder and Hand) or the SF-36 (Medical Outcome Survey

Short-Form) questionnaires. Complications were also assessed.

Henry's volar approach was used in all cases. Postoperative immobilization was maintained for a period ranging from one to 3 weeks, depending on the degree of osteoporosis or instability present. Subsequently active wrist mobilization was begun.

Statistical analysis

The association between continuous variables was analyzed by means of Spearman's rank correlation coefficient. Differences between categorical variables as regards their PRWE score were analyzed by means of the Mann-Whitney U test. Statistical calculations were carried out using the SPSS 13.0 Statistical Package for Windows XP (SPSS, Inc., Chicago, Illinois).

Results

Of the 95 patients in the study, 62 were female and 33 male. Mean age was 53 years (range: 18–82), mean evolution from surgery was 28 months (range: 12–48), with minimum follow-up of 12 months. Mean time to surgery was 8 days (range: 1–30). In 53 patients (55%) the fracture occurred on the dominant side. According to the AO classification, 29 fractures were type A (31%), 8 were type B (8%) and 58 were type C (61%). On the Fernández classification, 29 fractures were type I (31%), 7 were type II (7%), 57 were type III (60%), one was type IV (1%) and one was type V (1%) (table 1). Only 3 patients were implanted an autologous iliac crest graft. The Aptus plate was used in 58 cases (61%) and the Synthes plate in 37 cases (38%). Eleven cases (12%) required ulnar fixation. Six cases required anti-distraction cerclage wiring, 2 screws and 3 plates and in one case it was necessary to carry out a Sauvé-Kapandji procedure due to the presence of significant distal radioulnar destruction.

As regards the radiographic parameters measured both in the healthy and in the fractured wrist (table 2), a mean loss of radial tilt of 4.3° was observed as compared with the healthy wrist. The mean loss of radial height was 2 mm, loss of ulnar variance was 1 mm, and palmar tilt of the radius was 8.3° lower. The mean range of motion achieved when flexing the fractured wrists was 50° (range: 10°-80°), with a mean loss of 14º as compared with the contralateral wrist. Mean extension was 54° (range: 15°-80°), with a mean loss with respect to the healthy wrist of 12°. Mean pronation achieved was 76° (range: 40°-90°), with a mean loss of 5° and mean supination was 76° (range: 35°-90°), with a mean loss with respect to the healthy side of 6.5° (table 3). Mean score on the PRWE functional test was 13 points (range: 0–64) (0 being the best score and 100 the worst).

As far as complications are concerned, a tear occurred in the extensor pollicis longus muscle as a result of the protrusion of the tip of a screw on the dorsum. There were also 6 instances of transient flexor synovitis, 5 carpal tunnel syndromes, 2 algodystrophies and 4 chronic painful wrists where the pain was of unspecific origin. No cases of infection or pseudoarthrosis were observed. There were 2 malunions, of which one required a corrective osteotomy to address an intra-articular step-off. The hardware had to be removed in 10 patients because it caused them discomfort (table 4).

Table 1 Demographic data and AO classification (Association for the Study of Osteosynthesis)

No. of patients	95	
Mean age	53 years (18–82)	
Females (%)	62 (65)	
Dominant side (%)	53 (55)	
Length of evolution	28 months (12–48)	
AO classification	A1	0
No. of patients	A2	7
	A3	22
	B1	0
	B2	3
	B3	6
	C1	15
	C2	25
	C3	17

Table 2 Mobility of healthy and fractured wrists and their difference

Wrist mobility	Flexion	Extension	Supination	Pronation
Healthy	64°	76°	82°	81°
Fractured	50°	54°	76°	76°
Difference	14°	12°	6°	5°

Table 3 X-ray parameters for healthy and fractured wrists and their difference

Radiograph	Radial tilt	Radial height, mm	Ulnar variance, mm	Palmar tilt
Healthy	25.8°	12.8	+1.8	10.3°
Fractured	21.5°	10.8	—0.8	2°
Difference	4.3°	2	1	8.3°

Table 4 Complications

Complications	n
Infections	0
Pseudoarthrosis	0
Tendon tears	1
Tenosynovitis	6
Carpal tunnel syndrome	5
Complex Regional Pain Syndrome	2
Malunions	2
Unspecific chronic pain	4
Hardware removal	10

Statistical analysis

No statistically significant relationship was found between the functional result obtained in the PRWE test and the patients' age, gender or whether the fractured side was the dominant one or not. Nor was any significant relation found concerning length of evolution from surgery (one year minimum) or time to surgery (8 days on average).

There was no statistically significant relation either between the PRWE test results and the type of fracture according to the AO or the Fernandez grading systems, although there was a tendency for type C or type III fractures to obtain poorer results.

A statistically significant relation was found between wrist joint motion and the PRWE test: the greater the flexion ($p = 0.018$), the extension ($p = 0.002$) and supination ($p = 0.005$) mobility, the better the functional result. For pronation, the relationship was close to statistical significance ($p = 0.09$). As regards the x-ray parameters studied (radial tilt, radial height, ulnar variance and volar tilt) a tendency was observed towards poorer PRWE test functional results in cases with significant mean worsening of these parameters as compared with those on the healthy side. This tendency was not significant.

We observed no differences regarding the results obtained and the type of plate used. When we related the mean loss suffered in terms of the x-ray parameters studied with joint motion recovery, we observed that radial tilt significantly influences recovery of pronation ($p = 0,001$) and supination ($p = 0.002$), and that radial height significantly influences recovery of flexion ($p = 0.018$), pronation ($p = 0.004$) and supination ($p = 0.001$).

On the other hand, the influence of palmar tilt was not significant, although it is closely related to flexion ($p = 0.08$).

Discussion

Although distal radius fractures are the commonest bone injury in the human body, there is a lack of level 1 trials that contribute hard and fast scientific evidence as to what the most appropriate treatment for such fractures may be[2-4]. The purpose of fracture treatment, especially if the fracture affects the joint surface, is anatomic reduction and stable fixation in order to minimize post-traumatic arthritis since there is a well-known relationship between the functional result achieved and restoration of the wrist joint[5]. Classical treatment by external fixation, with or without Kirschner wires, often does not allow for accurate reduction, especially in the presence of significant comminution or osteoporosis. Such treatment also requires long-term immobilization and presents with many complications such as pin tract infection, stiffness or Suddeck syndrome[6-8].

In many cases, older generation plates were not able to maintain adequate stability since distal radius fractures tend to be accompanied by osteoporosis or comminution.

It would seem that the advent of the new fixed-angle plates has resolved many of the aforementioned problems. These plates allow an anatomic reduction of the distal radiocarpal and radiocubital joints, offer excellent stability even in the presence of significant comminution or poor bone quality and prevent metaphyseal collapse, which allows for early motion[9-13]. Furthermore, these plates can be implanted through a volar approach, which reduces the need to remove them.

All of this had led to a widespread adoption of these plates for the treatment of this kind of fracture. Indeed, since they were first adopted the use of other types of treatment of unstable distal radius fractures has fallen dramatically even in the absence of long-term comparative randomized studies[3,4]. In the face of this, the purpose of this study is to report on our experience of the use of fixed-angle plates. A recent prospective randomized multicenter study by Leung et al[14] on 137 distal radial fractures showed that patients treated with a plate obtained better functional results than those treated with a fixator plus wiring (at 2 years' follow-up).

In a retrospective study on distal radius fractures operated in the last 9 years in the U.S.A., Koval et al[3],., observed that, in 1999, 48% of cases were plated with this percentage rising to 81% of cases in which surgery was indicated in 2007. Moreover, they observed a significantly higher complications rate in fractures addressed with wiring. As regards costs, the authors saw there were practically no differences between the 2 types of treatment. They found that the global cost of treatment with a plate was 32 US dollars cheaper than Kirschner wire-based treatment.

Egol et al[15] reported that the global complications rate in patients operated with a fixator and wiring was much higher (9.8%) than that for patients operated with a locking plate implanted through a volar approach (4%).

The patients' functional status was assessed by means of the PRWE test. This test was designed specifically for evaluating the traumatic wrist[16]. In prospective studies comparing the effectiveness of the PRWE test with that of the DASH and SF-36 questionnaires in assessing the functional outcome of wrist fractures, the PRWE test came out as a more reliable and reproducible measurement than the DASH and SF-36 questionnaires. In addition, a direct relationship was found between clenching force and the PRWE test[2,17,18]. The test comprises 2 subscales: pain and function, with 15 easy questions. For some authors it constitutes the most appropriate of currently available result measurement methods[19]: it is easy and fast to apply. The mean score obtained in our study was 13 points (range: 0–64) (the worst possible score is 100 and the best 0), which means that we can consider our functional result to be good.

We found a lack of statistical correlation between functional results and such variables as sex, age affected side, time to surgery (mean: 8 days) or length of evolution (minumum: one year). In contrast, the variable that did exert a fundamental influence was mobility. Wrist flexion, extension and supination (pronation was very close to statistical significance) were decisive to obtain a good result. We also identified a correlation between certain radiographic parameters and recovery of motion. Radial tilt turned out to exert a decisive influence on supination and pronation, and radial height influenced on supination, pronation and flexion. On the other hand, this relationship was not found with ulnar variance or palmar tilt, probably due to the fact that the type of reduction achieved in these

parameters was better adjusted to the patient's anatomy. Another interesting finding is the lack of statistical significance between fracture type and functional outcome seen in the 2 classifications used, although in the more severe fractures there is a trend towards a poorer outcome. This could be due to the satisfactory degree of reduction achieved with even the most complicated fractures.

Plate removal was necessary in 10%of cases, one patient presented with a tear of the extensor pollicis longus, 6 patients presented with tendon irritation, 2 patients had algodystrophy, 4 patients chronic pain and one patient required a joint corrective osteotomy. There were no cases of infection or pseudoarthrosis, and only in 3 cases was it necessary to implant a bone graft (as a result of secondary displacements of orthopedic treatments for AO A3 type fractures with significant dorsal comminution). These results are comparable to those of other studies, such as the one by Arora et al or Rozental et al20,21, as regards joint motion, radiographic parameters, functional tests and complications.

The present study has several limitations. For one thing, it is retrospective, with all of what that implies. Our experience allows us to affirm that the kind of treatment proposed herein offers good functional results with few complications. In addition, it minimizes the use of bone grafting and allows for early wrist joint motion. Age, sex, the injured side, the fracture type or a one-week wait for surgery do not exert a significant influence on the results, but do however influence mobility, which is in turn dependent on the quality of fracture reduction.

Although more specific studies are needed, it can be said that a reduction that is as anatomic and stable as possible to permit early rehabilitation seems to be a key factor for the successful treatment of these fractures. Locking plates are the system that can most appropriately provide this type of treatment.

Conflict of interests

The present study has received no funding whatsoever. The authors declare they have no conflict of interests.

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