

DISTAL RADIUS FRACTURES. TREATMENT WITH VOLAR LOCKING PLATES. FUNCTIONAL RESULTS ACCORDING TO FRACTURE TYPE

FRATURAS DEL RADIO DISTAL. TRATAMIENTO CON PLACAS VOLARES BLOQUEADAS.

RESULTADOS FUNCIONALES SEGÚN EL TIPO DE FRACTURA

FRATURAS DO RÁDIO DISTAL - TRATAMENTO COM PLACAS DE BLOQUEIO VOLAR -

RESULTADOS FUNCIONAIS DE ACORDO COM O TIPO DE FRATURA

Juan Martin Patiño¹, Ignacio Mario Abdon¹, Alejandro Michelini¹, Alejandro Felix Rullan Corna¹, Alejandro José Ramos Vertiz¹

Las fracturas del radio distal, llamadas de muñeca, se encuentran entre las patologías más frecuentes para el traumatólogo. Se observan principalmente en casos de trauma de alta energía o traumas menores en los pacientes de mayor edad. La evidencia ha mostrado desde hace tiempo mejores resultados funcionales con la reducción y fijación con placas y tornillos. En relación a los tratamientos prolongados con yesos. Los implantes disponibles se han mejorado en cuanto a los diseños anatómicos y la mayor estabilidad con los sistemas de bloqueo. Es importante la evaluación de los resultados funcionales obtenidos. Estos pueden ser diferentes según el caso. En este estudio se presentan en un grupo de pacientes y se comparan según la gravedad de las fracturas.

Conceptos claves

Que se sabe sobre el tema.

Los resultados funcionales post reducción y osteosíntesis en las fracturas del radio distal han evolucionado en los últimos años. Existe bibliografía focalizada en el uso de diferentes diseños de placas anatómicas y bloqueos fijos o poliaxiales. Sin embargo, no abunda la evidencia de evolución a largo plazo y cómo es la misma según el tipo de fracturas.

Que aporta este trabajo.

En esta serie evaluamos los resultados funcionales finales de fracturas tratadas con placas regionales bloqueadas y los analizamos comparativamente. Creemos que la información sobre resultados y que expectativas tener con el tratamiento quirúrgico según la lesión es importante para la planificación y compartir con los pacientes.

1- Servicio de Cirugía de Mano y Miembro Superior. Departamento de Ortopedia y Traumatología del Hospital Militar Central. Cosme Argerich. Buenos Aires. Argentina. E-mail de contacto: drpatinojm@gmail.com

Recibido: 2019-11-25 Aceptado: 2020-07-31

DOI: <http://dx.doi.org/10.31053/1853.0605.v77.n4.26516>



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Resumen:

Introducción: el objetivo de este estudio es determinar si existen diferencias en los resultados funcionales en pacientes con fracturas del radio distal tratados con placas de bloqueo volar y, en segundo lugar, comparar estos resultados según el tipo de fractura (AO).

Métodos: se evaluaron 39 pacientes tratados entre enero de 2013 y diciembre de 2015. Fueron 19 mujeres y 20 hombres, con un promedio de 60 años y un rango entre 18 y 86 años. El seguimiento promedio fue de 46 meses. Se realizaron mediciones radiográficas postoperatorias del ángulo de inclinación cubital del radio, el ángulo de inclinación volar del radio y la altura de la estiloides. Evaluamos el dolor residual con VAS (Escala visual analógica). La función objetiva y subjetiva se evaluó con el cuestionario DASH (Discapacidades del brazo, hombro y mano) y el score de Mayo.

Resultados: La flexión media fue de 51°, la extensión fue de 55°, la pronación fue de 80° y la supinación fue de 75°. El ángulo medio de inclinación cubital fue de 19,66°, el ángulo medio de inclinación volar fue de 2,07° y la altura media de la estiloides fue de 8,97 mm. El DASH promedio fue de 14,38 y el promedio de Mayo fue de 78,58. No hubo correlación estadística significativa entre la complejidad de la fractura y las variables analizadas.

Conclusiones: las placas de bloqueo volar son una opción válida para la resolución de fracturas inestables de radio distal en sus diferentes patrones y en un amplio rango de edad.

Palabras clave: radio; distal; fracturas; placas bloqueadas; resultados; complicaciones; osteosíntesis

Abstract:

Background: The aim of this study is to determine if there are differences in functional results in patients presenting fractures of the distal radius treated with volar locking plates and, secondarily, to compare these results according to fracture type (AO).

Methods: 39 patients treated between January 2013 and December 2015 were evaluated. They were 19 women and 20 men, with an average of 60 years old and a range between 18 and 86 years old. The average follow up was of 46 months. We made radiographic postoperative measurements of the ulnar tilt angle of the radius, the volar tilt angle of the radius and styloid height. We evaluated residual pain with VAS (Analogue Visual Scale). The objective and subjective function were evaluated with the DASH inquiry (Disabilities of the Arm, Shoulder, and Hand) and Mayo wrist score.

Results: The mean flexion was of 51°, the extension was 55°, pronation was 80°, and supination was 75°. The mean ulnar tilt angle was 19,66°, the mean volar tilt angle was 2.07°, and the mean styloid height was 8.97 mm. The average DASH was 14.38 and the average Mayo was of 78.58. There was no significant statistical correlation between the fracture complexity and the analyzed variables.

Conclusions: In this series, volar locking plates were a valid option for the resolution of unstable distal radius fractures in its different patterns and in a wide age range.

Keywords: distal radius; fractures; locking plates; outcomes; complications; osteosynthesis

Resumo

Fundamento: O objetivo deste estudo é determinar se existem diferenças nos resultados funcionais em pacientes com fraturas do rádio distal tratadas com placas de bloqueio volar e, secundariamente, comparar esses resultados de acordo com o tipo de fratura (AO).

Métodos: 39 pacientes tratados entre janeiro de 2013 e dezembro de 2015 foram avaliados. Eles eram 19 mulheres e 20 homens, com média de 60 anos e variação entre 18 e 86 anos. O seguimento médio foi de 46 meses. Foram realizadas medidas radiográficas no pós-operatório do ângulo de inclinação ulnar do rádio, do ângulo de inclinação volar do raio e da altura do estilóide. Avaliamos a dor residual com EVA (Analogue Visual Scale). A função objetiva e subjetiva foi avaliada com o inquérito DASH (deficiências do braço, ombro e mão) e escore de pulso de Mayo.

Resultados: a flexão média foi de 51°, a extensão foi de 55°, a pronação foi de 80° e a supinação foi de 75°. O ângulo médio de inclinação ulnar foi de 19,66°, o ângulo médio de inclinação volar foi de 2,07° e a altura média do estilóide foi de 8,97 mm. O DASH médio foi de 14,38 e o Mayo médio foi de 78,58. Não houve correlação estatística significativa entre a complexidade da fratura e as variáveis analisadas.

Conclusões: Nesta série, as placas de bloqueio volar foram uma opção válida para a resolução de fraturas instáveis do rádio distal em seus diferentes padrões e em uma ampla faixa etária.

Palavras chave: Raio distal; fraturas; placas de travamento; resultados; complicações; osteossíntese

Introduction

Anatomic reduction and stable fixation imposes in unstable and displaced fractures of the distal radius. K-wires, with its different techniques, with or without external fixation, has historically been considered the first choice of treatment, but plates with angular stability have gained popularity in the last years [1,2]. Designs vary in contour [3], size and angle of the screws [4], or the material of which they are made of [3].

The aim of this study is to determine if there are differences in functional results in patients presenting fractures of the distal radius treated with volar locking plates and, secondarily, to compare this results according fracture type (AO).

Materials and Methods

This study was approved by our institution ethical comitte.

Between 2013 and 2015 we treated surgically 57 fractures of the distal radius. Inclusion criteria were: the use of volar locking plates for the distal radius, age above 18 years old and a minimum follow up of 24 months. 45 patients were identified and summoned following this criteria, from which 42 attended. Of these, we excluded fractures with associated neurological injuries or other articular fractures (elbow, shoulder), open fractures, and patients with a history of dementia or psychiatric illness. Finally, the study group included 39 patients with 39 fractures.

Fractures were classified according to the AO (Arbeitsgemeinschaft für Osteosynthesefragen) classification. In all cases, a modified Henry volar approach between the radial artery and the flexor carpi radialis muscle was used, followed by reduction of the fracture, transitory fixation with k-wires, and osteosynthesis with a distal radius volar locking plate with fixed-angle distal screws.

Postoperative radiologic measurements were made, assessing in each case: ulnar tilt angle of the radius, volar tilt angle of the radius and styloid height. We also evaluated: bone healing and residual pain using Visual Analog Scale (VAS). Subjective and objective function was evaluated using the *Disabilities of Arm, Shoulder and Hand Score (DASH)*, consisting of at least 27 questions over 30 that the patient must answer, and in which a greater amount of points equals a worst result or a greater incapacity (0-100); and the *Mayo Wrist Score*, which evaluates movement, strength, satisfaction and pain, conferring 25 points to each item, resulting a better result from a higher score.

Functional results were evaluated by measuring the affected wrist extension, flexion, radial and ulnar deviation, and pronosupination. Angular values were measured with a goniometer, and strength with a dynamometer (Jamar).

To compare results, the series was divided according the type of fracture (A, B, C).

In three cases, a K-wire was associated to the plate, but this was later removed. Surgery was protected with a plaster splint for two weeks. Finger movement was encouraged immediately after surgery; as well as wrist assisted progressive movement.

Statistical analysis

Two non-parametric tests were used for analysis: The Mann-Whitney test for two independent samples, and the Spearman's rho correlation coefficient.

An ordinal categorical variable that measures the type of fracture (A, B, C) was generated. Scores 1, 2 and 3 were assigned to each category respectively.

The Spearman's rho correlation coefficient was used to determine if there was a correlation with DASH and Mayo Wrist Scores. This score was also used to determine if there was a correlation between type of fracture (A, B, C), DASH, Mayo Wrist Score and VAS.

The software used was SPSS 17.0

Results

The study group consisted of 20 women and 19 men, with an average age of 60 years old (18 - 86). The mean follows up was 46 months (29 - 61) (Table 1).

Demographic Data		
n		39
Gender	Female	20
	Male	19
Mean age (years)		60
Affected side	Right	19
	Left	20

Table 1 Demographic data.

According to the type of fracture, there was two A2, nine A3, one B1, three B2, three B3, five C1, ten C2 and six C3 fractures.

The overall range of motion averages were: wrist flexion of 51° (35 - 85), wrist extension of 55° (45 - 90), pronation of 80° (70 - 90), supination of 75° (60 - 90), ulnar deviation of 25° (15 - 40), and radial deviation of 15° (5 - 25).

The overall averages of radiological measurements were: ulnar tilt angle of the radius of 19.66° (9 - 32), volar tilt angle of the radius of 2.07° ([-22] - 20), and styloid height of 8.96 mm (3 - 26). (Figures 1 and 2)

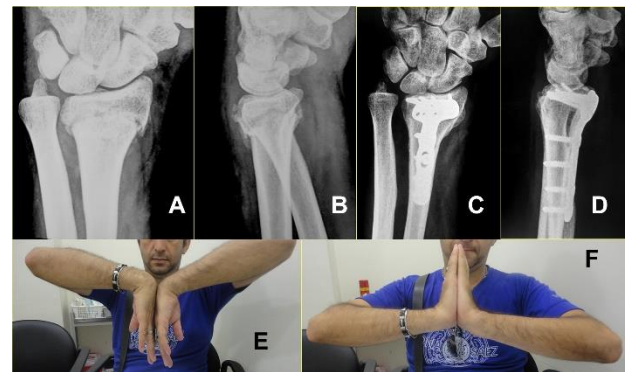


Figure 1. Type A fracture: A and B – Preoperative X-Rays. C and D – Healed fracture X-Rays. E and F – Clinical postoperative images



Figure 2. Type C fracture: A and B – Preoperative X-Rays. C and D – Healed fracture X-Rays. E and F – Clinical postoperative images

The mean DASH was 14.38 (0 - 43.2), and the mean Mayo Wrist Score was 78.58 (35 - 100). Mean VAS was 1.12 (0 - 9) (Table 2). Two patients required reoperation due to a flexor tenosynovitis, in which the plate needed to be withdrawn, resolving the complication. These reoperations were performed 1.5 years from the original surgery. Other complications included a flexor pollicis longus tendinitis that resolved with nonoperative treatment, a superficial infection that resolved with oral antibiotics, a carpal tunnel syndrome three months after surgery that needed a surgical intervention, and a sympathetic dystrophy.

The type of fracture didn't presented a significant correlation with none of the variables analyzed. The Spearman's rho correlation coefficient observed between the type of fracture and DASH was 0.106 (Pv=0.261), between the type of fracture and the VAS was -0.131 (PV=0.672), and between the type of fracture and the Mayo Wrist Score was -0.072 (Pv=0.332).

Results		
Type of fracture (AO)	A2	2
	A3	9
	B1	1
	B2	3
	B3	3
	C1	5
	C2	10
	C3	6
Average mobility (degrees)	Flexion	51
	Extension	55
	Pronation	80
	Supination	75
	Ulnar deviation	25
	Radial deviation	15
Averages of radiological measurements	Ulnar tilt (degrees)	19,6
	Volar tilt (degrees)	2,07
	Stiloid height (mm)	8,96
		14,3
Scores	DASH	8
		78,5
	Mayo	8
	VAS	1,12

Table 2 Results

Discussion

We did not find published experience on distal radius fractures in our region. Several international studies have been published on the treatment of distal radius fractures with volar plates. These evaluate different fractures with a wide range of age [5, 6, 7, 8, 9, 2].

In relation to these studies, the overall average functional results of our group study are similar: wrist flexion of 51° (35 - 85), extension of 55° (45 - 90), pronation of 80° (70 - 90), and supination of 75° (60 - 90). As regards the overall average radiologic measurements: ulnar tilt angle of the radius of 19.66° (9 - 32), volar tilt angle of the radius of 2.07° ([-22] - 20), and styloid height of 8.96 mm (3 - 26). [10, 11, 8] Orbay and Fernandez [12] achieved, in patients older than 75 years old, 55° of flexion, 58° of extension, 80° of pronation and 76° of supination, in 24 unstable fractures with a follow-up of 63 months. The same authors, in a series of 29 patients with dorsally displaced fractures and the same plate model, observed an average of 59° of extension, 57° of flexion, 27° of ulnar deviation, 17° of radial deviation,

80° of pronation and 78° of supination; obtaining 19 excellent and 12 good results according to Gartland and Werley [13]. As for the radiologic results obtained, these were: mean volar tilt of 5° (5° dorsal - 12° volar), mean ulnar tilt of 21° (15° - 26°), and mean radial shortening of 1mm (0mm - 2mm). [13]

This plate's design is based on the utilization of the volar side of the distal radius for the osteosynthesis, due to its anatomical advantages over the dorsal side [11, 12], among which it can identified a greater space between the skin and the bone surface, and the volar concavity of the radius, as well as the usually lesser volar comminution present in these fractures, and better tolerance to volar scars; all these factors that simplify the material placement, even in dorsally displaced fractures [11, 12].

The anatomical low profile design of the utilized plate allows one to place it proximal to the so-called "watershed line", where the radius concavity ends, this way avoiding intra-articular penetration of the distal screws [12]. The tridimensional orientation of the distal locking screws (2 mm pins, 2.5 mm total or partial thread screws) located in two rows with opposite tilt, allows the proximal row to support the dorsal subchondral area, and the distal row to support the volar and central subchondral area [11, 12, 13]. The goal is to create a scaffold for epiphyseal support. The plate has holes for transitory pin fixation, to obtain a satisfactory position prior to placing the screws. Proximal screws are 3.5 mm non-locking screws.

In this series no correlation was found between the three groups, divided according to the fracture type, and the scores. A mild difference in radiologic results was observed between the patients in group B compared to the other two groups. No difference was found either between the groups divided according to the aforementioned variables. The general average DASH in our series was 14.78 over 100, which indicates minimal limitations in daily life activities. The mean Mayo Score was 78.58 (range between 35-100) corresponding to the range of "sufficient". These results support the effectiveness of ORIF with locking plates for distal radius fractures. As well as for function, both Mayo and DASH scores in the general and group-divided series were similar to those obtained in other series [8, 9, 14].

Reports on complications present variable values: from the high percentages of 18-34% [15], which includes temporary complications of all source and not only those related to the plates (generally technique errors), to 6% [18], 7% [8], or 15.38% and 5% in this series considering general and plate-related complications respectively.

The aim of surgical treatment in distal radius fractures is to obtain a reduction with adequate stability to initiate early mobility and rehabilitation, thus obtaining functional results for daily life, and a return to pre-trauma activities.

It is not clear how statistical evaluations may result in bigger samples, with a higher amount of cases per fracture type. Likewise, this paper presents the limitations of a retrospective study.

Conclusion

Based on this study, we believe that this type of plate is a valid option in the resolution of unstable fractures, not finding any differences in functional results in its different patterns, displacements and age range.

Disclosure

The authors, their immediate family, and any research foundation with which they are affiliated did not receive any financial payments or other benefits from any commercial entity related to the subject of this article. The Authors declare that there is no conflict of interest.

Agradecimientos

Queremos agradecer a quienes participaron voluntariamente del estudio y especialmente a los trabajadores de la salud por su continua ocupación durante esta pandemia.

Limitaciones de responsabilidad

La responsabilidad del trabajo es sólo de los autores

Conflictos de interés

Ninguno

Fuentes de apoyo

No hubo fuentes de financiación ni apoyo.

Originalidad del trabajo

Este artículo es original y no ha sido enviado para su publicación a otro medio de difusión científica en forma completa ni parcialmente.

Cesión de derechos

Los participantes de este trabajo ceden el derecho de autor a la Universidad Nacional de Córdoba para publicar en la Revista de la Facultad de Ciencias Médicas y realizar las traducciones a otros idiomas.

Bibliografía

1. Gouk C, Ng SK, Knight M, Bindra R, Thomas M. Long term outcomes of open reduction internal fixation versus external fixation of distal radius fractures: A meta-analysis. *Orthop Rev (Pavia)*.2019 24;11(3):7809. doi: 10.4081/or.2019.7809

2. Yu X, Yu Y, Shao X, Bai Y, Zhou T. Volar locking plate versus external fixation with optional additional K-wire for treatment of AO type C2/C3 fractures: a retrospective comparative study. *J Orthop Surg Res*. 2019 27;14(1):271. doi: 10.1186/s13018-019-1309-4.

3. Mudgal CS, Jupiter JB. Plate and screw design in fractures of the hand and wrist. *Clin Orthop Relat Res*; 2006 445:68-80. DOI: 10.1097/01.blo.0000205887.04200.21

4.Egol KA, Kubiak EN, Fulkerson E, Kummer FJ, Koval KJ. Biomechanics of locked plates and screws. *J Orthop Trauma*; 200418(8):488-493. PMID: 15475843

5.Drobtz H, Kutscha-Lissberg E. Osteosynthesis of distal radial fractures with a volar locking screw plate system. *Int Orthop*; 2003 27(1):1-6.DOI: 10.1007/s00264-002-0393-x

6.Orbay JL, Fernandez DL. Volar fixed-angle plate fixation for unstable distal radius fractures in the elderly patient. *J Hand Surg*; 2004 29(1):96-102. PMID: 14751111

7. Rozental T, Blazar P.E.,Orrin I.F, BS, Chacko A.T.,Brandon B.S, Earp E. and. Day C.H. Functional Outcomes for Unstable Distal Radial Fractures Treated with Open Reduction and Internal Fixation or ClosedReduction and Percutaneous FixationA Prospective Randomized Trial *J Bone Joint Surg Am*. 2009 ;91(8):1837-46. DOI: 10.2106/JBJS.H.01478

8. Souer JS, Lozano-Calderon SA, Ring D. "Predictors of wrist function and health status alter operative treatment of fractures of the distal radius". *J Hand Surg*; 2008 33(2):157-163. doi: 10.1016/j.jhsa.2007.10.003.

9. Wong KK,Chan KW, Kwok TK, Mak KH "Volar fixation of dorsally displaced distal radial fracture using locking compression plate". *Journal Orthop Surg* 2005;13(2):153-157. DOI: 10.1177/230949900501300208

10.Drobtz H, Bryant AL, Pokorny T, Spitaler R, Leixnering M, Jupiter JB. Volar fixed-angle plating of distal radius extension fractures: influence of plate position on secondary loss of reduction—a biomechanic study in a cadaveric model. *J Hand Surg* ; 2006 31(4):615-622. DOI: 10.1016/j.jhsa.2006.01.011

11.Orbay JL. The treatment of unstable distal radius fractures with volar fixation. *Hand Surg* ; 2000 5(2):103-112. PMID: 11301503

12.Orbay JL. Volar plate fixation of distal radius fractures. *Hand Clin*. 2005 21(3):347-354. DOI: 10.1016/j.hcl.2005.02.003

13.Orbay JL, Fernandez DL. Volar fixation for dorsally displaced fractures of the distal radius: A preliminary report. *J Hand Surg*; 2002 27(2):205-215

14.Souer S.J, Ring D., Matschke S, Audige L, Hubert M. M, Jupiter J. "Comparison of Functional Outcome After Volar Plate Fixation With 2.4-mm Titanium Versus 3.5-mm Stainless-Steel Plate for Extra-Articular Fracture of Distal Radius. *J Hand Surg*; 2010 35(3):398–405. DOI: 10.1016/j.jhsa.2009.11.023

15.Arora R, Lutz M, Hennerbichler A, Krappinger D, Espen D, Gab M. Complications following internal fixation of unstable distal radius fracture with a palmar locking-plate. *J Orthop Trauma*; 2007 21(5): 316-322. DOI: 10.1097/BOT.0b013e318059b993