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ORIGINAL STUDY

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Results of the total wrist arthrodesis with contoured plate in a series of 41 wrists with median follow-up of 6 years

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We present a comparative analysis between the pre and postoperative status of 41 wrists subjected to total arthrodesis with contoured plate, analysing the functional and radiological results, subjective satisfaction and return to work. The indications for surgery were post-traumatic arthritis (56.1%), Kienböck's disease (17.1%), rheumatic disease (14.6%) or other reasons (12.2%). In 75.6% of the procedures, proximal row carpectomy took place prior to or at the same time as the surgical fusion procedure. The median follow-up was 6 years. Postoperatively, pain decreased by 7.5 points on the Visual Analogue Scale and grip strength increased by 6.3 kg. The improvement in the Quick Disabilities of the Arm, Shoulder and Hand was 43.5 points and 53.2 in the Patient-Rated Wrist Evaluation. All changes were statistically significant. There were postoperative complications in 14.6% of the arthrodesis procedures. Radiocarpal fusion was complete in 97.6% of cases. Finally, 62.5% of patients were able to return to work, with 92.5% being satisfied or very satisfied. These results allow us to conclude that, in the medium term, total wrist arthrodesis with contoured plate is a reliable and safe technique for the treatment of advanced radiocarpal arthritis.

Keywords: wrist; total wrist arthrodesis; contoured plate; post-traumatic arthritis; rheumatoid arthritis; Kienböck's disease.

INTRODUCTION

Total wrist arthrodesis (TWA) is the surgical procedure most commonly used in cases of advanced radiocarpal arthritis of primary, inflammatory or post-traumatic origin *(1)*, with various techniques having been described during the last century. Since the 1980s, the contoured plate has been the option most commonly used when compared with other osteosynthesis systems *(2)*, although we have found few studies comparing the pre and postoperative status using this fixing system *(3-5)*.

The objective of our retrospective work is to analyse, with medium-term follow-up, the functional and radiological results, subjective satisfaction and the ability to return to work in patients with advanced radiocarpal arthritis treated with TWA with contoured plate.

MATERIAL AND METHODS

In a period of 15.6 years between November 2005 and June 2021, a total of 61 TWAs were performed

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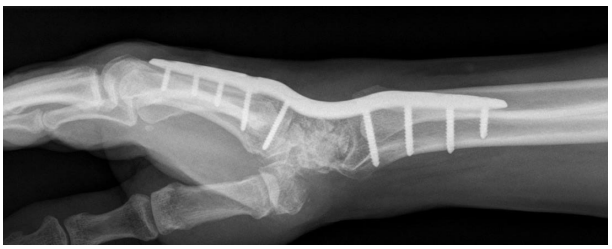

Figure 1. — Total wrist arthrodesis with a curved precontoured plate after the resection of the proximal carpal row in the same surgical procedure.

by the senior author (GMV) with an experience level of IV *(6)*. The following exclusion criteria were established in the selection of patients intended for this study carried out by the first independent author (LRN): absence of preoperative records, use of a fixing system other than the contoured plate, arthrodesis performed in the context of paralysis or congenital malformations of the distal forearm and the hand, follow-up less than two years, impossibility of contacting the patient or their refusal to participate in the study. The work was approved by the Clinical Research Ethics Committee of the Autonomous Community of Aragon (CEICA) with code CP-CI.PI 19/132.

The surgical technique used was the standard for a TWA with plate. We use two low-profile implant models made of titanium alloy: LCP™ from Synthes and VariAx 2™ from Stryker (Figure 1). The median surgery time was 98.5 (72-165) minutes.

The variables documented and recorded were: age, gender, laterality, dominant hand, etiology, previous surgeries, type of graft inserted in the fusion and procedures performed at the same time as the TWA surgery. In the study comparing pre and postoperative status, pain was estimated using the visual analogue scale (VAS) and grip strength in kg using a Jamar™ hydraulic dynamometer (Sammons Preston Inc., Bolingbrook, IL, USA). All patients were interviewed using the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) and the Patient-Rated Wrist Evaluation (PRWE) questionnaires. Anteroposterior and lateral x-rays were performed regularly to check the consolidation of the arthrodesis and note any complications. Finally, the ability of the patients to return to work was evaluated, as well as the level of satisfaction obtained using a qualitative scale.

The statistical analysis of the data was performed using the Shapiro-Wilk test to estimate the normality of the distribution of each of the variables. The comparison of the pre and postoperative results was made using Student's t-test for paired data if the variable followed a normal distribution, or the Wilcoxon test when the variable did not fit the assumption of normality. The level of significance was set at $p < 0.05$.

RESULTS

The study included 41 TWA corresponding to 40 patients with an average age of 52.3 (27-81) years, 27 of them male and 13 female. The right wrist was involved on 21 occasions and the left on 20, with the dominant hand involved 23 times. Thirty-two plates were curved and 9 were straight. The surgical indication for the arthrodesis was post-traumatic arthritis in 23 wrists, Kienböck's disease in seven and rheumatoid arthritis is six; in two wrists the arthrodesis was motivated by the consequences of tuberculosis, in another two by the removal of a total wrist prosthesis (TWP), and in one by a metaphyseal tumour of the distal radius. The median postoperative follow-up time was 6 (2-13) years.

Nineteen of the 41 wrists were subjected to 26 different surgical procedures before the TWA (Table I), with 44 procedures associated with the arthrodesis itself (Table II). In 10 wrists, there was no proximal row carpectomy, in 24 wrists this was performed as an intrinsic part of the TWA, and in seven it had already been performed as a rescue procedure before the arthrodesis. On 24 occasions, the graft used to strengthen the radiocarpal fusion was extracted from the proximal carpal row, from the iliac crest in 13, in two cases from the ulna after an enlarged Darrach (ulna-pro-radius) to cover a post-traumatic segmental defect of the distal radius, and an allograft from the bank was used in two cases.

Tables III and IV show the results of the grip strength, the pain evolution and the QuickDASH and PRWE evaluation scales, with all the variables showing a statistically significant improvement after the arthrodesis. Seventeen patients were very

Table I. — Previous surgeries

Proximal row carpectomy	7
Partial wrist arthrodesis	5
Radial styloidectomy	4
Darrach	2
Scapholunate ligamentoplasty	2
Total wrist arthroplasty	2
Total wrist arthrodesis	1
Curettage + graft	1
Distal radius fracture	1
Scaphoid fracture	1

Table II. — Concurrent procedures

Proximal row carpectomy	24
Darrach	6
Removal of material	4
Spinner Kaplan	3
Extensors tenorraphy	3
Carpal tunnel release	1
Radial styloidectomy	1
Thumb MCP arthrodesis	1
Elbow arthrolysis	1

MCP: Metacarpophalangeal.

Table III. — Grip strength

	Mean	SD	p
Preoperative	13	10,9	0,003
Postoperative	19,3	11,8	

SD: Standard deviation.

Table IV. — Scores and questionnaires

	Mean	SD	p
VAS (pre)	8,8	1,3	<0,001
VAS (post)	1,3	2,7	
QuickDash (pre)	73,5	21,8	<0,001
QuickDash (post)	30	21,3	
PRWE (pre)	81,1	15,6	<0,001
PRWE (post)	27,9	23,6	

SD: Standard deviation. VAS: Visual analogue scale. QuickDASH: Quick disabilities of the arm, shoulder and hand. PRWE: Patient-rated wrist evaluation. Pre: Preoprative. Post: Postoperative

Figure 2. — Loosening of the osteosynthesis material and failure of the total wrist arthrodesis (a) in a patient reinfected with tuberculosis (b).

satisfied with the results of the arthrodesis, 20 were satisfied and three unsatisfied. Thirty-five patients would undergo surgery again for the same reason and five would not do it again.

There was a complication rate of 14.6%: three cases of loosening of the osteosynthesis material, one of them in the context of a tuberculosis reinfection (Figure 2); one for a superficial infection, one due to protrusion of the plate on the third metacarpal, and other due to a peri-implant fracture after a road accident (Figure 3). Radiocarpal fusion was complete in 97.6 % of cases.

Twenty-five patients were able to return to work after the surgery. Of these, 17 were able to work without restrictions and eight with some restrictions or relocation in the usual position. Fifteen patients did not return to work due to functional limitation.

DISCUSSION

The etiology of radiocarpal arthritis is multiple, with the result being painful biomechanical alteration in the wrist. The most suitable surgical technique for the treatment of this disorder will vary depending on the damage. Proximal row carpectomy or partial arthrodesis are chosen in early stages; however, TWA or TWP are preferred in more

Figure 3. — Peri-implant fracture in the third metacarpal (arrows) a year and a half after the performance of total wrist arthrodesis with a curved precontoured plate.

advanced stages *(7)*, both with similar complications and functional results except for mobility *(8,9)*. Despite this, TWA is practised up to four times more often than TWP *(10)*. The reasons for this choice are due to the technical ease of TWA, the predictable and definitive results, the short follow-up time required, and a lower cost *(10)*, although a study by Cavaliere and Chung *(11)* showed that the difference with TWP is not significant. The most significant negative factors of TWA are loss of movement and the limits that may be placed on certain everyday activities *(1)*. The fusion of the wrist can also have a negative impact on the patient who needs movement due to tenodesis effect or in rheumatic disease, in which the joints involved in the arthrodesis have to bear greater mechanical stress *(12)*. These facts are even more pronounced when the patient has undergone a bilateral TWA.

In the surgical procedure of TWA, the resection of the proximal carpal row proposed in 1984 by Louis et al. *(13)* to fuse the radius and the capitate bone has shown numerous advantages, including: lower risk of nonunion, more comfortable positioning of the wrist and the plate, and the possibility of using removed bones as an autologous graft, reducing both the surgery time and the morbidity present if the iliac crest is used as a donor area *(14,15)*. Studies, such as that by Pham et al. *(16)*, have shown that the loss of carpus height when resecting its proximal row of bones is not a reason for the loss of grip strength after an adaptation period of several weeks.

Another of the points still being debated in the performance of TWA concerns the number of joints to be fixed. The surgical technique we have used involves fusion of the radius, the carpal bones and the third metacarpal *(3,17)*. As an alternative, Meads et al. *(4)* also propose fusing the second carpometacarpal joint, excluding arthrodesis of joints other than the scaphoid-capitate and the lunate-capitate. In our opinion, this solution may cause a symptomatic degenerative process so we prefer total intercarpal fusion.

The estimate of the pain and grip strength after a TWA are important results which have been analysed by few studies comparing pre and post-operative status *(4,5)*. Agreeing with them, our comparative analysis has shown that both variables improve significantly. Houshian and Schrøder *(3)* found that the final strength of a hand with a fused wrist is 12% less than the healthy hand.

Patients undergoing a TWA with contoured plate obtain good functional results thanks to the achievement of a stable wrist *(5,17,18)*. The price of the stability is loss of mobility, despite which more than 90% of patients are satisfied with the results obtained *(3,4,19)*.

The TWA is not free from complications *(20,21)*. In our experience, the rate is 14.6%, which is below that of other studies which ranges from 23.8% to 39.1% *(3-5,17-19)*. The most significant complica-

tion is failure of the consolidation, the incidence of which is reduced in patients operated on using a plate *(2)*. Houshian and Schrøder *(3)*, and Sauerbier et al. *(5)* described 7.1% and 8.3% of nonunion, respectively. In our series, the only failure occurred in a patient reinfected with tuberculosis whose wrist was definitively "floating", protected by a rigid brace as a solution in the context of their advanced age and the multiple pathologies presented. However, the number of studies that publish 100% wrist consolidation is high *(4,17-19)*.

A large number of patients who undergo TWA are of working age so their return to work is an importance aspect considered in few studies, with percentages of those returning to their previous position or an adapted position standing at between 70% and 95.2% *(3-5)*. This percentage was 62.5% in our series; that is, more than a third of the patients did not return to work. This data is paradoxical if we consider that 87.5% showed a statistically significant improvement in pain, grip strength, and the result on the subjective evaluation scales at the end of the postoperative follow-up. The lack of data on the sociolaboral characteristics of the patients studied in other published manuscripts has not allowed us to know the reason for this difference. We think it could be explained by the fact that the majority of our patients have strength jobs and are more restricted by TWA than those with less demanding jobs. Perhaps it also influenced that some of these patients were at the end of their working life and they decided to advance their retirement plans. These facts recommend clear preoperative information about the inconveniences of a TWA in patients who need a minimum of mobility in the wrist for the performance of certain professional activities. Ultimately, when expectations of returning to a previous job are difficult or unlikely, TWP could be considered as a first option, or the conversion of a failed TWA into TWP if the patient wishes to regain mobility in the wrist giving up strength activities *(22,23)*, as happened in some of our cases. Unfortunately, there are no established criteria for taking preoperative decisions in one direction or another in functionally very demanding wrists, so acting sheltered in simple hypotheses about the patient's response to a TWA seems extremely risky to us.

Based on our results and on the evaluation questionnaires completed, we can conclude that TWA with contoured plate is a reliable and definitive treatment in patients with advanced radiocarpal arthritis of various etiologies, giving the patient a good quality of life, with satisfactory functional standards and a favourable cost for health administrations.

Our study has certain limitations: it is a retrospective study lacking a randomised control group; the surgical indication for TWA is based on a heterogeneous pathology and the post-operative follow-up time has wide margins.

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