Proximal Row Carpectomy in Degenerative Wrist Conditions. Our Medium-term Experience

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ABSTRACT

Objective: Examining the medium-term clinical and radiological outcomes of proximal carpectomy for treating degenerative wrist conditions. **Materials and Methods:** Retrospective study of 33 patients who underwent proximal carpectomy between 2009 and 2019. Outcomes were assessed through range of motion measurements, pain evaluation using the Visual Analog Scale (VAS), and functional capacity using the Quick-DASH questionnaire. Biomechanical tests were performed and the rate of complications and reoperations was analyzed. Radiological progression of osteoarthritis and its impact on clinical outcomes were examined. **Results:** The mean range of motion was 77.11º (range 51–80º) in flexion-extension and 36.7º (range 29–42º) in radioulnar deviation. VAS scores improved significantly from 7.9 (range 7–9) to 2.7 (range 0–7) post-surgery (p<0.003). The Quick-DASH score at the final follow-up was 24.3 (range 11–45). We observed an inverse relationship between preoperative radiocarpal osteoarthritis severity and clinical outcomes (p<0.03), but no link between postoperative osteoarthritis progression and poor outcomes (p<0.04). Four patients (12.12%) required reoperation with total wrist arthrodesis. **Conclusions:** Proximal carpectomy demonstrates satisfactory medium-term outcomes for degenerative wrist conditions, offering good range of motion and a low complication rate. However, patients with more severe preoperative joint degeneration may lead to poorer clinical outcomes.

Keywords: Carpectomy; row; resection.
Level of Evidence: IV

Carpectomía de la fila proximal en procesos degenerativos de la muñeca. Nuestra experiencia a mediano plazo

RESUMEN

Objetivo: Evaluar los resultados clínico-radiográficos a mediano plazo del tratamiento de los procesos degenerativos de la muñeca mediante carpectomía proximal. **Materiales y Métodos:** Estudio descriptivo retrospectivo de 33 pacientes operados entre 2009 y 2019 en nuestro Centro. Se evaluaron el rango de movilidad, el dolor con la escala analógica visual y la capacidad funcional con el cuestionario QuickDASH. Se realizaron pruebas de valoración biomecánica. Se estudió la incidencia de complicaciones y de una segunda intervención. Se evaluó la progresión radiográfica de la artrosis y su asociación con los malos resultados clínicos. **Resultados:** El seguimiento medio fue de 10 años. El rango de movilidad medio fue de 77,11º en el arco de flexo-extensión y 36,7º en el radiocubital. El puntaje medio de dolor evolucionó de 7,9 a 2,7 tras la cirugía (p <0,003). El puntaje QuickDASH en el último control fue de 24,3. Se halló una asociación inversa entre el grado de artrosis radiocarpiana preoperatoria y el resultado clínico (p <0,03); sin embargo, no hubo una relación entre la evolución artrósica radiográfica posoperatoria con la mala evolución (p <0,04). Cuatro pacientes necesitaron una segunda intervención mediante artrodesis total de muñeca. **Conclusiones**: La carpectomía proximal es una opción terapéutica que ofrece resultados satisfactorios a mediano plazo en pacientes con procesos degenerativos de la muñeca, proporciona un adecuado rango de movilidad con una baja tasa de complicaciones. El uso de esta técnica en pacientes con degeneración articular de mayor grado antes de la cirugía puede llevar a un peor resultado clínico.

Palabras clave: Carpectomía; hilera; resección.
Nivel de Evidencia: IV

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How to cite this article: Matellanes Palacios C, Cabanes Ferrer I, Alfonso Porcar M, Gázquez Gázques G, Losar Sogues Colom A, Castillo Ruipérez L, Garrido Ferrer J, Hernández Ferrando L. Proximal Row Carpectomy in Degenerative Wrist Conditions. Our Medium-term Experience. *Rev Asoc Argent Ortop Traumatol* 2024;89(4):341-352. https://doi.org/10.15417/issn.1852-7434.2024.89.4.1843

INTRODUCTION

Radiocarpal osteoarthritis is a leading cause of wrist pain and functional disability. The most common causes of wrist osteoarthritis are the sequelae of fractures and fracture-dislocations of the distal radius and carpus.[1] Other frequent causes include nonunion and flexion instability of the scaphoid, known by the acronyms SNAC (Scaphoid Nonunion Advanced Collapse) and SLAC (ScaphoLunate Advanced Collapse), respectively, as well as necrosis of the lunate, or Kienböck's disease. Symptoms accompanying these degenerative processes include weakness, stiffness, pain, and restricted functional range of the wrist joint. Surgical treatments range from procedures that sacrifice motion, such as wrist arthrodesis, to those that aim to preserve it, such as partial arthrodesis, wrist denervation, and proximal row carpectomy.[2]

The goal of PRC is to achieve symptomatic relief while preserving wrist mobility.[3] It was originally described by Stamm[4] in 1944 for the palliative treatment of wrist osteoarthritis and involves creating a neoarticulation between the radius and the capitate bone that reproduces and preserves range of motion and grip strength while relieving pain.[2]

Good medium and long-term outcomes of proximal row carpectomy have been reported.[2,3] Numerous studies compare these outcomes with those of four-corner arthrodesis, with no clear superiority of one technique over the other.[5-8]

The primary objective of this study was to evaluate the medium-term clinical-functional outcomes of surgical treatment for degenerative wrist conditions using proximal carpectomy. Secondary objectives included analyzing the rate of complications and the need for subsequent total wrist arthrodesis. The study also evaluated the correlation between clinical scales and biomechanical tests that establish functional impairment and assessed whether there is an association between the degree of preoperative radiocarpal arthrosis and functional outcomes, with the aim of improving surgical indications for this procedure.

MATERIALS AND METHODS

A descriptive, retrospective, single-center, hospital-only study was conducted. The study population consisted of 33 consecutive patients who underwent proximal row carpectomy between January 2009 and January 2019 at the Hospital General Universitario de Valencia. All were registered in the surgery database of the Upper Limb Unit. Two patients were excluded from the study: one due to loss to follow-up and the other due to death from causes unrelated to the surgery under study. There is no evidence that the patient excluded due to loss to follow-up experienced complications related to the proximal row carpectomy.

The data were obtained by reviewing clinical records in accordance with the ethical principles of the Declaration of Helsinki and current regulations (Good Clinical Practice Guidelines).

Twenty-seven patients (82%) were men and six (18%) were women. The mean age was 51 years (range 26-71). In 22 patients (67%), the dominant hand was operated on, while in 11 patients (33%), the non-dominant hand was operated on. The etiologies included SNAC grade II (48%), Kienböck stage IIIB disease (24%), SLAC grade II (18%), and conditions such as psoriatic arthritis, rheumatoid arthritis, or chronic perilunate dislocation without degenerative involvement of the lunate fossa of the radius or capitate bone (9%) (Table 1). SLAC/SNAC grades were determined using Watson's classification,9 and Kienböck's disease stage was assigned based on Lichtman's classification, as recommended by De Carli and Zaidenberg, 2020.[10]

Surgical procedure

Preoperative planning was performed using MRI without contrast in most cases (97%) to study the articular cartilage and rule out associated injuries. In one patient, MRI was not possible due to the presence of metallic material, so computed tomography was used to assess the condition of the articular cartilage.

The mean time from surgical indication in outpatient clinics to surgery was 24 months. No new imaging studies were requested during this waiting period.

Table 1. Demographic data of the patients in the series.

Age	Sex	Dominant hand	Occupation	Diagnosis	Follow-up (months)
49	M	Yes	Unemployed	Kienböck* IIIB	55
44	M	No	Manager	Kienböck IIIB	58
61	F	Yes	Pre-retiree	SLAC II	58
51	F	Yes	Stay-at-home wife	SNAC II	79
26	M	Yes	IT specialist	Kienböck IIIB	87
45	M	Yes	Manager	Chronic perilunate dislocation	90
49	M	Yes	IT specialist	SNAC II	90
60	M	No	Painter	SNAC II	93
65	M	Yes	Retiree	SLAC II	94
57	M	No	Cook	Kienböck IIIB	95
48	M	No	Formworker	SNAC II	102
57	M	Yes	Printer	SLAC II	111
41	M	No	Farmer	SNAC II	112
52	M	No	Unemployed	SNAC II	114
53	M	Yes	Sanitary	Kienböck IIIB	115
44	M	No	Forklift	SNAC II	120
54	M	Yes	Warehouse handler	SNAC II	121
58	M	Yes	Banker	SLAC II	121
35	M	Yes	Waiter	Kienböck IIIB	126
53	M	Yes	Cartographer	SLAC II	128
59	M	Yes	Pastry chef	Rheumatism	130
58	M	Yes	Unemployed	SNAC II	138
60	M	Yes	Painter	SNAC II	140
40	M	No	Administrative	SNAC II	143
71	F	No	Retiree	SLAC II	150
44	F	Yes	Administrative	SNAC II	151
34	M	Yes	Engineer	Kienböck IIIB	156
57	M	Yes	Worker	Kienböck IIIB	159
50	M	No	Cook	Psoriatic arthritis	159
49	M	No	Mason	SNAC II	161
55	F	Yes	Nurse	SNAC II	162
52	F	Yes	Cake maker	SNAC II	163
48	M	Yes	Painter	SNAC II	171

*Lichtman classification.
M = male; F = female; SNAC = Scaphoid Nonunion Advanced Collapse; SLAC = ScaphoLunate Advanced Collapse.

Surgical technique

All operations were performed by the same surgical team. A dorsal approach was used, following the surgical and postoperative techniques described by Escribano Rey et al.[11]

Antibiotic prophylaxis was administered with 2 g of cefazolin intravenously, or clindamycin in cases of beta-lactam allergy.

With the use of a pneumatic tourniquet and prior exsanguination of the arm, the surgery began with a dorsal zigzag incision over the wrist, with the proximal end of the incision 1 cm proximal to Lister's tubercle and the distal end at the level of the base of the third metacarpal. An inverted "T" capsulotomy was performed, leaving a 2-3 mm capsular segment for subsequent closure. Total excision of the triquetrum, lunate, and scaphoid bones was performed (Figure 1). If radial styloid impingement was present, a partial styloidectomy was performed in 15% of cases. When a chondral injury was observed on the capitate bone (12% of cases), a capsule interposition was performed, and the joint was closed (Figure 2).

In all surgeries, the posterior interosseous nerve was also resected as an adjunctive measure for postoperative pain management, as we consider it a simple procedure that does not add morbidity to the patient.

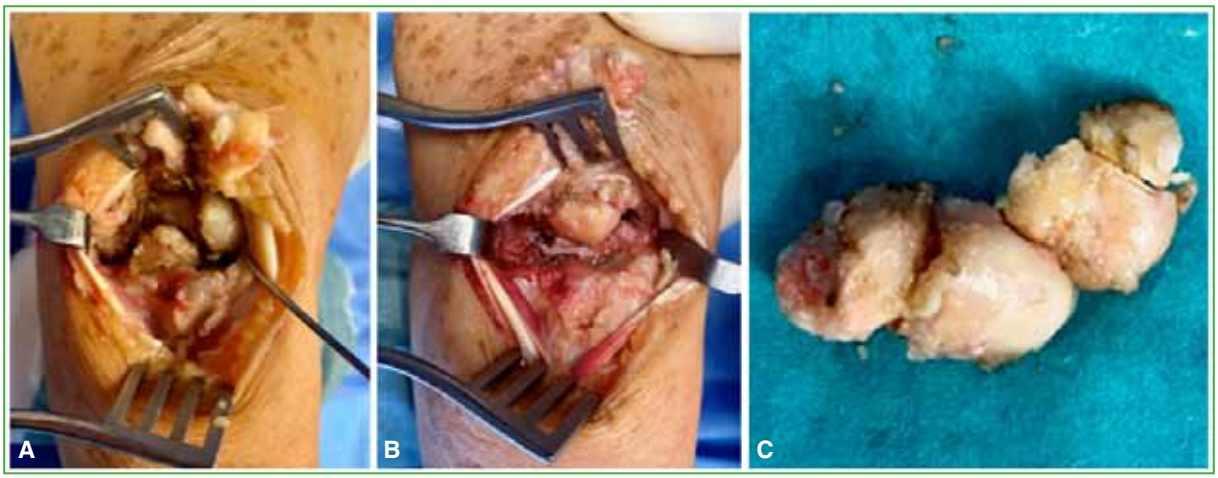

Figure 1. Intraoperative images. Proximal row carpectomy. **A.** Before resection. **B.** After carpectomy. **C.** Carpal bones after resection.

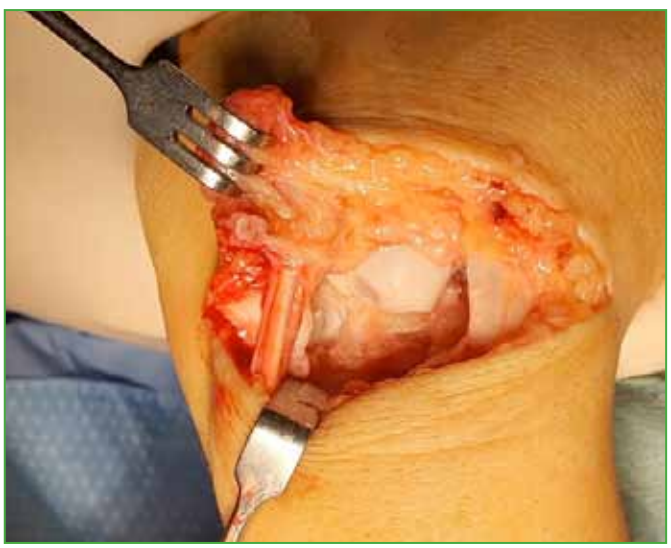

Figure 2. Patient with a small erosion in the cartilage of the capitate bone. A proximal row carpectomy was performed associating an interposition of the joint capsule.

Postoperative evaluation

Patients were evaluated clinically and radiographically at 3, 6, and 12 weeks, at 6 months, and then annually. To determine the degree of postsurgical osteoarthritis in the new joint between the radius and the capitate bone, the Culp-Jebson classification[12] was used based on radiographs. Postoperatively, patients were immobilized with a posterior splint for 3 weeks to ensure proper soft tissue healing and pain control. After this period, they began passive and active joint mobilization progressively and were referred to the Rehabilitation Service.

Pain was assessed using the visual analog scale (VAS), active joint range of motion was measured with a goniometer, and functional capacity was evaluated with the QuickDASH questionnaire.[13] Biomechanical assessment tests were conducted using a system developed by the Biomechanics Institute of Valencia, called NedMano/IBV and NedRangos/IBV,[14] thanks to collaboration with our hospital's Rehabilitation Service. NedMano/IBV is a computer program that assesses maximum strength in grip, distal pinch, and lateral pinch movements (Figure 3), records the data, and compares the results with the contralateral hand, as well as with a database of the Spanish population segmented by age, sex, and dominance. This allows for a comprehensive functional assessment of the hand. NedRangos/IBV assists specialists in assessing joint movement amplitudes, using data obtained from goniometers. The maximum amplitudes of the joints in all planes of anatomical movement are recorded with electronic instrumentation that aids in this process.

The complication rate and the need for a second operation were also studied. Radiographically, the degree of osteoarthritis progression in the new joint between the radius and the capitate bone was evaluated.

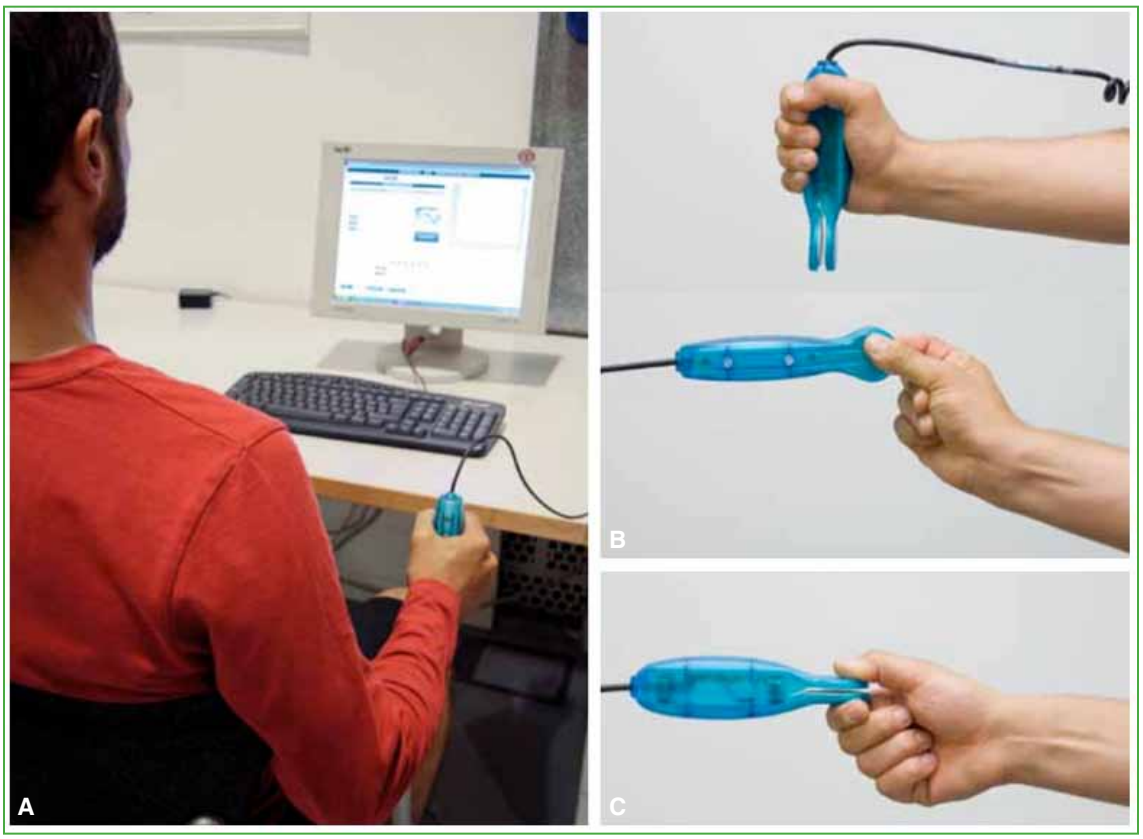

Figure 3. Biomechanical assessment using the NedMano/IBV system during different gestures. **A.** Gripping. **B.** Tip pinch. **C.** Lateral pinch.

Statistical analysis

The data were analyzed using SPSS 22 and XLSTAT statistical software for MAC OS. A descriptive analysis was performed, with quantitative variables expressed as mean and range (e.g., age, results from various classifications such as VAS, QuickDASH questionnaire, follow-up), and qualitative variables as absolute and relative frequencies (e.g., sex, laterality, diagnosis). The normality of quantitative variables was tested using the Kolmogorov-Smirnov test. The cumulative survival function was evaluated with the Kaplan-Meier method. In all statistical analyses, the significance level was set at 5%.

RESULTS

Clinical-functional outcomes

The mean follow-up time was 10 years (range 4.6-14.6 years). The mean preoperative VAS score was 7.9 (range 7-9), which decreased to 2.7 (range 0-7) at the last follow-up ($p<0.003$). In terms of functional outcomes, the mean joint range of motion was 77.11° (range 51°-80°) in the flexion-extension arc and 36.7° (range 29°-42°) in the radioulnar arc. The mean score on the QuickDASH questionnaire was 24.3 (range 11-45) (Table 2).

The complications recorded during surgery included one case of extensor tendon traction injury, which was repaired during the surgery. This required an extended period of immobilization, but the clinical and functional recovery was good by the last follow-up. Postoperative complications included one case of complex regional pain syndrome, which was completely resolved after 10 months of oral medication and intensive rehabilitation, and one case of acute intra-articular infection that required surgical debridement with synovectomy and antibiotic therapy, which also had a good outcome.

Seventy-eight percent of patients reported being satisfied or very satisfied with the surgery (Figure 4).

The need for further intervention with total wrist arthrodesis due to poor clinical outcomes was also assessed. A total of 12.12% (4 cases) required a second operation; these were patients with SNAC/SLAC II and a chondral injury in the capitate bone detected during surgery (Figure 5). The mean time to arthrodesis was 16.5 months (range 10-22 months).

Biomechanical outcomes

Biomechanical assessment tests were conducted using the NedMano/IBV and NedRangos/IBV systems,[14] developed by the Biomechanics Institute of Valencia, in collaboration with our hospital's Rehabilitation Service.

Statistical analysis revealed a statistically significant decrease in grip strength ($p <0.05$) in the operated dominant hands, but not in the non-dominant hands. For both lateral and distal pinch grips, there was a decrease in strength in both dominant and non-dominant hands, although the data were not statistically significant ($p >0.05$). An increase in fatigue was observed in all patients who completed the test, with statistically significant values in the non-dominant hand ($p <0.01$) but not in the dominant hand ($p >0.05$).

Radiographic outcomes

According to the Culp-Jebson classification,[12] 39.4% of the sample remained at stage 0 (no osteoarthritis); 24.24% at stage I (joint space narrowing <50%); 27.27% developed stage II (joint space narrowing >50% plus subchondral bone condensation), and three patients (9.1%) reached stage III (complete loss of joint space). Thus, postoperative degenerative changes between the radius and the capitate bone were detected in the medium term in 60.6% of the sample. However, no poor clinical or functional outcomes were observed in these patients according to the VAS and QuickDASH questionnaire ($p <0.04$), indicating no clinical-radiographic correlation in the medium term.

There was an inverse correlation between the degree of preoperative radiocarpal osteoarthritis and the clinical outcome as measured by the VAS ($p<0.03$). The worst clinical outcomes occurred in patients with a chondral injury in the capitate bone detected during surgery, who later required reoperation with total wrist arthrodesis.

Table 2. Proximal carpectomy outcomes.

n	Postoperative VAS*.	Average joint balance: flexion-extension arc (°)	Average joint balance: radioulnar arc (°)	QuickDASH score	Degree of postoperative osteoarthritis*.
1	2	79	41	27	II
2	3	78	38	25	II
3	4	80	42	11	I
4	3	79	39	16	I
5	2	78	36	16	0
6	2	79	37	20.5	I
7	2	78	38	16	0
8	2	78	35	27	0
9	0	80	40	11	I
10	2	79	39	16	0
11	3	79	38	34	II
12	6	66	30	43	III
13	7	74	31	20.5	I
14	0	80	38	16	0
15	3	78	39	16	0
16	7	75	32	27	I
17	2	78	35	34	0
18	2	80	39	16	0
19	1	79	37	25	0
20	2	78	36	16	I
21	3	76	33	43	II
22	2	78	38	25	0
23	2	80	39	20.5	0
24	3	75	30	43	II
25	1	80	42	34	III
26	4	74	31	43	II
27	2	79	35	16	0
28	2	80	41	16	0
29	2	79	42	27	II
30	2	80	39	11	III
31	0	79	34	29.5	II
32	7	51	29	45	II
33	3	79	38	16	I

*According to the Culp-Jebson classification. VAS = visual analog scale.

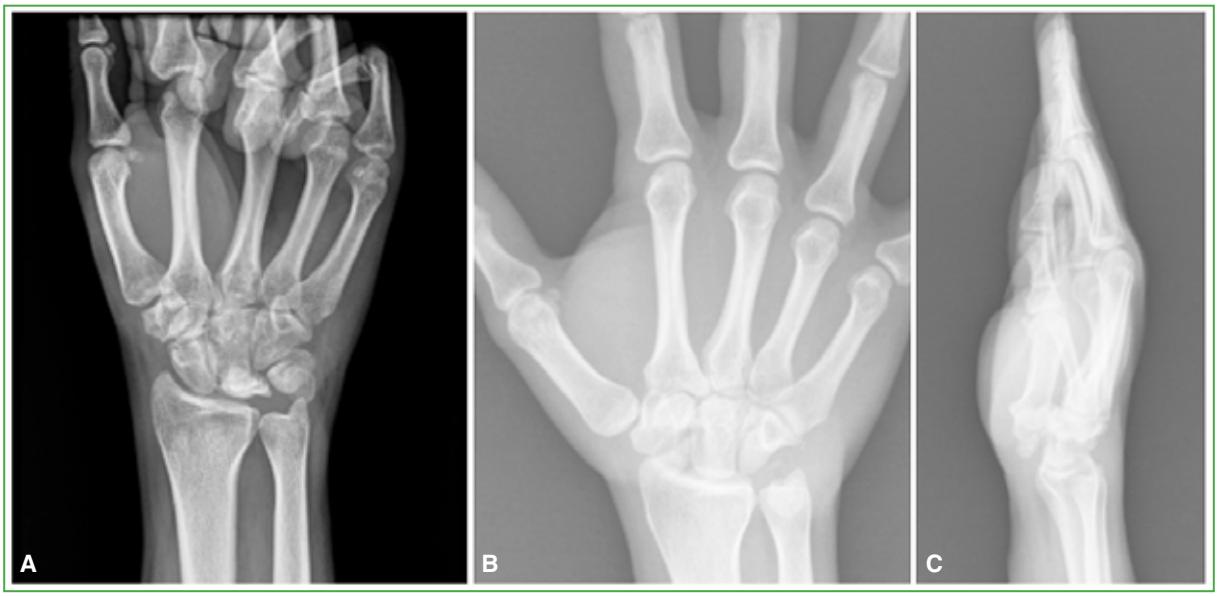

Figure 4. A. 26-year-old patient, manual worker, diagnosed with Kienböck's disease in the right hand. **B.** Anteroposterior radiograph of the right wrist, 7 years after proximal carpectomy. **C.** Lateral radiograph of the right wrist at 7 years of follow-up. Good clinical and radiographic evolution.

Figure 5. A. 57-year-old patient diagnosed with a SLAC wrist in the dominant hand. **B.** Poor clinical and radiographic evolution after proximal row carpectomy, with progression of osteoarthritis between the capitate bone and the radius. **C.** New intervention with total wrist arthrodesis, with good outcomes.

Survival

The Kaplan-Meier curve analysis for reoperation with total wrist arthrodesis due to poor clinical evolution showed a cumulative survival rate of 87.9% at 5 years. All second interventions were performed within the first 2 years of follow-up (Figure 6).

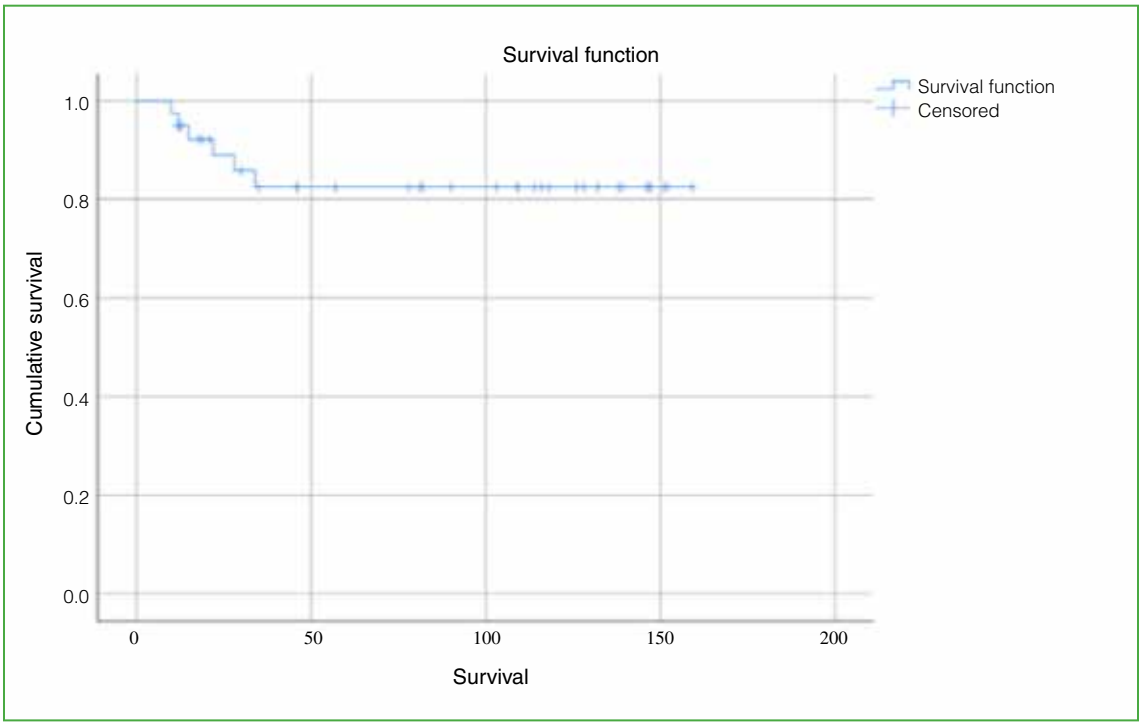

Figure 6. Kaplan-Meier curve for the second operation with total wrist arthrodesis due to progression of osteoarthritis, with poor clinical evolution (Survival expressed in months).

DISCUSSION

Our medium-term clinical-radiographic outcomes of treating degenerative wrist processes with proximal row carpectomy (PRC) show a significant improvement in the VAS pain score, without greatly sacrificing joint range of motion. This procedure also resulted in high patient satisfaction and a reoperation rate of 12.12% for total wrist arthrodesis.

The medium- and long-term results published on PRC confirm that it is a procedure capable of maintaining an adequate range of motion in the radiocarpal joint, with good functional outcomes and high levels of patient satisfaction.[3,12,15] Despite these positive results, a conversion rate to radiocarpal arthrodesis ranging from 4.9% to 15% has been reported.[3,16] Some authors have found that patient satisfaction with PRC is comparable to that of other procedures, such as four-corner fusion with a circular plate or midcarpal arthrodesis.[2,17]

PRC provides significant pain relief. El-Mowafi et al. reported an 80% reduction in pain,[18] which aligns with our findings, where the mean preoperative VAS score of 7.9 decreased to 2.7 at the final postoperative follow-up.

As shown in Table 3, the functional outcomes in our study are consistent with those of other published series involving similar patient samples. [3,12,15,19-22]

A significant number of patients exhibited radiographic signs of progressive degeneration in the space between the radius and the capitate. However, these radiographic changes did not correlate with wrist pain or function. Numerous studies have shown that the osteoarthritic changes in the capitate-radius that develop after PRC do not necessarily cause pain.[3,12,15] Hogan et al.[23] evaluated these radiographic changes and found that, post-surgery, load transmission in the lunate fossa of the radius increased by 37% compared to pre-carpectomy levels. The increased pressure on the radius makes it relatively common for medium-term radiographic osteoarthritis to develop. In our study, 60.6% of patients developed some degree of osteoarthritis in this new joint; however, no association was found between these findings and poor clinical or functional outcomes according to the VAS and QuickDASH questionnaire ($p < 0.04$).

Table 3. Comparison of functional outcomes with those of other published series.

	n	Flexion-extension arc (°)	Radio-ulnar arch (°)
This study	33	77.11	36.7
DiDonna et al. [15]	15	72	40
Renart et al.[19]	12	56.7	32.9
Richou et al.[20]	24	72	45
Ali et al.[21]	61	69.4	30.08
Jebson et al.[12]	20	76	34
Montiel et al.[3]	14	90.08	35
Bijon et al.[22]	24	93	28

A proper indication for PRC requires minimal or no involvement of the articular surfaces that come into contact. Stern et al. state that if the affected cartilage surface is less than 3 mm, the technique can be applied.[24] Several modifications have been proposed to minimize wear and preserve the capitate-radius joint. Rabinovich and Lee describe the use of decellularized dermal allograft to expand the indications for PRC to include selected patients with capitate degeneration.[25] In our series, we performed joint capsule interposition between the new radius joint and the capitate to prevent or slow osteoarthritic degeneration in four patients who had a chondral injury in the capitate bone detected during surgery.

In our sample, 12.12% of patients required another intervention—a total wrist arthrodesis due to poor clinical evolution—consistent with figures published in other studies, which report a conversion rate to radiocarpal arthrodesis between 4.9% and 15%.[3,7,16] These cases involved injuries diagnosed as SNAC/SLAC II, where a chondral injury in the capitate bone was detected during surgery. This suggests that using PRC in patients with more advanced joint degeneration before surgery may lead to poorer outcomes. We also believe that the long delay from diagnosis and patient inclusion on the surgical waiting list to the day of surgery (a mean of 2 years) may have contributed to the intraoperative finding of chondral injuries in the capitate boneAs described in numerous studies, posterior interosseous nerve denervation is used as an adjunctive procedure for postoperative pain management and does not alter outcomes, as it is a partial denervation that can spontaneously reinnervate. Moreover, denervation as an isolated technique has a failure rate of 25% within the first year after surgery.[26] In our cases, the posterior interosseous nerve was denervated in all operations as an adjunct to postoperative pain management, without any related complications.

A 2020 systematic review and meta-analysis by Amer et al. demonstrated that, in comparative studies, PRC was statistically superior to four-corner fusion for treating SLAC, with increased range of motion, grip strength, and decreased pain, although the differences were minimal.[6] Rahgozar et al. found that conversion rates to total wrist arthrodesis were significantly higher with partial arthrodesis (19.2%) than with PRC (4.9%), and that partial arthrodesis had higher associated direct costs.[7] However, other authors argue that patients undergoing PRC present more osteoarthritic changes in the long term compared to those with four-corner fusion, which has a 10% higher complication rate due to non-consolidation of the arthrodesis, dorsal impingement, and issues related to the osteosynthesis material.[5]

A 2022 meta-analysis was the first to include medium- and long-term studies comparing PRC and four-corner fusion.[8] In an analysis of 1,059 wrists, the main finding was that PRC is generally superior, achieving better range of motion and a lower complication rate. The authors reported no difference in grip strength or conversion rates to total wrist arthrodesis.

Perhaps future studies that evaluate patients with longer follow-up may affirm the superiority of one of these techniques over the other.

Future studies with longer follow-up periods may eventually affirm the superiority of one of these techniques over the other. We believe that further research, including the application of new and promising biological therapies for articular cartilage regeneration, may help improve the treatment of these conditions.

This study has several limitations, including those inherent in retrospective analyses, a heterogeneous cohort with a wide range of ages and mechanisms of injury, and the challenge of accurately assessing the progression of degenerative changes between the radius and capitate bone after surgery. Postoperative CT scans, while informative, would involve additional radiation exposure and economic costs, and are therefore not routinely performed at our hospital.

CONCLUSIONS

We consider proximal row carpectomy to be a therapeutic option that provides satisfactory medium-term results in treating degenerative wrist processes, as it achieves adequate radiocarpal joint range of motion with a low complication rate. However, using this technique in patients with a higher degree of joint degeneration before surgery may result in worse outcomes.

Conflict of interest: The authors declare no conflicts of interest.

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