Long-term outcomes of proximal row carpectomy: a minimum of 15-year follow-up

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Abstract

Introduction Proximal row carpectomy (PRC) is a popular procedure for the treatment of wrist arthritis; however, the long-term clinical outcomes of this procedure are not well-characterized. The purpose of this study was to evaluate long-term results with PRC and to identify factors that may improve clinical outcomes.

Methods A retrospective study was performed on all patients who underwent proximal row carpectomy between January 1967 and January 1992. Medical records and available radiographs were reviewed. The Disabilities of the Arm, Shoulder and Hand, and Patient Rated Wrist Exam, as well as hand motion diagrams were sent to all surviving patients. The contralateral extremity was used as a control. Data was analyzed using multivariate analysis and a Student's *t* test.

Results Eighty-one patients underwent PRC. Average age at the time of surgery was 41 years. Average follow-up was 19.8 years. Sixty-one patients responded to the questionnaires. On final follow-up, wrist motion and grip strength were not significantly different from preoperative values. Radiographic follow-up beyond 2 years revealed joint narrowing and arthritic changes within the radiocapitate joint. Forty-six patients (74%) were not satisfied with the results of their surgery due to persistent pain or inability to

return to previous occupational activities. Fifty-two patients required daily pain medication for wrist pain. Twelve patients had undergone a wrist arthrodesis.

Conclusions Post-operative motion and grip strength values following PRC appear to remain stable over time. Surgical failure rates with conversion to wrist fusion occurred early within the post-operative follow-up. Many patients continued to complain of pain requiring daily medication and were unable to return to manual labor type jobs. The results of this study suggest that long-term patient satisfaction following PRC can be poor and the surgeon may wish to consider alternative treatment options for younger patients and those with high-demand jobs.

Keywords DASH · Proximal row carpectomy · Radiocarpal arthritis · Wrist arthritis

Introduction

Wrist arthritis, particularly radiocarpal arthritis, can cause significant disability and pain [1, 9, 31, 32]. Many patients affected by radiocarpal arthritis are those with a history of manual labor or wrist trauma [13, 14, 27]. Options for wrist salvage in these patients may include total wrist arthroplasty, total wrist fusion, scaphoidectomy with four corner fusion, and proximal row carpectomy (PRC). Patients who place a high demand on their hands are historically poor candidates for total wrist arthroplasty and these patients often wish to avoid total wrist fusion. Thus, the most commonly performed procedures for wrist arthritis are PRC or scaphoidectomy with four corner fusion. These procedures have been developed in an attempt to allow for pain relief while maintaining motion and strength within the affected wrist [2, 10, 25, 28]. These procedures have been

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used over the last three decades for the treatment of patients with wrist arthritis; unfortunately information regarding the long-term outcome of these procedures and their ability to prevent patients from needing further wrist salvage procedures is not well established [5, 7, 33].

Several studies have demonstrated pain relief and minimal functional limitation following proximal row carpectomy [9, 10, 32]. While older studies indicated that patients were more likely to complain of weakness in grip strength and feelings of wrist instability, more recent studies have demonstrated good recovery of grip strength and that patients are able to return to manual labor jobs [1, 11, 31]. Of some concern are the findings in recent reports that arthritis develops within the lunate fossa 10–12 years following surgery [10, 18]. The clinical implications of these radiographic changes have been difficult to interpret as few studies have assessed patient satisfaction or functional outcomes scores beyond 10 years. Lack of long-term follow-up of patients having undergone PRC has prevented a clear consensus of whether this procedure is capable of providing a permanent solution for those suffering from radiocarpal arthritis. The purpose of this retrospective study was to critically evaluate the long-term (15-year minimum) functional outcome and satisfaction of patients who have undergone PRC.

Methods

Patient Demographics

An institutional review board approved, retrospective review of all patients who underwent PRC at our institution between 1967 and 1992 was undertaken. Inclusion criteria included all patients who underwent a PRC for any indication and minimum of 15-year follow-up. Patient charts were evaluated for demographics, reason for PRC, hand dominance, and evidence of further wrist surgery.

Survey and Survey Response

Subjective patient-related outcome measures were obtained using two previously validated questionnaires. Patients completed the Disabilities of the Arm, Shoulder, and Hand (DASH), a 30-item questionnaire that attempts to quantify patient outcomes by assessing physical function and patient symptoms [16]. Patients were also asked to complete the Patient-Rated Wrist Examination (PRWE), which is a previously validated patient outcome survey [23, 24]. In addition to the questionnaires for the DASH and PRWE, the patients were given a range of motion questionnaire. This included diagrams of the wrist which helped patients estimate wrist extension, wrist flexion, as well as radial and

ulnar deviation. Finally, patients completed a survey to rate their overall satisfaction with surgery, ability to perform occupational activities, need for daily pain medication, and to note any subsequent surgery performed on the affected wrist. These answers were used to calculate a Mayo Wrist Score [3]. Grip strength values were determined using a Jamar dynamometer (New York, NY, USA) from the patient's last clinical record. The contralateral extremity was used as a normal control. If the patient was not able to complete the questionnaires or had questions regarding measurements, a telephone contact number was included with the survey and the patient completed the examination with the assistance of an examiner via telephone.

Radiographic Data

Radiographs, when available, were evaluated for signs of degenerative changes at the capitate–lunate interface at final follow-up. The radiocapitate articulation was graded according to the 4-point grading system of Culp and Jepsen [4, 18]. Stage zero indicated no arthritic changes, stage 1 (minimal arthritic change) indicated minimal joint space narrowing, stage 2 (moderate arthritic change) indicated joint space narrowing with adjacent subchondral sclerosis, and finally, stage 3 (severe arthritic change) indicated bone collapse, erosion or subchondral cyst formation (Fig. 1a–d).

Only 15 patients had recent wrist radiographs (defined as within 1 year of final data collection). Patients were offered compensation to travel to our campus for complimentary radiographs, but most declined due to travel times. More than 75% of patients lived more than 2 h from our clinic facility. In total, 27 patients had long-term radiographs (defined as 2 years or beyond the original surgical procedure) for evaluation.

Surgical Technique

For all patients, the same general surgical technique was utilized. A dorsal longitudinal skin incision was made overlying the third and fourth extensor compartments. The extensor retinaculum was then opened between these extensor compartments along with the joint capsule. The lunate was sharply excised either en bloc or in piecemeal fashion, and then the scaphoid and triquetrum were removed. Following bone excision, the wrist capsule and extensor retinaculum were closed in layers. Post-operative protocols varied regarding immobilization, with wrist immobilization times varying from 3 to 10 weeks. Concomitant surgical procedures (when performed) were noted and included: interposition of the dorsal capsule between the lunate fossa and the capitate, posterior interosseous nerve excision, and radial styloidectomy.

Fig. 1 **a–d** PA and lateral radiographs were analyzed for signs of radiocarpitate arthrosis. Radiocarpitate arthrosis was graded as (1A). Stage zero if there was no evidence of arthritic changes (1B); stage 1 if there was joint space narrowing alone (1C); stage 2 if there was joint space narrowing with adjacent subchondral sclerosis and (1D); stage 3 if there were radiographic signs of bone collapse, erosion, or subchondral cyst formation

Statistical Analysis

Statistical analysis was performed using Student's *t* tests, analysis of variance, and chi-square tests. Statistical significance was defined as $p < 0.05$.

Results

During this time period, 81 patients underwent a proximal row carpectomy. The patient demographics are displayed in Table 1. The primary indications for surgery were pain and weakness with occupational activities (Table 1). Most patients underwent PRC for the treatment of degenerative arthritis. The causes of radiocarpal arthritis are listed in Table 2. Twelve patients had a proximal row carpectomy performed to treat significant wrist flexion deformity from either cerebral palsy or arthyrogryposis. These patients represented a unique subset within this study as their surgery was not performed for pain but for improvement in wrist extension (Table 2). Concomitant surgical procedures are listed in Table 3.

Table 1 Patient demographics

	<i>n</i>	Range/percentage
No. of surgical patients, 1967–1992	81	100%
No. of patients contacted	61	75.3%
No. of patients lost to follow-up	3	3.7%
No. of patients refusing participation	2	2.5%
No. of patients deceased at follow-up	15	18.5%
Average patient age at surgery (years)	41±18	Range: 10–72
Gender		
Males	53	65.4%
Females	28	34.6%
Occupation		
Manual labor	42	52%
Nonmanual labor	19	23%
Previous manual labor	20	25%
Operative extremity		
Dominant	55	68%
Nondominant	26	32%
Primary indication for surgery		
Pain at all times	63	77.8%
Pain with occupational activities	6	7.4%
Limitation of wrist extension	12	14.8%

During the follow-up period which averaged 19.8 years (range, 15.1–36.3 years), 15 patients died, two patients refused to participate in the survey portion of the study, and three were lost to follow-up despite extensive attempts to locate them. The final response rate to the survey was 75% (61 out of 81).

Patient Wrist Range of Motion

On average, patients had decreased wrist flexion, wrist extension, radial deviation, and ulnar deviation when compared to the contralateral wrist prior to surgical intervention. The patients' preoperative and most recent postoperative range of motion measurements was compared. On average, wrist flexion decreased 5.7°, wrist extension increased 6.3°, radial deviation increased 0.3°, and ulnar deviation decreased 0.4°, but none of these differences were statistically significant ($p > 0.2$; Table 4). In the 12 patients who had undergone proximal row carpectomy for neuromuscular spasticity, postoperative wrist extension improved on average from -13° (representing a wrist flexion contracture) prior to surgery to 21° of wrist extension following surgery; however, this improvement did not reach statistical significance.

Patient Grip Strength

Fifty-four of the 81 patients were seen by either a local physician or their primary surgeon for examination after a

Table 2 Preoperative diagnoses

Diagnosis	<i>n</i>	%
Scaphoid non-union with Advanced Collapse (SNAC)	8	9.8
Scapholunate Dissociation with Advanced Collapse (SLAC)	29	35.8
Kienböck's disease with carpal collapse	13	16.1
Neuromuscular spasticity	12	14.8
Rheumatoid arthritis	6	7.4
Trauma	13	16.1
Total	81	100

minimum of 15 years from surgery. Patients' medical records were used to determine differences in patient's grip strength. Patient grip strength in the affected extremity did not change significantly when compared to the contralateral extremity or when compared to their preoperative grip strength (Table 4).

Operative Failures

Twelve patients failed PRC and underwent either wrist fusion or wrist arthroplasty. One of these patients was a patient with arthrogryposis who underwent wrist fusion 20 years after PRC. If this patient is excluded, the remaining 11 patients underwent surgical salvage at an average of 2.9 years after proximal row carpectomy. Thus, of the total of 81 patients, 14.8% had to undergone a surgical salvage operation after failing PRC.

Patient Satisfaction/Functional Outcomes—PRWE, DASH, Mayo Wrist Score

Patient surveys reported that 27 out of 61 of patients (44%) experienced some pain relief from the PRC over the course of follow-up; however, 46 of the 61 surviving patients (74%) were not satisfied with the outcome of their surgery at the time of final follow-up. A full summary of survey results is provided in Table 5. Average postoperative DASH score was 25.2 (SD, 8.9), while PRWE was 32.2 (SD, 10.3). The average Mayo wrist score was 61.8 (Table 5). Grading was most adversely affected by requirements for ongoing pain medication and the inability to return to previous employment.

Table 3 Concomitant surgical procedures

Procedure	<i>n</i>	%
Total cases	81	100
Dorsal capsular interpositional	24	29.6
Posterior interosseus nerve excision	12	14.8
Radial styloidectomy	6	7.4

Preoperative surgical diagnosis was not found to significantly affect DASH or PWRE scores, with the exception of patients with neuromuscular disorders (Table 6). Patients with neuromuscular spasticity had a PWRE score of 18.7, which was significantly lower than the average PWRE score of 37.2 ($p<0.05$).

In examining the benefit provided by any concomitant surgical procedures (dorsal capsular interposition, posterior interosseous nerve neurectomy, and radial styloidectomy) on the PWRE or DASH, posterior interosseous nerve neurectomy at the time of PRC was associated with lower (improved) DASH and PWRE scores ($p<0.05$) (Table 6). Capsular interposition and radial styloidectomy were not found to result in significantly lower DASH or PWRE scores.

Radiographic Evaluation

Radiographic evaluation was available on only 27 patients. Radiographic follow-up averaged 165.4 months (range, 24–348 months). Six of these 27 wrists were fused and could not be evaluated for changes at the radiocapitate joint. Of the remaining 21 patients, the average arthritic grade at the radiocapitate joint was 2. Nineteen of the 21 wrists had evidence (grade 1 or higher) of arthritis at the radius capitate interface. Two wrists were graded as 0, with an average radiographic follow-up of 24.5 months. Six patients were graded as 1, with an average radiographic follow-up of 145.3 months (range, 99–240 months). Three patients were graded as stage 2 with an average radiographic follow-up of 163.7 months (range, 143–192 months). Ten wrists were graded as stage 3 with an average final radiographic follow-up of 201.1 months (range, 108–348 months). Patients grade 2 and 3 arthritis had an average radiographic follow-up of 192 months, which was noted to be significantly longer than patients with grades 0 and 1 arthritis, who had an average radiographic follow-up of 103 months ($p=0.005$).

Discussion

Proximal row carpectomy has historically provided a technically simple means of treating radiocarpal wrist

Table 4 Objective outcome comparisons

	Preoperative	Postoperative	% recovery of preoperative motion	<i>p</i> Value
Flexion	39±22°	33±16.9	97.2±6.5	0.432
Extension	31±33°	36.4±22	106.8±9.7	0.347
Radial deviation	9.4±9.0	9.8±11	103.9±6.2	0.541
Ulnar deviation	21±13	21±11	104.7±6.3	0.441
Pronation	66±22	69±15.2	105.1±8.2	0.388
Supination	62±24	67±19	102.9±7.8	0.551
Grip strength (% of contralateral side)	52±17%	48±21%	N/A	0.288
Grip strength (lb)	37.1±9.1	31.6±6.4	N/A	0.341

arthritis [17, 19, 33]. As a surgical procedure, its benefits have been reported to be a rapid return to function with relatively few post-operative complications; however, there is still some question regarding the procedures durability beyond 10 years and long-term patient satisfaction. The findings of our study demonstrate that wrist motion and grip strength remain comparable to pre-operative values. The surprising finding within this study was the high rate of patient dissatisfaction in comparison to previous reports [4, 18, 19, 21, 22, 26]. The majority of the patients in this study required pain medication for the management of ongoing wrist pain and were unable to return to manual labor type activities.

Despite patient dissatisfaction and ongoing wrist pain, our patient's DASH scores are comparable other shorter term outcome studies. Richou and colleagues reported a final DASH score of 31 in 24 patients followed for an average of 116 months [26]. Dacho noted a DASH score of 25 in 30 patients followed for 27 months [6]. Kremer noted a DASH scores of 26 in 45 patients followed for 32 months

[20]. This suggests that subjective function may remain stable over time following PRC.

Evidence of radiocapitate arthritis was seen in the majority of post-operative radiographs and appeared to worsen with time. The presence of radiocapitate arthritis has been noted in several studies and has not been found to be directly correlated with outcome [10, 18, 22, 33]; however, such progressive arthritis may contribute to the negligible improvement in wrist motion from pre-operative values seen within our study. The reasons for progressive deterioration of the radiocapitate joint has not been clearly identified, but biomechanical studies have suggested that there is an increase in contact pressure and a decrease in contact area at the lunate fossa following PRC [15, 29]. In addition, a mismatch may exist between the articular surface of the capitate and the lunate facet contributing to articular wear [34, 35].

Within this study, we also found that the etiology of the patient's wrist arthritis did not significantly affect final functional outcome scores. The exception to this was in

Table 5 Survey results and subjective outcome measures

	<i>n</i>	%
Any pain relief at any time after surgery	27	44
Unsatisfied with outcome of surgery	46	74
Need daily pain medications	61	85
Required narcotic pain medications in last year due to wrist pain	36	59
Returned to previous manual labor	1 out of 42	2.4%
	Average	SD
Patient-Rated Wrist Examination (PRWE)	37.2	10.3
Disability of Arm, Shoulder, and Hand (DASH)	25.2	8.9
Mayo Wrist Score	61.8	10.3
Excellent	4	6.6
Good	6	9.8
Fair	9	14.8
Poor	42	68.8

Table 6 Outcome scores based on diagnosis and treatment

	PRWE	DASH
Average score for survey responders ($n=61$)	37.2±10	25.2±9
Clinical diagnosis at surgery		
Scaphoid non-union with advanced collapse ($n=7$)	49.9±21	37.3±13
Scapholunate dissociation with advanced collapse ($n=22$)	35.7±16	27.5±9
Keinbock's disease ($n=11$)	41.2±14	44.4±12
Neuromuscular spasticity ($n=8$)	18.7±15 ($p=0.03$)	23.3±11
Rheumatoid arthritis ($n=3$)	22.5±18	21.2±14
Crush injury/trauma ($n=10$)	52.3±16	47.7±8
Surgical modifications to procedure		
Dorsal capsular interpositional ($n=20$)	31.1±9	22.3±7
Posterior interosseus nerve excision ($n=8$)	24.6±12 ($p=0.03$)	15.4±9 ($p=0.04$)
Radial styloidectomy ($n=4$)	39.2±20	25.8±13

p Values listed for any significant difference ($p<0.05$)

patients treated for neuromuscular disorders, in this group the PRC was done to improve wrist extension rather than to treat radiocarpal arthritis. The long-term improvement in wrist extension was not statistically significant in the neuromuscular group at final follow-up; however, these patients reported approximately double the level of satisfaction that was reported by the overall patient cohort, and these patients had a significantly lower PRWE. Long-term outcomes following PRC have not been reported in this group previously and may suggest that PRC is a useful procedure within this patient cohort.

The study also noted that patients who underwent a posterior interosseous nerve neurectomy performed better on PRWE and DASH scores than those who did not. Improvement in wrist pain and wrist function has been reported previously following partial wrist denervation and may explain this finding [8, 30]. Radial styloidectomy and dorsal capsular interposition did not appear to significantly affect subjective outcome measures. These findings have led us to add PIN neurectomy to all PRC procedures.

The reason for poor patient satisfaction within this study may be related to the length of follow-up and progressive deterioration of the radiocarpal joint over time. Other factors may include the high percentage of manual laborers within our study who could not return to their level of performance following PRC. Despite the majority of patients reporting ongoing wrist pain, it should be noted that only 14.8% of patients required fusion. This fusion rate is similar to previous studies by Richou, De Smet, and Elfar, where fusion rates have ranged from 10% to 13% [7, 12, 26]. This may suggest that while wrist pain was present, it was manageable with medical means. It may also imply that patients were unwilling to undergo a complete wrist fusion procedure to treat persistent wrist pain following PRC. These questions will need to be answered with prospective studies. The results of this study have caused us to be more cautious in

offering PRC as an option to young laborers. Similar recommendations have been made by Dacho's and others, who recommended against PRC for patients engaged in heavy lifting or manual laborers [6, 6, 12].

This study has several limitations. First, this is a retrospective study and survey results may have been subjected to recall bias. Larger patient numbers may have allowed for the identification of significant outcome differences between subgroups. DASH and PWRE scores were only obtained at a single time point and as such, changes in these values cannot be followed over time. In addition, most patients did not have recent radiographs performed for this study; this prevents us from directly attributing the cause of the patients' ongoing pain to progressive radiocarpal arthritis. Thirdly, a wide variety of patients underwent proximal row carpectomy over the 25-year period, including a subset with neuromuscular disorders, and this may have contributed to a wider distribution of data leading to a possibility of a type II error. Despite these weaknesses, this represents one of the largest studies with the longest follow-up averaging almost 20 years. In addition, validated patient outcome measures were used to evaluate patient function.

Future investigations should include comparison of long-term outcomes of proximal row carpectomy with other procedures such as four-corner arthrodesis and total wrist arthroplasty. Overall, proximal row carpectomy remains a technically simple procedure and is capable of preserving motion and grip strength beyond 20 years; however, patients should be instructed that failure rates can be as high as 15%, pain relief may deteriorate over time, and patients may require daily medication to help resolve wrist discomfort. Surgical adjuncts to improve long-term outcomes may be the addition of a PIN neurectomy with all PRC procedures. The results of this study suggest that long-term patient satisfaction following PRC can be poor and the

surgeon may wish to consider alternative treatment options for younger patients and those with high-demand jobs.

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