Acta Orthop. Belg., 2006, **72**, 535-540

ORIGINAL STUDY

Salvage procedures for degenerative osteoarthritis of the wrist due to advanced carpal collapse

Luc De Smet, Ilse Degreef, Filip Robijns, Jan Truyen, Patrick Deprez

From the University Hospital Pellenberg, Leuven, Belgium

Arthrodesis of the wrist has been considered as the gold standard for osteoarthritis of the wrist. In 1984 Watson and Ballet identified a specific pattern of carpal collapse (scapholunate advanced collapse = SLAC) with progressive osteoarthritis. In order to preserve some motion, other alternative procedures have been proposed : proximal row carpectomy (PRC) and scaphoidectomy combined with a four-corner arthrodesis (4CA). In this cohort of 63 patients, three types of surgical treatment were performed (arthrodesis in 19, PRC in 26 and scaphoidectomy with 4CA in 18). The DASH questionnaire was used to evaluate the residual disability. PRC had a significantly better outcome (DASH = 16), while there were no significant differences between full arthrodesis (DASH = 45) and four corner arthrodesis (DASH = 39). In PRC and in four corner arthrodesis a functional range of motion could be preserved (resepectively 44° and 52° flexion/extension arc). Gripping force remained inferior to the non operated side. There was a significant increase in gripping force in the PRC group, but not in the others. The final gripping force was not significantly different in the three treatment regimes.

Keywords : wrist ; arthrodesis ; SLAC/SNAC ; proximal row carpectomy ; DASH ; osteoarthritis.

INTRODUCTION

A lot has been written on the degenerative osteoarthritis of the wrist due to advanced carpal collapse since the pattern has been described in 1984 by Watson and Ballet (*56*). Several operative treatment options have been advocated : radiocarpal arthrodesis (RCA), partial wrist arthrodesis, resection or prosthetic arthroplasty and denervation all have been reported as valuable procedures. None of the comparative studies between proximal row carpectomy (PRC) and the four-corner procedure could demonstrate a significant difference (*6, 31, 36, 39, 53, 60*). Krimmer (*32*) compared partial four-corner arthrodesis with full radiocarpal arthrodesis and found no difference either. A previous survey of radiocarpal arthrodeses in our department revealed disappointing results (*11*).

The purpose of this paper is to see if four-corner arthrodesis (4CA) and PRC resulted in a better outcome than the full radiocarpometacarpal arthrodesis.

■ Luc De Smet, MD, PhD, Surgeon in Chief.
■ Ilse Degreef, MD, Orthopaedic Surgeon.
■ Filip Robijns, MD, Fellow Hand Surgery.
■ Jan Truyen, MD, Resident.
■ Patric Deprez, MD, Resident.

Department of Orthopaedic Surgery, U.Z.Pellenberg, Lubbeek (Pellenberg), Belgium.

Correspondence : Luc De Smet, Department of Orthopaedic Surgery, U.Z.Pellenberg, Weligerveld, 1, B-3212 Lubbeek (Pellenberg), Belgium.
E-mail : luc.desmet@uz.kuleuven.ac.be.

© 2006, Acta Orthopædica Belgica.

No benefits or funds were received in support of this study

MATERIAL AND METHODS

This is a retrospective survey in a training hospital with all inherent inconveniences. We reviewed all patients who were treated for degenerative osteoarthritis of the wrist due to advanced carpal collapse : scapholunate advanced collapse (SLAC) and scaphoid non-union advanced collapse (SNAC). Sixty-three patients with 63 involved wrists could be retrieved : 19 underwent an RCA, 26 a PRC and 18 a 4CA. The choice of the procedure was mainly determined by the surgeons' preference (five surgeons were involved). PRC was judged not indicated when severe damage on the head of the capitate was radiologically visible ; minor cartilaginous damage on the capitate observed during the a PRC did not change the operative plan. The surgical procedures have been described previously by several authors. There were 47 men and 16 women with a mean age of 50 years (range 28 to 73 y). The right side was involved 36 times, the left 27 times ; the dominant side 38 times, the non-dominant 25 times. There were 42 SLAC wrists and 21 SNAC wrists. There were no significant differences concerning age, gender distribution, pathology and involved side (left/right and dominant/non-dominant) between the patients in the three groups. The RCA group included significantly more blue collar workers than the 4CA group ($p < 0.01$ t-test). The PRC group was somewhat between both and not significantly different from the two other groups (table I).

The follow-up examination was performed by independent observers not involved in the patients' treatment : they asked for patients satisfaction (more than 75% satisfied with the procedure or not ?), the DASH score *(22)* was used to evaluate the disability ; range of motion and gripping strength were measured. The follow-up time was 64 months (SD 19.2) for RCA, 68 for (SD 35.3) PRC and 31 (SD 24.1) for 4CA. The difference in follow-up between RCA and PRC was not significant, but the 4CA was only performed more recently, with as a result a significantly shorter follow-up than in the PRC and RCA groups ($p < 0.01$, t-test). All data were analysed and compared with chi square test and Students't-test and paired t-test. Significance was set at $p < 0.05$.

RESULTS

The results are summarised in table II. In the RCA group, 10 patients were satisfied, 9 were not ; in the PRC group 16 were satisfied, 10 were not and in the 4CA, 8 were satisfied, 10 were not. Differences were statistically not significant (chi square $p > 0.1$). The mean DASH score was 45.2 (SD 23.6) for RCA, 16.0 (SD 16.8) for PRC and 38.7 (SD 30.9) for 4CA. There were no significant differences between PRC and 4CA, but for the outcome (DASH) score the difference was significant between RCA and PCR (Student's t-test, $p < 0.001$) and between PRC and 4CA (Student's t-test $p = 0.003$).

The range of motion after PRC and 4CA was in the functional range. Between these two groups the values were not significantly different ($p > 0.05$) (t-test). Gripping force was not significantly different between the three groups. Only in the PRC group did we note a significant increase from preoperative to postoperative values ($p < 0.006$, paired t test). There was a significant correlation between the DASH score and the gripping force at follow-up : ($p = 0.046$ with a correlation coefficient $r = -0.39$).

DISCUSSION

For several decades, and up until now in numerous publications and textbooks, total wrist arthrodesis or radiocarpometacarpal arthrodesis has been considered the gold standard for unsolved wrist problems. These often follow occupational

Table I. — Summary of the data of the cohort

	N°	Mean age (years)	Age Range (years)	M/F	SLAC/SNAC	Side L/R	Dominan/ non Dom.	Blue/white collar workers
RCA	19	49	32-69	10/9	14/5	7/12	12/7	15/4
PRC	26	48	28-71	22/4	17/9	12/14	14/12	15/11
4 CA	18	56	29-73	14/4	11/7	8/10	12/6	8/10

Table IIa. — Outcome (DASH) and range of motion (ROM) (mean SD)

	Follow-up (months)	Satisfaction Yes/No	DASH Score	Extension/flexion
RCA	64	10/9	45.2 (23.6)	Not Applicable
PRC	68	16/10	16 (16.8)	44° (14.7) / 37° (14.7)
4 CA	31	8/10	39 (30.9)	52° (12) / 32° (13)

(PRC = proximal row carpectomy, 4CA = four corner arthrodesis, RCA = radiocarpal arthrodesis).

Table IIb. — Gripping force : mean (standard deviation) in kgf

	Preop force	Postop force	contralateral	
RCA	13 (6.6)	20 (12.5)	30 (12.6)	Not Significant
PRC	22 (11.7)	31 (26.8)	42 (11.0)	$p < 0.01$
4CA	24 (5.7)	24 (12.0)	36 (16.3)	Not Significant

(PRC = proximal row carpectomy, 4CA = four corner arthrodesis, RCA = radiocarpal arthrodesis).

injuries and, for most insurance companies, this statement is of interest, as wrist fusion makes it possible to put an end to a sometimes long history. However there have been more critical voices (*10, 11, 16, 38*). The outcome of wrist arthrodesis has been studied by several authors. Their results have varied widely, and the outcome probably depends on socio-economic provisions, the composition of the patient cohort and the outcome assessment method used by the author(s) (*5, 10, 14, 16, 20, 21, 29, 34, 38, 42, 44, 46, 49, 57, 58*). Complete pain relief has been reported respectively in all patients (*57*), in 84% of cases (*42*), in 76% (*21*) and in 70% (*44*). However other series have less optimistic results : Nagy and Buchler (*38*) found that only 56% of their patients had relief while only 25% of Gaisne *et al* (*16*) patients were pain free. Field *et al* (*14*) found a postoperative visual analogue score for pain of 4/10 and Sauerbier *et al* (*46*) reported that pain was reduced on average by half. The postoperative DASH scores were 46 and 52 in two recent series (*29, 46*). The mean time off work has been reported in recent studies to be between 4.5 and 6 months (*14, 46, 57*) but 15% to 54% of the patients did not return to work. Gaisne *et al* (*16*) reported a mean time off work of 15 months and only seven patients could resume their previous work, seven had a lighter job and 17 of the 34 remained unemployed.

PRC converts a complex link joint system to a simple hinge joint by creating a radio-capitate articulation. The result is not physiologic and normal kinetics should not be expected, but satisfactory clinical results have been reported in most follow-up series (*1, 3, 7, 8, 13, 15, 19, 23- 27, 33, 35, 40, 41, 43, 45, 48, 50-52, 59*). Jebson *et al* (*26*) revealed only a trend toward an increasing prevalence and degree of osteoarthritis with longer follow-up evaluation : range of postoperative motion reported in prior studies has been variable, ranging from 40% to 60% of the unaffected side. Radial deviation has consistently been the movement most affected. A major criticism of PRC is weakness, which is believed to be secondary to the mechanical effect of the relative tendon lengthening. A large literature review has been presented by Nagelvoort *et al* in 2002 (*37*). They found a mean gripping force varying between 60 and 100% of the contralateral side. Trackle *et al* in 2003 obtained only 54% gripping force (*54*). Only the recent articles mention the DASH score ; it ranges between 9 and 36 (*12, 36, 37, 51, 54*). A large series of 50 patients with a minimum follow-up of one year in our department found a DASH score of 18 and a gripping force of 70% (Robijns *et al*, Scand J Plast, Reconst & Hand Surgery, accepted for publication).

In 1984 Watson and Ballet (*56*) described the SLAC pattern and proposed scaphoid replacement

with a silicone implant, combined with a 4CA. Later on, due to the ongoing problems with silicone implants, scaphoid excision rather than replacement was combined with four-corner arthrodesis. Since then numerous investigators have reported favourable outcome with this procedure *(2, 4, 9, 17, 18, 28, 30, 31, 47, 55, 60)*.

A few authors compared PRC with partial arthrodesis (scaphoidectomy and 4-corner arthrodesis) ; none of them observed any significant differences in terms of functional results *(6, 31, 36, 39, 53, 60)*.

Krimmer *et al* in 2000 *(32)* compared RCA with 4CA and found no significant difference in DASH score (33 for 4CA in 97 patients and 45 for RCA in 41 patients) and both groups were satisfied (respectively 86 and 84%).

Dap *et al* *(10)* compared their arthrodesis group with a multicentre group of PRC patients ; this was in favour of PRC, but the study did not compare similar groups.

The strength of this study is that is a relatively homogeneous series with well-defined pathology in one institution. There were reasonably complete data available and the DASH score was used for final evaluation.

All recent follow-up studies have introduced this concept of disability evaluation in their outcome analysis. A quick search in Medline® revealed more than 200 case controlled studies since 1997 using the DASH questionnaire. The weakness of this study however is its retrospective nature with all drawbacks inherent to retrospective studies : missing data, lost to follow-up, incomplete files, dissimilar indications. Besides, the allocation of the individual patients to a specific operative technique was not randomised, but was decided by the responsible surgeon based on specific clinical and radiological features, so that the three groups may not have been entirely comparable, all the more as five surgeons and several residents and fellows were involved, and the techniques were not always similar.

This survey demonstrates that PRC gives less disability than arthrodesis, partial or total, although prospective randomised investigations however are required for confirmation. The functional result following partial arthrodesis (4CA) was not significantly different from RCA, but the preservation of a functional range of motion was preferred by most patients. Concerning gripping force, the three groups had a similar outcome, with a recovery which was in no instance comparable with the non-operated side. The classical statement that RCA produces stronger hands than PRC did not hold true in this survey.

REFERENCES

1. **Alnot J, Bleton R.** [Resection of the proximal carpal bones in the sequelae of scaphoid fractures]. *Ann Chir Main* 1992 ; 11 : 269-275 (French).
2. **Ashmead D, Watson K, Damon C, Herber S, Paly W.** Scapholunate advanced collpase wrist salvage. *J Hand Surg* 1994 ; 19A : 741-750.
3. **Begley B, Engber W.** Proximal row carpectomy in advanced Kienbock's disease. *J Hand Surg* 1994 ; 19A : 1016-1018.
4. **Bertrand M, Coulet B, Chammas M, Rigout C., Allieu Y.** [Four-bone fusion of the wrist : review of 17 cases at an average 3.4 years follow-up]. *Rev Chir Orthop* 2002 ; 88 : 286-292 (French).
5. **Bolano L, Green D.** Wrist arthrodesis in posttraumatic arthritis : a comparison of 2 methods. *J Hand Surg* 1993 ; 18A : 786-791.
6. **Cohen M, Kozin S.** Degenerative arthritis of the wrist : proximal row carpectomy versus scaphoid excision and four-corner arthrodesis. *J Hand Surg* 2001 ; 26A : 94-104.
7. **Crabbe W.** Excision of the proximal row of the carpus. *J Bone Joint Surg* 1964 **;** 46B : 708-711.
8. **Culp R, McGuigan F, Turner M, Lichtman D, Osterman A, McCarrol H**. Proximal row carpectomy : a multicenter study. *J Hand Surg* 1993 ; 18A : 19-25.
9. **Dagregorio G, Saint Cast Y, Fouque P.** [Influence of the capitolunate fusion angle on the functional result of Watson's procedure in 58 cases of established carpal collapse]. *La Main* 1998 ; 3 : 363-373. (French)
10. **Dap F.** [Wrist arthrodesis : alternative to resection of the proximal carpal bones ?]. *Ann Chir Main* 1992, 11 : 285-291. (French)
11. **De Smet L, Truyen J.** Arthrodesis of the wrist for osteoarthritis : outcome with a minimum follow-up of 4 years. *J Hand Surg* 2003 ; 28-B : 575-577.
12. **Didonna M, Kiefhaber T, Stein P.** Proximal row carpectomy : study with a minimum of ten years follow-up. *J Bone Joint Surg* 2004 ; 86-A : 2359-2365.
13. **Ferlic D, Clayton M, Mills M.** Proximal row carpectomy : review of rheumatoid and nonrheumatoid wrists. *J Hand Surg* 1991 ; 16-A : 420-424.
14. **Field J, Herbert J, Prosser R.** Total wrist fusion : a functional assessment. *J Hand Surg* 1996 ; 21B : 429-433.

15. **Foucher G, Chmiel Z.** [Excision of the proximal row of the carpal bones. A propos of 21 patients]. *Rev Chir Orthop* 1992 ; 78 : 372-378 (French).
16. **Gaisne E, Dap F, Bour C, Merle M.** [Arthrodesis of the wrist in manual workers. Apropos of 36 cases]. *Rev Chir Orthop* 1991 ; 77 : 537-544 (French).
17. **Garcia-Lopez A, Perez-Ubeda J, Marco F, Molina M, Lopez-Duran L.** A modified technique for four-bone fusion for advanced carpal collapse (SLAC/SNAC wrist). *J Hand Surg* 2001 ; 26B : 352-354.
18. **Gill D, Ireland D.** Limited wrist arthrodesis for the salvage of SLAC wrist. *J Hand Surg* 1997 ; 22-B : 461-465.
19. **Green D.** Proximal row carpectomy. *Hand Clin* 1987 ; 3 : 163-168.
20. **Hastings H, Weiss A, Quenzer D, Wiedeman G, Hanington K, Strickland J.** Arthrodesis of the wrist for post-traumatic disorders. *J Bone Joint Surg* 1996 ; 78-A : 897-902.
21. **Houshian S, Schrøder H.** Wrist arthrodesis with the AO Titanium wrist fusion plate : a consecutive series of 42 cases. *J Hand Surg* 2001 ; 26-B : 355-359.
22. **Hudak P, Amadio P, Bombardier C.** Development of an upper extremity outcome measure : the DASH. *Am J Indust Med* 1996, 29 : 602-608.
23. **Imbreglia J, Broudy A, Hagberg W, McKernan D.** Proximal row carpectomy : clinical evaluation. *J Hand Surg* 1990 ; 15-A : 426-430.
24. **Inglis A, Jones E.** Proximal row carpectomy for diseases of the proximal row. *J Bone Joint Surg* 1977 ; 59-A : 460-463.
25. **Inoue G, Miura T.** Proximal row carpectomy in perilunate dislocations and lunatomalacia. *Act Orthop Scand* 1990 ; 61 : 449-452.
26. **Jebson P, Hayes E, Engber W.** Proximal row carpectomy : a minimum 10-year follow-up study. *J Hand Surg* 2003 ; 28-A : 561-569.
27. **Jorgensen E.** Proximal row carpectomy. An end result study of twenty-two cases. *J Bone Joint Surg* 1969 ; 51-A : 1104-1111.
28. **Kadji O, Duteille F, Dautel G, Merle M.** [Four bone versus capito-lunate limited carpal fusion. Report of 40 cases]. *Chir Main* 2002 ; 21 : 5-12. (French)
29. **Kalb K, Ludwig A, Tauscher A, Landslettner B, Wiemer P, Krimmer H.** [Treatment outcome after surgical wrist arthrodesis]. *Handchir, Microchir, Plast Chir* 1999 ; 31 : 253-259 (German).
30. **Kirschenbaum D, Schnieder L, Kirkpatrick W, Adams D, Cody R.** Scaphoid excision and capitolunate arthrodesis for radioscaphoid arthritis. *J Hand Surg* 1993 ; 18-A : 780-785.
31. **Krakauer J, Bishop A, Cooney W.** Surgical treatment of scapholunate advanced collapse. *J Hand Surg* 1994 ; 19-A : 751-759.
32. **Krimmer H, Lanz U.** [Post-traumatic carpal collapse. Follow-up and therapeutic concept]. *Unfallchirurg* 2000 ; 103 : 260-266 (German).
33. **Legre R, Sassoon D.** [Multicentric study of 143 cases of resection of the proximal carpal bones]. *Ann Chir Main* 1992 ; 11 : 237-263 (French).
34. **Leighton R, Petrie D.** Arthrodesis of the wrist. *Can J Surg* 1987 ; 30 : 115-116.
35. **Luchetti R, Soragni O, Fairplay T.** Proximal row carpectomy through a palmar approach. *J Hand Surg* 1998 ; 23-B : 406-409.
36. **Lukas B, Herter F, Englert A, Bäcker K.** [The treatment of carpal collapse : proximal row carpectomy or limited midcarpal arthrodesis ? A comparative study]. *Handchir, Mikrochir, Plast Chir* 2003 ; 35 : 304-309 (German).
37. **Nagelvoort R, Kon M, Schuurman A.** Proximal row carpectomy : a worthwhile salvage procedure. *Scand J Plast Reconstr Surg Hand Surg* 2002 ; 36 : 289-299.
38. **Nagy L, Buchler V.** [Is panarthrodesis the gold standard in wrist joint surgery ?]. *Handchir, Mikrochir, Plast Chir* 1998 ; 30 : 291-297 (German).
39. **Nakamura R, Horii E, Watanabe K, Nakao E, Kato H, Tsudnoda K.** Proximal row carpectomy versus limited wrist arthrodesis for advanced Kienbock's disease. *J Hand Surg 1998* ; 23-B : 741-745.
40. **Neviaser R.** Proximal row carpectomy for posttraumatic disorders of the carpus. *J Hand Surg* 1983 ; 8 : 301-305.
41. **Neviaser R.** On resection of the proximal row. *Clin Orthop* 1986 ; 202 : 12-15.
42. **O'Bierne J, Boyer M, Axelrod T.** Wrist arthrodesis using a dynamic compression plate. *J Bone Joint Surg* 1995 ; 77-B : 700-794.
43. **Rettig M, Raskin K.** Long-term assessment of proximal row carpectomy for chronic perilunate dislocations. *J Hand Surg* 1999 ; 24-A : 1231-1236.
44. **Sagerman S, Palmer A.** Wrist arthrodesis using a dynamic compression plate. *J Hand Surg* 1996 ; 21-B : 437-441.
45. **Salomon G, Eaton R.** Proximal row carpectomy with partial capitate resection. *J Hand Surg* 1996 ; 21-A : 2-8.
46. **Sauerbier M, Kluge S, Bickert B, Germann G.** Subjective and objective outcomes after total wrist arthrodesis in patients with radiocarpal arthrosis or Kienböck's disease. *Chir Main* 2000 ; 19 : 223-231.
47. **Sauerbier M, Trankle M., Linsner G, Bickert B, Germann G.** Midcarpal arthrodesis with scaphoid excision and interposition bone graft in the treatment of advanced carpal collapse (SLAC/SNAC wrist) : operative technique and outcome assessment. *J Hand Surg* 2000 ; 25-B : 341-345.
48. **Schernberg G, Lamarque B, Genevray J, Gérard Y.** [Proximal row carpectomy]. *Ann Chir* 1981 ; 35 : 269-274 (French).
49. **Shayfer S, Toledano B, Ruby L.** Wrist arthrodesis, an alternative technique. *Orthopedics* 1998 ; 21 : 1139-1143.
50. **Steenwerckx A, De Smet L, Zachee B, Fabry G.** Proximal row carpectomy : an alternative to wrist arthrodesis. *Act Orthop Belg* 1997 ; 63 : 1-7.

51. Streich N, Martini A, Daeke W. [Proximal row carpectomy in carpal collapse]. *Handchir Mikrochir Plast Chir* 2003 ; 35 : 299-303 (German).

52. Tomaino M, Delsignore J, Burton R. Long-term results following proximal row carpectomy. *J Hand Surg* 1994 ; 19A : 694-703.

53. Tomaino M, Miller R, Cole I, Burton R. Scapholunate advanced collapse wrist : proximal row carpectomy or limited wrist arthrodesis with scaphoid excision. *J Hand Surg* 1994 ; 19-A : 134-142.

54. Tränkle M, Sauerbier M, Blum K, Bickert B, Germann G. [Proximal row carpectomy : a motion-preserving procedure in the treatment of advanced carpal collapse]. *Unfallchirurg* 2003 ; 106 : 1010-1015 (German).

55. Voche Ph, Merle M. [Arthrodesis of 4 bones of the wrist. Study of 12 follow-up cases]. *Rev Chir Orthop* 1993, 79, 456-463 (French).

56. Watson K, Ballet F. The SLAC wrist : scapholunate advanced collapse pattern of degenerative arthritis. *J Hand Surg* 1984 ; 9A : 358-365.

57. Weiss A, Hastings H. Wrist arthrodesis for traumatic conditions ; a study of plate and local bone graft application. *J Hand Surg* 1995 ; 20A : 50-56.

58. Weiss A, Wiedemaman G, Quenzers D, Hanington K, Hastings H, Strickland J. Upper extremity function after wrist arthrodesis. *J Hand Surg* 1995 ; 20A : 813-817.

59. Welby F, Alnot J. [Resection of the first row of carpal bones : post-traumatic wrist and Kienbock's disease. *Chir Main* 2003 ; 22 : 148-153] (French).

60. Wyrick J, Sern P, Kiefhaber T. Motion preserving procedures in the treatment of scapholunate advanced collapse wrist : proximal row carpectomy versus four-corner arthrodesis. *J Hand Surg* 1995 ; 20-A : 965-970.