Proximal Row Carpectomy vs Four Corner Fusion for Scapholunate (Slac) or Scaphoid Nonunion Advanced Collapse (Snac) Wrists: A Systematic Review of Outcomes

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PROXIMAL ROW CARPECTOMY VS FOUR CORNER FUSION FOR SCAPHOLUNATE (SLAC) OR SCAPHOID NONUNION ADVANCED COLLAPSE (SNAC) WRISTS: A SYSTEMATIC REVIEW OF OUTCOMES

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Proximal row carpectomy (PRC) and scaphoid excision with four-corner fusion (4CF) are common motion-preserving, salvage procedures for the treatment of wrists with scaphoid nonunion (SNAC) or scapholunate advanced collapse (SLAC). A systematic review was undertaken to clarify controversies regarding which of these procedures has the better outcome. We collated 52 articles that examine outcomes for SNAC or SLAC patients undergoing PRC or 4CF. Although the lack of unbiased trials must be acknowledged, this systematic review confirms that both procedures give improvements in pain and subjective outcome measures for patients with symptomatic and appropriately staged SLAC or SNAC wrists. PRC may provide better postoperative range of movement and lacks the potential complications specific to 4CF (nonunion, hardware issues and dorsal impingement). However, the risk of subsequent osteoarthritis is significantly higher in PRC patients despite the majority being asymptomatic at the time of review. Grip strength, pain relief and subjective outcomes are similar in both treatment groups.

Keywords: systematic review, proximal row carpectomy, four-corner fusion, scapholunate advanced collapse, scaphoid nonunion advanced collapse, outcome

INTRODUCTION

Proximal row carpectomy (PRC) and scaphoid excision with four-corner fusion (4CF) are common motion-preserving, salvage procedures for the treatment of wrists with appropriately staged symptomatic scaphoid nonunion (SNAC) or scapholunate advanced collapse (SLAC). Controversy exists over which of these two salvage procedures has the better outcome. Advocates of PRC claim that the simpler surgical technique gives a greater range of motion without the risk of nonunion or complications secondary to hardware. Advocates of 4CF claim greater grip strength and a lower chance of progression of radiocarpal arthritis. There are currently no randomized controlled trials comparing the two techniques. A systematic review process was undertaken to clarify these questions.

This review aims to determine whether there is a difference in outcomes after PRC and 4CF in the treatment of SLAC and SNAC wrists. The examined outcomes include grip strength, range of motion (ROM), postoperative complications, pain relief and physician (e.g. Gartland, Mayo) or patient (e.g. DASH, SF-36) reported outcomes.

METHODS

A SNAC wrist is defined as arthritis of the wrist secondary to scaphoid nonunion. A SLAC wrist involves arthritis of the wrist secondary to scapholunate dissociation. A PRC is a surgical procedure to remove the scaphoid, lunate and triquetrum. A 4CF combines removal of the scaphoid with arthrodesis of the lunate, capitate, triquetrum and hamate.

Search

Articles were sourced from MEDLINE (1966–2008), EMBASE (1980–2008), CINAHL and the Cochrane Controlled Trials Register electronic databases. The search was undertaken with the help of a librarian experienced in searching electronic databases using the terms 'proximal row carpectomy', 'PRC', 'midcarpal fusion', 'four corner fusion', 'carpal instability', 'scaphoid nonunion', 'scapholunate advanced collapse', 'SLAC', 'scaphoid nonunion advanced collapse', 'SNAC'. All languages were included in the search. Duplicate articles or articles reporting on the same patients were dealt with by inclusion of the most recent publication. Authors were not contacted.

The title and abstract of papers identified in the search were screened separately by two orthopaedic surgeons trained in wrist surgery. Definite and possible articles identified by both reviewers were then retrieved for possible inclusion in the study.

References from review articles found in the search, major orthopaedic/hand text books (Browner et al., 2003; Canale and Beaty, 2007; Green et al., 2005) and primary articles were checked to identify any additional articles not located in the original search. A manual hand search of the table of contents of the Journal of Hand Surgery (American, British and European) was performed including reviewing published abstracts from European or North American Hand meetings. The reviewers were not blinded to any aspect of the study.

Inclusion and exclusion criteria

Inclusion criteria:

1. Original articles including patients with SNAC or SLAC wrists treated with PRC or 4CF.
2. Articles which reported on one or more of the primary outcomes: ROM, grip strength, pain score, physician or patient reported outcomes, and post-operative complications.

Exclusion criteria:

1. Articles which did not document the underlying aetiology and/or minimum length of patient follow-up.
2. Studies with less than 12 months of patient follow-up.
3. Duplicate publication of any type, for example abstracts, comments, review or technique articles, duplicate reports and articles based on preliminary data from larger series.
4. Studies that included diagnoses other than SLAC and SNAC (e.g. Kienböck's disease or Preiser's disease) data for SLAC and SNAC patients were extracted if possible. If this was not possible studies were only included if SLAC and or SNAC patients comprised at least 70% of the patients in the series.

The articles that met these criteria were reviewed for:

1. Patient demographic features: age of patient, gender, type of procedure, type of hardware used (wires, staples, screws, plate and screws), length of follow-up, and underlying pathology (SLAC or SNAC).
2. Outcomes:
3. Grip strength – measured as percentage of the other side, or in kilograms.
4. Range of motion (ROM) – measured in flexion/extension (F-E) and radial/ulnar (R-U) axis.
5. Pain relief – type of measure used and pre- and postoperative scores. Subjective scores were divided into 'Good Pain Outcome' (e.g. reported as excellent, good, satisfied) or 'Poor Pain Outcome' (e.g. reported as moderate, poor, severe).
6. Physician and patient reported outcome measures – subjective scores were divided into 'Good Outcome' (e.g. reported as excellent, good, satisfied, would have surgery again) or 'Poor Outcome' (e.g. reported as moderate, poor, severe).
7. Postoperative complications – nonunion, hardware failure, dorsal impingement, conversion to fusion, osteoarthritic changes, reflex sympathetic dystrophy and sepsis.

The methodology of each article was examined by recording study type, completeness of follow-up, blinding of assessor to surgical procedure and whether the study was prospective or retrospective. The data were collected independently by two of the authors and then compared. Differences were resolved by discussion.

A meta-analysis was planned for each outcome measure in those articles reporting on both techniques. A meta-analysis was to be considered only if continuous data with a standard deviation were reported or there were an appropriate number of articles with dichotomous data. Meta-analysis was planned to be performed using Cochrane Review Manager software (version 5) using a random effect analysis model with Matel-Haenszel statistical method for each analysis. Evidence of heterogeneity was sought by examining forest plots, using statistical methods in Cochrane Review Manager software and constructing funnel plots if appropriate.

To make some conclusions regarding the two surgical procedures, weighted averages based on number of patients in each study were calculated, to compare outcomes of the procedure. A comparison of outcomes between the two procedures, utilizing a meta-analysis of all articles, was not performed, due to expected heterogeneity between studies, lack of randomization, varying methodology and lack of direct comparative results.

RESULTS

The initial search identified 136 articles for review. Fifty-two articles met the inclusion criteria (Appendix 1).

Ten of the 52 articles compared outcomes of PRC and 4CF (Cohen and Kozin, 2001; Dacho et al., 2007; De Smet et al., 2006a; Della Santa et al., 2007; Krakauer et al., 1994; Lukas, 2006; Saffar and Fakhoury, 1992; Tomaino et al., 1994; Vanhove et al., 2008; Wyrick, 2003). Two of these studies could not be utilized in the meta-analysis. One was excluded as PRC was primarily performed for acute peri-lunate injuries (Della Santa et al., 2007) whilst the second article did not report on any of the outcomes of interest for patients undergoing 4CF (Saffar and Fakhoury, 1992).

Methodology of the studies

All articles included in the systematic review were observational studies. The majority were retrospective case series. All of the eight articles comparing PRC to 4CF were retrospective case series. A blinded independent assessor measured the outcomes in four of the eight articles.

Patient demographic features

The demographic features from all included articles are summarized in Table 1. The demographics of patients in the comparison studies are similar to those in all articles (Table 1).

Outcomes

Grip strength

When all articles were reviewed the weighted averages for PRC were 70% and 33 kg compared to 75% and 31 kg for 4CF (Table 2). The weighted average postoperative grip strength for the comparison papers was similar (Table 2). Meta-analysis was not performed due to lack of reported standard deviations.

A small number of articles reported pre- and postoperative grip strength for PRC (four for percentage grip strength and five for grip in kg). All showed improvement in grip strength after surgery. In the 4CF series eight articles reported pre- and postoperative percentage grip strength. One was worse, one the same and six better. Nine articles from the 4CF series reported pre- and postoperative grip in kg. Three showed decreased grip, one no change and five improved.

Range of motion

Articles reporting pre- and postoperative figures that showed the majority of patients in both techniques had a reduction in ROM after surgery (Table 3).

The pre- and postoperative values are similar for all measures of change in ROM (Tables 4 and 5, Fig 1). Meta-analysis of ROM outcomes was not possible.

Pain relief

Subjective pain scores were available for 12 of the PRC articles and 14 of the 4CF articles. The PRC had good

Table 2—Weighted average grip strength

Procedure	*Number studies reporting*		*% of other side*	*JAMAR kg*
	% GS	*kg GS*		
PRC	18	7	70	33
4CF	26	15	75	30
Comparison Papers				
PRC	8	6	73	30
4CF	8	6	72	35

GS = grip strength.

Table 3—Number of articles reporting on ROM change before and after surgery

ROM Change	*PRC F-E Arc*	*4CF F-E Arc*	*PRC R-U Arc*	*4CF R-U Arc*
Improved ROM Postop	3	1	2	2
No Change in ROM Postop	1	1	0	0
Decreased ROM Postop	7	10	5	4

F-E = flexion-extension, R-U = radial-ulnar.

Table 1—Summary of patient demographics

Procedure	*Number of articles*	*n wrists operated*	*n SNAC* (%)*	*n SLAC* (%)*	*Average Age (range)*	*Male* (%)*	*Female* (%)*	*Average F/U months (months)*
PRC	27	625	169 (45%)	211 (55%)	42 (8 to 84)	354 (71%)	146 (29%)	50 (12 to 240)
4CF	36	1173	233 (28%)	601 (72%)	48 (15 to 85)	765 (83%)	162 (17%)	39 (12 to 144)
Comparison Articles								
PRC	8	160	56 (38%)	90 (62%)	47 (21 to 71)	110 (71%)	45 (29%)	40 (12 to 132)
4CF	8	185	18 (19%)	79 (81%)	49 (19 to 73)	130 (86%)	22 (14%)	39 (12 to 96)

n = number, F/U = follow up, *not all articles reported these figures and thus do not add up to total number of operations.

results 84% of the time (277 wrists good and 51 poor) compared to 85% for 4CF (553 wrists good and 96 poor). Different forms of visual assessment scores (VAS) were utilized, all showing improved pain scores following surgery.

Subjective scores of 'good' or 'poor' pain relief were only available for two of the comparison papers. There was no significant difference between the two groups with meta-analysis (Risk Ratio 0.84 with 95% CI of 0.48 to 1.45). Three papers reported VAS before and after

Table 4—Weighted average for all articles reporting flexion-extension (F-E) ROM in degrees

	No. articles reporting ROM		*Pre F-E Arc**	*Post F-E Arc**	*Pre Flex*	*Post Flex*	*Pre Ext*	*Post Ext*
	Pre	*Post*						
PRC	11	22	72	75	35	38	34	41
4CF	12	30	71	64	36	33	30	33
Comparison Articles								
PRC	4	8	79	76	39	36	38	42
4CF	4	8	81	76	39	35	39	35

*The arc does not add up to the addition of appropriate means due to some papers only reporting certain values.

Table 5—Weighted average for all articles reporting radial-ulnar (R-U) ROM in degrees

	No. Articles reporting ROM		*Pre R-U Arc**	*Post R-U Arc**	*Pre radial*	*Post radial*	*Pre ulna*	*Post ulna*
	Pre	*Post*						
PRC	11	27	32	9	7	17	23	22
4CF	12	35	41	13	13	19	19	30
Comparison Articles								
PRC	4	8	33	32	13	9	19	22
4CF	4	8	30	30	14	12	16	17

*The arc does not add up to the addition of appropriate means due to some papers only reporting certain values.

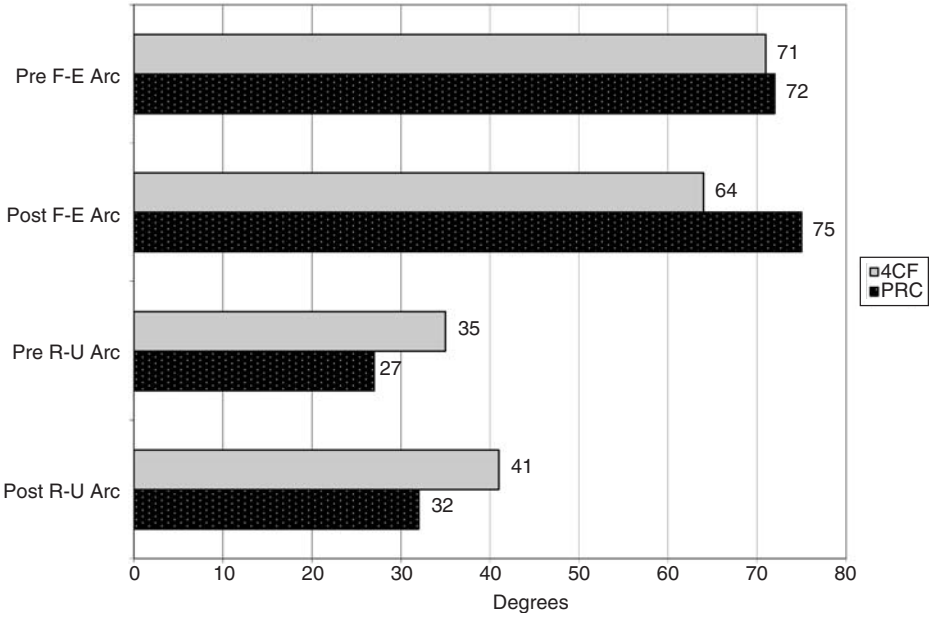

Fig 1 Weighted averages for all articles with pre- and postoperative arcs.

surgery and good pain relief occurred in both surgical groups.

Subjective outcome

Nine articles reported subjective outcomes for PRC and 15 for 4CF. Eighty percent of PRC patients were satisfied (107 of 136) compared to 90% of 4CF patients (633 of 726). There were not enough physician reported outcomes to summarize the data.

Subjective outcomes reporting 'good' or 'poor' outcomes were available in four of the comparison articles. There was no significant difference between PRC and 4CF in the meta-analysis (Fig 2) (Risk Ratio 1.14 with 95% CI of 0.86 to 1.50).

Post-operative complications

The number of complications reported in all the available literature is summarized in Table 6.

A meta-analysis of the six comparison articles reporting number of cases requiring conversion to fusion found no significant difference between techniques. The relative risk was 1.02 (95% CI 0.28 to 3.69) (Fig 3).

Six comparison articles reported on the number of patients with postoperative osteoarthritic changes.

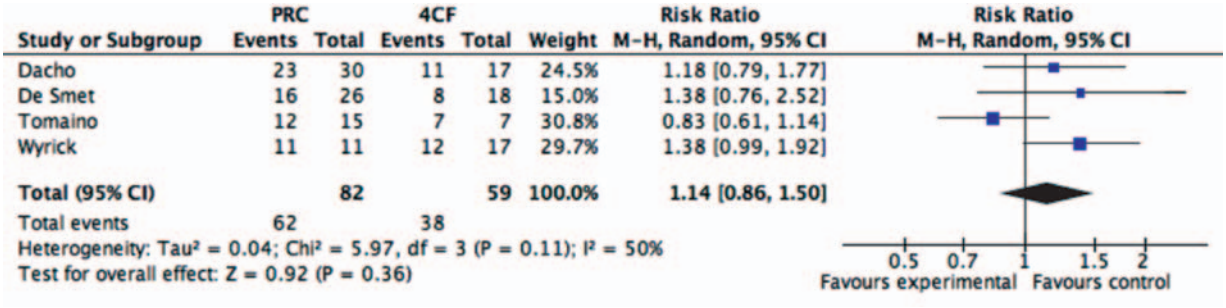

Fig 2 Meta-analysis of comparison studies reporting good subjective outcomes.

Table 6—Complications reported from all studies

	Total no. of wrists undergoing surgery	*Convert to fusion (%)*	*RSD*	*Sepsis*	*Other*	*OA*	*Nonunion*	*DI*	*HI*
PRC	619	24 (3.9%)	6 (1.0%)	1 (0.2%)	7 (1.1%)	23 (3.7%)			
4CF	1175	34 (2.9%)	12 (1.0%)	7 (0.6%)	17 (1.5%)	16 (1.4%)	66 (5.5%*)	30 (2.6%)	39 (3.3%)

*Note: overall nonunion in 4CF was 4.95% for articles reporting the procedure with wires or screws only whilst in articles presetting data for plate only the nonunion rate was 13.6%. RSD = reflex sympathetic dystrophy; OA = osteoarthritis; DI = dorsal impingement; HI = hardware problems.

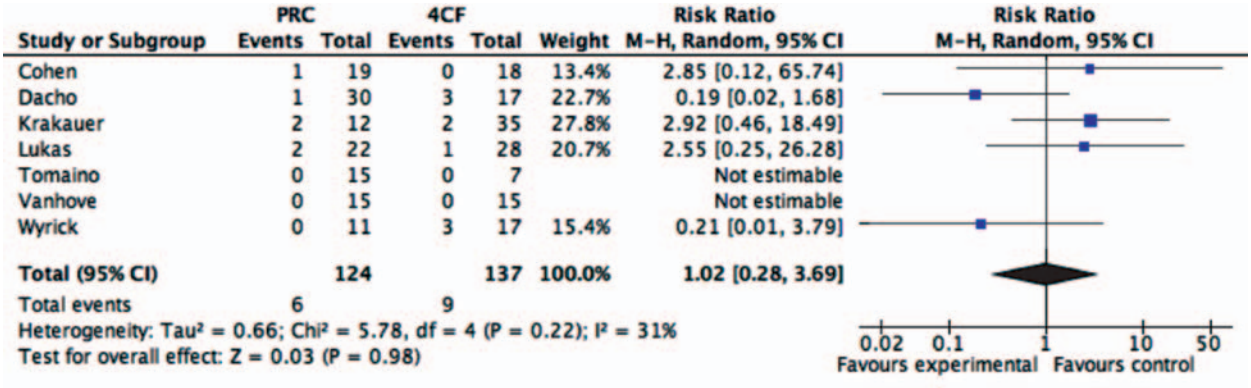

Fig 3 Meta-analysis of comparison studies reporting relative risk of postoperative conversion to arthrodesis.

Meta-analysis (Fig 4) shows a significantly higher risk of developing OA after PRC than 4CF (RR 4.35 with 95% CI of 1.20 to 15.71).

DISCUSSION

This systematic review collates all articles that examine outcomes for SNAC or SLAC patients undergoing PRC or 4CF. Although the lack of unbiased trials must be acknowledged, this study enables one to draw some preliminary conclusions regarding outcomes in these patient groups. The review suggests that grip strength, pain relief and subjective outcomes are comparable for both surgical groups. Range of motion is also similar in both groups, although it may be slightly less after 4CF. PRC has a higher rate of osteoarthritic change after surgery but 4CF has more complications overall due to nonunion, dorsal impingement and complications related to hardware.

The demographics in the comparison studies show a similar number of patients in each surgical group. The average age, sex distribution and follow-up are similar in both groups. The patient demographics in all included studies were also comparable. PRC is performed more commonly for patients with SNAC, which is a potential source of bias in the paper.

Traditional teaching implies that 4CF will result in a stronger grip than PRC. In this systematic review however, grip strength outcomes are comparable in both procedures. Other measures of strength, such as wrist torque strength were not recorded in these articles.

The collected data suggested that postoperative range of motion is slightly reduced after each procedure. The comparison studies identified no real difference between the two procedures. When reviewing the range of motion in all articles the postoperative flexion-extension arc was 10° lower for 4CF than for PRC. This finding must be interpreted with caution due to study heterogeneity and the lack of known confidence intervals. Some 4CF cases may have been performed in more severe disease (a potential confounder), for example, when the head of the capitate is involved or if the SLAC wrist is associated with a joint and capsular process such as chondrocalcinosis.

Patient satisfaction with pain relief was similar for the two procedures. The pain scale reporting methods were diverse, making direct comparisons difficult.

The subjective outcomes were similar. Many different types of subjective measure (patient and physician) were used. This lack of uniform reporting made collation and comparison difficult. For example, it was not possible to examine differences in DASH and Mayo Wrist scores between the two groups because few studies used them.

There were no differences in the rate of conversion to arthrodesis. However, postoperative progression of osteoarthritis was significantly more common after PRC than 4CF with a relative risk of 4.35 using meta-analysis. The 95% confidence intervals are wide (1.2 to 15.7). The clinical relevance of this significant result is uncertain, as most of these patients are reported to be asymptomatic. The results support the notion that incongruity between the capitate and the lunate fossa of the radius predisposes to osteoarthritis.

There are approximately 10% more complications occurring after 4CF, including nonunion, dorsal impingement and hardware problems. The rate of nonunion was higher in patients receiving a plate as opposed to K-wires or screws.

Caution is needed when interpreting the results as none of the studies have a randomization process to limit bias. Only eight of the 52 articles directly compared the two procedures and only four specifically mention blinding of the assessor to the surgery type. Heterogeneity between studies, quality of studies, bias within studies and publication bias are likely to affect the outcomes measured and therefore any summarized outcome. Observational studies, especially case series (which account for the majority of publications included) are likely to distort the magnitude or direction of associations in the outcomes measured. There was little reporting in the available literature of 95% confidence intervals (CI) or standard deviations.

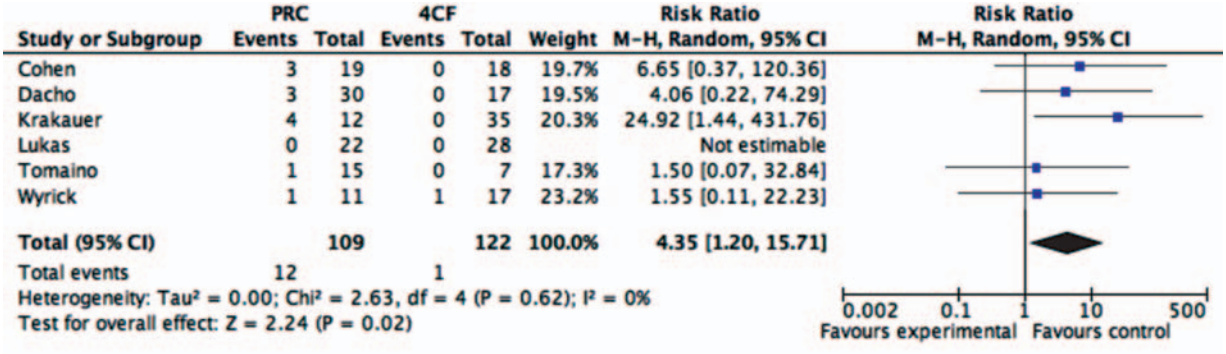

Fig 4 Meta-analysis of comparison studies reporting osteoarthritic change postoperatively.

These values enable one to estimate how close the mean values are to the real population mean and are essential if a meta-analysis of continuous variables is to be performed. Meta-analysis was not performed on grip strength or range of motion due to the lack of these data.

A randomized controlled trial would be the best way to confirm any differences in outcome between the two groups, but the numbers required to show significant differences based on the weighted averages from this systematic review are large and the patients would need to be followed for a long time to determine if the rate of osteoarthritis is significant and/or disabling. Long-term case series reporting on the outcomes of PRC and 4CF would be beneficial in understanding the natural history of a wrist after motion salvage surgery. Reporting standard deviations, confidence intervals and the use of physician (MAYO wrist score) and patient (DASH) reported outcomes would be beneficial.

The systematic review has confirmed that both procedures are good options for patients with symptomatic and appropriately staged SLAC or SNAC wrists. PRC may provide more motion and lacks the complications related to 4CF (nonunion, hardware problems and dorsal impingement). The risk of subsequent osteoarthritis appears to be higher in the PRC patients despite the majority being asymptomatic at the time of review. Grip strength, pain relief and subjective outcomes are similar in both treatment groups.

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