SCIENTIFIC ARTICLE

Routinely-Collected Outcomes of Proximal Row Carpectomy

Joris S. Teunissen, BSc (Hons),*† Liron S. Duraku, PhD, MD,‡§ Reinier Feitz, MD,*†
J Michiel Zuidam, PhD, MD,§ Ruud W. Selles, PhD,§‖
The BSSH Studyathon Consortium, Robbert M. Wouters, PhD, PT§‖

Purpose To describe patient-reported pain and function 12 months after proximal row carpectomy (PRC). Secondary outcomes included return to work, grip strength, range of wrist motion, satisfaction with treatment results, and complications.

Methods This cohort study was part of the British Society for Surgery of the Hand Studyathon 2021, using ongoing routinely-collected data of 304 eligible patients who underwent PRC (73% scapholunate advanced collapse, 11% scaphoid nonunion advanced collapse wrist; 11% Kienböck, 5% other indications) from Xpert Clinics, the Netherlands between 2012−2020. The primary outcome was the Patient Rated Wrist/Hand Evaluation total score (range, 0−100, lower scores indicate better performance).

Results Of the 304 patients, the primary outcome was available in 217 patients. The total Patient Rated Wrist/Hand Evaluation score improved from 60 (95% confidence interval [CI], 57−63) to 38 (95% CI, 35−41) at 3 months, and 26 (95% CI, 23−29) at 12 months. The pain and function subscales improved by 18 (95% CI, 17−20) and 16 (95% CI, 14−18) points, respectively. At 12 months, 82% had returned to work at a median time of 12 (95% CI, 9−14) weeks following PRC. Grip strength did not improve. Wrist flexion and extension demonstrated a clinically irrelevant decrease. Satisfaction with treatment result was excellent in 27% of patients, good in 42%, fair in 20%, moderate in 6%, and poor in 5%. Complications occurred in 11% of patients, and conversion to wrist arthroplasty occurred in 2 patients.

Conclusion A clinically relevant improvement in patient-reported pain and function was observed at 3 months after PRC, with continued improvement to 12 months. These data can be used for shared-decision making and expectation management. *(J Hand Surg Am. 2022;■(■):1.e1-e9. Copyright © 2022 by the American Society for Surgery of the Hand. Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).)*

Type of study/level of evidence Therapeutic IV

Key words Arthritis, PROMs, proximal row carpectomy, wrist.

Online Exclusive

WRIST OSTEOARTHRITIS (OA) can be a disabling condition with a radiographic prevalence of 1%−2% in the general population.[1] Common etiologies for wrist OA are scapholunate advanced collapse (SLAC), scaphoid nonunion advanced collapse (SNAC), or Kienböck's

*From the *Department of Plastic, Reconstructive and Hand Surgery, Radboud University Medical Center, Radboud Institute for Health Sciences, Nijmegen, The Netherlands; †Hand and Wrist Center, Xpert Clinics, Amsterdam, The Netherlands; ‡Department of Plastic, Reconstructive and Hand Surgery, Amsterdam University Medical Center, Amsterdam, The Netherlands; §Department of Plastic, Reconstructive and Hand Surgery, Erasmus MC, University Medical Center Rotterdam, Rotterdam, The Netherlands; ‖Department of Rehabilitation Medicine, Erasmus MC, University Medical Center Rotterdam, Rotterdam, The Netherlands.*

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The BSSH Studyathon Consortium: A. Rooney, MD, K. Hamlin, MD, Y. Khan, MD, G.S. Matharu, PhD, MD, A.E.F. Haddon, MD, S.A. Riesmeijer, MD, B.A. van den Berge, MD, J.C.E. Lane, PhD, MD, G.M. Smith, MD, D. Furniss, Prof, PhD, MD

The BSSH Studyathon Group collaborators: I. Teo, T. Hems, C. Sethu.

Hand-Wrist Study Group collaborators: R. A. M. Blomme, B. J. R. Sluijter, D. J. J. C. van der Avoort, A. Kroeze, J. Smit, J. Debeij, E. T. Walbeehm, G. M. van Couwelaar, G. M. Vermeulen, J. P. de Schipper, J. F. M. Temming, J. H. van Uchelen, H. L. de Boer, K. P. de Haas, K. Harmsen, O. T. Zöphel, J. S. Souer, R. Koch, S. E. R. Hovius, T. M. Moojen, X. Smit, R. van Huis, P. Y. Pennehouat, K. Schoneveld, Y. E. van Kooij, J. J. Veltkamp, A. Fink, W. A. de Ridder, H. P. Slijper, J. T. Porsius, J. Tsehaie, R. Poelstra, M. C. Jansen, M. J. W. van der Oest, L. Hoogendam, J. Dekker, M. Jansen-Landheer, M. ter Stege, C. Hundepool, B. van der Heijden, and J. W. Colaris.

Corresponding author: Joris Sebastiaan, BSc, Department of Plastic, Reconstructive and Hand Surgery, Radboud University Medical Center, Radboud Institute for Health Sciences, Geert Grooteplein Zuid 10, 6525 GA Nijmegen, The Netherlands; e-mail: joris.teunissen@radboudumc.nl.

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disease.[2] Proximal row carpectomy (PRC) is an established and well-investigated motion-sparing treatment for patients with wrist OA.

The International Consortium for Health Outcome Measurement (ICHOM) recently published a core outcome set for hand and wrist conditions.[3] This includes patient-reported outcome measures (PROMs), return to work, range of motion, grip strength, satisfaction, and an updated complications classification system. Previous systematic reviews on the outcomes of PRC mainly focus on the range of motion (ROM), grip strength, and complications.[4,5]

Fewer studies have reported on valid and reliable PROMs, such as the Patient Rated Wrist Hand Evaluation (PRWHE).[6–9] Although those studies generally show good outcomes, they have some limitations, such as low sample sizes, absence of baseline scores, or limited standardized time-dependent measurements. Furthermore, studies describing whether and when patients can return to their usual work after PRC seem to be scarce.

Additional research is needed to increase the generalizability of previous findings, quantify the improvement, and provide a better understanding of the trajectory of recovery after PRC. Closely adhering to the ICHOM's recommendations, the primary objective of this study was to investigate the longitudinal change in patient-reported pain and hand function up to 12 months following PRC. Secondary outcomes include time-dependent analyses of return to work, ROM, and grip strength. Furthermore, we report on patient satisfaction with treatment results and complications.

PATIENTS AND METHODS

Study design and setting

This study was part of the British Society for Surgery of the Hand Studyathon in September 2021. During this collaboration, a research team from the Hand-Wrist Study Group educated participants of the BSSH Studyathon on the strengths and weaknesses of big healthcare datasets in hand surgery such as the Hand and Wrist Cohort.[10,11]

This is a multicenter retrospective observational cohort study based on ongoing routinely-collected data following the reporting of studies conducted using observational routinely-collected data statement (RECORD).[12] Data were collected between January 2012 and June 2020 at Xpert Clinics comprising 18 centers specializing in hand surgery and therapy in the Netherlands.

After their first consultation with a hand surgeon, all patients were invited to participate in a routine outcome measurement system. Upon agreement, they received secure web-based questionnaires including PROMs before and at predefined timepoints after their treatment by email using GemsTracker.[13] The PROM collection was used for real-time patient monitoring, and this study makes secondary use of these data. Comprehensive details about our research setup, patient assessment, and follow-up regimens have been reported previously.[10,11] The study was approved by the local medical ethics committee and all patients provided written consent for their data to be used anonymously for this study.

Participants

Patients were eligible for inclusion when they met the following criteria: treated with PRC confirmed by manual patient record review, no previous wrist surgery (unrelated to the PRC pathology), or no concomitant surgery at the time of PRC that may interfere with treatment outcomes was performed, other than posterior interosseous nerve neurectomy which is performed in all patients, and radial styloidectomy, which was performed on the surgeons' discretion. In patients who underwent PRC in both wrists, outcomes of only one wrist were selected randomly to avoid potential within-patient correlation.

Treatment

As this was an observational study, there was some between-surgeon variability in how the surgery was performed. In general, the surgery was performed under regional anesthesia by 1 of 15 Federation of European Societies for Surgery of the Hand-certified or fellowship-trained hand surgeons based on clinical symptoms and imaging. A posterior interosseous nerve neurectomy was performed in all patients and a radially based capsular flap was created to provide an adequate view of the proximal and distal carpal rows.[14] The radial styloid was not removed routinely, this choice being left to the surgeons' discretion. Dorsal capsular interposition was not performed. The wrist capsule and skin were closed, and a volar plaster of Paris splint was applied. The routine postoperative immobilization protocol is detailed in Supplementary Table 1 (available online on the *Journal's* website at www.jhandsurg.org).

Variables and data sources/measurements

Patient, disease, and surgical characteristics: Variables available in the database for all patients included age, sex, occupation, symptom duration, laterality, and hand

dominance. Electronic healthcare records were screened for diagnoses/indications for PRC, concomitant interventions (e.g., carpal tunnel release), and conversion to salvage procedures.

Outcome Measurements: The primary outcome in this study was the PRWHE total score at 12 months after surgery. Patients completed the PRWHE before surgery and at 3 and 12 months after surgery by email.[15] It consists of questions relating to pain and function, with a total score ranging from 0 (no pain or dysfunction) to 100 (maximum pain or dysfunction). The minimal important change (MIC) for patients who undergo PRC is 21 points for the total score, 12 points for the pain subscale, and 10 points for the function subscale.[16]

We used the visual analog scale (VAS; range 0−100; higher scores indicate more pain) to measure pain at rest and pain during load-bearing.[17] The MIC for VAS pain at rest is 21 points and VAS pain during load 27.[16] Patients completed the VAS scores before surgery and at 6 weeks, and 3, 6, and 12 months after surgery by email.

Patients with paid employment were invited to complete a return to work (RTW) questionnaire at 6 weeks and 3, 6, and 12 months after surgery by email. Return to work was defined as the first time (in weeks) since surgery that the patient reported having returned to their usual work activities for at least 50% of their contractual working time (in hours). Details on the RTW questionnaire and definitions have been described previously.[18]

Patients completed their level of satisfaction with treatment results by email on a validated 5-point Likert scale.[19]

A hand therapist measured the active wrist ROM and grip strength during consultation before, and at 3 and 12 months after surgery. Grip strength and ROM were measured following the ICHOM Hand and Wrist standard set guidelines.[3,20]

Complications were scored following the Complications in Hand and Wrist conditions tool.[3,21] This tool classifies complications within 12 months after surgery into different grades (I−IIIC) based on the treatment needed. A detailed description for each grade is shown in the footnotes of Table 3. If multiple treatments were required, only the most invasive treatment was registered.

Data access and cleaning methods

The investigators had access to participant demographics, patient-reported outcomes, and clinician-reported outcomes. An anonymized participant's unique identification number linked all datasets together. Pseudo-anonymized patient identifiers were provided by the data manager to evaluate electronic medical records. Demographic characteristics and complications were shown for all participants who met the inclusion criteria. For the patient-reported outcomes (PRWHE, VAS) and clinician-reported outcomes (ROM, grip strength) that were evaluated preoperatively and at multiple time points after surgery, separate datasets were created that only contained patients who provided a preoperative and at least 1 postoperative measurement (3 and/or 12 months). This resulted in a varying number of patients at different timepoints per outcome measure based on data availability.

Statistical analysis

We assessed the distribution of continuous data with histograms and quantile-quantile plots. Normally distributed data were presented as mean values, including 95% confidence intervals (CI), and skewed data were displayed as median values, including interquartile ranges.

Linear mixed models were used to compare patient-reported and clinician-reported outcomes evaluated before PRC and at multiple time points after surgery. This method does not impute missing data but estimates the missing outcomes by assuming that the data were missing at random. Apart from time, no other covariates were included in the regression models. When analyzing scores between subgroups, the timepoint, subgroup variable, and their interaction term were added as fixed factors. We did not find any violation of the model assumptions: linearity, homoscedasticity, and normality of residuals.

We used the inverted Kaplan-Meier method to estimate the cumulative RTW during the first year after surgery and to calculate the median time until RTW. Loss to follow-up was addressed by censoring the patient.

For missing data, we performed a Little's test to investigate whether the PRWHE scores 12 months after surgery were missing completely at random.[22] Furthermore, tests for significant differences in demographics and preoperative scores between patients who completed the PRWHE before and at 12 months after surgery (responders), and patients who did not fill in the PRWHE at both timepoints (nonresponders) were performed using independent *t*-tests, Mann-Whitney *U* tests, and χ^2 tests. $P < .05$ was considered statistically significant. To determine whether our study was sufficiently powered for all analyses and comparisons, we performed *post hoc* sensitivity

TABLE 1. Demographic Characteristics of all Eligible Patients and for the Subgroups Included in the Corresponding Outcome Analysis

Variable	All	Included in Primary Analysis*
N	304	217
Age, y; mean (95% CI)	56 (55–58)	57 (56–60)
Sex, male; n (%)	205 (68)	149 (69)
Type of work, n (%)		
None	123 (40)	84 (39)
Light	60 (20)	50 (23)
Medium	53 (17)	40 (18)
Heavy	68 (22)	43 (20)
Nondominant side affected, n (%)	126 (42)	89 (41)
Duration of symptoms (mo), median (IQR)	24 (11–42)	24 (10–36)
Radial styloidectomy, n (%)	216 (71)	150 (69)
Indication, n (%)		
Kienböck	30 (10)	19 (9)
Undefined	11	7
II	4	4
III	11	5
IV	4	3
SLAC	221 (73)	163 (75)
Undefined	40	23
I	2	2
II	158	126
III	20	11
IV	1	1
SNAC	38 (12)	25 (12)
Undefined	6	3
II	31	21
III	1	1
Other	15 (5)	10 (5)
Diagnostics used, n (%)		
Bone scan	1 (0)	1 (0)
Computed tomography	28 (9)	20 (9)
Magnetic resonance imaging	26 (9)	15 (7)
Radiographs	233 (77)	173 (80)
Wrist arthroscopy	16 (5)	8 (4)

*Longitudinal analysis of the PRWHE. IQR, interquartile range.

analyses (Supplementary file A, available online at the *Journal's* website at www.jhandsurg.org).

RESULTS

Of 373 PRC treatment codes found in the database, 69 were excluded: 15 codes were wrongly indexed in the database, 7 patients underwent previous surgery unrelated to the PRC, 27 had incomplete patient charts, 12 underwent concomitant surgery during the PRC, and 8 wrists were excluded because the contralateral wrist already was included in the study. This left 304 eligible patients (68% males) with a mean age of 56 years (95% CI, 55–58; minimum, 19; maximum, 81) who were included (Table 1). The indication for surgery was a SLAC wrist in 221 patients (73%), SNAC wrist in 38 (12%), Kienböck disease in 30 (10%), and other diagnoses in 15 (5%).

TABLE 2. Summary of All Patient-Reported and Clinician-Reported Outcome Scores on different time points, marginalized mean values with 95% confidence intervals of the Linear Mixed Models are Presented Unless Stated Otherwise

	Intake	6 wk	3 mo	6 mo	12 mo
Domain	Value (95% CI)	Value (95% CI)	Value (95% CI)	Value (95% CI)	Value (95% CI)
PRWHE					
N (Response rate)	217 (71%)	–	204	–	174
Total score	60 (57–63)	–	38 (35–41)*	–	26 (23–29)*
Pain score	32 (31–34)	–	20 (18–21)*	–	14 (12–16)*
Function score	28 (26–29)	–	19 (17–20)*	–	12 (10–13)*
VAS					
N (Response rate)	244 (80%)	211	214	186	198
Pain in rest	40 (37–43)	25 (22–28)*	18 (15–21)*	14 (10–17)*	13 (10–16)*
Pain during physical activity	66 (63–69)	51 (48–55)*	36 (33–40)*	28 (25–32)*	25 (21–28)*
RTW					
N (Response rate in the subgroup with paid work before PRC)	–	128 (71%)	115	84	71
Cumulative return to work	–	31% (22–38%)	54% (44–62%)	74% (64–81%)	81% (72–88%)
Grip strength (kg)					
N (Response rate)	205 (67%)	–	197	–	99
Operated side	27 (25–30)	–	19 (17–22)*	–	29 (25–32)
Unoperated side	34 (33–36)	–	35 (34–37)*	–	36 (35–38)*
Range of motion					
N (Response rate)	206 (68%)	–	188	–	99
Wrist flexion	41 (39–43)	–	29 (27–31)*	–	35 (33–38)*
Radial deviation	13 (12–14)	–	9 (8–9)*	–	10 (9–11)*
Pronation	79 (77–80)	–	79 (78–81)	–	78 (76–80)
Wrist extension	−46 (−47–−44)	–	−32 (−34–−31)*	–	−40 (−43–−38)*
Ulnar deviation	−22 (−24–−21)	–	−17 (−18–−16)*	–	−20 (−22–−18)*
Supination	−78 (−79–−76)	–	−77 (−79–−76)	–	−78 (−80–−76)
Satisfaction with treatment results					
N (Response rate)	–	–	–	–	210 (69%)
Poor	–	–	–	–	5%
Moderate	–	–	–	–	6%
Fair	–	–	–	–	20%
Good	–	–	–	–	42%
Excellent	–	–	–	–	27%

Significance levels between preoperative and postoperative values were assessed using linear mixed models. The response rate is calculated as the number of patients who provided data before and at least once after surgery divided by the total number of patients in the study (304), outcome domain not measured at that time point.

*<0.05.

The subgroups of patients included in the analysis of the different outcome measures had similar characteristics to the whole group. For the primary PRWHE analysis, 217 patients (71%) were included (Table 1). Except for a slight difference in mean age, we found no differences between responders and nonresponders

TABLE 3. Complications following PRC scored according to the ICHOM Complications in Hand and Wrist conditions classification, modified and derived from Claviend-Dindo (2009)

Complication; Treatment	N
Overall	29 (10%)
Grade I*	8 (3%)
Swollen hand; Coban glove	1
Ulnar wrist pain; conservative	2
Stiffness; hand therapy	2
Pain; bracing	1
Carpal tunnel syndrome; conservative	1
De Quervain's disease; conservative	1
Grade II†	12 (4%)
Radial wrist pain; corticosteroid injection	4
Ulnar wrist pain; corticosteroid injection	4
De Quervain's disease; corticosteroid injection	2
Infection; antibiotics	2
Grade IIIA‡	0 (0%)
None	
Grade IIIB§	9 (3%)
Persistent osteoarthritis pain; wrist arthroplasty	2
Persistent pain; excision distal pole of scaphoid	1
Radial impingement; radial styloidectomy	2
Pisiform impingement; pisiformectomy	1
Carpal tunnel syndrome; carpal tunnel release	3
Grade IIIC¶	(0%)

*Any deviation from the normal treatment course without the need for surgical, endoscopic, and radiologic interventions. Acceptable therapeutic regimens are extra analgesics and additional hand therapy/splinting/cast. This grade includes, for example, tendinitis, scar tenderness, temporary sensory disturbances, and so forth.

†Any deviation from the normal treatment course requiring antibiotics, steroid injections, or other pharmacologic treatment not listed in grade I. Also included are wound infections and hematoma's not needing anesthesia.

‡Any deviation from the normal treatment course requiring minor surgical intervention under local anesthesia (e.g., irritating K-wire, suture removal subcutaneously). Also, this includes tendinitis, scar tenderness, persistent pain, and so forth not responding to conservative therapy, drugs, or injections.

§Major surgical intervention under regional or general anesthesia (e.g., repeat surgery, tenolysis, neurolysis, nerve repair or surgery for tendon rupture, breaking of the plate, nonunion, initial prosthesis failure).

¶Complex regional pain syndrome, diagnosed using Budapest criteria, independent of the initiated treatment.

(Supplementary Table 2, available online at the *Journal's* website at www.jhandsurg.org), and the nonsignificant Little's test ($P = .663$) also suggested that data were missing completely at random.

Outcome measures

The mean PRWHE total score improved from 60 (95% CI, 57−63) at intake to 38 (95% CI, 35−41) at 3 months, and 26 (95% CI, 23−29) at 12 months (Δ intake-12m, 35; 95% CI, 31−38; $P < .05$; Supplementary Fig. S1, available online at the *Journal's* website at www.jhandsurg.org), thereby already exceeding the MIC in the first 3 months after surgery. For the main subgroups, SLAC and SNAC wrist, this was respectively 61 (95% CI, 56−65) versus 57 (95% CI, 46−68) at intake, 37 (95% CI, 32−41) versus 41 (95% CI, 29−52) at 3 months, and 24 (95% CI, 20−29) versus 33 (19−46) at 12 months. The PRWHE pain subscale had improved by 18 (95% CI, 17−20; $P < .05$) at 12 months, whereas the PRWHE function subscale had improved by 16 (95% CI, 14−18; $P < .05$; Table 2).

The time-dependent VAS pain scores are shown in Table 2 and were similar for SLAC and SNAC wrist (Supplementary Table 3, available online at the *Journal's* website at www.jhandsurg.org). Between intake and 12 months after surgery, improvement was seen for VAS pain at rest (Δ28; 95% CI, 24−31) and VAS pain during load-bearing (Δ41; 95% CI, 38−45). Just like the PRWHE scores, the MIC already was exceeded in the first 3 months on both scales.

There was a gradual RTW with a median time until RTW of 12 weeks (95% CI, 9−14; Supplementary Fig. S2, available online at the *Journal's* website at www.jhandsurg.org). The cumulative incidence of RTW at 12 months after surgery was 81% (95% CI, 72%−88%; Table 2).

The level of satisfaction with treatment outcome after 12 months was generally high, with 69% of the patients reporting a good to excellent result (Table 2).

After an initial decrease at 3 months, grip strength returned to the preoperative level by 12 months (Δ1.4 Kg; 95% CI, −2.5−5.2; Table 2), whereas there was some improvement in the unoperated side (Δ2.0 Kg; 95% CI, 0.9−3.1). The operated side remained impaired compared with the unoperated side at 12 months (Δ8 Kg; 95% CI, 5−11). There was a reduction in wrist flexion (Δ6°; 95% CI, 3−8), radial deviation (Δ3°; 95% CI, 1−4), wrist extension (Δ5°;

95% CI, 3−7), and ulnar deviation (Δ3°; 95% CI, 1−5) at 12 months (Table 2).

Complications occurred in 10% (29/304) of patients: 3% (n = 8) grade I, 4% (n = 12) grade II, 0% (n = 0) grade IIIA, 3% (n = 9) grade IIIB, and 0% (n = 0) grade IIIC complications (Table 3).

DISCUSSION

We studied the recovery in the first 12 months after PRC for wrist arthritis using time-dependent outcome measures as recommended by ICHOM.[3] We found that PRC resulted in a clinically important improvement in patient-reported pain and function while maintaining wrist ROM and grip strength. Most patients were able to return to their original work. Satisfaction with treatment outcome generally was high and the complication rate low.

Previous studies have shown low levels of symptoms in postoperative PROMs.[8,9,23,24] We were able to confirm this in a large patient cohort. Furthermore, we found that the patient cohort already showed a clinically relevant improvement in pain and hand function within 3 months after surgery, with continued improvement to 12 months, although symptoms did not return to baseline population levels during the study period.[25] These data can be used for the shared clinical decision-making process and expectation management.

We did not find other reports on RTW after PRC for comparison of our data. However, the time until RTW is similar to that for other major wrist surgeries in our sample, such as open triangular fibrocartilage complex repair and ulna shortening osteotomy.[18,26]

Previous studies have shown that grip strength of 75%−91% of the contralateral side can be expected and a ROM arc of 72°−76°.[23,24] The present study enhances our knowledge by showing that although there is a reduction at 3 months, patients can be reassured that by 12 months, they will have regained almost 100% of their preoperative grip strength, although the operated side remained impaired compared with the unoperated hand (81% of unoperated hand). Moreover, 90% of wrist ROM was maintained after 12 months, though a reduction in ROM was seen at 3 months. Lumsden et al[27] showed ROM increasing by 16% and grip strength by 129% in their cohort at 10 years.

A clinical question that we were unable to answer is whether or when it is necessary to perform a radial styloidectomy during PRC. This is because of the retrospective nature of the study; we could not control for confounding by indication, which would potentially bias our results. A future study should investigate the indications and effectiveness of radial styloidectomy.

The data presented in our study were not collected in a study context to answer a specific research question. Although our outcomes reflect real-world data, they also have limitations. The main study limitation is the proportion of missing data in the patient-reported and clinician-reported outcomes. Despite the 2 rounds of reminders for questionnaire completion, the response rate of the PRWHE dropped from 85% at baseline to 57% 12 months after surgery, which is in line with retention rates from other studies from our group.[28,29] To mitigate this potential limitation, we conducted thorough *a priori* defined analyses of responders and nonresponders to evaluate missingness patterns. We found no systematic differences in the baseline characteristics between responders and nonresponders, except for a slight age difference. Also, the nonsignificant Little's test further suggested that data were missing completely at random.[22] Therefore, while having a different sample size per outcome measure and time point may be confusing, we consider our findings robust and representative of the target population. Second, the occurrence of complications was reviewed retrospectively from patient charts. Therefore, the incidence of complications should be interpreted with caution because it might be underestimated owing to underreporting in the patients' records or because the patients sought treatment at another institution. Another limitation is the absence of radiographic data at follow-up. Although routine X-ray assessment after surgery is not recommended in the ICHOM's Hand and Wrist Standard set, it would have been interesting to relate PROMs to radiographic measures.[3] Lastly, this study captures outcome data up to 12 months after surgery. Although this is the recommended follow-up period by ICHOM as most changes occur during this period, the results presented in this study are unlikely to be the eventual outcomes. From previous studies of wrist procedures within our cohort, such as open triangular fibrocartilage complex repair and ulna shortening osteotomy, we expect a further improvement in the mean PROMs at long-term follow-up. Previous long-term follow-up studies of PRC patents have shown consequently favorable PROMs.[7−9] However, based on previous research on the long-term outcomes of PRC, we also expect a rise in the rate of conversion to wrist arthrodesis.[7,23,27,30]

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The BSSH Studyathon Consortium

Members of the consortium include: A. Rooney, MD (Department of Trauma and Orthopaedic Surgery, Norfolk and Norwich University Hospital, Colney Lane NR4 7UY, Norwich, UK), K. Hamlin, MD (Department of Trauma and Orthopaedic Surgery, NHS Grampian, AB24 3FX, Aberdeen, Scotland, UK), Y. Khan, MD (Department of Trauma and Orthopaedic Surgery, NHS Grampian, AB24 3FX, Aberdeen, Scotland, UK), G.S. Matharu, PhD, MD (Department of Trauma and Orthopaedic Surgery, University of Bristol, Marlborough Street, BS1 3NU, Bristol, UK), A.E.F. Haddon, MD (Department of Trauma and Orthopaedic Surgery, NHS Grampian, AB24 3FX, Aberdeen, Scotland, UK), S.A. Riesmeijer, MD (Department of Plastic, Reconstructive and Hand Surgery, University Medical Center Groningen, Hanzeplein 1, 9713 GZ, Groningen, The Netherlands), B.A. van den Berge, MD (Department of Plastic, Reconstructive and Hand Surgery, University Medical Center Groningen, Hanzeplein 1, 9713 GZ, Groningen, The Netherlands), J.C.E. Lane, PhD, MD (NDORMS, Botnar Research Center, Oxford University, Windmill Road, OX3 7LD, Oxford, UK), G.M. Smith, MD (Oxford University Hospitals NHS Foundation Trust, Headley Way, OX3 9DU, Oxford, UK), D. Furniss, Prof, PhD, MD (NDORMS, Botnar Research Center, Oxford University, Windmill Road, OX3 7LD, Oxford, UK).

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