

# Should we always perform scaphoid nonunion surgery in patients with minor preoperative symptoms?

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## Abstract

The objective of this study was to assess the downsides of surgical treatment of scaphoid fracture nonunion in patients with minor preoperative symptoms. Patients were classified with minor symptoms based on the Patient-Rated Hand/Wrist Evaluation questionnaire. Of the 35 included patients, most patients encountered problems with patient-specific activities; 9% reported worse postoperative functional outcomes, 34% were not satisfied with the treatment and 9% were reoperated. The risk of a worse functional outcome after surgery with the need for further operations and the chance of developing wrist osteoarthritis, along with the possibility of poor patient satisfaction and ongoing daily functional impairment, should be considered during preoperative counselling.

**Level of evidence:** III

## Keywords

Clinical study, wrist, osteoarthritis, scaphoid bone

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## Introduction

The rationale behind surgical treatment in scaphoid fracture nonunion is to achieve bone healing in order to prevent progressive wrist osteoarthritis, which could result in impaired physical functioning and pain (Lindstrom and Nystrom, 1992). The additional goal of any surgical treatment will be to improve these symptoms (Cohen, 2021). However, both untreated and surgically treated patients with scaphoid nonunion have an increased risk of developing wrist osteoarthritis over time (Shah, 2013). Radiological signs of wrist osteoarthritis occur in 9%–38% of patients within 5 years, in 60%–92% at 5–9 years, and 75%–100% 10 years after an untreated scaphoid nonunion (Inoue and Sakuma, 1996; Lindstrom and Nystrom, 1992; Mack et al., 1984; Vender et al., 1987). After surgical intervention to achieve bony union, osteoarthritis can still occur. Previous studies reported that radiographic signs of wrist osteoarthritis were seen in a total of 46%–52% of the treated patients after a mean of 12 years, of

which 28%–39% had progression of the extent of osteoarthritis (Daecke et al., 2005; Malizos et al., 2017; Reigstad et al., 2012).

There is a great variability in the degree of symptoms experienced in wrist osteoarthritis (Cayci, 2014; Laulan, 2015; Lindstrom and Nystrom, 1992;

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Shah, 2013). Moreover, there is no correlation between wrist pain and the presence, extent or location of wrist osteoarthritis as well as the duration of the scaphoid nonunion in untreated patients (Inoue and Sakuma, 1996; Mack et al., 1984). In those patients who had treatment for scaphoid nonunion, there is no difference in patient-reported functional outcome between those with and without wrist osteoarthritis (Reigstad, 2012). Since the surgical treatment for scaphoid nonunion is mainly performed to prevent future onset of wrist osteoarthritis, in patients with minor preoperative symptoms weighing the advantages and disadvantages of surgery during preoperative counselling is essential when considering treatment options.

In a previous paper, we evaluated postoperative patient-reported outcomes in 118 patients who underwent scaphoid nonunion surgery irrespective of preoperative symptoms (Cohen, 2021). We concluded that physical functioning and pain improve postoperatively in most patients. However, in 24% of the patients, there was no clinically relevant improvement in physical function and pain. As the main purpose of surgery in those with minor symptoms is to prevent the onset of osteoarthritis, we decided to focus on a subset of the patients from the previous study to assess the outcome of nonunion surgery. The aim of this study was to evaluate patient-reported outcomes in those patients who underwent surgery for established scaphoid nonunion with minor preoperative symptoms.

## Methods

### *Study design and study group*

The study was performed following the declaration of Helsinki and was approved by the local medical ethical research committee (MEC-2018-1088). This study was written following the Strengthening The Reporting of Observational Studies in Epidemiology (STROBE) statement.

This retrospective study was conducted with prospectively collected data as part of routine clinical care from patients treated at the Xpert Clinics between September 2011 and April 2019. The Xpert Clinics are specialized hand and wrist treatment centres in the Netherlands. After the first clinical consultation with a surgeon, patients were invited to be involved in the collection and documentation of routine outcome measurements. Written informed consent was obtained before questionnaires were sent out or measurements were performed. The details about the patient cohort have been published previously (Selles et al., 2020).

We included adult patients with minor preoperative symptoms undergoing scaphoid nonunion surgery based on the Patient-Rated Hand/Wrist Evaluation (PRWHE) score. Since this patient-reported outcome measure has no cut-off value to divide patients into symptom groups and there is no patient acceptable state available, we used a PRWHE score of  $\leq 30$  as a cut-off value. This was based on the study by Feitz et al. (2021), who reported that patients with a PRWHE score of  $\leq 30$  failed to improve significantly after reinsertion of the triangular fibrocartilage complex tear. To assess if patients encountered individual functional impairment during daily life that was not captured with the PRWHE, we also evaluated the Patient-Specific Functional Scale (PSFS).

Scaphoid fracture nonunion was defined as a failure of union at least 3 months after the original trauma based on radiographs, computed tomography (CT) or magnetic resonance imaging as described in the previously reported studies (Ammori et al., 2019; Ferguson et al., 2016). Patients were excluded if a salvage procedure (proximal row carpectomy, distal pole resection of the scaphoid, four-corner fusion) had been performed, if patients had a concomitant ipsilateral hand or wrist injury, preoperative PRWHE questionnaires were incomplete or when the 1-year postoperative PRWHE questionnaires were not available from eligible patients. They were contacted in April 2020 to fill in the postoperative questionnaires and all patients without complete 1-year postoperative PRWHE questionnaires in May 2020 were excluded.

The patients included in this study were a subset of patients from our earlier published study about postoperative outcomes after scaphoid nonunion surgery, as previously described. Since the original acute scaphoid fracture was not treated at the Xpert Clinics, all the patients were referred by their general practitioner or by a physician from another hospital for a second opinion.

### *Surgical procedure and postoperative protocol*

The surgical approach, type of graft and fixation method were determined by the treating surgeon. Patients were postoperatively treated with a below elbow cast for 10–14 days until June 2015 and 3–5 days after June 2015, after a change in our protocol. After the cast was removed, the wrist was supported in a removable splint and hand therapy was started focusing on scar management and finger movements for the first 6 weeks, followed by unloaded active movements of the wrist only during hand therapy

outside the splint. After 9 weeks postoperatively, patients were allowed to start unloaded activities at home outside the splint. Based on signs of bony union on radiographs after 3 months, patients were allowed to remove the splint during activities that involved loading the wrist and were able to start practice on coordination, strength and stability with hand therapy.

### Outcomes

We collected data from electronic patient records regarding scaphoid nonunion characteristics and postoperative complications. Patient characteristics were collected preoperatively by electronic questionnaires.

We used the cut-off value of 30 on the PRWHE to classify patients with minor symptoms. To identify individual-specific preoperative functional problems during daily life that might not be captured with the fixed-item PRWHE questionnaire, we assessed the PSFS. The PSFS questionnaire consisted of three to five self-generated activities affected by the patient's condition, and each activity was scored on a range of 0–10, with a low score indicating inability to perform. The PSFS has been validated for patients with Dupuytren's disease (van Kooij, 2021). To quantify the self-generated activities, we classified the activities based on the International Classification of Functioning, Disability, and Health (ICF) Core Set for Hand Conditions as a framework (Fairbairn, 2012).

Our primary outcome was the percentage of patients who reported a worse postoperative functional outcome, i.e. a clinically relevant worse postoperative physical function and pain score compared to the preoperative scores ( $\Delta$ PRWHE score), reaching the minimally clinically important difference (MCID) of 11.5 points on the PRWHE. As secondary outcomes, we reviewed the percentage of patients with no change in postoperative functional outcome which was defined as a  $\Delta$ PRWHE score not reaching the MCID, and those who had a better postoperative functional outcome, which was defined as an improved  $\Delta$ PRWHE score reaching the MCID. Furthermore, we assessed the difference between the preoperative and postoperative PRWHE score on a group level, and the subdomain pain scores and the subdomain physical function scores (range 0–50) separately (a higher score indicates worse physical function and pain).

To report patient satisfaction, we used two questionnaires. We assessed the difference between the preoperative and postoperative scores with the Visual Analogue Scale (VAS) satisfaction with the exact question: 'How satisfied are you with your hand at this moment?' (range 0–100; a higher score indicates more satisfaction with the hand). Second, we recorded

satisfaction with the treatment result with two questions: 'How satisfied are you with your treatment result thus far?' (rated on a 5-point Likert scale: poor, moderate, fair, good and excellent) and 'If you would be in the same circumstances, would you be willing to undergo this treatment again?' (yes or no). Patients who reported good or excellent satisfaction were considered satisfied, and those with poor, moderate or fair satisfaction were considered unsatisfied. The satisfaction with the treatment result questionnaire has been validated and shown to be reliable in patients with hand and wrist conditions (De Ridder et al., 2021).

### Statistical methods

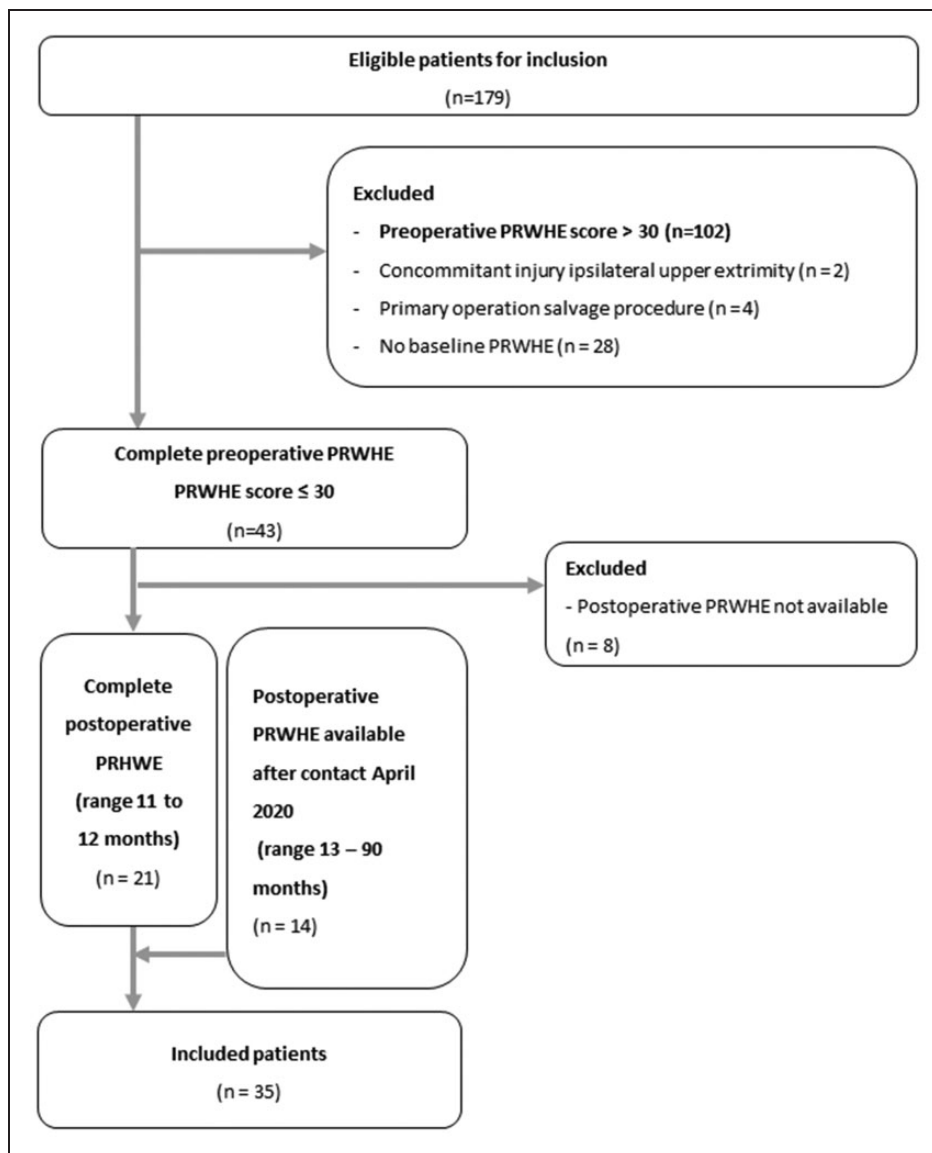
The differences regarding baseline characteristics between more than 2 groups was tested using the ANOVA for normally distributed continuous data, and the Kruskal–Wallis test for non-normally distributed continuous data. Data with normal distribution were reported as the mean with ranges, and data that were not normally distributed were reported as the median with interquartile ranges (IQR). Descriptive statistics with a 95% confidence interval (CI) were used to answer our primary research question. The improvement from preoperative to postoperative scores was analysed with a *t*-test when data were normally distributed. Non-normally distributed data were analysed with a Mann–Whitney *U* test or Wilcoxon one-sample test.

### Results

In total, 21 patients completed both their preoperative and 1-year postoperative PRWHE questionnaires. After contacting 22 patients with available preoperative PRWHE questionnaires but unavailable 1-year postoperative PRWHE questionnaires, inclusion increased to 35 patients (Figure 1). Patients responded to the postoperative questionnaires between 11 and 90 months postoperatively (median 12 months, IQR 11–28). Patient characteristics are reported in Table 1.

#### *Patient-specific function scale*

Of the 35 included patients, 29 reported 96 preoperative activities where they encountered difficulties within daily life, but only 16 of the 29 patients scored how much their wrist condition affected their ability to perform these activities (PSFS score). In total, 22 of the 29 patients reported problems with recreation and leisure. Of those 22 patients, 11 scored their problems with recreation and leisure with a mean PSFS score of 3.9 (range 0–9). Out of 29 patients, 12 reported problems with work and employment. Of those 12 patients, seven scored



**Figure 1.** Study flow chart.

their problems with work and employment with a mean PFSF score of 6.4 (range 4–9). Changing body position was difficult for 11 of the 29 patients. Of those 11 patients, four scored the difficulty they had with changing body position with a mean PFSF score of 2.3 (range 1–4). The mean PFSF score, including all activities scored, was 4.1 (range 0–9).

### *Physical function and pain*

A worse postoperative functional outcome beyond the MCID was reported by three of the 35 patients (95% CI: 1 to 8). The first patient, who had surgery for a persistent nonunion for an unknown period of time

after a previous surgical procedure for scaphoid waist fracture nonunion, developed a traumatic rupture of the extensor pollicis longus (EPL) tendon during follow-up. The preoperative PRWHE score of 0 worsened to 45 postoperatively in this patient. In a second patient, who had a scaphoid waist fracture nonunion for 7 months and needed a further operation to remove a prominent screw, the PRWHE score worsened from 8 to 23 postoperatively. The third patient, who had surgery 49 months after a proximal pole nonunion had persistent nonunion on CT scans 9 months after surgery, showed a worsening of the PRWHE score from 28 to 53 postoperatively. Of the other 32 included patients, 17 had no change in their

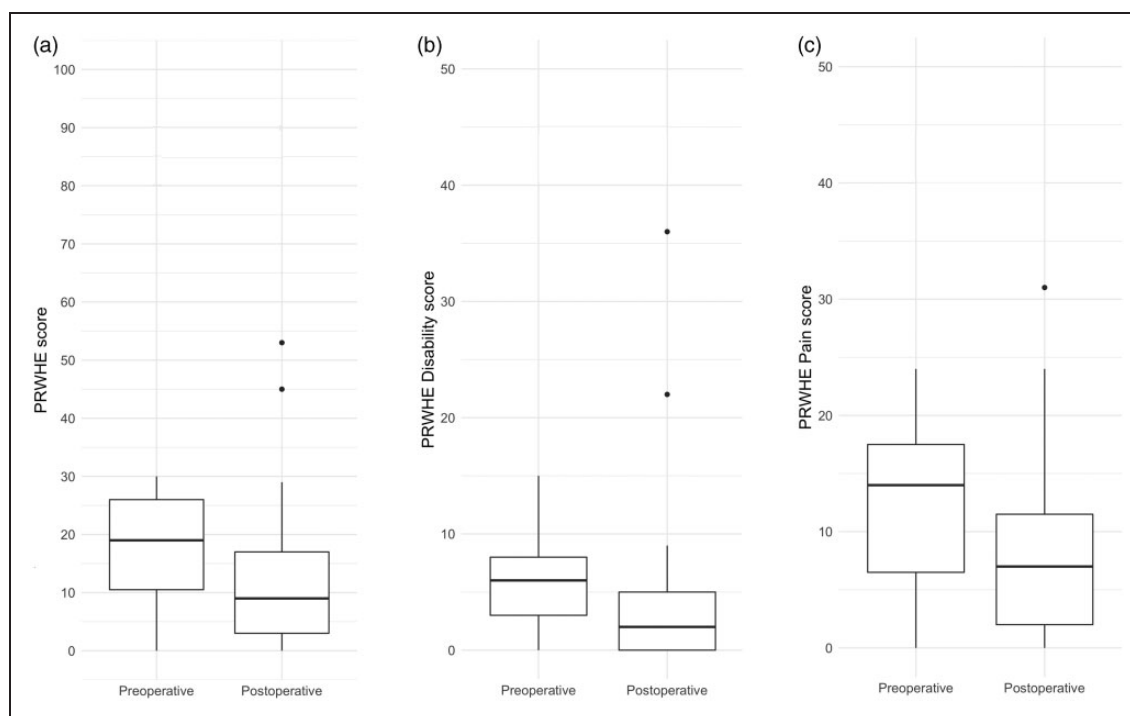
**Table 1.** Patient characteristics.

Characteristics	Patients (n = 35)
Age (years)	25 (21–31)
BMI (kg/m <sup>2</sup> )	23 (22–25)
Male/female	34/1
Smoking	7
Dominant side treated	17
Type of work	
Unemployed	9
Physical work: light/moderate/heavy	10/7/9
Duration of symptoms (months)	14 (8–21)
Location of nonunion	
Distal/waist/proximal	2/19/14
Previous treatment for scaphoid fracture	
Conservative	7
Operative for scaphoid fracture	2
Operative for scaphoid nonunion	3
None	23
Bone graft	
Non-vascularized/vascularized	27/4
Site of bone graft	
Distal radius/ilic crest	30/1

Data expressed as n or median (IQR).

BMI: body mass index; IQR: interquartile range.

functional outcome, 6 (95% CI: 3 to 12) had no clinically relevant worsening in their postoperative score and 11 (95% CI: 7 to 17) had no clinically relevant improvement in their postoperative scores. In total, 15 patients (95% CI: 10 to 21) noted an improvement in their functional outcomes beyond the MCID postoperatively. Between the three groups, patients were oldest in the group with worse postoperative functional outcome ( $p=0.03$ ), there was no significant difference between time from trauma to nonunion operation between the groups ( $p=0.86$ ) and no difference based on previous treatment ( $p=0.29$ ) or nonunion location ( $p=0.67$ ). The baseline characteristics of each group are presented in supplementary Table S1. The preoperative and postoperative PRWHE scores of each patient are shown in supplementary Figure S1. The median PRWHE score in our study improved from 19 (IQR 11–26) to 9 (IQR 3–17) after surgery ( $p=0.002$ ). A significant improvement was also seen in the median subdomain preoperative pain score of 14 (IQR 7–18) to 7 (IQR 2–12) postoperatively ( $p=0.005$ ). Similar results were found for the subdomain function score, where the median preoperative score of 6 (IQR 3–8) improved to 2 (IQR 0–5) postoperatively ( $p=0.001$ ) (Figure 2).



**Figure 2.** Box plots representing the preoperative to postoperative PRWHE scores. (a) PRWHE score. (b) PRWHE subdomain disability score and (c) PRWHE subdomain pain score. The horizontal line represents the median, the boxes the first and third quartile, and the dots the outliers. PRWHE: Patient-Rated Wrist/Hand Evaluation.

### Patient satisfaction

A moderate to poor satisfaction with the treatment result was reported by 12 patients (95% CI: 7 to 18). Eight patients (95% CI: 4 to 14) reported that they would not undergo the treatment again under similar circumstances (Figure 3). The median VAS satisfaction score in this study improved from a preoperative score of 42 (IQR 16–57) to 83 (IQR 71–91) after surgery ( $p < 0.001$ ).

### Postoperative complications

Four patients reported postoperative complications. These were de Quervain's tenosynovitis, which settled with non-operative treatment, screw protrusion through the cartilage needing removal, persistent nonunion after non-vascularized bone graft requiring revision surgery using vascularized bone graft and a proximal row carpectomy with radial styloidectomy due to persistent postoperative nonunion. None of the three patients who needed a reoperation reported better postoperative functional outcome.

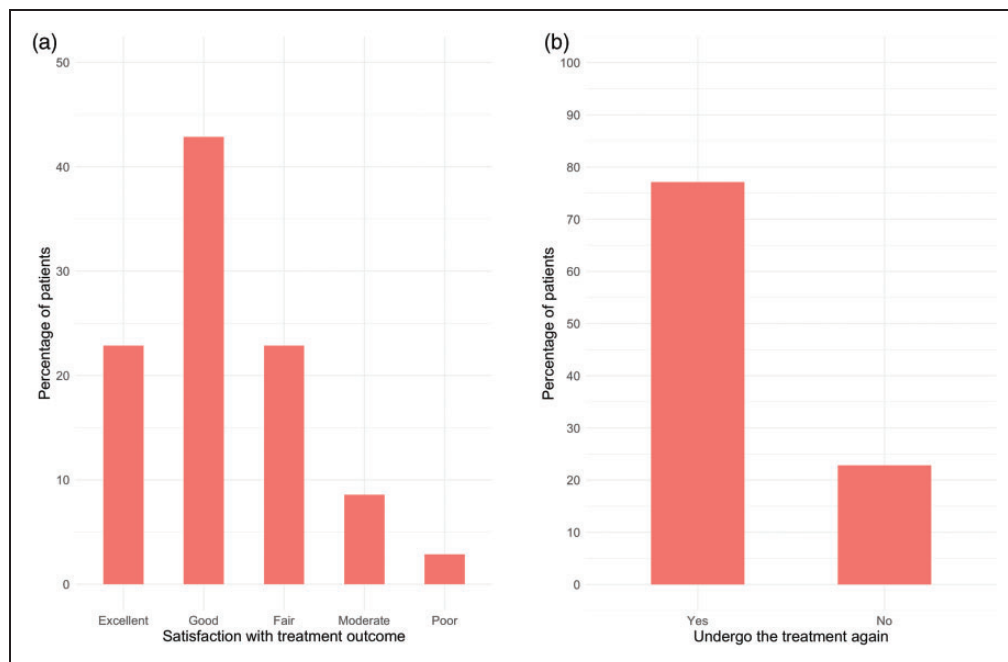
### Discussion

The onset of wrist osteoarthritis cannot be prevented in all patients who undergo treatment for scaphoid nonunion. However, it is also important to appreciate that wrist osteoarthritis is not always symptomatic.

Preventing symptomatic wrist osteoarthritis is the primary goal of scaphoid nonunion surgery in patients with minor preoperative symptoms. However, surgery could potentially also worsen symptoms in these patients. Previous studies do not report on the outcome of patients with minor symptoms separately, and they fail to report on surgical disadvantages when focusing on patient-reported outcomes. After evaluating the disadvantages of scaphoid nonunion surgery in 35 patients with minor preoperative symptoms, we found that 9% reported worse functional outcome after surgery, 34% were not satisfied with the treatment outcome and 9% needed a reoperation.

Of the three patients who reported a worse postoperative functional outcome (worse  $\Delta$ PRWHE score reaching the MCID) in our study, the patient whose postoperative score was affected by a reoperation for a traumatic rupture of the EPL tendon may not be an accurate reflection of the effect of the nonunion surgery. Previous surgical treatment for scaphoid fracture or scaphoid nonunion might influence the postoperative outcomes in this study. However, of the five patients who had a failed surgical treatment before enrolment in this study, only the patient with the traumatic EPL rupture had a worse postoperative outcome.

Compared to the study by Trezies et al. (2000), who reported improved pain in 77% of patients postoperatively, only 43% of patients had improved



**Figure 3.** Study outcomes showing patient satisfaction with the treatment. (a) Distribution of the percentage of patients on level of satisfaction with the treatment results and (b) Distribution of the percentage of patients who would undergo the treatment again under similar circumstances.



functional outcome in our study. Although pain and functional outcome are not the same and cannot be compared, their study does report the number of patients improving postoperatively but fails to consider patients with minor symptoms separately. Because we included patients with a low preoperative PRWHE score of <11.5 points to capture those with minor preoperative symptoms, it was not possible for every single one of our included patients to reach the MCID of 11.5 points on the PRWHE to show a clinically relevant improvement.

Although 23 of the 35 patients in this study were satisfied with their treatment, 12 were unsatisfied and eight would not undergo the same treatment again under similar circumstances. This is in line with our previous study, which included patients with minor and major preoperative symptoms where 31% of the patients were unsatisfied with the treatment (Cohen, 2021). Alluri et al. (2016) reported that only 8% of their patients were unsatisfied, but do not describe how they defined their satisfaction levels, which might explain the difference between the results of these two studies. Only patients with an excellent or good satisfaction score with the treatment were classified as satisfied in our study.

Most previous studies focus on median or mean difference in functional outcomes of all patients within the study, but do not specifically look at outcomes based on the extent of preoperative symptoms. Within our study, the median PRWHE and subdomain scores improved after surgery. This is in line with previous studies reporting a postoperative improvement in physical function and pain (Alluri et al., 2016; Çolak et al., 2022; Goyal et al., 2013; Malizos et al., 2017). Although there might be no difference between patients with minor and major preoperative symptoms when evaluating statistical significance alone, we believe that focusing on the degree of impact of those preoperative symptoms on patient-specific activities should be more relevant during preoperative counselling. The extent to which these problems affect each individual patient can differ from a minor to a major limitation. Evaluating patient-specific activities and the ability of each patient to adapt to those activities on an individual basis during preoperative counselling should establish the extent of the limitation experienced by each patient. Based on the PFSF, patients could be divided into patient-specific minor and major symptoms. In case of major patient-specific symptoms, improving these symptoms could be the other surgical goal besides preventing progressive osteoarthritis.

We evaluated outcomes after scaphoid nonunion surgery in patients with only minor preoperative

symptoms based on the widely used and validated PRWHE questionnaire (Dacombe et al., 2016; Hoang-Kim, 2011; Wouters, 2021), but additionally got more detailed information about problems during specific activities in daily life using the PSFS.

The present study has some limitations. First, we do not have a long-term follow-up to know what proportion of these patients will go on to develop progressive symptomatic osteoarthritis. However, our focus was not on wrist osteoarthritis but on patient-reported outcomes since we believe these outcomes can enhance shared decision-making when taking patient perception into account (Slover, 2012). Second, we included only 35 patients in our cohort study as a result of strict inclusion criteria, which resulted in wide confidence intervals. Therefore, it is likely that the number of patients who report worse postoperative symptoms could be in the range of 3%–22%. Third, it brings with it all the limitations of a retrospective study design. Finally, the Xpert Clinics only employs experienced hand surgeons certified by the Federation of European Societies for Surgery and the Hand (Tang and Giddens level 3–5), making our study results only applicable to the daily practice of experienced hand surgeons (Tang and Giddens, 2016).

During preoperative counselling when treating minimally symptomatic patients with a scaphoid nonunion, shared decision-making should be encouraged, balancing factors such as the risk of a worse postoperative functional outcome, the need for reoperations, only a minority achieving better postoperative functional outcome against the experienced impairment in daily life, the ability of each individual patient to adapt to daily activities and the previously published risk of developing symptomatic osteoarthritis.

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**Ethical approval** Ethical approval for this study was waived by the medical ethical research committee of the Erasmus MC University Medical Hospital because participants were not subjected to actions and there were no

rules of conduct imposed on them (MEC-2018-1088). This study was completed in accordance with the Helsinki Declaration as revised in 2013 (include details of relevant legislation where applicable).

**Informed consent** Written informed consent was obtained from all participants before the study.

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**Supplemental material** Supplemental material for this article is available online.

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