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Original article

# Proximal row carpectomy in total arthrodesis of the rheumatoid wrist



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## ABSTRACT

**Background:** Advanced proximal carpal row damage is common in rheumatoid arthritis (RA). Proximal row carpectomy (PRC) simplifies total wrist arthrodesis, obviating the need for an iliac bone graft. In theory, PRC also improves the chances of healing, as fusion of a single joint space is needed for the procedure to be successful. Potential effects of the loss of carpal height related to PRC are unknown.

**Hypothesis:** We hypothesised that PRC performed concomitantly with total wrist arthrodesis in patients with RA produces good clinical and radiological outcomes, without inducing loss of strength or digital deformities.

**Material and methods:** In 38 total arthrodeses of rheumatoid wrists, a clinical evaluation was performed, including a visual analogue scale (VAS) pain score, the Patient-Rated Wrist Evaluation (PRWE), grip strength, digital deformities, and patient satisfaction. A standard radiographic workup was obtained to assess healing and carpal height indices.

**Results:** After a mean follow-up of 50 months, the mean VAS pain score was 0.4 (range: 0–7), the mean PRWE score was 21 (range: 0–80.5), and grip strength as a percentage of the contralateral limb was 76%. The healing rate was 92% (35/38 wrists), and 34 (90%) patients reported being satisfied or very satisfied. No effects of carpal height loss on clinical or radiographic parameters was detected.

**Discussion:** Total wrist arthrodesis combined with PRC provides reliable and reproducible benefits. This study found no evidence of adverse effects related to the loss of carpal height.

**Level of evidence:** IV, retrospective study.

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## 1. Introduction

Total wrist arthrodesis provides stability, strength, and pain relief in patients with irreversible joint destruction due to rheumatoid arthritis (RA) [1]. The standard surgical technique in this indication is posterior wrist stapling and implantation of one or more Rush nails or Steinmann pins that bridge the carpus and end in the radial diaphysis [2,3]. The proximal carpal row is difficult to preserve in many patients, as it is often the site of advanced lesions [4], frequently with resorption of the lunate bone. Proximal row carpectomy (PRC) performed concomitantly with total wrist arthrodesis would be expected to improve healing rates, as a single joint space must undergo fusion for the procedure to be successful. Removing the proximal row also provides a source of bone grafts for achieving the arthrodesis. However, the loss of carpal height related

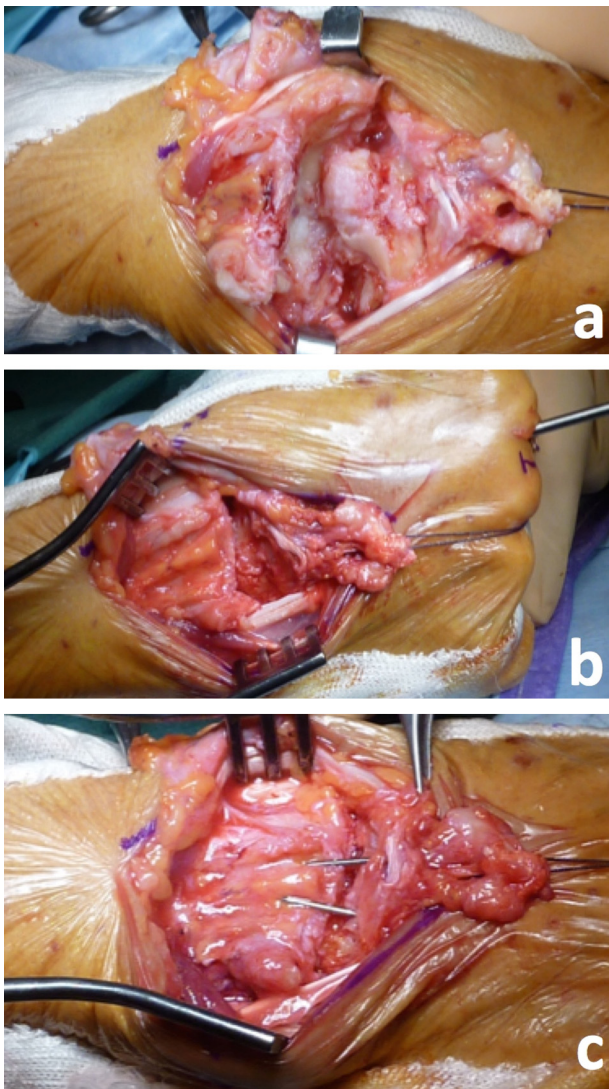
to PRC may decrease grip strength by inducing relative elongation of the flexor tendons [5,6]. The resulting decrease in extrinsic muscle activity may impose additional work on the intrinsic muscles, thereby explaining the high frequency of swan neck deformity in RA [7]. A single publication, by Kobus and Turner, reports outcomes after total wrist arthrodesis with PRC in patients with RA [8]. However, the advantages of this technique are not specified and the potential impact of carpal height loss are not considered.

We hypothesised that PRC performed concomitantly with total wrist arthrodesis in patients with RA produced good clinical and radiological outcomes, without inducing loss of strength or digital deformities.

## 2. Material and methods

Between 2005 and 2012, 46 total wrist arthrodesis procedures with PRC were performed in patients with RA and Larsen grade 4 or 5 wrist damage [9]. Among them, 38 (in 36 patients) were included in the study; 8 patients were lost to follow-up.

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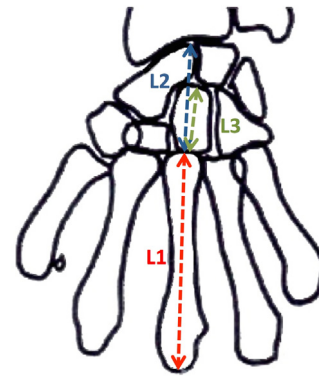
**Fig. 1.** Intraoperative views. (a) After proximal row carpectomy and joint synovectomy; (b) Compression of the arthrodesis site. The Steinmann pin is introduced into the space between the second and third metacarpals. (c) Implantation of the two dorsal staples to complete the fixation.

### 2.1. Surgical technique

The midline dorsal approach to the wrist was used [10], taking care to protect the superficial branches of the radial and ulnar nerve. The extensor retinaculum was reflected starting at its ulnar edge. After extensor tendon synovectomy, the head of the ulna was resected obliquely through a longitudinal arthrotomy of the distal radio-ulnar joint. A radiocarpal arthrotomy that preserved a rectangular flap with a distal base was then performed to allow PRC and joint synovectomy (Fig. 1a). The joint surfaces were abraded, and a Steinmann pin 3 to 4 mm in diameter was implanted through the second intermetacarpal space (Fig. 1b). Additional fixation was achieved using two or three staples (Fig. 1c). Finally, the joint capsule and extensor retinaculum were reattached, with dorsal transfer of the extensor tendons and stabilisation of the extensor carpi ulnaris.

Two direct extensor tendon repairs and four tendon transfers were also carried out to treat extensor tendon ruptures. Other procedures were:

- flexor tenosynovectomy with carpal tunnel release ( $n = 2$ );
- trapezo-metacarpal arthroplasty ( $n = 1$ );



**Fig. 2.** Indices used to assess carpal height (Youm and McMurthy index: L2/L1. Bouman's index: L3/L2).

- metacarpo-phalangeal arthroplasty ( $n = 1$ );
- interphalangeal arthrodesis of the thumb ( $n = 1$ );
- correction of swan neck deformity by tenodesis of the flexor digitorum superficialis slip to the first phalanx.

### 2.2. Data collection

An observer who had not participated in any of the surgical procedures assessed this single-centre retrospective case-series. Pain intensity was scored using a visual analogue scale (VAS) at rest and during exercise. The Patient-Rated Wrist Evaluation (PRWE) was completed by all patients [11]. Patient satisfaction was assessed as very satisfied, satisfied, somewhat satisfied, and dissatisfied. Grip strength was measured using a Jamar dynamometer comparatively to the other side. The existence and nature of any new digital deformities were recorded.

Anteroposterior and lateral radiographs of the wrist were obtained at last follow-up to assess the existence and position of joint fusion. The axes of the radius and third metacarpal were used as the reference lines. These radiographs were compared to those obtained preoperatively, to evaluate changes in the following parameters:

- carpal height estimated using the indices described by Youm and McMurthy [12] and Bouman et al. [13] (Fig. 2);
- ulnar translation as reflected by the DiBenedetto index [14];
- radial deviation of the carpus and ulnar drift of the long fingers as measured by Shapiro's angles [15] (Fig. 3).

### 2.3. Statistical analysis

As the preoperative loss of carpal height varied across wrists, the potential impact of PRC on this parameter was assessed by looking for associations between the clinical outcomes and the difference in carpal height before versus after surgery. The change in the A2 angle of Shapiro was also evaluated according to the loss of carpal height.

Student's *t* test was chosen to compare two quantitative variables that were normally distributed and had similar variance. When these conditions were not met, the Mann-Whitney U test was used. For all tests,  $p$  values  $\leq 0.05$  were considered significant.

## 3. Results

After the mean follow-up of 50 months, 38 total wrist arthrodesis procedures in 36 patients were reviewed. Mean age was 57 years (range: 22–83 years) and 31 patients were females. Surgery was performed on the dominant side in 21 cases.

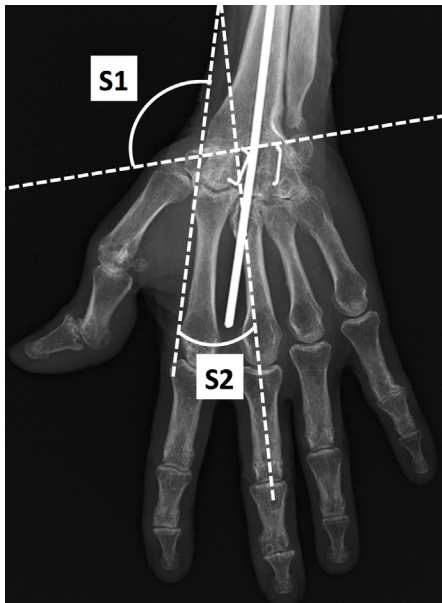


Fig. 3. Shapiro's angles A1 and A2.

Mean pain scores were 0.5 (0–7) at rest and 1.1 (0–10) during exercise. Mean PRWE score was 20.9 (0–80.5). Of the 36 patients, 28 were very satisfied, 4 (6 wrists) satisfied, 2 somewhat satisfied, and 2 dissatisfied. Mean grip strength as a percentage of the other side was 76%.

Swan neck deformity was present in only 5 hands (in 4 patients). Boutonniere deformity was noted in 6 hands (6 patients). All these deformities were already present before surgery.

The healing rate was 92%. Nonunion occurred in 3 cases. The fused wrist was in  $3.6^{\circ} \pm 6.1^{\circ}$  of extension and  $9.3^{\circ} \pm 7.5^{\circ}$  of ulnar deviation. The Youm and McMurthy index diminished from 0.43 before surgery to 0.30 at last follow-up ( $P < 0.001$ ). Bouman's index increased from 0.76 to 1 ( $P < 0.001$ ). DiBenedetto's index was 0.14 before and 0.11 after surgery ( $P < 0.001$ ). The Shapiro A1 angle decreased from  $120^{\circ}$  to  $107^{\circ}$  ( $P < 0.001$ ), whereas the Shapiro A2 angle showed no significant change ( $12^{\circ}$  before and  $11^{\circ}$  after surgery).

No association was found between the position of the arthrodesis and the clinical or radiographic outcomes. None of the changes in carpal height indices was significantly associated with postoperative grip strength or Shapiro's A2 angle (Fig. 4).

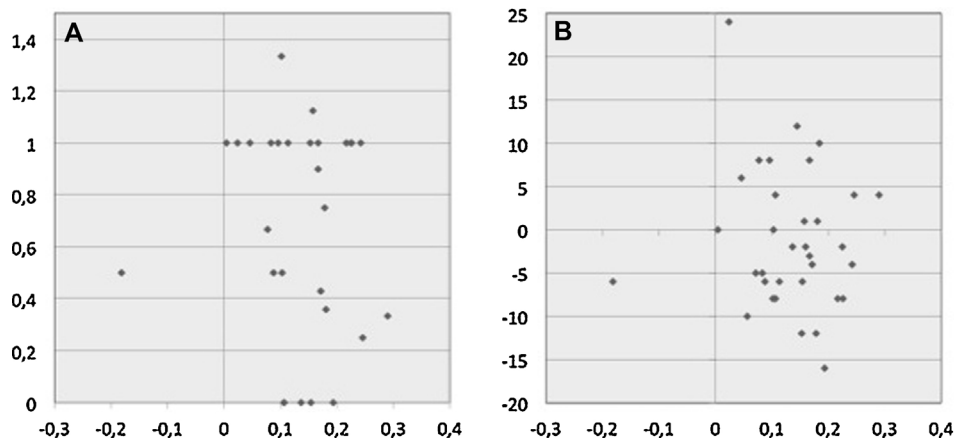


Fig. 4. Postoperative grip strength (a) and change in ulnar drift as assessed by Shapiro's angles (b) according to the change in carpal height.

#### 4. Discussion

Total wrist arthrodesis is the reference standard surgical procedure in patients with painful destructive wrist damage due to RA. Although wrist arthrodesis can be achieved with a dorsal plate, the most widely used techniques involve implanting Rush nails or Steinmann's pins into the third metacarpal bone, across the carpus, and into the radius. This method, initially described by Mannerfelt and Malmsten [3], minimises impingement of the material on the soft tissues, an important advantage in patients with fragile skin or, in some cases, damage to tendons [16]. It is also simpler, faster, and less expensive than internal plate fixation [2,17]. Healing rates are satisfactory, with a range of 75 to 100% [18–21]. The wrist stability afforded by the procedure relieves the pain in most patients. The mean VAS pain score after healing was 0.4 in a study by Barbier et al. [1], and Vanhaven et al. reported persistent pain after only 1 of 59 procedures [20]. Finally, Kluge et al. found excellent or good functional outcomes in 82% of cases after this procedure [19].

In a technical variant developed by Millender et al., the nail is introduced into the second intermetacarpal space instead of the third metacarpal [2]. We prefer this method, as it eliminates the risk of metacarpal fracture [19,21] and of metacarpo-phalangeal joint damage due to migration of the material [17,18]. Furthermore, the size of the diaphyseal shaft of the third metacarpal may limit the size of the nail that can be used for the Mannerfelt technique [2]. Millender and Nalebuff reported that healing was achieved after 68 of 70 arthrodeses [2] and consistently found improvements in strength and function. Using the same technique to perform 87 arthrodeses, Kobus and Turner recorded only 2 fusion failures, with good or excellent outcomes in 97% of cases and functional improvements in 95% [8]. The healing rate was 92% in our study, i.e., slightly lower than in the earlier reports. Of the 3 failed procedures, 1 was performed without additional staple fixation. In a revision procedure, adding staples together with an iliac bone graft ensured healing. Revision surgery was performed in another case of nonunion because of Steinmann pin migration. The last patient had a very good outcome with no symptoms and therefore did not undergo revision surgery. Our clinical findings are similar to those reported by others. Most of our patients were free of pain at rest and during exercise, and 89% reported being satisfied or very satisfied. The mean PRWE score was 20.9 points. These outcomes were better than those obtained by Elherik et al., who reported a mean PRWE score of 45.5 points [22]. This difference is probably ascribable in large part to the 9-year older mean age and greater proportion of dominant-side procedures in their study.

Performing PRC concomitantly with total wrist arthrodesis has a number of advantages. The proximal row of the rheumatoid wrist is

often either destroyed or dislocated [4,11]. The limited bone stock is an obstacle to abrasion and makes preservation of the proximal row difficult to achieve during total wrist arthrodesis. PRC simplifies the surgical procedure and decreases the operative time. In addition, the first row provides cancellous bone for grafting. In our experience, iliac crest graft harvesting was never necessary during the primary procedure. Finally, removing the proximal row leaves a single joint space to undergo fusion, thereby increasing the chances of healing. Chantelot et al. investigated the healing rates of the radiocarpal and midcarpal joint spaces [23]. Although fusion of the radiocarpal joint space was readily obtained, fusion of all intracarpal joints was achieved in only 8 of 25 arthrodeses. Nonunion between the lunatum and triquetrum correlated with persistent pain. Despite these findings, reported healing rates are usually excellent [1,2,8,19,20,24]. However, some authors assessed healing based only on the radiocarpal joint space [1,20], and others failed to specify whether healing was complete or partial [2,8,19,24].

Routine PRC during wrist arthrodesis has rarely been reported. Robinson and Kayfetz emphasized the simplicity and short completion time of PRC [25]. Louis et al. described good primary stability of the capitate head in the radius [26]. Richards and Roth evaluated 38 arthrodeses in patients without inflammatory joint disease or spastic hemiplegia [6]. Their findings suggest that PRC may facilitate both correction of the carpal dislocation and adjustment of the arthrodesis. Out of 110 wrist arthrodesis in patients without RA studied by Green and Henderson, only 2 failed to heal, and the authors pointed out the advantage of not having to harvest an iliac crest graft [27]. A single previous study, by Kobus and Turner, focused on total wrist arthrodesis with PRC in patients with RA [8]. However, the authors discussed neither the advantages nor the potential consequences of PRC. Concern has been voiced that the loss of carpal height might diminish grip strength by inducing relative elongation of the flexor muscles [5,6]. In their case-series study of wrist arthrodesis with PRC, Richards and Roth found that grip strength on the operated side was 79% of that on the nonoperated side [6]. Based on a literature review, they felt their outcomes compared favourably with those obtained using conventional arthrodesis techniques. The amount of carpal height loss induced by PRC varies widely in RA, depending on whether collapse of the carpus has occurred [4,11]. We found no impact of the amount of carpal height loss on grip strength. The development of swan neck deformity is another theoretical adverse effect of loss of carpal height [7]. However, in our study, only 4 patients had swan neck deformity, which was consistently present before surgery. Importantly, although most study reports provide carpal height measurements, we are not aware of studies establishing associations between these measurements and the development of digital deformities [1,16,28].

Finally, in keeping with many previous studies [2,18,19,28], our work showed no associations linking the position of the arthrodesis to the clinical outcomes. The effects of position were difficult to assess because the same arthrodesis adjustment criteria were used in all patients. The flexor tendons act as tension bands, and it is therefore recommended to position the arthrodesis in slight ulnar inclination to avoid the development of ulnar drift of the digits [8,14,15,29]. In our opinion, an advantage of PRC is a decrease in flexor tendon tension, which diminishes any preexisting digital deformities in the coronal plane. In support of this opinion is our finding that none of the patients experienced worsening ulnar drift, as shown by the lack of change in Shapiro's angle A2 between the preoperative period and last follow-up.

Total wrist arthrodesis, combined with PRC, is a reliable and simple technique that seems to provide similar outcomes to those of conventional techniques.

## Disclosure of interest

The authors declare that they have no competing interest.

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