Can Total Wrist Arthroplasty Be an Option in the Treatment of the Severely Destroyed Posttraumatic Wrist?

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Abstract

Background Severely destroyed posttraumatic wrists are usually treated by partial or total wrist fusion or proximal row carpectomy. The indications for and longevity of total wrist arthroplasty (TWA) are still unclear.

Case Description The aim of this study was to analyze a series in which one last-generation total wrist arthroplasty was used as a salvage procedure for wrists with severe arthritis due to traumatic causes. The data were prospectively recorded in a web-based registry. Seven centers participated. Thirty-five cases had a minimum follow-up time of 2 years. Average follow-up was 39 (24–96) months. Pain had improved significantly at follow-up, mobility remained unchanged. The total revision rate was 3.7%, and the implant survival was 92% at 4–8 years.

Literature Review Very few studies have described specific results after TWA in posttraumatic cases and almost none using classical “third-generation” implants. The number of cases and the follow-up in the published series are small.

Clinical Relevance Although painful posttraumatic wrists with severe joint destruction can be salvaged by partial or total fusion, we found that, evaluated at short- to midterm, total wrist arthroplasty can be an alternative procedure and gives results that are comparable to those obtained in rheumatoid cases.

Level IV Case series

Keywords

- total wrist arthroplasty
- posttraumatic
- wrist arthritis
- wrist arthrosis
- prospective

Total wrist arthroplasty (TWA) still remains a controversial procedure. Early types of implants have given disappointing results: The first generation were silicone implants

whose risks included implant breakage, subsidence, and silicone synovitis.^{1–3} The next generation of implants required extensive bone resection, which had implications if

Fig. 1 The Re-motion Total Wrist.

conversion to fusion was necessary. Moreover, fixation of the distal component in the metacarpals was another severe problem with these designs, often leading to subsidence through the dorsal metacarpal cortices.⁴⁻⁶ The last generation requires less bone resection and avoids metacarpal fixation,^{1,7} which could imply better and more durable results. However, clinical documentation remains modest because of limited numbers of patients or short follow up.⁸⁻¹⁰ This is especially true in the case of wrists with severe posttraumatic joint destruction. Carpal destabilization after longstanding scaphoid nonunion (scaphoid nonunion advanced collapse [SNAC] wrists), scapholunate dissociation (scapholunate advanced collapse [SLAC] wrists), or sequel of intraarticular distal radius fractures is usually treated with partial or total fusion, and the possibility of treating the advanced stages of these conditions with TWA have not been investigated on a larger scale. One recent study has demonstrated that results after TWA in nonrheumatoid cases are comparable to those obtained in rheumatoid arthritis,¹¹ but without specific data on posttraumatic cases, and thus the potential of TWA in posttraumatic cases remains to be evaluated.

The purpose of this study was to report the results of a multicenter series using one last-generation TWA in posttraumatic cases. The questions to be answered were primarily how TWA performs in patients with severe posttraumatic wrist problems in terms of (1) patient-related outcome measures, (2) objective measures, (3) radiological findings, and (4) longevity of the implants.

Methods

The Re-Motion Total Wrist implant (Small Bone Innovation, Morristown, PA) has a ball-and-socket design with a radial and a carpal chromium-cobalt component that are titanium coated. There is an intercalated polyethylene component that primarily articulates with the radial component but also has some articulation with the carpal plate (►Fig. 1). The carpal plate is fixated to the carpus by its stem and two screws, of which only the most radial normally may penetrate the metacarpal for a very short

distance (►Fig. 2). Typically the procedure is done without using cement.

In 2009 we created a web-based registry in which surgeons using the Re-Motion Total Wrist could enter prospectively collected data. Seven participating centers that contributed with at least 15 consecutive cases and regular follow-up examinations were selected, and the data they had entered in the registry were analyzed: preoperative data on the etiology of wrist destruction, pain (0–100 on a visual analogue scale [VAS]), function (0–100 according to the QuickDASH questionnaire), active wrist motion, forearm rotation and grip strength (with the JAMAR Dynamometer), data concerning the operative procedure and complications,

Fig. 2 X-ray view of the Re-motion Total Wrist (frontal view).

and data from the clinical follow-up examinations, performed at 6 weeks, 6 months, and 1 year after the arthroplasty and thereafter yearly without upper limit. The evaluation of the surgeons regarding the position of the implants and the presence of osteolysis, with or without loosening, made at the annual postoperative follow-up examinations was noted, loosening being assessed in terms of angulation or subsidence on serial radiographs (posteroanterior [PA] and lateral views). In the present study, only cases with a posttraumatic diagnosis were included, and only cases with minimum 2 years of follow-up. Revision cases were excluded.

Statistics

Kaplan-Meier survival analysis was used to estimate the cumulative probability of remaining free of revision (i.e., reoperation with total or partial removal of the implants). A nonparametric Wilcoxon signed-rank test was used for data not normally distributed (QuickDASH scores), and the parametric Student's *t*-test was used for normally distributed data (range of motion, grip strength, and VAS scores). Significance was set at a *P*-value of less than 0.05.

Results

At the time, when this analysis was performed, the seven participating centers had included 253 cases. Of these, 54 were posttraumatic cases, and 35 of them had a follow-up period of minimum 2 years. Our follow-up analysis is based on these 35 cases, the demographics of which are listed in ►Table 1. In all cases, the extent of joint destruction was considered to exclude the possibility of performing partial wrist fusion. The revision rate and the implant survival curve, however, were calculated on the basis of all 54 cases in order not to exclude possible early revisions.

The following complications were encountered: one case of reflex sympathetic dystrophy and one case of carpal tunnel syndrome. Mean follow-up time was 39 (24–96) months. In ►Table 2, the clinical data before operation and at the latest performed follow-up are shown.

Patient-Related Outcome Measures

There was an improvement of 42 points in VAS score (highly significant) and of 14 points in QuickDASH-score (not significant).

Objective Outcome Measures

Grip strength improved slightly (not significant). Motion was not different at follow-up, except for improved rotation (not significant) (►Table 2). This was not only the case for the mean values, but also for the individual patients. There was a direct correlation between preoperative motion and motion at follow-up.

Radiological Findings

At final follow-up no signs of loosening (angulation, subsidence, or any other change in position of the implants) were reported. Some degree of osteolysis without loosening of the implants was reported in six cases.

Table 1 Demographics

Age (mean and range)	63 (33–81) years
Gender (men/women)	17/18
Side (dominant/nondominant)	18/16 1 NA
Follow-up (mean and range)	3 (2–8)
Diagnosis	22 SNAC/SLAC 11 malunited distal radius fractures 2 carpal fracture-dislocations

Longevity of the Implants

Two cases were revised. The total revision rate was thus 3.7%, calculated as the percentage of all the 54 posttraumatic wrists. One case was revised two and a half years after operation due to malposition of the implants, causing painful impingement. At revision all components were found solidly fixated. The components were exchanged, but the radius had to be decorticated widely, and fixation of the new radial component failed. Ultimately the wrist was fused successfully. In the other case the carpal component loosened and was

Table 2 Clinical results at latest follow-up compared with preoperative values

	Mean values and range	Significance
Pain (VAS 0–100) Preoperative Postoperative	65 (35–100) 23 (0–82)	$p = 0.0000018$
Function (QuickDASH 0–100) Preoperative Postoperative	47 (12–79) 33 (0–77)	$p = 0.33$
Grip strength (kg) Preoperative Postoperative	18 (2–42) 22 (2–43)	$p = 0.29$
Motion (degrees) Extension Preoperative Postoperative	37 (0–70) 34 (0–80)	$p = 0.43$
Flexion Preoperative Postoperative	36 (0–70) 33 (0–80)	$p = 0.56$
Radial flexion Preoperative Postoperative	12 (0–35) 9 (0–25)	$p = 0.37$
Ulnar flexion Preoperative Postoperative	19 (0–52) 22 (0–46)	$p = 0.33$
Pronation Preoperative Postoperative	77 (30–90) 82 (60–90)	$p = 0.21$
Supination Preoperative Postoperative	74 (10–90) 79 (45–90)	$p = 0.15$

Fig. 3 Implant survival curves according to the Kaplan-Meier method with 95% confidence interval (log-type). Failure was defined as “revision with removal of implants.”

exchanged after 10 months. The implant survival curve according to the Kaplan-Meier method shows an implant survival rate of 92% at 4–8 years (► **Fig. 3**).

Discussion

Many destroyed posttraumatic wrist joints often are salvaged by partial fusions, such as the four-corner procedure or the radiocarpal fusion, and even in panarthritic wrists efficient pain relief can often be obtained with total fusion. Patients may accommodate well for the loss of motion,¹² and a recent systematic review of a large series of TWAs concluded that there were no sufficient data to support the preference for TWA over wrist fusion,¹³ but in that study only rheumatoid wrist were considered. Nevertheless, total wrist fusion is not always unproblematic and does not give uniformly good results,^{14,15} and motion-preserving solutions must also be sought for in cases where partial fusion is impossible because of extensive damage of the cartilage. Little is known about the results of TWA in general for the salvage of severely destroyed wrists in posttraumatic conditions. Only one study of a second-generation wrist implant (the Biax TWA) had a somewhat larger number of posttraumatic cases and reported a high dislocation rate and revision rate.¹⁶ Levadoux and Legré reported on 28 posttraumatic cases treated with a last generation TWA (the Destot TWA) with a follow-up time of 3.9 (1–6) years. Results were good in terms of pain relief and especially in terms of motion: extension-flexion, 89 degrees, and radial-ulnar, 34 degrees.¹⁷ This implant is, however, no longer available. Nydick et al have published a series of 23 cases in which the Maestro TWA was used, 13 being posttraumatic. The follow-up time (0.3 to 4.6 years) is too short to be informative on longevity.¹⁸ Reigstad et al reported 30 SLAC and SNAC cases treated with the Motec TWA with a follow-up time of 3.2 (1.1–6.1) years.¹⁹ That implant is a metal-on-metal

implant with uncemented fixation in the radius and the third metacarpal. Motion was not reported in detail, but total wrist motion was not statistically significantly different at follow-up. Pain and Disabilities of the Arm, Shoulder, and Hand (DASH) scores improved significantly. Grip strength was significantly better at some of the annual follow-up examinations. Periprosthetic radiolucency without prosthetic loosening was seen at follow-up in 10% at the proximal and 7% at the distal component. A report from the Norwegian Arthroplasty register stated less favorable longevity of this implant, 0.77 at 4 years, but that figure was the subject of a later discussion, in which it was claimed that wrist implants had been underreported in the registry, thus skewing the figures.²⁰ A different concept is the Amandys pyrocarbon interposition arthroplasty, which was described by Bellemère et al²¹ and by Pierrart et al,²² reporting quite favorable results. In their series there are several posttraumatic cases, but the reports do not differentiate the results according to the diagnoses (rheumatoid arthritis, osteoarthritis, posttraumatic, and other), and follow-up time was very short. Cooney et al published a series of 39 cases operated with 3 different implants: the Biaxial, the Universal, and the Re-Motion. Ten cases were posttraumatic. Motion at follow-up was stated to be better in posttraumatic arthritis than in rheumatoid arthritis but no further details were given concerning the results in posttraumatic conditions.²³

The question concerning the durability of TWA is very important. Generally, posttraumatic patients are more active than rheumatoid patients. From that point of view, one might fear a lower longevity of TWA in these patients. On the other hand, the bone quality as well as the soft tissue quality is usually better. In the present study we have retrieved data from an international registry.¹¹ The number of cases is relatively small and the follow-up time relatively short, but large enough to show clinical results at short term that are comparable to those obtained in rheumatoid patients, in terms of both pain relief and the ability to return to activities of daily living. The revision rate is comparable with what has been published in other communications reporting on last-generation TWA for rheumatoid arthritis,^{7,9–11,24,25} and the survival curve compares with total elbow arthroplasty and may be better than that of total ankle arthroplasty.^{26,27} The implication of osteolysis without migration of the implants that has been reported in several of our cases (and in other series as well) is not clear. So far, we have no certain indication of its causes and, despite the serial annual radiological examinations that we performed, there are no indication of its consequences in terms of longevity of the implants.

The method we have used for this analysis combines aspects of a registry report with aspects of a conventional prospective multicenter study. Its strength, compared with single-center study, is that we are able to produce a larger cohort and reflect the diversity of several specialized wrist units in different countries rather than the results of a single unit, which might be dependent on the specific opinion and strategy of a single surgeon. The weakness is that (as in other registry reports) there is a limit to how far the analysis can go into details, since this is dependent on the number of criteria

chosen to conduct the registry. Nevertheless, we believe that a sufficient range of criteria has been selected to permit valid conclusions.

We consider the Kaplan-Meier method for the analysis of implant survival as a powerful tool in the evaluation of the durability of TWA. The method makes it possible to analyze data from patients with different lengths of follow-up, taking into account dropouts for any reason.²⁸ It has been used for evaluation of implants in the hand and wrist for many years.^{6,8,17,29} A disadvantage is the fundamental assumption that patients who are lost to follow-up and patients who have died have the same failure rate as those who comply with regular follow-up examinations, which is not necessarily true. However, there were no dropouts in our series.

The most widely accepted and commonly used definition of failure in implant survival analysis is revision (removal of implants). This endpoint has been criticized because the criteria used to decide the need for removal may vary between patients and surgeons, and sometimes it is argued that other definitions should be considered. These could be severe pain or the presence of radiolucency or subsidence combined with moderate or severe pain. Yet other definitions can be considered, but as yet there exist no clear indicators of *early loosening* of TWA (i.e., before subsidence is evident on plain radiographs) that can be used for routine purposes, and it will remain difficult to compare survival analyses until consensus is reached about which other outcome measures should be used rather than revision. In our study the decision to revise implants is based on the judgment of several surgeons or units that work independently, which is an advantage compared with studies in which the decision is made by a single surgeon and solely dependent on this person's views. We have demonstrated a favorable survival rate for the Re-Motion TWA in posttraumatic diagnoses at 4–8 years, with some revisions during the early years. This finding must be interpreted correctly: The survival rate at the “tail” of the curve is less reliable because of the small number of patients with long follow-up, and it must be expected that the incidence of revision will increase as the implants inevitably wear out, which also is indicated by the number of implants with signs of loosening at follow-up in this study. For this reason we prefer to conclude cautiously that the implant survival was ~90% at four years and not to make any assumptions beyond that.

It is not the intention of this article to advocate for the general use of TWA for painful posttraumatic wrist destruction but merely, for the sake of general scientific information, to report on the results we have obtained. In many cases, partial wrist fusion or selective denervation certainly remains the first-choice solution; if those approaches are not feasible, total wrist fusion also remains an option.

Conflict of Interest
None

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