Results of the Universal 2 Prosthesis in Noninflammatory Osteoarthritic Wrists

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Abstract

Background/Purpose Many treatment options are available for wrist osteoarthritis, with the objective of decreasing pain and preserving function. In later stages when midcarpal and radiocarpal osteoarthritis occur, two choices remain: total wrist arthrodesis or total wrist arthroplasty. The purpose of this study is to present the short-term functional changes following total wrist arthroplasty with the Universal 2 total wrist system (Integra Life Sciences) in patients with noninflammatory wrist osteoarthritis.

Patients and Methods Patients with severe noninflammatory wrist osteoarthritis were assessed preoperatively, 6 and 12 months after surgery using a range of motion, grip strength, pain, and the disabilities of the arm, shoulder, and hand (DASH) score. The additional assessment was performed after 1 year for a range of motion using a biaxial electrogoniometer, grip strength, DASH, and the Michigan hand questionnaire. **Results** All range of motion directions and grip strength did not change from preoperative values. The DASH score improved from 53 preoperatively to 14 during latest follow-up. Median patients' satisfaction score decreased with approximately 20 points during the last follow-up.

Conclusion The relatively good DASH score combined with the partly maintained wrist range of motion indicates that reconstruction with the Universal 2 total wrist prosthesis should be considered in patients with end-stage noninflammatory wrist osteoarthritis.

Level of Evidence Level IV, therapeutic study.

Keywords

- ▶ posttraumatic osteoarthritis
- ▶ scaphoid nonunion advanced collapse
- ▶ scapholunate advanced collapse
- ▶ total wrist arthroplasty
- ▶ Universal 2 total wrist prosthesis

Posttraumatic (noninflammatory) osteoarthritis of the wrist and rheumatoid arthritis (RA) are the two common causes of wrist diseases associated with end-stage wrist arthropathy. The most common forms of posttraumatic wrist osteoarthritis (PTOA) is scapholunate advanced collapse (SLAC), followed by the scaphoid nonunion advanced collapse (SNAC) wrist.¹ Many surgical options are available for wrist osteoarthritis, with the

objective of decreasing pain and preserving function. The choice depends on the stage and etiology of the osteoarthritis, age, and lifestyle of the patient. In end stages when midcarpal and radiocarpal joints are affected, two choices remain total wrist arthrodesis or total wrist arthroplasty.

Although all wrist range of motion is lost, some surgeons prefer total wrist arthrodesis due to its predictable outcomes,

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such as good pain relief and a low failure rate.^{2,3} Preference for arthrodesis is based on studies predominantly on RA patients. Residual pain and substantial dysfunction have been reported after arthrodesis in noninflammatory patients.^{4,5} Furthermore, RA patients are prone to joint subluxation, a higher infection risk, and have worse bone stock^{2,6} translating results from RA to osteoarthritis less representative. In contrast, PTOA patients are usually younger, their problem is isolated, and they have higher functional demands leading to greater risk for early arthroplasty failure. A systematic review concluded that total wrist arthroplasty has similar functional outcome and patient-reported outcome as total wrist arthrodesis in RA patients.⁷

The first total wrist arthroplasty was performed by Gluck in 1890.⁸ The surgical technique, design, and mechanism of the total wrist prosthesis have evolved with improved stability and outcome.⁹ The Universal 2 total wrist system (Integra Life Sciences) is a fourth-generation prosthesis, and several studies have already reported good results with this implant for RA patients, but they have not been reported for noninflammatory patients.^{10–13} In this study, we present the early functional results following total wrist arthroplasty with the Universal 2 total wrist system in patients with severe noninflammatory wrist osteoarthritis.

Patients and Methods

Population

Between January 2006 and January 2011, 21 PTOA patients (2 distal radius fractures, 4 SNAC wrists, and 15 SLAC wrists grade 3/4) and two Kienböck's disease patients were treated with a Universal 2 total wrist system at the Department of Plastic Surgery, Diaconessenhuis, Utrecht/Zeist, the Netherlands. Of these 23 noninflammatory patients, 14 (61%) were females, 13 right wrists and 14 dominant wrists were affected. Mean age of the patients at the time of surgery was 60 years (range, 31–80 years). Preoperative data were available from 18 patients. One patient was treated with Universal 2 prosthesis for both the wrists. Seven patients had previous surgery, such as scapholunate ligament reconstruction, four-corner fusion, wrist arthrodesis, and shortening of the radius or ulna. The medical ethics committee approved this study (MEC-2010–295) and included patients gave consent.

Surgical Technique and Postoperative Protocol

Two hand surgeons (R.F. and T.M.) performed all surgeries. Each patient had a standard surgical approach and postoperative management, based on the technique described by Menon¹⁴ and Adams.¹⁵ All patients received a single dose of prophylactic antibiotics. Through a dorsal longitudinal incision, the wrist joint was exposed, and the joint entered through the third extensor compartment by an inverted T-shaped incision of the dorsal wrist capsule. In 11 patients the distal ulna was resected through its neck because the distal radioulnar joint was arthritic or interfered with the radial component. The proximal and distal surfaces were

prepared using cutting blocks, and trial components were placed. After testing wrist motion and stability, the final prosthesis was inserted (without cement and with two screws for the distal component), and the alignment was radiographically checked. The dorsal capsule was closed. After surgery, the wrist was immobilized in a plaster of Paris cast for 1 week, followed by a protective volar splint for 6 weeks. Active motion exercise was started 1 week after surgery. All patients received hand therapy. Standard radiographs were obtained after 6 months and assessed for implant alignment, the position of the screws, bone reaction, and evidence of implant loosening (► Fig. 1).

Short-Term Outcome Assessment

A standardized outcome assessment protocol was applied to all wrist patients in our clinic. An independent hand therapist assessed them preoperatively, and at 6 and 12 months after surgery. The range of motion of the wrist (flexion–extension, and radial–ulnar deviation) was assessed with a handheld goniometer and grip strength with the Jamar dynamometer. All patients were asked to complete the full disabilities of the arm, shoulder, and hand (DASH) questionnaire (Dutch language version) and visual analog scale (VAS) pain score (0–10) at each of the three time points.¹⁶

Fig. 1 (A) Preoperative X-ray (PA and lateral view) of a patient with grade 4 osteoarthritis, (B) postoperative X-ray (PA and lateral view) of the same patient 6 months after Universal 2 implant (Integra Life Sciences). PA, posteroanterior.

Additional Outcome Assessment

Between January and March 2011, all noninflammatory patients with a Universal 2 prosthesis that were implanted 12 months earlier were invited to our clinic for several additional assessments by an independent researcher. They were divided into two groups: (1) with a follow-up of 1 to 2 years (mean: 14 months [range, 12–18 months]) and (2) with a follow-up of more than 2 years (mean: 34 months [range, 24–50 months]). To evaluate hand function, patients were asked about their working status and completed the DASH questionnaire and the Michigan hand questionnaire (MHQ) (Dutch language version). The MHQ is divided into six subscales, which include overall hand function, activities of daily living, work, pain, aesthetics, and satisfaction.¹⁷

The range of motion (flexion–extension, radial–ulnar deviation, and circumduction) of the affected wrist was assessed with a biaxial flexible electrogoniometer (Biometrics: XM-65, Biometrics Ltd., Gwent, United Kingdom) using a protocol that has been reported to be accurate and reliable.¹⁸ All patients were instructed to perform flexion–extension, radial–ulnar deviation, and circumduction of the wrist at a comfortable speed, and to focus on maximizing range of motion.

Grip strength was assessed with the MIE pinch/grip analyzer (MIE, Medical Research, Leeds, United Kingdom), which was set at the same width as that of a Jamar dynam-

ometer in position 2. Patients were asked to perform maximum grip for 60 seconds. This method allows for assessment of mean force, peak grip strength, and endurance.

Data collected with the flexible electrogoniometer and the MIE pinch/grip analyzer were processed with Matlab 7.1 software. Variables derived from the output of the flexible electrogoniometer were flexion–extension arc, radial–ulnar deviation arc, and circumference of the circumduction. The mean force, peak force, and the slope of the force time curve were extracted from the MIE grip/pinch analyzer output.

Results

► **Table 1** shows the results of the short-term assessment and additional outcome assessments. Overall, after surgery, the range of motion and grip strength did not change compared with preoperative values. However, DASH scores improved compared with preoperative values by 22.8 points at 1-year follow-up and 35.7 points after >2-year follow-up. Mean VAS score 1 year after surgery improved with three points compared with the preoperative value on a scale of 0 to 10. No malalignment of the prosthesis or periprosthetic osteolysis was observed when reviewing postoperative X-rays.

Of the 11 patients, 4 patients that were additionally assessed were already retired before surgery. Preoperatively, three patients performed heavy manual labor. After surgery,

Table 1 Results for range of motion, grip strength, and MHQ assessed during short-term outcome assessment and additional outcome assessment

	Short-term outcome assessment			Additional outcome assessment	
	Preoperative (n = 18)	6 mo (n = 14)	12 mo (n = 12)	1–2 y (n = 4)	≥2 y (n = 8)
Active ROM	Mean (SD)	Mean (SD)	Mean (SD)	Median (range)	Median (range)
Flexion–extension arc (degrees)	71 (32)	66 (15)	71 (25)	84 (18–53)	74 (19–90)
Radial–ulnar deviation arc (degrees)	48 (22)	55 (17)	54 (18)	35 (29–39)	31 (21–49)
Circumference of circumduction (degrees)				129 (87–141)	91 (23–148)
Grip strength					
Peak force (kg)	11.5 (8)	9.6 (4)	11.9 (4)	11.2 (9.3–16.2)	12.5 (4–39.4)
Mean force (kg)				6.4 (3.8–10.4)	9.1 (2.9–31.4)
Slope				–0.4 (–1.1 to –0.13)	–0.7 (–1.54 to –0.27)
DASH score	53.2 (20)	36.8 (24)	30.4 (20)	37.5 (18–53)	17.5 (3–34)
VAS score (pain at rest)	6 (1)	4 (2)	3 (3)		
Michigan hand questionnaire					
Overall hand function				60 (50–95)	55 (40–100)
Activities of daily living				75 (70–95)	83 (40–100)
Pain				35 (5–55)	37.5 (0–55)
Aesthetics				100 (75–100)	100 (81.3–100)
Satisfaction				75 (54.2–100)	54.2 (25–100)
Total score				66.1 (56.6–97.3)	71.5 (46.9–100)

Abbreviations: DASH, disabilities of the arm, shoulder, and hand; ROM, range of motion; SD, standard deviation; VAS, visual analog scale.

one patient returned to work (nurse), one patient switched to desk work, and one patient was unable to work. Two patients did not work preoperatively and did not start working even after surgery.

Complications

One patient fell on his wrist that led to an extension lag. Two patients developed De Quervain's disease, which settled with a corticosteroid injection in the first extensor compartment. Four patients complained of volar wrist pain and needed excision of the pisiform bone. However, in one patient, this reduced grip strength that we could not explain. One patient fell on his wrist 6 months after surgery which resulted in extension lag and pain on the ulnar side of the wrist. Therefore, a Darrach's procedure was performed 1 year after initial surgery. ▶**Fig. 2** shows the preoperative X-rays and post-

operative X-rays after Universal 2 and Darrach's procedure, respectively. In another patient, the distal ulna was resected 1 month after surgery because of ulnar-sided wrist pain. The ulnar pain persisted after surgery. Therefore, it was decided to excise the pisiform bone 3 months later. An ulnar head prosthesis was inserted 4 months after because of persisting pain.

Discussion

There has been much debate over the last decade on whether patients with end-stage wrist osteoarthritis are best treated with a wrist arthroplasty or arthrodesis. Previous case series focused on RA patients. Cavaliere and Chung⁷ performed a systematic meta-analysis (503 total wrist arthroplasties vs. 860 total wrist arthrodeses) in RA patients and concluded that outcomes for total wrist fusion were comparable and possibly better than that for total wrist arthroplasty. However, their total wrist arthroplasty data mainly consisted of second- and third-generation total wrist prostheses (Meuli's [Sulzer Orthopaedics Ltd], Volz's [Howmedica Company], and biaxial prostheses [DePuy Orthopaedics, Inc]). Boeckstyns¹⁹ recently performed a systematic review on wrist arthroplasty in RA and PTOA patients. He concluded that more recent generations of implants provide an improvement of function through pain reduction and preservation of mobility, despite methodological shortcomings in the reviewed studies. Also, he concluded that more recent generation implants showed high survival rates (range: 90–100%) at 5-year follow-up.

The newest—fourth generation—implants need less bone resection, screw fixation to the carpus, and are uncemented. Nydick et al²⁰ found similar patient-reported outcomes when comparing PTOA patients who received the Maestro's prosthesis (Biomet) to PTOA patients with a total wrist arthrodesis. However, Adey et al⁴ reported substantial dysfunction after total wrist arthrodesis for PTOA patients. Also, 20 of their 22 patients would elect to undergo a procedure to regain wrist movement. Vicar and Burton²¹ found that RA patients who have had total wrist arthrodesis on one wrist and a total wrist arthroplasty on the other preferred the side with the arthroplasty.

Literature on the Universal 2 prosthesis showed conflicting and incomplete (i.e., missing preoperative information) data on different outcome measures.^{10–13} Comparison of our results with existing literature was therefore not possible. A couple of studies reported range of motion and functional outcome of the Universal 2 total wrist implant.^{10–13} However, all of these studies were performed on a small patient group and almost exclusively in RA patients. The reported postoperative range of motion ranged from 28 to 68 degrees for flexion–extension, and 18 to 26 degrees for radial–ulnar deviation. We found a slightly higher postoperative range of motion in our patients. DASH and patient-rated wrist evaluation improved after an arthroplasty, but the DASH scores varied between 55.1 and 91 preoperatively, and between 41.9 and 65 postoperatively.^{10–13} We noted a 35-point improvement after more than 2 years.

The few studies on other fourth-generation total wrist implants in PTOA patients demonstrated similar results to

Fig. 2 (A) Preoperative X-ray (PA and lateral view) of a patient with grade-4 osteoarthritis, (B) postoperative X-ray (PA and lateral view) of the same patient after Universal 2 implant (Integra Life Sciences) with distal ulnar abutment, and (C) postoperative X-ray (PA and lateral view) of the same patient after Darrach's procedure. PA, posteroanterior.

our study. Herzberg²² ($n = 7$), Boeckstyns et al²³ ($n = 15$), and Nydick et al²⁴ ($n = 13$) all found preservation or a slight increase in range of motion and grip strength. Nydick et al²⁴ also reported a postoperative DASH score of 33. Unfortunately, no preoperative patient-reported outcome was available, so these results could not be compared with ours. Reigstad et al²⁵ presented the 1- to 6-year outcomes of the third-generation Motec (Swemac Orthopaedics AB) total wrist arthroplasty (Swemac Orthopaedics AB) in posttraumatic patients ($n = 30$) and reported a 20-point improvement in DASH score, significant improvement in VAS scores, and preservation of wrist motion and grip strength.

Previous studies have shown that assessment of wrist circumduction provides a good representation of the capacity of the wrist.^{18,26,27} Wrist circumduction combines flexion, extension, and radioulnar deviation, which are necessary for activities of daily living. No previous studies have reported wrist circumduction after a total wrist arthroplasty. We found that the circumference of circumduction in PTOA patients after arthroplasty was reduced compared with healthy wrists by 56%.¹⁸

A limitation of our study is the small number of patients. This is comparable to published literature and reflects the tiny patient population. Another limitation is that follow-up was short. While our follow-up is sufficiently long to describe the functional outcome, we cannot comment on long-term implant loosening, fracture, dislocation, or failure. We did not have preoperative data on circumduction and MHQ scores. Furthermore, the range of motion during additional assessment was assessed with flexible electrogoniometers compared with handheld goniometers during short-term outcome assessment. Therefore, differences in radial-ulnar deviation may be due to the assessment method or due to the small number of patients. This study did not have a randomly assigned control group, so we cannot comment on how the outcome would relate to alternative treatment, such as wrist arthrodesis.

It is not clear from literature what range of motion is needed for normal activities of daily living function. Ryu et al²⁸ concluded that most activities of daily living could be performed with 40 degrees flexion, 40 degrees extension, and 40 degrees radial-ulnar deviation. However, Palmer et al,²⁹ found smaller values: 5 degrees flexion, 30 degrees extension, 10 degrees radial deviation, and 15 degrees ulnar deviation. Since we noted 74 degrees flexion-extension and 31 degrees radial-ulnar deviation after more than 2 years we conclude that the range of motion after Universal 2 prosthesis is sufficient for activities of daily living, as confirmed by the MHQ scores and improved DASH score.

In conclusion, the Universal 2 total wrist prosthesis could be considered in patients with end-stage noninflammatory wrist osteoarthritis as an alternative to wrist arthrodesis, especially since the fourth generation of total wrist implants requires less bone excision, leaving an arthrodesis after a failed arthroplasty as a salvage option. We found good results at follow-up. At present, not much is known about the long-term implant failure. Although results of the newest generation implants suggest significant improvement compared with older generation implants, longer follow-up periods

are needed to determine their survival rate. A survival rate that is comparable to the survival rate of hip or knee implants would truly clear the way for wrist arthroplasty in PTOA patients. Future studies should, therefore, focus on a prospective design, a substantial sample size, and long-term follow-up.

Note

This study was performed at the Diaconessenhuis, Zeist, The Netherlands. The medical ethics committee of the Diaconessenhuis Utrecht/Zeist approved this study (MEC-2010-295).

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Conflict of Interest

None.

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