Ulnar Head Replacement: 21 Cases; Mean Follow-Up, 7.5 Years

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Purpose To report clinical and radiographic outcomes for the Herbert ulnar head prosthesis after a mean of 7.5 years (range, 2.0−12.5 years).

Methods We performed 22 Herbert ulnar head prosthesis arthroplasties between 2000 and 2011. Five were primary procedures, and the remaining 17 were done after an average of 2 (range, 1−5) previous operations. The mean age at surgery was 55 years (range, 31−74 years). Follow-up including clinical examination, standardized questionnaires, and radiographic examination was done after mean 7.5 years (range, 2.0−12.5 years) in 21 cases. We used the Disabilities of the Arm, Shoulder, and Hand questionnaire, the Patient-Rated Wrist Evaluation questionnaire, and the Mayo wrist score questionnaire. Pain and satisfaction were evaluated with a 10-cm visual analog scale (VAS). Measurements of range of motion and strength for grip were recorded.

Results Wrist range of motion was not affected by the arthroplasty except for supination, which significantly improved from 55° to 70°. At follow-up, grip strength averaged 25 kg (range, 10−48 kg) in the operated wrists and 31 kg (range, 8−74 kg) on the contralateral side. Visual analog scale-pain averaged 2.9 (range, 0−8.7) during activity and 1.7 (range, 0−7) at rest. Satisfaction VAS was 8.9 (range, 4.3−10). Five patients had VAS-pain above 5 during activity, and 1 patient was dissatisfied and regretted having undergone arthroplasty. Mean outcomes were 27 (range, 5−50) for Disabilities of the Arm, Shoulder, and Hand measure, 31 (range, 0−90) for the Patient-Rated Wrist Evaluation score, and 71 (range, 30−90) for the Mayo wrist score. One patient was reoperated with capsuloplasty 9 months after the arthroplasty owing to recurrence of painful instability. Full stability was not achieved but the pain resolved. None of the implants showed any radiographic signs of loosening.

Conclusions The Herbert ulnar head prosthesis was a safe method of treatment and provided satisfactory midterm results for selected cases of distal radioulnar joint disorders.

Clinical relevance Increased knowledge of performance for ulnar head implant arthroplasty may aid surgical decision making for distal radioulnar joint disorders. *(J Hand Surg Am. 2015;40(9):1731−1738. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic IV.

Key words Distal radioulnar joint, ulnar head replacement, ulnar head prosthesis, wrist arthroplasty.

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Instability and arthritic pain of the distal radioulnar joint (DRUJ) severely affect basic functions of the wrist and forearm.[1,2] Treatments for these conditions have been complete or partial resection of the ulnar head or a combination of distal ulnar resection and DRUJ arthrodesis, the Sauvé-Kapandji procedure. Because the ulnar head is fundamental to the function of the DRUJ,[3,4] it cannot be resected without mechanical consequences.[5,6] Despite this, the outcome of

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resection procedures has often been satisfactory, especially in patients with low demands for loading.[7,8] In patients with a more active lifestyle, the risk of failure with these procedures is higher.[9–11] If this occurs, it might end up in painful instability that is even more disabling than the condition existing prior to the resection.[10,12,13] Such instability might be treated with soft tissue procedures, radioulnar arthrodeses, allograft interposition, or one of several other methods,[14–19] but results have been inconsistent.[20,21]

Another approach to treat DRUJ disorders or failed resection arthroplasties is to replace the deficient or missing ulnar head with an artificial implant. Early attempts were made with Swanson silicone implants. The initial results were encouraging, but most cases failed after the short term.[22] Herbert and coworkers[23] further developed this concept to a more resistant, metal ulnar head implant. The initial reports from groups involved in the development of this and similar implants have been promising.[23–25] Biomechanical laboratory studies of ulnar head implants support the early clinical results and indicate that kinematics and loading properties can be restored.[6,26–29] Few studies, however, have reported mid- to long-term results.[30,31] Hence, we know little about durability, long-term efficacy, and safety of these implants. To address these issues, we reviewed our midterm radiographic and clinical outcomes of a consecutive series of arthroplasties performed with the Herbert ulnar head prosthesis (Herbert UHP). Ulnar head arthroplasties have commonly been performed as salvage procedures for painful radioulnar impingement syndrome. Indications have expanded to arthritis and other DRUJ disorders, but there is less support of this usage in the literature. Secondary aims of our study were, therefore, to analyze if there were any differences in results for primary compared with secondary procedures or if surgery was performed owing to painful instability or painful arthritis. We also studied if the outcome could be correlated to the state of soft tissue support or radiographic features such as the condition of the sigmoid notch.

MATERIALS AND METHODS

Patient series

Ethical approval for this study was obtained. All patients who had undergone Herbert UHP arthroplasty at our department at least 2 years earlier were requested to attend a follow-up visit. All 21 accepted, but 1 died before scheduled follow-up. One patient had bilateral procedures performed. Thus, we were able to evaluate 20 patients (11 men and 9 women) with 21 prostheses. The mean age at surgery was 55 ± 12 years (range, 31–74 years). Table 1 lists demographics and characteristics of the study population.

All procedures were performed or supervised by senior surgeons not involved in the re-examination of the patients. The first author (P.A.) reviewed all patients at an average 7.5 years (range, 2.0–12.5 years) after surgery. The rationale for the procedure was painful instability after previous resection arthroplasty (10 wrists), pain due to osteoarthritis (9 wrists), and rheumatoid arthritis (3 wrists). Ten patients had an initial injury, 9 fractures and 1 ligament tear. Eleven patients had bilateral DRUJ arthritis. Fourteen procedures were performed on the dominant side. The arthroplasty was the first wrist surgery in 5 cases. Seventeen patients had previously undergone a total of 34 surgical procedures at the wrist, corresponding to median/mean values of 1 and 2 (range, 1–5). Previous surgery included fixation of distal forearm fractures (n = 2), corrective osteotomy of the distal radius (2), plate removal (2), ulnar shortening (2), ulnar styloidectomy (1), triangular fibrocartilage reinsertions (3), Darrach procedures (10), stabilizations of unstable ulnar stump (3), total wrist arthroplasty (3), total wrist arthrodesis (1), arthroscopy with shaving (1), tendon transfer (1), synovectomy (1), and neuroma excision (2).

Implant design

The Herbert UHP (Martin Medizin Technik, Tuttlingen, Germany) is a modular total head endoprosthesis with a ceramic head. The head is available in 3 different sizes, which fit any of the 9 sizes of titanium-coated stems (3 different thicknesses and 3 different neck lengths) that are press-fit into the ulnar medullar cavity (Fig. 1). The operations were performed as described in detail by van Schoonhoven et al[23] and Herbert and van Schoonhoven.[32]

Postoperative care

The limb was placed in an above-elbow plaster splint for 3 weeks and then in a below-elbow cast for another 3 weeks. Some patients were treated with a wrist orthosis for an additional 3 weeks if full stability was not present. Formal physiotherapy started after removal of the cast. The patients were initially allowed unloaded active mobilization and then gradually returned to normal activity.

Follow-Up

Pain and satisfaction were estimated on a 10-cm visual analog scale (VAS). Functional and general outcomes were evaluated using the Mayo wrist score questionnaire and the validated Swedish versions of the Disabilities of Arm, Shoulder, and Hand (DASH) and

TABLE 1. Demographics and Characteristics of Study Population

Sequence (Case)*	Follow-Up (y)†	Sex	Age (y)	Initial Pathology‡	Previous Surgeries§	Indication for Arthroplasty
1	12.5	M	52	TFCC	1	OA 2°
2	11.5	M	59	DRF	2	OA 2°
3	11.5	F	56	DRF	5	Darrach
4	10.5	M	41	DRF	1	OA 2°
5‖	10	M	61	RA	5	Darrach
6	10	F	45	Radiation	0	OA 2°
7	9.5	F	73	DRF	2	Darrach
8	9	F	68	RA	1	Darrach
9	8.5	F	56	EDS	0	OA 2°
10	8	F	52	RA	1	Darrach
11	7.5	F	37	RA	0	RA
12	8	M	39	DRF	3	OA 2°
13	¶	M	59	DRF	3	Darrach
14	7	M	51	DRF	0	OA 2°
15	7	F	39	OA	3	OA
16	5.5	M	73	OA	1	Darrach
17	5.5	M	74	DRF	1	OA 2°
18	5	M	66	RA	0	RA
19	4	M	31	DRF	2	Darrach
20‖	3.5	M	68	RA	1	RA
21	4	F	61	RA	1	Darrach
22	2	F	61	RA	1	Darrach
Mean	7.6		55		1.5	
Median	8		58		1	

DRF, distal radius fracture; EDS, Ehlers-Danlos syndrome; OA, primary osteoarthritis, OA 2°, secondary osteoarthritis; RA, rheumatoid arthritis; Radiation, radiation injury; TFCC, triangular fibrocartilage complex injury.
*Sequence of index operation and case number.
†Time between index operation and latest follow up visit in years.
‡Presenting disorder.
§Number of surgeries performed at the wrist before the index operation.
‖Cases 5 and 20 are the same patient with bilateral procedures.
¶Deceased, no late follow-up.

Patient-Rated Wrist Evaluation (PRWE) questionnaires. Clinical assessment included measurement of active range of motion (ROM) by a goniometer. Grip strength was recorded using the Jamar dynamometer (Sammons Preston, Inc., Bolingbrook, IL). Values for grip strength and ROM were compared with the contralateral side. Range of motion was also compared with preoperative values obtained from the patient charts. Radioulnar ballottement and radioulnar compression tests were used to assess stability and pain.

Radiographic evaluation

At the latest follow-up, standard radiographs were obtained. These were compared with the preoperative radiographs and postoperative radiographs available at either 1, 3, or 6 months. To increase accuracy all radiographic measurements were done with mdesk software (RSA Biomedical; Umeå, Sweden). The bone resorption index and the sigmoid notch erosion index were calculated as proposed by Herzberg.[33] Radiographic instability was evaluated as proposed by Kakar et al[34] for a similar implant. The position of the head of the implant in relation to the joint surface line of the radius, the condition of the sigmoid notch, and signs of instability or loosening were evaluated subjectively. Presence of radiolucent or sclerotic zones was recorded. Loosening was defined as the presence of a complete radiolucent line surrounding

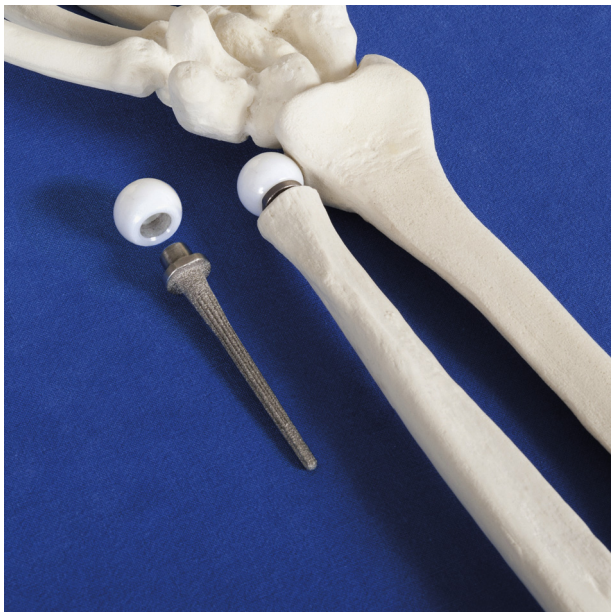

FIGURE 1: Herbert UHP, before and after implantation in a bone model.

the implant. Presence or absence of heterotopic bone formation was noted.

Statistical analysis

Values for ROM were compared with preoperative values. The difference was analyzed by the Wilcoxon signed rank test. Comparison between independent groups (eg, cases with or without radiographic instability, with or without the presence of previous trauma, indication of arthritis versus instability, primary or secondary arthroplasty) was done using the Mann-Whitney test. For patients with a unilateral procedure, the grip strength was compared with the nonoperated side and analyzed with paired *t* test. These tests were 2-sided and the level of significance was set to less than 5% probability ($P < .05$). Values for DASH were related to the number of patients (20); other outcome values were related to the number of wrists (21).

RESULTS

Clinical outcome

Data for assessment of pain, satisfaction, patient-reported outcomes, and strength are summarized in Table 2. Five of the patients marked a VAS greater than 5 for pain during activity. These patients still recorded a mean satisfaction value of 8.3. Fourteen patients indicated 9 or higher on satisfaction VAS. One patient recorded satisfaction VAS 4.3 and regretted having undergone arthroplasty. For the entire cohort, grip strength for the operated hand reached 83% of the nonoperated side. This difference was not statistically significant ($P = .11$).

TABLE 2. Clinical Data and Health Scores at Latest Follow-Up Visit

Parameter	Mean	CI*	Range
VAS-pain rest†	1.7	0.6–2.8	0–7.0
VAS-pain activity†	2.9	1.6–4.1	0–8.7
VAS-satisfaction†	8.9	8.2–9.6	4.3–10
DASH score	27	20–35	5–50
PRWE score	31	20–41	0–90
Mayo wrist score	71	64–79	30–90
Strength A	25	20–30	10–48
Strength NA	31	21–38	8–74

CI, confidence interval; Strength A, arthroplasty side in kg; Strength NA, nonarthroplasty side in kg.
*95% CI of mean.
†Pain and satisfaction measured by 10-cm VAS.

A synopsis of ROM data is presented in Table 3. Significant improvements, after the arthroplasty, could only be detected for supination ($P = .03$). Sixteen of the 21 arthroplasties were stable. Four arthroplasties were partially unstable, meaning unstable on ballottement test of the DRUJ in any of the positions tested (pronation, supination, neutral position). In 1 patient, the arthroplasty was globally unstable. Clinical instability could not be correlated to any clinical outcome or radiographic features. Grip strength was significantly higher for patients who had the procedure performed owing to an initial trauma ($P = .02$), but there were no significant differences in pain ($P = .06$), satisfaction ($P = .21$), or forearm rotation ($P = .08$), DASH scores ($P = .09$), or PRWE scores ($P = .28$). Similarly, we did not find any significant differences for the same outcome parameters when we compared patients who were operated owing to painful instability or arthritis. There was a trend for less residual pain and better functional scores if no wrist surgery had been performed previously, but neither of these differences were statistically significant ($P = .09$ and $P = .09$, respectively).

Radiographic outcome

We observed bone resorption beneath the collar of the implant in all cases, but there was no progression after 12 months. The average length of this resorption zone was 3.9 mm ± 2.7 mm (range, 1–13 mm). The bone resorption index was 7% (range, 0%–26%). Sigmoid notch erosion was self-limiting except for 1 patient, case 10 (Fig. 2). None of the implants were loose, and no heterotopic ossification was detected. Fifteen patients were radiographically unstable according to the criteria by Kakar et al.[34] We could not correlate

TABLE 3. Range of Motion*

Parameter	Before	Latest Follow-Up	Nontreated	*P* Value
Extension	45 (0–100)	50 (0–80)	55 (0–85)	.58
Flexion	40 (0–85)	35 (0–85)	50 (0–100)	.38
Supination	55 (10–90)	70 (0–90)	80 (40–90)	.03
Pronation	65 (20–90)	65 (40–90)	70 (45–90)	.44

*Mean values for ROM before arthroplasty and at latest follow-up evaluation and for the nontreated side. Ranges are in parentheses.

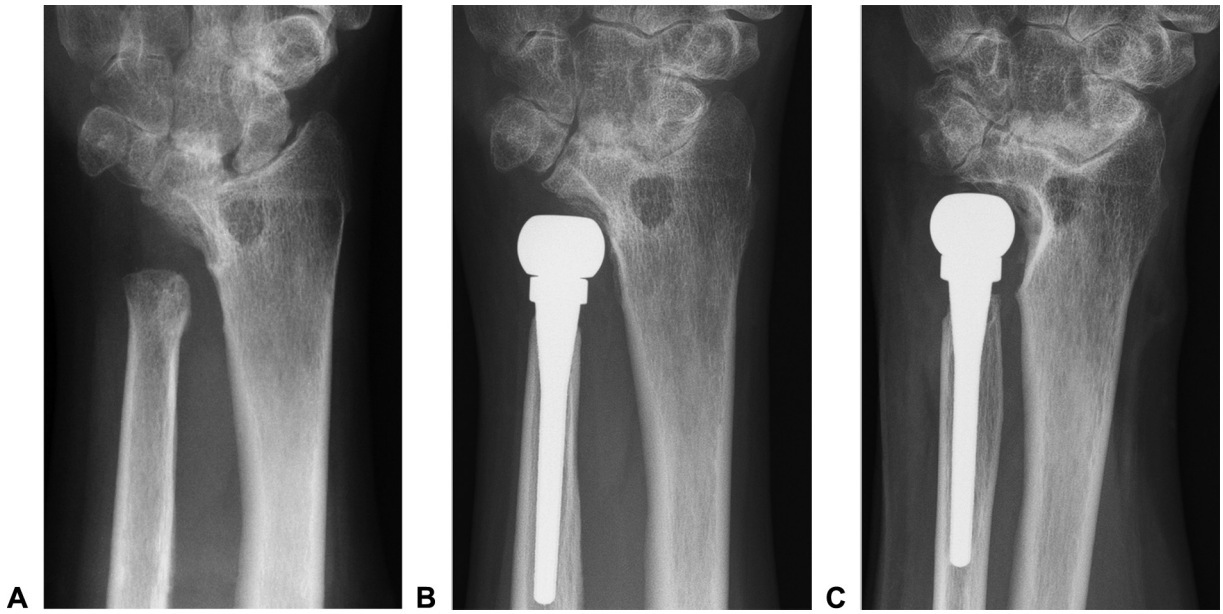

FIGURE 2: Case 10. Progressive radius erosion. VAS-pain 0.7. **A** Before surgery. **B** One year after surgery. **C** Eight years after surgery.

radiographic instability to any of the clinical outcomes ($P > .15$). Neither could we relate the condition of the sigmoid notch or position of the implant to any of the clinical results ($P > .19$ and $P > .16$, respectively).

Complications

Minor complications included a temporary seroma. One patient reported a persistent ulnar nerve sensory deficit. One patient experienced little finger stiffness, which resolved over several years. There were no infections. One patient (case 16) experienced disabling pain during activity shortly after the index operation. Upon clinical examination, the DRUJ was dorsally unstable. Capsuloplasty was performed 9 months after the ulnar head replacement. The pain resolved, but the DRUJ did not become stable.

DISCUSSION

Clinical outcome

As in previous studies of the Herbert UHP[30,35] and similar ulnar head implants,[24,25,33,34] a majority of the patients in our study demonstrated very low levels of pain after the arthroplasty. Nonetheless, 5 patients experienced considerably higher levels of residual pain during activity (VAS > 5). One of these patients had a chronic pain syndrome diagnosed before the arthroplasty, and when radiographs were reviewed, the others were found to have either a destroyed adjacent joint or a malpositioned implant as a probable origin of pain, examples seen in Figures 3 and 4. These 5 patients with the highest level of pain were still very satisfied, with a mean satisfaction level of 8.3. The patients claimed that their pain had been worse before the arthroplasty and that they were improved.

As in the study by van Schoonhoven et al,[30] the overall satisfaction level in our cohort was high, with an average of 8.9 out of 10. One patient in our study, case 4, was dissatisfied and regretted having undergone arthroplasty despite comparatively low levels of residual pain during rest and activity (VAS 0.5 and 2.7, respectively). Sabo et al[31] recognized a considerably higher proportion of dissatisfied patients (14 of

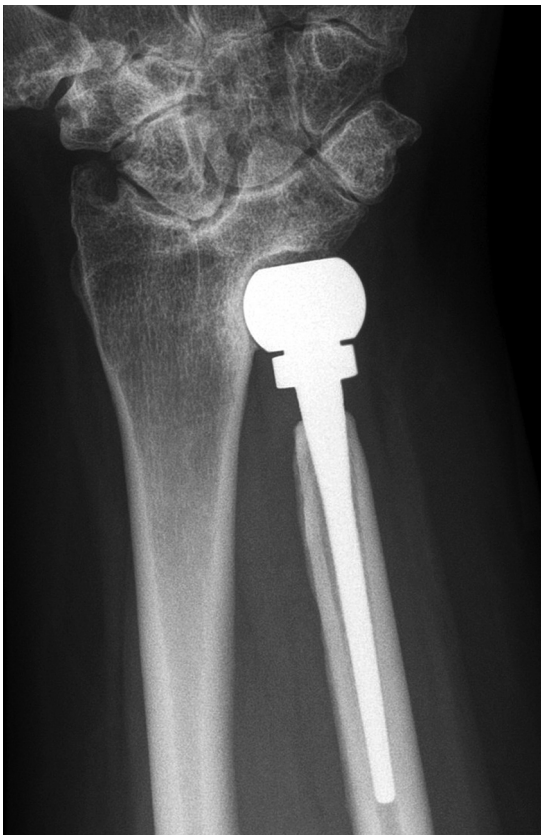

FIGURE 3: Case 11. Ninety-two months after surgery. Radiocarpal arthritis. VAS-pain 7.0.

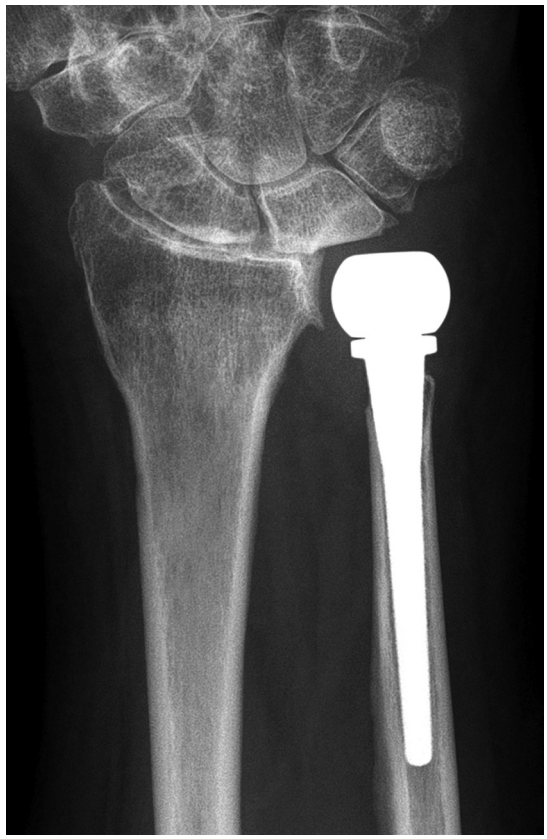

FIGURE 4: Case 20. Forty-eight months after surgery. Ulnocarpal impingement. VAS-pain 5.2.

47); however, it is unclear how many of these ulnar head arthroplasties were performed with the Herbert prosthesis.

A few previous studies have used patient reported outcomes. Kaiser et al[36] reported an average DASH score of 40.5, but there were only 8 participants in this study and the authors concluded that the DASH results were skewed. Sauerbier et al[25] recorded a level similar to that in our study, DASH score 33, and Warwick et al[35] recorded lower scores with a median of 12.5. Only Sabo et al[31] have reported PRWE scores in relation to DRUJ arthroplasty and noted a mean score of 52. We see no obvious reason why we observed lower values. Kakar et al[34] recorded Mayo wrist scores for the U-head implant arthroplasty that compared well with our findings.

In contrast to van Schoonhoven et al,[30] who found that all their patients had a clinically stable DRUJ, 5 patients in our study were to some extent unstable. However, we could not link patients with instability to any particular outcome. The majority of the arthroplasties in this study were salvage procedures, which is the common indication for ulnar head replacement. Earlier reports have indicated that outcome might be at least as good if previous surgery has not been performed.[24,25,30,31] There was a weak trend toward better outcome regarding pain, satisfaction, and functional scores for primary arthroplasties also in our study. These results were not statistically significant, but the primary group consisted of only 5 patients. The number of patients was more evenly distributed when we divided patients according to treatment for arthritis or failed Darrach procedure, but we did not find any significant differences in outcome.

Radiographic outcome

All wrists showed some degree of bone resorption at the distal ulna and many displayed erosion of the radius. As discussed in previous papers,[33,37] these changes are usually benign and come to a halt within 12 months. For 1 patient, case 10, the adaptive changes progressed and a large erosion developed in the distal radius. This patient has rheumatoid arthritis and had a preexisting radiolucent radius cyst, which probably contributed to the progressive changes. The patient reported low levels of pain, 0.7 on VAS both for pain at rest and during activity. Her satisfaction score was 9.4.

The most common form of suboptimal position of the implant was too far distal, causing the prosthesis

head to impinge against the carpus. We were not able to statistically correlate this or other aspects of radiographic outcome to clinical outcome. However, the patients with highest residual pain levels all showed suboptimally positioned implants or variable radiographic changes that could be associated with clinical outcome. The reason for absent statistical association is uncertain, but low power or poorly defined radiographic standards are most certainly of importance.

Complications

The limited published information about mid- to long-term results for ulnar head implant arthroplasty have shown that late occurrence of complications are rare.[30,31] Our midterm results seem to confirm this observation in that all complications arose within the first 6 months after the arthroplasty. We found a low complication incidence and no radiographic signs of loosening despite a comparatively long follow-up in this limited number of patients. Other authors have also reported a low frequency of aseptic loosening for the Herbert UHP.[30,31,35] Sauerbier et al[25] found no signs of loosening in their study of mainly U-head implants, and Kakar et al[34] reported 5 aseptic loosenings for a series of 47 patients with the same implant. They found that a previous fracture that changed the relationship of the DRUJ constituted a risk. Overall, loosening for UHP implants seems rare.[37] Perhaps loads are not transferred through the implant despite the fact that laboratory testing has shown that an implant arthroplasty restores values to near-normal DRUJ properties.[26–28,38] It could otherwise be that forces are sufficiently low to be absorbed and distributed along the stem of the implant. Previous observations that even constrained implants seem durable at the DRUJ could support this hypothesis.[39,40]

We believe that postimplant DRUJ instability is more of a concern, and this has also been the experience of other authors.[30,32,35] However, we were not able to statistically correlate clinical instability to worse outcome, but the only additional surgery in our series was performed owing to recurrence of painful instability.

Limitations

Because this is a retrospective study, we were only able to retrieve reliable data about preoperative values of ROM for comparisons. Information on the specific indications for the procedure including judgment of the sigmoid notch or degree of preoperative instability could not consistently be found in the medical records. Neither could we consistently find any thorough documentation concerning the specific reasons for choosing the Herbert prosthesis in each individual. Other limitations are that radiographic and clinical instability were not well defined.

Power analysis showed that the sample size in this study was too small to detect clinically important differences. For example, to prove a difference of 17 DASH points, which has previously been reported as minimally clinically important difference,[41] between patients having the arthroplasty as their first operation and those that were done as revisions, we would have needed at least 15 patients in each group. Furthermore, the indications and the background of the patients were heterogeneous, but this reflects the population commonly in question for DRUJ arthroplasty.

Strengths of this study include length of follow-up and that only 1 patient was lost to follow-up in this consecutive series of arthroplasties. The independent clinical and radiological assessment, including preoperative evaluation for some clinical parameters, is also beneficial.

Our study has several other limitations, mainly related to difficulties to study a larger number of patients. Most of our cases were revisions; hence, the 5 primary cases are too small to evaluate the efficacy of the Herbert prosthesis as a primary procedure. However, according to previous studies, implant arthroplasty seems to be superior to resection arthroplasty.[27,29] Based on the limited data available, we think that, in cases with sufficient soft tissues and a well-defined sigmoid notch, a UHP of the design used by us could be considered as a first option for the treatment of failed DRUJ resection arthroplasties.

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