Constrained Implant Arthroplasty as a Secondary Procedure at the Distal Radioulnar Joint: Early Outcomes

Peter Axelsson, MD, Christer Sollerman, PhD

Purpose To evaluate the clinical and radiological outcomes for the Scheker total joint endoprosthesis when used for previously failed surgeries of the distal radioulnar joint (DRUJ).

Methods Eight patients with DRUJ derangement with painful instability and 1 patient with DRUJ synostosis received a Scheker DRUJ total joint endoprosthesis between 2006 and 2010. All patients had at least 1 procedure previously performed on the distal ulna (mean, 3.6 procedures). The follow-up time was on average 3.7 years (range, 2–5 y). Standardized preoperative and postoperative assessments included radiographic examination, evaluation of pain by a visual analog scale, and measurements of range of motion and grip strength. We evaluated patient-perceived function with the Disabilities of the Arm, Shoulder, and Hand questionnaire.

Results There was significant improvement in pain and Disabilities of the Arm, Shoulder, and Hand scores. Grip strength was improved but not significantly. Range of motion was not impaired. We encountered no major complications. Radiographic evaluation showed bone resorption at the distal ulna for most patients and at the tip of a screw in 1 patient, but we found no evidence of implant loosening.

Conclusions Our short-term results in a limited patient series show that in selected cases, the Scheker total joint endoprosthesis is a safe and efficient treatment option for previously failed surgeries of the DRUJ. *(J Hand Surg 2013;38A:1111–1118. Copyright © 2013 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, instability, ulnar head arthroplasty, wrist replacement.

Pain and instability of the distal radioulnar joint (DRUJ) with weakness and restricted pronosupination are common entities, not only posttraumatically after distal radius fractures and triangular fibrocartilage complex tears,[1] but also in joint diseases such as rheumatoid arthritis and osteoarthritis.[2] Because the DRUJ is important for wrist and hand function, injuries to the ulnar head, sigmoid notch, and surrounding ligaments can result in marked disability.[3] Many different procedures have been advocated to treat a painful and unstable DRUJ, such as total ulnar head resection (Darrach procedure),[4] partial ulnar head resection,[5,6] and arthrodesis of the DRUJ combined with an ulnar shaft resection (Sauvé-Kapandji procedure).[7]

From the Department of Hand Surgery, Sahlgrenska University Hospital, Göteborg, Sweden.

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Corresponding author: Peter Axelsson, MD, Department of Hand Surgery, Sahlgrenska University Hospital, Blå Stråket 3, SE-413 45 Göteborg, Sweden; e-mail: peter.axelsson@vgregion.se.

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TABLE 1. Demographics and Characteristics of Study Population

Patient	Follow-Up (mo)*	Sex	Age (y)†	Indication for Arthroplasty	Previous Surgeries‡	First Surgery
1	62	F	45	DRUJ synostosis	1	External fixation of forearm fracture
2	62	F	38	Failed Darrach procedure	1	Open reduction internal fixation of forearm fracture, primary ulnar head excision
3	62	F	39	Failed Sauvé-Kapandji	7	Re-insertion of TFCC
4	61	M	33	Longitudinal instability	1	Primary ulnar and radial head excision
5	60	M	42	Failed Bowers procedure	6	Excision of ganglion at DRUJ
6	24	F	61	Instability and arthritis	1	DRUJ arthroscopy, synovectomy
7	24	F	49	Failed Darrach procedure	6	Primary ulnar head excision
8	26	M	44	Instability and posttraumatic osteoarthritis	2	Re-insertion of TFCC
9	24	F	71	Failed Sauvé-Kapandji	7	Re-insertion of TFCC

TFCC, triangular fibrocartilage complex.
*Time between Scheker arthroplasty and latest follow-up visit.
†Age at the time of joint replacement.
‡Number of surgeries performed at the DRUJ before the Scheker arthroplasty.

Residual pain and instability may warrant further surgical procedures, including soft tissue stabilization of the distal ulna.[8–10] Replacement of the ulnar head with a silicone prosthesis was advocated in 1973 by Swanson[11] and further developed to include the use of metal implants by Van Schoonhoven et al.[12] Implant arthroplasty has mainly been used as a secondary procedure when other methods have failed.[13,14] One obvious drawback with this technique is that the implant stability depends on the soft tissues, which may be of poor quality. Ulnar head replacement is by definition a hemiarthroplasty in which the joint surface of the sigmoid fossa is left intact. Pain might be caused by cartilage destruction of this joint surface, and incongruency may cause instability. In such cases, a total joint arthroplasty that replaces both the ulnar head and the sigmoid fossa might prove helpful.

There are reports of 2 constrained total joint arthroplasties developed specifically for the DRUJ.[15,16] One of these, the Scheker total DRUJ endoprosthesis (Aptis, Louisville, KY), is commercially available. To evaluate the outcome and safety of this implant, we studied a series of patients with previously failed surgery at the distal ulna. We report our results for 9 patients with a minimum follow-up of 2 years.

MATERIALS AND METHODS

Patient series

We carried out 5 Scheker total DRUJ arthroplasties in 5 patients between March 2006 and May 2007. After an observation period of 3 years, we treated another 4 patients during 2010. This series of 9 patients was the total number of salvage procedures performed with the Scheker prosthesis at our department during this period. Six patients were women and 3 were men, with a median age of 44 years (range, 33–71 y). Table 1 lists demographics and characteristics of the study population. The rationale for using the Scheker implant was pain and gross instability in addition to DRUJ derangement in 8 patients and posttraumatic DRUJ synostosis in 1 patient. All patients had undergone at least 1 previous surgical treatment of the DRUJ area (mean, 3.6; range, 1–7). The first author (P.A.) performed all procedures in this series. We obtained institutional review board approval to study this patient cohort.

Implant design

The Scheker DRUJ prosthesis is a modular implant. The ulnar component consists of a titanium plasma-sprayed stem that is press-fit into the ulnar medullar cavity. The distal end of the stem is a highly polished peg that fits inside an ultrahigh molecular weight polyethylene ball. The radial component is made of a cobalt chromium alloy and is fixed by a peg and screws to the ulnar side of the distal radius. The distal end of the radial plate consists of a hemi-socket. A cover with a corresponding hemi-socket is fitted intraoperatively to secure the polyethylene ball inside the radial component (Figs. 1, 2). Because the peg on the ulnar stem is locked inside the central tunnel of the ball, which is

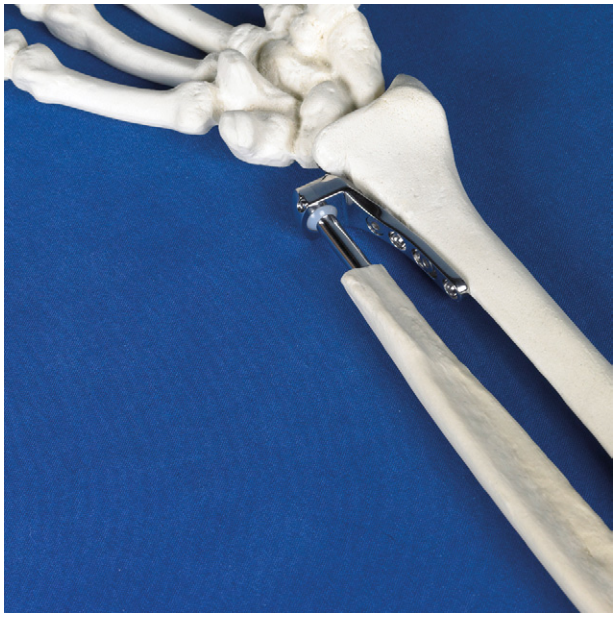

FIGURE 1: Implant on bone model, assembled.

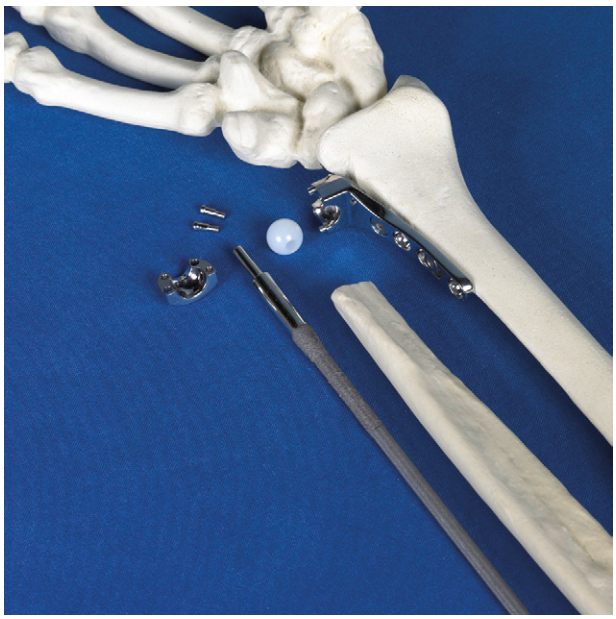

FIGURE 2: Implant on bone model, disassembled.

locked by the cover of the radial component, a linkage is created between the distal radius and ulna. This constrained construct allows for rotation, axial translation, and physiological angulation in the DRUJ.

Surgical technique

We used x-ray templates for preoperative planning. A longitudinal skin incision was made dorsally over the distal part of ulna. The extensor retinaculum was partially opened through the fourth compartment. We created an ulnarly based rectangular flap by sectioning of septae. The joint was exposed by continuing the dissection between the extensor digiti minimi and the extensor carpi ulnaris tendons. The ulna and the interosseous membrane were exposed by elevating the extensor digiti minimi and the extensor carpi ulnaris muscles for a distance of about 10 cm. If present, we removed the ulnar head by osteotomy through the ulnar neck and by sharp dissection to release it from its soft tissue attachments. By dividing the interosseous membrane along the radius for at least 8 cm, the ulna could be retracted in a volar direction. The trial plate was then carefully aligned with the ulnar border of the radius. The distal part of the radius often required contouring with a saw blade or a burr, which is particularly important for the volar lip of the sigmoid notch, because it might cause the implant to displace dorsally. At this point, we also ensured that there was a gap of at least 3 mm between the distal part of the implant and the distal margin of the sigmoid notch, to avoid impingement with the carpus. After drilling the hole for the radial peg, we removed the trial plate and replaced it with the definitive radial component, which we secured with screws. With the forearm in full pronation, we used the measuring device for the ulnar stem to determine the final level of ulna resection. We then drilled the ulna's medullary canal and broached it to the size of the ulna stem defined by the preoperative templating. The stem was introduced, and the polyethylene ball was placed over the distal peg before it was secured to the radial component by the cover. We assessed forearm motion and reattached the retinacular flap under the extensor carpi ulnaris to cover the prosthesis. Figures 3 through 5 show the radiographic appearance of the Scheker arthroplasty.

Postoperatively, we treated the patient with the synostosis with indomethacin for 6 weeks. She also started immediate mobilization supervised by a physiotherapist. All other patients were immobilized in a dorsal wrist splint for 10 to 14 days and mobilized without help of a physiotherapist. After 2 weeks, the patients gradually increased loading and active motion exercises. Six weeks after surgery, normal functional activity was permitted. There were no restrictions regarding use or loading of the prosthesis beginning 3 months after surgery.

Follow-up

To all patients we administered a standardized preoperative and postoperative *pro forma* including the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire and performed radiographic and clinical examinations. Preoperative tests included the DRUJ compression test[17] and the distal ulna ballottement

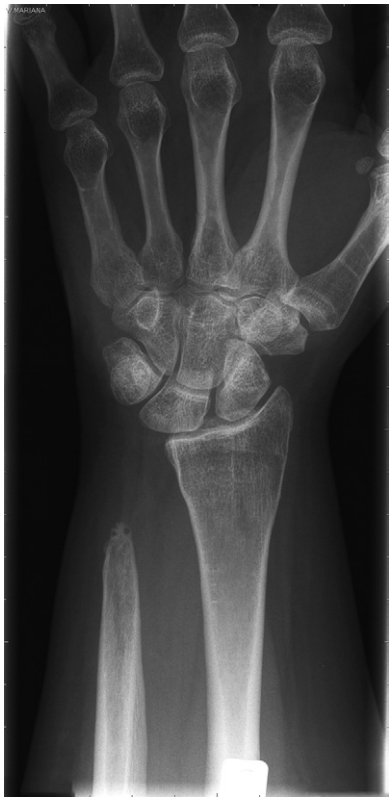

FIGURE 3: Radiographic appearance before arthroplasty, patient 2.

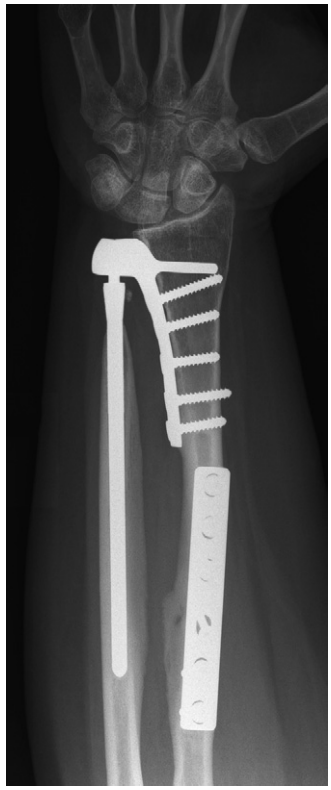

FIGURE 4: Radiographic appearance after arthroplasty, patient 2.

test.[18] Regular follow-ups were scheduled at 2 and 6 weeks, at 3 and 6 months, and then at 12-month intervals. No patient was lost to follow-up. We collected data for this report from re-examinations performed on average 45 months (range, 24–62 mo) postoperatively.

We measured active wrist and forearm motions according to the American Medical Association guidelines of permanent functional impairment.[19] We measured grip strength using a dynamometer (Jamar dynamometer; Sammons Preston, Inc, Bolingbrook, IL). Pain was evaluated on a 10-cm visual analog scale (VAS) and functional outcomes were evaluated using the Swedish version of the DASH questionnaire.[20,21] For radiographic evaluation after surgery, we assessed the position of the prosthesis, radiolucent zones, and bone resorption or reaction.

For statistical analysis, we used a nonparametric method, the Wilcoxon signed-rank test, to assess the difference between preoperative and postoperative outcomes. The tests were 2-sided, and $P < .05$ was considered significant.

RESULTS

Figure 6 shows differences between the preoperative and postoperative values after 1 year for pain, DASH scores, and grip strength. Table 2 lists preoperative and

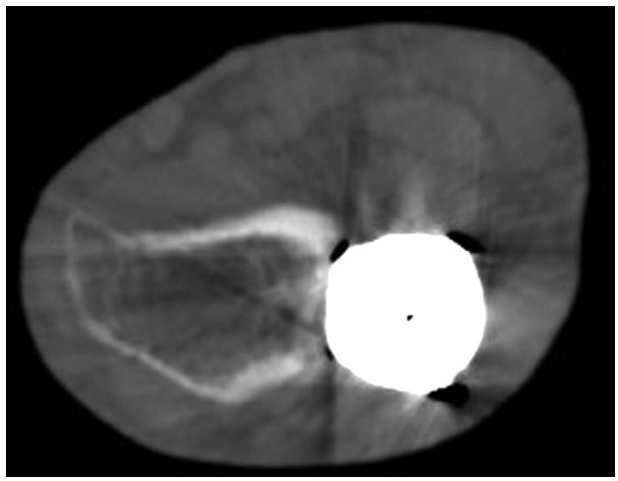

FIGURE 5: Computed tomographic image: axial view of implant at the distal part of radius, patient 9.

latest follow-up measurements. At the latest follow-up, all patients reported notable improvement in pain. Median DASH also improved significantly. Median values for grip strength increased but not significantly. Forearm rotation was only slightly affected by the operation, except for the patient with DRUJ synostosis, who experienced an improvement of 150° (patient 1 in Table 2). When this patient is ex-

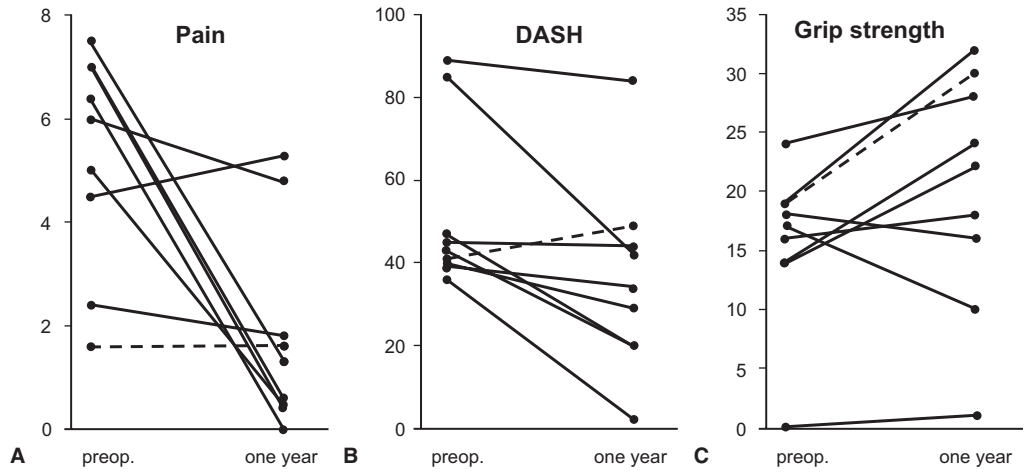

FIGURE 6: Change between preoperative and 1-year follow-up values. Dotted lines represent patient 5, whose preoperative values are compared with the 3-year values because he missed the 12- and 24-month follow-up evaluations. **A** Pain (cm), **B** DASH (score), and **C** grip strength (kg).

TABLE 2. Clinical Data and Health Scores Before Arthroplasty and at Latest Follow-Up Evaluation

	Range of Motion (°)				
Patient	Supination	Pronation	Grip Strength (kg)	Pain VAS (cm)	DASH (Points)
1	0/80 (90)	0/70 (85)	19/24 (30)	7.0/0.3	43/8
2	90/85 (90)	50/70 (80)	14/18 (20)	6.4/0.0	36/7
3	80/80 (85)	60/60 (70)	14/21 (29)	7.5/0.3	85/28
4	45/40 (90)	55/70 (70)	17/32 (62)	2.4/0.4	45/37
5	70/60 (70)	60/55 (55)	24/54 (74)	1.7/0.8	42/25
6	80/90 (90)	80/80 (75)	18/10 (26)	4.5/0.3	39/48
7	80/80 (85)	55/75 (90)	0/0 (4)	6.0/5.2	89/92
8	75/85 (90)	65/50 (75)	19/30 (50)	5.0/0.0	40/26
9	90/85 (85)	70/70 (70)	16/16 (22)	7.0/0.1	47/16
Median	80/80 (90)	60/70 (75)	17/21 (29)	6.0/0.3	43/26
P value	.17	.14	.09	.01	.03

Range of motion and grip strength values shown are preoperatively and at latest follow-up evaluation; data within parentheses show nontreated side values. For the pain level on the 10-cm VAS scale and the Disabilities of the Arm, Shoulder, and Hand score, values shown are preoperative and at latest follow-up evaluation.

cluded, there was a 10° increase in median values for pronosupination. There were 4 minor postoperative adverse events. One patient experienced transient carpal tunnel syndrome postoperatively, and 1 patient required surgery for De Quervain disease a year after the arthroplasty. Two patients reported lateral elbow pain, which responded well to conservative treatment. The radiographic evaluation showed bone resorption of the distal ulna from around the implant stem of more than 2 mm in 6 patients (median, 2.5 mm; range, 0–8 mm) (Figs. 7, 8). One patient developed bone resorption around a screw tip of the radial component (Fig. 9). There were no signs of loosening.

DISCUSSION

Procedures to treat an unstable and deranged DRUJ after previous surgeries vary from a variety of soft tissue procedures[8–10,22] to options of last resort, such as wide resection of ulna,[23] radioulnar arthrodesis,[24] and creation of a 1-bone forearm.[25] Limitations with these techniques include demanding surgical technique, in-

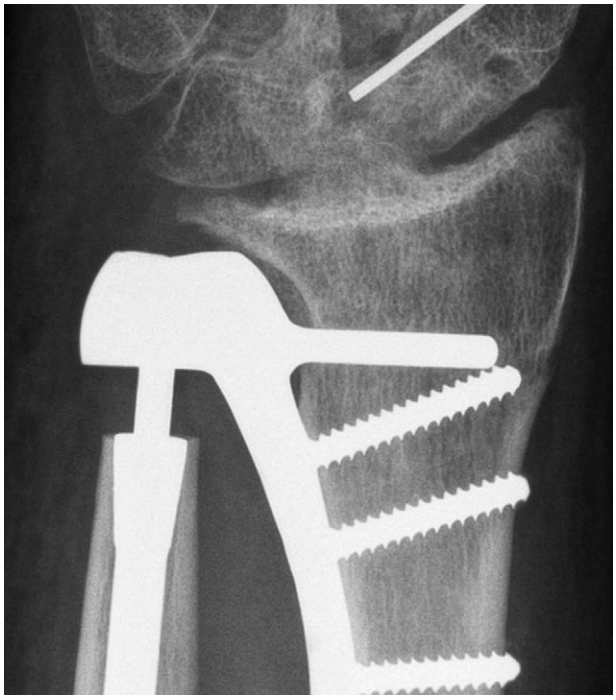

FIGURE 7: Distal part of the ulna, 6 weeks after surgery, patient 4.

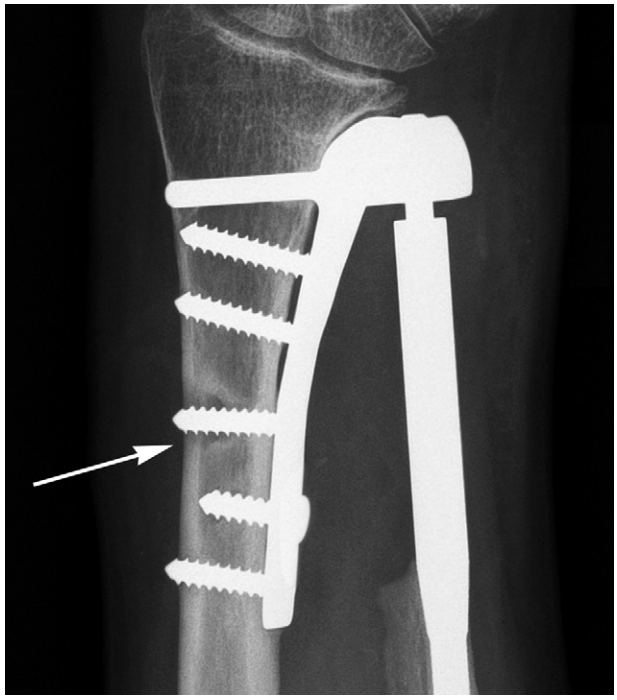

FIGURE 9: Bone resorption at tip of screw 2 years after surgery, patient 9. Arrow points to radiolucent area.

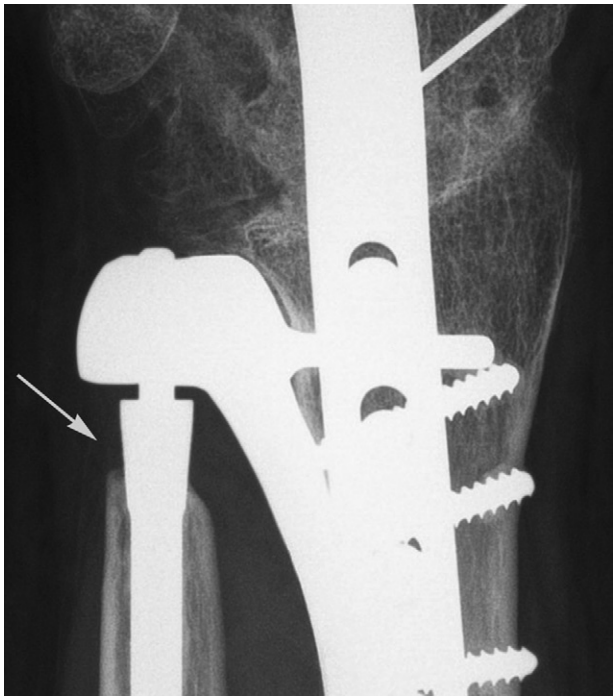

FIGURE 8: Patient 4, 8-mm bone resorption at the distal part of ulna, 5 years postsurgery. Arrow points to area of resorption.

consistent results, and the lack of revision possibilities.[26,27] Ulnar head replacement has shown good short-term and long-term results,[13,14,28] but reports on these implants focus on the importance of restoring stability by repair or recreation of soft tissues around the implant. In the case of severely compromised soft tissues, for example, owing to multiple previous surgeries, ulnar head arthroplasty is less likely to be successful. The benefit of a constrained total joint prosthesis in these situations is the autonomy of the quality of soft tissue constraints and the condition of the sigmoid notch and the distal part of the ulna.

This study demonstrates that most patients experienced a statistically significant and clinically relevant reduction of pain after total joint arthroplasty. Such results of joint replacement for secondary conditions at the DRUJ are supported by earlier reports.[14,28–30] There was also a significant change in functional outcome, in which DASH scores improved from 43 to 26. Schuurman and Teunis[16] reported both preoperative and postoperative DASH with regard to implant arthroplasty and observed a 20% improvement, which did not reach statistical significance. Several authors have reported improvement in grip strength after different ulnar head implant arthroplasties.[14,28,29] In our study, we found a trend for increased grip strength with a median value increase of about 25%, but this was not statistically significant. Previous reports on DRUJ implant arthroplasties[14,28,29] have shown moderate increases in forearm arc of motion. Similar to these results, we found small or no changes in any axis of motion except

for patient 1. This is not surprising because instability and not stiffness was the problem for all but 1 patient in our group.

In our study, 2 patients had inferior results. Patient 6 experienced worse pain at the 1-year follow-up despite an initial improvement after the arthroplasty. The radiographs then revealed midcarpal arthritis, which we treated by a 4-corner arthrodesis. At her latest visit, 2 years after DRUJ arthroplasty, her pain score was 0.3, compared with a preoperative score of 4.5. Even though the pain decreased, her function was impaired according to the DASH score, probably because of decreased grip strength and severe radiocarpal stiffness. She developed symptoms in other joints and is being evaluated by a rheumatologist. The second patient with an inferior outcome was patient 7, who has a chronic pain syndrome. Comparable to what Zimmerman and Jupiter[30] reported about a similar case in their series, our patient experienced minor or no improvement for all parameters. This illustrates the importance of patient selection, as in all major surgical procedures.

We encountered no major complications. Laurentin-Perez et al[29] reported 1 deep infection that was treated by revision. Zimmerman and Jupiter[30] had to reoperate on 1 patient because of tendon irritation at the distal radius caused by a protruding screw tip. Because of radial-sided wrist pain, we performed a release of the first dorsal tendon compartment on 1 patient at 1 year after surgery. Radiographs and perioperative findings established no relationship to the implant. In our study, as in previous reports about the Scheker total DRUJ prosthesis,[29–31] we found no evidence of loosening. However, we noticed resorption at the distal part of ulna on the radiographs in most patients. These findings developed during the first year and have previously been described as remodeling resulting from stress shielding.[14,28,32] Radiographs of 1 patient demonstrated a slowly progressive radiolucency around a tip of a radial plate screw. This reaction was obvious on the 2-year radiographs, but in retrospect, it could also be seen on the 1-year films. The patient is free of symptoms, and blood tests are normal including leukocyte scintigraphy. The cause of the resorption is unclear, and monitoring continues.

Contraindications to this procedure are active infection, less than 11 cm remaining of the proximal ulna, and severe osteoporosis. A total wrist implant obstructs the use of Scheker implant, and a severely malaligned distal radius or a deformed ulna might be other hindrances.

Our report has several limitations. We present early results from a small, heterogeneous patient series without controls. There may be recording and performance biases, because the first author performed the surgeries as well as conducted the follow-up visits and measurements. Strengths of the study are that it was a consecutive series of patients with prospectively collected data and no loss to follow-up.

We find our clinical results encouraging, especially with regard to the complexity of the patients' conditions. The lack of signs of early loosening or failure of the implant is satisfying, because constrained implants in other joints historically have been associated with high complication rates, because constraint increases stress transfer through the implant and implant–bone interface.[33,34] This is still a concern, and until long-term results are available, we recommend that the Scheker implant be used mainly as a salvage of salvage procedures.

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