Outcomes of a self-constrained distal radioulnar joint arthroplasty: a case series of six patients

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Introduction

Resection arthroplasty of the distal radioulnar joint (DRUJ), such as the Darrach procedure, is a common treatment for pathology that proves refractory to more conservative measures. Although outcomes are often favorable, complications include pain, instability, ulnar translation of the carpus, and abutment of the ulnar stump on the radius [7, 13]. Darrach procedures yield inferior outcomes in patients with high functional demands [7, 26] and numerous soft-tissue stabilization procedures have been developed to control an unstable residual ulnar stump [3, 4, 12]. Unfortunately, the failed distal ulnar resection has proved quite problematic, with persistently poor outcomes despite multiple stabilization procedures [2].

DRUJ implant arthroplasty offers a possible solution. Distal ulnar hemiarthroplasties exist [5, 10], as do total ulnar head replacements [8, 14, 20, 25], but their stability requires some contribution from native soft tissues, which are often deficient, especially in salvage situations [22]. More recently, total DRUJ replacements have been developed [11, 19, 23]. One particular implant is the bipolar,

self-constrained Aptis Total DRUJ Replacement Prosthesis (Aptis Medical, Louisville, KY) [21, 22]. This report describes our experience with this new implant.

Materials and Methods

Under an IRB-approved protocol, all patients undergoing Aptis Total DRUJ Replacement Prosthesis (Aptis Medical, Louisville, KY) implantation from 2007 to 2009 by a senior hand surgeon at a tertiary care center associated with an academic teaching institution were included in this study. This implant is bipolar and self-constrained, consisting of an intramedullary ulnar stem and UHMW polyethylene ball that fits into a socket on a radial side plate (Fig. 1) [22]. Please refer to the article by Scheker (2008) for details regarding surgical technique [21].

Clinical data and radiographic studies were reviewed. A total of six patients, age 44.4 ± 2.6 years (range (R) 42–49 years) at surgery, received the implant and all were included, with follow-up of 2.4 ± 0.7 years (one lost to follow-up after 1.3 years, the remainder with 2-year follow-up). Clinical measurements included range-of-motion and grip and pinch strength measurements. Routine clinical examination maneuvers for DRUJ stability were also performed by the senior author. Longitudinal radiographs were inspected for any signs of component loosening and clinical signs of implant instability were also assessed.

Subjective outcomes were assessed using a novel ten-item questionnaire developed for this study. Our clinical experience with complex upper extremity pathology has been that standardized questionnaires, such as the Disabilities of the Arm, Shoulder and Hand (DASH), may reflect global upper extremity complaints and thus not necessarily reflect changes specific to the wrist. For that

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Fig. 1 Image demonstrating the components of the Aptis Total DRUJ Replacement Prosthesis (Aptis Medical, Louisville, KY). This implant is self-constrained with an intramedullary ulnar stem and ultra-high molecular weight polyethylene ball replacing the ulnar head. The ball is affixed to the ulnar aspect of the radius at the previous site of the sigmoid notch using a radial side plate, secured by several screws

reason, we developed a new instrument, attempting to emphasize pre- to postoperative changes and focus on the DRUJ anatomically. The questionnaire consisted of three items assessing current status, six items assessing pre- to postoperative changes, including global numeric scores, and then directly asking the patients if they were aware of their current clinical status during preoperative decision making, whether they would still elect to under DRUJ implant arthroplasty. The first eight questions offered five possible responses and were scored 1–5 with greater numerical values reflecting more positive replies (Fig. 2). Questionnaires were completed by 5/6 patients (the patient lost to follow-up after 1.3 years could not be contacted).

DRUJ pathology was traumatic in five of six patients (one crush injury, three work related) and one patient's disease was primarily a non-inflammatory osteoarthritis. The average duration from symptom onset to DRUJ replacement was 9.0 ± 3.5 years (R 5–14 years). Right and left, dominant and non-dominant hands were affected equally. All patients had prior distal ulnar resection, as well as a total of 5.0 ± 5.5 prior wrist surgeries (R 2–16), including one transmetacarpal wrist fusion and one prior ulnar head hemiarthroplasty. Full surgical records were not available for one patient, thus not all prior procedures are known. All patients presented with DRUJ pain, instability or clicking and three also reported neurologic symptoms (Table 1).

Results

Final postoperative range-of-motion was excellent, with $80.0 \pm 8.9^\circ$ supination (R 60–90°) and $86.7 \pm 5.2^\circ$ pronation (R 80–90°). Grip strength was 48.6 ± 35.8 lb and 82.2 ± 31.5 lb on the operative and nonoperative sides, respectively, at final follow-up, representing 59% of contralateral grip strength in the operative wrist. Pinch strength was even

better preserved, with 72% of contralateral strength in the operative wrist (13 ± 3.6 lb and 21.0 ± 8.2 lb for the operative and nonoperative sides, respectively) (Table 2).

Two patients continued to report wrist pain at final follow-up, one with unrelated radial sensory nerve symptoms and one with stable wrist pain secondary to a chronic pain syndrome. There were no complaints of DRUJ instability or clicking by any patient following surgery, nor was clinical examination concerning for persistent instability in any patient. There was one complication: downsizing of a cortical screw used to affix the barrel to the radial shaft was required due to tendon irritation from the protruding tip. Postoperative films did not reveal radiographic evidence of loosening in any patient, nor did any report complaints consistent with implant loosening (Fig. 3).

Using the questionnaires, patients reported generally mild to moderate disability at final follow-up. Specifically, one patient reported her wrist to be somewhat unstable, one reported mild instability, and three denied any instability. Two patients felt very limited in lifting everyday objects (e.g., light groceries, purse, paperback book), one totally limited and one patient each reporting being mildly or not limited at all. Motion was felt to be very limiting by one patient, somewhat limiting by two patients, and not at all limiting by two patients. Notably, for each of these questions, the patient with an unrelated chronic pain syndrome reported the lowest subjective outcomes.

When asked to make pre- to postoperative comparisons, patients generally reported being either “slightly better” or “much better”. Specifically, 4/5 patients reported improvements overall, as well as specific improvements in strength and motion. Two patients reported unchanged pain, while the remainder reported their pain to be “much better”. Again, the patient with a chronic pain syndrome reported the least positive scores overall and also reported the least improvement postoperatively (Table 3). When asked to

Fig. 2 Subjective questionnaire used in this study. Items 1–8 were scored 1–5 with greater numbers reflecting more positive responses

The first 3 questions refer to the way your wrist is right now:

1. In a typical day, how unstable does your wrist feel?

Totally	Very	Somewhat	Mildly	Not at all

2. In a typical day, how much does your wrist limit your ability to lift everyday objects (i.e. light groceries, purse, paperback book)?

Totally	Very	Somewhat	Mildly	Not at all

3. In a typical day, how limited are you by your forearm rotation/stiffness?

Totally	Very	Somewhat	Mildly	Not at all

The next 6 questions refer to the change in your wrist comparing before and after you got the implant:

4. Since getting the implant, how would you describe the overall change in your wrist?

Much Worse	Slightly Worse	No Change	Slightly Better	Much Better

5. Since getting the implant, how limited do you feel by your wrist?

Much Worse	Slightly Worse	No Change	Slightly Better	Much Better

6. Since getting the implant, how would you describe the overall change in your wrist strength?

Much Worse	Slightly Worse	No Change	Slightly Better	Much Better

7. Since getting the implant, how would you describe the overall change in your forearm rotation/stiffness?

Much Worse	Slightly Worse	No Change	Slightly Better	Much Better

8. Since getting the implant, how would you describe the overall change in pain coming from your wrist (not elsewhere in your arm, shoulder or hand)?

Much Worse	Slightly Worse	No Change	Slightly Better	Much Better

9. On a scale from 0–100 (with 0 being totally dysfunctional and 100 being perfect), what number would you give your wrist before getting the implant? What number would you give it now?

Before Surgery (0–100):	After Surgery (0–100):

10. If you knew ahead of time what your arm would be like at this point after surgery, would you get the implant again?

No	Yes

score their wrists pre- and postoperatively from 0 to 100, the average preoperative score was 33 ± 12 and the average postoperative score was 73 ± 12 (Fig. 4). The average change was 40 (R 15–55). Four out of five patients would again elect to undergo total DRUJ implant arthroplasty; only the patient with a chronic pain syndrome would not.

Discussion

Management of a failed distal ulnar resection arthroplasty remains a challenging problem in hand surgery, often

refractory to multiple interventions [2]. Numerous soft tissue procedures attempt to control the distal ulnar stump [3, 4, 12] and salvage techniques include vascularized fibular autograft [15–17, 27], wide excision of the distal ulna [27], and radioulnar synostosis. Fibular autograft is certainly the most elaborate management technique and may not be suitable for all patients. Wolfe et al. (1998) [28] reported satisfactory outcomes in 10/12 patients undergoing wide (25–50%) distal ulna excision and recent biomechanical analysis of interosseous membrane dynamics during progressive ulnar shortening has offered mechanical evidence to explain these outcomes [6, 27]. Interestingly,

Table 1 Patient cohort characteristics

Patient characteristics	
Age (years)	44.4±2.6
Male	50%
Dominant hand	50%
Work related	50%
Time from symptom onset to DRUJ replacement (years)	9.0±3.5
Prior wrist or DRUJ procedures	
Total per patient	5.0±5.5
Range	2–16
Specific procedures ^a	
Darrach	4
Sauve-Kapandji	4
Ulnar hemiresection	1
Resection arthroplasty with tendon interposition	4
Ulnar stump tenodesis	3
Transmetacarpal wrist fusion	1
Distal ulnar hemiarthroplasty	1

^a Complete surgical records were unavailable for one patient; only the known procedures were included in tabulations

although recent work has demonstrated the load-bearing function of the DRUJ and its importance in load transmission to the forearm [24], Wolfe et al. nonetheless reported reasonably well-preserved strength in their series [27]. Radioulnar synostosis, or creation of a one-bone forearm (OBF), represents the ultimate salvage procedure. First described by Hey-Groves, this procedure eliminates forearm rotation but strives to provide a stable, painless forearm [9]. In a case series of seven patients who underwent posttraumatic radioulnar synostosis, Allende et al. (2004) reported uniformly successful achievement of a stable and pain-free forearm with 58–109% grip strength of the contralateral side [1]. Another series by Peterson et al. (1995), including patients with both traumatic and non-traumatic etiologies of radioulnar instability, documented more varied results and found that previous trauma, infection, severe nerve injury, and multiple prior procedures were associated with poorer outcomes [18]. Notably, all of the patients in our series had at least one of these risk

factors for poor outcome with radioulnar synostosis, and the utility of an OBF as a salvage technique must be questioned if multiple prior procedures are a risk factor for poor outcomes.

The Aptis DRUJ prosthesis is notable in that it is self-constrained, replacing both bony and soft-tissue components of the DRUJ. Prior implants typically required reparable native soft tissues for stability, which are often incompetent, especially in salvage situations and in the multiply operated wrist, a requirement obviated by the self-constrained design [11, 21, 27]. Prior reports describe positive outcomes with this device. Laurentin-Perez et al. (2008) and Scheker (2008) reported postoperative grip strength of 52 and 44 lb, supination of 70° and 72°, and pronation of 74° and 79°, respectively [11, 21]. These values are roughly consistent with the data from our series (grip 48 lb, supination 80°, and pronation 87°). Scheker (2008) also reported a reduction in pain (scored 0–5) from 3.8 to 1.3 postoperatively in his group of 49 patients with 2-year follow-up; our patients reported mildly to much improved pain [21]. Earlier DRUJ arthroplasties have been troubled by loosening [23], although there was no clinical or radiographic evidence of loosening in our series. We also observed no new instances of chronic regional pain syndrome (the one patient in our series with a chronic pain syndrome had been diagnosed preoperatively) and no instances of infection.

Schuurman et al. (2010) used both DASH and visual analog score (VAS) data to assess patient outcomes in a different DRUJ prosthesis. Changes in DASH improved from 39 to 31 postoperatively (relatively modest in terms of clinical significance), but this change did not achieve statistical significance. VAS scores in their series did demonstrate statistically significant improvement [23]. We elected to create a new questionnaire for this study due to our clinical experience that instruments such as the DASH, which correspond to multiple anatomic domains, may reflect ongoing generalized upper extremity complaints, not all of which are necessarily related to DRUJ pathology. Indeed, our series of patients generally reported being either slightly or much improved postoperatively, despite continuing disability. This simultaneous improvement in the context of ongoing disability may have prevented earlier DASH data from showing a statistically significant change. One of the more interesting results was comparing the pre- and postoperative subjective wrist scores (item 9 on the questionnaire, Fig. 4). No specific scoring criteria or guidance was offered, yet every patient, including the one with a chronic pain syndrome who had previously responded quite negatively, reported marked improvements. Four out of five patients would still elect to undergo surgery, were their current status known to them preoperatively.

Table 2 Clinical measurements at final follow-up (average±SD)

Clinical measurements		
Parameter	Operative side	Nonoperative side
Grip strength (lb)	48.6±35.8	82.2±31.5
Pinch strength (lb)	13±3.6	21.0±8.2
Supination (°)	80.0±8.9	
Pronation(°)	86.7±5.2	

Fig. 3 Preoperative (a), 6 months (b), and 24 months (c) AP radiographs of a 48-year-old woman who underwent DRUJ reconstruction with the Scheker prosthesis. She had prior Darrach resection and ECU tenodesis of the ulnar stump with persistent pain and clicking during rotation. Postoperative pronation and supination were full

Table 3 Questionnaire results

	Average score (range)	Correlation
Current status		
Instability	4.4 (3–5)	Mildly to not at all limited
Lifting	2.8 (1–5)	Very to somewhat limited
Rotation/stiffness	3.6 (2–5)	Somewhat to mildly limited
Pre- to postoperative change		
Overall change	4.2 (3–5)	Slightly to much better
Limitation due to wrist	4.2 (2–5)	Slightly to much better
Strength	4 (2–5)	Slightly better
Motion	4 (3–5)	Slightly better
Pain	4.6 (3–5)	Slightly to much better

Responses were scored 1–5, with ascending values representing progressively more positive results. The average score and range are presented, as well as the corresponding response(s) for each questionnaire item

Fig. 4 Pre- and postoperative subjective global wrist scores, corresponding to item 9 on the questionnaire. Each score is presented as the average $\pm$ standard deviation

There are several limitations of this study. Most notably, our sample size is modest and the study is retrospective. However, much of the work involving this prosthesis has involved similar investigators, so we felt it important to report the early results of another senior surgeon. Our cohort is also quite heterogeneous. Given the complex nature of the wrist pathology that typically requires a DRUJ salvage procedure, such variability is almost to be expected. Satisfactory outcomes and a low complication rate which can be obtained across a heterogeneous group may offer support for this device as a safe salvage alternative. The questionnaire used is not validated and pre- to postoperative changes which were assessed retrospectively are potential sources of bias but also opportunities for future research. Further research is necessary to determine long-term outcomes, as well as the indications for this implant, such as whether it might be appropriate in the acute setting of complex wrist trauma involving the DRUJ. Our series offers evidence that the Aptis Total DRUJ Replacement Prosthesis can be a safe implant with satisfactory outcomes and an acceptable complication rate for treating complex DRUJ pathology.

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