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Original article

Short- to mid-term results of ulna head replacement as both a primary and revision implant

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ABSTRACT

We present the results of short- to medium-term follow-up of 10 patients following ulna head replacement. The mean age of patients was 63.2 years (range 48–81 years), with the mean duration of follow-up being 48 months (12–88 months). The indications for the procedure were primary osteoarthritis ($n = 3$), post-traumatic osteoarthritis ($n = 4$), failed Darrach's procedure ($n = 2$) and rheumatoid arthritis ($n = 1$). Two patients required revision (20%), one for gross aseptic loosening of the stem and another for an initially oversized head. At final follow-up, the satisfactory rate was 90%. The mean VAS score was 2.4 (range 0–8). The average DASH score was 37 (range 0–72.5). Our study suggests that ulna head replacement can give satisfactory forearm function; however, concerns exist regarding bone resorption and tapering around the prosthesis, which may affect the long-term performance of the prosthesis.

Level of evidence: IV.

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1. Introduction

The distal radio-ulnar joint (DRUJ) has an important role in forearm stability and force transmission from the forearm to the wrist.^{1,2} The radius rotates about the fixed ulna at the wrist, articulating through the DRUJ.³ Stability is maintained by both bony architecture and soft tissue. Arthritis of the DRUJ can lead to pain and decreased pronosupination with a resultant loss of significant function.⁴

Surgical options for the management of DRUJ arthritis include excision of the distal ulnar (Darrach's procedure),⁵

fusion of the DRUJ and excision of a segment of ulna by Sauvé-Kapandji procedure⁶ and hemi-resection of the ulnar head.⁷ These procedures do not restore normal joint anatomy or kinematics. They have their own complications, such as distal ulnar stump instability with the Sauvé-Kapandji procedure, and radio-ulnar convergence and pain with distal ulnar excision.^{8–11} To overcome secondary painful instability, several soft tissue stabilising procedures using part of the flexor and/or extensor carpi ulnaris tendon have been described. None of these have been able to restore stability and reduce symptoms reliably in clinical studies.^{12–14} However, ulnar head arthroplasty has been shown to restore the normal axis of forearm

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Table 1 – Table summarising outcome at final follow-up.

Age	Indications	FU/m	VAS	DASH	Fl	Ext	U	R	P	S	Complications	Satisfaction	Resorp/mm	Tapering
61	Failed Darrach's ^a	43	2	42.5	70	90	20	10	90	70	Revised for osteolysis/loosening at 5 m	Much better	None	None
81	Primary OA ^a	36	8	48.3	60	45	30	20	90	70	Undersized head changed at 20 m	Better	6	Yes
71	Post-traumatic OA	48	0	11.7	55	40	20	20	90	90	Dorsal hand paraesthesia	Much better	5	Yes
68	Post-traumatic OA	56	2	27.5	35	35	20	20	90	45	None	Better	4	Yes
58	Post-traumatic OA	12	6	72.5	60	30	15	10	80	70	Dorsal hand paraesthesia	Worse	12	Yes
46	Post-traumatic OA	44	0	16.7	55	60	20	20	90	90	None	Much Better	2	Yes
48	Failed Darrach's	88	6	71.7	30	30	25	30	60	60	None	Better	2	Yes
76	Primary OA	60	0	0	55	70	45	45	90	45	None	Better	6	Yes
71	Primary OA	64	0	19.8	70	60	40	15	90	90	None	Much better	13	Yes
52	RA	30	0	14.2	0	0	0	0	60	60	None	Much better	9	Yes

FU/m = follow-up in months; VAS = pain as measured with a Visual Analogue Scale; Fl = flexion/°; Ext = extension/°; U = ulnar deviation/°; R = radial deviation/°; P = pronation/°; S = supination/°; resorption/mm = gap between the collar of the prosthesis and bone around the stem in millimetres; tapering = presence of tapering of bone around stem.

^a Length of follow-up and clinical results after revision.

rotation while also resisting tensile and compressive forces across the wrist.⁹

We present a retrospective review of the results of one type of distal ulna replacement from a district general hospital in 10 patients for a range of disorders.

2. Method

This is a review of the outcomes of patients who underwent ulna head end-prosthetic replacement between 2006 and 2012 using the Avanta implant (Small Bone Innovations, Morrisville, PA). This is a modular device with a range of stems and heads. All procedures were performed by the senior author (BDF).

The indications for surgery were pain in the distal radio-ulnar joint associated with radiological degenerative changes that was unresponsive to non-operative treatment (e.g. directed intra-articular injections) with physiotherapy and analgesia or a failed previous surgical procedure to treat DRUJ pathology (i.e. Darrach's). The preoperative diagnosis is shown in Table 1.

Prior to incision, all patients were examined under anaesthetic to assess stability of the DRUJ. A dorso-ulnar incision was made, taking care to protect the dorsal branch of the ulnar nerve. The distal ulna was exposed and the triangular fibrocartilage complex (TFCC) was preserved if it was present. The sigmoid notch was assessed and the surrounding soft tissue envelope was preserved. The amount of bone resected from the ulna was determined by a jig to allow insertion of either a standard or extended prosthesis. The bony canal was reamed. The stem of the prosthesis was impacted into the shaft of the ulna, and a suitably sized ulna head was applied, which was sutured to the TFCC using the distal holes within the implant. The implant was sized so it fitted snugly into the sigmoid notch and was either ulnar neutral or minus. The soft tissue sleeve was reconstructed around the prosthesis and the wound was closed with non-absorbable sutures. The forearm was placed in a heavy bandage for 2 weeks and gentle mobilisation was commenced immediately.

All 10 patients were reviewed clinically and radiologically. This was done by the two authors not involved in the surgery (TB and RP). Complications and re-operations were documented. Range of motion (ROM) (wrist flexion, extension, radial and ulnar deviation, and forearm pronation and supination) was measured using a goniometer. Patient satisfaction was established as “much better”, “better”, “the same” or “worse.”

Specific radiographic variables were noted, including alignment of implant, evidence of loosening, bone tapering around the implant (see Fig. 1), secondary changes of the sigmoid notch and ulnar variance.

3. Results

The mean age of patients was 63.2 years (range 48–81 years), with the mean duration of follow-up being 48 months (range 12–88 months). The indications for the procedure were primary osteoarthritis ($n = 3$), post-traumatic osteoarthritis ($n = 4$), failed Darrach's procedure ($n = 2$) and rheumatoid arthritis ($n = 1$). Of the four patients with post-traumatic osteoarthritis, one had undergone a manipulation and k-wire fixation of a distal radius fracture and another had sustained a distal ulna fracture that required plate fixation. The other two had had non-operative management of a distal radius fracture.

Fig. 1 – Radiograph 3 years after DUR showing complete resorption of cortical bone from the collar of the prosthesis and tapering of the rest of the cortical bone along the length of the stem.

Fig. 2 – Radiograph showing customised HA-coated revision implant following aseptic loosening of primary implant.

Preoperative on-table assessment of the DRUJ revealed no evidence of instability in any of the patients. A summary of each patient's results is shown in [Table 1](#).

Two patients required further surgery. In one patient, the implant had to be exchanged for gross aseptic loosening after 5 months to a customised hydroxylapatite (HA) coated implant (Stanmore Instruments Worldwide, Elstree, UK) ([Fig. 2](#)). The patient recovered well from revision surgery and despite the customised revision implant being slightly long, there was no clinical evidence of ulna impaction syndrome. The other patient needed the head of the implant changed for initial over-sizing (retaining the initial stem). Two patients experienced paraesthesia across the dorsum of their hand. There were no surgical wound infections. The one patient with rheumatoid arthritis was excluded from the results analysis as this patient had previously had a radio-carpal fusion.

The mean VAS score was 2.7 (range 0–8). The average DASH score was 37 (range 0–72.5). Nine patients (90%) felt that their symptoms were either 'better' or 'much better' following this procedure. One patient felt the outcome was worse. The average amount of flexion that our patients could achieve was 54° (30°–70°), extension was 51° (30°–90°), ulnar deviation was 26° (15°–45°), radial deviation was 21° (10°–45°), pronation was 86° (60°–90°) and supination was 70° (45°–90°).

At final follow-up, nine of the patients (all except the patient that underwent revision of stem) demonstrated radiological evidence of resorption of bone from the head of the prosthesis and tapering of the distal ulna ([Fig. 1](#)). The average distance from bone to the implant collar was 6.5 mm (2–13 mm). Five patients also demonstrated secondary changes to the sigmoid notch of the distal radius.

4. Discussion

Over the last decade, there has been an increase in the use of ulna head replacement to treat a variety of pathologies affecting the DRUJ.^{9,10,15–20}

The results obtained from our series suggest that this implant can provide patient satisfaction and symptom control with reasonable overall hand and forearm function when assessed at mid-term follow-up, a finding that is supported by other studies.^{17–20} Obviously our results are specific to the Avanta implant and not necessarily representative of general DUR. Early results for this prosthesis have previously been published and showed encouraging results¹⁶ with a 50%

reduction in pain and a threefold improvement in function. Half the patients in our study experienced no pain at all at final review. The majority of patients underwent one or more procedures prior to the DUR and all except one had a satisfactory outcome indicating that this is a good salvage operation at intermediate follow-up. Both patients who had previously undergone a elective procedure (Darrach's) for DRUJ pathology reported the outcome as either better or much better (although one did still experience significant pain), which indicates this is a viable option as a salvage procedure consistent with the series published by van Schoonhoven et al.¹⁸

There were four patients whose DASH score was more than 40, indicating a poor result. Three of these patients were satisfied and felt that overall their symptoms and function were better when compared to their preoperative symptoms and function. They had, also, all undergone at least one previous procedure, which may have compounded their function and symptoms. One of those patients, subsequently, was diagnosed with an inflammatory arthropathy. The fourth patient suffered from clinical depression and did not comply with the postoperative rehabilitation program.

There are several limitations to this study, which include a relatively small number of patients who have been operated on by a single surgeon in one unit; however, ulna head replacement is not recognised as a routine procedure and patients should be selected with care. We have no preoperative functional or pain scores and no postoperative grip strength.

None of the patients in our study demonstrated clinically symptomatic instability, pre- or postoperatively of the implant, which has been reported as a problem in other studies, where revision often required attention to the distal radius in conjunction with the ulna (i.e. partial replacement).^{17,19,20} This may be due to our patient group being not only older and having lower demand, but it also may highlight the importance of selecting the correct implant size and taking care to reconstruct the soft tissue envelope, including re-attachment of the TFCC to the slot on the implant head.

One patient did undergo revision at 20 months due to persistent pain (but not clinical instability) and required the head of the implant to be exchanged for a smaller size without revision of the stem. Another patient was revised at 5 months for early aseptic to a customised implant. Both had satisfactory outcomes after the revision. Two patients did experience some dorsal ulnar paraesthesia of the hand, but this was not significant and needed no extra treatment. There were no postoperative infections, which is reassuring as the ulna head replacement was a secondary procedure in several of our patients. The rate of patients within this study needing further surgery is lower than has previously been reported.

There are discrepancies between VAS scores and patient satisfaction where, despite two patients continuing to experience significant pain, they were still satisfied with the outcome of the operation. One of these patients was revised for initial under-sizing of the head and the other suffered from clinical depression and had had a previous fracture malunion of the distal radius. This may be explained by the pain being improved and episodic but having good function postoperatively.

A significant finding of this study is the tapering and resorption of bone around the stem, which was seen in all 9 patients (90%) that retained the original Avanta DUR stem

(see Fig. 1). Presumably, this is due to stress shielding. This has been commented on in other studies^{17,19–21} and seems to stabilise after about 6 months, although there are no studies, as yet, looking at the long-term effect of this bone loss. In the one patient who had the stem revised for a customised HA-coated implant, there was no radiological evidence of bone resorption at 43 months (see Fig. 2). However, there does not seem to be any deterioration in function or pain associated with the bone resorption – the two patients with the greatest re-absorption gap (12 mm and 13 mm) have contrasting clinical outcome (one much better after surgery and one worse). There is no trend of increasing resorption linked to a poorer result, although in a study of this size formal analysis is not possible. However, the re-absorption is extensive in some of our patients and there is a concern that eventually there will be risk of either aseptic loosening (which has been reported as a common cause for revision)¹⁷ or peri-prosthetic fractures. At present, however, there is no evidence to support either risk or this is purely speculative. We are not aware of any prostheses currently available that incorporate HA on their stems and this is a design feature that should be considered in the future to limit the amount of bone resorption.

Currently, there is further innovation in treating pathology of the DRUJ. A spherical, headed implant has been developed to treat failed Sauvé–Kapandji procedures with it articulating with the residual ulna head with encouraging preliminary results.²² Total DRUJ replacement is available for treatment of unstable, arthritic ulna heads.²³ Bone preserving implants (First Choice™, Ascension Orthopaedics, Austin, TX, USA) and potentially less erosive pyrocarbon heads (Eclipse™, Tornier, Montbonnot Saint Martin, France) are also available.

There are several limitations to this study, which include a relatively small number of patients that have been operated on by a single surgeon in one unit; however, ulna head replacement is not recognised as a routine procedure and patients should be selected with care.

Despite these limitations, our study suggests that the Avanta ulnar head replacement hemi-arthroplasty is a reliable implant for aiding forearm function and pain in the short- to mid-term and this is irrespective of the aetiology. The results are comparable to outcome of other designs of distal ulna replacement, such as the Herbert Ulna Head Replacement.¹⁹ Studies with long-term follow-up are required to look further at the survivorship of this prosthesis and specifically the effect of the bone re-absorption around the stem.

Conflicts of interest

The authors have none to declare.

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