Indications and early to mid-term results of ulnar head replacement

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ABSTRACT

INTRODUCTION The aim of this study was to explore the indications and show the early to mid-term results of ulnar head replacement for the treatment of pathological conditions of the distal radioulnar joint.

METHODS Our study group comprised 52 patients with a mean age of 64 years who had 56 ulnar head replacements. Seven were implanted to salvage an unstable delective procedure; the rest were for primary treatment of osteoarthritis, rheumatoid arthritis and trauma. Concomitant procedures along with the ulnar head replacement included wrist arthrodesis, joint replacement and tendon transfers.

RESULTS The follow-up duration ranged from 1 year to 11 years (mean: 60 months, median: 60 months). In almost all of the patients, pain improved with a median visual analogue scale score of 2 (mean: 2.2, range: 0–8) and a median DASH (Disabilities of the Arm, Shoulder and Hand) score of 12.5 (mean: 17.9, range: 0–56). Of the 52 patients, 47 reported they would have the same procedure again.

CONCLUSIONS Ulnar head replacement appears to be a reliable and effective procedure solving several pathological problems of the distal radioulnar joint. We present a large patient group with a short to medium-term follow-up duration.

KEYWORDS

Arthroplasty – Ulnar head – Distal radioulnar joint – Darrach's procedure

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An intact distal radioulnar joint (DRUJ) is critical to stability and load transmission in the wrist and forearm.¹ Chronic instability and arthritic change at the DRUJ can lead to pain, decreased forearm rotation and diminished grip strength.² Everyday activities such as turning a key or opening a bottle require painless rotation of the forearm. DRUJ pathology or unsuccessful surgery can cause significant pain and functional disruption.

DRUJ arthritis and other pathology have been managed conventionally with delective procedures such as total ulnar head resection,³ partial ulnar head resection,⁴ with or without interposition,⁵ and DRUJ arthrodesis.^{6,7} Complications after distal ulna resections are not uncommon. Convergence of the ulna towards the radius is an inevitable consequence of all delective procedures.^{8,9} Functional disabilities after distal ulna resection can be considerable and potentially worse than if surgery had not been performed at all.^{8,10}

Patients who have painful instability after resection arthroplasty of the distal ulna present a difficult challenge. Several reconstructive procedures have been developed as alternatives or supplements to the resection procedures in an attempt to prevent complications associated with instability between radius and ulna. These procedures, how-

ever, tend to be unpredictable in relieving pain, preventing radioulnar impingement and providing a stable forearm.

Ulnar head replacement (UHR), rather than deletion, is intuitively appealing. An ulnar head prosthesis maintains the biomechanics of the DRUJ by replacing the mechanical function of the ulnar head after resection.^{11–15} The aim of this study was to audit the short to medium-term outcome of UHR in the treatment of a range of DRUJ pathologies.

Methods

Overall, 56 UHRs were implanted by the senior author in 52 patients (37 female, 15 male). All these patients were reviewed.

Assessment

For the purposes of this evaluation, all 52 patients (56 implants) were assessed for indications and early complications. All patients who had had an implant for more than one year were assessed subjectively with the DASH (Disabilities of the Arm, Shoulder and Hand) score and a pain scale (0 = no pain, 10 = worst pain imaginable) as well as an inquiry into patient satisfaction and whether the patient would sub-

Figure 1 Intraoperative implantation of ulnar head prosthesis

mit to the procedure again. The DASH score and pain scale were administered in person in clinic if the patient was still under review or by telephone if the patient had been discharged. Those who were followed up over the phone were offered an appointment; all declined owing to high satisfaction and function. The four patients who had the operation on both sides were assessed independently for each side.

Furthermore, objectively, the notes were examined for complications. The last available radiography was inspected for any signs of loosening, migration, congruity or ulnar variance (Fig 2). It was felt that routine radiographical evaluation was not required unless indicated clinically. Range of motion data were recorded subjectively but not precisely before and after the procedure so these were omitted from the audit.

Surgical technique

The surgery was carried out under general anaesthesia or ultrasonography guided regional blockade with tourniquet control. A longitudinal dorsal skin incision was centred over the DRUJ. The extensor retinaculum was identified and divided through the fifth extensor compartment, protecting the dorsal branch of the ulnar nerve. The extensor carpi ulnaris (ECU) subsheath and ECU tendon were left in place and elevated subperiostally in a radial-to-ulnar direction as a capsular subperiosteal flap. The triangular fibrocartilaginous complex was left in continuity with the ECU subsheath as they are freed from the distal ulna.

The Herbert prosthesis (KLS Martin, Tuttlingen, Germany) was used in 52 cases, the uHead™ prosthesis (Avanta Orthopaedics, San Diego, CA, US) in 3 cases and the spherical ulnar head prosthesis (KLS Martin) in 1 case. The Avanta implant was used when the Herbert implant was not available while the spherical head prosthesis was for an unstable Sauvé–Kapandji procedure.

The correct length and width of the implant were estimated provisionally by preoperative radiography, and an osteotomy was made through the ulnar neck with a cooled oscillating saw. After removal of the ulnar head, the siäoid notch was inspected. If necessary, the siäoid notch was

Figure 2 Postoperative radiography

reamed with a burr to restore an elliptical profile, particularly removing eburnised and ridged osteoarthritic bone or following reversal of a Sauvé–Kapandji procedure. A new siäoid notch was created if required against the radial shaft rather than the native siäoid notch for treatment of a painful short Darrach's procedure. The intramedullary canal of the distal ulna was reamed for the press-fit stem.

A trial prosthesis was used to check the size of the head and stem that restored optimum length and stability. The stem and modular head were impacted (Fig 1). The capsular flap was closed over the implant with sufficient tension to ensure stability of the DRUJ. If necessary, the capsule was reinforced with extensor retinaculum. When required, more sophisticated techniques were used (eg bone anchors to reattach the capsule or soft tissue reinforcement). For revision of an unstable Sauvé–Kapandji procedure, various techniques were used: in two patients the implant was placed under the fused ulnar head, in one patient the ulnar head fusion was taken down and the implant put into its proper position in the original notch, and in a further patient a spherical UHR was implanted into the ulnar head bone block.

Postoperative care

Skin sutures were removed after two weeks. The patients were usually protected in a splint for 2–4 weeks depending on the integrity of the soft tissues and ancillary procedures. Hand therapy was continued until the therapist felt there was no further scope for input. All patients were reviewed in the hand clinic at approximately two weeks, six weeks, three months and then annually with clinical review and radiography until the patients were satisfied and discharged.

Table 1 Indications for ulnar head replacement (n=56)	
Indication	Number
Rheumatoid arthritis	21
Osteoarthritis	18
Failed Sauvé–Kapandji procedure	4
Failed Darrach’s procedure	3
Fracture of ulnar neck	2
Radius malunion	2
Ulnar malunion	2
Vaughan-Jackson syndrome	2
Benign tumour	1
Psoriatic arthritis	1

Table 2 Operations performed along with ulnar head replacement (n=39 of 56)	
Operation	Number
Wrist fusion	14
Tendon transfer	9
Chamay fusion	3
Interphalangeal joint fusion	3
Metacarpophalangeal replacement	3
Radial osteotomy	3
Wrist replacement	1

Figure 3 Radiography of wrist arthroplasty and ulnar head replacement at three years following surgery

Figure 4 Radiography of radial shortening osteotomy at three months following surgery

Figure 5 Pain scores

Results

The duration of follow-up was 1–11 years (median: 60 months, mean: 60.6 months). By the time we started reviewing our results, four patients had died and one had severe dementia. The patient reported outcome measures were not available for these patients but the indications for surgery and concomitant procedures were described. Review of their last appointment letters concluded they were satisfied by their operation.

Our indications are shown in Table 1. Patients with DRUJ problems frequently have other pathology that may benefit from concomitant reconstruction (Table 2, Figs 3 and 4).

Subjective outcomes: pain

The median pain score was 2 (mean: 2.15, range: 0–8) (Fig 5).

Disabilities of the Arm, Shoulder and Hand

The DASH scores were compiled for each procedure when reviewed at least one year following surgery. Forty-nine DASH scores were available. There were no preoperative

data for comparison. The median DASH score was 12.5 (mean: 17.9, range: 0–56).

Complications

There were five complications directly attributable to the UHR as opposed to any concomitant procedures: a delayed tendon rupture treated with tendon transfers; one infected loosening treated with two-stage revision; one aseptic loosening treated with impaction grafting; one periprosthetic fracture treated non-surgically; and one painless, dorsally unstable UHR that was left alone as the patient had no pain and was functioning well enough (Figs 6–8). Two patients treated for unstable Sauvé–Kapandji procedures have since undergone further reconstruction (one tenodesis, one awaiting a total distal radioulnar replacement). These patients deteriorated rapidly owing to increasing forearm instability. The one patient in whom we implanted the spherical UHR for an unstable Sauvé–Kapandji procedure also had a wrist fusion. At 35 months' follow-up, he had a DASH score of 25 and a pain score of 5. The fourth salvage Sauvé–Kapandji patient, who had the ulnar head implanted against the native notch, which had not united, remains unstable and is awaiting a total DRUJ replacement.

Patient satisfaction

Forty-seven patients would have the same procedure again. Only two patients responded that they would not have the same operation again. The patients' view of the operation is shown in Figure 9.

Radiography

There was some resorption of bone around the collar of the implant in all patients within the first year but this did not progress. No cases of progressive radial migration were found beyond the second year (Fig 10). If erosion was seen, this tended to stabilise and a sclerotic notch often formed. In most cases, the UHR usually formed a congruous seat in the sigmoid notch, often with remodelling shown by subchondral sclerosis (Fig 11). There were no cases of symptomatic ulnotriquetral abutment. Only one case of aseptic stem loosening was found; this occurred within the first three years and was treated with impaction grafting. No patient has returned to clinic complaining of pain, clunking or weakness that would have led to investigation for notch erosion or stem loosening.

Discussion

We present a large series of UHRs. In contrast to other series and progressing beyond the original purpose of the implant, the majority of operations were for primary treatment rather than for salvage of a previous delective procedure. Our results show that the implant generally produces low pain scores, good function and high patient satisfaction. No progressive symptomatic sigmoid notch erosion or stem loosening was found in those with the longest follow-up period. Indeed, subchondral sclerosis usually forms in the sigmoid notch, congruent with the ulnar head.

Our study has drawbacks. It was retrospective and, as a result, there are no preoperative data (pain scale, DASH)

Figure 6 Radiography of painless dorsal subluxation at one year after surgery

Figure 7 Radiography of aseptic loosening. Treated successfully with longer stem and impaction grafting

for comparison. Owing to pressure on clinic time and the patients' choice to be discharged when satisfied with their outcome, current radiography was not available for all patients. The objective range of movement was not routinely collected. The prospect of progressive symptomatic erosion

Figure 8 Radiography of periprosthetic fracture

Figure 9 Patient satisfaction: ‘How do you feel after the operation?’

cannot be excluded but no case was encountered on analysis of all available serial radiographs. Subgroup analysis was underpowered for determining whether the implant fared differently for primary or revision treatment. The DASH and pain scales in some patients were probably influenced by concomitant pathology (eg rheumatoid) or concomitant surgical procedures (eg wrist fusion).

Management of DRUJ problems has evolved. Simple ulnar head deletion, described initially by Darrach and followed by various eponymous versions (Baldwin, Bowers, Sauvé–Kapandji, Watson), fails to maintain the quadrilateral forearm joint. Instability of the ulnar shaft is inevitable, and symptoms are therefore unpredictable and usually

Figure 10 Asymptomatic erosion of the sigmoid notch (no change between one year and five years postoperatively) (A). Stabilised erosion (asymptomatic at four years, sclerotic notch formed) (B). Erosion of the sigmoid notch (stable at seven years, pain score 2/10, DASH score 10; at three years: pain score 2/10, DASH score 11.7) (C)

Figure 11 Radiography of: typical remodelling of sigmoid notch with subchondral sclerosis for osteoarthritis (A), for a salvaged Darrach's procedure with excessive resection (follow-up at 72 months, DASH score 25, pain score 3) (B) and for a salvaged Darrach's procedure, long-stemmed implant (follow-up at 36 months, pain score 5) (C), and after initial erosion, showing that a stable sclerotic notch has formed (follow-up at 51 months, DASH score 53, pain score 0) (D)

intractable. The results of deletion in trauma are less satisfactory than in rheumatoid arthritis.^{14,15} The use of deletive procedures for either instability or distal radius malunion (instead of either ligament reconstruction or osteotomy respectively) defies logic. In some patients with rheumatoid arthritis, the results of deletion may nevertheless be satisfactory. Low demand with inhibition from both same-limb rheumatoid arthropathy and coincident tendinopathy may obscure symptomatic instability. Furthermore, soft bone stock would be a contraindication to implant arthroplasty. In higher demand rheumatoid patients, with good bone stock, controlled arthropathy and tendinopathy (increasingly encountered with the advent biological antirheumatoid drugs), replacement rather than deletion may be sensible.

Initial attempts to replace the ulnar head with silicone implants^{16,17} were encouraging but complications including dislocation, prosthetic fracture and silicone synovitis led to withdrawal of the implant in 1993. An unconstrained prosthesis was described in 2000, with its use reported in 25 patients who had previous failed salvage at an average 27-month follow-up with ‘stability and marked functional improvement in all patients’.¹⁸

The Mayo Clinic developed the uHead™ (Avanta, San Diego, CA, US). The design is also modular with the addition of a slot for suture fixation of the triangular fibrocartilaginous complex and the ECU subsheath to the device. Willis *et al* followed 19 uHead™ replacements (16 without previous ulnar head procedures) for 2 years and reported pain reduced by 50% and function improved threefold.¹⁹ They reported two early failures. Yen Shipley *et al* reported on 20 Herbert or uHead™ replacements (six without previous procedures) followed for an average of 54 months.²⁰ Telephone follow-up suggested a reduction in pain and good functional scores.

There is further scope for the development of the UHR. A spherical headed version has been designed, with encouraging early results, for salvage of unstable distal ulnas following Sauvé–Kapandji procedures.²¹ The need for such a device serves as a warning against this deleterious procedure. The total DRUJ replacement designed by Scheker²² is an option for the unstable arthritic ulnar head; the potential advantage of resurfacing both sides of the joint in those with DRUJ arthritis should be balanced against the complexity and constrained mechanics of the device as well as the acceptable outcomes with simple hemiarthroplasty shown in this present series and that of Willis *et al*.¹⁹ Further developments for which peer reviewed results are awaited include preservation of the ulnar styloid (First Choice™; Ascension Orthopedics, Austin, TX, US) and pyrocarbon heads with theoretically less potential for erosion against the sigmoid notch (Eclipse™; Tornier, Montbonnot Saint Martin, France).

Longer term follow-up of the UHR is required to determine whether there is a risk of symptomatic progressive sigmoid notch erosion or stem loosening for the ulnar head hemiarthroplasty.

Conclusions

In our experience, UHR is versatile and suitable for a range of pathologies; implantation to stabilise a Sauvé–Kapandji procedure may not be successful. Our results suggest very high patient satisfaction, with most having good function and low pain. Significant complications can occur. We have not established absence of risk of longer term stem loosening or notch erosion but neither have we encountered this as a significant clinical problem within the timeframe and limitations of our follow-up period.

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