Non-constrained elbow arthroplasty for mutilans deformity in rheumatoid arthritis

A REPORT OF SIX CASES

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Six highly unstable elbows with severe bone loss due to rheumatoid arthritis were replaced by a non-constrained, unlinked prosthesis. Bone defects were filled with autogenous bone grafts. The mean follow-up was 4.5 years (2 to 8).

The clinical results were excellent in four elbows and good in two, with good varus-valgus stability in all. Radiological follow-up showed no appreciable signs of loosening, and the bone grafts had retained most of their original size, with minimal resorption. There were no major complications such as dislocation, skin necrosis, infection or ulnar neuropathy.

The study has shown that the so-called mutilans elbow can be successfully replaced using a properly selected type of non-constrained, unlinked prosthesis with bone grafting of the major defects.

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In some patients with long-standing rheumatoid disease the elbow becomes extremely unstable because of extensive bone loss due to severe osteolysis. This so-called mutilans elbow interferes with the normal activities of daily living and especially with the supportive or weight-bearing function of the elbow which is essential in patients with severe disability of their lower limbs.

In the last few decades, total elbow arthroplasty has increased in popularity for patients with rheumatoid arthritis (RA), but reconstruction of an unstable elbow by a prosthesis is a challenging procedure. In 1992, Morrey and Adams¹ reported the use of a semiconstrained, linked arthroplasty in seven elbows with severe destruction of grade IV of their radiological criteria. In 1995 Dent, Hoy and Stanley² reported 21 revision operations after failure of total elbow arthroplasties; they dealt successfully with

shortage of bone stock by using custom-made prostheses. There are few other reports of the reconstruction of grossly unstable elbows.

Six patients are described in whom reconstruction was performed using a non-constrained, unlinked prosthesis together with large autogenous bone grafts.

Patients and Methods

The prosthesis. The prototype was originally developed by the author in 1972, followed by first-generation types 1 and 2 and second-generation types 3 to 5. The original humeral component, used from 1972 to 1982, had no stem for intramedullary fixation, and the long-term results were not entirely satisfactory.³ In 1982, the type-3 second-generation prosthesis was developed. The humeral component of stainless steel has an intramedullary stem with an articular portion consisting of a central trochlea and medial and lateral condylar moulds. The ulnar component of high-density polyethylene has a matching articular surface for the trochlea of the humeral component and a short stem for intramedullary fixation. In 1988, with a view to cementless fixation, the humeral component was modified to type 4, made of titanium alloy with a porous-coated stem. No change was made to the ulnar component. Problems with the tribology of titanium alloy against high-density polyethylene, such as metallosis and a high rate of wear,^{4,6} caused the humeral component to be modified to type 5 (Fig. 1), using a cobalt-chromium alloy with half of the surface of the stem porous-coated by a plasma spray of titanium alloy. The base of the stem was slightly modified. The ulnar component remained unchanged except that an optional metal back support was designed for cementless use. In the six elbows now reported the type-3 prosthesis was used in cases 1 and 2, type 4 in case 3 and type 5 in cases 4, 5 and 6.

Patients. The details of the six patients are shown in Table I; all had long-standing and severe RA and all had previously had at least two total replacement arthroplasties in the lower limbs. Their hands showed variable degrees of opera-glass deformity of the fingers, and all had moderate to severe pain on active movement of the elbow, but relatively minor pain at rest. Gross varus instability made it almost impossible for them to move the elbow actively

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Fig. 1a

Fig. 1b

The type-5 prosthesis. The humeral component is cobalt-chromium alloy, with the proximal part of its stem porous-coated. There is a choice of two ulnar components: one is all-polyethylene, the other has a metal back and a porous-coated stem.

while attempting to bring a fork or cup to their mouth. None was able to support their trunk with the affected arm when rising from a chair or bed.

Radiography. All six sets of radiographs before the operation showed almost the same pattern of involvement. There was complete loss of the trochlea of the humerus and almost complete disappearance of the medial condyle with only a spicule of bone remaining. There was severe erosion and loss of bone on the anterior side of the capitellum, and deep and wide erosion of the trochlear notch of the ulna. The coronoid process had become rudimentary, and the radial head almost completely absent.

Operation. The standard operative technique has been described elsewhere;^{3,7} only important and specific features will be described.

Through a straight posterior midline skin incision, the ulnar nerve is released as far distally as the deep pronator-flexor aponeurosis which encases the nerve deep to the muscle fibres of flexor carpi ulnaris.⁸ As in Campbell's posterior approach,⁹ a triangular flap of the triceps tendon based on the olecranon is raised and turned upwards. The joint is opened widely both dorsolaterally and posteriorly; all granulation tissue and synovium are meticulously removed.

A trial humeral component is applied to the distal humerus to indicate the extent of the loss of bone stock in the region of the medial humeral condyle which will require a large strut of bone graft. The trochlear notch of the ulna usually has defects needing bone grafting at the medial margin of its floor and the proximal part of the coronoid process. A fairly large full-thickness corticocancellous graft is taken from the iliac wing and cut into two pieces, one for the humeral defect and the other for the ulnar side. During the procurement of bone graft, the arm tourniquet is released for about 20 minutes, then reinflated.

The bone grafts are trimmed and positioned at the two sites in the trochlear notch before the ulnar component is inserted and fixed by methylmethacrylate cement (Fig. 2). It is important to preserve as much of the olecranon process as possible so that it can act effectively as a posterior bony support. Before the humeral component is inserted, a full-thickness strut bone graft is placed inside the mould of the medial condyle. The prosthesis is then tapped into the prepared site at the distal end of the humerus, so that the strut graft is locked into place by the bony spicule which is usually all that remains of the medial humeral condyle (Fig. 3).

The humeral component can be used with or without cement. In our series, two of the six (cases 4 and 5) had cementless fixation. The ulnar component was always fixed with acrylic cement. After reduction, the joint should show reasonable stability with no tendency to sublux after two tight sutures have been placed in the fascial layer on the dorsolateral aspect of the olecranon. The flap of the triceps tendon is sutured back to its proximal stump in a V-Y

Table I. Details of the six patients

Case	Gender	Age (yr)	Side	Duration of RA (yr)	Functional class	Follow-up (yr)	Elbow prosthesis	Previous surgery*
1	F	58	R	25	4	3	Type 3	Bilat TKA Cervical spine fusion R THA
2	F	60	L	13	3	8	Type 3	L TKA R ankle fusion
3	F	61	R	28	4	7	Type 4	Bilat TKA Bilat THA
4	F	54	L	21	3	4	Type 5	Bilat THA
5	F	59	L	30	3	3.5	Type 5	Bilat TKA
6	F	51	R	32	2	2	Type 5	Bilat TKA L TEA

* TKA = total knee arthroplasty; THA = total hip arthroplasty; and TEA = total elbow arthroplasty

Fig. 2

The thinner of two full-thickness grafts from the iliac crest is trimmed and placed in the region of the coronoid process. The ulnar component and the bone graft are then fixed with cement.

Fig. 3

The thicker piece of full-thickness graft is used to fill the bone defect at the medial condyle of the humerus.

Table II. The Mayo Clinic performance index for the elbow (excellent, 90 points or more; good, 75 to 89 points; fair, 60 to 74 points; poor less than 60 points)

Function	Score
Pain	
None	45
Mild	30
Moderate	15
Severe	0
Arc of movement (degrees)	
100 or more	20
50 to 100	15
Less than 50	5
Stability*	
Stable	10
Moderate	5
Gross	0
Function	
Combing hair	5
Feeding oneself	5
Hygiene	5
Putting on shirt	5
Putting on shoes	5
Maximum possible total	100

* stable, no clinical varus-valgus laxity; moderate instability, less than 10° of varus-valgus laxity; gross instability, 10° or more of varus-valgus laxity

fashion; this gives lengthening of the tendons by as much as 2 cm, which is usually necessary to allow an adequate range of flexion. The ulnar nerve is transposed anteriorly during the final stage of the operation.

The average duration of the operation is 140 minutes, including 20 minutes for the period of tourniquet release. Postoperatively, the elbow is immobilised at 90° of flexion for ten days, before gentle active and assisted movement is started.

Results

Clinical. The six patients were followed up for a mean of 4.5 years (2 to 8). One died from rheumatoid complications in the lung at four years. The clinical results before operation and at the last review were assessed by the Mayo Clinic performance index¹ (Table II) and the results are shown in Table III. There was remarkable improvement in the scores for pain, stability and daily function. Range of movement improved, with the maximum arc of flexion increasing from a mean of 110.8° to 139.2° (paired *t*-test, *p* = 0.002), but there was a slight but significant loss of extension after operation, from 17.5° to 31.7° (paired *t*-test, *p* = 0.001). This worsening of flexion contracture is prob-

Table III. Mayo scores for the six elbows before and after operation

Case	Preoperative					Follow-up				
	Pain	Arc of movement (degrees; range)	Stability	Function	Total	Pain	Arc of movement (degrees; range)	Stability	Function	Total
1	15	15 (20 to 100)	0	0	30	45	20 (30 to 140)	10	15	90
2	15	20 (10 to 130)	0	0	35	45	20 (30 to 140)	10	15	90
3	15	15 (20 to 100)	0	0	30	45	20 (30 to 135)	10	10	85
4	15	20 (20 to 120)	0	0	35	45	20 (30 to 145)	10	10	85
5	15	20 (20 to 120)	0	0	35	45	20 (35 to 140)	10	15	90
6	15	15 (15 to 95)	0	0	30	45	20 (35 to 135)	10	15	90

Fig. 4a

Fig. 4b

Case 2. Anteroposterior and lateral radiographs showing severe osteolytic changes (a,b). At eight years after operation showing a cemented type-3 prosthesis (c,d).

Fig. 4c

Fig. 4d

ably caused by lengthening after insertion of the implant, and may be the price to be paid for the restoration of stability in very frail elbows with this type of prosthesis. All six elbows had good varus-valgus stability after operation. On the Mayo rating, four elbows were excellent and two were good, all six being poor before operation. All six patients were very satisfied.

Radiological assessment. Radiography can detect impending failure and helps to forecast the long-term results. Radiographs taken one year after operation were compared with those at the latest follow-up, noting any change in the position of either component, the presence of a translucent zone at the cement-bone or porous metal-bone interfaces, and the fate of the bone grafts.

There was no detectable migration of components and no distinct translucent zone around the stem of the hum-

eral component in four cemented and two uncemented elbows (cases 4 and 5). On the ulnar side there was a translucent zone of 1 mm or less around the trochlear notch in two elbows (cases 3 and 6), but this was local, not extending distally around the stem. All of the bone grafts had retained their original size, with minimal resorption (Figs 4 and 5).

Complications. There were no major complications such as dislocation, deep infection, skin necrosis or ulnar neuropathy. The absence of the last is noteworthy because 'lengthening' of the joint¹⁰ occurred during operation; the good outcome may be attributable to the extensive release and anterior transposition of the nerve. Review of the medical records of all six patients showed no minor complications such as transient nerve paresis, haematoma, superficial infection or donor-site problems.

Fig. 5a

Fig. 5b

Fig. 5c

Fig. 5d

Case 4. Anteroposterior and lateral radiographs before operation showing the same pattern of involvement as case 2 (a,b). Four years after operation showing a cementless type-5 prosthesis (c,d).

Discussion

All six grossly unstable elbows showed nearly complete resorption of the trochlea and the medial condyle of the humerus, with extensive erosion of the trochlear notch of the ulna. This gross pattern of involvement is uncommon even after severe, long-standing rheumatoid disease, and may have received less frequent surgical attention because the patients tend to complain less of pain and more of instability. They nearly always have multiple joint involvement and the operation is technically difficult.

The type of implant for such reconstructive surgery is another point of interest. A semiconstrained, linked type seems to be better than a non-constrained unlinked type, because of the gross instability, extensive bone defects and the lack of ligamentous integrity. Postoperative dislocation or persistent subluxation is possible without some form of interlocking mechanism between the components. This

series has shown that a properly selected non-constrained, unlinked prosthesis can be successful. The key point may be the spacer effect and lengthening of the joint¹⁰ which led to recovery of function of the stabilising structures including ligaments, joint capsule, fascial layers and surrounding muscles. This was confirmed by the restoration of good varus-valgus stability after operation.

Fairly large bone grafts were used at the sites of gross bone defect. Although all six elbows had shown considerable bone resorption before operation, radiological review showed that resorption of grafted bone has been minimal. This may be attributable to the synovectomy, which had changed the local environment.

Conclusions. It has been shown that very satisfactory clinical results, with restoration of functional stability, can be achieved for completely unstable rheumatoid elbows by arthroplasty using a non-constrained, unlinked prosthesis. Proper selection of the prosthesis is a very important factor

as is the appropriate use of large autogenous bone grafts. Structural augmentation by grafts seems to be effective in providing secure fixation of the prosthesis even in the mutilans form of rheumatoid disease of the elbow.

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