TOTAL REPLACEMENT ARTHROPLASTY OF THE ELBOW FOR RHEUMATOID ARTHRITIS

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To be successful, arthroplasty of the elbow joint must not only restore movement and abolish pain but must also provide a stable fulcrum for the forearm. In tuberculosis and occasionally after trauma a varying degree of success may be achieved by meticulous surgery using standard techniques of non-prosthetic arthroplasty (Ollier 1885, Defontaine 1887, Campbell 1924, MacAusland 1947, Kirkaldy-Willis 1948, Knight and Zandt 1952). In rheumatoid arthritis, however, the result of such an operation is often disappointing and it is unusual for adequate stability and movement to be obtained (Hurri, Pulkki and Vainio 1964; Kirkaldy-Willis 1968; Dee 1969).

Because of the uncertain outcome of such surgery in rheumatoid arthritis and in view of the unsuitability of the prostheses then commercially available for the elbow joint, a new prosthesis was designed and produced, with particular regard to the problems of the patient with rheumatoid arthritis. In fact the device has a wider application than this and is now being used to replace the elbow joint in patients with other forms of arthritis.

This is a preliminary report, with the results of the first twelve arthroplasties.

THE PROSTHESIS

The prosthesis is of standard size and will fit into the medullary cavity of humerus and ulna without risk of splitting the soft rheumatoid bone (Figs. 1 and 2). Difficulty may be
expected only in patients under five feet in height or in adults with burnt-out Still's disease in whom the bony architecture is grossly abnormal: under these circumstances it may be necessary to shorten the stems of the prosthesis to facilitate its insertion. Such a manoeuvre has not been necessary in any of the cases reported in this series.

The prosthesis is a chrome-cobalt hinged joint cast in two sections and articulated at operation by means of an axis pin. One end of this pin is flared at manufacture and the pin is retained by flaring the other end with a special G-clamp. An extractor is also available for removing the pin. The ulnar part of the prosthesis consists of a platform which rests upon the olecranon: it carries the joint and also the jaws of the humeral component.

The stems of both the humeral and ulnar components are curved with their convexity posteriorly. The stem of the ulnar component has in addition a curve which is convex laterally and follows the corresponding curve of the olecranon and proximal part of the ulna. Because of this, separate right and left prostheses have to be made.

The prosthesis is used with acrylic cement. Keying points for the cement are provided in the form of two buttons on the outer aspect of the base of the humeral stem and one on the under-surface of the ulnar platform.

THE OPERATION

A pneumatic tourniquet is applied high on the arm. The operation is conveniently done with the arm across the chest and a sandbag under the shoulder. Through a curved posterolateral incision (Fig. 3) and by raising full thickness flaps good access is provided to the medial and lateral aspects of the elbow. The ulnar nerve is mobilised throughout the length of the incision proximally, and distally to a point one centimetre beyond the coronoid process (Fig. 4), for which purpose as little as possible of the origin of the flexor carpi ulnaris muscle is stripped from the olecranon so as to preserve its blood supply and also to facilitate closure.

The joint is opened laterally by detaching the common extensor origin, the extensor carpi radialis longus and brevis muscles and the lateral ligament from the humerus and retracting them anteriorly. The brachio-radialis muscle is left undisturbed. The attachments of the anconeus muscle to the humerus are divided: the muscle is retracted posteriorly but the whole of its insertion to the ulna is left undisturbed (Fig. 5). The head of the radius is then excised.

The distal ten centimetres of humerus are cleared of remaining muscular and ligamentous attachments. The elbow is dislocated medially to prevent tension on the ulnar nerve; this is made easier by first removing the medial epicondyle. The humerus is then cut across half a centimetre proximal to the upper margin of the olecranon fossa (Fig. 6). When bony ankylosis is present it is necessary to do this before dislocation and the distal end of the humerus is removed piecemeal.

Flexion of the elbow and full supination of the forearm give a good exposure of the trochlear notch (Fig. 7). The capsule of the elbow is detached from in front of the coronoid process by sharp dissection, but is not excised, nor is synovectomy done apart from the excision of any unusually large villi. With fine nibbling forceps the margins of the trochlear notch are fashioned into a flat platform. The tip of bone retained proximally near the triceps insertion provides additional security for the prosthesis as shown in Figure 8, in which the contour of a severely eroded ulna is shown by the hatched line; also shown is the line of bone section (solid line) which must be unchanged and not made level with the floor of the enlarged trochlear notch because the prosthesis would then ride high of its bony support.

The centre of the floor of the trochlear notch is deepened with a small gouge and the medullary cavity broached. Reaming this cavity of the ulna is the most difficult and tedious step of the whole operation because it may be so small that it can only be located by using a long blunt-ended guide wire over which is then passed a six-millimetre diameter flexible reamer. It is important that the guide wire is always an inch or so in advance of the tip of the reamer and it is important to avoid blockage by bony debris. When the necessary length
of medullary cavity has been reamed out, its proximal portion is shaped as needed using the conical end of a Putti rasp (Fig. 9). The medullary cavity of the humerus is easy to ream either with small sharp curettes or with the triangular end of the Putti rasp. The ulnar portion of the prosthesis is cemented into position, and after a trial reduction the humeral portion

![Figures 3 to 8](image-url)

Figure 3—The incision. Figure 4—Medial dissection and mobilisation of ulnar nerve. Figure 5—Lateral dissection. Radial head has been excised. Figure 6—Dislocation and the line of humeral section. Figure 7—Flexion and supination gives a good exposure of trochlear notch. Figure 8—Preparation of the ulnar cortex (solid line). This line of section is same even if trochlear notch has been severely eroded (hatched line).

is also cemented into place. The axis pin is inserted and flared using the G-clamp (Fig. 10). Full flexion and extension should be possible and only a little allowance is made for the presence of the pneumatic tourniquet. The axis of rotation of the prosthesis approximates closely to the normal (Fig. 11).
The extensor muscles are sutured to the triceps and to the flap of anconeus muscle. The flexor muscles are sutured to the triceps and flexor carpi ulnaris muscles beneath the ulnar nerve, which is transposed anteriorly. Suction drainage is used for forty-eight hours after operation and the elbow is immobilised in a well-padded plaster cylinder, leaving the hand free, for seven days. Pronation, supination and also some active flexion and extension movement are possible in this plaster and are encouraged from the first day after operation. A simple sling is worn for the second week.

The wounds are often slow to heal, possibly because of steroid treatment over many years, and the skin sutures are not removed until the fourteenth day. No passive movement is allowed at any stage. Excellent function is usual at three weeks.
RESULTS
The clinical material is shown in Table I. The indication for operation was severe or total loss of function of the limb from rheumatoid involvement of the elbow joint, with sufficient destruction of the bony surfaces to contra-indicate more conservative surgery. Most of the patients were aged between forty-four and fifty-five years. The youngest patient was

TABLE I
DETAILS OF TWELVE PATIENTS WITH RHEUMATOID ARTHRITIS

<table>
<thead>
<tr>
<th>Sex</th>
<th>Male 2</th>
<th>Female 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side</td>
<td>Right 7</td>
<td>Left 5</td>
</tr>
<tr>
<td>Ankylosis</td>
<td>2</td>
<td>Painful instability 10</td>
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</table>

TABLE II
RESULTS OF TWELVE ELBOW ARTHROPLASTIES

<table>
<thead>
<tr>
<th>Follow-up period</th>
<th>8-24 months</th>
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<tbody>
<tr>
<td>Average follow-up</td>
<td>14 months</td>
</tr>
<tr>
<td>Result: Excellent</td>
<td>10</td>
</tr>
<tr>
<td>Fair</td>
<td>1</td>
</tr>
<tr>
<td>Poor</td>
<td>1</td>
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</table>

TABLE III
RESULTS

<table>
<thead>
<tr>
<th>Case number</th>
<th>Range and arc of movement in degrees</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1*</td>
<td>—</td>
<td>30-120 90</td>
</tr>
<tr>
<td>2*</td>
<td>—</td>
<td>30-125 95</td>
</tr>
<tr>
<td>3</td>
<td>0-90 90</td>
<td>20-140 120</td>
</tr>
<tr>
<td>4</td>
<td>80-100 20</td>
<td>40-135 95</td>
</tr>
<tr>
<td>5</td>
<td>30-120 90</td>
<td>10-140 130</td>
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<td>40-100 60</td>
<td>10-130 120</td>
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<td>7</td>
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<td>0-140 140</td>
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<td>9</td>
<td>80-90 10</td>
<td>20-140 120</td>
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<td>0-140 140</td>
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<td>11</td>
<td>80-100 20</td>
<td>45-120 75</td>
</tr>
<tr>
<td>12</td>
<td>55-130 75</td>
<td>40-110 70</td>
</tr>
</tbody>
</table>

* Case 1 had had bony ankylosis for twenty years and Case 2 fibrous ankylosis for six years.
thirty-six. Four patients had had previous synovectomy or non-prosthetic arthroplasty but fortunately the olecranon had been preserved.

Patients who regained 90 degrees of movement or more after operation, with power 4 or more and no pain were graded “excellent”. A “fair” result implied an elbow that was free from pain, with power 4 or more in the flexors and extensors of the elbow joint, and with a range of movement of less than 90 degrees but in a useful arc. A “poor” result was one in which there was less movement or persistent loss of function due to pain, or some other complication.

The results are shown in Tables II and III.

*Fig. 12*—Radiographs of the right elbow of a woman aged 36 who had had bony ankylosis for many years. *Fig. 13*—Fifteen months after operation she had good movement and function.

*Fig. 14*—A man of 52 years had almost total loss of function in the arm because of painful instability. There was severe erosion of the trochlear notch. *Fig. 15*—Eighteen months after operation. The correct position of the ulnar portion in the severely eroded trochlear can be seen; function was practically normal.

The two patients with previously ankylosed elbows achieved excellent results. One of these patients had had ankylosis of both elbows for twenty years (Figs. 12 and 13), and the handicap had been even more severe because of similar involvement of the shoulder joints. It is of interest that this patient achieved almost all of the eventual 90 degrees of movement within four weeks of operation.

The commonest indication for operation was painful instability rather than ankylosis. Such patients often had a good range of movement before operation when examined under general anaesthetic (Table I) but were unable to flex the elbow actively against gravity alone.
because of pain. After operation, however, not only was the total range of movement increased but the entire arc was accompanied by useful function without pain (Figs. 14 and 15).

**COMPLICATIONS**

The blood supply to the olecranon is important. Early in the series, the importance of the blood supply to the olecranon was overlooked apart from the insertion of the triceps, all soft-tissue attachments were stripped from the olecranon to facilitate the preparation of the platform. The patient graded "poor" had achieved almost full movement and was symptom-free when the triceps tendon ruptured six weeks after operation (Figs. 16 and 17). At repair the tip of the olecranon was found to be avascular and was removed. Wound healing had been slow because the triceps repair broke down and it was only after a large rotation flap had been performed to cover the bare metal that the wound healed (Figs. 18 and 19). The patient was left with 45 degrees of movement in a useful arc, but had no power of active extension, although pleased because of the relief of pain.

The present technique was then adopted, and the problem has not recurred. Only a little acrylic cement should be used in the floor of the trochlear notch when at operation it is seen to be eroded to a thin shell (Fig. 16).
Other problems have been few and there have been neither vascular nor neurological complications or prosthetic failures. Skin healing was delayed by a week or so in three patients, all of whom had had steroid therapy for many years.

SUMMARY
1. A chrome-cobalt hinged prosthesis has been specially designed for total replacement of elbow joints disorganised by rheumatoid arthritis, and has been used in twelve patients over the last two years.
2. The technique of insertion includes fixation of the two main portions in the humerus and in the ulna by acrylic cement before they are joined by an axis pin.
3. Ten of the twelve patients obtained 90 degrees or more of painless movement and good muscle control of the artificial joint.
4. The results to date suggest that the prosthesis and surgical technique have a wider application than for rheumatoid arthritis.

I wish to thank Mr P. H. Newman and Mr D. R. Sweetnam for their helpful criticism and encouragement during the development of this prosthesis and also for permitting me to undertake this clinical trial in the Orthopaedic Department of the Middlesex Hospital. I am also indebted to the Committee for Research into Apparatus for the Disabled for financial aid and to Dr B. D. Wyke, Director of the Neurological Laboratory of the Royal College of Surgeons of England, for affording me laboratory facilities. I am also grateful to Mr F. A. Doddington and Mr C. H. Redman of the Photographic Departments of the Middlesex Hospital and the Royal College of Surgeons of England and to Miss K. Ockendon for sketches of the operation.

REFERENCES