Souter-Strathclyde total elbow arthroplasty
A LONG-TERM FOLLOW-UP STUDY
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We have reviewed 66 consecutive Souter-Strathclyde arthroplasties of the elbow implanted in 59 patients between 1982 and 1993. Thirteen patients (15 elbows) (19.6%) died. Sixteen elbows (24.2%) were revised, six for aseptic loosening (9%), four (6%) because of fracture or loosening after a fracture, three (4.5%) for infection and three (4.5%) for dislocation. Four patients refused to attend for review.

In 33 elbows with a follow-up of 93 months (60 to 167) complete relief of pain was achieved in 22 (67%) when seen at one year. After ten years or more 36% of the elbows were painfree and 64% had occasional slight pain especially under loading or stress. The mean gain in the arc of movement was 16°, but a mean flexion contracture of 33° remained. The main early complications were intraoperative fractures of the epicondyles (9%), postoperative dislocation (4.5%) and ulnar neuropathy. The incidence of ulnar neuropathy before operation was 19%. After operation 20 patients (33%) had an ulnar neuropathy, in seven of which it had been present before operation, and of these weakness of the hypothenar muscle occurred in two. The probability of survival of the Souter-Strathclyde elbow prosthesis based on the Kaplan-Meier calculation is 69% at ten years.

Received 27 April 1999; Accepted after revision 22 December 1999

Replacement arthroplasty is a well-accepted treatment for the arthritic elbow, as an alternative to synovectomy, with or without resection of the radial head, or fascial excision arthroplasty. This study reports the long-term results of the Souter-Strathclyde total elbow prosthesis.

Patients and Methods

Between 1982 and 1998, we performed 140 primary total elbow replacements and in 135 patients the Souter-Strathclyde prosthesis was used. The results of 66 replacements in 59 patients who had surgery before January 1993, and with a follow-up from five to 15 years, are described.

The main indication for operation was pain combined with radiological destruction of the elbow of grade IV or grade V according to Larsen, Dale and Eek. In elderly patients surgery was sometimes carried out on a grade-III elbow.

There were 22 men and 37 women with a mean age of 60 years (42 to 80) at the time of surgery. Of these, 54 had rheumatoid arthritis, two had juvenile rheumatoid arthritis, one psoriatic arthritis, one osteoarthritis secondary to synovial chondromatosis and one had pain after resection arthroplasty. There were 37 replacements of the right elbow of which 32 were in right-handed patients and 29 of the left of which six were on the dominant side. Twelve patients had had a previous synovectomy of the elbow, in six combined with an excision of the radial head. According to the radiological classification of Larsen et al seven elbows were grade III, 32 grade IV and 27 grade V.

All patients were examined by the author and assessed clinically and radiologically before the operation, one year later and then at regular intervals using a shortened version of the assessment developed by Souter. The data collected at follow-up of more than five years were used for this study. At the time of this review 16 elbows had been revised, 12 within five years of the original surgery, and 13 patients (15 elbows) had died. Eleven died within five years of surgery but the other two were included in the study because they had been followed up for more than five years. Four patients refused to attend for follow-up. They were interviewed by telephone. No patient was lost to surveillance.

Thus, 33 of the 66 primary elbow replacements were available for clinical follow-up five years or more after the surgery. All 33 elbows in 31 patients were examined and radiographs taken. The mean duration of follow-up in this group was 93 months (60 to 167). Of 16 which had been revised, 11 were still functioning well after insertion of a new prosthesis and five had a resection arthroplasty.
Prosthesis. The Souter-Strathclyde elbow prosthesis (Stryker Howmedica Osteonics, Limerick, Ireland) is modelled on the anatomy of the trochlea and the surface of the olecranon. The humeral component has a flat intramedullary stem for fixation in the epicondylar ridges with flanges for the capitellum and medial epicondyle of the humerus. The ulnar component has a keel and a small stem and is made of ultra-high-molecular-weight polyethylene. The components were fixed with Palacos cement (Schering, Kenilworth, New Jersey). Before 1992 four different sizes of humeral component were available: small, medium, large and a long-stemmed medium component with small flanges. The polyethylene ulnar component was available in two sizes, small and medium, and there was a metal-backed snapfit ulnar component with a longer intramedullary stem. In this series the following sizes of humeral component were used: small 37; medium 24; large 3; and long-stemmed 2. Of the ulnar components 42 were small, 23 medium, and one snapfit metal-backed.

Operative technique. The technique of insertion has been previously described. Although the ulnar nerve was not routinely visualised release of the fibrous arch at the ulnar sulcus is now carried out to prevent postoperative compression or kinking of the nerve. Preparation of the humerus can be difficult. The trochlea is excised using a saw. The supracondylar ridges, capitellum and medial epicondyle are excavated with a ball-shaped burr. Insertion of the trial humeral component may be difficult because the tip of the coronoid is in the way or the excavation of the distal humerus is not deep enough. There is a risk of fracturing the medial or lateral epicondyles leading to aseptic loosening. After using a trial prosthesis the definitive components are cemented with Palacos. Careful reattachment and tensioning of the annular ligament to the proximal part of the ulna and the medial and lateral heads of triceps to the tip of the olecranon stabilise the prosthesis.

A bulky dressing is applied with the elbow in 90° of flexion and neutral rotation. It is removed after five days and replaced by a posterior splint, for protection at night, which is worn for six weeks. Active and passive flexion-extension exercises are started on the fifth postoperative day under the supervision of a physiotherapist.

Results

The improvement in pain and function of most of the 33 elbows did not deteriorate with time (Table I). Their scores did not change significantly between follow-up at one year (0 to 80) and that at a mean of 93 months (60 to 167). The active range of movement increased after surgery. Preoperatively, the mean range of movement was between 38° (0 to 80) and 123° (90 to 150). After surgery the mean range increased to between 31° (10 to 60) and 132° (100 to 145). The mean improvement was therefore 15°. Forearm supination increased from a mean of 43° (0 to 90) to 51° (10 to 90) and pronation from 62° (20 to 90) to 75° (25 to 90). The movement did not decrease with time.

In 13 of the 33 elbows, radiography at the last follow-up (mean 93 months) showed no radiolucent lines at the cement-bone interface of either the humeral or ulnar components. In 19 of the 33 humeral components there was no radiolucency, partial radiolucency of 1 mm or less was seen.

Table I. Details of pain and function before and after operation in 33 elbows

<table>
<thead>
<tr>
<th>Pain severity</th>
<th>Before operation</th>
<th>After operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>22</td>
<td>14</td>
</tr>
<tr>
<td>Occasional</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Mild</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Significant</td>
<td>16</td>
<td>1*</td>
</tr>
<tr>
<td>Severe</td>
<td>16</td>
<td>1*</td>
</tr>
<tr>
<td>At rest</td>
<td>26</td>
<td>5</td>
</tr>
<tr>
<td>At night</td>
<td>29</td>
<td>6</td>
</tr>
<tr>
<td>On movement</td>
<td>33</td>
<td>5</td>
</tr>
<tr>
<td>Under loading or stress</td>
<td>33</td>
<td>7</td>
</tr>
</tbody>
</table>

Function

<table>
<thead>
<tr>
<th>Function</th>
<th>Before operation</th>
<th>After operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand to mouth</td>
<td>28</td>
<td>29</td>
</tr>
<tr>
<td>Hand to perineum</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>Lift kettle</td>
<td>7</td>
<td>24</td>
</tr>
<tr>
<td>Lift teacup</td>
<td>18</td>
<td>26</td>
</tr>
<tr>
<td>All household tasks</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Most household tasks</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Light household tasks</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>No household tasks</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Range of movement (degrees)

<table>
<thead>
<tr>
<th>Range of movement</th>
<th>Before operation</th>
<th>After operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>38 ± 17.1 to 123 ± 14.9</td>
<td>34 ± 19.3 to 133 ± 10.3</td>
</tr>
<tr>
<td>Pronation</td>
<td>62 ± 21.3</td>
<td>79 ± 12.5</td>
</tr>
<tr>
<td>Supination</td>
<td>43 ± 30.4</td>
<td>53 ± 25.7</td>
</tr>
</tbody>
</table>

* radiological loosening
The medial epicondyle and two of the lateral. These occurred did not occur.

Late dislocations were removed. In one this was secondary to a pressure sore at the olecranon after the operation. In two patients infection was a late complication at ten and 23 months after the operation. In one, a custom-made ulnar component was successfully implanted 38 months after the primary operation and in the other resection arthroplasty was required 30 months after the initial procedure.

Intraoperative complications included four fractures of the supracondylar ridge and complete radiolucency around the other seven. In five of the latter it measured 2 mm or more. Two humeral components were considered loose and two probably loose (Table II). In 20 prostheses there was radioluency around the ulnar component. In 11 it was partial, of 1 mm or less, and in seven of these it was located at the coronoid. In the remaining nine it was complete, measuring 2 mm or more in four. These also had complete radioluency around the humeral component. In two elbows the humeral and ulnar components were considered probably loose and in two the humeral and ulnar components were certainly loose (Table II).

Table III shows the complications encountered in the 66 elbow replacements. In one patient there was early deep infection; the prosthesis was removed and after eradication of the infection a new prosthesis was inserted six months later. In two patients infection was a late complication at ten and 23 months after the operation. In one this was secondary to a pressure sore at the olecranon after the patient had been comatose for a few days. Both prostheses were removed.

Three prostheses dislocated in the first week after surgery. Closed and subsequent open reduction was unsuccessful. Initially, the patients did not want the elbow revised but they were replaced with constrained prostheses at 13, 17, and 45 months after surgery, respectively. Late dislocations did not occur.

Intraoperative complications included four fractures of the medial epicondyle and two of the lateral. These occurred during preparation of the humerus and were probably the cause of aseptic loosening in two elbows which were revised 36 and 99 months after surgery.

Two patients sustained a fracture of the olecranon in a fall. In one, a custom-made ulnar component was successfully implanted 38 months after the primary operation and in the other resection arthroplasty was required 30 months after the initial procedure.

Surgical treatment was required in 21 patients. In seven of these the elbow was revised or reimplanted after 23 months, and in one elbow a constrained prosthesis was inserted after 87 months. In one patient a new, custom-made ulnar component was inserted 30 months after the initial procedure and another elbow was revised 36 and 99 months after surgery.

Revision for aseptic loosening of the prosthesis was carried out in eight patients including the two patients with a perioperative epicondylar fracture. In all of these elbows the humeral component was loose, in four combined with loosening of the ulnar component (Fig. 1). Radiological deterioration according to the classification of Larsen et al was grade III in one, grade IV in six and grade V in one. The elbows were revised at a mean time after surgery of 87 months (36 to 140). A new prosthesis was inserted and is still functioning in six elbows. One prosthesis became loose again seven years later and one elbow was infected two years after revision.

A Kaplan-Meier curve of the probability of survival of the prosthesis, for the endpoint of revision with removal of the prosthesis with or without reinsertion of a new implant, indicated survival at ten years of 69 ± 8% (Fig. 2).

Discussion

The results of total elbow arthroplasty are related to the type of prosthesis used and the underlying disease. The Souter-Strathclyde prosthesis is a non-linked, non-constrained surface prosthesis like that of Kudo and Iwano and the capitellocondylar prosthesis.

The rate of infection of 4.5% was comparable with that reported in other series; in the unconstrained capitellocondylar prosthesis it ranges from 1.5% to 8%.

Intraoperative fractures occurred only in the first group of patients. Since 1982 all patients with an elbow prosthesis have been regularly evaluated and assessed and since 1993 no fractures occurred during primary elbow replacement. When the epicondylar ridges of the humerus are found to be eroded or weak at operation the use of a long-stemmed
Anteroposterior and lateral radiographs showing a Souter-Strathclyde elbow prosthesis one year after operation (a,b) and three years later (c,d). The humeral component shows an anterior tilt which is typical of loosening.

Kaplan-Meier survival curve, with revision as the endpoint for 66 Souter-Strathclyde elbow prostheses.
medium component is recommended to avoid fracture of the epicondylar ridge and to improve fixation.

A major problem with an unconstrained elbow prosthesis is dislocation. At operation ten elbows had the tendency to dislocate after cementing of the components and could be stabilised only by careful tensioning of the ligaments, capsule and the medial and lateral heads of the triceps. In three elbows (4.5%) the prosthesis dislocated in the first week after operation. Dislocation occurred only early after surgery, as in other reports of the use of this prosthesis.10,11 All the dislocated elbows required open reduction. Late recurrent dislocation did not occur. With the capitellocondylar prostheses dislocation occurred in the immediate postoperative period and as a late complication.8 With a semiconstrained prosthesis, such as the GSB, uncoupling of the device may result in dislocation, with an incidence of 9.8%.6 In the semiconstrained prosthesis of Coonrad-Morrey no dislocation was reported but in the long-term follow-up the bushings were completely or partly worn in 15%. In this series the possibility of dislocation can be decreased by using the largest size of component which will fit. If it is impossible to stabilise the prosthesis a metal-backed snapfit ulnar component may be used.

The most common complication, and the most difficult to avoid, was ulnar neuropathy which was seen in 13 patients (22%), in seven (12%) of whom it was the same before and after operation. The possible causes included rheumatoid neuropathy, traction or mechanical injury at the time of operation, tourniquet-induced ischaemia and fibrosis, or ischaemic injury of the nerve after neurolysis. Intraoperative neurography of the ulnar nerve during replacement surgery of the elbow has been performed12 and decompression of the ulnar nerve as a routine procedure at the time of arthroplasty has been addressed. Release of the fibrous arch at the medial epicondyle, leaving the ulnar nerve in situ without disrupting the blood supply, suggested that the lateral approach was associated with a lower incidence of ulnar neuropathy than the posterior approach,8 although this was not confirmed in some reports. The frequency of dysfunction of the ulnar nerve has ranged from 18%13 to 31%.9 Severely disabled patients were sometimes not aware of a slight ulnar neuropathy and it was diagnosed only after thorough questioning and investigation.

The duration of follow-up influences the evaluation of outcome after elbow replacement. Since in our previous review of 57 elbows with a mean follow-up of four years (2 to 8) there were only five revisions.5 In this current series of 66 elbows with a mean follow-up of 7.5 years (5 to 11.5) there were 16 revisions. This difference is partly due to an increase in aseptic loosening, two further infections and two post-traumatic fractures. Revision for aseptic loosening was carried out at a mean time of more than seven years. This may be why in some reports of unconstrained elbow prostheses with a follow-up of less than five years loosening was not considered to be a problem.5,10 With the unconstrained capitellocondylar prosthesis, it was postulated that late failure due to aseptic loosening was uncommon, in a series with a mean follow-up of 6.5 years.9 Cement-bone radiolucencies, however, were found in 23 of 34 elbows and three humeral components had migrated from 5 to 12 mm. In another report of 40 elbows after a mean period of 7.2 years no clinical loosening occurred despite radiolucent lines in ten elbows.11 In a series of 202 capitellocondylar replacements radiolucent lines were seen in eight humeral components and 19 ulnar components, with three aseptic loosenings.8 The prevalence of loosening was low and did not increase with time.

These studies suggest that the capitellocondylar prosthesis continues to function well clinically despite radiolucency and that the latter will not necessarily progress to gross radiolucency and loosening. With the Souter-Strathclyde elbow prosthesis experience indicates that radiolucency may remain stable for many years, although it is not known what proportion of cases will progress to loosening and migration of the prosthesis. The incidence of aseptic loosening in this series was 15%, higher than with other unconstrained prostheses. This may have been due to the frequent use of small-sized components. This choice was made to preserve as much bone stock as possible at the time of surgery. Souter14 recommended use of the largest sized component which will fit in the bone and reported loosening of 12% in 250 cases over a ten-year period. This may be a reason for the difference in outcome between his patients and this series.

If revision is considered as the endpoint in survivorship analysis the semiconstrained Coonrad-Morrey prosthesis had a probability of survival of 92.4% at ten years.15 For unconstrained capitellocondylar prostheses survivorship after 5.5 years was 83%. Another report of the Souter-Strathclyde elbow prosthesis indicated survival of 87% after 12 years with a large standard deviation.16 In this series the probability of survival of the Souter-Strathclyde elbow prosthesis was 69% with a standard deviation of 8%.

The long-term outcome of unconstrained Souter-Strathclyde elbow prostheses is not well documented. The incidence of early complications, such as intraoperative fractures, postoperative dislocation and infection may be reduced with increasing experience. Palsy of the ulnar nerve is a frequent complication and remains a difficult problem. The rate of aseptic loosening at ten years was found to be higher than that of some other semiconstrained and unconstrained prostheses.

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References


