Long-term survival of the Souter-Strathclyde total elbow replacement in patients with rheumatoid arthritis

Between 1982 and 1997, 403 consecutive patients (522 elbows) with rheumatoid arthritis underwent Souter-Strathclyde total elbow replacement. By the end of 2007, there had been 66 revisions for aseptic loosening in 60 patients. The mean time of follow-up was 10.6 years (0 to 25). The survival rates at five-, ten-, 15 and 19 years were 96% (95% confidence interval (CI) 95 to 98), 89% (95% CI 86 to 92), 83% (95% CI 78 to 87), and 77% (95% CI 69 to 85), respectively. The small and medium-sized short-stemmed primary humeral components had a 5.6-fold and 3.6-fold risk of revision for aseptic loosening respectively, compared to the medium-sized long-stemmed component. The small and medium-sized all-polyethylene ulnar components had respectively a 28.2-fold and 8.4-fold risk of revision for aseptic loosening, compared to the metal-backed ulnar components.

The use of retentive ulnar components was not associated with an increased risk of aseptic loosening compared to non-retentive implants.

The primary indication for total elbow replacement (TER) in rheumatoid arthritis is pain. The long-term results are, however, worse than for knee and hip arthroplasties. Diverse causes of wear after TER can lead to osteolysis, aseptic loosening and prosthetic and periprosthetic fracture necessitating revision surgery. Aseptic loosening is the most frequent cause of failure. A rate of loosening of 12% has been reported at five years in patients with rheumatoid arthritis.

In a biomechanical study, the primary non-constrained Souter-Strathclyde TER has been shown to perform in a relatively constrained manner, and this may be a risk factor for aseptic loosening due to increased interface stresses. We have previously reported the five- and ten-year survival rates after TER in patients with rheumatoid arthritis using different Souter-Strathclyde prostheses. The purpose of this study was to analyse the long-term survival of the same cohort of replacements with short- and long-stemmed humeral components, non-constrained all-polyethylene and metal-backed ulnar components and metal-backed retentive ulnar components, and to calculate the relative risks of revision.

**Patients and Methods**

Between 1982 and 1997, a total of 522 primary TERs using Souter-Strathclyde prostheses (Stryker, Kalamazoo, Michigan) (Fig. 1) were performed in 403 patients (370 women, 33 men) in a specialist hospital for rheumatoid arthritis. Of these patients, 119 had a staged bilateral procedure. Their mean age at operation was 57.0 years (20 to 81). During follow-up, 156 patients (35 bilateral TERs) died of causes unrelated to the operation.

The indication for surgery was seropositive rheumatoid arthritis in 480 elbows, juvenile chronic arthritis in 20, seronegative rheumatoid arthritis in 15, non-specific chronic arthritis in five and psoriatic arthritis in two. The mean duration of the disease was 25 years (2 to 70) before TER, and the mean duration of elbow symptoms was 12 years (0 to 50). There was severe destruction in most elbows; it was Larsen grade 4 in 151 joints and grade 5 in 301 joints. There were 34 pre-operative fractures, of which 28 were in the humerus and six in the ulna.

The operations were carried out by four orthopaedic surgeons (including MI) using a standard posterior approach and a triceps ten- ton turn down. Prophylactic intravenous antibiotics were administered routinely. The ulnar nerve was identified but not routinely released or transposed. After exposure of the humeral condyles the radial collateral ligaments were divided at their ulnar insertion. Synovectomy was always undertaken and the radial head resected if this had not previously been done. All components were introduced with gentamicin-loaded cement, the divided ligaments were...
resutured and suction drainage used routinely. The elbow was immobilised with a splint for ten to 14 days postoperatively, except for daily range of movement exercises and continued for a further week as a night splint.

**Statistical analysis.** The endpoint for survival was revision for removal or exchange of either or both components. Each patient was reviewed annually. By the end of follow-up 156 patients had died, 35 of whom had bilateral TERs. No other patients were lost to follow-up. The mean follow-up for the whole group was 10.6 years (0 to 25). Kaplan-Meier survival data were used to construct the survival probabilities of implants, and were compared by the log-rank test. Cox’s multiple-regression model was used to study differences between implant designs and to adjust for potential confounding factors. The model included adjustment for differences in age and gender. The survival rates of the other designs were compared with those of the long-stemmed primary implant in the humeral group and the metal-backed prostheses in the ulnar group. The Cox regression analyses provided estimates of revision risk ratios for the different designs. The Wald test was applied to calculate p-values for data obtained from Cox’s multiple regression analysis. Differences between groups were considered statistically significant if p < 0.05 in a two-tailed test. We used SPSS 17.0 statistical software (SPSS Inc., Chicago, Illinois) for the analysis.

**Results**

There were 95 revisions (18%) at a mean follow-up of 10.6 years (0 to 25) at a mean of 6.1 years (0 to 21) after the primary procedure. The majority (66, 70%) were for aseptic loosening, which involved the humeral component in 21 elbows, the ulnar component in 16, and both in 29. In ten TERs a peri-prosthetic fracture was also present. Other reasons for revision were dislocation in 18 elbows (19% of revisions), infection in eight (8%) and peri-prosthetic fracture in three (3%). The Kaplan-Meier survival curves for all TERs using revision for any reason or revision for aseptic loosening as the endpoint are shown in Figure 2 and Table I.
The short and medium-sized humeral components had respectively a 5.6-fold (95% CI 2.2 to 13.9) and a 3.6-fold (95% CI 1.4 to 9.1) adjusted risk ratio for revision due to aseptic loosening compared to the long-stemmed primary humeral component (Fig. 3 and Table II). The small and medium-sized all-polyethylene ulnar components had respectively a 28.2-fold (95% CI 3.8 to 206.9) and an 8.4-fold (95% CI 1.03 to 68.8) adjusted risk ratio for revision due to aseptic loosening compared to all the metal-backed ulnar components (Fig. 4 and Table III). The increased

Table I. Kaplan-Meier cumulative survival rates of 522 primary Souter-Strathclyde total elbow replacements in patients with rheumatoid arthritis. The endpoint was defined as a revision of one or both components for aseptic loosening, or for any reason.

<table>
<thead>
<tr>
<th></th>
<th>Mean follow-up (yrs) (range)</th>
<th>At-risk 5 yrs</th>
<th>% 5-year survival (95% CI)*</th>
<th>At-risk 10 yrs</th>
<th>% 10-year survival (95% CI)</th>
<th>At-risk 15 yrs</th>
<th>% 15-year survival (95% CI)</th>
<th>At-risk 19 yrs</th>
<th>% 19-year survival (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aseptic loosening</td>
<td>10.6 (0 to 25) 435</td>
<td>96 (95 to 98)</td>
<td>334</td>
<td>89 (86 to 92)</td>
<td>94</td>
<td>83 (78 to 87)</td>
<td>20</td>
<td>77 (69 to 85)</td>
<td></td>
</tr>
<tr>
<td>Revision for any reason</td>
<td>10.6 (0 to 25) 435</td>
<td>92 (89 to 94)</td>
<td>334</td>
<td>84 (80 to 87)</td>
<td>94</td>
<td>78 (73 to 82)</td>
<td>20</td>
<td>72 (65 to 88)</td>
<td></td>
</tr>
</tbody>
</table>

* CI, confidence interval

Table II. Survival and adjusted risk ratio for revision of six different humeral components in 522 primary Souter-Strathclyde total elbow replacements in patients with rheumatoid arthritis. The endpoint was defined as revision for aseptic loosening of the humeral or both components.

<table>
<thead>
<tr>
<th>Humeral implant</th>
<th>Used since n*</th>
<th>Mean follow-up (yrs) (range)</th>
<th>At-risk 5 yrs</th>
<th>% 5-year survival (95% CI)</th>
<th>At-risk 10 yrs</th>
<th>% 10-year survival (95% CI)</th>
<th>At-risk 14 yrs</th>
<th>% 14-year survival (95% CI)</th>
<th>Adjusted risk ratio for revision (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short primary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>1982 22/118</td>
<td>11.6 (0 to 25) 104</td>
<td>97 (94 to 100)</td>
<td>75</td>
<td>85 (78 to 92)</td>
<td>45</td>
<td>79 (70 to 87)</td>
<td>1.0</td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Medium</td>
<td>1982 19/154</td>
<td>11.5 (0 to 25) 124</td>
<td>94 (90 to 98)</td>
<td>101</td>
<td>85 (84 to 95)</td>
<td>64</td>
<td>85 (79 to 92)</td>
<td>3.6</td>
<td></td>
<td>0.006</td>
</tr>
<tr>
<td>Large</td>
<td>1982 1/5</td>
<td>12.9 (8 to 15) 5</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any revision humerus implant</td>
<td>1991 2/37</td>
<td>7.7 (0 to 16) 27</td>
<td>100</td>
<td>16</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>2.3</td>
<td></td>
<td>0.31</td>
</tr>
<tr>
<td>Custom humerus implant</td>
<td>1996 0/1</td>
<td>12.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long stem primary medium</td>
<td>1985 6/207</td>
<td>9.9 (0 to 22) 178</td>
<td>99 (97 to 100) 137</td>
<td>97 (94 to 99)</td>
<td>27</td>
<td>97 (94 to 99)</td>
<td>1.0</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* n, number of revisions/number of total operations
† CI, confidence interval
intrinsic stability of the retentive ulnar components was not associated with an increased adjusted risk ratio for revision due to aseptic loosening (Fig. 5 and Table IV).

Discussion
In this long-term study our main finding was the relatively high overall survival, with 72% of the TERs free of revision for any reason and 77% free of revision for aseptic loosening at 19 years. Furthermore, we showed superior survival rates for the long-stemmed primary humeral component compared to the short-stemmed components, and of the metal-backed ulnar component compared to the all-polyethylene ones. Finally, the use of retentive ulnar components was not associated with an increased risk of revision, despite possibly higher interface stresses.

Van der Lugt, Geskus and Rozing\(^9\) reported a ten-year survival of 77% and an 18-year overall survival of 65% in their prospective series of 204 primary Souter-Strathclyde TERs. Talwalkar et al\(^10\) found a 16-year overall survival of 74% in 263 primary Souter-Strathclyde TERs in his older group of patients. Our 19-year overall survival rate of 72% was slightly higher, possibly owing to a high proportion of long-stemmed humeral and metal-backed ulnar implants. We acknowledge that the failure rate of TERs would be higher if radiological loosening was considered and a weakness of this study is that this assessment was not undertaken.
Whereas the use of short primary Souter-Strathclyde humeral components has been associated with higher risk of loosening by some authors,\(^7\)\(^,\)\(^11\) others have not been able to confirm this.\(^9\) Most of these components migrate into external rotation.\(^12\) In our study, the statistically significant 3.6- to 5.6-fold adjusted risk ratio for revision due to aseptic loosening in small and medium-sized short-stemmed humeral components compared to long-stemmed components, supports the former view.

The all-polyethylene ulnar components were associated with a markedly elevated adjusted risk ratio for revision due to aseptic loosening. The introduction of metal-backed ulnar components dramatically reduced the rate of loosening. Fixation of the metal-backed component is probably more reliable and the interface stresses more widely distributed. Surprisingly, the more constrained retentive ulnar component was not associated with higher rates of aseptic loosening. However, this finding must be interpreted with caution, because our numbers did not allow comparison with unconstrained metal-backed components.

We believe that the Souter-Strathclyde TER continues to be a viable solution for end-stage rheumatoid arthritis of the elbow. However, based on the Cox regression analysis, we discourage the use of both short-stemmed primary humeral components and all-polyethylene ulnar components. We believe that the ulnar component should be retentive rather than unconstrained.

Table IV. Survival and adjusted risk ratio of 522 primary Souter-Strathclyde total elbow replacements in patients with rheumatoid arthritis according to the constraint of the prosthesis. The endpoint was defined as revision for aseptic loosening of one or both components

<table>
<thead>
<tr>
<th>Ulnar implant design</th>
<th>Mean follow-up (yrs) (range)</th>
<th>At-risk 5 yrs</th>
<th>At-risk 10 yrs</th>
<th>At-risk 14 yrs</th>
<th>At-risk 19 yrs</th>
<th>% 5-year survival (95% CI)</th>
<th>% 10-year survival (95% CI)</th>
<th>% 14-year survival (95% CI)</th>
<th>% 19-year survival (95% CI)</th>
<th>Adjusted risk ratio for revision (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retentive</td>
<td>9.6 (0 to 17)</td>
<td>110</td>
<td>94</td>
<td>83</td>
<td>76</td>
<td>97 (95 to 100)</td>
<td>94 (91 to 98)</td>
<td>-</td>
<td>-</td>
<td>1.2 (0.6 to 2.4)</td>
<td>0.0003</td>
</tr>
<tr>
<td>Non-retentive</td>
<td>10/178</td>
<td>141</td>
<td>21</td>
<td>75</td>
<td>67</td>
<td>87 (83 to 91)</td>
<td>87 (76 to 86)</td>
<td>115</td>
<td>2.4 (1.2 to 4.7)</td>
<td>0.011</td>
<td></td>
</tr>
</tbody>
</table>

\(n\), number of revisions/number of total operations

\(95\% \text{ CI}\), confidence interval

References


