We present the results of 525 primary Souter elbow arthroplasties undertaken in 406 patients between 1982 and 1997. There were 372 women and 34 men with a mean age of 57 years; 119 patients had a bilateral procedure. The elbows were affected by chronic inflammatory disease, usually rheumatoid arthritis, which had been present for a mean of 24.7 years (2 to 70). In about 30% the joints were grossly destroyed with significant loss of bone. In 179 elbows the ulnar components were metal-backed and retentive; in the remaining 346, with better bone stock, non-retentive, all-polyethylene prostheses were used.

Because of complications, 108 further operations were required in 82 patients. During the early years the incidence of complications was higher. Dislocation was the indication for 30 further procedures in 26 patients. Thirty patients underwent 33 revision procedures for aseptic loosening, 12 had 29 operations because of deep infection, two for superficial infection, and 14 further operations were done for other reasons. The cumulative rate of success, without aseptic loosening, five and ten years after surgery, was 96% and 85%, respectively.

Patients and Methods
Between 1982 and 1997, we performed 525 primary total elbow replacements with the Souter-Strathclyde prosthesis (Stryker-Howmedica-Osteonics, Limerick, Ireland) in 406 patients at the Rheumatism Foundation Hospital in Heinola, Finland; 119 had a bilateral procedure. There were 372 women and 34 men with a mean age at the time of surgery of 57 years (20 to 81). A total of 64 patients died during the follow-up period for reasons which were not related to the surgery.

The indication for operation was seropositive RA in 480 elbows, seronegative RA in 15, juvenile chronic arthritis in 20, osteoarthritis in 1, post-traumatic and psoriatic arthritis in two each and non-specific chronic arthritis in five.

Replacement of the elbow is undertaken much less commonly than that of the hip or knee. The elbow is rarely affected by osteoarthritis and most patients requiring replacement arthroplasty have chronic inflammatory joint disease, usually rheumatoid arthritis (RA). At the onset of RA, the elbow is rarely primarily affected but as the disease progresses severe degeneration occurs in about 66% of cases.

Interposition arthroplasty with various soft tissues has been used previously and was often complicated by progressive bony erosion and instability. It has therefore been abandoned.

In the last two decades many types of prosthesis have been used. With constrained hinge designs the main complication was aseptic loosening whereas dislocation has been a problem with non-constrained implants. Consequently, various semiconstrained implants have been developed.

No single design of implant is appropriate for all stages of involvement of the elbow. The aim is to find the best option for each patient. We describe our experience with the primary Souter elbow arthroplasty over a period of 15 years.

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ing long-term non-steroidal anti-inflammatory drug therapy, 54% systemic steroids and 44% disease-modifying anti-rheumatic drugs. Previous synovectomy had been undertaken in 216 elbows, excision of the radial head in 57 and interposition arthroplasty in 50.

Operative technique. The operations were carried out by four orthopaedic surgeons. Some modifications to the approach have been adopted during the course of the study. Initially, we used the posterior Campbell approach with a straight incision over the olecranon and a triceps tendon flap. Subsequently, the incision has been curved medially or laterally. A lateral approach without a tendon flap was used for some elbows, and the transtricipital approach, described by Gschwend et al, 6,21 in 20 elbows. Synovectomy was always carried out and the radial head resected if this had not been done previously. Section of the humerus and ulna was performed with a saw, and the medullary cavity was reamed with a drill. The original aim was to resect bone from the olecranon to produce a plane parallel to the axis of the ulna. This, however, was seldom possible because of the degree of destruction and bone loss, and often only the tip of the olecranon was resected. It was difficult, partic-

ularly in grossly destroyed joints, to determine the appropriate rotation of the components, and some correction was often needed after trial introduction. Polymethylmethacrylate bone cement (CMW; De Puy, Exeter, UK) was used in most elbows and, after 1995, with added gentamicin. Divided ligaments were resutured with 0-polydioxanone (Ethicon, Brussels, Belgium) passed through drill holes in the bone. During the synovectomy, the fat pad of the olecranon fossa was preserved. Suction drainage was always used. Different humeral and ulnar components were used as shown in Table I. Figure 1 shows the use of the retentive ulnar component in which the articular contour is greater than a semicircle.

Postoperative management. After surgery the elbow was immobilised in a splint for ten to 14 days and this was then retained at night for a further week. Mobilisation and functional exercises were carried out under the supervision of a physiotherapist.

Documentation and follow-up. The mean follow-up was 5.0 years (0 to 17.0). Since 1986 the clinical evaluation at follow-up has been carried out using the EULAR assessment chart. Preoperative and peroperative information was incomplete in 19 patients operated upon before 1986, but the results and complications of all patients are reported. Since 1992, postoperative review has been carried out at three and six months, at one and four years and every four years thereafter. Some patients could not attend for follow-up because of poor general health and radiographs taken in local hospitals were forwarded for evaluation. The Kaplan-Meier survivorship method and life tables with 95% confidence intervals (CI) were used to analyse the overall survival of the arthroplasty (Fig. 2). If only one component was removed, this revision was used as the endpoint for overall curves.

Results

Complications and reoperations. Out of the 525 cases, 108 further operations were required in 82 patients. One or both components were changed in 55 patients. Most of the reoperations were done early in the study when dislocation
was the most common major complication (Fig. 3); 26 patients underwent 30 procedures for this (Table II). Of the non-retentive ulnar components 18 (16 early) have been changed to retentive models. Secondary reconstruction of a ligament or capsule was undertaken in 12 patients; four of these had further dislocation requiring a change of the ulnar component. There were 22 dislocations when using the small standard ulnar component and four with the medium standard component. Subluxations were more common with the small ulnar component than with the medium standard (9 v 4). The number of different types of component are shown in Table I.

**Aseptic loosening.** We undertook 33 revision procedures in 30 patients for aseptic loosening (Table II). In seven there was an associated fracture. Both components were changed in 20 operations, the humeral component only in seven and the ulnar component only in six. The cumulative rate of success without aseptic loosening five and ten years after surgery according to the survival analysis was 96% (95% CI 94 to 98) and 85% (95% CI 79 to 92), respectively (Fig. 2).

**Infections.** Two patients required early revision of the wound because of superficial infection and one infected bursa was excised (Table II).

Because of deep infection 29 operations were carried out in 12 patients, six of whom presented early and six late. Seven further replacements were undertaken in this group as a two-stage procedure, with the interval between the stages being between 6 and 12 weeks, and one in one-stage since the infection had not been identified at the time of surgery. One patient had a further infection; the prosthesis was removed again and she later underwent bone grafting to the humerus with a good result. Irrigation only, without removal of the implant, has been successful on only three occasions; in one of these loosening occurred three years later without evidence of infection. After irrigation two patients with minor symptoms continue to require low-dose antibiotic therapy. One of these had a previous revision for dislocation and the other for deep infection.

**Dysfunction of the ulnar nerve.** Before operation, 25.1% of patients had some sensory impairment affecting the ulnar nerve. At follow-up at one year this had fallen to 5.6%, with a slight decrease at four and eight years (Table II).

There were two patients with severe peroperative nerve lesions; one of these patients died soon after surgery and the other has a permanent palsy. Two other patients underwent subsequent exploration of the ulnar nerve, but no cause for the palsy was found.

**Other reoperations.** The 12 further operations were carried out in ten patients for other reasons. Six underwent reconstruction of the triceps tendon. Two with a fracture of the ulna at the level of the tip of the prosthesis required fixation by a plate. One patient with a poor range of movement required release of adhesions, one had a bursectomy and two had wound revisions for marginal necrosis.

**Range of movement.** Before operation, the mean active range of flexion was 32.7° to 132.5° and at follow-up at one year 32.0° to 142.9°. The mean preoperative range of pronation was 70.5° and of supination 60.5°; at follow-up at one year it was 77.5° and 69.4°, respectively, and at four and eight years the figures were very similar.

**Discussion**

The outcome after total elbow arthroplasty has changed considerably. In the 1980s the incidence of complications was high and there were few excellent long-term results. Newer designs evolved from hinged prostheses as non-constrained models, either without a stem or with a short stem. Stability relied on the ligaments and capsular structures.

There was a risk of dislocation. There remains some controversy as to whether the soft-tissue-supporting structures can be destroyed to such an extent by the arthritic process that a non-retentive prosthesis cannot be used.

Some of the dislocations may be related to poor operative technique.
The classification into a constrained, semi-constrained and non-constrained type of prosthesis is unclear. There are differences in the inherent stability of different types of prosthesis from different manufacturers and also with different components from the same manufacturer. A modern ‘floppy’-hinge type of prosthesis can be equivalent to a non-retentive prosthesis in terms of both mediolateral and rotational stability.

In the 1990s there were several reports of total elbow replacements with better short-term results.\textsuperscript{5,6,9,15}

Our study covers a long period. At the beginning the number of operations was small and experience accumulated slowly. In retrospect, it seems that short-stem non-retentive prostheses were used too often in severely destroyed elbows. The prevailing attitude was also to avoid hinged prostheses in order to reduce the risk of aseptic loosening.

Between 1982 and 1992, standard humeral components were used routinely (Fig. 4), but in order to avoid resection of bone, especially from the lateral condyle, the medium-size revision model with a 7 cm stem gained popularity (Table I; Fig. 5). Because of a high incidence of dislocation, retentive components have been used more often primarily and as the early results appeared promising the retentive model became popular. The use of the metal-backed long-stemmed component was also favoured, not only because the incidence of dislocation was lower but it was also thought to have better fixation in elbows with...
gross destruction of the olecranon. During recent years, the non-retentive metal-backed component has superseded the retentive model in elbows with satisfactory local soft tissues. In our opinion the latter is more stable than the all-polyethylene component because of its coronoid prominence, and of the all-polyethylene components, the medium one seems more stable for similar reasons. Reduction in the incidence of dislocation is not only related to the selection of the component during the operation, but also to surgical experience. There are reports of low rates of dislocation when only standard components have been used. The case mix varies between countries and hospitals as does the timing of the operation with regard to the degree of destruction of the elbow. In our series 30% of patients (158 of 525) had gross bony destruction and, in these, the metal-backed ulnar component allowed better fixation than the all-polyethylene implant.

In the early period, the tightness of the retentive component was variable; some could be assembled with a gentle compression while others required considerable force. In all elbows, the humeral and ulnar components were tested manually before introduction. When required the polyethylene was trimmed by scalpel to allow ease of assembly. This caused a slight increase in mediolateral laxity, which was assumed to be beneficial in the long term. There were no postoperative dislocations in elbows in which retentive components were used. Recently, there has been a trend towards using even tighter retentive components which may not be manually assembled. There may be a similar incidence of aseptic loosening when using tightly retentive components as when employing a hinged prosthesis.

It has not been possible to have cement pressurisation, as used in the proximal femur, when introducing the components, since a cement gun with a sufficiently narrow syringe was not available. Manual syringes were usually used for lavage; pressure systems have only become available recently.

There were a few early infections and the incidence is decreasing. This may be related to improved operative technique with experience, but the incidence of haematogenous late infection is not, however, related to this. Some patients had symptoms in the ulnar nerve before operation because of synovitis and deformity. Most resolved after operation. There was a low incidence of long-term neuropathy, and this decreased with surgical experience.

Although the Souter elbow arthroplasty remains a technically demanding procedure, good results can be obtained.

References


