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ORIGINAL STUDY

Mechanism of loosening of the Souter-Strathclyde total elbow replacement Evidence from revision surgery

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Nine Souter-Strathclyde humeral and ulnar components retrieved from revision surgery for aseptic loosening were examined macro- and microscopically. The wear patterns were compared and photographed.

Humeral components demonstrated no evidence of wear. All ulnar components exhibited similar wear patterns. Six of the nine exhibited macroscopic evidence taking the form of deep linear grooves on either the medial or lateral articulating surfaces. Microscopic examinations revealed wear on all nine, exhibited as disruption of the polyethylene machining lines on the articular surfaces, but almost complete preservation on the central gliding ridge.

We believe our observations are explained by 'rocking' of the humeral component on the ulnar as a result of the congruent surfaces of the Souter-Strathclyde prosthesis, which resist rotational and translational movements, characteristic of the normal elbow.

Keywords : elbow prosthesis ; Souter-Strathclyde ; loosening ; revision.

INTRODUCTION

The Souter-Strathclyde Total Elbow Replacement (TER) has been in use since the 1970's. It is an un-linked system in which the components approximate the normal bony anatomy of the trochlea of the humerus and of the trochlear notch of the ulna, i.e. the humeral and ulnar components are congruent. Its survival rates are variously reported as between 69% (*3*) and 85% (*1*). While its results are comparable with other prostheses, loosening of the humeral component remains a concern (*8*). Valstar *et al* (*7*), in their study of 18 elbows demonstrated that 8 were at risk of loosening (detected by radiostereometry) after only two years. Some of the quoted reasons behind the loosening include : the short humeral stem (4), persistent extension deficit (*4*) and anterior tilt of the proximal tip of the humeral component (*6,7*).

In reality a combination of the above factors contribute, but we aim to support a hypothesis of humeral component rocking as a primary cause of loosening – by demonstrating similar wear patterns on retrieved components and considering them in

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the context of normal elbow biomechanics and surface congruity of the Souter-Strathclyde prosthesis.

MATERIALS AND METHODS

Between December 1985 and 1989, 33 primary TER operations were carried out on a series of 27 patients with rheumatoid arthritis using the Souter Strathclyde prosthesis. Thirteen elbows have been revised – nine for aseptic loosening of either the humeral or ulnar component or both (Loosening was defined as a change in the relationship of the prosthetic components to underlying bone demonstrated by radiographs, together with recurrence of pain in a previously asymptomatic joint). At revision surgery the removed components were retained – and so nine humeral and ulnar components were available for analysis.

The medial and lateral articular surfaces and the central gliding ridge of each ulnar component were examined and photographed under low power magnification and compared. Macroscopic photographs were taken of the components exhibiting evidence of gross wear.

RESULTS

Inspection of the retrieved humeral components revealed no evidence of surface wear – the articular surfaces had retained a smooth, highly polished appearance. However examination of the polyethylene ulnar components revealed clear evidence of surface wear in a particular distribution. Only the medial and lateral articulating surfaces were affected. Microscopic wear was exhibited as disruption of the polyethylene machining lines on the medial and lateral articular surfaces (fig 1), with preservation of the lines on the central gliding ridge (fig 2). The wear pattern was macroscopic in five of the nine components with one ulnar component exhibiting a deep linear groove (fig 3) and another a full thickness defect (fig 4).

Fig. 1. — Disruption of machining lines on medial and lateral articular surfaces.

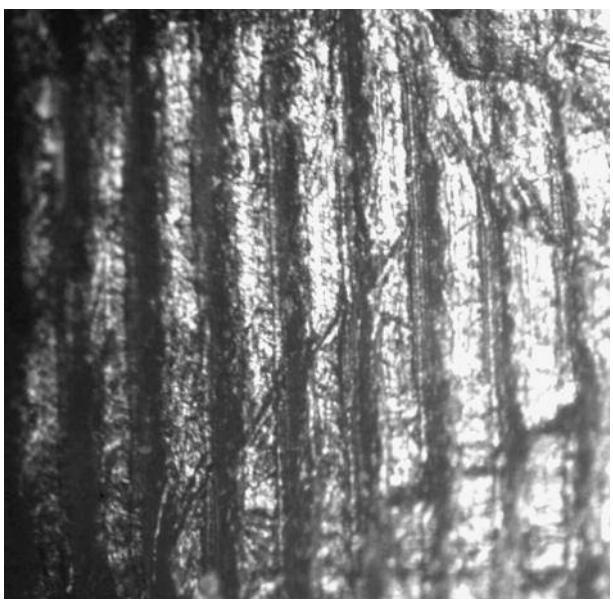

Fig. 2. — Central gliding ridge displaying preserved lines

DISCUSSION

It is well recognised that the normal elbow joint is not a simple hinge joint (*9*). In addition to flexion/extension, five degrees of axial rotation and abduction/adduction motion patterns also occur (*2*). Furthermore Shiba *et al* (5) suggested a certain sloppiness of fit between the normal humerus and ulna, which presumably facilitates these out of plane movements. However articulating surfaces of the Souter-Strathclyde components are highly

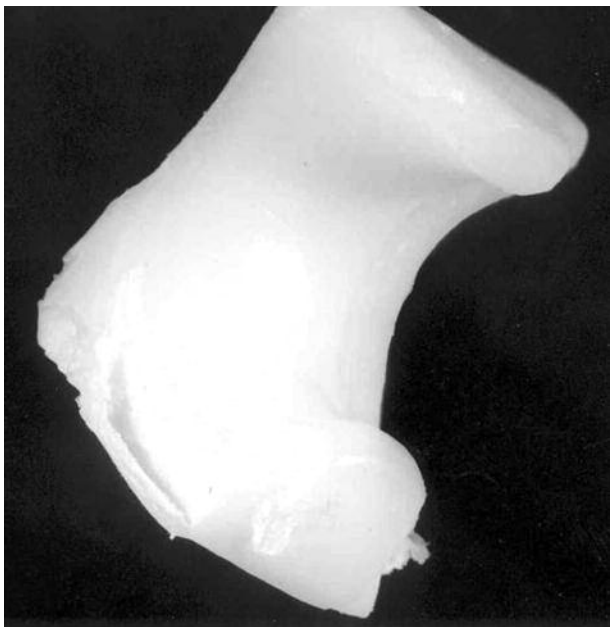

Fig. 3. — Deep linear groove in one of the ulnar components

Fig. 4. — Full thickness defect in one of the ulnar components

congruent and no such 'sloppiness' exists, thus it follows that it resists the elbow's normal translational and rotational movements.

We believe this resistance results in rocking of the humeral component during flexion and extension and believe this best explains our observed patterns of wear. The central gliding ridge is preserved because the humeral component is not always in contact with it as it rocks out of its articulation in the coronal plane. Furthermore as the humeral component rocks, the sharp edge of its articulating surface makes contact with the articulating surface of the ulna causing abrasion and in the extreme circumstance the deep linear grooves observed above (fig 3). The particulate polyethylene debris liberated by this activity then incites the cellular response, which results in component loosening.

In conclusion, similar wear patterns observed on Souter-Strathclyde TER components retrieved at revision surgery support a theory of humeral component rocking as a primary cause of loosening in this prosthesis when considered in the context of congruity of the component surfaces and normal elbow kinematics.

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