Wear and loosening of the hip prosthesis

A roentgen stereophotogrammetric 3-year study of 14 cases

Herbert Franzén[1] and Bengt Mjöberg[2]

Fourteen patients were followed by roentgen stereophotogrammetry for 3 years after hip arthroplasty. In 11 of the 14 acetabular components, definite wear was identified. The mean wear rate was 0.13 mm per year. There was no correlation between the wear and loosening of either the acetabular or the femoral component. Our findings indicate that products of wear do not initiate prosthetic loosening.

The cause of loosening of the cemented hip prosthesis is still controversial. Excessive wear of the acetabular component has been suggested to cause prosthetic loosening by foreign body response (Willert 1977, Buchhorn et al. 1984, Ohlin and Kindblom 1988). We have measured the linear wear using roentgen stereophotogrammetry, and have compared the amount of wear with the migration of the prosthetic components.

Material and methods

Sixteen hips operated on for arthrosis with a Scan® prosthesis (MITAB, Sjöbo, Sweden) were examined with roentgen stereophotogrammetry for 3 years after surgery (Mjöberg et al. 1990). The acetabular components were supplied with tantalum balls by the manufacturer. Roentgen stereophotogrammetry (Selvik 1989) was performed 1 week, 4 months, 1 year, and 3 years postoperatively. One patient died of an acute myocardial infarction during the observation period, and one hip was excluded because of missing radiographs. The cranial displacement of the head of the femoral component in relation to the tantalum balls in the acetabular component was determined. The wear data were correlated with loosening (defined as migration measured by roentgen stereophotogrammetry) of the prosthetic components (Mjöberg 1986).

The accuracy of the wear measurements were evaluated by double examinations. The femoral head displacement along the longitudinal axis in relation to the acetabular cup was calculated for these double examinations, and the standard deviation of the displacements (errors) from zero (zero is the expected mean difference within pairs) was determined.

Results

Accuracy of wear measurements. To determine the experimental error, 36 double examinations were performed. The standard deviation for error of measurement of wear along the longitudinal axis was 0.046 mm. Using Student's t distribution, the minimal significant ($P < 0.05$) wear was found to be 0.09 mm.

Wear of the acetabular component. In 11 of the 14 acetabular components, significant wear was revealed. The mean (*SEM*, range) wear of the acetabular component was 0.38 (*0.07*, 0–0.79) mm after 3 years, i.e., the mean rate of wear was *0.13* mm per year (Figure 1). There was no correlation between the wear and loosening of either the acetabular ($r = 0.12$) or the femoral ($r = -0.13$) component (Figures 2 and 3). Three acetabular components had worn 0.7 mm or more: one was associated with cup migration and one with stem migration; but in one case, both components were well fixed.

Departments of Orthopedics, Lund University Hospital[1], and Uppsala University Hospital[2], Sweden

Correspondence: Dr. Bengt Mjöberg, Department of Orthopedics, Uppsala University Hospital, S-751 85 Uppsala, Sweden

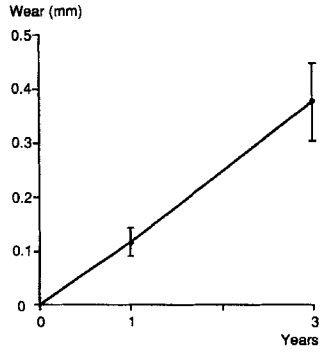

Figure 1. The mean *(SEM)* wear of the acetabular component 1 and 3 years postoperatively.

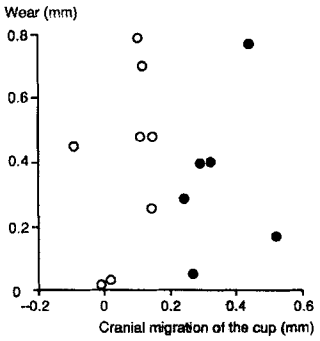

Figure 2. Correlation between wear and migration of the acetabular component 3 years postoperatively (r = 0.12, P = 0.7). Significant ● and nonsignificant ○ migration of the acetabular component.

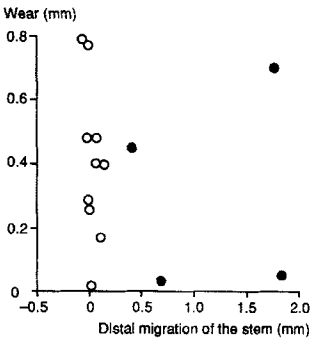

Figure 3. Correlation between wear and migration of the femoral component 3 years postoperatively (r = −0.13, P = 0.7). Significant ● and nonsignificant ○ migration of the femoral component.

Discussion

The 3-year migration of these prosthetic components has been reported earlier (Mjöberg et al. 1990): 8/16 acetabular components migrated cranially, and 4/14 femoral components migrated distally. Because all but two migrations were obvious 4 months postoperatively, we concluded that which is called late loosening is probably the result of late detection rather than of late occurrence of loosening.

Some long-term follow-up studies have demonstrated a correlation between wear of the acetabular component and prosthetic loosening (Buchhorn et al. 1984, Wroblewski 1986), and an excessive wear has been suggested to cause prosthetic loosening by foreign-body response (Willert 1977, Ohlin and Kindblom 1988). This association between wear and loosening can, however, be explained by the fact that cement or metal particles from a loose prosthetic component accelerate the wear of the acetabular component when the particles become trapped between the bearing surfaces (McKellop et al. 1990). The main source of cement particles is probably the acetabular side (Isaac et al. 1990), a conclusion concurring with the observation that migration of the acetabular component is more common than migration of the femoral component in the cemented hip arthroplasty for arthrosis (Mjöberg 1986). Excessive wear of the polyethylene cup without associated prosthetic loosening and subsequent cement fragmentation may be due to free cement particles resulting from the operation (Isaac et al. 1990).

The mean rate of wear was in the range previously reported (Charnley 1979, Buchhorn et al. 1984, Isaac et al. 1990). We found no correlation between wear and migration of either prosthetic component. Our findings support the view (Mathiesen et al. 1986, Mjöberg 1986) that products of wear do not *initiate* prosthetic loosening: products of wear cannot be expected to have their major influence during the initial 4 postoperative months—the period when the most rapid prosthetic migration occurs (Mjöberg 1986, Mjöberg et al. 1990). Loosening, however, may cause excessive wear once micromovements have caused cement fragmentation and cement particles are pumped into the joint cavity.

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