WEAR OF HIGH-DENSITY POLYETHYLENE ON BONE AND CARTILAGE

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Wear of high-density polyethylene on bone and cartilage has resulted in a large volume of plastic particles being shed into the two knees and two hips studied. The giant-cell foreign-body reaction of the synovium may not be sufficient to cope with the amount of debris presented and the destruction of the endosteal bone in one hip, caused by the wear particles and movement of the prosthesis, has made revision impossible. Articulation of high-density polyethylene against bone or cartilage either by design or by the failure of alignment of the component must be avoided.

It is not at all surprising that the unprecedented success of the high-density polyethylene (HDP) and stainless steel articulation in the Charnley low-friction arthroplasty should lead to the use of similar combinations for the replacement of other joints. With numerous designs intended to replace the knee and other joints it is only to be expected that the loss of alignment of the component or failure of fixation may result in movement between the bone and the HDP, this wear resulting in particles being shed into the joint cavity.

The unsuitability of Teflon for joint replacement is well documented; the tissue reaction and bone destruction have been reported (Charnley 1963). Experimental hip arthroplasty in dogs, using HDP on HDP fixed with acrylic cement, resulted in failure from fracture of the femoral neck and loosening of the components, with extensive reaction in the synovium and the surrounding soft tissues due to the HDP particles (Mendes et al. 1972).

This aspect of wear of HDP against bone or apparently normal cartilage in the human has not received adequate attention. In this paper a histological study of four such cases is presented. The clinical aspect is only mentioned where it is directly related to the estimated volume of HDP shed, the histological changes, or the outcome of revision procedures.

CLINICAL MATERIAL

Four cases of failed joint replacement were studied. Two were of the knee, one for rheumatoid arthritis, the other for osteoarthritis, where unlinked components were used to replace articular surfaces; in one, metal formed the tibial component, while in the other it was used for the femoral component. In one, the loss of alignment, the abnormal articulation and HDP wear were known to have existed for less than two years, in the other for longer.

The two other cases were of femoral head replacement using an uncemented femoral endoprosthesis capped with HDP; one of these was inserted for a fracture of the femoral neck, the other for osteoarthritis. Articulation between the acetabulum and the HDP was apparently intended by the design of the prosthesis.

In all four patients the revision was performed because of pain which was severe in the two with the femoral head replacement. In the two knees the main problem was instability.

![Fig. 1](image)
The wear of the HDP tibial component and the resulting typical polyp formation in the synovium (∗0.4).

RESULTS

Macroscopical appearances. In all four of the joints the synovium was dull-white, leathery and avascular. Its surface was smooth with areas of sessile, polyp-like outgrowths (Fig. 1). On palpation of the polyps there was a suggestion of firm inclusions. The extent of these synovial changes appeared to be proportional to the amount of HDP worn from the prosthesis. It was most pronounced in one knee where the estimated amount of

HDP shed was in excess of 5 cubic centimetres (Fig. 1) and least so in the other knee where this was estimated at less than 1 cubic centimetre. In the femoral head replacements the estimated HDP loss was 3 and 4 cubic centimetres respectively. In the rheumatoid knee, which had the least HDP wear, a small cyst was present below the tibial condyles.

In the two patients with femoral head replacement the acetabulum and the femoral canal were lined with friable granulation tissue. This was more plentiful within the medullary canal of the patient treated for fracture of the femoral neck where the replacement had been performed two and a half years previously (Figs 2 and 3). **Microscopical appearances.** After fixation in formol saline the sections were stained with haematoxylin and eosin. While the specimens were being sectioned it was possible to feel the drag of the knife on the HDP particles within the synovial polyps. Various areas of the synovium were examined as well as the lining from the femoral canals, the acetabula and the small tibial cyst. **Synovium.** The appearance of the synovial polyps was similar irrespective of the site of origin. Aggregations of foreign-body giant cells with large collections of HDP particles were the common feature. The smallest of the HDP particles were within the giant cells (Figs. 4 to 6). There were areas within the polyps which, despite the large number of HDP particles, contained very few giant cells. Single nuclei were surrounded by the HDP particles. The overall impression was of necrotic areas (Figs. 7 to 9).

**Lining of the acetabulum and the medullary canal.** This was friable, lacked the firm feel of the synovium and did not show polyp formation. Large parts of it resembled the necrotic areas seen within the synovial polyps and contained few giant cells. Some of the HDP particles were gross (Fig. 10).

**Subchondral tibial cyst.** This had a thin fibrous lining. Its contents were fibro-fatty tissue with large numbers of HDP particles but few giant cells.

**Clinical progress.** In the hip that had had a fracture of the femoral neck the HDP replacement had to be converted to a pseudarthrosis. The destruction of the endosteal surface of the femoral shaft was so extensive, that although a Charnley low-friction arthroplasty was technically possible it would have been mechanically unsound.

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**Figure 2**—Erosion of the medullary canal by the HDP granuloma. **Figure 3**—HDP granuloma removed from the joint cavity, acetabulum and the medullary canal.

Figure 4—Original magnification ×33. Figure 5—Under polarised light. ×33; Figure 6—Under polarised light, ×132.
DISCUSSION

Rapid wear of HDP against bone and articular cartilage results in a large volume of the plastic particles being shed into the cavity of the joint. The large synovial area of the knee and the hip can reasonably cope with a certain amount of the debris. Extension of the HDP into the medullary canal, however, leads to progressive destruction of the bone from the endosteal surface making a revision operation difficult if not impossible.

To prevent this rapid wear of the HDP and consequent destruction of bone proper alignment of the components in knee replacements is essential. In femoral head replacements there can be no justification for the use of HDP in direct contact with a normal or an abnormal acetabulum.

REFERENCES