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The Reaction of the Acetabular Articular Cartilage to Bipolar Hemiarthroplasty

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An evaluation of the acetabular cartilage was performed grossly and histologically in a patient who had a bipolar hemiarthroplasty, which had served satisfactorily for 2 years until the femoral prosthetic head had been separated from the acetabular assembly due to creep deformation of the inner bearing polyethylene cup. This study indicates that the double-bearing bipolar prosthesis does not necessarily have an advantage over the classical single-piece prosthesis in the prevention of acetabular cartilage wear.

Key Words: Bipolar hemiarthroplasty, creep deformation, acetabular cartilage.

A major mode of failure of endoprosthesis is migration of the prosthesis through the articular cartilage of the acetabulum. This complication is generally thought to be caused by excessive pressure on the cartilage and by friction between the metal head of the prosthesis and the acetabular cartilage (D'Arcy and Devas 1976; Harris *et al.* 1975; Hinchey and Day 1964; Steen Jensen and Holstein 1975).

Introduction of a prosthesis with an inner bearing was an important step forward in decreasing complications arising from single-piece hemiarthroplasty. The underlying idea was that movements of the hip should occur mainly in the built-in bearing, rather than in the joint between the prosthetic cup and the acetabulum, thus sparing the acetabulum. Reports in the literature on this point are few and contradictory (Chen *et al.* 1980; Cruess *et al.* 1984; Drinker and Murray 1979; Long and Knight 1980; Meyer 1981; Søreide *et al.* 1980).

I undertook an evaluation of the acetabular cartilage grossly and histologically in order to determine the fate of articular cartilage in a patient who had a bipolar hemiarthroplasty. In this patient, the bipolar prosthesis had served satisfactorily until the separation of the femoral prosthetic head from acetabular assembly occurred as a result of creep deformation of the inner bearing polyethylene cup.

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A CASE REPORT

In May 1983, a forty-eight-year-old man was seen for left hip joint pain of one year's duration with no history of antecedent trauma or disease. Roentgenograms showed avascular necrosis of both femoral heads (stage 2 on the right and stage 3 on the left) (Marcus *et al.* 1973). Through a posterior approach, an HD-2 bipolar prosthesis was cemented in the left hip joint using a medium sized femoral stem and an acetabular assembly fifty millimeters in outer diameter. The acetabular cartilage was thoroughly investigated to determine any change in color or surface fibrillation; it was proven normal. The femoral head was measured using a comparative contour gauge to select an appropriate size acetabular cup (Clark and Amstutz 1981). Postoperative roentgenograms showed the prosthesis to be in place (Fig. 1). His recovery from the operation was uneventful and he was discharged from the hospital ten days after the operation.

The patient was seen every three months in the first year of operation and once twelve months thereafter for yearly follow-up. His last visit was in May 1985. He was active during the years following surgery and his hip remained painless with a free range of movement. Radiographs showed the prosthesis to be solidly fixed, with no visible change in the cartilaginous space.

In June 1985, while the patient was in deep squatting position he heard a "pop" and then was not able to move his left lower extremity due to severe

Fig. 1. A postoperative roentgenogram shows an HD-2 bipolar prosthesis to be in place in the left hip joint.

Fig. 2. A radiograph made two years postoperatively discloses the prosthetic femoral head separated from the acetabular assembly which is still in the acetabulum. The radiolucent line between the bone and cement interface of the femoral component is less than 1 millimeter in width and incomplete.

pain in the hip joint. He was taken to a local clinic and was told that the femoral component was separated from the acetabular assembly. For the next fifteen days, he used forearm crutches and walked without bearing weight on the left lower extremity.

On June 14, 1985, he was readmitted to our hospital for a revision arthroplasty.

Physical examination revealed that the left lower extremity was held in adduction, slight flexion, and in moderate external rotation. The patient had a painful restriction of movement of the joint. Radiographs showed that the prosthetic femoral head was separated from the acetabular assembly which was still in the original position. The radiolucent line between the bone and cement interface of the femoral component was less than 1 millimeter in width and incomplete (Fig. 2).

On June 18, 1985, the patient was brought to the operating room for surgery. The operative findings confirmed the radiographic findings; the femoral head was separated from the acetabular assembly which remained in the acetabulum and the prosthetic femoral head was displaced superolaterally. The acetabular cup was in abducted position by dense fibrous tissues encircling the acetabular assembly. A creep deformation was noted in the inferior portion of the inner bearing polyethylene cup. Grossly, there was surface fibrillation and grayish discoloration in the acetabular cartilage. The size of the acetabular cup was noted to be appropriate for the patient's acetabulum. Photographs were taken of the acetabulum and the entire acetabular cartilage was removed by a sharp dissection. Histological sections of the cartilage were carried out. The sections were stained with hematoxylin-eosin and safranin-o (Rosenberg 1971), and were studied to determine the

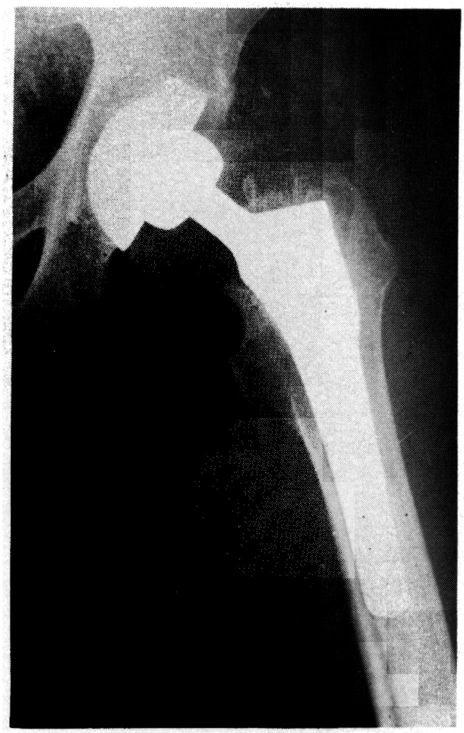

Fig. 3. A radiograph made after the revision shows the cementless P.C.A. prosthesis to be in place.

Fig. 4. A photomicrograph shows loss of the surface layer of the articular cartilage, clumps or clones of cells and diffuse increase in cellularity. (H-E stain, ×100).

presence of any degenerative changes.

Revision with a total hip replacement was elected on the basis of the degenerative changes in the acetabular cartilage. Although the femoral component was solidly fixed, it was revised with a cementless bony ingrowth P.C.A. prosthesis in order to match its size with the inner diameter of the P.C.A. acetabular component (Fig. 3).

DISCUSSION

In this patient, the actual mechanism of the creep deformation of the inner bearing polyethylene cup, causing the separation of the femoral component through the defective area, was not certain. However, the most convincing explanation was that dense fibrous tissues encircling the acetabular component was holding the cup in severe abduction in the acetabulum while the femoral component was in the functional position; therefore, the medial portion of the neck of the femoral component has been constantly compressing the inferior portion of the polyethylene cup, thus resulting in a creep deformation. When the patient was in deep squatting position he had hip joints in hyperflexion, which led the prosthetic femoral head to lever out through the defective area in the polyethylene cup by an impingement of the femoral component on the rim of the acetabular cup.

In this bipolar hemiarthroplasty (which had served satisfactorily for 2 years), radiographically, the acetabular cartilaginous space was well preserved. Grossly, however, there was discoloration and surface fibrillation in the acetabular cartilage; and histologically, there was loss of the surface layer of the articular cartilage. Clumps or clones of cells and diffuse increase in cellularity were noted (Fig. 4). Safranin-o staining disclosed loss of color, which indicated depletion of the proteoglycans (Rosenberg

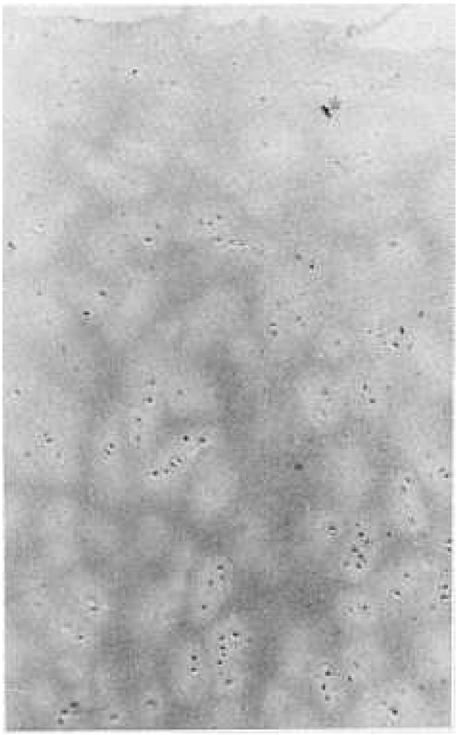

Fig. 5. A photomicrograph shows loss of color, indicating depletion of the proteoglycans as well as loss of the surface layer of the articular cartilage, clumps or clones of cells and diffuse increase in cellularity. (Safranin-o stain, ×100).

1971) (Fig. 5).

The most convincing explanation of the mechanism of the acetabular cartilage degeneration in this patient is; dense fibrous tissues encircling the acetabular assembly and the neck of the femoral prosthesis had made movements of the inner bearing virtually impossible. In this bipolar hemiarthroplasty, as in most of the conventional single-piece endoprostheses, the rigid metallic cup surface was putting abnormal stress on the articular cartilage, causing increased release of degradative enzymes. Some of these might be lysosomal enzymes (Ehrlich *et al.* 1975; Ehrlich *et al.* 1977), and release of such enzymes might have been the cause of early loss of glycosaminoglycans altering the biomechanical properties of the articular cartilage and causing it to become softer and loss its elastic recoil (Kempson *et al.* 1973). I suspect that such organic changes led to breakage of the surface collagen fibers in the lamina splendens (Freeman 1974) and, consequently, to the loss of surface integrity and fibrillation.

I think, therefore, that double-bearing bipolar hemiarthroplasty, as it stands now, cannot be expected to prevent acetabular erosion and does not necessarily have an advantage over the classical single-piece prosthesis in this regard.

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