Abrasive Three-Body Wear of Polyethylene Caused by Broken Multifilament Cables of a Total Hip Prosthesis A Report of Three Cases

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Abrasive Three-Body Wear of Polyethylene Caused by Broken Multifilament Cables of a Total Hip Prosthesis

A Report of Three Cases*

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Polyethylene wear debris has been associated with osteolysis of the acetabulum and femur and may be an important cause of aseptic loosening of total joint prostheses. The rate of polyethylene wear can be accelerated by the interposition of hard particles in the joint space, so-called three-body wear. The sources of three-body wear in the hip include particles of bone cement[15,25], metal beads or fibers from porous coatings[17], broken wires[2,7,10,11,13,24], and particles of bone. Smaller metal particles from modular interfaces[5] or from instruments have also been implicated.

Fixation of the greater trochanter may be necessary at the time of a primary or revision total hip arthroplasty[14], but it may be associated with complications, including broken wires or cables[9]. Fracture of monofilament trochanteric wires appears to be relatively common, occurring in approximately 8 per cent (eight of 100 total hip replacements) to 33 per cent (ninety-two of 277 total hip replacements)[1,4,8,18,22]. However, we are aware of only six reports in which the migration of broken wires into the joint space has been documented radiographically[2,7,10,11,13,24].

In 1983, Dall and Miles described the use of a multifilament cable-grip system for improving the attachment of the greater trochanter in a total hip arthroplasty. Although this technique is clinically useful for trochan-

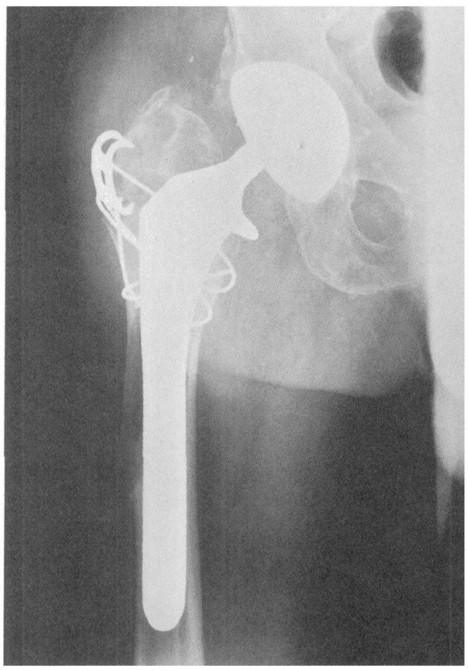

FIG. 1-A

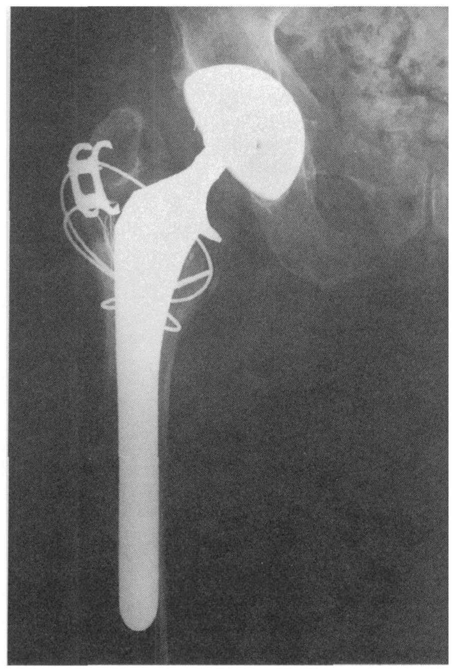

FIG. 1-B

Figs. 1-A through 1-D: Case 1.

Fig. 1-A: Postoperative radiograph, made in December 1992, showing the reduction and fixation of a fracture of the greater trochanter with the Dall-Miles cable-grip system.

Fig. 1-B: Radiograph, made immediately before the repeat revision in November 1993, showing the broken and frayed cables at the junction of the inferior aspect of the grip assembly.

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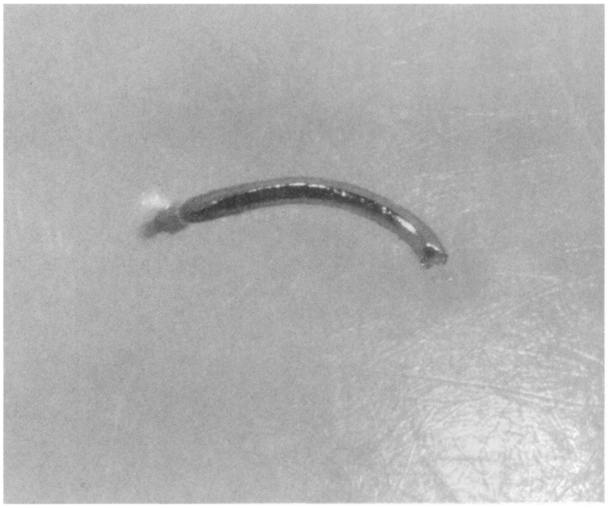

FIG. 1-C

Photograph, made with a dissecting microscope, showing a filament of wire embedded in the polyethylene of the acetabular component. Scratches of the adjacent polyethylene are also evident (× 30).

teric attachment, Ritter et al. reported breakage of the Dall-Miles cables after thirteen (33 per cent) of forty hip replacements in which stainless-steel cables had been used but after only one (5 per cent) of twenty-two hip replacements in which cobalt-chromium-alloy cables had been used[20]. Kelley and Johnston reported a higher rate of loosening of the acetabular component after total hip replacements in which multifilament cobalt-chromium-alloy cables had been used to attach the trochanter compared with those in which monofilament stainless-steel wires had been used. They also reported migration of metal debris and filaments, but they did not describe intra-articular particles or three-body wear induced by the metal fragments. Although radiographs have been used in a few reports[2,7,11,13,24] to show broken monofilament wires in the joint space, we are unaware of previous documentation of debris from multifilament cables of retrieved acetabular components. We present the cases of three patients in whom the acetabular component of a total hip replacement had abrasive three-body wear of the polyethylene because of intra-articular migration of fragments from broken and frayed multifilament cables.

Case Reports

CASE 1. A seventy-three-year-old man had a revision arthroplasty of the right hip in October 1992 for a failed total hip prosthesis that had been inserted with cement. Although the patient was doing well clinically, he fell two months postoperatively and sustained a fracture of the right greater trochanter. The greater trochanter was reduced, and a multifilament cable-grip system with two-millimeter-diameter cobalt-chromium-alloy cables (Dall-Miles cables; Howmedica, East Rutherford, New Jersey) was used for fixation (Fig. 1-A). Four months after the operation, he was seen with a dislocated right hip and radiographs showed proximal migration of the greater trochanter. During the next several months, he had recurrent dislocations. A repeat revision procedure was performed in November 1993, at which time broken cables were removed and the metal-stained synovial and fibrous tissues were debrided (Fig. 1-B). As the femoral and acetabular components were found to be stable, new cables were used to repair the greater trochanter. The acetabular polyethylene insert and the modular femoral head were replaced.

The retrieved polyethylene liner of the acetabular component contained obvious fragments of metal wire embedded in the weight-bearing portion of the articular surface. Five metal fragments that had a diameter of 320 micrometers and ranged from 1.2 to 3.7 centimeters in length were found (Fig. 1-C). Abrasive wear, consisting of numerous fine scratches, was also present in the weight-bearing region of the polyethylene adjacent to the embedded metal. Energy-dispersive x-ray spectroscopy, which was used to identify the composition of the metal debris, showed that the embedded filaments and the separately submitted cables were composed of identical cobalt-chromium alloy

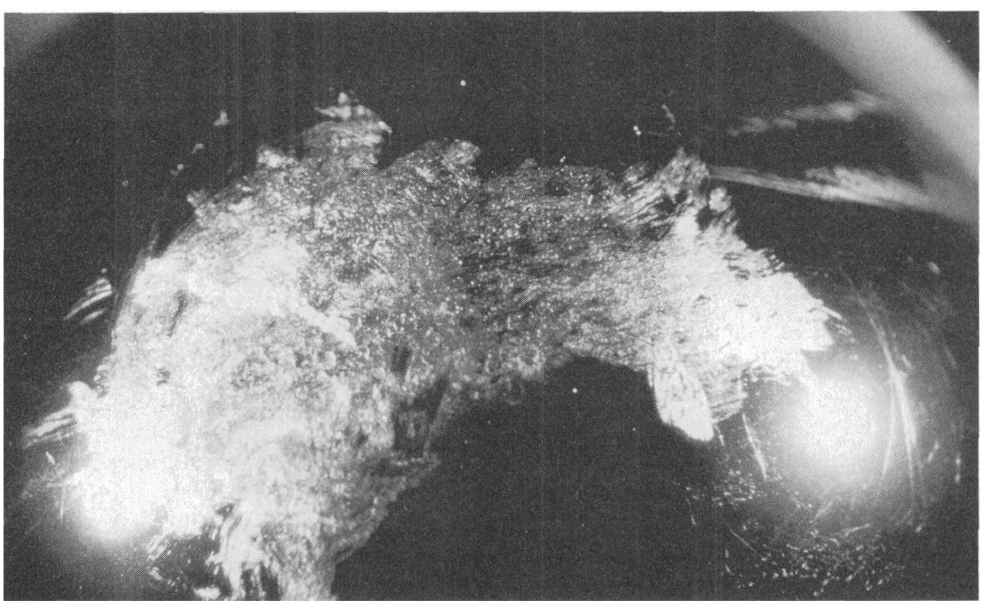

FIG. 1-D

Photograph, made with a dissecting microscope, showing a geographic region of scratches on the articular surface of the modular femoral head. The scratches are likely to have resulted from abrasion with the embedded wire (× 6.5).

and were of the same diameter. The modular femoral head had a geographic region of severe abrasive wear, measuring approximately 12.0 by 7.9 millimeters, which was almost certainly the result of contact with the embedded wire (Fig. 1-D).

CASE 2. A sixty-five-year-old man had a revision arthroplasty of the right hip in October 1990 for a failed total hip prosthesis that had been inserted with cement. At revision, the greater trochanter was reattached with use of the Dall-Miles multifilament cable-grip system and cobalt-chromium-alloy multifilament cables with a diameter of two millimeters. However, the patient continued to have pain, and follow-up radiographs eventually showed an osteolytic lesion around the distal tip of the femoral component. The patient had a repeat revision in June 1993, at which time the broken multifilament cables were removed, the loose femoral component was revised, and the polyethylene acetabular liner was replaced.

The retrieved polyethylene liner of the acetabular component contained fine metal filaments, several of which had been polished flat, embedded in the weight-bearing region. As in the first patient (Case 1), energy-dispersive x-ray spectroscopy confirmed that the embedded filaments had the same composition as the separately submitted cables and that the filaments were of essentially the same diameter. Both the weight-bearing aspect of the polyethylene and the surface of the modular head showed countless small, multidimensional scratches consistent with abrasive wear.

CASE 3. A sixty-eight-year-old woman had a primary total arthroplasty of the left hip in January 1978 for osteoarthrosis and a fracture of the femoral neck. In 1987, pain developed in the left hip. A revision total hip arthroplasty was performed in March 1989. A cable-grip system, including stainless-steel multifilament cables with a diameter of 1.6 millimeters, was used for reattachment of the greater trochanter. In September 1990, a repeat revision arthroplasty was performed because of the formation of heterotopic bone, worsening of the pain in the hip, and evidence of aseptic loosening of the acetabular component.

The polyethylene liner of the acetabular component contained four filaments of metal embedded within its weight-bearing surface. The fragments were polished and flattened by wear. The separately submitted cables showed fraying at the entrance to the holes of the grip assembly. Energy-dispersive x-ray spectroscopy showed that the filaments embedded in the polyethylene had the same composition and essentially the same diameter as the separately submitted cables. Both the polyethylene acetabular liner and the cobalt-chromium-alloy head of the femoral component had numerous small, multidirectional scratches consistent with three-body abrasive wear.

Discussion

Apparently first described by Dall and Miles in 1983, a multifilament cable-grip system is sometimes used for reattachment of the greater trochanter. Multifilament cable appears to have a higher resistance to fatigue and therefore offers theoretical advantages over monofilament wire in this application[14,16,21,23]. Dall and Miles reported rates of breakage of only 8 per cent (five of sixty-two hips) for 1.6-millimeter-diameter cables and 3 per cent (four of 130 hips) for two-millimeter-diameter cables. Ritter et al., however, reported broken cables in thirteen (33 per cent) of forty arthroplasties of the hip in which a transtrochanteric osteotomy had been fixed with the Dall-Miles multifilament cable-grip system and stainless-steel cables[20]. This rate of failure was not different from the 33 per cent rate of failure of monofilament wires in a study of 635 trochanteric osteotomies[19]. However, Ritter et al. noted a lower rate of breakage (one [5 per cent] of twenty-two hips) after changing to the use of multifilament cobalt-chromium-alloy cables[20]. Chandler et al. reported that multifilament cables had fractured in three (10 per cent) of thirty hips in which the assembly had been used to fix an allograft at the time of revision arthroplasty.

Recently, Kelley and Johnston retrospectively reviewed the results of 322 primary total hip replacements that had been performed with cement through a transtrochanteric approach; the duration of follow-up was at least four years. Monofilament stainless-steel wire with a diameter of 1.2 millimeters had been used in 162 procedures and cobalt-chromium-alloy multifilament cable with a diameter of 1.5 millimeters, in 160 procedures. The rates of breakage for the entire fixation construction were 42 per cent (sixty-eight of 162 hips) for the group that had fixation with wire and 13 per cent (twenty of 160 hips) for the group that had fixation with cable. However, unraveled cable was present in ninety hips (56 per cent) in which cable had been used. Fragments of wire or cable had migrated into the area of the acetabular notch in thirteen hips (8 per cent) fixed with wire and in twenty-five (16 per cent) fixed with cable. Such fragments had migrated more than two centimeters in forty-one (25 per cent) of the hips that were fixed with wire and in forty-two (26 per cent) of those fixed with cable. Analysis of tissue obtained from some of the hips that had a revision showed a prominent foreign-body reaction to the debris, but it was unclear whether the reaction was primarily to the metal or to the combination of metal and polyethylene. Even after adjustment for the different types of acetabular components, the rate of loosening of the acetabular component was notably greater for the hips in which multifilament cable had been used than for those in which monofilament wire had been used. The authors speculated that the hips in their study might have had three-body wear. However, as the study was primarily a radiographic analysis, they were unable to document metal filaments embedded in the acetabular components[12].

Although multifilament cables may have theoretical advantages over monofilament wires, accelerated three-body wear is a concern. In the hips available for our analysis, the mechanism by which the cables broke appeared to be fretting at their junction with the grip assembly. Fraying of the cables with breakage of individual wire filaments at this site was evident in one of the retrieved specimens and could also be visualized on several of the radiographs. Our results show that broken filaments can migrate into the joint space, become trapped between the articulating surfaces of the femoral and acetabular components, and participate in abrasive third-body wear. Besides directly scratching the articular surface of the polyethylene, the filaments can become embedded in the polyethylene and scratch the surface of the femoral head with each step that the patient takes. The resulting increased roughness of the femoral head is likely to accelerate the over-all process of polyethylene wear, increasing the release of debris particles. If this process occurs with high frequency, then it could account for the higher rate of acetabular loosening reported by Kelley and Johnston for hips in which multifilament cables had been used than for those in which monofilament wires had been used. Because most of the cables appeared to have broken at the junction with the grip assembly, modification of the device might help to reduce the prevalence of cable failure and subsequent three-body wear.

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