Correspondence

HA particles can be released from well-fixed HA-coated stems

Sir—I would like to comment on the paper by Magne Røkkum, Astor Reigstad and Carina Johansson in Acta Orthopaedica Scandinavica 2002; 73: 298-306. In this very interesting paper, the authors show the histopathology of biopsies from 20 hips, 2–8 years after implantation. During the revisions, which were done mainly because of acetabular problems (in 19/20 cases), they took 1–3 biopsies from each hip, including bone and soft tissue from the proximal femur at the medial or anterior aspect of the stem. On the basis of their findings, I conclude that in at least 4 cases (8, 12, 14 and 18) the biopsy was not satisfactory. 2 hips (no. 9 and 13) had no HA coating on the metal interface, but nevertheless in Table 2, a mean HA thickness of 94 µm is reported for case 13?

More surprising, however, is the fact that still in 5 hips the metal interface was completely covered by HA , which had a mean thickness between 127–241 µm. In case 19 the HA thickness was 277 µm, but the manufacturer (Landos Corail, Landanger, Chaumont, France) states that the HA layer is 155 ± 35 µm. Therefore quality control must be done.

An evaluation of the findings in this paper indicates that HA degradation is common and continuous, as shown by many others (Bauer et al. 1991, Hardy et al. 1994, Lintner et al. 1994, Yang et al. 1996. Overgaard et al. 1996, 1997, 1998, Tonino et al. 1999, 2001). However, it is disturbing that the authors found large flakes of delaminated HA which were not degraded and could therefore migrate into the joint and cause various sequels. Two questions arise here:

1) Does delamination always occur with thicker types of HA coating, as in this Corail prosthesis? This has not been seen with much thinner HA coatings (thickness of Ha layer 60 ± 20 µm)—e.g., the ABG and Omnifit prostheses (Bauer al. 1991, 1993, Tonino et al. 1999, 2001). 2) Is the delamination of the HA produced during insertion of the stem or does it develop, as the authors suggest?

As regards the first question there is now overwhelming evidence from clinical and experimental work, that thicker HA layers (over 100 µm) tend to delaminate (Serekian 1993, Wang et al. 1993, David et al. 1996, Muller et al. 1997, Yang et al. 1997, Donnelly et al. 1998, Morscher et al. 1998). This is because of weaker bonding to the metal as shown by this Corail prosthesis (20–30 Mpa), while the bonding strength of thinner coatings as in the ABG prosthesis is 2.5 times greater (62–65 Mpa). These large flakes of delaminated HA are difficult to desintegrate by cell mediation. They therefore persist and may cause more polyethylene wear, since they scratch the prosthestic head and lead to more abrasion of metal and polyethylene particles.

It is harder to answer the second question. It seems that during insertion of the stem, shear and friction forces will be higher on the proximal part of the stem than during loading afterwards and that delamination will occur just then. However, repetitive loading cycles that exceed 10^7 during life after insertion of prostheses may also cause fatigue failure of the Ha-metal interface, as the authors suggest. Especially when the bonding strength of the HA is as weak as with this prosthesis. But then the delaminated Ha flakes should all be attached to the calcar bone, which was not consistently seen in the figures. It is therfore problable that both mechanisms cause the delamination.

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Sir—We appreciate the interest of Alphons J. Tonino in our article. He concluded that in 4 cases (8, 12, 14 and 18) no reliable biopsy was obtained. In Patients and methods we stated that distinctively demarcated and smoothly-shaped biopsy surfaces corresponding to the implant were assumed to represent the metal interface. We found no such surface in the biopsies from these 4 hips, which were excluded from the interface analyses. However, the biopsies were useful in the qualitative evaluation and in assessing particles, bone resorption, and HA degradation. We reported the findings of a bone layer between the smooth surface and the HA coatings in 6 hips, as illustrated in Figure 6 A and B. No HA coating was found in the metal interface of hips no. 9 and 13, the latter showing that the HA coating was separated from the metal by bone and soft tissue. We hope this clarifies Dr. Tonino's opening remarks.

We aimed at a cutting direction perpendicular to the biopsy surface that had been in contact with the prosthesis. Our thickest HA coating values can hardly be due to inaccurate measurements, which considerably exceeded the manufacturer's description. Thus, we share Tonino's concern related to quality control.

In most Corail hips we have found excessive polyethylene wear and osteolysis, that rapidly increased after 5 years (Røkkum and Reigstad 1998, Røkkum et al. 1999). Reoperations showed matte steel heads and black staining of the soft tissue, even when the polyethylene inlay had not worn away (Røkkum et al. 1999). Lausmaa et al. (1998) found HA particles embedded in the articulating surface of polyethylene inlays that we had removed because of wear. In all reoperations, we saw that HA-coated surfaces uncovered by bone had almost completely lost the coating. These areas corresponded with the proximal radiolucent lines, which we found adjacent to most of the HA-coated stems after 7–9 years of follow-up (Røkkum et al. 1999). We suspect that HA particles liberated from the proximal part of the stem migrated into the artificial joint, causing third-body wear (Røkkum 2001).

Our paper provides little information about detachment of HA during insertion of the stem, since the first biopsies were taken 2 years later. After causing a diaphyseal fracture in early cases, we inserted the stems cautiously and fairly gently. Peroperatively, we found no delamination of HA. In later operations, some wrong-sized stems were replaced in the same procedure, but no HA abrasion was recorded. Due to the design, the proximal part of the stem will usually be surrounded by relatively soft trabecular bone, whereas the distal stem is fixed against the cortex. Any abraded HA will probably become trapped between the implant and bone, and only to a small extent can reach the articulation. HA abrasion during insertion is thought to cause wear immediately afterwards, and is probably of less importance to the chief wear problem, which develops later (Røkkum and Reigstad 1998, Røkkum et al. 1999). Therefore, we believe HA detachment during insertion to be a minor problem compared to long-term fatigue failure of the HA-metal interface. However, the effect of mechanical force on the HA coating should be examined more closely—for instance, by experimental insertions in cadaveric bone. We found delamination to be a significant factor in the production of HA particles, without regard to the exact time of the event. Subsequent resorptive undermining of the HA coating may subsequently cut the final attachment to bone and liberate HA particles.

It is unclear whether such mechanisms occur in other HA-coated hips, since the quality and thickness of the coating may be different. D'Lima et al. (1999) reported that lytic lesions at the calcar were correlated with greater polyethylene wear in the Omnifit-HA total hip arthroplasty. Of course, polyethylene wear could have been the primary event in this case, causing the calcar lesions, but that remains to be established. We examined a retrieved 80 µm HA-coated finger joint prosthesis (Røkkum et al. 1998, Røkkum 2001), and the histological findings were very similar to the biopsy results with the Corail stem. Adjacent to the joint we found delamination, resorptive undermining of the coating and liberation of large HA flakes with free access to the articulation, where many metal particles were produced. Hence, HA third-body wear problems can not be ruled out for any HA coated joint replacement.

It has been debated whether an HA coating should be as thin as possible in order to be resorbed after providing bone ingrowth, or if it should be thick enough for permanent bonding. Thin coatings run

a greater risk of being completely resorbed. The 155 μm HA coating of our prosthesis was among the thickest coatings used clinically. Some reports suggest that thick coatings have poorer mechanical properties than thin ones (Geesink et al. 1987, Wang et al. 1993), which may increase the risk of HA abrasion or delamination. A thick coating provides a larger reserve of HA, being a source of potentially harmful HA particles. In addition, thick coatings provide a lot of space for inflammatory soft tissue invasion of the bone-implant interface, which may eventually interfere with implant stability. Our findings accord with other data that if an HA coating is considered necessary, it should be as thin as possible.

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