

Guest editorial

Tribological tests cannot replace clinical trials

In the development of total hip arthroplasty (THA), preventive measures have reduced the infection rate, whereas loosening is still a major challenge, despite numerous trials with various designs and fixation principles.

Advances in the science of tribology (from the Greek, *tribein*, to slide), concerning wear, friction and lubrication, will probably lead to the development of new “bearing” materials, to reduce the rate of aseptic loosening and revision operations.

Friction torques generated in the articulation should be minimized; however, the degree of friction torque harmful for prosthetic fixation is not known. Concerning wear, it is now generally accepted that release of wear particles promotes localized bone resorption, resulting in implant loosening. The exact mechanism of lubrication in artificial joints is not yet understood.

The first generation of THA had a metal ball articulating a metal socket. Charnley then focused on the problem of friction and introduced a socket made of Teflon® (PTFE), articulating the metallic ball because of the extremely low friction torques recorded in the laboratory. However, this caused a severe wear problem, since friction and wear are very different! His solution was to use polyethylene (UHMWPE) as a socket material. Since then this concept has been fundamental in the era of arthroplasties. A slow but more or less constant wear occurs which may contribute to the loosening processes; therefore clinical trials with modifications of UHMWPE are in progress.

Bearing surfaces made from ceramics have been used in THA since the 1970s in central and southern Europe on a large scale, to reduce wear and friction. It has not gained full acceptance because of reports of unexpected wear and rare occasions of ball fractures, but also a lack of reliable long-term reports. At present, however, there are series with long-term results surpassing those of metal-on-UHMWPE articulations. Advances in ceramic manufacturing have also made this concept more attractive.

In the present issue, Saikko et al. (pp. 443–448) report on a tribological study of a ceramic (alumina, Al₂O₃) prosthesis in a ceramic-on-ceramic design. Under well-standardized conditions, they investigated sliding pairs of ball and socket made from contempo-

rary manufactory, lubricated with distilled water. They found, as expected from a ceramic-on-ceramic articulation, a low-friction torque and virtually no wear, assessed gravimetrically. Surface analyses showed very discrete changes.

The principle of metal-on-metal THA has been revived and is at present widely used in central and southern Europe. From the Helsinki laboratory, Saikko et al. (pp. 449–454) again report on a tribological investigation comparing CoCr-on-CoCr, CoCr-on-alumina and CoCr-on-UHMWPE pairs of ball and socket, this time lubricated with bovine serum. By means of atomic absorption spectroscopy they detected a substantial release of metal from the first pair of articulations but negligible amounts from the others. Even though no clinically severe toxicological effects have been reported concerning the McKee-Farrar or other metal-on-metal prostheses, very high concentrations of chromium ions in urine, hair and nails have been reported. The results of this study requires careful consideration, although the authors are very modest in their conclusion: “the CoCr-on-CoCr articulation is hardly the final solution to wear problems in total hip arthroplasty,” a statement which is probably correct. Recent advances in material technology, with thin diamond coatings of metal surfaces, appear to give extreme wear resistance and an ultra-low friction. This particular method of creating outstanding bearing surfaces will probably be tested on artificial joints in the near future.

From the history of artificial joints we have learned that, although tribological studies were performed before the introduction of new concepts or designs, large-scale failures due to wear can occur, one example being the Christiansen THA, well known to all Scandinavian orthopedic surgeons. Therefore, before the introduction of a new prosthetic concept or design, prospective randomized studies of limited cohorts, if possible augmented with radiostereometric analysis, are mandatory.

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Saikko V, Nevalainen J, Revitzer H, Ylinen P. Metal release from total hip articulations in vitro. Substantial from CoCr/CoCr, negligible from CoCr/PE and alumina/PE. *Acta Orthop Scand* 1988; 69 (5): 449-54.