#2855 - Experimental Study / Posters

Catastrophic Wear-Through Of Ceramic–On–Polyethylene Bearings: Retrieval Analysis Of Ten Implants, Characterisation Of Wear Debris And Reactions Of Periprosthetic Tissues

General Topics / Implants, Biomaterials & Registry Study

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Background
Catastrophic failure (CF) of total hip replacemens (THRs) with complete wear-through of the polyethylene (PE) liner and acetabular shell is an incidental complication following joint arthroplasty. In recent years we revised a series of ceramic – on – polyethylene (CoP) THRs where such failure occurred more than 15 years after implantation. Surprisingly patients reported little or no symptoms, acetabular shells remained well fixed, there was little osteolysis but large pseudotumors were formed.

Objectives
In this study we analyzed possible failure modes of implants our series in order to determine why despite severe PE wear none of the components became loose.

Study Design & Methods
We included a series of 12 Aesculap Parhofer-Moehnch uncemented THRs with a CoP bearing : 10 CF cases CF, and 2 cases of severe liner wear (LW) with no wear-through. Implants were revised after a mean of 17,6 (range 15,1 – 22,11) years, featured identical 32 mm ceramic femoral heads (second generation ceramics, Ceramtec Biolox) and conventional PE liners; one unused head was included as reference. Implants were examined using scanning electron microscopy (SEM), surface roughness of heads was measured using a contact profilometer. Samples of periprosthetic tissues (unavailable for two CF) were examined under optical microscopy. Fragments of periprosthetic tissues were also digested using nitric acid, and wear particles were isolated using filtration on polycarbonate membranes followed by gold sputtering and SEM examination.

Results
In all CF cases we found surface damage to the ceramic heads in a semi-lunar shape, adjacent areas exhibited metal transfer, while the remainder of the heads was not damaged. Polyethylene liner showed gradual thinning and presence of embedded third bodies in the material. SEM studies demonstrated pull-out of grains from the worn part of ceramic heads and Ti alloy deposits around them. The roughness of damaged areas was high (mean Ra 0,56 micrometers), while in non-weight-bearing parts it was similar as in the unused head (mean Ra 0,045) micrometers). Heads from LW group had surface morphology and roughness identical to that of the unused sample.
Periprosthetic tissues from CF patients contained massive amounts of metal, ceramic and PE debris, and multiple giant cells and macrophages. In LW patients we found PE debris and a large number of giant cells. All samples were classified as type I according to Morawietz

(particle induced inflammation). We did not observe perivascular inflammatory infiltration typical for adverse reaction to metal debris from metal-on-metal bearings.
SEM studies of isolated wear particles demonstrated, that LW tissues contained largely PE debris with a mean diameter of 2-10 micrometers; in samples from CF patients such particles were also found however we predominantly found large PE (30-90 micrometers) debris. Additionally in CF tissues we found large number of ceramic and metal debris with sizes ranging from submicron up to 10 micrometers.

Conclusions
Previous studies suggested, that there is a critical size of PE particles which is required to initiate osteolysis. Our material demonstrated, that CF of a CoP bearing can be associated with release of a large number of very large PE debris. Their lower osteolytic potential could explain why there was little osteolysis in our patients. Since damage to the femoral heads was caused predominantly by contact with metal, we conclude that PE oxidation could have caused the initial wear, as in LW cases. Our study demonstrates, that regular X-ray check-ups should be performed many years after THR to verify liner wear.