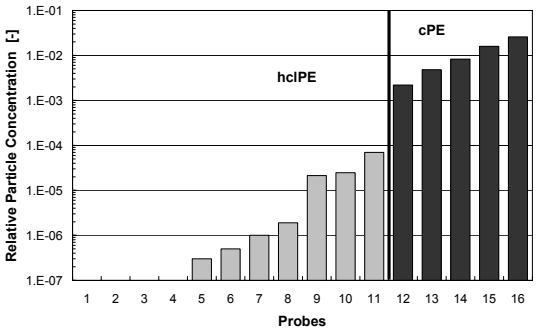
No or Extremely Low Wear Debris from Cross–Linked Polyethylene Cups

- Histomorphology of Retrieved Tissues from Early Revisions of Total Hip Endoprostheses -

Hans G Willert[1], Ingeborg Lang[1], Lothar Rabenseifner[2], Reinhard Hilgers[3]
Departments of [1]Orthopaedics and [3]Medical Statistics, Georg August University, D - 37075 Göttingen, Germany
[2]Department of Orthopaedics, General Hospital, D - 76532 Baden - Baden, Germany

Introduction: Hip simulator tests, analyses of retrieved components as well as radiostereometric measurements revealed that cups made of highly cross-linked polyethylene (hclPE) show, in the long run, a better wear performance than cups of conventional polyethylene (cPE).
Usually, the femoral head penetration into the cup is higher in the early postoperative period. Thereafter the penetration rate increases linear in cups made of cPE, while it clearly lowers after about 6 months in hclPE cups [1]. The higher early penetration has been attributed to factors like wear, creep or bedding in. Information about the amount of abraded PE particles would be helpful to decide which of the three factors is the most important one. However, to the best of our knowledge, histomorphological studies of tissues from the surrounding of highly hclPE components have not been reported yet. The aim of this study was to examine such tissues for particles, released from hclPE cups and to compare the findings with those of cPE.
Material and methods: So far, periprosthetic tissues retrieved at revisions of 11 total hip endoprostheses with hclPE cups (Durasul™, Zimmer GmbH, Switzerland) could be analysed. The revisions became necessary 3 to 50 months after implantation because of cup loosening (4), stem loosening (1), infection (3), periprosthetic fracture of the femur (1), multiple dislocations (1) and periarticular ossification (1). The findings were compared with those of 5 artificial joints with cPE cups (2 ABG, 2 Müller cemented cup, 1 pressfit cup) of 54 to 231 months of function. 5 µm sections were made from the tissues and conventionally stained with HE and van Gieson. Morphometric measurements were done using objectives 10 and 40 of an Olympus microscope CX 40 (Olympus, Hamburg Germany) and the 'Analysis' software (Soft Imaging System GmbH Münster, Germany). The area of the individual particles was estimated as well as the relative particle concentration, defined by dividing the particles area by the area of examined tissue. In the hclPE cases, the total amount and the total area of particles were ascertained while in the cases used for comparison only random samples could be measured because of the much higher content of particles.

Results: The hclPE cases showed, in contrast to the cases with cPE cups, no distinct foreign body reaction.
The average area of the individual particles of hclPE was clearly bigger (44.3 μm^2 / range: 4.6 - 136.3 μm^2) than those of cPE (1.9 μm^2 / range: 0.7 - 3.6 μm^2).
In four of the hclPE cases no particles could be detected at all. In the remaining seven, particles could be found only in a few areas, their number per section was between 6 and 1,208 and the relative particle concentration ranged between $0.03 \cdot 10^{-5}$ and $6.99 \cdot 10^{-5}$ (median: $0.05 \cdot 10^{-5}$). In the cPE cases the number of particles per section was between 2,832 and 71,447, the relative particle concentration ranged between $1.06 \cdot 10^{-3}$ and $25.91 \cdot 10^{-3}$ (median: $8.25 \cdot 10^{-3}$). This difference is statistically highly significant (Mann-Whitney U test / $p = 0.0005$).
Discussion and conclusions: The measurements in tissues of early revisions show that hclPE releases much less particles into the surrounding than cPE and cause rather no foreign body reaction. Accordingly, the burden of the tissue with polyethylene debris is much lower while the particle size is bigger with hclPE than with cPE. Furthermore, it is very unlikely, that the relatively high early penetration rate in the hclPE cups is caused by PE wear.



Relative particle concentration - logarithmic scale

References:

1 Digas G et al, Clin Orthop 429: 6-16, 2004