Reducing the Risk of Postoperative Infection with Ceramic in THA: A Comparative Study

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Is there a difference in infection rates between MoP and CoP bearing couples? A study recently published by Rothman Institute shows significantly higher infection rates when metal femoral heads are involved.

Due to concerns regarding early revision and complications associated with the use of metal-on-metal (MoM) couplings[1], metal-on-polyethylene (MoP) and ceramic-on-polyethylene (CoP) have become the most commonly used bearing surfaces for total hip replacement in the USA. While MoP bearings have several advantages over MoM, they have also recently been shown to release metal particles and ions. Upon contact with host tissue and joint fluid, these ions and particles can enhance tribocorrosion mechanisms due to the combined action of mechanical loading and chemical corrosion.[2,3,4] Thus, similarly to MoM bearings, CoCr wear particles and cobalt and chromium ions can be found in the tissue surrounding the implant as well as in systemic circulation[5,6] in patients with MoP bearings. Ceramic has become the material of choice in the US[1] due to the proven low incidence of implant failure with CoP bearings[7,8] and the ceramic heads' ability to mitigate fretting corrosion.[9]

Earlier studies also suggested that metal heads are associated with an increased rate of revision for post-surgical infection, namely periprosthetic joint infection (PJI).[10-14] However, the studies were not without limitations and further research was needed.

MoP vs CoP cohort

In a recently published study[15], we aimed to investigate this relationship, using prospectively collected data from our internal total hip replacement database. Our primary endpoint was the risk of infection based on the 2018 International Consensus Meeting (ICM) definition of periprosthetic infection.[16] We reviewed a consecutive series of patients who underwent primary total hip arthroplasty (THA) between 2015 and 2019. 6,052 of them received a CoP and 4,550 a MoP bearing. Patients inconclusive for PJI were excluded based on the 2018 ICM definition. Both acute and chronic PJI were included.

Patients who did not meet either of these criteria for infection at the time of most recent follow-up were considered uninfected. For patients undergoing revision for reasons connected to infection, culture results and causative pathogens were identified. Evidence of adverse local tissue reaction (ALTR) noted in the operative report based on macroscopic observation or patient record was also recorded.

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The statistical analysis consisted of descriptive statistics, univariate analysis, and regression modeling. Compared to the CoP patient cohort, the MoP cohort was older, included more females, had a higher body mass index, and was more commonly affected by comorbidities.

Four times more reinfections with MoP

The most important finding was the significantly higher rate of PJI in patients receiving MoP implants compared to CoP (2.40% vs 1.64%). This association remained significant when adjusted for confounders including age, sex, BMI, and Charlson Comorbidity Index. While we did not find a significantly higher rate of reinfection within one year of revision, after the first year, patients initially treated with MoP showed reinfection rates that were almost four times higher than those seen in CoP patients (12.6% vs 3.6%, p=0.031). This finding is consistent with basic science studies suggesting permanent pro-inflammatory changes promoting leukocyte recruitment to the environment surrounding prosthetic joint implants. This may be a result of the hypothesized "trojan horse" mechanism.[17-19]

Total revision-free survivorship (p=0.017) and infection-free survivorship (p=0.006) were both significantly higher in the CoP group. While rates of ALTR were similar between the groups, these findings provide strong clinical evidence that MoP implants present a higher risk for PJI than CoP implants.

Chemotaxis

The causal relationships or mechanisms of infection with metal bearings surfaces remain unclear. It is well established that the local toxicity of these metal ions is associated with ALTR, adverse reactions to metal debris (ARMD), inflammatory pseudotumors and local osteolysis.[20,21] Based on alterations in native host tissues and increased T-lymphocyte migration, the local and systemic toxicity of these metal ions has also been increasingly taken into focus.[22-24] One of the possible mechanisms considered describes that CoCr wear particles and ions released by the implant induce a pro-inflammatory response that ultimately chemoattracts leukocytes, including macrophages and neutrophils, to the surgical site. In other words, there is a "trojan horse" mechanism: the neutrophils and macrophages transport intracellular pathogens from a remote site and bring them to the prosthetic joint via chemotaxis because of specific cytokines at the site of ALTR.[17-19]

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Despite the lack of a definitive description of the biological mechanisms involved, all clinical evidence to date shows an increased risk of biological complications with metal bearings. These findings may also lead the orthopaedic community to further consider ceramic bearing surfaces for other joint replacements such as total knee arthroplasty or dual mobility hip implants. Previous data have shown that modular junctions for each of these implant types create cobalt and chromium ions.

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