WEAR AND FRICTION CHARACTERISTICS OF THE TRI-POLAR ALL CERAMIC HIP PROSTHESIS

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Materials and Methods
The tri-polar hip prosthesis (CeramConcept L.L.C., USA) comprised a 22 mm ceramic head, a 22/32 mm mobile ceramic head, a 32 mm internal diameter ceramic acetabular insert, and a polyethylene retaining ring. All ceramic components were manufactured from BioLoc Delta ceramic matrix composite (CeramTec AG, Germany).

The wear of the tri-polar bearing was compared to a 28 mm ceramic on ceramic (BioLoc Delta) bearing couple in the Leeds II Physiological Anatomical hip joint simulator over 5 million cycles, using 25% bovine serum as the lubricant and the results were determined gravimetrically.

Results
The wear rates for the tri-polar and conventional Bioloc Delta hip bearings are detailed in Table 1. Under standard conditions the wear of the tri-polar and conventional ceramic on ceramic bearing were very low. The wear of the tri-polar all ceramic hip was less than 0.01 mm³/million cycles, the detection limit for wear measurement, while the conventional ceramic on ceramic bearing produced a wear rate of 0.07 mm³/million cycles. The difference between these very small wear rates is not clinically significant. Under micro-separation conditions even lower wear was observed for the tri-polar bearing due to the absence of edge loading and hence absence of stripe wear. The design of the tri-polar bearing with the mobile ceramic head prevented edge loading of the head on the edge of the cup, so significantly reducing wear under these severe, but clinically relevant micro-separation conditions.

Discussion
Low wear rates of under 1 mm³/million cycles for BioLoc Delta ceramic on ceramic hip prostheses under both standard conditions and micro-separation has been previously reported [4]. Under standard conditions even lower wear was observed for the tri-polar bearing due to the small head diameter. The majority of the sliding distance in the tri-polar hip occurred at the 22 mm diameter ball head, and since wear is proportional to the sliding distance this resulted in lower wear than a conventional 28 mm ceramic hip.

Under micro-separation conditions the wear of the tri-polar bearing was low due to the absence of edge loading and hence absence of stripe wear. The design of the tri-polar bearing with the mobile ceramic head prevented edge loading of the head on the edge of the cup, so significantly reducing wear under these severe, but clinically relevant micro-separation conditions.

The tri-polar hip also showed improved frictional characteristics with a reduced frictional torque due to articulation at the smaller diameter 22 mm inner femoral head.

Table 1 Wear Rates (mm³/million cycles) ± Standard Error for Tri-polar and Conventional BioLoc Delta Ceramic on Ceramic Bearings

<table>
<thead>
<tr>
<th>Condition</th>
<th>Tri-polar</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard ISO</td>
<td>&lt;0.01</td>
<td>0.07 ± 0.03</td>
</tr>
<tr>
<td>Micro-separation</td>
<td>&lt;0.01</td>
<td>0.16 ± 0.05</td>
</tr>
</tbody>
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Table 2 Coefficient of Friction for Tri-polar and Conventional BioLoc Delta Ceramic on Ceramic Bearings

<table>
<thead>
<tr>
<th>Condition</th>
<th>Friction Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tri-polar</td>
<td>0.02</td>
</tr>
<tr>
<td>Conventional</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Conclusion
The tri-polar all ceramic hip prosthesis examined in this study showed improved wear and friction characteristics in comparison with a conventional BioLoc Delta ceramic on ceramic bearing. Most importantly wear could not be detected under micro-separation conditions, and stripe wear was not observed.

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References

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Replacement surgery of hip joint consists of the substitution of the joint with an implant able to recreate the articulation functionality. This article aims to review the current state of the art of the biomaterials used for hip implants. Hip implants can be realized with different combination of materials, such as metals, ceramics and polymers. In this review, we analyze, from international literature, the specific characteristics required for biomaterials used in hip joint arthroplasty, i.e., being biocompatible, resisting heavy stress, opposing low frictional forces to sliding and having a... Materials for Hip Prostheses: A Review of Wear and Loading Considerations. by. Massimiliano Merola. The tripolar bearing with the mobile ceramic head show very high resistance to wear and stripe wear. To date, functional and radiological results confirm the preclinical studies. Keywords. Jennings, L M; Fisher, J; Stewart, T D; Masson, B; Lazennec J-Y. Wear and friction characteristics of the tripolat all ceramic hip prosthesis. Annual Meeting of the Orthopaedic Research Society 2006 poster 498Google Scholar. 7. Predicting wear of ceramic-ceramic hip prosthesis using finite element method for different radial clearances. S. Shankar. Materials Science. A Three-Axis Hip Joint Simulator for Wear and Friction Studies on Total Hip Prostheses. V. Saikko. Engineering, Medicine. Laboratory wear tests and clinical observations of the penetration of femoral heads into acetabular cups in total replacement hip joints: II: A microscopical study of the surfaces of Charnley polyethylene acetabular sockets. A hip prosthesis is an artificial joint used to replace all or part of a damaged hip during a hip replacement procedure. The characteristics of the materials used in this type of prosthesis mimic the ball-and-socket action of a natural human joint. Hip replacement is usually recommended in cases of osteoarthritis or rheumatoid arthritis. What is a hip prosthesis made of? The implant can be made from strong plastic, typically polyethylene, ceramic and various metals such as: stainless steel, cobalt, chrome, titanium alloys. The insert allows the hip to move easily. A metal or ceramic sphere that replaces the round (upper) head of the femur. A metal stem that is attached to the femur to give more stability to the joint. What are the different types of hip prostheses? The wear patterns of the ceramic components of the prosthetic head indicate the role of microseparation that occurs during implant functioning. Discover the world's research. 19+ million members. Tabulum is the most intrinsic characteristic of the artificial joint, especially in young patients who lead an active lifestyle. is to analyze the wear results of the ceramic-ceramic friction pair of hip endoprosthesis after. 25 years of operation in the patient's organism. Materials and methods.