Contribution of Surface Polishing and Sterilization Method to Backside Wear in Total Knee Replacement

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Introduction: Polyethylene wear is a well-established detriment to the longevity of total knee replacement. While most wear occurs at the condylar surface of the polyethylene tibial insert, the backside surface has also been identified as a potential source of debris. Modern gas-plasma polyethylene sterilization is known to reduce polyethylene wear compared to historical gamma-air sterilization. The purpose of this study was to compare the relative contributions of backside wear from polished and roughened tibial baseplates and the difference between sterilization methods.

Methods: From a total of 79 retrieved implants, three groups of tibial inserts of the same design were matched based on tibial baseplate design and polyethylene sterilization: roughened gamma-air, polished gamma-air, and polished gas- plasma. Damage scoring was used to establish the presence of seven common damage modes. Each insert was also scanned with micro-CT to generate deviation maps, from which the maximum penetration was measured.

Results: Total backside damage was higher ($p=0.045$) in the roughened gamma-air group (13.8 ± 3.4) compared to the polished gamma-air group (8.7 ± 3.4) and the polished gas-plasma group (8.2 ± 4.8). Backside wear rates were greatest ($p=0.02$) in the roughened gamma-air group (0.038 mm/year), followed by the polished gamma-air group (0.012 mm/year), and lowest in the polished gas-plasma group (0.009 mm/year).

Conclusion: Sterilization with gas plasma improved wear resistance compared to sterilization with gamma air, consistent with previous findings. With this knee system, use of a roughened tibial baseplate over a polished tibial baseplate had an even greater effect on wear magnitude than sterilization method. The effect of implant locking mechanisms was not investigated but could also contribute to wear. Use of a TKR implant with a polished tibial baseplate is preferable for preventing backside wear debris generation.