Retrieval Analysis For Hinge Knee Megaprostheses

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Introduction

- Megaprostheses are one of the most common implants used for reconstruction after segmental resections of long bones in the extremities for their fixation [1]
- Rotating Hinge Knee implants are one kind of megaprostheses used in Knee Replacement surgeries to help with good function and immediate fixation [2]
- Despite benefits, many complications often arise due to the complexity of the procedure, with mechanical failures and infections being revision reasons. [3]

Objective

The purpose of this study was to evaluate the prevalent damage modes and the predominant cause of failure for both the polyethylene and metallic components of the rotating hinge knee megaprostheses.

Methods

- 37 megaprostheses were sorted from over 100 implants that were received from 9 hospitals: CCF, HUMC, JH, RI, SHB, UP, HN, TOC And UPMC. All the implants came from 3 manufacturers: Stryker, Zimmer-Biomet And Depuy
- Using previously established databases such as patient op-notes, surgical notes, radiographs and retrieved implant images, all important information was corroborated and organized with all the necessary data present such as revision reasons, XRF data, age, material, cement, implantation time, etc.
- To examine the damage on each of the implants, the surface damage scoring process was conducted for the polyethylene components based on Kahlenberg Method where each implant was examined for scratching, pitting, burnishing, abrasion, delamination, surface deformation and embedded debris. [4]

Figure 1. *Components of Rotating Hinge Knee Implant.*

SCORE	Description
0	Damage not present
1	Damage existent in less than 10% of the surface
2	Damage existent in 10-50 % of the surface
3	Damage existent in more than 50% of the surface

Table 1. *Kahlenberg Grading/Scoring Sheet.*

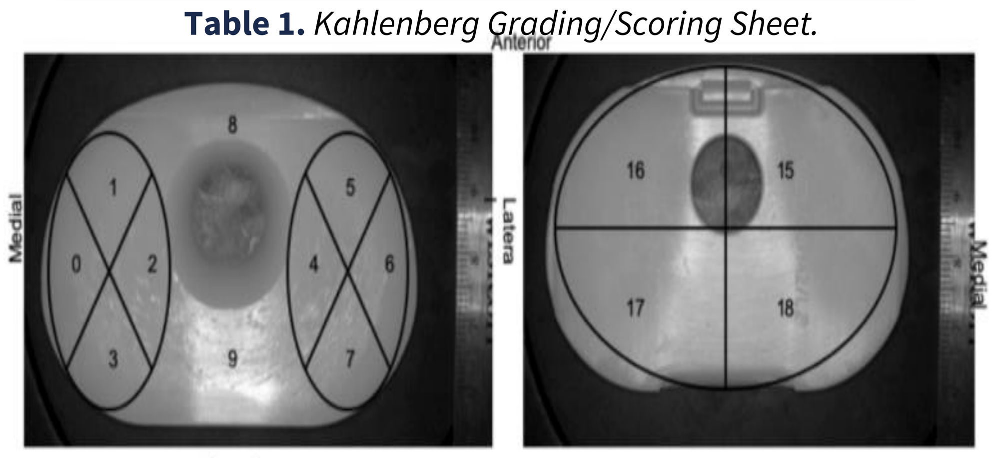

Figure 2. *Polyethylene Scoring Zones And Labels.*

- All the metallic components were scored for surface damage, where each implant was examined for scratching, burnishing, discoloration and fretting corrosion. The materials were identified with XRF, and damage was observed visually and using light microscope. Every region except for fretting corrosion was scored using the Kahlenberg method from 1-3. But fretting corrosion, was scored from 1-4. The Metallic scoring zones were the Femoral condyle(A), Femoral stem(B), Tibial axle(Top C), Tibial baseplate(Bottom C) and Hinge pin(D). [4]

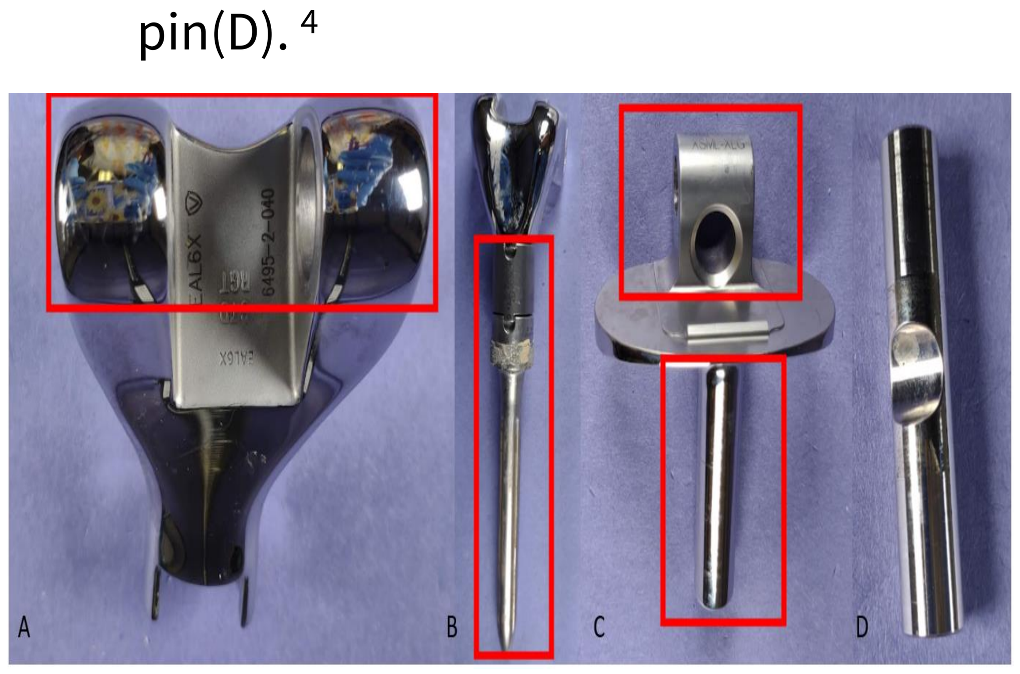

Figure 3. *Metallic Scoring Zones And Areas*

SCORE	Description
1	Fretting present in less than 10% of the surface; Corrosion not present
2	Fretting corrosion present in more than 10% of the surface and/or corrosion attack confined in one or more small areas
3	Fretting corrosion present in less than 30% of the surface and/or aggressive local corrosion attack with corrosion debris
4	Damage over majority of the surface (>50%) with severe corrosion attack and abundant corrosion debris

Table 2. *Fretting Corrosion Grading/Scoring Sheet*

- Due to the large amounts of data as well time constraints, the only implants whose data we were able to analyze was Stryker's rotating hinge knee

Results

- Infection was the most predominant revision reason among all the implants.
- Scratching was the most prominent damage mode observed for all the metallic components and fretting corrosion was the least observed.
- For the polyethylene inserts, scratching, pitting and burnishing had the highest recorded damage modes. Abrasion, delamination, surface deformation and embedded debris had the lowest recorded damage modes amongst the polyethylene components.

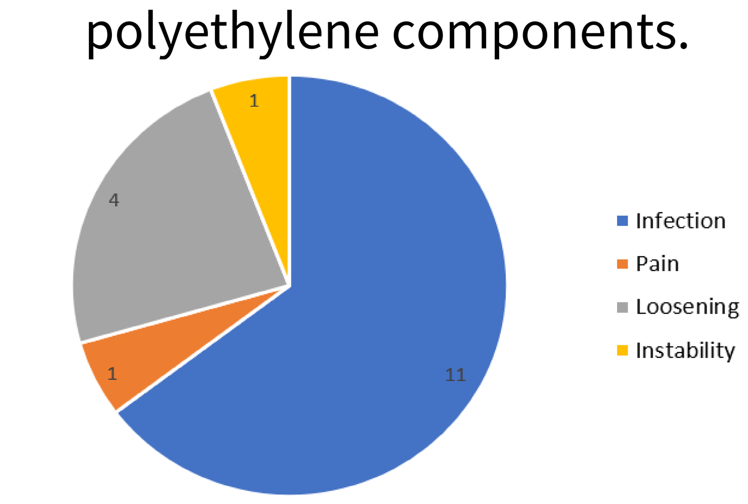

Figure 4. *Number of patients per revision reason*

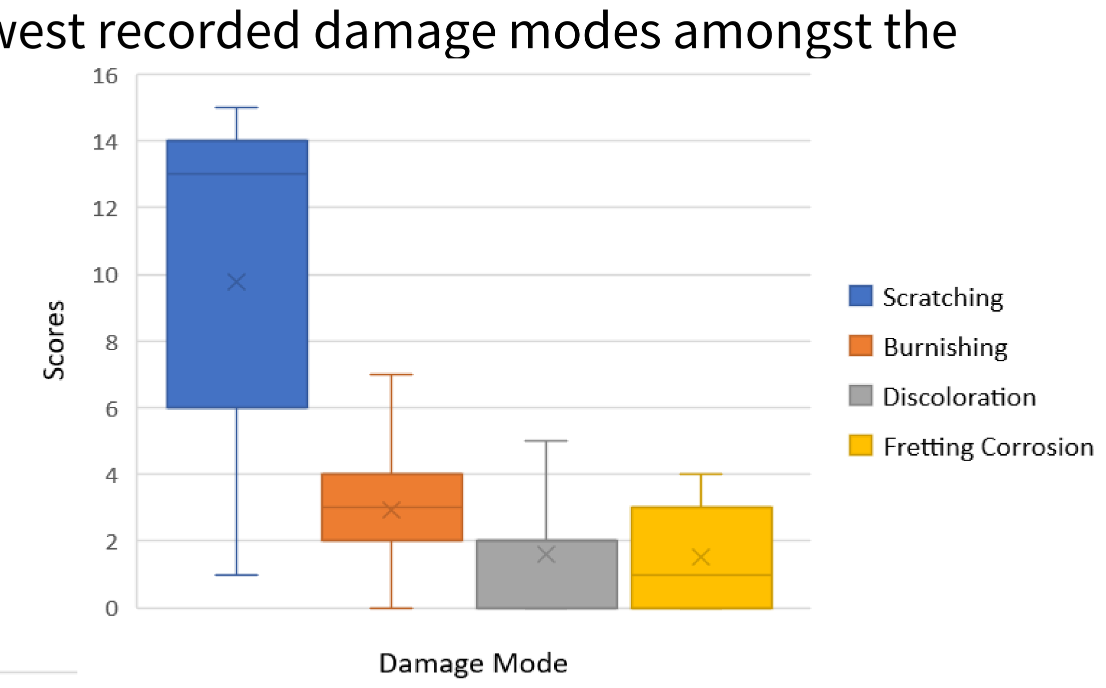

Figure 5. *Damage scores for all the metallic components*

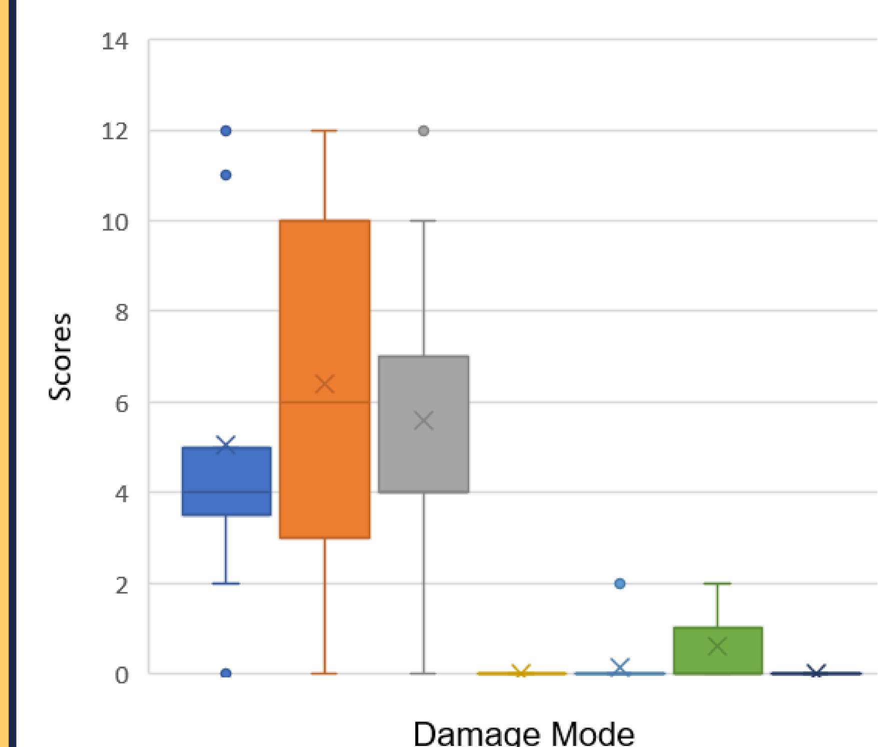

Figure 6. *Damage scores for inferior polyethylene surface*

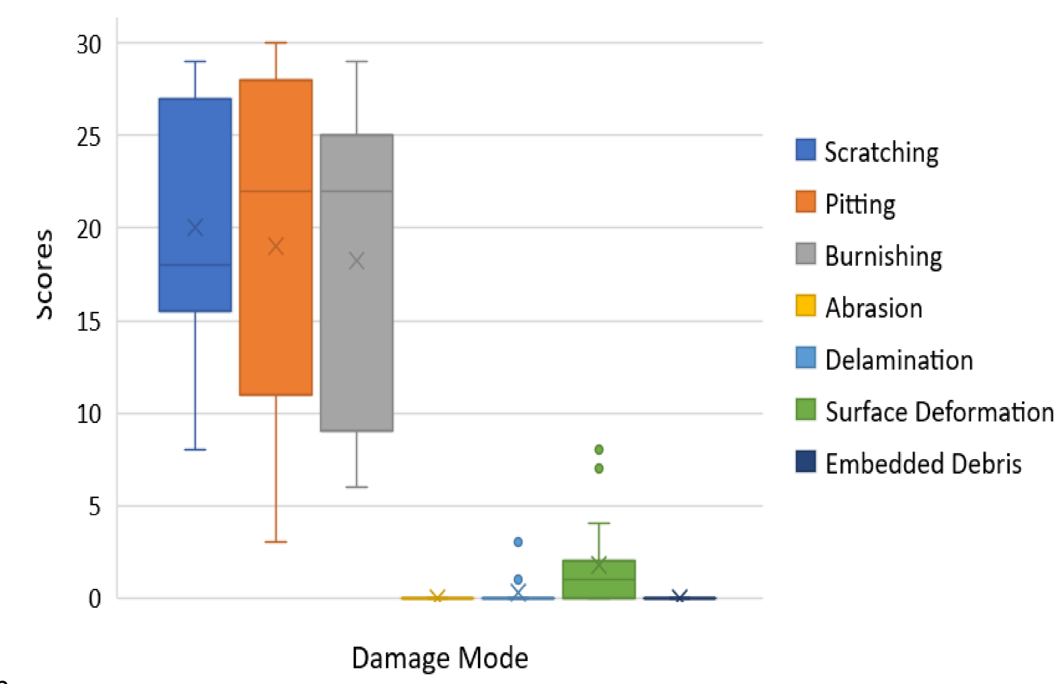

Figure 7. *Damage scores for superior polyethylene surface*

- No significant difference between medial and lateral side (p=0.884) and significant difference between anterior and posterior side(p<0.001)

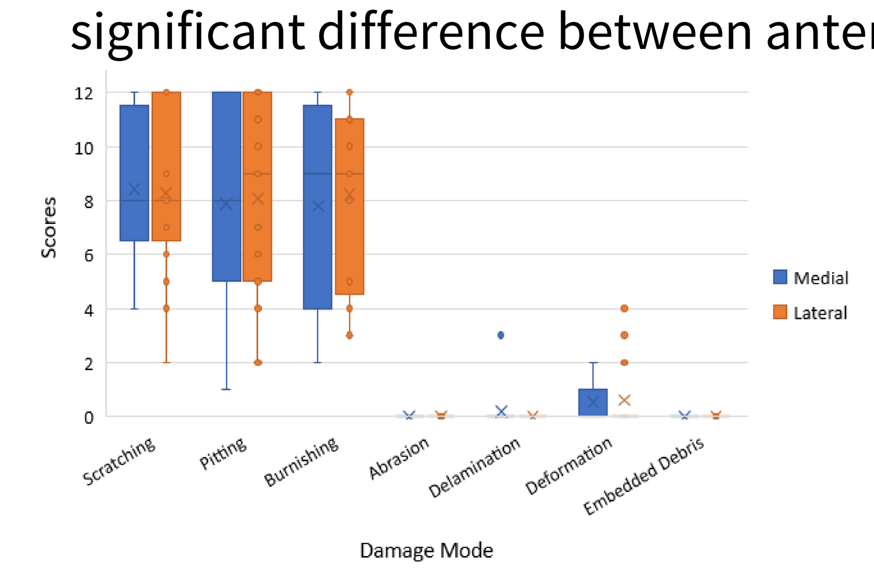

Figure 8. *Comparison of Damage on Medial and Lateral side*

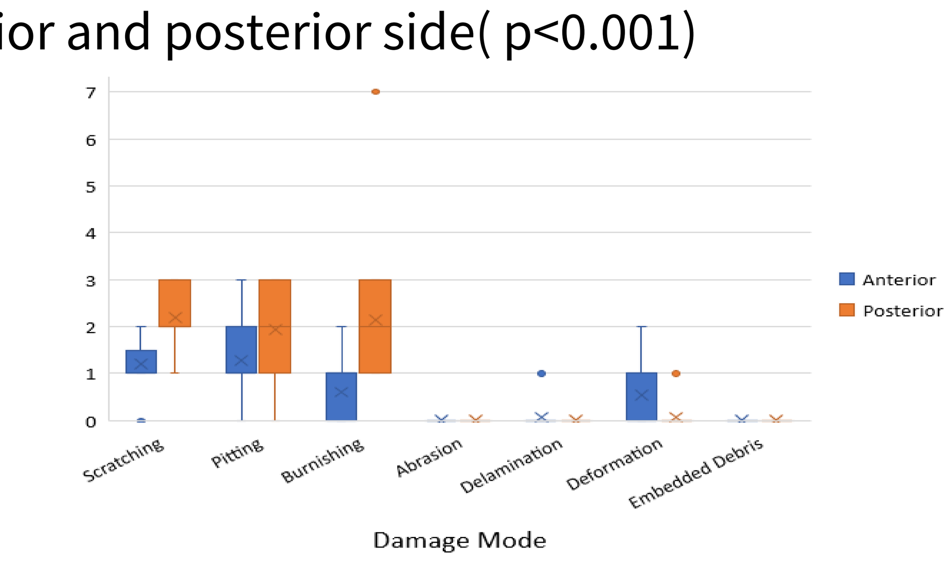

Figure 9. *Comparison of Damage on Anterior and Posterior side*

Discussion

- Infections being the predominant revision reason is consistent with previous studies that were conducted about implant revisions and failure.
- There was less fretting corrosion observed on the metallic components due to most of them being metal on polyethylene rather than metal on metal implants.
- More damage was observed on the posterior side of the polyethylene compared to the anterior side primarily because of there being far more rotation on the posterior side when compared to the anterior side.

References

[1] *Pala, E., Trovarelli, G., Angelini, A., Maraldi, M., Berizzi, A., & Ruggieri, P. (2017, June 7). Megaprosthesis of the knee in tumor and revision surgery. Acta bio-medica : Atenei Parmensis.* [2] Abdulkarim, A., Keane, A., Hu, S. Y., Glen, L., & Murphy, D. J. (2019). Rotating-hinge knee prosthesis as a viable option in primary surgery: Literature review & meta-analysis. Orthopaedics & Traumatology: Surgery & Research, 105(7), 1351-1359.[3] Kahlenberg, C. A., Baral, E. C., Lieberman, L. W., Huang, R. C., Wright, T. M., & Padgett, D. E. (2021). Retrieval Analysis of Polyethylene Components in Rotating Hinge Knee Arthroplasty Implants. The Journal of Arthroplasty. [4] Kahlenberg, C. A., Baral, E. C., Lieberman, L. W., Huang, R. C., Wright, T. M., & Padgett, D. E. (2021, April 13). Retrieval analysis of POLYETHYLENE components in ROTATING HINGE Knee Arthroplasty implants. The Journal of Arthroplasty.

Acknowledgments

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