Retrieval Analysis' Contributions to Orthopedics

Carlos Rodrigo de Mello Roesler[1], Enrico Baldessar Fava[1], Renir Reis Damasceno Neto[1], Alan de Paula Mozella[2], Lourenço Pinto Peixoto[2], João Matheus Guimarães[2], Patricia Ortega Cubillos[1]

[1]Laboratório de Engenharia Biomecânica (LEBm/UFSC), [2]Instituto de Traumatologia e Ortopedia (INTO)

Email of Presenting Author: f.enrico27@gmail.com

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INTRODUCTION: Hip and knee arthroplasties are one of the most successful fields in orthopedics today. However, this panorama is not free of problems and adverse events. Some medical devices systematically fail during clinical use. Despite the existence of National Arthroplasty Registries in several countries, including pioneering Sweden (1970), Australia and the United States, revision surgeries associated with implant failure are not clearly reflected in these data due to their small number compared to the volume of primary surgeries performed. Retrieval analysis of implants removed from patients appears to be a potential alternative for identifying designs and techniques with poorer performance in a short space of time. This work proposes to elucidate the potential of retrieval analysis to enhance orthopedics devices and support medical decisions.

METHODS: A literature review of retrieval analysis in hip and knee arthroplasty was conducted. The included articles discussed information of prostheses similar to those received by the Centro Nacional de Explantes from Brazil. The utilized databases included Scopus and Pubmed. The articles filled the following selection criteria: (a) studies that applied retrieval analysis in orthopedic prostheses; (b) articles published in peer reviewed scientific journals; (c) studies with full text available.

RESULTS SECTION: Following the proposed guidelines, seven studies were chosen to be presented as examples of retrieval analysis effectiveness (Table *1*).

DISCUSSION: The research published by Gilbert et al. (2014), Bistolfi et al. (2021), Zein et al. (2021) amidst others, led to an improvement in implant design for the two most common orthopedic prosthesis, hip and knee. Gilbert et al. (2014) research in knee prostheses evaluated two designs, where through retrieval analysis and numeric simulations an improvement in the curvature angle of the knee insert posts was implemented, reducing stress in the interface between anterior and lateral edges of the post. In hip prostheses, Zein et al. (2021) evaluated 157 explants, comparing the effect of fretting-corrosion damage severity caused by different femoral head diameters, materials, and femoral stem taper geometry, where ZTA – zirconia-toughened alumina 32 mm heads and 12/14 tapers presented the best medium-term results, which is an indication of better combinations of femoral head diameter and taper angle could lead to better results long term. Bistolfi et al. (2021) evaluated the fractured surface of two ceramic insert liners through electronic microscopy, suggesting that the failure was caused due to intra and postoperative reasons, such as component positioning, instead of materials defects, highlighting the importance of correct intraoperative techniques for proper design performance. Considering shoulder prothesis, the research published by Nicholson et al. (2022) and Kurdziel et al. (2018): Nicholson et al. (2022) studied 21 humeral liners examining them under light microscope and damage on the articular and backside of the liner surface was graded using the modified Hood score. The location and damage modality were compared between the articular side and backside of the implant, demonstrating the backside wear was present in almost all liners, which could indicate that better locking mechanisms or micromovement reduction could hinder wear particle generation; Kurdziel et al. (2018) evaluated the humeral liner deviation and the volumetric wear for 32 explants, and the retrieved and unworn liners underwent micro-computed tomography scanning, so the retrieved liner volumes were isolated, co-registered to controls of matching geometry, and surface deviations of the articulation surface and rim were computed, concluding the volumetric and articulation surface wear in the liners is correlated to term-of-service.

SIGNIFICANCE/CLINICAL RELEVANCE: The use and study of retrieval analysis techniques has been proving itself a valuable tool in the evaluation and continual improvement of arthroplasty prosthesis designs, as of surgical technique. The conducted analyses also contribute to implant performance evaluations.

Table 1 - Article Summarization Table.

Orthopaedic Field	Author	Year	Number of explants analyzed	Methods	Equipments
Knee	Gilbert et al.	2014	80	Numerical analysis	Patran MSC software and Abaqus software
Hip	Bistolfi et al.	2021	2	Morphological and compositional analyses	Scanning Electron Microscope Zeiss FESEM
Hip	Zein et al.	2021	157	Goldberg fretting-corrosion damage severity	Light microscope Zoom MZ-16
Shoulder	Nicholson et al.	2022	21	Modified Hood damage severity	Light microscope (10-30 magnification)
Shoulder	Kurdziel et al.	2018	32	Geometric deviation and the volumetric wear	VivaCT-80 Scanco Medical AG scan, MATLAB software,