

# A Comparative Analysis Between Evaluated Area of Macroscopic Damage Analysis and Total Condyle Area of Knee Retrieval Inserts

Enrico Baldessar Fava<sup>1</sup>, Patricia Ortega Cubillos<sup>1</sup>, Gean Vitor Salmoria<sup>1</sup>, Alan de Paula Mozella<sup>2</sup>, João Matheus Guimarães<sup>2</sup>, Carlos Rodrigo de Mello Roesler<sup>1</sup>

<sup>1</sup>Laboratorio de Engenharia Biomecanica (LEBm/UFSC), <sup>2</sup>Instituto de Traumatologia e Ortopedia (INTO)

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

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**INTRODUCTION:** Macroscopic damage analysis has been long utilized as a preliminary evaluation of wear mechanisms on polyethylene tibial knee inserts, since its introduction by Hood et al. (1983). This method has been applied and utilized numerous times in the literature since its conception, and yet it is unclear how much of the actual area is evaluated in each region, given the standard 10x magnification utilized in the method. Studies of older generation prosthetic designs such as Collier et al. (1991) using Fuji film demonstrate areas of contact between 20 to 70 mm<sup>2</sup>, depending on model and varus offset. Utzschneider et al. (2010) demonstrated the growth of the contact area through in vitro testing. Therefore, understanding the ratio between total condyle area and the total evaluated area in the macroscopic analysis of knee wear is imperative to present meaningful wear retrieval analysis results. To the best of the authors knowledge, this is the first study to address the matter.

**METHODS:** Three insert model PFC Sigma (Depuy) were used in the evaluation (sample 1 was size 4 and sample 2 & 3 were size 2.5). As the model has congruent condyles, only one condyle of each was photographed for the study. Firstly, the standard evaluation was carried out, where one image of each of the four regions was taken. The area of the image was calculated utilizing the ImageJ software, for a standard image size of 110,17mm<sup>2</sup>. Then, each condyle was photographed in its entirety, totalizing ten images. These were reconstructed as a single image for each sample. Lastly, the total of the four pictures in the standard evaluation and the reconstructed image were compared. In a complementary manner, the total affected area of each region was evaluated, through the standard method using area score, through a quantitative method of the four images using percentage, and quantitatively for the whole condyle using percentage.

**RESULTS SECTION:** For the standard evaluation, a single condyle has a total of 440,68mm<sup>2</sup> evaluated through four images. Sample 1 has a total condyle area of 640mm<sup>2</sup>, while sample 2 and 3 have 600mm<sup>2</sup> total condyle area. The comparison for evaluated size resulted in 69% evaluated area for sample 1 and 73% evaluated area for samples 2 and 3. The comparisons of the damage evaluation for the three samples resulted in great agreement for sample 1, having no differences in total damaged area score and the calculated percentages falling inside the range for the scores; sample 2 showed good agreement with some differences; sample 3 showed no difference, given that the entirety of the condyle surface was damaged.

**DISCUSSION:** Through this analysis it is possible to ascertain that the standard imaging and scoring method developed by Hood is representative of the whole condyle surface given that wear and critical tension and shear forces occur at specific zones and not the entire condyle surface. It is also comparable to quantitative analysis of regions utilizing imaging manipulation software's such as ImageJ. The limitations of this study include the small range of samples and implant sizes.

**SIGNIFICANCE/CLINICAL RELEVANCE:** The understanding of damage modes and locations from retrieved implants may guide new designs to overcome performance limitations of old models, improving the clinical results. Better understanding the capabilities of the macroscopic evaluation of wear in retrieved tibial inserts is valuable for such as extensively used technique for the past 40 years, which continues to prove its usefulness and relevance in preliminary evaluation of wear.

Table 1 - Standard score and Percentile Scores Comparison for the Samples

Sample/Area	Standard Score	Percentage Damage Score	Total Condyle Percentage Score
Sample 1	A1	2	24,69
	A2	2	28,96
	A3	3	52,00
	A4	2	10,19
Sample 2	A1	3	40,24
	A2	3	56,00
	A3	3	49,80
	A4	3	43,37
Sample 3	A1	3	100
	A2	3	100
	A3	3	100
	A4	3	100

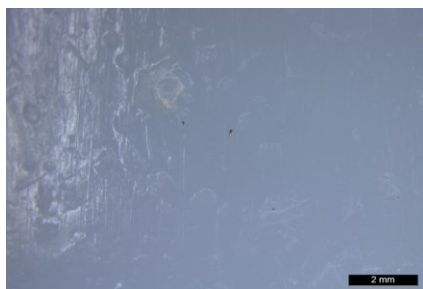


Figure 1 - Representation of Standard Evaluation Image