Medial vs. Lateral Thinning in Retrieval Series of Four Knee Designs

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Introduction: A number of biomechanical studies conclude that the load passing through a TKA is, on average, greater in the medial compartment than the lateral. [1-3] Other studies demonstrate more motion in the lateral compartment than the medial. [4,5] This leads to the question of whether load or motion is a greater contributor to wear. Wear of polyethylene tibial inserts has been cited as being responsible for up to 25% of revision surgeries [6] but accurate measurement of material loss from retrieved knee bearings presents difficult challenges because gravimetric methods are not useful with retrievals and unworn reference dimensions are often unavailable.

The objective of the current study is to quantify dimensional changes of tibial inserts in a large series of retrieved knees. This allows us to focus on the in vivo abrasive/adhesive wear performance and to make comparisons between medial and lateral wear. In pursuit of this objective, we aim to establish a methodology for determining reference thickness of retrieved knee inserts where design dimensions are not available.

Methods: The archive from an IRB approved retrieval program was queried for modular fixed-bearing tibial inserts over a range of in vivo durations (0-185.8 mos., mean 63.1 mos.). Inserts that had received modified Hood method [7] cracking or delamination ratings greater than 0 were excluded. This survey resulted in four series of knees for measurement: 276 Sigma (DePuy/Synthes, Warsaw IN), 52 NexGen (Zimmer, Warsaw IN), 27 Triathlon (Stryker, Mahwaw NJ), and 16 Genesis II (Smith & Nephew, Memphis TN). The minimum thicknesses within the medial and lateral condylar bearing areas of each insert were measured using a dial indicator with 3-mm radius ball end contacts.

As-manufactured reference thickness was estimated by using the average of the short-duration retrievals (< 10 months) from each thickness designation of each device design [8]. Geometric data from one device (Sigma) were made available by the manufacturer, which allowed validation of the reference thickness determination using the short duration retrievals. A comparison was made between the average of the short-duration retrievals’ thickness and the nominal manufacturer’s dimensions for three of the most common categorical thickness designations (8 mm (n = 14), 10 mm (n = 12), and 12 mm (n = 14)) of the Sigma design.

Through-thickness dimensional change for each condyle of each insert was calculated by subtracting the measured thickness dimension from the reference dimension.

One-tailed, paired student t-tests were conducted to compare medial and lateral changes of all the retrievals and of each design.

Results: The short-duration reference methodology was shown to be a valid approach. The results showed that while individual measurements exceeded manufacturer’s tolerances in some cases, the average measured thicknesses fall within the manufacturer’s tolerance range of +/- 0.005 inches (Figure 1). Manufacturer’s thickness designations are in mm but nominal dimensions are reported in inches.

The paired t-test showed that thinning of the medial condyle is significantly greater than thinning of the lateral condyle for the aggregate series (p < 0.001) (Figure 2). When the data are separated by knee design, each of the four series also show greater thinning on the medial side: Sigma: p < 0.001, NexGen: p = 0.05, Triathlon: p = 0.001, Genesis II: p = 0.01.

Discussion: When design dimensions are not available, using the average measurements of short-duration (<10 months in vivo) retrievals proved to be a reasonable method to estimate as-manufactured reference thickness in retrieved knee inserts. Having this methodology established greatly expands the number of retrieved knee devices for which in vivo dimensional change can be quantified. This allows measurement and comparison of different designs and materials with a sample population much greater and more representative than has been available before. The current study shows that thinning of the medial compartment was greater than thinning of the lateral compartment for the overall population tested, and also for each individual design. More retrieval devices over a larger spread of durations are needed to compare dimensional change rates between different knee designs and different materials.

Significance: Quantification of in vivo knee deformation and wear is possible via averaging of short-duration device dimensions even when no as-manufactured data are available. Using this technique as a basis, this study shows that more thinning occurs on the medial side than on the lateral side of the knee.

Acknowledgments:
8. Van Citters et al., In vivo dimensional change of UHMWPE tibial inserts. ORS
Figure 1: Thickness of short-duration (< 10 mo.) retrievals (average and range) compared to manufactured dimensions for three thickness designations of Sigma inserts.
Figure 2: Measured wear of the medial (x) and lateral (+) bearing areas of each retrieved insert in the aggregate series (n = 371). Medial wear was significantly greater (p < 0.001).