Post Damage in Three Contemporary Designs of Posterior-Stabilized Knee Components: Comparison to a Historical Gold Standard

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Introduction: Posterior-stabilized total knee arthroplasty (PS-TKA) has been used for more than three decades with satisfactory results. This procedure introduced the post-cam mechanism, which allows the patient a greater range of movement and femoral rollback, at the expense of the posterior cruciate ligament. Despite its success, some concerns remain regarding post damage and transmission of anteroposterior stresses to the articular and inferior surfaces of the tibial insert. Our aim was to study the mechanisms of damage at the post in three contemporary PS-TKR designs and compared them with a historical gold standard. We hypothesized that different PS designs would suffer from different wear damage mechanisms at the post. Our secondary hypothesis was that post damage would be associated with articular condylar and backside wear.

Materials and Methods: 102 PS knee inserts were collected after revision surgery from two institutions. They were classified into 4 groups: Control (Insall/Burstein II; Zimmer), Design “A”, Design “B”, and Design “C” (Table 1).

The patients were 57F and 45M, on average 62y at insertion (range: 39-86y) and weighed 197.9 lbs (112.2-282.7lbs). The knee inserts were implanted for an average of 4.2y (0.05-18.2y). The most common revision reasons were loosening (n=36), infection (n=24), instability (n=8) and PE wear (n=8). The average patients’ weight and age were not significantly different for the three design groups.

Wear damage was evaluated according to Hood et al. [1]. The articular, inferior and post surfaces were inspected to assess the seven damage modes (scratching, pitting, burnishing, abrasion, delamination, surface deformation, embedded debris) scores, which ranged from 0 (no damage) to 3 (severe damage) [2]. The condylar, backside and post surfaces were divided into 10, 4 and 4 regions, respectively, giving maximum scores of 210, 84 and 84, respectively.

A digital photogrammetry technique [3] was used to better quantify the extent of wear on the front and backside surfaces of implants. The surfaces of the implants were measured first, and then areas of adhesive/abrasive and fatigue wear were subsequently outlined and measured.

Student t-tests served to assess differences between knee designs in the wear scoring and photogrammetry results. In addition, the influence of the design on damage scores was studied by using a linear model with implantation time as a covariate. Non-parametrical statistical methods (Spearman’s correlation) were used to confirm associations (p<0.05) between patient factors, implant factors and damage assessments.

Table 1. Wear score results for each PS knee design. A, B, C T-test: levels connected by different letters are significantly different

Results: IBII retrievals showed the highest damage scores among the 4 groups, except for the inferior surface (Table 1). As for the damage modes, scratching and burnishing prevailed at the post surfaces, whereas scraping and pitting were predominant in the bearing and inferior surfaces, regardless of the design (Figure 1). Surface deformation and delamination were also found in all the regions, but with lower scores. We observed a significant correlation between the condylar and posterior wear scores of Control (rho=0.39/p=0.02), Design B (rho=0.41/p=0.02) and Design C (rho=0.49/p=0.03) inserts. However, the backside wear score did not correlate either with in vivo time or post damage for any of the designs. Implantation time was correlated with the Control condylar wear score (rho=0.46/p=0.01) and Design A post damage (rho=0.69/p<0.01). Moreover, the fitting of the global wear score results to a linear model confirmed the effect of implantation time on condylar and post damage, but no significant influences of the different designs (p > 0.05).

Discussion: Evidence of damage, usually scratching or burnishing, to the stabilizing post was noted for control and contemporary PS TKR designs. The extent of post damage was generally mild, and the post was generally not observed to suffer from severe fatigue wear. In general, the wear performance seemed to be scarcely sensitive to different designs, although the difference in the in vivo times for each group prevented from a more appropriate comparison. Nevertheless, the condylar and post wear damages followed an increasing trend with in vivo time, consistent with a fatigue mechanism, while the backside wear was less sensitive to it. More research, with the use of potentially more sensitive techniques (MicroCT), and with larger number of implants, is needed to confirm if the wear performance significantly differs between different PS designs.


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Fig. 1: A) Pitting and impingement B) Scratching, and C) burningish from retrieved PS inserts

Table 2. Photogrammetry results (% area) and t-tests for each PS knee design

Table 3. Photogrammetry results (% area) and t-tests for each PS knee design

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