Assessment of Damage on a Dual Mobility Acetabular System

Chelsea Koch, BS, Marcella Elpers, BS, Christina Esposito, PhD, Geoffrey Westrich, MD, Timothy Wright, Ph.D.,
Hospital for Special Surgery, New York, NY, USA.

Disclosures: C. Koch: None. M. Elpers: None. C. Esposito: None. G. Westrich: 3B; Stryker. T. Wright: None.

Introduction: Dual mobility total hip arthroplasty (THA) designs were introduced to increase stability and reduce the risk of dislocation by combining the reduced wear of a small femoral head and the benefit of stability from a large diameter femoral head. A recent hip simulator study demonstrated that dual mobility THA designs had similar wear rates to that of traditional single articulation bearings [1]. Similarly, current clinical reports have suggested promising results with dual mobility THA designs, especially in reducing dislocation rates [2-4]. At our institution, dual mobility bearings were coupled with a modular stem that has been associated with adverse local tissue reactions, requiring revision surgery. Therefore, we retrieved short term dual mobility bearings and were able to evaluate the polyethylene bearing surfaces of a dual mobility design to determine if evidence existed of (1) severe polyethylene damage and (2) motion at that bearing surface.

Methods: Thirty-six dual mobility highly cross-linked polyethylene liners were identified through our ongoing institutional review board approved implant retrieval program. Patient demographic data were collected from medical records including age at index, BMI, length of implantation, and revision diagnosis. The average patient age at index procedure was 65.4 ± 12.1 (52-86), and average BMI was 26.9 ± 6.6 (18.2-53.7). The average length of implantation was 15.7 ± 19.1 (2-96) months. Adverse local tissue reactions (ALTR) was the revision diagnosis in 17 cases, dislocation in 5 cases, periprosthetic fracture in 3 cases, allergic reaction in 2 cases, and aseptic loosening in 1 case. Thirty patients had monoblock cobalt-chromium alloy acetabular cups, and 6 patients had modular dual mobility (MDM) acetabular shells with cobalt-chromium alloy inserts. The most common outer diameter of the dual mobility polyethylene liner was 46mm. Of this series, 24 (66.7%) were paired with a modern modular neck stem design that was recently withdrawn from the market. Implant characteristics were determined by manufacturing markings on the components and confirmed with the manufacturer. Surface damage on the outer bearing of each cross-linked polyethylene acetabular liner was visually assessed. The outer bearing of the liner was divided into 12 zones, four quadrants each for the pole, equator, and rim (Fig. 1). Due to mobility of the polyethylene, orientation of each liner was standardized using the manufacturing markings on the rim. Each zone was scored based on the extent and severity of damage, on a scale of 0-3 (none to severe), for 7 modes of damage according to an established method [5] The maximum damage score for the outer bearing was 252. Rim impingement lesions were assessed using light microscopy. Damage scores were compared using a Kruskal-Wallis ANOVA on Ranks and Tukey test, when appropriate. P 6 months) were evaluated to determine the force required for dislocation of the cobalt-chromium femoral head from the polyethylene liner using a lever-out test. The outer diameters of these liners ranged from 40mm to 48mm. The assembled specimens were uniaxially loaded 100mm from the femoral head, at a rate of 20N/s. Force required for dislocation was compared...
between the liner groups, which were designated based on outer diameter, using a One Way ANOVA test. P<0.05 was deemed significant.

**Results:** On average, the outer bearings had a mild surface damage score, 51.4 ± 14.6 (max. 252). The dominant damage modes (p<0.05) were scratching (22.6 ± 7.4) and pitting (25.1 ± 8.5), (Fig. 2). There was no difference between the pitting and scratching damage scores for the pole, equator, or rim regions. Embedded metallic particles were observed on 7 of the 36 retrieved polyethylene liners (Fig. 3). Impingement was observed on three retrieved liners. Of the dislocations, two were intraprosthetic with dissociation of the 22mm femoral heads from the polyethylene. The other three were with monoblock acetabular cups with 28mm femoral heads, where the larger polyethylene bearings dissociated from the acetabular component. Thirty-two outer polyethylene bearings were measured with CMM, of which 20 had no wear, 6 had concentric wear, 2 had edge loading and 4 had multiple parallel scratches. The lever out assessment did not reveal a significant trend. The average lever out load for dislocation was 261 ± 52N. The average lever out moment that resulted in dislocation was 2.6 ± 0.5N*m. On average, the 48mm liners could withstand higher loads prior to dislocation; however, among all diameters no significant difference was found between the loads required for dislocation (p=0.0122).

**Discussion:** Dual mobility systems were designed to improve stability of the hip joint, especially for patients prone to dislocation. However, concern exists about the wear related implications of having another bearing articulation. In our series, while the outer bearing showed various amounts of pitting and scratching, many of the retrieved components had the original machine marks still visible on the outer bearing. This suggests that the outer bearing is not the primary source of motion, consistent with previous simulator studies [1]. Additionally, no distinct damage patterns emerged, though we had relatively short implantation times and many of the components were revised for issues not related to the dual articulation. The five dislocations in our study were surprising, but after further review, can be attributed to complicated revision cases, abnormal patient anatomy, and events that occurred immediately post-operatively. The instances of embedded debris on the outer bearing were also unexpected. The small metallic particles could be attributed to the plasma sprayed coating on the acetabular cup, to the head/neck junction, or to the modular stem junction. Further analysis of the metallic particles and their origin is warranted. While the outer bearing can provide some insight into the in vivo performance of these dual articulation devices, further assessment of the inner bearing and polyethylene locking mechanism is necessary to understand how all of these components perform as a system in vivo.

**Significance:** This is the first series of its kind to evaluate the damage performance of a dual mobility acetabular system in which none of the components were revised for bearing wear related reasons. These short-term data suggest that the outer bearing is not the primary source of motion within the dual articulation system.