Introduction: In total joint arthroplasty, third body particles can migrate between the articulating surfaces and result in accelerated wear, by directly abrading the polyethylene acetabular component and by scratching the metal femoral counterpart. Third body particles embedded in polyethylene acetabular components are a well-documented finding in total hip retrieval studies, and are suspected of being a major contributor to the variability of wear.

Hip joint subluxation is an under-appreciated means by which third body particles can potentially enter the closely conforming articular bearing space. THA subluxation is commonplace; retrieval studies have found a high rate of damage on the rim of acetabular liners, indicative of femoral neck impingement. A computational fluid dynamics model has provided quantitative support for the intuitive expectation that, during THA subluxation, joint fluid is drawn into the space that opens between the head and liner [1]. Third body particles suspended in this fluid would be convected to the articulating surfaces by this mechanism.

The present study was designed to test the hypothesis that occasional events of femoral head subluxation would increase the number of third body particles that enter the bearing space and become embedded in the acetabular liner, as compared to level walking cycles alone.

Materials and Methods: For each test, a fresh 28mm femoral head and matching fresh UHMWPE acetabular liner were attached to a femoral stem and an acetabular shell. The femoral stem was potted into a femoral fixture at 12° adduction. The metallic acetabular shell was potted into an acetabular fixture at 30° tilt. The femoral and acetabular fixtures (Figure 1) included rings around which a hip simulator mounted in an MTS 858 Bionix. The metallic acetabular shell was potted into an acetabular fixture at 30° tilt. The femoral and acetabular fixtures (Figure 1) included rings around which a hip simulator mounted in an MTS 858 Bionix. The joint motion simulator included a pair of concentric yokes that allowed control of rotations about flex/extension and ab/adduction axes, in addition to the load and endo/exorotation (about the vertical axis) available with the standard axial-torsional Bionix system.

Each head-liner pair was first preconditioned by six minutes of level walking at 1 Hz. After preconditioning, twenty-five grams of third body particles (CoCrMo beads sieved to 44 – 106 microns) were then injected into the system, where they circulated along with the synovial fluid analog. In five of the ten head-liner pairs tested, twenty flexion subluxation events were interspersed within the next two hours of walking cycles, with one subluxation event before every six minutes of walking. The subluxation event caused an average resultant separation of 3.5 mm between the head and liner centers of rotation. After the test period was completed, the number and location of embedded particles on the acetabular liner were determined.

Results: Subluxation during hip simulator testing dramatically increased the number of third body particles that became embedded in the bearing surface (Figure 2), from an average of 21 particles per liner in the walking-only group, to an average of 334 particles per liner in the walking-plus-subluxation group (p = 0.017, 1-tailed Student’s t-test).

Discussion: The present hip simulation experiment convincingly demonstrated that subluxation facilitates the entry of third body particles into the bearing space. Adding twenty intermittent subluxation events to two hours of level walking cycles in a hip simulator resulted in more than an order of magnitude increase in the number of third body particles embedded in the acetabular liner.

Third body debris becomes embedded into the acetabular liner at wear-critical locations, and subsequently scratches the femoral head. This can lead to increased wear of the acetabular liner. In contemporary total hip arthroplasty, third bodies unfortunately are a fact of life, due to the supervening desirability of component modularity and non-cemented fixation. Subluxation is also a fact of life, as is demonstrated by the multiple retrieval studies showing impingement damage on the acetabular liner. The potent combination of third body particles and hip subluxation needs to be borne prominently in mind when considering mechanisms of wear, both for presently available bearing couples and for contemplated future innovations.


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