

EPISODIC SUBLUXATION INCREASES THIRD BODY INGRESS AND EMBEDMENT IN THE THA BEARING SURFACE

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INTRODUCTION

In total joint arthroplasty, third body particles can migrate between the articulating surfaces and result in accelerated wear, by directly abrading the polyethylene liner and by scratching the metal femoral counterface. 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, involving separation between the head and liner subsequent to impingement, is a means by which third body particles could potentially enter the closely conforming articular bearing space. A computational fluid dynamics model has provided theoretical evidence that, during THA subluxation, joint fluid is drawn into the space that opens between the head and liner (Lundberg et al., in press). Third body particles suspended in this fluid would presumably 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.

METHODS

A cemented smooth femoral stem was potted into a femoral fixture at 12° adduction. A metallic acetabular shell was potted into an acetabular fixture at 30° tilt. For each test, a fresh 28mm femoral head and matching fresh UHMWPE acetabular liner were attached to the stem and shell. The specimens were placed in a multi-axis joint motion simulator (Figure 1) mounted in an MTS 858 Bionix. The joint motion simulator allows control of rotations about three axes, as well as control of axial load.



Figure 1: Total hip arthroplasty preparation in a multi-axis joint simulator, with third body particle circulation.

The femoral and acetabular fixtures included rings around which a hip capsule surrogate, consisting of thin plastic sheeting, was secured. The sheeting confined a glycerin-water mixture which served as a (viscosity-matched) surrogate synovial fluid. This fluid was kept circulating through the hip capsule surrogate throughout the test, by means of a peristaltic pump.

Each head-liner pair was first preconditioned by six minutes of level walking cycles. Twenty-five grams of metallic third body particles (CoCrMo beads) were then injected into the system, to circulate along with the surrogate synovial fluid. The walking cycles were then continued for two hours. In five of the ten head-liner pairs tested, twenty flexion subluxation events (Figure 2) were interspersed within the walking cycles. After the test period was completed, the number and location of embedded particles on the acetabular liner were determined.

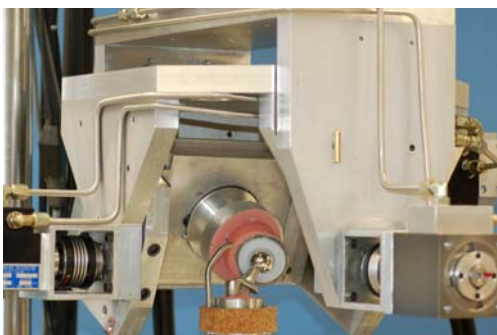


Figure 2: Flexion subluxation motion (hip capsule surrogate removed for clarity).

RESULTS

Subluxation during hip simulator testing dramatically increased the number of third body particles that became embedded in the bearing surface (Figure 3), 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 ($p = 0.007$, 1-tailed Student's t-test). The

addition of subluxation also considerably increased the amount of scratching on the femoral heads.

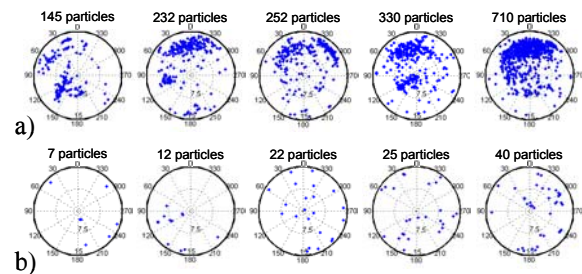


Figure 3: Location and count of embedded third body particles for acetabular liners tested in a hip simulator for a) walking-plus-subluxation cycles, and for b) walking-only cycles. The superior direction is vertical.

DISCUSSION

Subluxation allows third body particles to more easily enter the bearing surface, become embedded into the acetabular liner, and subsequently scratch the femoral head. In contemporary THA, third bodies 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 retrieval studies showing impingement damage on the majority of acetabular liners. The potent combination of third body particles and hip subluxation therefore needs to be borne prominently in mind when considering mechanisms of accelerated wear.

REFERENCE

Lundberg, H.J. et al. (accepted). *J Biomechanics*

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