

RETRIEVAL ANALYSIS OF CERAMIC ON POLYETHYLENE TOTAL HIP REPLACEMENT

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ABSTRACT

The most common material used in bio ceramic hip implants is polycrystalline aluminum oxide. This study examined the use of a ceramic on polyethylene implant in a single patient for six weeks, during which time the device subluxated. Implant components and specifications include a 36mm dual mobility acetabular liner, a 56mm acetabular cementless shell and a 36mm head. Patient presented to the attending physician after 6 weeks with positive hip pain. The implant was subsequently removed and revised. The femoral head of the implant was found to have significant macroscopic wear limited to one side of the head, with visible wear throughout the entire component. SEC analysis was performed on the head, with results showing abrasive wear at the microscopic level as well. The acetabular cup was also observed to have a variation in dimensional thickness. In summary, the surgical findings, data reviewed, images and analysis taken from this case report warrant further study.

Keywords: Total hip replacement, Dislocation, Manufacturer error, Ceramic on polyethylene, Revision

INTRODUCTION

There are various hip implant devices available today. While each manufacturer has different models, each style falls into one of four basic categories: metal on polyethylene (polyethylene or ultra-high molecular weight polyethylene), metal on metal (MoM), ceramic on ceramic (CoC) and ceramic on polyethylene (UHMWPE) [1]. Ceramic on Polyethylene hip implants are known for being a good combination of two very reliable materials. Ceramic heads are harder than metal as well as being the most scratch resistant implant material. The hard, ultra-smooth surface can reduce the wear on the polyethylene bearing greatly, with the potential wear for this type of implant being less than Metal-on-Polyethylene. The polyethylene liner used in this patient was composed of a crosslinked UHMWPE.

The overall success rate upon implantation of any of the above-mentioned devices is 90–95% ten years after surgery and 80–85% after 20 years. [4], depending on a variety of factors, some being: the age of the patient, patient activities, patient weight and avoiding potential complications. A study conducted on ceramic-on-polyethylene bearing surfaces in total hip arthroplasty, in order to determine the viability of ceramic-on-polyethylene use in total hip arthroplasty, found the following: Of sixty-four hip prosthesis implanted in fifty-six patients from 1978 to 1981, at the time of the latest follow up, approximately twenty-one years later, eighteen (28%) were still in place and five (8%) had been revised [5]. The remaining 41 implants were in patients who had died and were functioning normally until the patient's death. Although today's ceramic-on-polyethylene implants have not been in commercial use for enough time yet to establish twenty plus years of research data, they are highly expected to meet or exceed the results of earlier studies, as well as those of current and previous commercially available implant types.

METHODS

In this study, a comprehensive review of the patient's medical history and physical activity regarding the total hip arthroplasty was conducted, including data recorded from physician office visits before the initial surgery, post-surgery and pre and post-revision. Post-operative and post revision radiographic images and surgical photographs were reviewed and analyzed. Scanning Electron Microscopy was performed on the ceramic head and polyethylene insert, with micro and macroscopic photos taken of each. India ink was used on the acetabular liner to better visualize and obtain an approximate measurement of surface scoring on the polyethylene.

RESULTS

The patient was a 74-year-old male with a history of diagnosed osteoarthritis of the left hip. On

March 2, 2018, the patient presented to the attending physician's office with persistent, worsening left hip pain after finding no relief from medication or physical therapy. Aside from being a former smoker, deaf in one ear with reduced hearing in the other and taking blood pressure medication with an allergy to sulfur, his medical history is otherwise unremarkable. After examination and review of the patient's history, it was decided that a total left hip arthroplasty would be in the patient's best interest.

Approximately 6 weeks following the surgery, the patient presented to the surgeon's office complaining of squeaking in the left hip. An anteroposterior imaging showed subluxation of the implant (Figure 1). A CT scan was ordered to supplement the radiographic images and showed asymmetric seating of the femoral head component within the acetabular cup. There was no periprosthetic fracture or evidence for osteolysis at that time, nor was there any aseptic loosening of the implant. Revision was discussed with the patient and subsequently performed.

Analysis of the original (pre revision) liner and femoral head, found the ceramic head and polyethylene liner to both have scratches and abnormal wear. Post-operative review of the implant showed no signs of malpositioning of the femoral stem. The acetabular liner had shallow as well as deep scratches of varying lengths, with the longest being approximately 2.0cm in length (Figure 2). Scanning electron microscope photos show aberrant scrapes and wear at the microscopic level (Figure 3). The ceramic head did not seat evenly when placed into the liner, with uneven spacing on adjacent sides. On some sides the ceramic head was touching the polyethylene liner with no visible space between them, while on other sides there was an approximate 0.10cm gap between the head and liner (Figure 4). The liner was found to have an inner diameter measurement of 37mm when measured top to bottom and 36mm when measured side-to-side. Wall thickness was measured at 5.4mm at one side and 4.5mm at the opposite side (Figure 5).

The revised implant consisted of a 44mm dual mobility acetabular liner, 28mm dual mobility bearing and 28mm ceramic head. After revision, a CT scan of the hip was retaken. During the patient's routine office follow-up, the results were reviewed with him, showing the left total hip arthroplasty in good alignment. The patient complained of mild, aching pain common of postsurgical procedures of this type. To date the revised implant has been functioning normally.

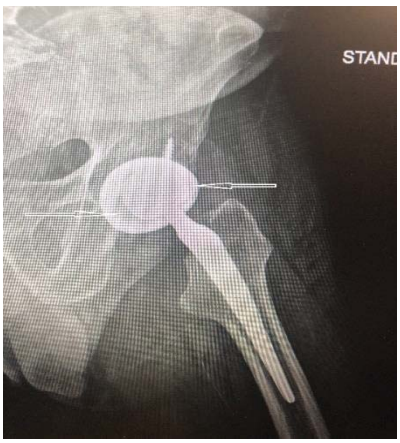

Figure 1: AP lateral image showing partial dislocation of the femoral head.

Figure 2: The acetabular liner (left) with deep and shallow scoring, with the longest on the lower right with a length of approximately 2.0cm. The ceramic head (right) showing broad amounts of wear as well.

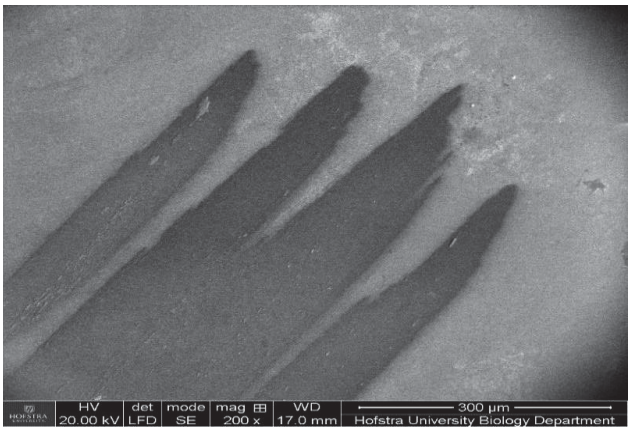

Figure 3: Scanning electron microscopic image of shallow scoring of the ceramic femoral head.

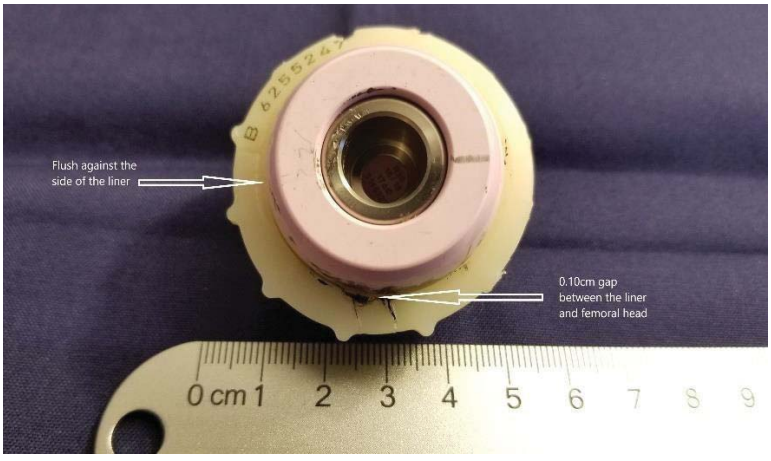

Figure 4: The ceramic head was not seating evenly within the acetabular liner. The head did not move freely within the liner. Note the approximate 0.10cm gap at the six o'clock position and the head resting flush against the liner at the nine o'clock position.

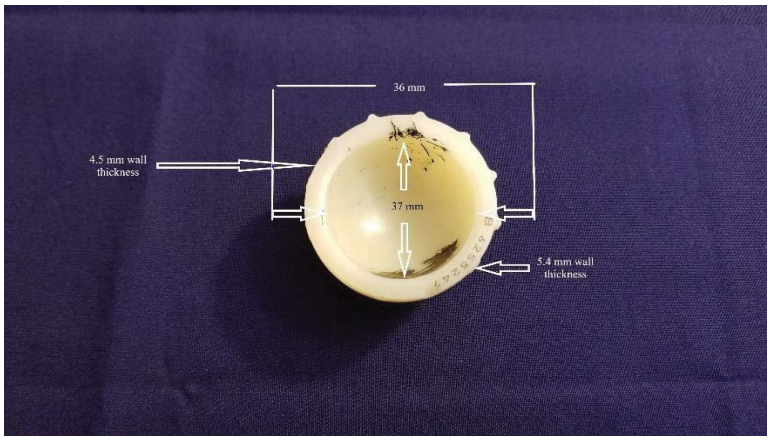

Figure 5: Diameter of the liner varied between 36mm and 37 mm. Dimensional density was measured at 4.5mm and 5.4 mm at opposite locations on the same liner.

DISCUSSION

This is an unusual type of joint replacement failure. According to Dr. Eric N. Hanson, MD in his article "Total Hip Replacement Surgery Risks and Complications", experts estimate "between 3% and 4% of hip replacement patients have at least one episode of hip dislocation", and that it is most common in the first six to eight weeks following hip replacement surgery [6]. Dr. Hanson also states that those most likely to experience a dislocation (subluxation) would be patients who: are female, are eighty years of age or older, are alcoholic, had previous hip surgery or have weak muscles surrounding the hip. The patient in this case had none of these characteristics.

The scratches and other physical wear to the polyethylene liner and ceramic head can occur from the patient walking on a partially dislocated hip. No bone cement was used during surgery and no foreign object was found during removal, which would support this. The dimensional differences in the acetabular liner and reduced free rotation of the ceramic head may have contributed to the subluxation (Figure 2),

Potential causes of this failure might range from poor implant surface continuity or misalignment, to surgical mismanagement, although the data would indicate that the latter is the less likely principle. Patients are given instructions after surgery advising them of things such as how far they may bend the hip, not allowing the affected leg to turn inward and not crossing the legs past the midline of the body [6]. Although the patient claims to have adhered to the instructions given and not engaged in any of the above-mentioned activities, there is always the possibility that the patient had somehow inadvertently turned, bent or twisted the affected joint in such a way without realizing.

CONCLUSIONS

This case illustrates that although total hip replacement dislocations can occasionally occur, that they also are not limited to any definitive cause. In this case, the cause of the dislocation would appear to be manufacturer error in the production of the polyethylene acetabular liner. The inconsistency in dimensional thickness of the walls of the liner and diameter (giving the liner an uneven, non-cylindrical shape), caused the femoral head to seat improperly impeding free rotation within the liner. When the femoral ceramic head met a certain level of resistance due to improper seating in the liner, the force caused the head to become unseated from the liner and a dislocation to occur.

While dislocations are generally rare, and causes may vary, manufacturer error resulting in failure is not unheard of. Defects in implant devices are not always noticeable to a surgeon, being that measurements out of conformity by even 1mm can contribute to implant failure and potentially lead to dislocation, as this study has shown. Discrepancies of this type can be unnoticeable in an operating room environment. Although this always has the potential to occur, overall, hip implants are produced free of errors and can be considered safe.

DISCLOSURES

The authors declare that no conflict of interest exists.

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