

Circumferential Ceramic Liner Fracture in a Squeaking Hip



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Abstract

We present a case of a painless, squeaking ceramic on ceramic total hip replacement secondary to an unusual circumferential pattern of liner fracture.

Keywords: Ceramic liner fracture; Squeaking hip

Introduction

Ceramic-on-ceramic bearings for use in total hip replacements have become a popular option to minimize the wear of bearing surfaces and subsequent osteolysis from debris. Initially developed in the 1970's the early models had high rates of failure primarily due to aseptic loosening [1]. Modern designs have managed to reduce this complication, with fracture of the acetabular liner becoming the primary mode of failure [2-5].

Prior reports have described radial or rim-type fracture of the liner [6-7]. This has been attributed to incorrect insertion of the liner resulting in edge-loading of the liner, with subsequent fracture. One report has also described a central 'punch-out' fracture of a ceramic liner thought to be due to a loss of the normal ceramic-on-ceramic lubrication secondary to an infective process [8]. We describe an unusual pattern of liner fracture, which to our knowledge has not been described before, presenting as a non-painful, squeaking hip.

Clinical History

A 57-year-old man, with a Body Mass Index of 28, underwent an uncomplicated total hip arthroplasty for osteoarthritis in February 2010. The implants used were an uncemented Synergy stem (Smith and Nephew, Memphis), a 36mm +0 Biolox head (Smith and Nephew, Memphis), a R3 52mm uncemented

cup (Smith and Nephew, Memphis) and a Biolox forte R3 ceramic liner (Smith and Nephew, Memphis), which has an imbedded circumferential titanium support ring. There were no complications reported with the liner insertion and no adverse events in the immediate post-operative period.

The patient presented to our department with persistent squeaking of his hip. This had started approximately 3 years after the initial operation. The patient recalls that he first noticed the squeaking whilst officiating as a goal umpire for a football match. He denied any history of trauma, impact exercise apart from brisk walking, or stumbling. Squeaking from the hip was initially sporadic but over the subsequent weeks became persistent. Eventually it changed in character from a squeak to a grating noise. Over the entire period, the patient did not report any pain or change in the range of movement of the hip.

The patient underwent investigation to find a cause of the noise generated by his hip. Plain radiographs of the hip did not demonstrate any mal-alignment of the prostheses or eccentric position of the head to suggest liner wear (Figure 1). The gentleman subsequently underwent a revision of the cup and liner in July 2013. During revision it was found that the ceramic liner had fractured circumferentially with multiple fragments (Figure 2), with minimal wear of the liner or the head.



Figure 1: Pre-operative radiograph demonstrating normal alignment and head position.



Figure 2: Photographs of the retrieved head, liner, and shell demonstrating the circumferential liner failure.

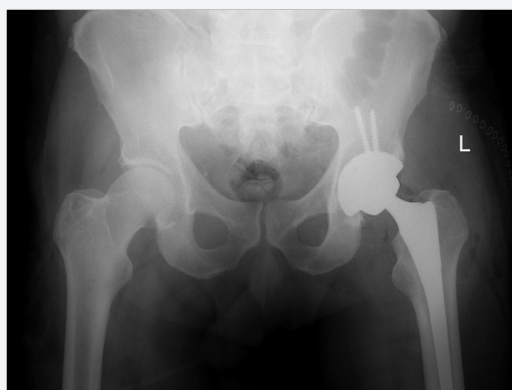


Figure 3: Post-operative radiograph demonstrating revision of the head, cup and liner.

The retrieved implants were sent to the local Implant Retrieval Unit for failure analysis according to normal retrieval protocols. Components were sent from theatre in formalin buffered saline. Following revision of the head and cup (Figure

3), the patient made an uneventful recovery and at the time of reporting has not had any further issues with squeaking due to his hip replacement.

Failure Analysis

Evaluation of the device incorporated qualitative macro analysis and photography of the components in terms of degradation mechanisms and identification of the part and lot numbers. Analysis demonstrated that the liner had catastrophically fractured, the ceramic rim of which was intact due to the supporting titanium ring. There were several large and innumerable small ceramic fragments. It was noted that there was minimal wear of the liner and femoral head indicative that either the failure had occurred within a short time of revision or more likely that the intact rim had acted as the entire bearing surface. In this case it was noted that the remaining bearing surface was displaced inwardly towards the posterior surface of the acetabular shell. Overall the fracture pattern was essentially circumferential and in three distinct regions:

- i. adjacent to the lower edge of the titanium reinforcing ring
- ii. a large piece encompassing the polar region of the liner
- iii. Intermediate between the ring and the large polar piece.

Bioengineering concluded that the ceramic liner is relatively thin and the fracture pattern was commensurate with having a titanium constraining ring. It is noted that the part number was 71331652 and lot number 08CT17907, the importance of which will be discussed in light of a field safety correction notice from March 2011.

Discussion

To our knowledge this is the first time a circumferential fracture of a ceramic liner with a circumferential metallic band designed to act as reinforcement has been reported. From our review of the literature there is no previous report of circumferential failure of ceramic liners. According to the manufacturer the BioloX Forte R3 liner features a titanium alloy support ring that is designed to increase the burst load of the liner to over 91 kilo-newtons, resulting in a liner that should not fracture under normal conditions.

In March 2011 Smith and Nephew, and the Federal Drug Authority released a product recall for two batches of the R3 BioloX Forte ceramic liners. This was for the 09 and 10 batches. This was claimed to be a result of a error resulting in the titanium liner being implanted at a higher than allowed force, potentially weakening the liner. In our case report the liner is from the 08 batch. This raises two possibilities: the 08 batch may have also suffered from the same manufacturing error as the 09 and 10 batches, or that there may be an increase risk of fracture when a ceramic liner incorporates a metal reinforcing ring.

What is also unusual about this case is that the patient presented with painless squeaking of the hip. A recent review by Walter [9] described squeaking as not being a major clinical problem and one that can be avoided by activity modification alone. There are several mechanisms that have been proposed as the cause of squeaking in ceramic-on-ceramic bearings, all resulting in stick-slip friction between the surfaces. Edge-loading and rim impingement have also been shown to increase surface friction sufficiently to result in stick-slip conditions and squeaking. Other mechanisms contributing to audible noise are: interposition of ceramic debris between the bearing surfaces [10], metal transfer to the head [11], and starvation of lubricant without edge-loading [12].

Conclusion

This case illustrates that painless squeaking of a ceramic-on-ceramic hip replacement is not always a benign problem, and may indicate catastrophic liner failure. Squeaking in this case is likely the result of a combination of ceramic debris between the bearing surfaces and loading of the head against the fractured ceramic edge. Furthermore it raises question about the suitability of the R3 design and its clinical safety that may warrant further investigation. The authors recommend thorough investigation of all patients that have a R3 Bilox Forte ceramic liner or similar that present with a noise generating hip as it may indicate catastrophic implant failure.

Conflicts of interest

None of the authors received payments or services, either directly or indirectly (i.e., via his or her institution), from a third party in support of any aspect of this work.

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