CASE REPORT

Catastrophic failure of ceramic-on-ceramic total hip arthroplasty presenting as squeaking hip

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SUMMARY

A 68-year-old woman with osteoarthritis had a ceramic-on-ceramic left total hip arthroplasty, including ceramic femoral head and acetabular liner. At 5 years after surgery, the patient developed onset of a very loud squeaking noise, which could be heard 25 m from her, associated with limited hip movement. Findings at revision surgery included a broken ceramic femoral head component, complete wear of the ceramic acetabular component, and black wear debris. Squeaking hip after ceramic-on-ceramic total hip arthroplasty may be associated with catastrophic failure of the arthroplasty components.

BACKGROUND

As the population ages, there is an increased frequency of total hip arthroplasty performed and associated complications, including wear, particulate debris, osteolysis, infection, dislocation and prosthetic fracture, loosening and failure.[1] Squeaking hip is a high-pitched audible noise with hip movement, and it is a complication unique to total hip arthroplasty having a hard femoral head in contact with a hard acetabular cup ('hard-on-hard'). The incidence of squeaking hip ranges from <0.5% to 11% after total hip arthroplasty, and some hip squeaking may not be reproducible in clinic or mentioned to clinicians.[2 3] Squeaking hip usually is not associated with pain or functional impairment,[2] but it has been extensively publicised in scientific and lay media.[4]

The mechanism of squeaking hip may be forced vibration, including a frictional driving force and dynamic response.[2] Squeaking may also be caused by increased friction between the bearing surfaces resulting from the absence of lubricating film or interruption of lubricating film by third bodies.[5] Edge loading, impingement, bearing surface damage and altered lubricant consistency may also interrupt the film and cause squeaking.[2 5] The causes of squeaking may be attributed to the patient (age, height, weight, level and type of activity), implant (bearing material and implant design) or surgical factors (femoral component head size, acetabular component position and skill of the surgeon).[2]

Catastrophic failure of total hip arthroplasty includes fracture or complete wear through the acetabular component. This rare but important complication may occur in 0.25% to 10.5% of total hip arthroplasty patients and may be associated with different combinations of bearing surfaces including metal-on-polyethylene and ceramic-on-polyethylene hip prostheses.[6]

There has been an increase in ceramic-on-ceramic total hip arthroplasty because of better characteristics of friction, lubrication, and wear than polyethylene-on-ceramic, polyethylene-on-metal or metal-on-metal prostheses. Furthermore, ceramic-on-ceramic prostheses may have less debris formation, osteolysis, loosening and prosthetic failure.[7] However, complications of ceramic-on-ceramic implants include hip squeaking and ceramic fracture. Ceramic fracture may occur in <0.5% of prostheses manufactured since 1990[8] and is associated with trauma, high activity level and obesity; impingement of the acetabular cup rim from extreme flexion and abduction, inadequate design, manufacture and surgical skill. Ceramic fracture usually is associated with pain and functional impairment of the affected joint.[9]

Excessive acetabular wear has been reported in a squeaking ceramic-on-ceramic total hip arthroplasty,

Figure 1 A 68-year-old woman who had left total hip arthroplasty. Initial postoperative radiograph shows satisfactory position of the femoral stem, head and acetabular shell and liner.

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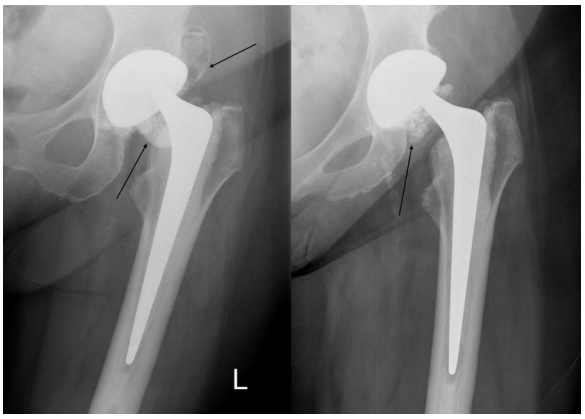

Figure 2 At 5 years after surgery, the patient presented with hip squeaking and reduced range of motion. Asymmetry of the femoral head relative to the acetabular shell and liner is noted. Wear debris is noted about the hip joint (arrows).

and wear debris may cause squeaking by interfering with the lubricating fluid film.[10] However, a literature search did not show any previous reports of catastrophic failure of ceramic-on-ceramic total hip arthroplasty because of complete wear through the acetabular component. We treated a patient who had catastrophic failure of a total hip arthroplasty at 5 years after surgery because of complete wear of an alumina ceramic-on-ceramic hip prosthesis.

CASE PRESENTATION

A 68-year-old woman with primary osteoarthritis had a ceramic-on-ceramic left total hip arthroplasty, including ceramic femoral head and acetabular cup liner (Exeter total hip system (femoral component) and ABG (acetabular component), Stryker, Kalamazoo, USA) (figure 1). She had good postoperative recovery with physiotherapy and occupational therapy, and she had no postoperative trauma or dislocation.

At 5 years after surgery, the patient developed onset of a very loud squeaking noise, which could be heard 25 m from her, associated with limited hip movement.

INVESTIGATIONS

Physical examination showed short limb gait, and the left lower extremity was 1 cm shorter than the right lower extremity. There was 50% decreased range of motion of the left hip, and the squeaking noise was evident with slight hip movement. Radiographs showed that the ceramic prosthetic head was broken with debris around the joint (figure 2).

TREATMENT

At revision surgery using a Hardinge approach, black discolouration and debris were noted in the adductor muscles and acetabulum (figure 3). The femoral prosthetic stem was intact and was not revised. The broken prosthetic ceramic femoral head was replaced with a metal head, and the acetabulum was revised with a metal acetabular component with a polyethylene insert (Orthodynamics, SERF, Bourton, UK). The postoperative radiograph showed satisfactory position of the implant (figure 4). Analysis of the removed acetabular component showed marked wear of the ceramic cup. The mean hole diameter was 29 mm and shell thickness was 5.5 mm, consistent with 3600 mm^3 wear (equivalent to 10 mm^3/day for 1 year) (figure 5). Retrieval analysis and wear calculations were conducted by Dr Amir Kamali (The Implant Development Centre, Leamington Spa, UK).

DISCUSSION

This patient had catastrophic failure of a total hip prosthesis from complete wear of the ceramic-on-ceramic components. The average annual wear rate for squeaking hips is 2.9 mm^3 for the femoral head and 3.4 mm^3 for the acetabular liner, and the average annual wear rate for ceramic-on-ceramic bearings is 0.1 mm^3 for the femoral head and 0.04 mm^3 for the acetabular liner.[2] However, the wear in the present patient after 5 years was much greater, equivalent to 720 mm^3 wear per year for the acetabular component.

In another patient who had a squeaking ceramic-on-ceramic total hip arthroplasty (average annual wear rate: head, 8.6 mm^3; liner, 34 mm^3), increased wear at 32 months after surgery was attributed to a steep acetabular component inclination angle, resulting in edge loading, ceramic granular pullout, roughened surfaces and reduced lubricating fluid thickness; there was no microseparation or intragranular fracture in the ceramic.[10] In the present patient, the inclination was 55° and implant duration was 5 years; these factors may have contributed to increasingly excessive wear compared with the previous patient. In addition, a ceramic chip may have occurred upon insertion of the total hip arthroplasty, resulting in a roughened surface that may have

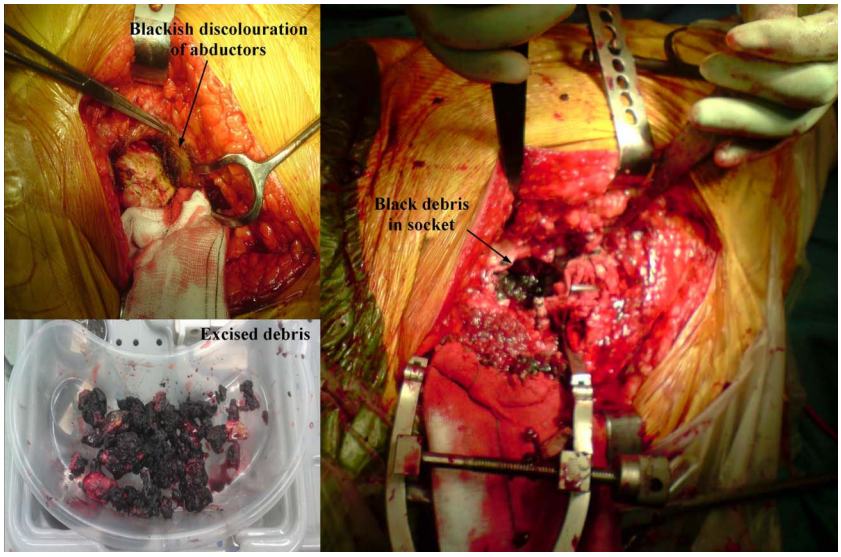

Figure 3 Intraoperative image showed black discolouration and debris in the adductor muscles and acetabulum (arrows).

Figure 4 Postoperative radiograph following revision of the acetabular component showed satisfactory position of the implant.

become progressively worn. Poor ceramic material may contribute to wear,[9] even though ceramic manufacturing is extremely rigorous and usually includes isostatic pressing, laser and thermal etching and hydraulic press testing of all implants.[11]

A ceramic femoral head may wear through a titanium acetabular shell in a ceramic-on-polyethylene total hip arthroplasty.[12] Possible causes for catastrophic wear include reduced shell surface area in contact with the liner because of drill holes and suboptimal locking between the acetabular liner and shell, causing backside non-articular wear of the polyethylene and titanium components.[12] This mechanism could not be excluded in the present case.

The wear associated with shear in the present patient was >38 mm^3/year.[2] In contrast with metal-on-polyethylene total hip arthroplasty, wear debris and associated osteolysis in ceramic-on-ceramic arthroplasty may be an effect and not a cause of failure.[13]

Squeaking usually begins between 6 and 26 months after surgery, and the present case is unusual because squeaking did not occur until 5 years after surgery.[2] An uncoupled shell may resonate at audible frequencies heard in squeaky prosthetic hips in vivo.[14] Therefore, it is likely that that squeaking began in the present patient after the ceramic liner had fully eroded, causing uncoupling at the liner-shell interface.

The present case shows that hip squeaking is not just a nuisance characteristic of some total hip replacement bearings, but it may be a symptom of serious prosthetic complications.

Figure 5 The ceramic femoral head and acetabular shell removed at revision surgery. The femoral head was broken, and the acetabular cup had complete wear.

Therefore, it may be prudent to assess and screen for potentially serious complications associated with hip squeaking. In our practice, all total hip arthroplasties are reviewed at 6 and 12 weeks after surgery. Despite this practice, the present patient presented with reduced range of motion and squeaking 5 years after surgery. In patients with squeaking total hip arthroplasty, regular follow-ups with plain radiographs and CT scans may help identify patients who may benefit from earlier revision surgery or activity modification.[2]

Learning points

- Hip squeaking after total hip arthroplasty is not just a nuisance symptom, because it may be a symptom of serious prosthetic complications.
- Squeaking hip after ceramic-on-ceramic total hip arthroplasty may be associated with catastrophic failure of the arthroplasty components.
- Postoperative clinical follow-up is advised to assess and screen for potentially serious complications associated with hip squeaking.

Competing interests None.

Patient consent Obtained.

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