Is Metal-on-Metal Squeaking Related to Acetabular Angle of Inclination?

Thomas Bernasek MD, David Fisher MD,
David Dalury MD, Melissa Levering BS,
Kirk Dimitris MD

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Abstract

Background Postoperative audible squeaking has been well documented in ceramic-on-ceramic hip prostheses, and several metal-on-metal (MOM) THA designs, specifically those used for large-head resurfacing and MOM polyethylene sandwich designs, and are attributed to different implant- and patient-specific factors. Current literature does not identify the incidence of squeaking in modular MOM THA or possible etiologic factors.

Questions/purposes Our purposes were to (1) identify the incidence of squeaking in modular MOM prostheses in THA; (2) determine whether males or females were more

likely to have squeaking; and (3) determine whether the incidence of squeaking relates to acetabular inclination angle.

Methods We retrospectively reviewed the patient records and radiographs of 539 patients (542 hips) from three independent centers who underwent a MOM THA between February 2001 and December 2005. Demographic and implant factors were evaluated, including measurement of cup inclination angles. The minimum followup was 36 months (mean, 76 months; range, 36–119 months).

Results We identified squeaking in eight of the 542 hips (1.5%); five were in women and two were in men (one patient had bilateral squeaking). The time to onset of patient-reported audible squeaking averaged 23 months (range, 6–84 months). Squeaking was more likely to occur in women (six of eight hips). No hips with 45° or less acetabular inclination squeaked (291 hips); eight of 251 hips (3.2%) with inclination angles greater than 45° squeaked. Patients who reported squeaking had higher inclination angles than those who did not report squeaking.

Conclusions Our observations suggest an increased frequency of squeaking in female patients and in patients with greater inclination angles with this MOM implant design.

The following authors certify that they act as consultants and receive royalties from DePuy Inc (TB, DD, DF).

Each author certifies that his or her institution has approved the reporting of these cases and that all investigations were conducted in conformity with ethical principles of research.

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T. Bernasek (✉)
Florida Orthopaedic Institute, 13020 Telecom
Parkway, N. Tampa, FL 33637, USA
e-mail: tbernasek@floridaortho.com

D. Fisher
OrthoIndy, Indianapolis, IN, USA

D. Dalury
Orthopaedic Associates, Inc, Baltimore, MD, USA

M. Levering
Foundation for Orthopaedic Research and Education,
Tampa, FL, USA

K. Dimitris
Holy Family Memorial Lakeshore Orthopedics,
Manitowoc, WI, USA

Introduction

Hard-on-hard articular bearings were introduced with the premise of improved wear rates and longevity [8]. In the United States, approximately 65,000 MOM and 8000 ceramic-on-ceramic hip prostheses are implanted each year [9]. These bearings have the potential advantage of low wear rates facilitated by large femoral head size, lubrication, and improved stability.

Postoperative articular squeaking is well documented for ceramic-on-ceramic hip prostheses, with incidences of 0.48% to 10% [6–8]. Squeaking also has been described for MOM prostheses used in THA, with incidences ranging from 3.7% to 16% [1, 4, 5]. One study of 230 patients, who had large-head MOM hip resurfacing, noted nine patients (3.9%) experienced transient squeaking [1]. Most squeaking was noted within the first 6 months of implantation and occurred when the hip was at the limit of flexion or the patient was picking up a heavy load; no new case squeaking was reported beyond 2 years. These authors did not mention component position as a possible factor in squeaking. Loss of lubrication was the suggested etiology. The breakdown of fluid film may be from decrease in contact area, third body debris, and damage to the articular surface, or mismatched bearing diameters [14]. Despite squeaking it appears there is no adverse effect on the prostheses [1, 4, 5].

Holloway et al. reported one patient with audible squeaking immediately after THA using a Metasul MOM bearing using a polyethylene sandwich cup design [5]. The squeaking was transient and lasted 3 months, however, it again was reported to occur on occasion after 10 years. The squeak occurred under load in the midrange of flexion. The cup position was slightly retroverted. The patient was otherwise asymptomatic and the components appeared to be well fixed.

A study of sound emissions of a total hip prosthesis under in vivo conditions showed all patients with a MOM THA experienced squeaking [4]. This study amplified sound from the hip using a microphone at the hip-joint interface to capture sound emissions during activity.

Our purposes were to (1) identify the incidence of squeaking in modular MOM prostheses in THA; (2) determine whether males or females were more likely to have squeaking; and (3) determine whether the incidence of squeaking relates to acetabular inclination angle.

Patients and Methods

Between February 2001 and December 2005, we (TB, DF, DD) implanted 706 modular MOM THA prostheses in 637 patients in three centers. All implants were DePuy (Warsaw, IN, USA) with Summit™ stems and Pinnacle™ cups with modular cobalt-chromium MOM heads and acetabular inserts. The acetabular cup and femoral stem are made from titanium alloy with a porous surface coating (Porocoat®). Patients undergoing primary THA using MOM prostheses with at least 3 years of followup were included in this retrospective study. The average age of these patients at the time of surgery was 54 years and the average body mass index (BMI) was 31. All patients were

contacted by telephone by research staff to inquire regarding hip noise, such as a clicking, popping, or squeaking. Five hundred thirty-nine patients (85%) with 542 hips were contacted; the remaining 98 did not respond despite multiple contact attempts and were lost to followup. Patients were asked if they heard any noise from their hip. If they answered yes, they were asked to describe it as a “click”, “pop” or “squeak” and with what activity did the noise occur. Five patients with squeaking were able to reproduce the sound by demonstration in the clinic. The other two patients verbally indicated that they heard a squeak from their hip with specific movements. The minimum followup was 36 months (mean, 76 months; range, 36–119 months). Institutional Review Board approval was received before data collection.

For one study site (TB), the surgical approach consisted of a direct lateral approach through the abductor complex with a flake of greater trochanter attached. Repair of the abductor complex back to the greater trochanter was performed with heavy nonabsorbable suture in each case. THA was performed through a posterolateral approach at the other two study sites (DD, DF). Five hundred six hips had 36-mm heads implanted whereas 36 hips had 28-mm heads implanted.

Postoperatively, the patients were allowed to bear weight as tolerated, with standard hip precautions. They were followed at regular intervals of 3 weeks, 6 to 12 weeks, and annually thereafter. Radiographs and functional and pain assessments were obtained at all preoperative and postoperative visits. Patient demographic information was collected.

Patient radiographs were analyzed for acetabular component position (AP, Lowenstein lateral, and cross-table lateral) at each study center using a standardized technique [16] (Fig. 1). In this multicenter collaboration,

Fig. 1 An AP postoperative radiograph shows acetabular inclination angle measurement (Medview version 6.5; Aspyra Inc, Westlake Village, CA, USA). Nonprogressive radiolucencies can be seen in Zones 1 and 3 of the acetabular cup. Pelvic obliquity increased the functional angle of inclination of the prosthesis.

radiographs were not shared between centers and therefore interrater agreement and interobserver variability were not calculated.

Descriptive statistics were reported as averages and percentages. A Mann-Whitney U-test was used to determine if the inclination angle was greater for patients with squeaking and to compare demographic information between groups. Fisher's exact test was used to compare the frequency of males and females between groups.

Results

We identified seven patients with squeaking in eight of the 542 hips (1.5%) in two men and five women. Seven of 506 hips (1.4%) with 36-mm heads squeaked and one of 36 hips (2.7%) with a 28-mm head squeaked. The average age of the patients with squeaking was similar ($p = 0.772$) to that of patients without squeaking: 54 years versus

55 years, respectively. The average BMI for the two groups also was similar: 28 versus 31 ($p = 0.210$) (Table 1). The mean postoperative Harris hip scores recorded at the most recent visit for patients with squeaking was 95.6.

The percentage of squeaking was greater ($p = 0.009$) in women than in men (3.1% versus 0.3%). The average angle of inclination for patients with reported squeaking was 57.2° (range, 48° – 68°), which was greater ($p = 0.001$) than the average of 47.6° for patients without squeaking (range, 34° – 69°). No patients with cup inclination angles less than 45° (291 hips) reported squeaking. Two of 143 (1.4%) hips with cup inclination between 46° and 50° exhibited squeaking. One of 77 patients with inclination angles between 51° and 55° experienced squeaking (1.3%). Two of 20 hips with inclination angles between 56° and 60° squeaked (10.0%), and three of 11 hips with cup inclination greater than 60° (27%) squeaked. The average time until onset of squeaking was 32 months postoperatively. One metal liner was revised to a polyethylene liner; the other seven are currently under observation (Table 2).

Table 1. Patient data

Case number	Age of patient (years)	Diagnosis	Gender	BMI
1	40	Posttraumatic degenerative joint disease	Female	22
2	46	Rheumatoid arthritis	Female	20
3	62	Osteoarthritis	Male	34
4	60	Osteoarthritis	Female	25
5	60	Osteoarthritis	Female	25
6	67	Osteoarthritis	Male	27
7	57	Posttraumatic	Female	26
8	49	Osteoarthritis	Female	21

BMI = body mass index.

Case 1

A 40-year-old woman with a history of posttraumatic degenerative joint disease, stemming from an axial loading injury when she was 20 years old, underwent THA with complete resolution of pain and return to normal activity. She returned to the office 3 years postoperatively, reporting an audible squeaking sound. The noise was described as high-pitched and occurred frequently at midday with walking. The patient declined revision surgery. At 5 years followup, the squeaking had decreased, occurring only during deep squats. No signs of component failure were observed on plain radiographs (Fig. 2).

Table 2. Component data and position for patients with squeaking

Case number	Acetabular cup size (mm)	Femoral head size (mm)	Provoking activity	Associated pain	Acetabular inclination	Anteversion	Time to presentation	Resolved?	Continuous or intermittent
1	56	36	After prolonged walking	No	58°	26°	36 months	No	Intermittent
2	48	28	Bending	No	64°	25°	44 months	Yes	Intermittent
3	58	36	Bending	No	64°	20°	21 months	Yes-revised	Intermittent
4	52	36	Walking	No	56°	25°	6 months	Yes	Intermittent
5	52	36	Walking	Yes	58°	23°	6 months	No	Intermittent
6	56	36	Bending	No	62°	Not collected	84 months	No	Intermittent
7	54	36	Any activity	No	48°	Not collected	50 months	No	Intermittent
8	54	36	Bending	No	50°	Not collected	12 months	No	Intermittent

Fig. 2 This AP postoperative radiograph shows a 36-mm MOM prosthesis in a patient who experienced squeaking. At last followup the patient was pain free and the periprosthetic cysts were unchanged since implantation of the prosthesis.

Case 2

A 46-year-old woman with a history of rheumatoid arthritis underwent staged bilateral THAs with MOM components. Her initial postoperative course was uneventful, with complete relief of pain and return to normal activity. She returned to the office for routine followup 44 months after surgery, describing an occasional squeaking noise in her left hip that occurred when bending at the waist. The patient declined revision surgery. No signs of component failure were observed on plain radiographs (Fig. 1).

Case 3

A 62-year-old man with a history of osteoarthritis underwent a left THA. His postoperative recovery initially was uneventful, with complete resolution of pain and he returned to normal activities. The patient returned approximately 1½ years postoperatively with a chirping noise and no associated pain. He elected revision surgery. Revision to a polyethylene liner was uneventful, with complete resolution of squeaking. At 2.5 years postoperatively, he was noise-free and had returned to normal activities.

Cases 4 and 5

A 60-year-old woman with bilateral osteoarthritis underwent bilateral THAs using MOM components. She reported catching, clicking, and a squeaking noise in both hips after 6 months. One year later, her right hip was asymptomatic and the left was progressively painful with every step. At last followup, the pain had resolved, although the noises and sensations remained unchanged

and occurred with side-to-side motion and when swinging her legs forward and back.

Case 6

A 67-year-old man with a history of osteoarthritis underwent MOM THA. His rehabilitation was uneventful, however, 7 years postoperatively; the patient reported intermittent squeaking with bending. No pain was associated with the noise and the patient declined revision surgery.

Case 7

A 57-year-old woman with posttraumatic arthritis who underwent a MOM THA reported squeaking 4 years after surgery. The patient indicated that there was no associated pain and the squeaking occurred with any nonspecific activity. She declined revision surgery and currently is under observation.

Case 8

A 49-year-old woman with a history of osteoarthritis underwent a MOM THA. One year after surgery, she reported squeaking with bending activities, specifically during golf. The patient is pain free and declined revision surgery.

Discussion

Postoperative audible squeaking has been well documented in ceramic-on-ceramic hip prostheses, and several MOM THA implant designs, and is attributed to different implant- and patient-specific factors. The current literature does not identify the incidence of squeaking in modular MOM THAs or possible etiologic factors. Our purposes were to (1) identify the incidence of squeaking in modular MOM prostheses in THA; (2) determine whether males or females were more likely to have squeaking; and (3) determine whether the incidence of squeaking relates to inclination angle.

The limitations of our study include the following. First, we lost 98 patients (15%) to followup. Given the small numbers of patients with squeaking, if a few of these 98 patients had squeaking, our interpretations regarding differences in males or females or inclination angles could be in error. Second, the numbers of males with squeaking was too small to draw any definitive conclusions. Third, we

Table 3. Review of current literature

Study	Bearing surface	Incidence of squeaking	Average followup	Findings
Holloway et al. [5]	MOM bearing with polyethylene sandwich cup	3.7% (1/27)	105 months	Occurs transiently and on occasion 10 years postoperatively when dressing
Willert et al. [15]	MOM	15.8% (3/19)	Unknown	Population of patients scheduled for revision THA
Glaser et al. [4]	MOM	100% (5/5)	Unknown	No audible sounds detected by patients before study
Back et al. [1]	MOM resurfacing	3.9% (9/230)	36 months	Isolated episodes that occurred within 6 months of operation
Current study	Modular MOM	8/539 (1.5%)	76 months	Intermittent noise with no pain, one patient elected revision of metal to polyethylene liner

MOM = metal-on-metal.

did not determine interobserver variability of the measurement of inclination. However, we suspect any errors would not substantially modify our conclusions.

We identified the incidence of squeaking in eight of 539 hips (1.5%) with MOM prostheses. This is less than that reported for large-head MOM resurfacing and MOM polyethylene sandwich cup designs [1, 5]. Only one of our seven patients with squeaking had a metal liner revised to a polyethylene liner, with complete resolution of noise. The clinical importance of squeaking produced by THA components remains to be seen. Some authors believe that squeaking raises concerns of decreased implant longevity, owing to the possibility of component malposition and potential of increased or abnormal wear [10].

As reports of squeaking in MOM bearing surfaces are relatively few, it is difficult to identify etiologic factors (Table 3). However, some authors have concluded that squeaking in ceramic-on-ceramic bearing surfaces is a result of multiple factors such as edge loading, malposition, or patient demographics [3, 11–13]. Brockett et al. [2] reproduced squeaking using hip resurfacing components with three different diametric clearances between the femoral head and acetabular opening. As the clearance increased they noted increases in friction, with thinner polar fluid film thickness, as measured by ultrasound techniques. The presence of squeaking was noted in every component in the high clearance group. Walter et al. [13] found if the acetabular orientation was outside the range of 15° to 35° anteversion or 35° to 55° inclination, the hip was 29 times more likely to squeak. Also, patients with squeaking hips were younger, taller, and heavier. Other studies have suggested that with component malposition, edge loading or neck impingement can occur at extremes of motion, resulting in a loss of congruency and microseparation [11–13]. This also may cause breakdown of fluid film lubrication, increased friction with high local stresses, and audible squeaking [12, 13].

Our observations suggest there is an increase in frequency of squeaking in patients with greater acetabular inclination angles, however, it is not possible to establish a causal relationship between acetabular component inclination and occurrence of squeaking owing to possible confounding factors. Future studies are necessary to investigate possible causes of squeaking in MOM hip prostheses.

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References

1. Back DL, Dalziel R, Young D, Shimmin A. Early results of primary Birmingham hip resurfacings: an independent prospective study of the first 230 hips. *J Bone Joint Surg Br.* 2005;87:324–329.
2. Brockett CL, Harper P, Williams S, Isaac GH, Dwyer-Joyce RS, Jin Z, Fisher J. The influence of clearance on friction, lubrication and squeaking in large diameter metal-on-metal hip replacements. *J Mater Sci Mater Med.* 2008;19:1575–1579.
3. Clarke IC, Manley MT; Implant Wear Symposium 2007 Engineering Work Group. How do alternative bearing surfaces influence wear behavior? *J Am Acad Orthop Surg.* 2008;16(suppl 1): S86–93.
4. Glaser D, Dennis DA, Komistek RD, Miner TM. In vivo comparison of hip mechanics for minimally invasive versus traditional total hip arthroplasty. *Clin Biomech (Bristol, Avon).* 2008;23:127–134.
5. Holloway I, Walter WL, Zicat B, Walter WK. Osteolysis with a cementless second generation metal-on-metal cup in total hip replacement. *Int Orthop.* 2009;33:1537–1542.
6. Jarrett CA, Ranawat AS, Bruzzone M, Blum YC, Rodriguez JA, Ranawat CS. The squeaking hip: a phenomenon of ceramic-on-ceramic total hip arthroplasty. *J Bone Joint Surg Am.* 2009;91:1344–1349.
7. Keurentjes JC, Kuipers RM, Wever DJ, Schreurs BW. High incidence of squeaking in THAs with alumina ceramic-on-ceramic bearings. *Clin Orthop Relat Res.* 2008;466:1438–1443.
8. Manley MT, Sutton K. Bearings of the future for total hip arthroplasty. *J Arthroplasty.* 2008;23(7 suppl):47–50.

9. Mendenhall Associates Inc. Hospital resources and implant cost management: a 2009 update. *Orthopedic Network News*. Vol. 21. Birmingham, AL: Mendenhall Associates Inc; 2010: 13–19.
10. Ranawat AS, Ranawat CS. The squeaking hip: a cause for concern-agrees. *Orthopedics*. 2007;30:738, 743.
11. Restrepo C, Parvizi J, Kurtz SM, Sharkey PF, Hozack WJ, Rothman RH. The noisy ceramic hip: is component malpositioning the cause? *J Arthroplasty*. 2008;23:643–649.
12. Taylor S, Manley MT, Sutton K. The role of stripe wear in causing acoustic emissions from alumina ceramic-on-ceramic bearings. *J Arthroplasty*. 2007;22(7 suppl 3):47–51.
13. Walter WL, O'Toole GC, Walter WK, Ellis A, Zicat BA. Squeaking in ceramic-on-ceramic hips: the importance of acetabular component orientation. *J Arthroplasty*. 2007;22:496–503.
14. Walter WL, Waters TS, Gillies M, Donohoo S, Kurtz SM, Ranawat AS, Hozack WJ, Tuke MA. Squeaking hips. *J Bone Joint Surg Am*. 2008;90(suppl 4):102–111.
15. Willert HG, Buchhorn GH, Fayyazi A, Flury R, Windler M, Koster G, Lohmann CH. Metal-on-metal bearings and hypersensitivity in patients with artificial hip joints: a clinical and histomorphological study. *J Bone Joint Surg Am*. 2005;87:28–36.
16. Woo RY, Morrey BF. Dislocations after total hip arthroplasty. *J Bone Joint Surg Am*. 1982;64:1295–1306.