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SYMPOSIUM: COMPLICATIONS OF HIP ARTHROPLASTY

Squeaking in Metal-on-Metal Hip Resurfacing Arthroplasties

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Abstract

Background While most reports of audible squeaking in total hip arthroplasty (THA) have focused on ceramic bearings, squeaking can occur in metal-on-metal bearings and may be an important clinical complication to consider during patient followup.

Questions/purposes We retrospectively identified 10 patients with squeaking metal-on-metal hip resurfacings.

Methods This study reports acetabular inclination angles and patient satisfaction, and describes two patients with squeaking resurfacings: one was revised and the other is pending revision. The minimum followup time in all 10 patients was 6 months (mean, 52 months; range, 6 to 79 months).

Results The average time to onset was 11 months (range, 3–22 months). Hips started squeaking after bending, heavy activity, or prolonged periods of walking and the squeaking resolved within a week in all episodes. All hips except one were in the range of 45° ± 10° inclination (median, 48°). One patient who reported squeaking at 6 weeks was revised 6 years postoperatively for a cystic mass. A second patient, now 76 months postoperative, who reports squeaking weekly after walking long distances, is scheduled for revision due to high serum metal ion levels and osteolysis in DeLee and Charnley Zone 1 of the acetabulum.

Conclusions We cannot conclude whether these complications are related to squeaking. Most patients with squeaking hip resurfacings do not appear to have an adverse response or clinical complication after 6 years. Squeaking in hip resurfacings is a short-term episode that could not be related to acetabular component inclination or decreased patient satisfaction.

Level of Evidence Level II, prognostic study. See Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Introduction

Postoperative audible squeaking is a rare complication reported in hip arthroplasty as early as the 1950s [5], but before 2005, squeaking was not considered a clinically relevant complication of total hip bearings [26]. Recent reports of squeaking hips in the orthopaedic literature have primarily involved ceramic-on-ceramic bearings. The incidence of squeaking in ceramic-on-ceramic THAs ranges from less than 1% to 21% depending on how the sound is defined [15, 25], but the incidence of revision is substantially lower, since not all patients with squeaking

require revision. However, on rare occasions, squeaking ceramic hips have been revised for noise alone based on the patient's wishes, not associated with any other symptoms such as pain or instability [19].

Squeaking is not a complication commonly reported in hip resurfacing studies. In the few reports in the literature describing squeaking metal-on-metal hips, the incidence ranges from 4% to 10% [1, 10]. A prospective series of 230 hip resurfacings included nine squeaking hips (3.9%) at a mean followup of 3 years and 12 squeaking hips (5.3%) at a mean followup of 5 years [1, 12]. We identified no reports of recurrent noise as a reason for revision of a metal-on-metal resurfacing. The lack of reported squeaking in most hip resurfacing series may reflect a low incidence of squeaking or that squeaking is not considered clinically important and therefore not reported.

Squeaking is a multifactorial phenomenon [20] and in ceramic-on-ceramic bearings is dependent on patient factors (such as age, height, and weight), surgical factors (such as acetabular component placement), and component factors (such as bearing material) [26]. Given the limited reports of noise in metal-on-metal resurfacing implants, it is unknown whether squeaking might be associated with similar demographic or surgical factors.

The primary purposes of this study were to (1) determine the incidence of squeaking in a consecutive cohort of metal-on-metal hip resurfacing arthroplasties; (2) characterize the presentation of this event; (3) determine the component acetabular inclination of squeaking resurfacings; (4) report the level of satisfaction of patients with squeaking implants; and (5) describe two patients who had a revision.

Patients and Methods

Between December 1999 and June 2009, three surgeons implanted six different designs of metal-on-metal hip resurfacings in 259 patients (290 hips).

All surgeries were performed using the posterior or posteroinferior approach [16]. The posteroinferior approach places the incision more posteriorly and more inferiorly. In hip resurfacing, this approach may preserve abductor function and reduce the incidence of heterotopic formation [16].

For routine postoperative followup consultations at 6 weeks, 6 months, 1 year, 2 years, and 5 years, patients were asked to bring in current AP and lateral radiographs and to fill out a detailed questionnaire specifically designed to document complications. One question asked about squeaking: "Has your hip ever made a squeaking noise?" Response options were: (1) No; (2) Yes; (3) No, but it makes other noises, describe as (blank for patient's response). At the followup visit, the surgeon asked patients who reported noise: (1) What activity causes the noise? (2) How often does the noise occur? (3) How long did the noise last? (4) Is there any pain associated with the noise? Some studies have distinguished between squeaking and other types of noise such as clicking, clunking, popping, and grating [14]. The squeaking hip resurfacings in this study were identified apart from other resurfacings reporting other types of noises or no noise. The squeaking resurfacing patients were divided into three groups: rare squeakers, episodic squeakers, and persistent squeakers.

Two observers (CE and PTB), who were not the treating surgeons, used AP radiographs of the pelvis to measure acetabular inclination of squeaking resurfacings. A horizontal line was drawn across the bottom of the acetabular teardrops to determine the transverse axis, and a line connecting the superior and inferior edges of the acetabular component was connected to the transverse axis to measure the angle of inclination [3]. The interobserver variability for these measurements was within 2 degrees.

At the followup visit, patients were asked to report satisfaction with their hip arthroplasty using a visual analog scale ranging from 0 to 10, segmented at each integer [7]. Three patients (Patients 3, 9, and 10; Table 1) were not seen in clinic within the last 2 years of this study, so in October 2009 we attempted to contact them over the telephone. One patient was lost to followup, and two patients were contacted over the telephone. We were able to discuss squeaking, but the patients could not give a satisfaction score using the visual analog scale.

Two patients with squeaking implants are presented here; one has been revised and the other is pending revision. In the revision surgery, the femoral and acetabular components were fixed in 10% buffered formalin and the bearing surfaces were protected. Periprosthetic tissues were fixed in 10% buffered formalin and processed into paraffin wax. Hematoxylin and eosin-stained sections were examined by light microscopy for cell content, tissue viability, and the presence and extent of wear debris. The wear of the femoral and acetabular components was measured using a RedLux Artificial Hip Profiler (RedLux Ltd, Southampton, UK), which scanned the surfaces and produced a data set in the form of a three-dimensional sphere with a resolution of 20 nanometers. The RedLux results were verified by roundness measurements [23], which is a commonly used method for wear determination [27]. Blood samples were collected from the patient before revision to measure serum metal ion levels (Pacific Laboratory Medicine Services, Sydney, Australia) using inductively coupled plasma mass spectrometry [24].

Patient 1 had a CT scan; anteversion was measured using InteleViewer™ Version 5-3-1-P115 (Intelerad Medical Systems Inc, Montreal, Quebec, Canada).

Brightness and contrast were used to lessen the scatter from the implant and give a more detailed view of the acetabular edge. Anatomic anteversion was measured using the anterosuperior iliac spines as landmarks to define the transverse axis of the pelvis, and a line connecting the edges of the acetabular component was connected to the transverse axis [25].

Radiographs from Patient 2 were reviewed for osteolysis and neck narrowing [9, 13].

Results

From the 290 hip resurfacing patients who responded to our questionnaire, 10 patients (3.4%) reported audible squeaking postoperatively (Table 1). Eight patients involved Birmingham™ Hip Replacements (BHR) (Smith & Nephew, Memphis, TN) and two were MITCH TRH™ resurfacings (Stryker, Mahwah, NJ). Average time to onset was 11 months (range, 3–22 months). The minimum followup time in these ten patients was 6 months (mean, 52 months; range, 6 to 79 months).

There were three rare squeakers, five episodic squeakers, and two persistent squeakers. The rare squeakers reported a single squeaking event that lasted for a few hours or 1 day, and noise was not reproducible, even after similar activity. The episodic squeakers experienced rare episodes of squeaking, which lasted from a few hours to a few days. The persistent squeakers reported regular squeaking after specific activities (Table 2).

Table 1. Clinical details of 10 patients reporting audible squeaking postoperatively

Patient	Age (years)	Gender	Height (cm)	Weight (kg)	Postoperative inclination angle (°)	As of January 2010, time postoperatively (months)	Most recent followup (months postoperatively)	Satisfaction score at most recent followup
1	62	Male	180	85	50	Revised after 72	Prerevision	5
2	55	Male	170	125	45	76	63	4.5
3	31	Male	165	70	Radiographs missing	77	26*	9
4	52	Female	163	65	41	12	6	No score
5	56	Male	188	83	48	31	13	10
6	48	Male	195	108	64	76	61	10
7	59	Male	160	77	52	89	72	10
8	63	Male	178	86	42	75	57	10
9	49	Male	167	83	47	87	19	10
10	67	Male	183	96	51	77	16*	10

* Patients were contacted over the telephone after this followup date for this study.

Table 2. Details of squeaking in 10 patients with hip resurfacings

Patient	Type of squeaker	Time postoperatively to first squeak (months)	Activity	Duration of squeaking	Number of episodes	Last squeak reported (months postoperatively)	How did the squeaking stop?
1	Episodic	3	Bending to pick up an object	Few hours	Few	6	Spontaneously
2	Episodic	4	Climbing stairs and walking	5 days	Few	5	Spontaneously
3	Rare	22	Bending to pick up an object	1 day	One	22	Progressively
4	Rare	5	Walking distance	1 hour	One	5	Spontaneously
5	Episodic	12	Bending to reach for object and walking	1–2 days	Few	24	Spontaneously
6	Persistent	12	Walking distance	Few hours	Weekly	69	Spontaneously
7	Episodic	9	After activity	Few hours	Few	9	Spontaneously
8	Episodic	15	After activity or first thing in the morning	1 hour	Few	15	Spontaneously
9	Rare	19	Climbing stairs	1 day	One	19	Progressively
10	Persistent	12	Bending to reach for object and after activity	Few hours	At least once a month	Unknown	Stopped with decreased activity due to illness

All squeaking hip resurfacings except one were in the range of 45° ± 10° inclination (median, 48°) (Table 1).

Two episodic squeakers reported a satisfaction score of less than 9 (Table 1). Both persistent squeakers reported a satisfaction score of 10 at the most recent followup. Patient 9 was lost to followup. Over the telephone, Patient 3 reported no episodes of squeaking since the last followup visit, and Patient 10 reported persistent squeaking with activity, until the patient's activity level drastically decreased due to illness.

One patient with a squeaking resurfacing has been revised (Patient 1), and another patient is scheduled for revision (Patient 2).

Patient 1

A 62-year-old man with a BHR (50-mm femoral component, 58-mm acetabular component) was revised 6 years postoperatively for a large, painful cystic mass in the groin. He reported squeaking of the implanted hip around 6 weeks postoperatively. This was heard after heavy lifting on several occasions from 6 weeks to 3 months postoperatively, and then the noise resolved. The patient was troubled by irritation of the psoas tendon over the years, and at 5 years after surgery, he reported pain and a lump in his groin. A MRI scan showed a fluid-filled cyst located anteriorly (Fig. 1A).

There was slight neck narrowing in the AP and lateral radiographs over the course of 6 years, but no indication of component loosening (Fig. 1B). The inclination angle of the acetabular component was 50° on the AP radiograph, and anteversion was 25° on the CT scan. Before revision, serum metal levels were 2 µg/L and 2 µg/L for cobalt and chromium, respectively. The components no longer squeaked, but clicking could be heard at 90° of flexion in passive ROM. It was unknown whether the mass would continue to grow and become more locally disruptive.

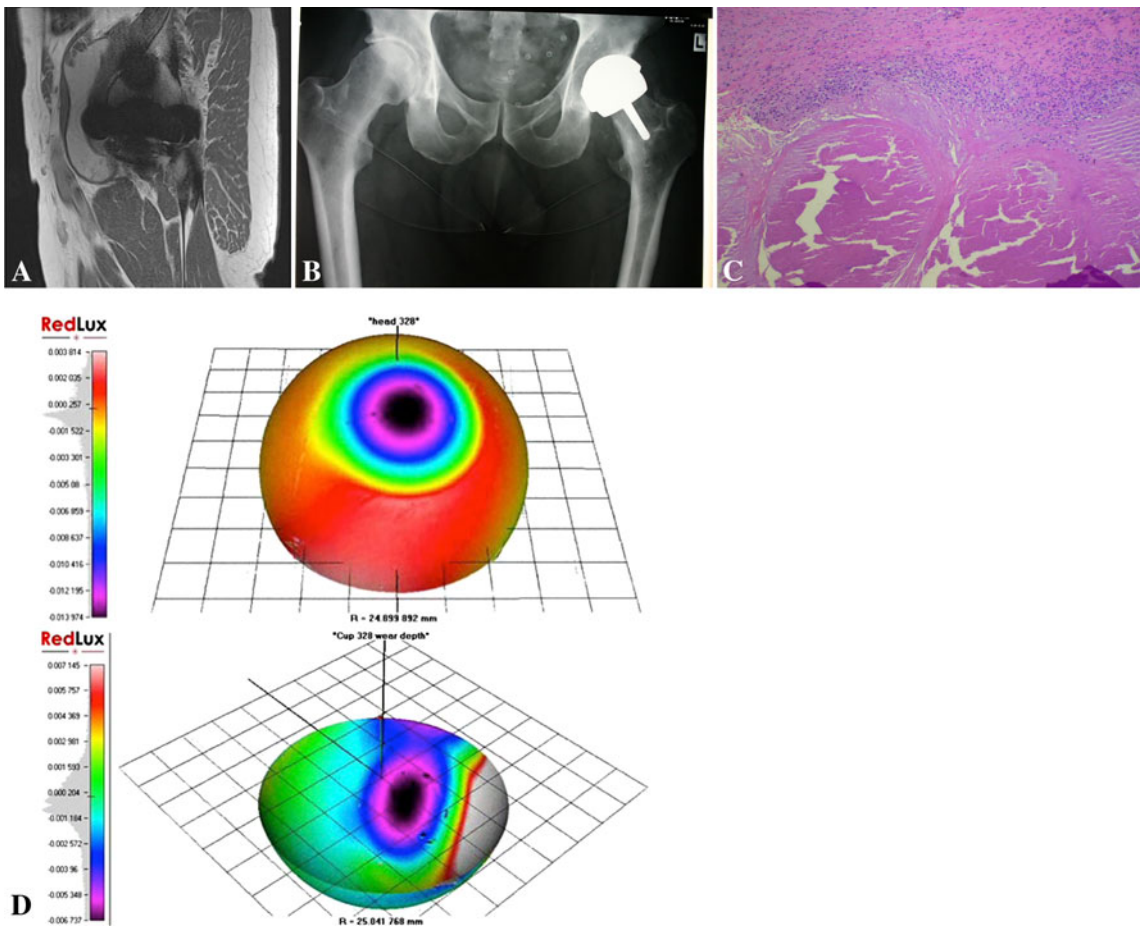

Fig. 1A–D (**A**) A sagittal MRI scan of Patient 1 shows a cyst located anterior to the hip resurfacing. During revision surgery, 80 mL of watery, brown joint fluid was collected. (**B**) A 6-year postoperative radiograph shows a left hip resurfacing in good position. (**C**) A light micrograph of periprosthetic tissue stained with hematoxylin and eosin shows a mild histiocytic infiltrate adjacent to fibrin lining the surface response (original magnification, × 40). (**D**) The wear map of the femoral head shows a round wear patch with a maximum wear depth of 14 µm. The wear map of the acetabular component shows a wear patch and deformation (white area) from surgical removal.

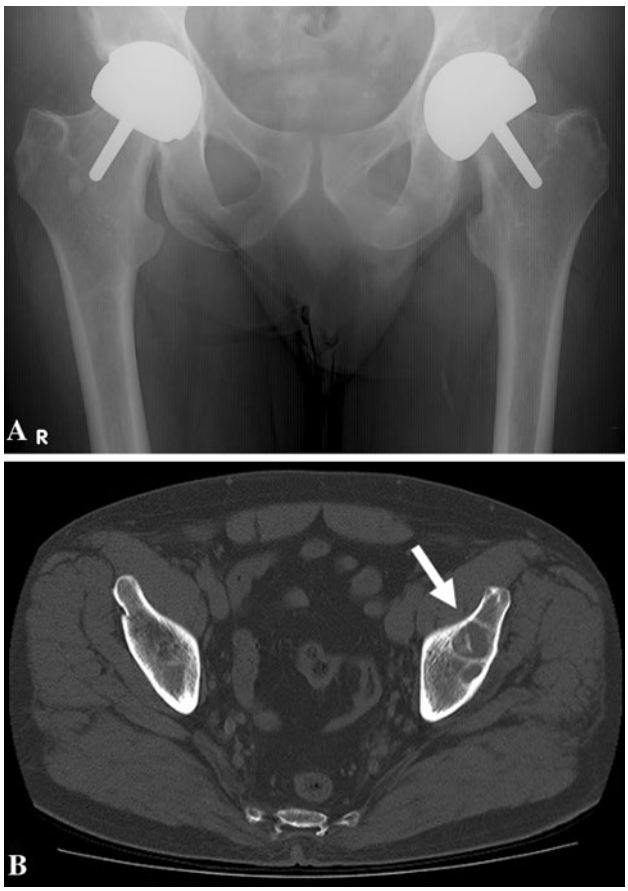

Fig. 2A–B (**A**) Inclination angles are 64° for the squeaking left hip and 49° for the silent right hip. (**B**) An axial CT scan of Patient 2 show bilateral BHRs. The arrow points to a lytic lesion in the anterior ilium, superior to the acetabular component.

Therefore, the patient underwent revision for pain associated with the mass in his groin.

At revision surgery, there was osteolysis at the margins of the acetabulum in the form of granulomatous tissue eroding into the acetabular bone superiorly, anterosuperiorly, and directly inferiorly. Histologically, the joint tissues included areas of extensive fibrinoid necrosis and viable fibrous tissue infiltrated by histiocytes that contained hematin and occasional metal particles. Fibrin often lined the surface in contact with the joint fluid (Fig. 1C). There was also focal bone debris and occasional round spaces containing granular debris bordered by foreign-body-type giant cells (bone cement). There was no indication of infection or metal sensitivity [4].

The components were measured for wear. The maximum wear depth on the femoral head was 14 μm. The wear patch on the acetabular component seemed enclosed within the bearing surface, and did not include the edge. There was deformation from surgical removal (Fig. 1D).

The patient was revised to a ceramic-on-ceramic THA with no complications.

Patient 2

A 48-year-old man with bilateral BHRs reported persistent squeaking in his left hip. The left hip (54-mm femoral component, 62-mm acetabular component) was implanted in August 2003 and the right hip (54-mm femoral component, 60-mm acetabular component) was implanted in April 2004. The inclination angles of the acetabular components were 64° for the squeaking left hip and 49° for the silent right hip, measured on the AP radiographs (Fig. 2A).

Two years after left hip surgery, the patient was very mobile, walking up to 5 km several days a week with good ROM and no pain. He was reviewed again in May 2009, 6 years after surgery. He continues to walk extensively and has remained active, without pain. The patient reported hearing squeaking regularly after heavy activity, including walking far distances and going up and down stairs. The squeaking usually lasted for a few hours and then resolved.

There was osteolysis in DeLee and Charnley Zone 1 of the acetabulum (Fig. 2B) and slight neck narrowing of less than 10%. Serum levels of cobalt and chromium were 134 μg/L and 60 μg/L, respectively. The left hip will be revised for osteolysis and high ions.

Discussion

Since 2005, squeaking in ceramic-on-ceramic bearings has received much attention. However, squeaking is not a complication commonly reported in hip resurfacing studies. This article is one of very few that describes patients with squeaking hip resurfacings, giving clinical and radiographic data on a retrospective group of 10 patients.

The number of squeaking resurfacings is small, but that is expected with the low reported incidence of squeaking in hip resurfacings. The incidence of squeaking has been reported in BHRs as 3.9% at a mean followup of 3 years, and 5.3% at a mean followup of 5 years [1, 12]. There are no other reports of squeaking in MITCH hip resurfacings (Table 3).

We found rare, episodic and persistent squeaking in metal-on-metal hip resurfacings. No squeaking resurfacings have been revised for noise alone based on the patient's wishes. Persistent squeaking in hip resurfacing patients does not resemble the persistent squeaking rarely heard in ceramic-on-ceramic hips, where the noise is constant with activity.

The acetabular component inclination in patients with squeaking varies, and only one patient (Patient 2) had a steep acetabular component. Patient 2 also had osteolysis and high metal ion levels, which is consistent with the reports in the literature on the importance of acetabular component position [6, 8]. Most squeaking metal-on-metal

Table 3. Reported incidence of noise and squeaking in ceramic-on-ceramic and metal-on-metal bearings

Author	Arthroplasty type	Type of noise	Mean followup (yrs)	Number of noisy hips	Total Number of Hips	%
Pandit et al. [18]	MOM	any noise	minimum 1 yr	2	20	10
Jarrett et al. [14]	COC	any noise	2	43	131	32.8
Keurentjes et al. [15]	COC	any noise	4	9	43	20.9
Mai et al. [17]	COC	any noise	minimum 2 yrs	55	320	17
Toni et al. [22]	COC	any noise	not mentioned	10	554	1.8
Ebied and Journeaux[10]	MOM	squeaking	minimum 2 yrs	not reported	over 200	10
Hing et al. [12]	MOM	squeaking	5	12	230	5.3
Back et al. [1]	MOM	squeaking	3	9	230	3.9
Rosneck et al. [21]	COC	squeaking	1	1	case report	n/a
Jarrett et al. [14]	COC	squeaking	2	14	131	10.7
Mai et al. [17]	COC	squeaking	minimum 2 yrs	32	320	10
Restrepo et al. [19]	COC	squeaking	2	30	1056	2.7
Walter et al. [25]	COC	squeaking	minimum 1 yr	17	2716	0.6
Esposito et al.	MOM	squeaking	4	10	290	2.9

MOM = metal-on-metal resurfacing; COC = ceramic-on-ceramic total hip.

components were well-positioned according to AP radiographs. However, we do not have data on the anteversion of squeaking resurfacing acetabular components. In ceramic-on-ceramic bearings, squeaking is related to the anteversion of the acetabular component.

One patient with episodic squeaking underwent revision for a painful cystic mass in the groin after 6 years. The squeaking occurred during the running-in period of the prosthesis [11] and was not heard after the 6-month postoperative visit. This patient had low metal ions and low wear of the components. The RedLux images show a circular wear pattern on the femoral head, and it appears the acetabular wear patch is contained within the bearing surface and does not reach the edge of the component. However, the wear depth at the edge of the cup is difficult to measure and may be affected by deformation of the cup during surgical removal.

Clicking detected before revision may have been the result of impingement. Metal-on-metal resurfacing components are large in diameter and have a lower head-to-neck ratio that can increase the likelihood of impingement and edge loading [2]. The surgeon could detect the components clicking in 90° of flexion; the clicking was thought to relate to anterior bone impingement, posterior subluxation, and posterior edge loading. Impingement of the acetabular component on the femoral neck was further supported by the histologic findings of cement and bone debris in the tissues. The cause for the effusion in this patient is unclear, but it did not appear to be the result of infection, metal sensitivity, or high wear, leaving the possibility that mechanical irritation led to this response.

We believe patients with squeaking resurfacings should be seen for regular followup examinations. At 5 years, we recommend a CT or MRI scan of a persistent squeaker to exclude pseudotumor or osteolysis. Metal ion measurement may be a useful diagnostic tool for identifying problems with a metal-on-metal resurfacing [8].

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