Natural History of Squeaking after Total Hip Arthroplasty

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Abstract

Background In recent years, a number of alternative bearing surfaces, such as ceramic on ceramic, are being used in THA. Squeaking after THA is a recently recognized complication; however, its incidence is unknown.

Questions/purposes Find the incidence of squeaking; when it ensues; activities associated to squeaking; its natural history, and outcome of revisions for squeaking.

Methods A prospective observational study between 2002 and 2007; yield 1486 ceramic-on-ceramic THA performed at our institution. All patients were followed up by office visits or by phone, to obtain information regarding squeaking, pain and function. Minimum followup was 2.5 years (mean, 5.5 years; range, 2.5–7.9 years).

Results Ninety-five of the 1486 hips (6%) developed squeaking after THA, 39 females (44%) and 49 males (56%) with an average age of 49.9 years. Squeaking began on average 19.7 months after surgery but not associated with pain or functional impairment in any patient. Squeaking could be heard during walking (38%), ascending stairs

(24%), bending forward (21%), and other activities (18%), was constant in 26% of the patients and intermittent in 74%. The intensity and frequency remained similar over time in 70% of the patients.

Conclusions Squeaking is a real phenomenon that occurred in about 6% of our patients. The etiology for this problem remains elusive and is likely to be multifactorial in nature. Squeaking, when developed, does not seem to be self-limited and persists in the majority. Nine patients underwent revision arthroplasty for squeaking. No fractures or other implant-related issues were observed.

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

Introduction

In recent years, an increasing number of alternative bearing surfaces have been used in THA [21, 22]. These surfaces include ceramic on highly crosslinked polyethylene, metal on metal (MOM), and ceramic on ceramic (COC). The latter two were developed in an effort to eliminate polyethylene wear and its consequent debris accumulation, which is believed responsible for periprosthetic osteolysis and loosening [1, 2, 9, 17].

Despite the potential for greater longevity [2, 18], MOM and COC bearing surfaces have the disadvantages of creating audible noise [8, 19, 24]. There are a variety of noises including “clicking,” “grinding,” and “squeaking.” These noises may or may not be audible but are common after conventional THA [8], with an overall incidence as high as 96%; however, squeaking noise is specific for hard-on-hard bearing surfaces and has in recent years been recognized as

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Each author certifies that his or her institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

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a complication of MOM and COC THA [6, 8, 12, 13, 16, 19, 20, 24, 25].

The actual incidence of squeaking—a high frequency noise, similar to one emitted from a nonlubricated hinge—after COC THA is unknown, with reports varying between less than 1% and 20%, according to several studies [5, 12, 13, 19]. The reported etiologies of squeaking implicate patient factors, implant factors such as malposition and different design combinations, and factors inherent to the bearing surface itself such as microseparation, lubrication disruption, metal transfer, and third-body mechanisms [6, 8, 19, 20, 23, 24]. The multitude of postulated mechanisms suggests a multifactorial etiology of squeaking. In a study of nine patients (11 hips) we previously described similar functional outcomes after revision THA for squeaking and revision THA for other causes. The complication rate for that study was also comparable to a revision THA for liner exchange.

The purposes of our study were to find (1) the incidence of squeaking; (2) when it usually begins; (3) associated activities that trigger it; (4) its natural history; and (5) the outcome of revision THA for squeaking.

Patients and Methods

After institutional review board approval, we conducted this observational study. Between January 2002 and May 2007, we prospectively followed all patients who underwent THA with a COC bearing using an institutional database to record data. The eligibility or indications for a COC THA at our institution during the study period were young, active adult with end-stage osteoarthritis. Patients were followed clinically and radiographically at 6 weeks, 6 months, and every 2 years thereafter. No patients were lost to followup. We used the database for this study; no patients were recalled specifically for the study, but some patients were contacted by telephone when scheduled followup visits were missed.

A total of 1486 COC THA were implanted in 1284 patients (202 patients receiving bilateral COC THA); 504 patients (39 %) were female and 780 patients (61%) were male. The average age at implantation was 49.9 years (range, 15.3–79.7 years). All variables of interest were available in all 1284 patients. Minimum followup was 2.5 years (average, 5.5 years; range, 2.5–7.9 years) (Table 1).

All patients received a Hemispherical or Peripheral Self-Locking (PSL) Trident[®] acetabular cup (Stryker Orthopaedics, Mahwah, NJ) with sizing varying from 46 mm to 68 mm in diameter. (The Hemispherical Trident[®] cup has the same diameter at the pole and the equatorial zone (rim), while the PSL Trident[®] cup has an increase of 1.8 mm at the equatorial zone (rim), making the press-fit compliance greater at the equatorial (rim) zone.) All patients received a ceramic alumina liner (Ceramtec AG, Plochingen, Germany), reinforced with a titanium sleeve. All femoral stems used were also Stryker Orthopaedics products. All patients received a ceramic alumina head (Ceramtec AG), with head sizes varying from 28 mm to 36 mm in diameter (Table 2).

After undergoing THA, each patient is evaluated clinically and radiographically by a senior orthopaedic surgeon, at 6 weeks, 6 months, and every 2 years thereafter. Clinical evaluation includes a history of any relevant issues, physical assessment to determine gait and ROM, functional outcomes including Harris hip score (HHS) [10], the SF-36 [14], and WOMAC [3]. Radiographic evaluation includes an AP view of the pelvis and AP and lateral views of the affected hip.

To obtain the incidence of squeaking in our cohort, all patients undergoing a COC THA were specifically asked about squeaking during their followup visits or when contacted by phone. Patients were asked to characterize the noise emitted from their hips between grinding, clicking, snapping, squeaking, and other. For the purpose of this study, only the patients who clearly identified the noise as having a high frequency pitch, similar to one emitted from

Table 1. Demographic distribution and followup among patients with ceramic-on-ceramic bearing THAs

Parameter	Nonsqueaking (controls)	Squeaking (cases)	P value
Number of patients (hips)	1284 (1486)	88 (95)	0.5923
Female/male	504/780	39/49	0.3682
Age at surgery (years)*	49.9 (15.3–79.7)	46 (18–67)	0.75
Height (m)*	1.74 (1.24–2.49)	1.72 (1.52–1.98)	0.4997
Weight (kg)*	89.5 (37–215)	83.6 (43–140)	0.3490
Body mass index (kg/m ²)*	28.4 (13.1–57.6)	27.9 (16.3–49.7)	0.32
Followup (years)*	5.5 (2.5–7.9)	4.9 (2.6–7.6)	0.42

* Values are expressed as means, with ranges in parentheses.

Table 2. Prosthetic component distribution among patients with ceramic-on-ceramic bearing THAs

Parameter	Nonsqueaking (controls)	Squeaking (cases)	P value
Acetabular components*			0.33
Trident Hemispherical/PSL	761/725	32/63	
Diameter (mm) [†]	52 (46–68)	52 (46–62)	
Femoral components*			
Accolade TMZF	1131 (90%)	83 (87%)	0.5041
Omnifit	123 (8%)	8 (8%)	1.0000
Restoration HA	14 (1%)	0 (0%)	0.6173
Restoration Modular System	8 (0.5%)	0 (0%)	1.0000
Super Secure-Fit HA	8 (0.5%)	1 (15%)	0.4636
Secure-Fit HA	2 (0.15%)	0 (0%)	0.4636
Femoral heads [‡]			
28 mm diameter	230 (16%)	15 (16%)	0.8822
32 mm diameter	913 (61%)	59 (62%)	0.1930
36 mm diameter	334 (23%)	21 (22%)	0.5398

* Implant components were made by Stryker Orthopaedics (Mahwah, NJ); [†]values are expressed as mode, with range in parentheses; [‡]femoral heads and liners were alumina ceramics made by Ceramtec AG (Plochingen, Germany); PSL = peripheral self locking; TMZF = titanium-molybdenum-zirconium-ferrous; HA = hydroxyapatite.

a nonlubricated hinge, were included as “squeaking” patients. To obtain onset, triggering activities, and natural course of squeaking, all patients were asked to characterize the squeaking noise by answering questions relating to audibility (whether the patient alone or others standing nearby could hear the noise), onset (the time at which the noise started after their surgery), intensity, frequency, and mechanisms involved in generating the squeaking noise, including walking, bending forward, sitting, or rising from a sitting position, going up or down stairs, and other. Patients were followed longitudinally and the progression of the intensity and frequency of squeaking were carefully documented at each followup visit. Furthermore, during followup visits, attempts were also made to reproduce the noise in the office. Fifty-five patients (63%) complained of squeaking in a regular or scheduled postoperative followup visit and 33 patients (37%) when contacted by telephone followup.

Any patient undergoing revision for squeaking was followed to obtain data relevant to the retrieved implant, which, if the patient approved, was sent for macro- and microscopic analysis to search for signs of impingement, third-body residue, edge loading, etc. Followup also included functional outcomes and any orthopaedic and nonorthopaedic complications.

The two-tailed Fisher exact test was used to assess differences for unilateral/bilateral and female/male

distribution among cases and controls and to assess differences among implant components. The two-tailed T test was used to assess continuous variables for height, weight, body mass index, followup time, as well as for HHS, SF-36, and WOMAC and radiographic evaluation for cup abduction and anteversion.

Results

Eighty-eight patients (95 hips or 6%) developed squeaking after COC THA. Eighteen of these 88 patients had bilateral COC THA. Seven of these patients developed squeaking in both hips, while in 11 only one hip squeaked. The cohort included 39 female patients (44%), two of them with bilateral squeaking hips, and 49 male patients (56%), five of them with bilateral squeaking hips. Demographic variables and followup time did not differ between patients with and without squeaking (Table 1). The acetabular, femoral, and head distribution also did not differ between the groups (Table 2). There was no difference in the postoperative values for functional outcomes (HHS, SF-36, and WOMAC) (Table 3) or in the inclination and anteversion of the cup between the groups (Table 3).

In all hips, the squeaking noise was initially audible only by the patient but then became audible to others. Squeaking started on average at 19.7 months after THA (range, 1.7–48.2 months).

The noise could be heard mostly while walking in 33 patients (38%), ascending stairs in 21 patients (24%), bending forward in 18 patients (21%), during deep flexion and/or squatting in 12 patients (14%), or during sexual intercourse in four patients (5%); 81 patients (92%) had a combination of initiating events.

The squeaking noise was constant in 23 patients (26%) and occurred intermittently in 65 patients (74%). Over the duration of the study, the intensity and frequency of the

Table 3. Postoperative functional outcomes and radiographic evaluation for patients with ceramic-on-ceramic bearing THAs

Parameter	Nonsqueaking (controls)	Squeaking (cases)	P value
Physician assessed			
Harris hip score	91.2 (77.1–99.7)	91.3 (77.1–99.7)	0.089
Self assessed			
SF-36	82.6 (80–94.9)	81.2 (77.9–94.8)	0.89
WOMAC	4 (0–9)	4 (0–12)	0.092
Radiographic findings			
Cup abduction (°)	38.5 (23.9–55)	38.8 (23–52)	0.27
Cup version (°)	41.5 (0–67)	44.6 (9–67)	0.69

Values are expressed as means, with ranges in parentheses.

noise remained similar in 62 patients (79%) and diminished (but was still audible) in 12 patients (30%). Squeaking had not self-resolved in any of the patients in our cohort at last followup. Squeaking was not associated with pain or functional impairment in any of the 88 patients.

Nine of the 88 patients (11 of the 95 hips, or 12%) underwent revision arthroplasty for squeaking. All 11 hips were revised to a metal on highly crosslinked polyethylene liner without any complications. Analysis of the retrieved components did not show any fractures of the alumina ceramic bearings. Signs of impingement and stripe wear were seen in some of the retrieved explants.

Discussion

Alternative bearing surfaces such as metal or ceramic on highly crosslinked polyethylene, along with MOM and COC, are presently being used in an effort to avoid periprosthetic osteolysis and loosening encountered with conventional metal-on-polyethylene bearing surface [1, 2, 9, 17]. New or unpredicted complications have recently been identified that are inherent to these new bearing surfaces, such as metal hypersensitivity with MOM bearings [7] and smaller polyethylene debris size with highly crosslinked compared to conventional polyethylene. Despite overall lower wear rates, these complications can ultimately lead to high rates of osteolysis in the long term [15] and squeaking with hard-on-hard bearing surfaces

[6, 8, 12, 13, 16, 20, 24, 25]. The purposes of our study were to find (1) the incidence of squeaking in COC THA, (2) when it usually begins, (3) associated activities that trigger it, (4) its natural history, and (5) the outcome of revision THA for squeaking.

We recognize several limitations. First is the fact that our data were collected from a particular group of active young and mostly healthy patients with degenerative joint disease of the hip who were preselected to receive COC bearings, representing a common selection bias encountered in most of the published studies related to COC THA. However, it is a relatively large cohort and was prospectively followed. Second is the fact that this is an observational study based on data required for our database or our questions about squeaking, and we did not evaluate activity levels and the influence squeaking had on them. Finally, our study lacked a quality of life or satisfaction score to evaluate the impact of squeaking on the patients.

Even though clicking or tapping noise was expected with the use of hard-on-hard bearing surfaces in the presence of microseparation, grinding or squeaking was unexpected and proved to be an actual phenomenon after COC THA.

The squeaking incidence of 6% we found fell within the widely variable reported range of as low as less than 1% [4] to as high as 20% [13] (Table 4). This wide range may be due to a number of different variations among the different series, such as different implant designs, combination of ceramic types, position of the components, or even

Table 4. Comparative values among published studies regarding squeaking ceramic-on-ceramic THAs

Study	Incidence	Etiology	Time of appearance (months)*	Associated mechanisms
Capello et al. [4]	0.8%			
Chevillotte et al. [6]		Multiple unknown		
Glaser et al. [8]		Multiple unknown		
Jarrett et al. [11]				Walking (7 patients), bending, stair climbing, other, eg, "putting on pants" (two patients), "during sex" (1 patient)
Jarrett et al. [12]				Midrange motion while load bearing as in a simulated stair climbing
Keurentjes et al. [13]	20.9%			
Restrepo et al. [19]		Multiple unknown	17 (6–32)	Extension phase of gait (10 hips), standing from a chair (4 hips), throughout walking (16 hips)
Walter et al. [24]		Increased cup anteversion		Bending (8 hips), walking (4 hips), prolonged walking (5 hips)
Restrepo et al. [current study]	6%	Multiple unknown	18 (2–48)	Walking (33 patients), ascending stairs (21 patients), bending forward (18 patients), deep flexion and/or squatting (12 patients), sexual intercourse (4 patients), combination of previous events (81 patients)

* Values are expressed as means, with ranges in parentheses.

collection bias or Type I error. However, despite its relatively high incidence, the etiology for squeaking remains elusive and it is likely to be multifactorial in nature [6, 8, 19, 24] (Table 4), nonetheless, the fact that we had patients with bilateral COC THA in which only one of the implanted hips was squeaking dismisses patient factors such as habitus (weight, body mass index, etc) as a cause of squeaking, drawing attention to implant material and/or implant position as culprits. In our cohort, 16 of 18 of the bilateral patients were implanted simultaneously; the other two were staged within 3 months. Implant position (inclination, anteversion) was similar between the squeaking and nonsqueaking side. Due to the low number of events, we cannot come to any definite conclusion.

The time of appearance of the squeaking phenomenon after COC THA averaged 18 months postoperatively, with a wide range from 2 to 48 months; this range is similar to that in other studies [19] (Table 4).

Activities associated with squeaking production were mostly walking (38%), ascending stairs (24%), bending forward (21%), and combined mechanisms (92%). Combined mechanisms associated with squeaking production also seem to be common in other studies [11, 12, 19, 24] (Table 4).

The natural history of squeaking appeared to have no gender predilection, was self-limiting, and was not associated with pain or functional impairment. Squeaking persisted in the majority of the patients; the intensity and frequency decreased in about 30% of the patients but did not subside completely.

Only 10 of our patients experienced a squeaking intense enough to seek revision THA. When revision was performed, no complications occurred. We anticipated the risk of complications would be equivalent to a liner exchange revision surgery.

Long-term studies including multivariate analysis or meta-analyses along with adequate biomechanical models are warranted to better delineate the causes of squeaking.

In conclusion, squeaking is an actual complication after COC THA. When faced with a patient with squeaking, the adult reconstruction surgeon can inform the patient the symptoms are likely to persist and there is a 30% chance it may decrease over time if faced with a decision to revise the THA.

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