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Can Squeaking With Ceramic-On-Ceramic Hip Articulations In Total Hip Arthroplasty Be Avoided?

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ABSTRACT

Squeaking is a recognized complication of total hip arthroplasty with ceramic on ceramic bearings but the etiology has not been well identified. We evaluated 183 hips in 148 patients who had undergone ceramic-on-ceramic noncemented total hip arthroplasties at one center between 1997–2007 by standardized telephone interviews and radiographic review. Audible squeaking was reported from 22 hips (12% of 183) of 19 patients. Prevalence of squeaking was associated with younger age; obesity; lateralized cup position; use of beta titanium alloy femoral components and shortened head length options; and higher reported activity level, greater pain, and decreased satisfaction at the time of the interview. Squeaking was described as having little personal significance by most patients. Squeaking might be preventable in part through medialization of the acetabular cup and avoidance of the use of shortened femoral necks.

The artificial surfaces of total hip replacements (THA) are commonly comprised of metal and polyethylene, however wear and osteolysis due to wear debris are potential limitations of these materials [1–4]. Bearings made of alternative materials including ceramic, zirconia, and various metals have been developed in an attempt to reduce clinical wear rates. In the 1970s, total hip prostheses using alumina ceramic on ceramic bearing surfaces were introduced. Several studies have demonstrated excellent clinical and radiographic results with minimal wear and reduced osteolysis with the use of ceramic bearing surfaces [5–8]. However, squeaking sound from this bearing couple has been reported in recent years [9–11].

Although several theories have been posited regarding causes of hip squeaking, the mechanism or mechanisms responsible for noise generation in ceramic on ceramic bearing THA has not been identified. Increased acetabular component abduction, and increased component anteversion are thought to be important factors that could cause hip squeaking [10–12]. However, knowledge about the effect of socket position, stem configuration, and alloys used remains limited.

The purpose of this study was to determine the prevalence of squeaking from patients with ceramic-on-ceramic bearing primary THA and to investigate whether characteristics of the reconstructed hip condition are associated with presence or absence of noise. Specifically, we hypothesize that increased cup abduction, increased cup anteversion, increased body weight lever arm, and/or increased cup cephalization may be associated with increased prevalance of squeaking. If this hypothesis is correct, some cases of squeaking might be avoidable with added attention to these surgical details.

Patients and Methods

Patients

We reviewed 200 hips of 164 patients who underwent total hip arthroplasty (THA) with ceramic-on ceramic bearings performed by the senior author between January 1997 and September 2007. The indications for use of a ceramic-on-ceramic bearing were based on patient's age and activity level. Beginning July, 2009, we undertook a cross-sectional study which included a detailed interview of current and past symptoms by telephone, and retrospective review of medical records and radiographs. The study group included all patients implanted with ceramic on ceramic bearings during this time with no exclusions, with the exception that patients who were unable to give valid informed consent on behalf of themselves and/or were unable to personally participate in the interview were not included (we did not accept proxy interview data). Of the 164 patients in the series, 16 (17 hips) did not participate in the study for the following reasons: 4 were deceased at the time of the study, 5 were unable to give their own consent and/or complete the interview, 2 declined to participate, and 5 could not be located (lost to follow-up). Thus 148 patients (183

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hips) were available and willing to participate. All patients were 2 years or longer post-THA at the time of participation. The institutional review board (IRB) approved the study, and informed consent was obtained from all participating patients. Squeaking from ceramic-on-ceramic hip replacements had been a subject of public media attention prior to the start of the study; therefore, in order to avoid response bias, patients were (with IRB approval) told the study was an evaluation of general outcomes of patients after hip replacement surgery. They were not informed either verbally or in informed consent documents that noise was an outcome of interest. The IRB approved the plan according to existing standards for social and behavioral research involving deception for the protection of response validity. According to IRB policy, all patients were informed of the objectives of the study via debriefing letter after all data collection was completed, and any questions patients had about the study were answered.

The study group included 71 hips of 56 women, and 112 hips of 92 men with median post-THA follow-up time of 5.6 years (mean 5.9 yrs, range 2.1 to 11.9 yrs). Mean age was 51 yrs (range 18–79 yrs) and mean body mass index (BMI) was 29.0 (range 16.1-43.9) at the time of surgery. Primary pathology of the hips was osteoarthritis (147 hips), avascular necrosis (23), posttraumatic arthritis (6), rheumatoid arthritis (2), ankylosing spondylitis (2), or developmental dysplasia (3). An anterolateral approach was used in 169 hips, a direct lateral approach in 9, and a posterior approach in 4; one patient's approach could not be classified because the op note could not be located. Three cementless primary THA femoral components were utilized in the series: Accolade (Stryker Orthopaedics, Mahwah, NJ) stems with V-40 taper neck and 127° (75 hips) or 132° (20 hips) degree neck-shaft angle; Omnifit stems (Stryker Orthopaedics) with C-taper neck and 132° neck-shaft angle (56 hips); and Secur-Fit stems (Stryker Orthopaedics) with C-taper neck and 127° (14 hips) or 132° (16 hips) degree neck-shaft angle. Additionally, one hip was implanted in the primary THA procedure with a Restoration HA cementless revision femoral component with C-taper neck and 127° neck-shaft angle due to severe proximal femoral disease. The Omnifit and SecurFit stems are made of conventional titanium alloy with a C-taper neck geometry, while the Accolade utilizes beta titanium alloy. Two acetabular components were utilized: 166 Trident-HA hydroxyapatie coated cups (Stryker Orthopaedics) and 17 SecurFit-HA hydroxyapatite coated cups (Stryker Orthopaedics). Head sizes used were 28 mm (11 hips), 32 mm (149 hips), and 36 mm (23 hips). Treatment indications, patient characteristics, and device utilization changed over the 10 year period of time of the implantations due to changes of FDA status and availability of devices (Table 1).

Survey Data and Self Reported Noise

All participating patients were interviewed by telephone by the same trained interviewer who was not an author of the study and had no association with the sponsor of the study. The interview followed a standardized script and questionnaire designed to elicit both quantitative and qualitative information. In summary, patients were first asked several lead in questions of a general nature, including questions about current levels of satisfaction, hip pain (prevalence, frequency, and intensity), and physical activity (classifications are shown on Table 3). Patients were then asked, "Has there ever been noise from your hip replacement, such as squeaking, popping, or other sounds?" If the response was yes, the patients were asked to qualitatively describe the noise ("What does it sound like?"). Patients with noise were furthermore asked a series of questions including how long after THA surgery they had first noticed the noise; how frequently the hip made noise on average (daily, weekly, monthly, less than monthly); what they were physically doing at times when they heard noise; whether and by what means they were able to cause the noise themselves, for example by certain movements; how loud the noise has been at its loudest (minimal ("In a quiet room only I would hear it, or someone very close to me might hear it"); moderate (someone 6 feet away might hear it); loud (someone 12 feet away would probably hear it)); and, how serious the noise problem seemed to them (very serious, serious, somewhat serious, not serious). Finally, all patients were asked "Have you ever heard about anyone having squeaking or other noise from some hip replacements, for example from television, news, internet, or from another person?" and, if yes, they were asked to recount their exposure to this information.

Radiographic Analysis

The patients in the series had undergone standard pre- and post-operative radiographic examinations according to the normal standard of clinical care. Pre- and post-operative anteroposterior (AP) pelvic radiographs were retrieved and reviewed by an orthopedic surgeon examiner who was unaware of the survey results. Radiographic measurements were taken using a digital caliper (Cedara I-Reach™). Pelvic height (PH), femoral offset (FO), body-weight lever arm (BWLA), and leg length discrepancy (LLD) were measured (Fig. 1). In addition, the ratio of FO to BWLA (FO ratio) and the ratio of BWLA to PH (BWLA ratio) were calculated (Fig. 1) [13]. Acetabular anteversion angle was calculated according to the method described by Pradhan [14]. Pelvic inclination was calculated according to the method described by Siebenrock [15]. The radiographic

Table 1
Patient Population and Device Utilization Over Time Among Single-Surgeon Series Of 183 Primary Total Hip Arthroplasties Implanted With Ceramic-on-Ceramic Bearings, 1997–2007.

	Nov, 1997–Oct, 1998	July, 2001–Jan, 2003	Mar, 2003–Sept, 2007	p Value
No. hips	17	40	126	
Device FDA status	Phase 3 Investigational Device Exemption	Phase 4 Continued Access Study	Commercially Available	
Patient population	Participants of a randomized clinical trial allocated to investigational group	Participants of a single arm Continued Access Study (no comparator group)	Post-market population selected for ceramic-on-ceramic bearings	
Femoral components (No. hips)	Omnifit (17)	Omnifit (40)	Accolade (95) SecurFit (30) Restoration (1) (used concurrently)	
Acetabular components	ABC	Trident	Trident	
Patient age at THA (yrs) (mean ± sd, (range))	58 ± 16.7 (23–73)	47 ± 12.4 (18–66)	52 ± 9.5 (19–79)	0.003
Sex (% Male/Female)	41% / 59%	78% / 22%	59% / 41%	0.022
Obesity (% with BMI>30)	29%	23%	46%	0.018
BWLA ratio (%) (mean ± sd, (range))	43.1 ± 2.6 (39.6-47.5)	42.1 ± 3.1 (35.8-50.0)	42.0 ± 3.0 (33.7-49.4)	0.357
Squeak (No. hips)	4	0	18 (16 Accolade, 2 SecurFit)	0.01