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Squeaky hips make media, medical noise

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What's behind those squeaking hips?

"You didn't put one of those squeaking hips in me, did you, doc?"

"My hip made a funny sound last week, and my husband read in the paper that there's been a recall. Am I going to have to have my new hip taken out?"

Orthopaedic surgeons have been answering these questions ever since The New York Times published "That Must Be Bob. I Hear His New Hip Squeaking" this past May. The article addressed the issue of squeaking ceramic-on-ceramic total hip arthroplasties (THA). The fact that a THA could make an audible noise is not a new idea. So-called "clicks" or "grinds" have been described after THA, regardless of whether metal-on-polyethylene, metal-on-metal, or ceramic-on-ceramic bearings were used (Fig. 1).

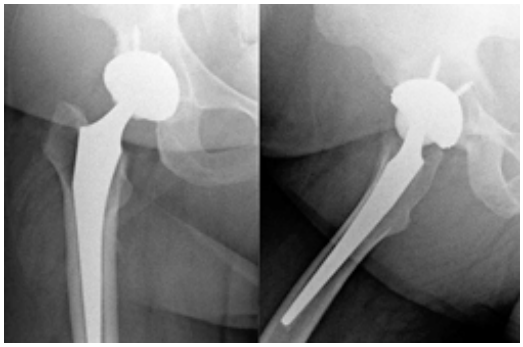

Fig. 1 Anteroposterior and lateral views of a ceramic-on-ceramic total hip arthroplasty. Courtesy of Cale A. Jacobs, PhD

In actuality, all THAs produce some level of audible noise during gait. The “squeak” that has been recently described appears to be limited, however, to hard bearing couples. The prevalence of squeaking ceramic bearings reported in published articles has ranged from 0.66 percent to 7 percent; generally, the audible noise develops more than 1 year after surgery.

Although the prevalence of squeaking ceramic bearings has received an increasing amount of attention over the past few years, a small percentage of metal bearings may also be prone to squeaking. One prospective study reported that 4 percent of hip resurfacing patients experienced a transient audible squeak in their hip.

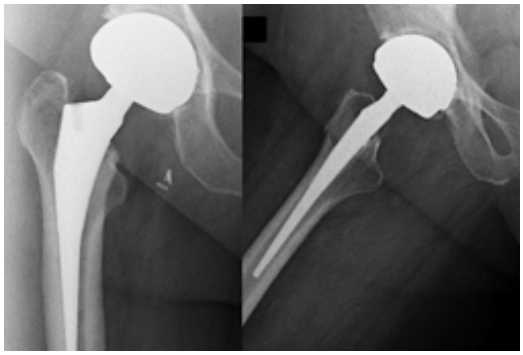

Fig. 2 Anteroposterior and lateral views of metal-on-metal total hip arthroplasty. Courtesy of Cale A. Jacobs, PhD

Members of the AAOS Biomedical Engineering Committee have noted persistent squeaky bearings in patients at a prevalence of up to 7.5 percent in patients treated with a ceramic-on-ceramic THA, and a prevalence of up to 2 percent in patients with metal-on-metal THAs (Fig. 2). Among patients with squeaky metal bearings, the squeaking has been transient, lasting no more than 36 hours.

Although persistent squeaking sensations may not lead to reoperation, they are annoying, potentially embarrassing, and may reduce patient satisfaction or cause patients to alter or modify their daily activities.

How and when do squeaks occur?

Patients with ceramic THAs have stated that the noise occurs during regular gait, ascending stairs, rising from a chair, bending over to pick something up, or when rotating the hip about a planted foot. No single activity triggers complaints more frequently or consistently from one patient to the next.

A recent hip simulator study concluded that the activity was not as important as the presence of stripe wear in causing squeaking. Stripe wear seems to occur as a result of edge loading, such

as when the contact area between the femoral head and the rim of the ceramic liner is reduced. The decreased contact area results in a loss of fluid film lubrication and increases contact stress and grain pullout from the ceramic head. As the surface roughens, friction increases during weight-bearing articulation and may be involved in the etiology of squeaking ceramic bearings.

In a recent evaluation of 10 retrieved squeaking ceramic components, researchers found visible signs of edge loading wear on all 10 components and evidence of femoral neck impingement on six components. Impingement-created titanium debris that enters the articulation has been suggested as another potential cause of squeaking.

To date, the only certainty in the etiology of squeaking ceramic bearings is that it appears to be multifactorial, including patient-, surgical-, and implant-related factors. Patient-related factors such as age, height, and weight have been reported to differ between groups of squeaking and silent ceramic hips; these differences, however, have not been consistent across the few comparative studies that have been performed.

Surgical Factors

One hypothesis is that placing the acetabular component in a more vertical position may result in reduced contact area, increased edge loading, and a greater risk of squeaking, but this has not been supported by clinical observations. Although cup inclination may not be a significant factor, placing the cup in either too much or too little anteversion may increase edge loading because the femoral head becomes relatively uncovered during dynamic activity. This, however, has not been consistently observed clinically.

Edge loading may also occur dynamically as a result of microseparation of the femoral head from the ceramic liner. Previous fluoroscopic and simulator studies have demonstrated that increased laxity leads to microseparation between the femoral head and the acetabular liner. Microseparation results in increased edge loading in the superior lateral aspect of the ceramic acetabular liner. In a recent evaluation, patients with squeaking bearings demonstrated increased intra-operative measures of laxity as well as decreased femoral offset when compared to their nonsqueaking counterparts.

Underreaming of the acetabulum may cause deformation of both the metal shell and ceramic liner of contemporary modular designs. The deformation of the ceramic liner may then diminish the space between the head and liner, affecting fluid film lubrication. Because interrupting the fluid film lubrication may then lead to the formation of stripe wear, underreaming—combined with a thinner, more flexible acetabular shell—has been suggested as a causative factor in the development of squeaking ceramic bearings.

Careful surgical technique may reduce the risk of impingement and/or edge loading, thus reducing the risk that ceramic bearings will develop squeaks. Proper cup placement, with specific attention paid to the amount of cup anteversion, may reduce the risk of impingement-related squeaking. Careful assessment of intra-operative range of motion and impingement during surgery is arguably more critical with ceramic liners than with polyethylene liners.

Impingement may further be avoided by using implants with reduced neck diameters and/or variable offsets, or by avoiding the use of negative neck length femoral heads. Maintaining femoral offset may also keep the abductors appropriately tensioned, thus reducing joint laxity and the risk of edge loading. Finally, reaming line-to-line with the use of dome screws to reduce the risk of deforming the shell could be considered, although this could compromise fixation.

Few surgeons have reported performing revisions for squeaking bearings, but approximately 40 reports of ceramic THAs being revised for squeaking have been filed in the U.S. Food and Drug Administration's (FDA) Center for Devices and Radiological Health's MAUDE database since 2005. Exchanging the ceramic liner of a squeaking THA with a polyethylene liner has been recommended; revising ceramic components, however, may be technically challenging.

Liners that feature a Morse taper may be difficult to extract from the shells and performing a simple liner exchange can take time, due in part to less-than-perfect extraction instrumentation for removing ceramic liners from the shells. In addition, several acetabular systems do not allow a direct exchange of ceramic and polyethylene liners. The lack of flexibility of these designs may require the removal of a well-fixed acetabular shell to treat a problem that solely involves the articulating surfaces.

Implant factors

Although squeaking is possible with all hard bearing couples, scrutiny has focused on one design that features a titanium-encased ceramic liner with an elevated titanium rim to help protect against impingement-related ceramic fractures. (See references in the online version of this article.) The tradeoff of protecting the ceramic liner from fracture is an inherent increased risk of impinging the femoral neck against the elevated titanium liner rim.

The creation of impingement-related titanium debris has also been suggested as a potential cause of squeaking bearings. In some clinical series, audible emissions have developed in up to 7 percent of hips in which the titanium-encased ceramic liner system was used, which is dramatically higher than the 0.5 percent that has occurred with implant systems that do not have this feature. Another design factor that may predispose a ceramic bearing to squeak is a thinner acetabular shell. This feature may allow easier vibration-induced resonance of the metal cup for a given amount of friction experienced by the ceramic components.

Design characteristics of the femoral component may also be involved in predisposing the development of a squeaky ceramic bearing. Pairing the titanium-encased ceramic liner type of acetabular component with a flat designed femoral hip prosthesis has been reported to produce a significantly greater incidence of squeaking than pairing the same insert with a more traditional dual taper type of stem.

Squeaking has also occurred with third-generation alumina ceramic components. Although the FDA has recently approved alumina matrix composite bearings, conclusions drawn from the references cited within this article are based on alumina ceramic components and cannot be generalized to components made of the recently approved bearings.

Squeaking not limited to hips

Noise from motion-sparing spinal implants has been noted, although no studies have been published. Anecdotal reports within our committee of disk prostheses revisions associated with noise (usually clicking) have occurred, but whether the noise was related to the device is unknown.

Facet replacement systems stabilize the spine with a pedicle-based articulated prosthesis after radical posterior decompression. Several such devices are in clinical trial. The pivotal trial of one of these systems was stopped when abnormal noise occurred after implantation. Expert investigation deemed that the noise was from abnormal motion secondary to a design flaw, and the study was discontinued. A design change to the implant has resulted in a recent approval for the study to again enroll patients.

Conclusions

The recent media attention directed at squeaking ceramic THAs may encourage patients to raise questions about noisy hip replacements. All THA bearing couples have the potential to create audible noise, and this should be discussed with patients preoperatively.

Patients with a squeaking ceramic THA may become dissatisfied or annoyed and may decide to alter or modify their activities. No clear evidence of an adverse effect on implant survivorship exists, but these patients should have annual radiographs and physicians should emphasize the importance of follow-up with them.

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