Influence of Prosthetic Design on Squeaking after Ceramic-on-Ceramic Total Hip Arthroplasty

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DISCLOSURE: No author has received anything of value or owns stock in any company or institution related directly or indirectly to the subject of this study.

INTRODUCTION

Squeaking ceramic-on-ceramic total hip articulations are a cause for concern. Although used in Europe for almost 40 years, ceramic-on-ceramic hips did not exhibit a significant problem with squeaking until FDA approval of two ceramic hips in 2003. Since then, many studies have attempted to elucidate the etiology of squeaking. Proposed causes include component malposition causing impingement or "edge loading," ligamentous laxity leading to microseparation and "stripe wear," inadequate lubrication, particulate metal debris, and component design.

The primary author began implanting ceramic-on-ceramic total hips in 1999. Over the course of 10 years, four distinct implant brands were utilized. However, an unusually high incidence of intense, audible squeaking became apparent shortly after implanting a cohort of Stryker Trident acetabular components and Accolade femoral stems. This study was undertaken to determine if squeaking is related to this particular implant combination and to elucidate any other factors which might be related to squeaking.

METHODS

From November 1999 through February 2007, the primary author implanted 306 ceramic-on-ceramic total hip arthroplasties in 267 patients. Four acetabular component designs were used: 1) *Plus Orthopedics MPF, 2) Stryker Trident PSL, 3) Wright Medical Lineage, and 4) Encore Keramos. Femoral components used were the Plus Orthopedics SL-Plus, Stryker Accolade, and Wright Medical Profemur-Z.

In this study, 233 patients with 270 total hips were contacted telephonically to complete a survey regarding squeaking of their hip prostheses. Only patients with a minimum 24 months follow-up were included in this study. Demographic and operative data were collected by questionnaire and review of the patients' medical records.

Additionally, all patients who reported squeaking were matched with controls based on nine matching criteria. Acetabular abduction and anteversion angles were measured from plain radiographs and compared using Student's t test.

Frequency and severity of squeaking were graded as shown in Table 1. "PROBLEM SQUEAKING" was defined as squeaking which was always perceptible to others (Severity Grades 3-4) and occurred at least once per week (Frequency Grades 2-4).

Twelve independent variables (Table 2) were analyzed using a logistic regression analysis with additional Chi-square analysis where appropriate to determine variables associated with squeaking.

TABLE 1: FREQUENCY AND SEVERITY RATING OF SQUEAKING

Severity Grade	Severity of Squeak
1	Perceptible only to patient
2	Occasionally perceptible to others
3	Always perceptible to others, but not social problem
4	Loud; creates social problem for patient
Frequency Grade	**Frequency of Squeak**
1	<1 time/week
2	1-4 times/week
3	>4 times/week
4	Daily

TABLE 2: INDEPENDENT VARIABLES ASSESSED

Demographic Variables	Implant Variables
Age	Acetabular Component Company
Height	Acetabular Component Size
Weight	Femoral Head Size
Body Mass Index (BMI)	Femoral Head—Neck Length
Gender	Femoral Component Offset
Diagnosis	

**Plus MPF acetabular component not FDA approved at time of use.*

RESULTS

Incidence of Squeaking	**24/270 (8.8%)**
Mean time to Squeaking	**19.6±19.7 months (1-65 months)**

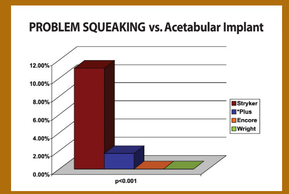
Incidence of PROBLEM SQUEAKING	**6/270 (2.2%)**
Mean Time to PROBLEM SQUEAKING	**22.4±21.4 months (8-72 months)**

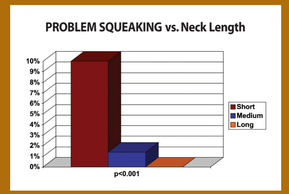
PROBLEM SQUEAKING was associated with three independent variables:

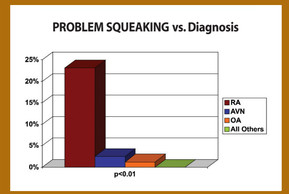
1. Acetabular implant (Stryker Trident)
2. Short neck length
3. Diagnosis of rheumatoid arthritis

PROBLEM SQUEAKING was not associated with:

1. Age, height, weight, BMI, gender
2. Activity level
3. Acetabular component size
4. Femoral head size
5. Femoral component offset
6. Acetabular component position







FREQUENCY GRADE BY ACETABULAR IMPLANT

Grade (1-4)	Stryker	*Plus	Encore	Wright
4: Daily	5	2	0	0
3: >4/week	1	1	0	0
2: 1-4/week	1	1	2	0
1: <1/week	9	0	1	1

INCIDENCE OF SQUEAKING (ANY FREQUENCY/SEVERITY)

Acetabular Implant	Number of Squeakers	Number of Implants	Incidence
Stryker	16	45	35.6%
*Plus	4	58	6.9%
Encore	3	138	2.2%
Wright	1	29	3.4%
Total	24	270	8.8%

SEVERITY GRADE BY ACETABULAR IMPLANT

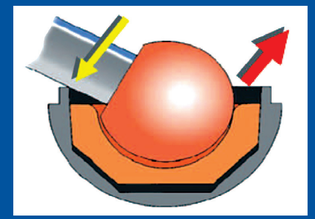
Grade (1-4)	Stryker	*Plus	Encore	Wright
4: Creates Social Problem	4	0	0	0
3: Always Perceptible to Others	4	1	0	0
2: Seldom Perceptible to Others	5	2	1	0
1: Perceptible Only to Patient	3	1	2	1

INCIDENCE OF PROBLEM SQUEAKING

Acetabular Implant	Number of Squeakers	Number of Implants	Incidence
Stryker	5	45	11.1%
*Plus	1	58	1.7%
Encore	0	138	0
Wright	0	29	0
Total	6	270	2.2%

DISCUSSION

Stryker's Trident acetabular component design is unique compared to the other three designs investigated in this study in that the ceramic is encased in a metal shell which extends past the rim of the ceramic to protect it from neck impingement. However, this extended rim increases the likelihood of neck impingement against the metal casing. Rim impingement may generate particulate metal debris or may result in levering of the ceramic head against the liner, either which may damage the articular surfaces and lead to squeaking (Figure 1).



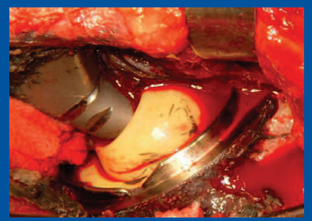


Figure 1: Levering of the femoral neck against the elevated rim resulting in damage to the acetabular rim and femoral neck (Eickmann, 2003[1]).

Capello, et al.[2] reported a low incidence of squeaking in their series of Stryker Trident cups and Omnifit stems made from the standard alpha+beta titanium alloy (Ti-6Al-4V). However, Murphy[3] recently reported a high incidence of squeaking ONLY when the Trident cup was mated with the Accolade stem (which is HA coated and uses a beta titanium alloy (TMZF) containing molybdenum, zirconium, and iron). This study corroborates his findings.

Short necks may increase the likelihood of damage to the ceramic articulation if inadequate offset results in lax soft tissues and microseparation with resultant stripe wear damage to the ceramic surfaces. Short necks may also lead to more impingement if the geometry of the neck is tapered such that a short neck positions a wider part of the femoral neck against the acetabular rim than a long neck[4].

The explanation for a higher incidence of squeaking in rheumatoid patients remains elusive. One would speculate that rheumatoids would be less likely to damage the ceramic surfaces due to a) relatively low activity levels and b) reduced mobility resulting in less likelihood of impingement. Perhaps inflammatory synovial fluid loses some of its lubricating properties in rheumatoids.

1. Eickmann, et al. Squeaking in a ceramic total hip. Clinical results in hip arthroplasty. In: Proceedings from the Eighth Annual BIOLOX Symposium. Berlin, Germany: Springer Verlag; 2003: 187-192.
2. Capello, et al. Ceramic-on-Ceramic total hip arthroplasty: Update. J. Arthroplasty. 23(7 Suppl 1):39-43, 2008.
3. Murphy, SB. The squeaking hip: A cause for concern—opposes. Paper#23, 24th Current Concepts in Joint Replacement, Orlando, FL, December 12-15, 2007.
4. Keurentjes, et al. High incidence of squeaking in THA's with alumina ceramic-on-ceramic bearings. Clin Orthop Relat Res 466:1438-1443, 2008.

CONCLUSIONS

Based on the findings of this study, the authors recommend against the use of the Stryker Trident cup with the Accolade stem and the use of short necks in ceramic-on-ceramic total hip arthroplasty. Ceramic-on-ceramic articulations should be used with caution in rheumatoids. Further research will likely elucidate the mechanisms causing problem squeaking in these subgroups of patients.