Original Article

Noise production in ceramic-on-ceramic total hip arthroplasty is associated with lower patient satisfaction and hip scores

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ARTICLE INFO

Article history:

Received 23 April 2016

Accepted 23 June 2016

Available online 29 June 2016

Keywords:

Total hip arthroplasty

Ceramic

Noise

Squeak

ABSTRACT

Background: Ceramic-on-ceramic total hip arthroplasties (THA) are commonly implanted. We investigated the incidence of noise in ceramic-on-ceramic and determined any association with patient satisfaction and hip scores.

Methods: We recruited 140 THA. Questionnaires were completed to assess the incidence and frequency of noise, and satisfaction level. Hip and SF-12 scores were recorded.

Results: Forty-two patients (30%) were aware of noise production. Patients with noise production had lower satisfaction, mean hip and SF-12 scores than those with silent hips.

Conclusion: Given the high incidence of noise in ceramic-on-ceramic THA, patients should be counselled on this risk pre-operatively.

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1. Introduction

Ceramic bearings have been shown to represent an excellent option in total hip arthroplasty (THA).¹ With manufacturing improvements, namely hot isostatic pressing, wear properties have been vastly improved.^{1,2} It is therefore most often utilised in active patients where wear and implant longevity is a concern. Multiple long-term follow-up studies have demonstrated low rates of osteolysis, wear, revision and complications.^{3,4} However, there have been reports within the literature of an increase in the frequency of squeaking or other similar noises with ceramic bearings when compared to metal or polyethylene.^{2,5} The incidence of this noise phenomenon is variable, ranging from 0.7%⁶ to 20.9%.⁷ The aetiology is also unclear, although an number of potential contributory factors have been proposed, including component malposition,⁷ stripe wear,⁸ microfracture⁹ and loss of the lubrication layer.¹⁰ Given the wide range of proposed causes, a multifactorial mechanism has been suggested.¹¹ Studies have noted that squeaking does not affect patients quality of life or satisfaction.¹² We therefore set out to establish the incidence of noise in ceramic-on-ceramic THA and determine whether there

was any association with patient satisfaction and hip outcome scores.

2. Materials and methods

Using our unit's arthroplasty database, we identified 226 ceramic-on-ceramic primary THA performed by two surgeons between 2007 and 2012. Revision cases or those utilising other bearing materials than ceramic were excluded. All used the fourth generation BioloX Delta bearings (zirconia-toughened, platelet-reinforced alumina ceramic) which are 74% alumina and 24% zirconia. These patients were sent a postal questionnaire to determine the frequency and type of noise produced, and provide a satisfaction score. At least two attempts were made to contact patients who did not respond. Satisfaction was assessed using a visual analogue score (0–10). Patients were asked to describe noise frequency as never; less than once per week; 1–4 times per week; 5–6 times per week and daily. They were also asked to describe the main sounds as click, crack, pop, grind, squeak, creak, judder, or other. Patients were then split into two groups for further analysis; those who experienced noise and those who did not. From our arthroplasty database, we recorded patient age, body mass index (BMI), weight (kg), implant type and size, Oxford Hip, WOMAC and SF-12 scores. Any cases of revision were documented. Statistical analysis was performed using SPSS[®]. The *t*-test was used to analyse satisfaction rates and outcomes scores between groups, and Pearson's *r* test to assess correlation between noise frequency and satisfaction.

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3. Results

The questionnaire response rate was 62% i.e. 140 hips (96 female; 44 male) in 124 patients. Mean age at surgery was 52 years (range 16–76) and follow-up 2.5 years (range 1–6). Forty-two patients (30%) were aware of noise production from their THA. Of these patients, noise was present daily in 31%, several times per week but not daily in 38% and less than once per week in 31% of cases. A range of noises observed are presented in Table 1. Squeaking was described by 12 patients (8.6%). Mean BMI between the silent and noise-production groups was comparable (28.9 *cf* 29.5). Conversely, a higher mean weight was noted in the noise group (82.2 kg *cf* 70.0 kg). A higher proportion of the noise-production group were female (male:female ratio 1:5 *cf* 1:1.6). The median cup size in both groups was 50.

On the visual analogue satisfaction scale, patients who were aware of noise production were less satisfied than those who had silent hips (8.0 *cf* 9.0, $p < 0.05$). A correlation was observed between increasing noise frequency and lower satisfaction scores (Pearson $r = -0.28$, $p < 0.05$). These scores ranged from 9.0 for the silent hips, to 6.8 those who experience daily noise.

All patients' pre-operative scores improved following THA. Mean pre- and post-operative scores were as follows: WOMAC 20.4 *cf* 48.5, Oxford Hip score 17.8 *cf* 40.8, and SF-12 29.5 *cf* 38.2. However, post-operative WOMAC and Oxford Hip scores were found to be lower in patients who observed noise (50.8 *cf* 43.3, $p < 0.001$, and 42.6 *cf* 37.2, $p < 0.001$, respectively) as was the SF-12 (39.4 *cf* 35.6, $p < 0.001$), which measures general physical and mental health (Fig. 1). At last follow-up, no patients in the groups who experienced noise underwent revision surgery. One hip (1%) in the silent group was revised for a peri-prosthetic fracture.

4. Discussion

The evolution of the total hip arthroplasty has led to the increased use of ceramic bearings, which offer superior wear properties to polyethylene and have low complication rates.^{1,4,13} With this has come the new issue of noise production, the aetiology of which is poorly understood.¹¹ This issue has potentially led to other bearings, such as metal-on-metal or metal-on-polyethylene, being used in favour of ceramic-on-ceramic. Previous studies have reported a variable incidence and minimal effect on patient satisfaction.^{2,5,12} In this study, we set out to establish the incidence of ceramic-on-ceramic THA-related noise and determine the effect on patient satisfaction and hip scores.

There are limitations to our study. Firstly, not all patients returned our questionnaire, which could have affected the overall incidence. At least two attempts to contact each patient were made. Causes for the reduced return rate may include incorrect recording of addresses in medical records and lack of incentive to complete the questionnaire. We believe that 140 hips represent a sufficient sample size despite this. Furthermore, the response rate

Hip and SF-12 Scores

Fig. 1. WOMAC, Oxford Hip and SF-12 scores were significantly lower in patients who reported noise from their THA.

to postal questionnaires recorded in the literature¹⁴ is consistent with what we experienced in our study. It should also be noted that the aim of our study was to establish the effect of noise on satisfaction, rather than establish its incidence, which is unlikely to be affected by questionnaire return rate. Secondly, we utilised patient rather than clinician reported noise, and it is possible that different patients have a varying awareness of noise production. We also did not study the potential aetiology of noise production in our cohort as this was out with the scope of this paper.

Squeaking was the most commonly reported noise in our cohort, with an overall incidence of 8.6%. This frequency is comparable to other studies within the literature, given the range from 0.7%⁶ to 20%.⁷ It is interesting to note that when other noises, such as grinding and clicking, are included the overall incidence of noise production increases to 30% which is far greater than other studies have observed, perhaps as many assessed squeaking alone. Given that almost a third of these patients experienced noise daily, patients should be informed of this potential issue pre-operatively in order to manage expectations.

We found that patients who experience noise have lower satisfaction levels, with a negative correlation between increased noise frequency and worsening satisfaction. This contradicts previous evidence presented by Chevillotte,¹² Schroder² and Haq.¹⁵ We also observed lower Oxford Hip, WOMAC and SF-12 scores. This is also in opposition to other studies.^{3,12} Our scores were gathered by independent practitioners not involved in this study and are therefore not open to bias. Given these scores include an assessment of pain and function, this suggests patients who experience noise have other associated negative symptoms.

We found a higher mean weight in the group who experienced noise. This has been noted by other authors, who have proposed squeaking occurs more commonly in heavier, taller and younger patients.^{7,12} This could be explained by the increased force placed through the joint bearings. No studies have identified a definite weight or BMI at which squeaking occurs, however.¹¹ Other patient demographics previously examined within the literature, including age and sex, have not been shown to correlate with noise production.¹¹ However, in this series we noted a higher proportion in females in the noise production group. The significance of this gender difference is uncertain.

5. Conclusion

A significant proportion of patients who undergo ceramic-on-ceramic THA will observe noise from their hip and there is an association between noise production and lower satisfaction and hip scores. Although there are benefits to using ceramic bearings, namely that of improved wear properties, patients should be advised of the incidence of squeaking during the consenting process to manage expectations.

Table 1
patient reported noise by description and frequency.

Noise description	Number of patients
Squeak	12
Click	10
Grind	8
Creek	6
Judder	2
Crack	2
Pop	1
Other	2

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest

The authors have none to declare.

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