■ HIP

Early to mid-term results of ceramic-on-ceramic total hip replacement

ANALYSIS OF BEARING-SURFACE-RELATED COMPLICATIONS

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Ceramic-on-ceramic bearings in hip replacement have low rates of wear and are increasingly being used in young adults. Our aim was to determine the incidence of audible phenomena or other bearing-related complications.

We retrospectively analysed 250 ceramic-on-ceramic hip replacements in 224 patients which had been implanted between April 2000 and December 2007. The mean age of the patients at operation was 44 years (14 to 83) and all the operations were performed using the same surgical technique at a single centre.

At a mean follow-up of 59 months (24 to 94), the mean Oxford hip score was 40.89 (11 to 48). There were six revisions, three of which were for impingement-related complications. No patient reported squeaking, but six described grinding or clicking, which was usually associated with deep flexion. No radiological evidence of osteolysis or migration of the components was observed in any hip.

The early to mid-term results of contemporary ceramic-on-ceramic hip replacement show promising results with few concerns in terms of noise and squeaking. Positioning of the acetabular component remains critical in regard to the reduction of other impingement-related complications.

The use of ceramic-on-ceramic bearings in total hip replacement (THR) has increased since improvements in manufacturing have decreased the risk of catastrophic failure.¹ The perceived advantages over polyethylene bearings are thought to be a much reduced risk of osteolysis and increased longevity.¹ In addition, the small volume of particulate third-body debris generated by the ceramic-on-ceramic bearing is thought to be bio-inert,¹ therefore possibly avoiding the emerging issues recently published regarding metal-on-metal articulations.² Unfortunately, the increased use of ceramic-on-ceramic bearings has been associated with reports of audible noises, in particular squeaking.^{3,4} Recent studies have suggested that the incidence of squeaking is about 3%, although it has been suggested there may be some under-reporting or reporting bias.⁵

Our aim in this study was to review a large series of ceramic-on-ceramic THRs, with specific reference to the generation of noise from the bearing and any other problems not as yet identified.

Patients and Methods

We identified a series of 272 cementless ceramic-on-ceramic THRs in 236 patients which had been performed by or under the

supervision of the senior author (JDW) between April 2000 and December 2007 with a minimum follow-up of two years. There were 91 men and 145 women with a mean age of 44 years (14 to 83). Of these, we are able to contact 224 patients (250 hips) with 12 patients lost to follow-up. Most patients had osteoarthritis, but a substantial proportion had inflammatory arthritis, in particular juvenile idiopathic arthritis (Table I).

All patients had surgery through the posterior approach with repair of the capsule and external rotators using intraosseous sutures. The selection of the implant depended on the individual anatomy of the patient. Femoral components included the Furlong (Joint Replacement Instrumentation (JRI), London, United Kingdom), S-ROM and Corail (De Puy, Warsaw, Indiana). Acetabular components included the Furlong CSF/CSF plus (JRI), the Duraloc and the Pinnacle (both De Puy) (Table II). The ceramic-bearing components were either BioloX Forte or BioloX Delta (CeramTec, Plochingen, Germany) (Table III). All patients received prophylactic antibiotics, low-molecular-weight heparin and wore graduated elasticated compression stockings. Most were mobilised the day after surgery and

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Table I. Distribution of pathology in 250 hips

Pathology	Number of hips (%)
Mucopolysaccharidosis	2 (0.8)
Epiphyseal dysplasia	3 (1.2)
Tumour	2 (0.8)
Post joint sepsis	5 (2.0)
Post SUFE*	2 (0.8)
Perthes' disease	3 (1.2)
Trauma	8 (3.2)
Other inflammatory arthropathy	16 (6.4)
CDH/DDH†	32 (12.8)
Avascular necrosis	30 (12.0)
Juvenile idiopathic arthritis	48 (19.2)
Rheumatoid arthritis	15 (6.0)
Primary osteoarthritis	84 (33.6)

* SUFE, slipped upper femoral epiphysis

† CDH, congenital disease of the hip; DDH, developmental dysplasia of the hip

Table II. Details of the number of different types of femoral stem and acetabular component used

Femoral stem	Number	Acetabular shell	Number
Furlong	178	Furlong	106
S-ROM	46	Duraloc	99
Corail	26	Pinnacle	45

Table III. Details of the number of hips with different types of ceramic-bearing components

	Number
BioloX Forte 28	123
BioloX Forte 32	79
BioloX Delta 36	48

Fig. 1

Photograph of the explanted acetabular component with ceramic liner showing discoloration at the site of impingement.

allowed to bear weight as tolerated. Post-operatively, the patients were asked to complete the revised Oxford hip score (OHS)⁶ questionnaire with an additional question specifically on noises from their hips. Those who did not return the questionnaire were contacted by telephone. If they reported unusual symptoms they were contacted again by telephone to gain further information.

The most recent radiographs were reviewed for each patient and assessed for signs of wear and osteolysis by two authors (GHS, SUI). Eccentricity of the femoral head in the acetabular component was considered as a sign of wear. Heterotopic ossification, considered as a sign of migration, was assessed on plain films.⁷ Any radiolucencies were reported in the zones described by DeLee and Charnley⁸ around the acetabular component and in those around the femoral component according to Sarmiento and Gruen.⁹

Results

The mean follow-up was 59 months (24 to 94) and the mean final OHS was 40.89 (11 to 48). No patient reported squeaking of the hip, but six stated that there were occasional 'grinding' or 'crunching' noises, which were associated with movements involving deep flexion. One sometimes felt a grinding sensation when walking, but could not provide greater detail. None of these hips were painful and the unusual phenomenon tended to be first

noticed more than 12 months after surgery. The most frequent occurrence of grinding or crunching was about once every 14 days. None of the patients felt that they needed further treatment or investigation. Of these patients, three had 28 mm diameter modular heads, two a 32 mm (all BioloX Forte) and one a 36 mm head (BioloX Delta).

Six patients have undergone revision, two for deep infection. One patient sustained a spontaneous fracture of a 28 mm BioloX Forte head with a short neck on a Furlong stem; two patients were revised for recurrent dislocation secondary to impingement, one of whom had two episodes of posterior dislocation in close succession four years after the primary replacement. The acetabular component lacked anteversion resulting in impingement in flexion (Fig. 1). The other patient developed recurrent anterior dislocation eight years after the primary THR as a result of impingement in extension and external rotation. A small notch in the posterior aspect of the femoral neck was noted on the radiographs where it was impinging against the acetabular component (Fig. 2). The orientation of the acetabular component at revision appeared to be anatomical. One hip with a 32 mm BioloX Forte bearing was revised for recurrent clicking of the hip when it was extended, which the patient found troublesome. There was excessive anteversion of the acetabular component and the hip was revised two years after surgery. At revision, moderate metallosis involving the

Fig. 2

Radiograph of a Furlong femoral component showing an indentation in the trunion (arrow) as a result of impingement.

joint capsule with an associated effusion was found in all patients. The areas where impingement had been occurring were easily identifiable.

Other complications included avulsion of the greater trochanter after a dislocation. No active treatment was required. Two patients had a dislocation, but did not require revision. One patient sustained a Vancouver type C¹⁰ peri-prosthetic fracture at four years after operation. This was treated by internal fixation retaining the original components.

Radiological analysis showed no signs of osteolysis around either component in all 250 hips, or signs of migration or subsidence. The identification of radiological evidence of wear is very difficult because the outline of the ceramic-on-ceramic articulation is not easily identifiable. However, we did not find any eccentrically located femoral heads and there was no signs of malalignment of the liner. In eight hips evidence of heterotopic bone formation was noted none of which exceeded Brooker grade II.⁷

Discussion

The production of biologically active wear debris leading to osteolysis has not been associated with ceramic-on-ceramic bearings.¹¹ Additionally, they show very low wear rates and the long-term survival of these implants is of great interest.¹¹ The cumulative survival of the first generation of this articulation has been reported to be 84.4% at 20 years¹² and in that study no episode of squeaking was reported. The long-term results of the current generation of ceramic components remain to be determined since there is only one reported study with a follow-up of ten years.¹³

The relatively low mean OHS of 40.89 (11 to 48) at the final review in our series is due to the inclusion of a substantial number of patients with inflammatory arthritis including juvenile idiopathic arthritis. These patients tend to have

low functional outcome scores because of the involvement of other joints. We recognise that there is heterogeneity in both the pathology and implants used in our series with selection of the femoral component matched to the proximal femoral morphology. The variation in the acetabular components used related to the evolution of the design of implants in particular to allow for the use of femoral heads of larger diameter. This lack of uniformity is a potential weakness of our study, which nevertheless demonstrates a consistent performance of the ceramic bearings in spite of this.

There was one fracture of a ceramic head with a 28 mm short-neck Biolo Forte head on a JRI Furlong stem. In the short 28 mm diameter head the ceramic is relatively thin at the apex, which may have been a causative factor in the fracture. The short-neck 28 mm Biolo Forte head has previously been considered to be at an increased risk of fracture.¹⁴ However, with advances in ceramic formulation, heads of larger diameter are available which are compatible with smaller acetabular components reducing the concern about the possibility of fracture.

Three hips required revision for impingement. In two with 28 mm bearings recurrent dislocation occurred at four and eight years after surgery. We suspect that the late presentation resulted from the accumulation of a considerable effusion because of metallosis secondary to impingement, and the subsequent gradual increase in local soft-tissue laxity which develops in association with this. Revision in these patients was relatively straightforward and involved changing the acetabular components and their orientation as required, and increasing the diameter of the bearing.

Although no patient in our series described squeaking, a small number did report other phenomena. In most patients these events were related to deep flexion, indicating that the femoral head was probably subluxing posteriorly as a result of anterior impingement.^{1,15} This inaudible 'grinding' or 'crunching' may have been due to stripe wear secondary to edge loading, but there have been no studies thus far to prove this conclusively.¹⁶ None of these phenomena was noted before one year after operation which is consistent with the findings of previous studies that suggested a run-in period before such occurrences took place.^{1,17} The incidence of hip-related noises in our series was low compared with findings in other series, but the literature reports a considerable variation. Petsatodis et al¹² reported no squeaking in 85 hips followed up for 20 years, but it was not apparent whether patients were questioned about other noises related to their hips. Lusty et al¹ reported one case of squeaking in 241 third-generation ceramic-on-ceramic THRs which began six years after operation. This hip functioned well and was not revised. Sexton et al⁴ recently reported squeaking in 74 hips of 2406 ceramic-on-ceramic THRs (3.1%) at a mean follow-up of 9.5 years. Jarrett et al⁵ however, reported audible squeaking in 14 of 131 (10.7%) ceramic-on-ceramic THRs. This high incidence may have been implant-specific with similar results reported elsewhere.^{17,18}

Our results are consistent with those of other studies by demonstrating that this bearing couple is sensitive to the position of the components.^{1,3,5,15,19,20} A recent paper from the Australian National Joint Replacement Registry²¹ reported a higher rate of revision for dislocation in ceramic-on-ceramic bearings than in metal-on-polyethylene bearings when heads of smaller size (28 mm or less) were used in younger patients (< 65 years). The lack of any considerable osteolysis is in keeping with other published reviews.^{14,20} With the larger size of head now available it is hoped that the potential for impingement will be reduced although the positioning of the acetabular component remains crucial to the success of the implant.

Overall, our results appear to be satisfactory in terms of the lack of squeaking or osteolysis, particularly in this relatively young series of patients. However, our experience confirms that all patients should be informed pre-operatively of the risks of fracture of the ceramic component, noise and impingement.

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