

Outcome of Total Hip Replacement with Ceramic on Ceramic Bearings, Case series from Aga Khan University Hospital, Karachi, Pakistan

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Abstract

Total Hip replacement offers complete resolution of symptoms and restoration of the hip function. The long-term success of hip replacement primarily depends on wear and osteolysis resulting from the bearing surfaces used in hip replacement surgery. Different bearing surfaces have been used in hip replacements, with variable success rates. Traditional combinations include metal on polyethylene, ceramic on polyethylene, and metal on metal articulations. Ceramic on ceramic Bearing couple is a relatively newer combination recommended for younger patients, requiring Total hip Arthroplasty. Ceramics have the lowest wear rate and are showing promising long-term results in international literature. We report the use of this bearing surface for the first time in Pakistan.

Keywords: Hip Replacement, Ceramics, and Arthroplasty.

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Introduction

Total Hip Arthroplasty relieves pain and improves function in patients with disabling hip arthritis and is considered by some as "Operation of the Century".¹ The procedure is traditionally performed in older age groups. However as surgical techniques, implant materials, and designs are getting better, the success and longevity of total hip replacement is improving and its indications are expanding to younger age groups.² One of the main challenges to the longevity of total hip replacement is wear and osteolysis related to bearing surfaces. The common bearing surfaces for total hip replacement include metal on polyethylene (MOP), metal on metal (MOM), ceramic on polyethylene (COP) and more recently Ceramic on Ceramic (COC) combinations.³ Young and active patients requiring hip replacement demands the use of best bearing materials with lowest wear rates, to improve long term success of this operation in young populations.

Ceramics offer advantages of extreme hardness and scratch resistance. This improves lubrication and the coefficient of friction resulting in extremely low wear rates. Moreover, ceramics are biologically inert and minimise

chances of osteolysis. These properties make ceramic bearings an attractive choice for young patients. There are concerns of squeaking (audible noises) and fractures of ceramics in patients with hip arthroplasty. These are related to material properties and specific technical aspects of hip replacement surgery.⁴ Improvements in the manufacturing process of ceramics, paralleled with properly trained and fellowship accredited hip surgeons has reduced these problems and there is an increasing trend for using ceramic bearings in young patients requiring hip arthroplasty.⁵

We report the use of ceramic on ceramic bearings in hip replacement for the first time in Pakistan. The objective of our study is to see the functional outcome of our patients and to report any associated complications.

Case Series

A retrospective review of all patients who had hip replacement surgery at Aga Khan University Hospital, Karachi, Pakistan was performed by the senior author from 1st June 2015 till 31st December 2019. All patients who had Total Hip Replacement with ceramic on ceramic bearing surface were enrolled in the study. However patients with hip replacement using other bearing surfaces with revision total hip replacement or total hip replacement as a secondary procedure were excluded from the study. A total number of 21 Patients were identified. Of these, 13 were male and 8 were female. The mean age was 33.2 ± 8.9 years (range 28-72 years). The most common diagnosis for replacement was Avascular Necrosis of femoral head (fifteen Patients) Figures 1-A & B, primary osteoarthritis (three patients), and osteoarthritis secondary to developmental hip dysplasia (two patients) followed by neck of femur fracture (one). The average follow up was 28 ± 6.0 months. Demographic data of the patients is tabulated in table-1.

All operations were performed through a standard posterior approach. Cementless total hip prosthesis of the same design was used. Fourth generation ceramic (BIOLOX delta – from Ceramtec, Germany) was used as a bearing couple in all the patients. All surgeries were done under general anaesthesia. Only 4 patients required blood transfusion of 500 ml packed cells. The mean duration of surgery was 113.8 minutes. Nine (43%) patients had one stage bilateral Total Hip replacements, 8 (38%) had THR on

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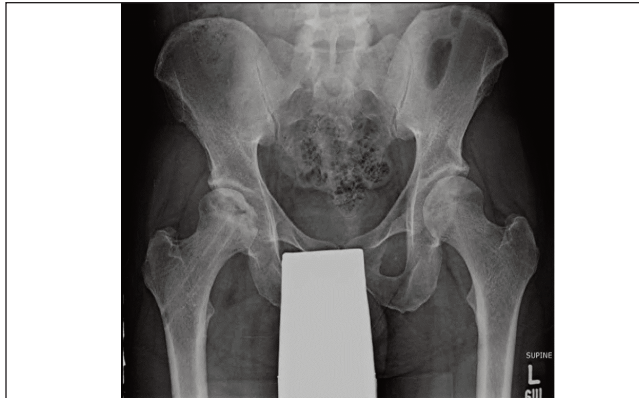


Figure-1 A: Patient with bilateral AVN of femoral heads with persistent pain despite optimal analgesia and activity modification. Core decompression of right femoral head was done with minimal pain relief.



Figure-1 B: MRI of both hips revealed extensive Necrosis in femoral heads bilaterally.

Table-1: Demographics.

			(%)
Mean Age (years)	33.2±8.9	Range: 28-72	71.4
Gender	13 males	8 females	
Mean Follow up (months)	28±6.0	Range: 12-36	
Diagnosis			
AVN	15		
Osteoarthritis	3		14.3
Secondary OA	2		9.5
Hip fracture	1		4.8

SD: Standard Deviation; AVN: Avascular Necrosis.

Table-2: Functional outcome of patients in our case series.

	T	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
MHHS pre-op	9.901	0.000	16.1426	12.1471	19.5440
MHHS	62.901	0.000	90.1426	87.1535	93.1322

MHHS: Mean Harris Hip Score.

the left side, and 4(19%) patients had right side total hip replacement. Immediate full weight bearing was allowed to all of our patients. Check X-rays were done as a routine procedure after hip replacement surgery. Patients were

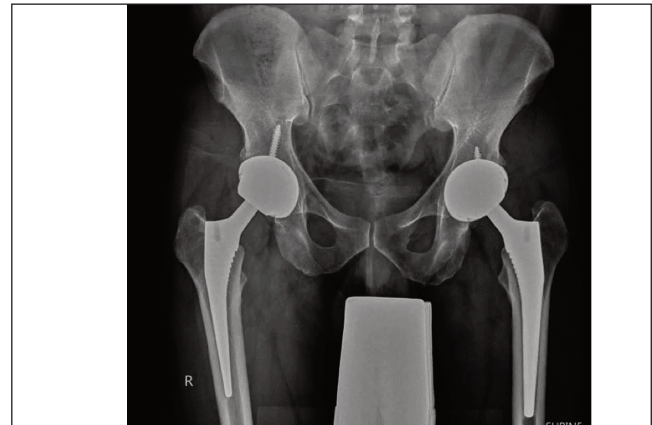


Figure-1 C: Bilateral one stage uncemented Ceramic-on-Ceramic Hip replacement was done. X-ray at 4 years Follow up showing both hips with no signs of osteolysis or loosening and patient has no symptoms.

followed up in clinics at two weeks, three months, six months and then at yearly intervals for wound check and suture removal. Functional assessment was done by Harris hip score. Given the peculiar history of squeaking (audible noises) related to ceramic bearing couple, patients were specifically examined and questioned if they experienced any audible click or noise from the hip after the surgery.

Preoperatively, 16 (76.1%) patients were community ambulant with support. Their mean Harris Hip score was 16.14 ± 7.4 . Post operatively the mean HHS was 90.14 ± 6.5 , (excellent = 90-100, Good 80-89, Fair 70-79, Poor <70). A mean difference of 74 between the pre and post op Harris Hip Score was noted which was found to be statistically significant (Table-2). General complications of hip replacement surgery were actively sought in these patients including post-operative infection, dislocation and periprosthetic fracture. We also looked for specific complications like squeaking and implant fracture which were relevant to ceramic on ceramic bearing surface. None of the general complications were observed in any of our patients. Only one of our patients reported squeaking for a short period of time, which later disappeared, and was not reproducible in the clinic.

Discussion

Total hip replacement is one of the most successful and commonly performed procedures in orthopaedic practice. Current debates and discussions are focused on finer details of the procedure, affecting longevity of the implant such as the long-term outcomes with different bearing surfaces. The quest for the best bearing couple has continued since the invention of Sir John Charnley's low friction metal on polyethylene arthroplasty.⁶ Currently, various combinations for bearing surfaces are used including metal on polyethylene (MOP), metal on metal

(MOM), Ceramic on Polyethylene (COP) and more recently Ceramic on ceramic (COC) bearing combination.

Ceramics as a bearing was first introduced by French Orthopaedic surgeon, Pierre Boutin in 1970.⁷ Ceramics exhibit outstanding tribological properties including hardness and wettability. Hardness withstands major scratches and undetectable wear while the wettability facilitates fluid film lubrication, contributing to low friction between articulating surfaces.⁸ Ceramic on Ceramic Hip arthroplasty therefore exhibits extremely low wear rates. Furthermore, Ceramic particles have a much lower biological activity than metal or polyethylene particles, thus minimising the chances of osteolysis (Figure 1-C).⁹

Despite their excellent tribological properties, early reported complications of ceramics include noise production (referred as squeaking) and component fractures. These reports limited their generic use in Total Hip Arthroplasty. However, since their introduction, ceramics have undergone generations of changes in manufacturing process as to address the problems of fractures and noise production (sometimes referred as squeaking). These changes were implemented by decreasing grain size and porosity, and by tempering process as for increased toughness. The newest fourth generation of ceramics (BioloX Delta by Ceramtec, Germany) is much better. They are composites of tetragonal, Nano sized, yttrium-stabilized zirconia particles (close to 25%) with alumina matrix (close to 75%). This improves their mechanical properties and prevents initiation and propagation of cracks. BioloX Delta has shown promising results in studies, with its superior mechanical properties and excellent wear behaviour.^{10,11}

Ceramic squeaking and fractures have also been related to surgical techniques during Total Hip replacement. Surgical factors include extremes of Acetabular component positions (too vertical or too anteverted acetabular cup position), larger size femoral heads, short femoral necks, and incomplete seating of ceramic liners in the acetabular cup.¹²⁻¹⁴ Optimal implant position, stability and proper liner seating are therefore important to avoid complications associated with ceramic bearing surfaces. In our patients, we did not notice any clinically reproducible squeaking or implant fracture. Although this is encouraging, but due to a small sample size and short follow up, general conclusion is difficult to establish.

Interestingly, some studies have reported that Ceramic-On-Ceramic (COC) bearings have a lower risk of dislocation than Metal Polyethylene bearings in Hip Arthroplasty. Hernigou ET al¹⁵ specifically addressed this topic with primary Total Hip Replacement, comparing the risk of

dislocation in Ceramic – Polyethylene and Ceramic-On-Ceramic (COC) bearings that were implanted between 1972 and 1982. Interestingly, they noted biologic factors that differed between the bearings, which enabled significantly greater capsular thickening and hypothetically, greater long-term dislocation resistance in the COC cohort. Although, we have a small cohort of patients, we did not observe any dislocation in our series.

Conclusion

Ceramics are harder than metals, are biologically inert and have better lubrication properties leading to low wear rates. Therefore CoC bearings make an attractive choice for ensuring long term survival of hip prosthesis.

Consent: Verbal consent has been taken from all of our patients for the publication of this case report.

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Conflict of Interest: None.

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