CASE REPORT
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Non-traumatic Ceramic Head Fracture in Total Hip Arthroplasty with Ceramic-on-Ceramic Articulation at Postoperative 16th Years

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Ceramic articulation has gained popularity in total hip arthroplasty (THA); however, one of the most important concerns about the use of ceramic materials is the potential for breakage. Importantly, almost all ceramic fractures occur within the first six years after surgery. Here, we present a case report of a 52-year-old female patient who experienced an atraumatic ceramic head fracture at the 16th year after surgery. Key parameters that may be associated with ceramic head fracture are considered to be the use of a 28-mm head and high body mass index (BMI); the patient described here had a BMI of 34.3 kg/m^2. Surgical treatment of the case included removal of the broken ceramic head and replacement with an alumina matrix composite ceramic head. At the 12th month follow-up visit, the patient was mobilized independently and could perform her daily activities. Ceramic head fracture after THA may occur even in late periods after surgery. For the treatment of fractures of ceramic material, the fractured component must be removed together with extensive soft tissue excision to ensure that no residual fragments are left behind.

Key Words: Ceramics, Arthroplasty, Hip, Hip prosthesis

Total hip arthroplasty (THA) is the standard approach for the surgical treatment of advanced stage coxarthrosis, particularly in elderly patients. Ceramic-on-ceramic articulation in total hip prosthesis has gained popularity due to some key advantages (e.g., minimal osteolysis, low wear rate, low coefficient of friction, corrosion resistance, excellent biocompatibility, and favorable lubrication characteristics), especially in young and active patients[1-4]. However, the most important drawback to the use of this material during replacement surgery is that the ceramic, which has a high elastic modulus, breaks down without plastic deformation[1]. In the literature, fracture of ceramic components is reported to be between 0.1 and 13.4%[5-7].

A variety of causes have been identified for fracture of a ceramic component (e.g., weight bearing stress, impingement of the femoral neck, component malpositioning, manufacturing defect, and trauma)[2,3,8]. In ceramic articulations, fractures frequently occur on the acetabular liner and rarely on the femoral head[9]. Late-period ceramic material breakage is very rare compared with early-term fractures. Approximately 60% of femoral head fractures occur in the first 12 months and 90% in the first 72 months after operation[6]. Here, we

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report a 52-year-old patient with ceramic femoral head fracture that developed without trauma 16 years after ceramic-on-ceramic articulation. To our knowledge, this case has the latest atraumatic ceramic head fracture occurring after ceramic-on-ceramic articulation.

CASE REPORT

A 52-year-old female patient was admitted to the outpatient clinic due to pain in her right groin. The patient's complaint began with a crunch while squatting without any major trauma. The patient had undergone femoral osteotomy 35 years ago due to developmental of dysplasia to the right hip. She had undergone THA due to right coxarthrosis 16 years prior and left coxarthrosis 14 years prior. At the time of primary arthroplasty, the patient's body mass index (BMI) was 28.2 kg/m^2. The patient did not have any complaints after replacement surgeries. The patient's weight, height, and BMI were 88 kg, 160 cm, and 34.3 kg/m^2, respectively.

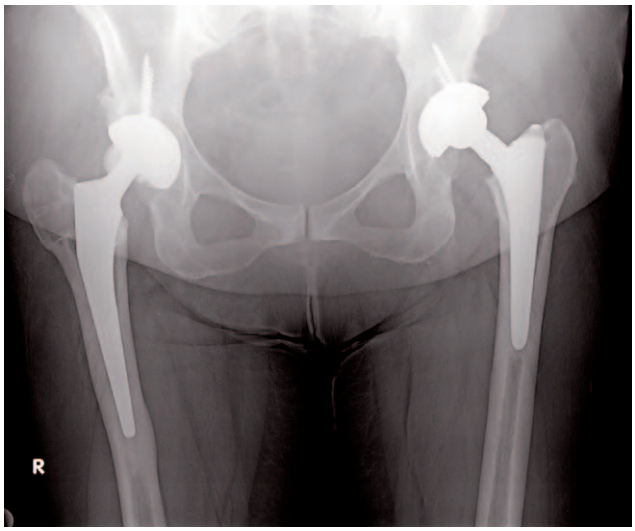

Fig. 1. Pelvic anteroposterior radiography reveals the non-centralized position of the ceramic head in the acetabulum on the right side.

Internal and external rotations of the right hip were painful during physical examination. Bilateral hip abduction and adduction were 20˚ and 10˚, respectively. There was no evidence of infection (e.g., fever, redness, and increase in temperature) around the old incision line. The patient received pelvic and femoral (anteroposterior and lateral) radiological evaluation and pelvic computed tomography (CT). Radiographic evaluation revealed that the ceramic femoral head was broken (Fig. 1). The acetabular cup inclination was 43˚ and there were no signs of loosening in the acetabular cup and femoral stem. CT scan revealed that: i) the ceramic head was broken, ii) the liner was intact, and iii) acetabular cup anteversion was 14˚ (Fig. 2A, B). Revision arthroplasty was planned for the patient by removing the broken ceramic femoral head.

The patient was operated under general anesthesia in the lateral decubitus position using a posterolateral skin incision. Subcutaneous tissue, fascia and joint capsule were opened. It was observed that the ceramic femoral head was broken into four major parts within the capsule (Fig. 3). Prosthetic components used were: i) an uncemented acetabular shell, ii) an ceramic liner, iii) an uncemented femoral stem, and iv) an alumina ceramic 28 mm femoral head (IOTA, St. Etienne, France). Irrigation was performed by saline solution. Extensive synovectomy and capsulectomy was performed to avoid residual ceramic fragments in the capsule and soft tissues. The ceramic liner was not damaged upon macroscopic examination. The acetabular cup and femoral stem were not revised due to the absence of observable loosening.

No trunnion damage was observed in the femoral

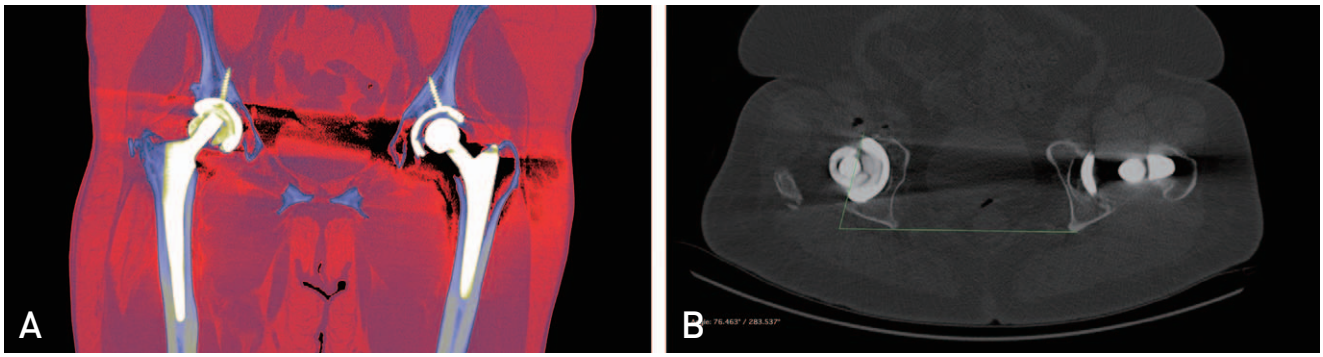

Fig. 2. Computed tomographic evaluation reveals fragmentation in the ceramic head (A). Acetabular cup anteversion was measured as 14˚ (B).

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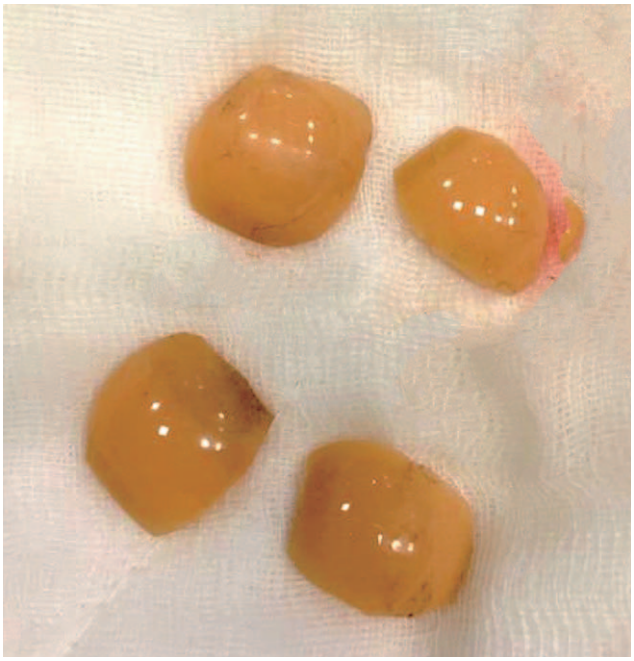

Fig. 3. Intraoperative image of the broken ceramic head.

component. There was no visible corrosion sign according to Goldberg's criteria (score 1)[10]. A 28 mm Biolox delta ceramic femoral head (DePuy Orthopedics, Warsaw, IN, USA) placed on femoral stem. It was observed that there was no impingement during the repetitive joint movements and the adduction balance was optimal. A hemovac drain was placed under the fascia. The soft tissues were closed and dressed. After 24 hours postoperatively, the drain was removed and the patient was mobilized with full weight bearing using a walker. The patient was discharged on the 3rd postoperative day. Stitches were removed 15 days after surgery. No problems were observed in the postoperative follow-up period. The patient was instructed to avoid excessive hip flexion and adhere to a diet program for the postoperative period. At the final follow-up (12 months), the patient had achieved completely independent mobilization and could perform her daily activities. The Harris hip score was 82 and there were no problems related to prosthesis upon radiological evaluation during the postoperative follow up. Written informed consent was obtained from the patient.

DISCUSSION

THA may improve a patient's functionality and quality of life when used to treat advanced stage coxarthrosis[6]. Currently, hip prostheses are frequently used in patients with advanced stage coxarthrosis[5]. Ceramic implants were first used in THA by Boutin in the 1970s[11]. Ceramic-on-ceramic articulation has gained popularity due to its favorable properties (e.g., low wear rate, low friction coefficient)[4,12]. Ceramic materials are frequently preferred in prosthetic applications, especially in patients with long life expectancy. According to the American Joint Replacement Registry, in 2014, the rate of ceramic head usage in THA is 49%[6].

The most important potential problems related to the use of ceramic materials in THA are component fracture risk and high cost[13]. Ceramic component fracture may occur due to some intraoperative and postoperative factors. Potential causes of intraoperative fracture include excess hoop stress from impaction, component malposition, increased cup inclination, taper design, taper mismatch and impingement[2,6,8]. The use of 28-mm head and shorter neck during surgery are other risk factors for component breakage[6,14]. Component malposition and impingement have been associated with acetabular liner fracture, but not ceramic head fracture[8]. In the case reported here, acetabular cup anteversion was measured as 14˚ and inclination was 43˚; both are within normal limits. No macroscopic erosion of the ceramic acetabular liner was observed during intraoperative evaluation. Therefore, in our case, ceramic head fracture could not be associated with an intraoperative cause outside of the use of a 28-mm head.

The most important postoperative causes of ceramic fractures are trauma and hip dislocation[6]. However, atraumatic spontaneous fractures are not uncommon[4,5,15,16]. Other risk factors for ceramic component fractures are high level of activity and obesity[13]. The risk of ceramic component fracture increases by 2.3 times for an increase of 10 units in BMI[17]. A finite element analysis study revealed that increased BMI directly correlated with ceramic component fractures[18]. In this case, high BMI and activity level may be, at least in part, responsible for the ceramic head fracture.

The ceramic materials used in hip arthroplasty are classified as either alumina (Al_2O_3), third-generation alumina or alumina matrix composite[19]. In this case, the fractured femoral head was manufactured with a third-generation alumina ceramic material. While the fracture rate of the ceramic material in the first-generation production (i.e., before 1990) was 13.4%, this rate decreased to 0.001% for implants produced since 1990[5,6,8]. In the present case, the ceramic liner was not changed due to an absence of macroscopic wear, whereas the third-generation alumina head was replaced by an alumina matrix composite ceramic head. Another reason for the retention of the intact ceramic

liner was the risk of component mismatch between new liner and acetabular shell during implantation. However, the final articulation was ceramic delta on ceramic alumina. There is no interpretation in the literature regarding different generations of ceramic articulations.

In THA, ceramic articulation can be applied as ceramic-on-polyethylene or ceramic-on- ceramic. Ceramic head fracture can be observed after both types of articulation. In the literature, the ceramic head fracture rate after ceramic-on-polyethylene articulation is reported to be 0.07%. However, the ceramic head fracture rate after ceramic-on-ceramic articulation is relatively frequent (i.e., 13.4% for early generation products)[7]. In the literature, almost all femoral head fractures were reported in the first six years after surgery[5,15]. In a retrospective study which evaluated nearly 6 million ceramic head application, it was noted that 80% of fractures occurred within the first 48 months and 90% of fractures occurred within the first 72 months after operation[6]. In the literature, a few cases with long-term ceramic head fractures after ceramic-on-polyethylene articulation have been reported[4,12]. However, late-term fracture is very rare in ceramic-on-ceramic articulations. To our knowledge, this case is the longest reported time to occurrence of a ceramic head fracture following ceramic-on-ceramic articulated THA.

Femoral head fractures remain a potentially serious problem in cases with THA, especially those using previous generation ceramic materials. Atraumatic ceramic head fractures appear to be associated, at least in part, with the use of a 28 mm ceramic head. During the surgery, a large capsulectomy and synovectomy should be performed and no residual ceramic fragments should remain.

CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

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