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Revision of Ceramic Head Fracture After Third Generation Ceramic-on-Ceramic Total Hip Arthroplasty

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ABSTRACT

We performed 24 revisions of fractures of third generation ceramic heads. The stem was not changed in 20 revisions; a new ceramic-on-ceramic bearing was used in four and a metal-on-polyethylene bearing in 16. The stem was changed in four revisions; a new ceramic-on-ceramic bearing was used in three and a metal-on-polyethylene bearing in one. During the follow-up of 57.5 months, complications occurred in five hips among the 20 stem retained revisions: a fracture of the new ceramic head in two, metallosis with pseudocyst in two, and femoral osteolysis with stem loosening in one. However, there were no complications in the four revisions where the stem was changed. Revision surgery after ceramic head fracture shows high rates of early complications. We recommend stem revision in cases of THA failure due to fracture of a modern ceramic head.

Ceramic head fracture is a serious complication following total hip arthroplasty (THA) with use of ceramic bearing surfaces [1–3]. Although the hip is immobilized immediately after the diagnosis of ceramic head fracture to avoid spread of the ceramic particles and to minimize the damage to the stem-neck taper, the taper is inevitably damaged by fracture fragments of ceramic head [2,3].

Several studies reported the results of revision arthroplasty for fracture of early generation ceramic heads [1–4]. Although one multicenter study involved 105 patients from 35 institutions with a wide range of follow-up (mean, 3.5 years; range, 6 months to 20 years) [1–4], most studies involved a limited number of patients, ranging from 8 to 16 [2–4]. These studies suggested their guidelines for revision arthroplasty: urgent surgery, thorough removal of ceramic particles and complete synovectomy [2–4]. They reported satisfactory results even without revising the stem if the revision was performed according to the guideline and recommended revising the entire femoral component only when the stem-neck taper was severely damaged [2–4].

Modern ceramic bearings have been used in THA since 1990s [5]. The fracture fragments of the modern ceramics are much sharper and harder than early generation ceramics, resulting in more severe damage to the stem-neck taper [5]. Thus, known guidelines for stem revision in early generation ceramic head fracture might not be applicable to modern ceramic head fracture. However, there are few studies reporting the results of revision arthroplasty for contemporary ceramic head fracture and accordingly, there is no established guideline for the revision.

We followed patients who underwent revision total hip arthroplasty specifically to treat a ceramic head fracture after third generation ceramic-on-ceramic THA. We evaluated the results, identified complications and suggest a potential guideline of the revision for contemporary ceramic head fractures.

Materials and Methods

The design and protocol of this multicenter study was approved by the Institutional Review Board at each center, and all patients were informed that his or her medical data could be used in a scientific study.

Between April 2002 and June 2009, 24 patients underwent revision surgery specifically due to a fracture of the ceramic head after THA with use of the third generation alumina-on-alumina articulation at five hospitals.

There were 19 male patients (19 hips) and five female patients (five hips). The primary THAs of the 24 patients had been done between November 1997 and October 2005. In the primary THA, a 28-mm alumina femoral head (BIOLOX forte, CeramTec AG, Plochingen,

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Germany) and an alumina acetabular insert (BIOLOX forte, CeramTec AG) were used in all hips. Four types of cementless titanium stems were used: BiCONTACT (AESCULAP AG & Co., Tuttlingen, Germany) in 20 hips, Corail (DePuy, Leeds, UK) in two hips, S-ROM in 1 hip (DePuy, Warsaw, IN), and Accolade (Stryker Orthopaedics, Mahwah, NJ) in one hip. Manufacturers of above four stems supplied alternative metallic head as well as ceramic head which could be coupled with the four stem designs. Three types of cementless titanium acetabular cups were used: PLASMACUP SC (AESCULAP AG & Co.) in 11 hips, Duraloc (DePuy, Leeds, UK) in two hips, and SECUR-FIT (Stryker Orthopaedics) in one hip. While alternative polyethylene liner was available for PLASMACUP SC and Duraloc, SECUR-FIT had no alternative polyethylene liner.

The fractures of the ceramic head occurred at nine to 115 months (mean, 48.9 months) after the primary THAs. All 24 ceramic fractures occurred in 28-mm short-neck ceramic heads during normal daily activities without a history of trauma. The mean age of the patients at the index revision was 51 years (range, 23–74 years). They reported a crunch one to three days before radiographs confirmed fracture of the ceramic head, and the revision arthroplasties were performed three to five days after the crunch (Table 1).

All 24 femoral stems were well fixed. However, the Morse taper was damaged with multiple scratches in all femoral stems. The scratches apparently resulted from sharp edges of ceramic fragments. In spite of damaged Morse taper, the original femoral stem was not exchanged in 20 hips because we were concerned about the possible damage of the proximal femur during the removal of well-fixed stem. However, four stems were simply tapped out after a procedure of cleaving the coated portion of the stem from the proximal femur. Those were exchanged with new stems (Fig. 1).

The original acetabular cups were well-fixed and grossly intact in all 24 hips. One acetabular cup (the SECUR-FIT cup of patient 9) was damaged during the removal of ceramic liner, which was replaced with a new cup. In 23 hips, ceramic liners were easily removed from the metal shells by tapping the pit at the rim of the metal shell and the original metal shells were retained at the index revision.

In 20 stem retained revisions, a new ceramic-on-ceramic bearing was used in four and a metal-on-polyethylene bearing in 16. In four stem changed revisions, a new ceramic-on-ceramic bearing was used in three and a metal-on-polyethylene bearing in one.

At the index revision surgery, we cautiously removed ceramic particles and attempted a complete synovectomy as much as possible. Patients were followed after the index revision at six weeks, then at three, six, nine, and 12 months, and every six to 12 months thereafter.

Clinical evaluation was performed using the Harris hip scoring system [6]. The six-week anteroposterior and cross-table lateral radiographs were considered to be the baseline studies for radiographic comparison. Fixation of the femoral component was determined using the method of Engh et al [7] and the fixation of the

Table 1
Twenty-Four Patients Who Underwent Revision Due to Ceramic Head Fracture.

Patient	Age (Years) at Revision	Sex	Initial Diagnosis	Stem of Primary THA	Cup of Primary THA	Time Between Prior Operation and Revision (Months)	Preexisting Stem	Bearing of Revision	Complication After Revision	Follow-Up After Last Revision (Months)	Follow-Up After Index Revision (Months)
1	57	m	ON	BiCONTACT	PLASMACUP	115	Retained	COC		60	60
2	36	m	ON	BiCONTACT	PLASMACUP	28	Retained	COC	Fracture of the revised ceramic head		80
2[a]				Retained	Retained	1	Retained	MOP	None	79	
3	54	m	ON	BiCONTACT	PLASMACUP	44	Retained	COC	Fracture of the revised ceramic head		65
3[a]				Retained	Retained	10	Retained	MOP	Metallosis		
3[b]				Retained BiCONTACT	Retained PLASMACUP	31	Changed	COC		24	
4	36	m	ON	BiCONTACT	PLASMACUP	48	Retained	MOP	None	56	56
5	42	m	ON	BiCONTACT	PLASMACUP	9	Retained	MOP	None	78	78
6	53	m	FX	BiCONTACT	PLASMACUP	27	Retained	MOP	None	60	60
7	34	m	ON	BiCONTACT	PLASMACUP	59	Retained	MOP	None	72	72
8	43	m	ON	S-ROM	Option	37	Retained	MOP	None	62	62
9	55	f	ON	Accolade	SECUR-FIT	53	Retained	MOP	None	60	60
10	61	m	ON	BiCONTACT	PLASMACUP	56	Retained	MOP		60	60
11	74	f	ON	BiCONTACT	PLASMACUP	31	Retained	MOP			79
12	34	m	ON	Corail	Option	23	Retained	MOP	Osteolysis and stem loosening		72
12[a]				Retained	Retained option	25	Changed	COP	None	47	
13	60	m	ON	BiCONTACT	PLASMACUP	34	Changed	MOP		36	36
14	61	m	ON	BiCONTACT	PLASMACUP	48	Changed	COC	None	60	60
15	23	f	ON	Corail	Option	35	Retained	MOP	None	59	59
16	37	f	ON	BiCONTACT	PLASMACUP	42	Retained	MOP	None	36	36
17	39	m	ON	BiCONTACT	PLASMACUP	44	Retained	MOP	Metalosis		70
17[a]				Retained	Retained	10	Retained	COC	Fracture of the revised ceramic head		
17[b]				Retained	Retained	20	Retained	4thCOC	None	40	
18	49	m	ON	BiCONTACT	PLASMACUP	78	Retained	MOP	Metalosis		36
18[a]						25	Changed	COC		11	
19	54	m	ON	BiCONTACT	PLASMACUP	72	Retained	MOP	None	36	36
20	54	m	ON	BiCONTACT	PLASMACUP	30	Changed	COC	None	53	53
21	60	m	OA	BiCONTACT	PLASMACUP	34	Changed	MOP	None	70	70
22	65	f	FX	BiCONTACT	PLASMACUP	65	Retained	MOP	None	36	36
23	68	m	ON	BiCONTACT	PLASMACUP	86	Retained	MOP	None	36	36
24	70	m	ON	BiCONTACT	PLASMACUP	50	Retained	COC	None	48	48

ON, osteonecrosis; FX, femur neck fracture; OA, osteoarthritis; COC, alumina-on-alumina; MOP, cobalt–chromium-on-polyethylene; COP, alumina-on-polyethylene; 4th COC, delta-on-delta.

[a] Second revision.

[b] Third revision.