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Original Article

Patients with a Dorr type C femoral bone require attention for using a Summit cementless stem: Results of total hip arthroplasty after a minimum follow-up period of 5 years after insertion of a Summit cementless stem

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ABSTRACT

Background: The Summit cementless stem has been used as a device to occupy the proximal medullary canal space in total hip arthroplasty (THA). The purpose of this study was to evaluate the mid-term clinical and radiographic results of the Summit stem and the differences in the results as a function of medullary cavity shape.

Methods: This study analyzed the 90 consecutive patients who underwent THA by using the Summit cementless stem. The minimum clinical and radiographic follow-up period for the patients was 5 years (mean, 5.5 years; range, 5.0–7.1 years). The radiographic and Harris hip scores (HHS) were evaluated across the three Dorr type classifications of femoral bone.

Results: The postoperative HHSs were significantly higher than the preoperative HHS scores ($p < 0.05$). No significant differences in preoperative and postoperative HHSs were found among the three Dorr types. Stress shielding was observed in 58 hips. Spot welds and cortical hypertrophy were observed in various zones in 53 and 11 hips, respectively. No significant difference in the number of occurrences of cortical hypertrophy was found among the three Dorr types. However, the number of occurrences of severe stress shielding in Dorr type C was higher than that in Dorr type B. The number of occurrences of spot welds in Dorr type C was lower than that in both Dorr types A and B.

Conclusions: Mid-term clinical results were good regardless of the medullary cavity shape. However, severe stress shielding in Dorr type C was more frequently than that in Dorr type B. Therefore, attention should be paid to the types of medullary cavity shapes for Summit stem use.

1. Introduction

Total hip arthroplasty (THA) was introduced by Phillip Wiles in 1938, and Sir John Charnley advanced the THA surgical technique and equipment in the 1960s [1,2]. Since then, the THA procedure has been performed by many surgeons and orthopedists worldwide. The old generation of cementless stems had many poor results [3–5]. Callaghan et al. reported that 24% of 50 THAs were to have loosening of beads of the femoral component at 2-year follow-up after primary THA [4]. Smith et al. also reported aseptic loosening of the femoral component in 14% of 102 THAs after 4.5 years from primary THA [5]. By contrast, new generation of cementless stems were much improved [6,7]. Burt et al. reported that only 4% of 47 THAs were found to have aseptic loosening of the femoral component at a 10-year follow-up after primary THA [6]. McLaughlin et al. also reported aseptic loosening of the femoral component in only one of 114 THAs after 10 years from primary THA [7].

Dorr et al. classified proximal femoral conformation into types A, B, and C, according to the thickness of the cortical bone and the shape of the medullary canal [8]. They demonstrated that type C femurs showed structural changes, increased numbers of cells and reduced

Abbreviations: total hip arthroplasty, THA; Canal-Flare index, CFI; Harris hip score, HSS.

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cell activity. These characteristics indicated an environment that was less favorable to biological fixation of cementless implants. Some authors have indicated cementless femoral components for use in young patients with femurs of types A and B [9]. The bone quality of these patients allows greater security in surgical manipulation and better initial stabilization for uncemented femoral prostheses, with the theoretical advantage of better osseointegration.

The Summit cementless stem has been in clinical use since 1997 in the United States and Europe, and has been used in Japan since 2009. This femoral stem is meant to occupy the proximal medullary canal space. The proximal third is coated with a Porocoat (DePuy Synthes, UK) porous coating that favors bone ingrowth and effectively seals the femoral canal, reducing the rate of radiolucent lines and endosteal osteolysis [10,11]. The middle-third portion of the stem is grit blasted, and the distal tip is polished. A stepped coating is placed on the proximal porous part and this feature can convert the load stress into compressive stress. The distal part is a reduced structure and this feature keeps this stem from becoming fixed distally. Several reports indicated good clinical results following THA performed using a femoral component of the Summit cementless stems [12–14]. However, no report has compared clinical and radiographic results in accordance with femoral shape. Therefore, the purpose of this study was to evaluate the mid-term clinical and radiographic results of the Summit cementless stem, and the differences in the results according to medullary cavity shape. We hypothesized that the Summit cementless stem could achieve good clinical and radiographic results regardless of medullary cavity shape.

2. Materials and methods

2.1. Patients and surgeries

This study analyzed 99 consecutive patients (83 women and 16 men) who underwent THA with a Summit cementless stem (Depuy, Warsaw, IN) between May 2009 and April 2012. Nine patients were lost to follow-up, leaving a total of 90 patients (77 women and 13 men) available for study. The follow-up rate was 90.9%. The minimum clinical and radiographic follow-up of the patients was 5 years (mean, 5.5 years; range, 5.0–7.1 years). The preoperative diagnosis for the 90 patients who underwent hip surgery included osteoarthritis (84 patients), rheumatoid arthritis (4 patients), and osteonecrosis (2 patients). The mean age of the patients at the time of surgery was 63.9 ± 10.0 years. The mean heights, weights, and body mass indexes were 153.1 ± 5.7 cm, 56.3 ± 8.7 kg, and 24.0 ± 3.4 kg/m^2, respectively. Pinnacle acetabular cup, and a 36-mm or 28-mm diameter (35% of patients and 65% of patients, respectively) Ultamet metal head system (DePuy, Warsaw, IN) were used in this study. All surgeries were performed minimally invasively, using the anterolateral approach in the supine position. One day after surgery, physical therapy was initiated, and all patients were encouraged to be fully weight bearing.

2.2. Radiographic and clinical evaluations

The physical or radiographic examination follow-ups were conducted at 3, 6, and 12 months, and subsequently, once a year. The anteroposterior radiographs at final follow-up were evaluated by an orthopedic surgeon with 20 years of experience and specialization in hip joints, who had no relationship to the present study. Femoral osteopenia resulting from stress shielding was graded according to the system described by Engh et al. [15]. By using the Dorr classification for proximal femoral shape [16], 17 patients were identified as having a Dorr type A femur (funnel shaped); 56 patients, a Dorr type B femur (intermediate); and 17, a Dorr type C femur (cylindrical). Other parameters were also evaluated including the incidence of spot welds [17] (endosteal new bone formation on the prosthesis), cortical hypertrophy, the ratio of canal filling [18], and the Canal-Flare index (CFI) [19]. The ratio of canal filling was defined as the ratio of the width of the stem over the width of the femoral canal at the following 3 sections: (a) proximal (15 mm above the lesser trochanter), (b) middle (60 mm below the lesser trochanter), and (c) distal (15 mm above the tip of the stem). The Harris hip score (HSS) [20] was investigated preoperatively and postoperatively at the last follow-up clinical evaluations. We also evaluated for the presence or absence of complications such as dislocation, infection, and need for revision.

2.3. Statistical analysis

All the values were expressed as mean ± standard error. Data analyses were performed using a statistical software package (Statview 5.0; Abacus Concepts Inc, Berkeley, CA). The Shapiro–Wilk test (SPSS Statistics 21; IBM Japan, Tokyo, Japan) was performed to analyze the normally distributed data. Correlations between the preoperative and postoperative HHS were analyzed using paired *t* tests, and correlations between CFI and postoperative HHS were analyzed using simple regression analysis. Furthermore, we evaluated the number of occurrences of stress shielding, spot welds, and cortical hypertrophy among the 3 Dorr types by using a multiple comparison. The number of occurrences of stress shielding, spot welds, and cortical hypertrophy were also evaluated between Dorr types A and B, types A and C, and type B and C by using Fisher's exact test. The ratio of canal filling and HHS was also evaluated among the 3 Dorr types by using 1-way analysis of variance. P values of <0.05 were considered statistically significant.

2.4. Ethical approval and consent to participate

The study protocol was approved by Kobe University Graduate School of Medicine Ethics Committee on September 8, 2011 (No. 1220), and informed consent for participation in the study was obtained from all participants.

3. Results

The preoperative and postoperative HHS were respectively 49.4 ± 5.2 and 86.2 ± 3.1 in Dorr type A, 50.5 ± 2.2 and 86.5 ± 1.6 in Dorr type B, and 49.7 ± 3.3 and 81.0 ± 1.9 in Dorr type C. The postoperative HHS in all three types were significantly higher than the preoperative HHS ($p < 0.05$). However, no significant differences in preoperative HHS and postoperative HHS were found among three Dorr types (Table 1). The mean CFI was

Table 1
Preoperative and postoperative Harris hip score (HHS).

	Door type A (17 hips)	Door type B (56 hips)	Door type C (17 hips)	P value type A vs B	P value type A vs C	P value type B vs C
Preoperative HHS	49.4 ± 5.2	50.5 ± 2.2	49.7 ± 3.3	0.823	0.968	0.885
Postoperative HHS	86.2 ± 3.1	86.5 ± 1.6	81.0 ± 1.9	0.930	0.186	0.096
P-value	<0.001	<0.001	<0.001			

The postoperative HHS in all three types were significantly higher than the preoperative HHS ($p < 0.05$). However, no significant differences in preoperative and postoperative HHS were observed among the three Dorr types.