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Research Article

Does Ultra-Short Anatomic Cementless Stem Increase Revision Rates Compared to Contemporary Cemented Femoral Stem in Patients with Dorr Type C Femur?

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Abstract

Objectives: The optimal fixation strategy for femoral stems in patients with Dorr type C femora remains debated, with uncertainty about whether cementless or cemented methods achieve superior long-term stability. This study aimed to compare outcomes between a proximally loading, short anatomic cementless stem and a contemporary cemented stems in patients with this femoral morphology.

Methods: A total of 200 patients (224 hips) were enrolled in this randomized controlled trial with half receiving a proximally loading short anatomic cementless Total Hip Arthroplasty (THA) and other half treated with a contemporary cemented THA. There were 53 men and 47 women (mean age, 71.2 years) in the cementless THA group and 55 men and 45 women (mean age, 72.4 years) in the cemented THA group. Clinical outcomes were prospectively evaluated. The average follow-up was 17.5 years (range, 15 to 20 years) in the cementless group and 18.8 years (range, 15 to 22 years) in the cemented group.

Results: At final review, both groups demonstrated comparable functional outcomes. Harris hip scores averaged 92 in the cementless group, and 93 in the cemented group, WOMAC scores were 15 versus 12, and UCLA activity scores were 8 versus 7. Cortical Thickness Index (CTI) values were nearly identical (0.71 vs 0.73, $P = 0.528$). Femoral stem revision was required in 4.5% of the cementless hips and 3.5% of the cemented hips. Kaplan-Meier analysis estimated femoral component survivorship was 95.5% for cementless stems at 17.5 years and 96.5% for cemented stems at 18.8 years.

Conclusions: Both the ultra-short anatomic cementless design and the cemented femoral stem yielded durable fixation and excellent long-term survivorship in patients with Dorr type C femora.

Keywords: Long-Term; Clinical Results; Proximal Loading; Anatomic; Cementless Stem; Contemporary Cemented Stem; Dorr Type C Femur

Introduction

The optimal fixation strategy for femoral stems in patients with Dorr type C femora remains unresolved and subject to ongoing debate. This bone type is defined by markedly thinned cortical walls, reduced biological activity, and a characteristic cylindrical, stovepipe-like morphology [1]. Historically, cemented fixation was favored because it produced an immediate, mechanically stable interlock with the host bone, offering predictable early stability and symptomatic relief [2,3]. By contrast, proximally loading short anatomic cementless stems have been advocated for their potential advantages over traditional designs, such as reducing proximal-distal mismatch, minimizing stress shielding at the metaphysis, and decreasing the likelihood of perioperative fracture. Yet, questions persist regarding whether ultra-short stems can achieve firm fixation in the structurally compromised Dorr type C femur. To date, no comparative study has directly evaluated the outcomes of an ultra-short anatomic cementless femoral stem (DePuy, Leeds, United Kingdom) against those of a contemporary cemented stem (DePuy, Leeds, United Kingdom) in this femoral subtype. Thus, in the present randomized controlled trial, we sought to address 4 key questions: (1) Do ultra-short anatomic stems yield inferior long-term (≥ 15 years) results compared with cemented stems? (2) Are aseptic loosening rates different between 2 fixation strategies? (3) Do cemented stems result in fewer perioperative or long-term complications than cementless stems? (4) Is survivorship free from revision surgery influenced by the choice of fixation method?

Materials and Methods

Inclusion and Exclusion Criteria

We included all consecutive patients who had an end-stage hip disease with Dorr type C femur. The study exclusion criteria were the presence of Dorr type A or B bone, an active infection in the joint or body, and a diagnosed neuromuscular disorder. The operations were performed by one surgeon at one academic institution.

Demographics and Follow-up

From January 2004 to January 2009, ultra-short anatomic cementless stems were implanted in 120 patients (132 hips) and with contemporary cemented stems in 125 patients (132 hips) with Dorr type C proximal femoral morphology (Table1). The study was approved by our institutional ethical committee review board, and all patients provided informed consent. This study is a randomized controlled trial. The patients were randomly assigned, by means of a computer-generated random number table, to receive either a ultra-short anatomic cementless stem or a contemporary cemented stem. The randomization table was stored at the coordinating center. Preoperatively, a study nurse added the participants to a randomization table in sequential order.

A total of 13 patients (13 hips) (6 patients [6 hips] with a cementless stem and 7 patients [7 hips] with a cemented stem) died less than 10 years after the operation, and 32 patients (14 patients [14 hips] in the cementless group and 18 patients [18 hips] in the cemented group) were lost to follow-up before 5 years. Therefore, 100 patients (112 hips) in each group were available for clinical evaluation at a mean of 17.5 years (range, 15 to 20 years) in the cementless group and at a mean of 18.8 years (range, 15 to 22 years) in the cemented group (Fig. 1).

Surgical Technique

All procedures were performed by the senior author using a posterolateral approach. In the cementless group, cementless Pinnacle acetabular component (DePuy, Warsaw, Indiana) was used with an alumina delta ceramic liner of inner diameter of 28-mm (25 hips), 32-mm (56 hips), or 36-mm (31 hips) (Ceram Tec, Plochingen, Germany). All patients received an ultra-short anatomic cementless stem (Proxima; DePuy, Leeds, United Kingdom) with a 28-mm (25 hips), 32-mm (56 hips), or 36-mm (31 hips) alumina delta ceramic head (Ceram Tec). A "round-the-corner" technique [5-7] was utilized for femoral broaching and insertion of the femoral stem. In the cemented group, a cementless pinnacle acetabular component (DePuy) was used with an alumina delta liner of inner diameter of 28-mm (28 hips), 32 mm (50 hips), or 36 mm (34 hips). All patients received a Charnley Elite-Plus stem [Orthron 90] (DePuy, Leeds, United Kingdom) with a 28-mm (28 hips), 32-mm (50 hips), or 36-mm (34 hips) alumina delta ceramic head (CeramTec).

Patients started standing and walking on the 2nd postoperative day and then progressed to full weight bearing with crutches as tolerated in both groups. They were advised to use a pair of crutches for 6 weeks and walk with a cane thereafter as needed.

Clinical Evaluation

Clinical follow-up was carried out at 3 months, 1 year, and 3 or 5 years thereafter. The Harris Hip Score and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score were determined before surgery and at the time of each follow-up [8,9]. Patients subjectively evaluated thigh pain on a 10-point visual analog scale, where 0 = no pain and 10 = severe pain [10]. The level of activity of patients after the THA was assessed using the University of California, Los Angeles (UCLA) activity score at each follow-up. The mean follow-up was 17.5 years (range, 15 to 20 years) in the cementless THA group and 18.8 years (range, 15 to 22 years) in the cemented THA group [11].

Radiographic Analysis

Radiographic follow-up was performed at each follow-up. A research associate who did not know the patient's identity analyzed the radiographs. An anteroposterior radiograph of the pelvis with the patient supine with both hips in neutral rotation and 0° abduction was made. Dorr type C femur is determined by thin cortices, compromised biological activity and a stovepipe configuration [1]. In addition, the Cortical Thickness Index (CTI) was defined as the ratio of cortical width minus endosteal width to cortical width at a level of 10 cm below the tip of the lesser trochanter on anteroposterior radiographs. Dorr type C femur was defined as > 0.65 [12]. Anteversion of the acetabular component was measured on the lateral radiograph of the hip as the angle between the horizontal line where the film cassette rested on the X-ray table, and a second line marking the plane of the opening of the acetabular component. In order to measure inclination of acetabular component a line that joined the inferior margins of the teardrops was drawn on the AP pelvic radiograph and its intersection with a line marking the plane of opening of the acetabular component determined the angle of inclination. Radiological evaluation was performed at each follow-up for radiolucent lines around the cup in Zones Ⅰ, Ⅱ or Ⅲ according to the system of DeLee and Charnley in both groups. In the cemented group, radiolucent lines around the femoral component were determined in zones 1 to 14 according to Gruen, et al., [13,14]. In the Proxima anatomic cementless stem group, the Gruen zones were modified because of the absence of the distal stem.

Subsidence of the femoral component was measured with use of a perpendicular line drawn from the greater trochanter to the lateral border of the implant as well as from the proximal-medial portion of the stem to the lesser the trochanter as references. Migration of the acetabular component was measured vertically between the inferior margin of the ipsilateral teardrop and horizontally between Köhler's line and the center of the outer shell of the acetabular cup. A change of 2 mm compared with the baseline value was considered important.

Definite loosening of the acetabular component was defined when there was a progressive change >2 mm vertically and/or medially or laterally or a continuous radiolucent line of >2 mm on both the anteroposterior and the lateral radiographs [15]. The stability of the cementless femoral component was classified as bone ingrowth or either stable or unstable fibrous ingrowth [16]. The criteria used to define loosening of the cemented femoral component have been reported previously [17].

Statistical Analysis

An a priori power calculation was performed using a clinically relevant difference in the Harris hip score of 5 points between the two groups, with a standard deviation of 5 points. For an effect size of 20% in the functional outcome, measured using a validated instrument such as the linear analog scale assessment (in which $\alpha = 0.05$ and $\beta = 0.80$), 85 patients would be needed in each group. Fifteen more patients were recruited to allow for possible attrition. All analyses were performed using SPSS statistics version 15 (SPSS Inc.). A p value ≤ 0.05 was deemed significant. Continuous data were analyzed using a Mann-Whitney U-test, and categorical data were analyzed using chi-squared tests. Fisher's exact tests were used to compare the prevalence of osteolysis, and Wilcoxon's rank-sum tests were used to compare nonparametric ordinal data. Paired t-tests were used to compare the Harris hip score and the incidence of pain in the thigh. Radiographic data were compared between the two groups using chi-squared tests, and Kaplan-Meier survival analyses were performed to determine the cumulative survival rates of the implants during the study, with 95% Cis [18].

Parameters	**Type of Implant**		
	Calcar loading with lateral flare cementless stem	**Cemented stem**	**P-value**
Patients (hips)	100 (112)	100 (112)	1.000‡
Male / female	53 / 47	55 / 45	0.381*
Mean age (yrs) (SD; range)	71.2 (4.29; 50 to 82)	72.4 (5.12; 51 to 85)	0.341†
Mean weight (kg) (SD; range)	63.1 (8; 51 to 97)	65.2 (10.1; 48 to 95)	0.412†
Mean height (cm) (SD; range)	163 (9; 149 to191)	161.9 (10.3; 143 to 189)	0.641†
Mean BMI§ (kg/m^2) (SD; range)	23.4 (5.6; 20 to 29)	25 (3.9; 19 to 31.2)	0.187†
Dorr C type (patients, hips)	100 (112)	100 (112)	1.000‡
Diagnosis (No. of hip, %)			

Osteonecrosis	73 (65)	74 (66)	0.375‡
Osteoarthritis	15 (14)	13 (12)	0.321‡
Developmental dysplastic hip	13 (12)	16 (11)	0.175‡
Multiple epiphyseal dysplasia	6 (5)	7 (6)	0.158‡
Ankylosing spondylitis	5 (4)	2 (2)	0.213‡
Mean follow-up (yrs) (range)	17.5 (15-20)	18.8 (15-22)	0.135†
* Chi-Squared Test † Student t-Test; ‡ Mantel-Haenszel chi-Squared Test; § BMI: Body Mass Index			

Table 1: Patient characteristics.

Results

Clinical Outcomes

No statistically significant differences were identified between the 2 groups with respect to Harris Hip scores, pain scores, function scores, WOMAC scores, activity levels, and thigh pain severity (Table 2). In the cementless group, the mean preoperative Harris hip score was 48 ± 9 points (range, 9 to 51 points), which improved to a mean of 92 ± 11 points (range, 75 to 100 points) at the time of the final follow-up. In the cemented group, the mean preoperative Harris hip score was 45 ± 8 points (range, 7 to 56 points), which improved to a mean of 93 ± 9 points (range, 71 to 100 points) at the final follow-up. In the cementless group, the mean preoperative WOMAC score was 65 ± 15 points (range, 41 to 89 points), which improved to 15 ± 6 points (range, 4 to 29 points) at the final follow-up. In the cemented group, the mean preoperative WOMAC score was 68 ± 14 points (range, 38 to 91 points), which improved to 12 ± 8 points (range, 4 to 31 points) at the final follow-up. The UCLA activity score was 3 points (range, 1 to 4 points) preoperatively in the cementless group and improved to 8 points (range, 6 to 10 points) at the final follow-up. In the cemented group, the preoperative UCLA activity score was 2.4 points (range, 1 to 4 points) and improved to 7.6 points (range, 6 to 9 points) at the final follow-up. The prevalence of severe (10 point) thigh pain at the final follow-up was 3% (3 hips) due to aseptic loosening of the stem in the cementless group, and it was 4% (4 hips) due to aseptic loosening of the stem in the cemented group at the final follow-up. Seventeen hips (15%) in the cementless group and 16 hips (14%) in the cemented group displayed a clicking sound, and 9 hips (8%) in the cementless group, and 11 hips (10%) in the cemented group displayed squeaking sound.

Radiographic Findings

Radiologic comparisons revealed no major intergroup differences (Table 3). Cortical Thickness Index (CTI) was 0.71 in the cementless group and 0.73 in the cemented group (p=0.528). In the cementless group, as seen on the postoperative radiographs, 91 femoral stems (81%) were neutral, 19 (17%) were in varus (<5°), and 2 (2%) were in valgus (<5°). The mean inclination and anteversion of the acetabular component were 44° (range, 37° to 49°) and 21° (range, 17° to 25°), respectively. All acetabular components and all but 3 femoral components had osseous integration. Three femoral coponents were subsided due to aseptic loosening. One hundred and five (94%) hips exhibited Grade 1 stress shielding in the calcar region and 7 (6%) hips had Grade 2 stress shielding. No acetabular or femoral osteolysis was identified in any hip (Fig. 2-4).

In the cemented group, 104 femoral stems (93%) were neutral, 5 (4%) were in varus (<5°), and 3 (3%) were in valgus (<5°). The mean inclination and anteversion of the acetabular component were 41° (range, 36° to 50°) and 23° (range, 19° to 28°), respectively. One hundred five hips (94%) had the Grade A cementing technique; 5 hips (4%), Grade B; 2 hips (2%), Grade C. All cementless acetabular components had osseous-integration (Fig. 4,5). Four hips (4%) had >2 mm radiolucent line around the femoral component and subsided femoral component due to aseptic loosening. No acetabular component had osteolysis. Four femoral stems (4%) had osteolysis in zones 1, 2, 5, 6, and 7.

Parameters	Cementless THA	Cemented THA	P-value (Student t-test)
Harris hip score* (points) (range)			
Preoperative	48±9 (9-51)	45±8 (7-56)	0.612
Postoperative	92±11 (75-100)	93±9 (71-100)	0.712
Excellent (>90 points), n (%)	47 patients (47)	48 patients (48)	0.348
Good (between 80 and 89 points), n (%)	46 patients (46)	47 patients (47)	0.718
Fair (between 70 and 79 points), n (%)	3 patients (3)	2 patients (2)	0.322
Poor (< 70 points), n (%)	4 patients (4)	3 patients (3)	0.698
WOMAC score (points)			
Preoperative	65±15 (41-89)	68±14 (38-91)	0.731
Postoperative	15±6 (4-29)	12±8 (4-31)	0.712
UCLA activity score (points)			
Preoperative	3 (1-4)	2.4 (1-4)	0.692
Postoperative	8 (6-10)	7.6 (6-9)	0.581
Thigh pain, n (%)	3 (3)	4 (4)	0.288
THA: Total Hip Arthroplasty; UCLA: University of California; Los Angeles; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index			

Table 2: Clinical results.

Parameters Dorr type C femur Cortical thickness index (CTI)	Cementless THA 100 patients (11 hips) 0.71	Cemented THA 100 patients (112 hips) 0.73	P-value (Student t-test) 0.528
Acetabular component position* (deg)			
Inclination	44 (37-49)	41 (36-50)	0.719
Anteversion	21 (17-25)	23 (19-28)	0.269
Femoral component position (n,[%])			
Neutral position	91 (81)	104 (93)	0.156
Varus position	19 (17)	5 (4)	0.166
Valgus position	2 (2)	3 (3)	0.125
Center of rotation*			
Horizontal (mm)	42 (35-48)	43 (36-47)	0.126
Vertical (mm)	16 (13-22)	15 (12-21)	0.217
Femoral offset* (mm)	41 (35-49)	39 (33-47)	0.184
Abductor moment arm* (mm)	46 (40-81)	47 (42-83)	0.152
Radiolucent line (> 1 mm) (no, [%])			
Acetabulum	0 (0)	0 (0)	N/A
Cementing technique, n (%)			
Grade A	N/A	105 (94)	N/A
Grade B	N/A	5 (4)	N/A
Grade C	N/A	2 (2)	N/A
Osteolysis			
Acetabular component	0 (0)	0 (0)	N/A
Femoral component	0 (0)	0 (0)	N/A
* The values are given as the mean, with the range in parentheses THA: Total Hip Arthroplasty; N/A: Not Applicable			

Table 3: Radiographic results.

Complications

In the cementless group, an early deep postoperative infection developed in 2 hips (1.8%), and these 2 hips were revised in 2 stages. Three hips (2.7%) had an aseptic loosening of the femoral component and these 3 hips were revised. Two hips (1.8%) had intraoperative calcar femoral fractures, which were fixed with a cable. No hip had any postoperative femoral fracture. Two hips (1.8%) had a recurrent dislocation, and these 2 hips were revised with a constrained cup. There was no further dislocation.

In the cemented group, an early, deep postoperative infection developed in 3 hips (2.7%). Open debridement and exchange of an acetabular liner and a femoral head were performed, and intravenous antibiotics were administered for 6 weeks. There were no recurrent infections in these 3 hips. Four hips (3.5%) had an aseptic loosening of the femoral component and these 4 hips were revised using a cementless stem (Solution; DePuy, Warsaw, Indiana). Four hips (3.5%) had an intraoperative calcar femoral fracture, which was fixed with a cable. All of these revised 4 hips had a rigid fixation by osseonintegration. Three hips (2.7%) had a recurrent dislocation, and these 3 hips were revised with a constrained cup. There was no further dislocation.

Revision Procedures

In the cementless groups, 5 femoral stems (4.5%) were revised, 2 (1.8%) for infection and 3 (2.7%) for aseptic loosening. Two hips (1.8%) had a revision of the acetabular component for a recurrent dislocation. Two (1.8%) acetabular components were revised for infection. In the cemented group, 3 hips (2.7%) were revised for an aseptic loosening of the femoral component. Two acetabular components (1.8%) were revised for a recurrent dislocation.

Survivorship

In the cementless group, Kapaln-Meier survivorship analysis at 10 years reveald that the survival rate of the femoral component was 98.5% (95% confidence interval, 93% to 100%) and 98% (95% confidence interval, 93% to 100%) at 15 years and 95.5% (95% confidence interval, 91% to 100%) at 20 years, with loosening or revision considered the end point for failure (Fig.6) [18]. The rate of survival of the acetabular component was 99% (CI, 95% to 100%) at 10 years and 97% (CI, 92% to 100%) at 15 years and 96.4% at 20 years (95% CI, 92% to 100%). In the cemented group, Kaplan-Meier survivorship analysis at 10 years revealed that the survival rate of the femoral component was 98% (95% CI, 94% to 100%), 96% (95% CI, 94% to 100%) at 15 years and 94% (95%CI, 92% to 100%) at 22 years, with loosening or revision considered the end point for failure. The survival rate of the acetabular component was 98.5% (95% CI, 93% to 100%) at 10 years, and 97.5% (95% CI, 93% to 100%) at 15 years, and 97.3% (95% CI, 95.5% to 100%) at 22 years, with loosening or revision considered the end point for failure (Fig. 7).

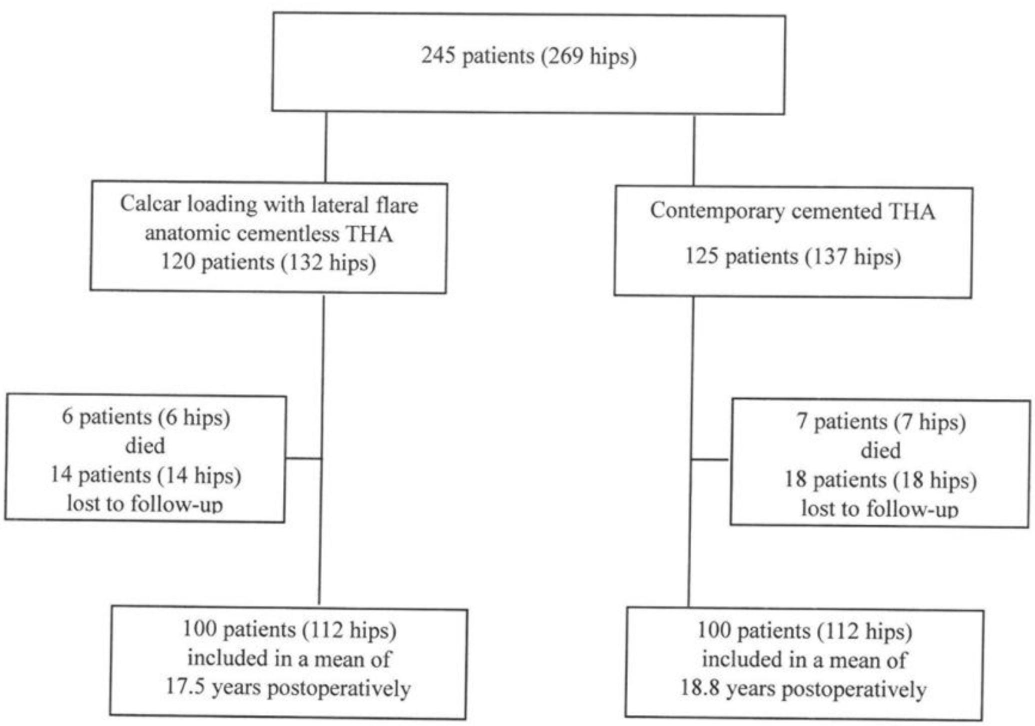

Figure 1: The Consolidated Standards of Reporting Trials (CONSORT) flow diagram of patient in this study.

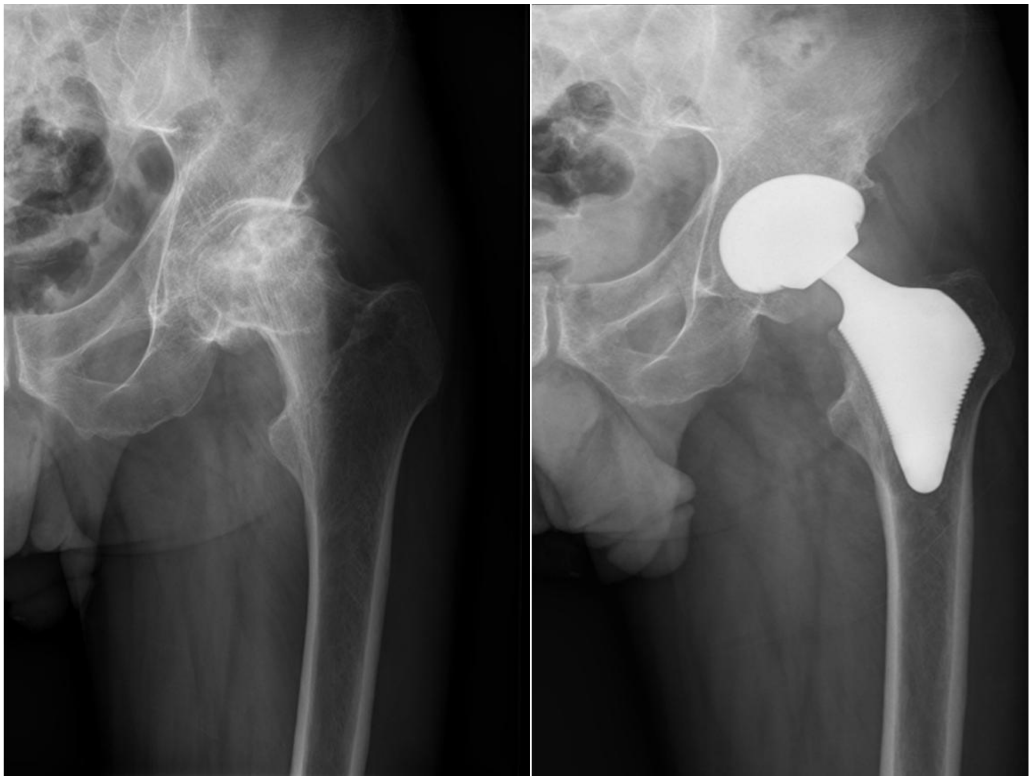

Figure 2: Anteroposterior and lateral radiographs of a 48-year-old man with osteonecrosis of left femoral head. A: Preoperative radiograph of left hip demonstrates collapse of left femoral head (Ficat stage Ⅳ) and Dorr type C femur; B: Postoperative radiograph of left hip obtained. 17 years after the operation. The acetabular component and a calcar loading with a lateral flare anatomic cementless femoral component are well fixed in a satisfactory position without radiolucent line or osteolysis.

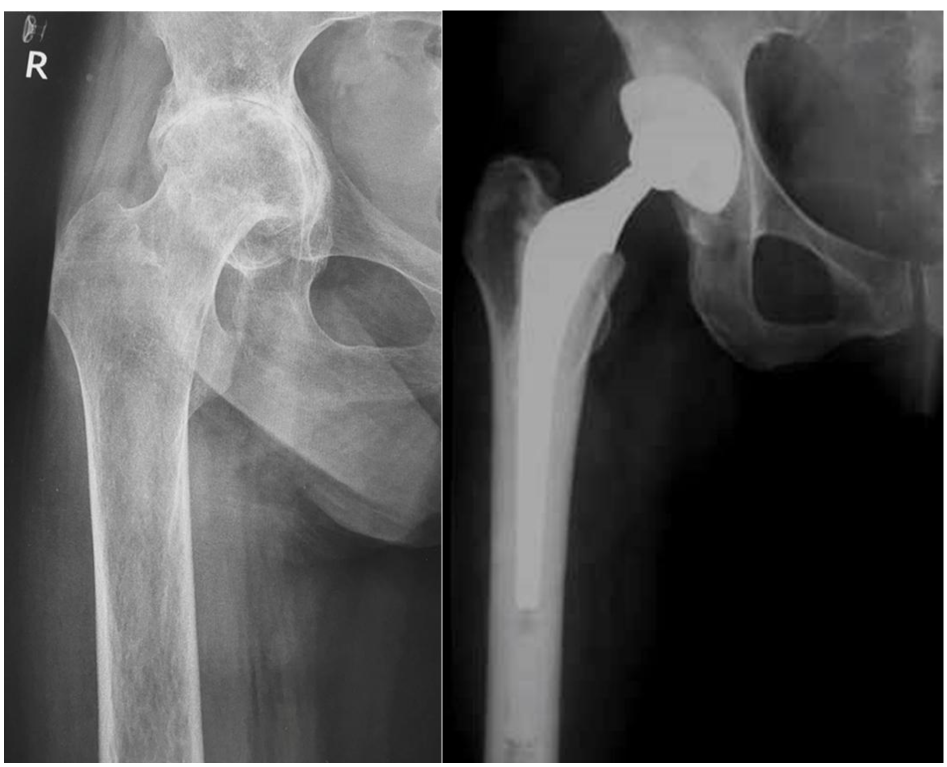

Figure 3: Anteroposteiror and lateral radiograph of a 57-year-old woman with osteoarthritis of right hip. A: Preoperative anterioposterior view of right hip reveals osteoarthritis hip (Dorr type C femur); B: Postoperative anteroposterior view of right hip obtained. 18 years after the operation. The cementless acetabular and cemented femoral components are well fixed in a satisfactory position without radiolucent line or osteolysis.

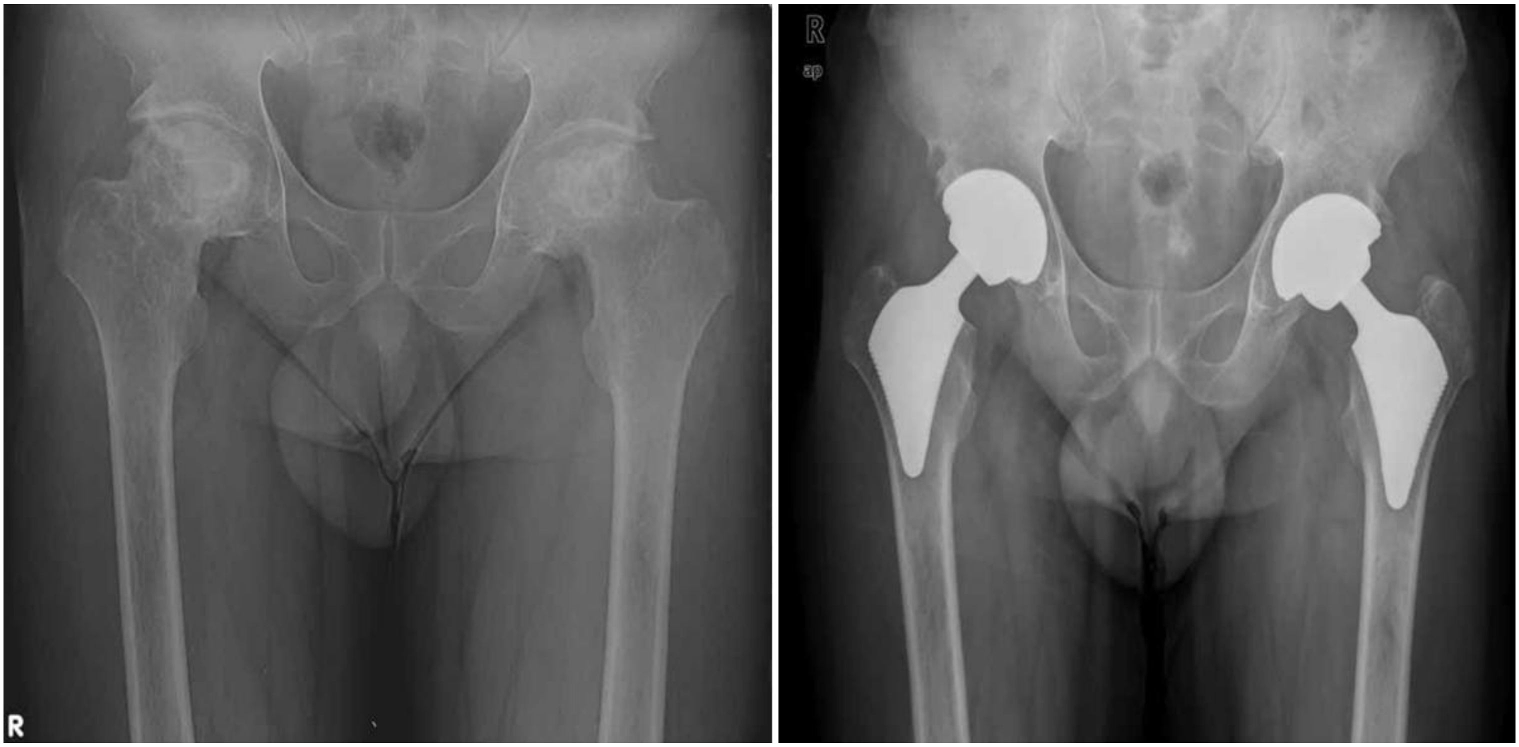

Figure 4: Radiographs of a 68-year-old man who had osteonecrosis of both femoral heads. A: Preoperative radiograph of both hips demonstrates collapse of both femoral heads (Ficat stage Ⅲ) and Dorr type C bone; B: Postoperative radiograph of both hips obtained 20 years after surgery demonstrates that the proximal stem is rigidly fixed in a satisfactory position of both hips.

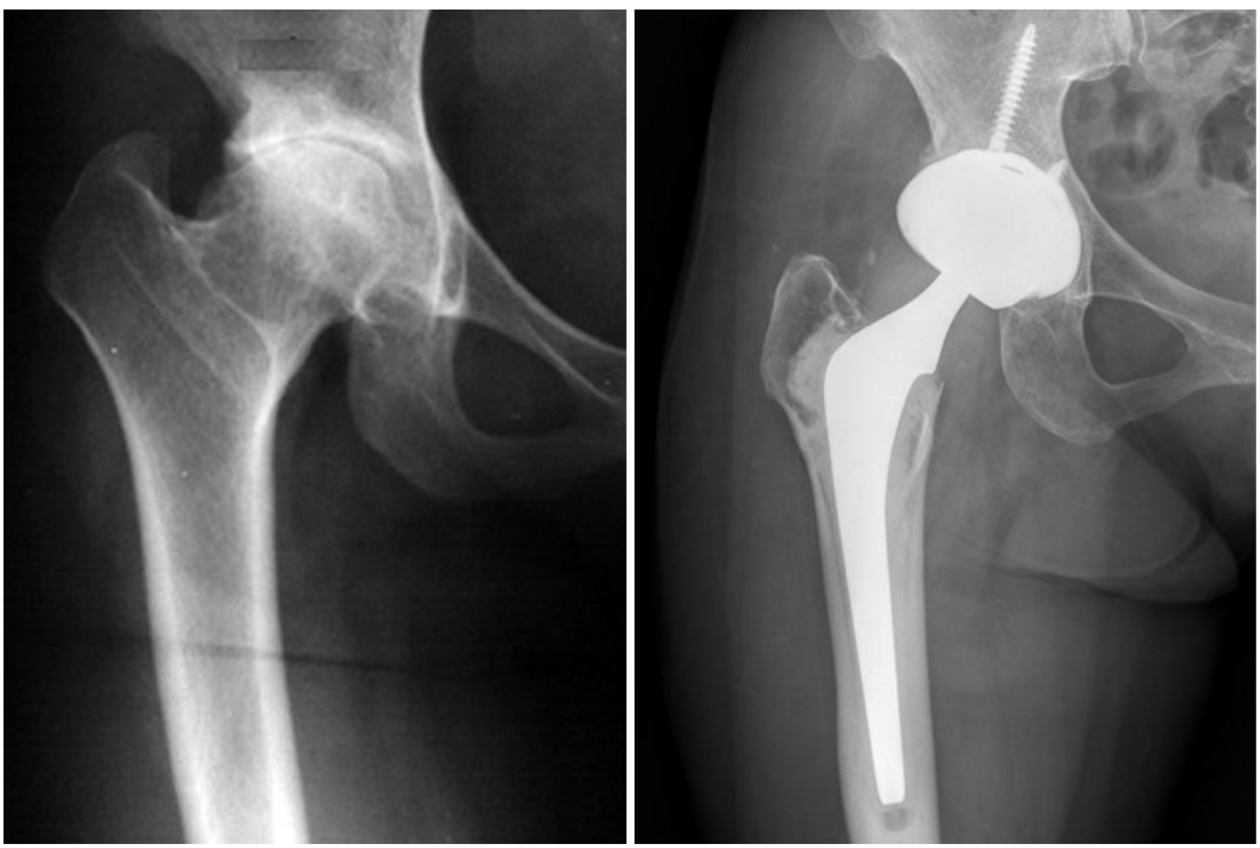

Figure 5: Radiographs of a 55-year-old man who had osteoarthritis due to childhood pyogenic arthritis of the right hip. A: Preoperative radiograph of the right hip reveals complete loss of articular cartilage of the hip joint and Dorr type C bone; B: Anteroposterior radiograph of the right hip, made 19 years after the operation, demonstrating that both components are well fixed. There is no evidence of acetabular or femoral osteolysis.

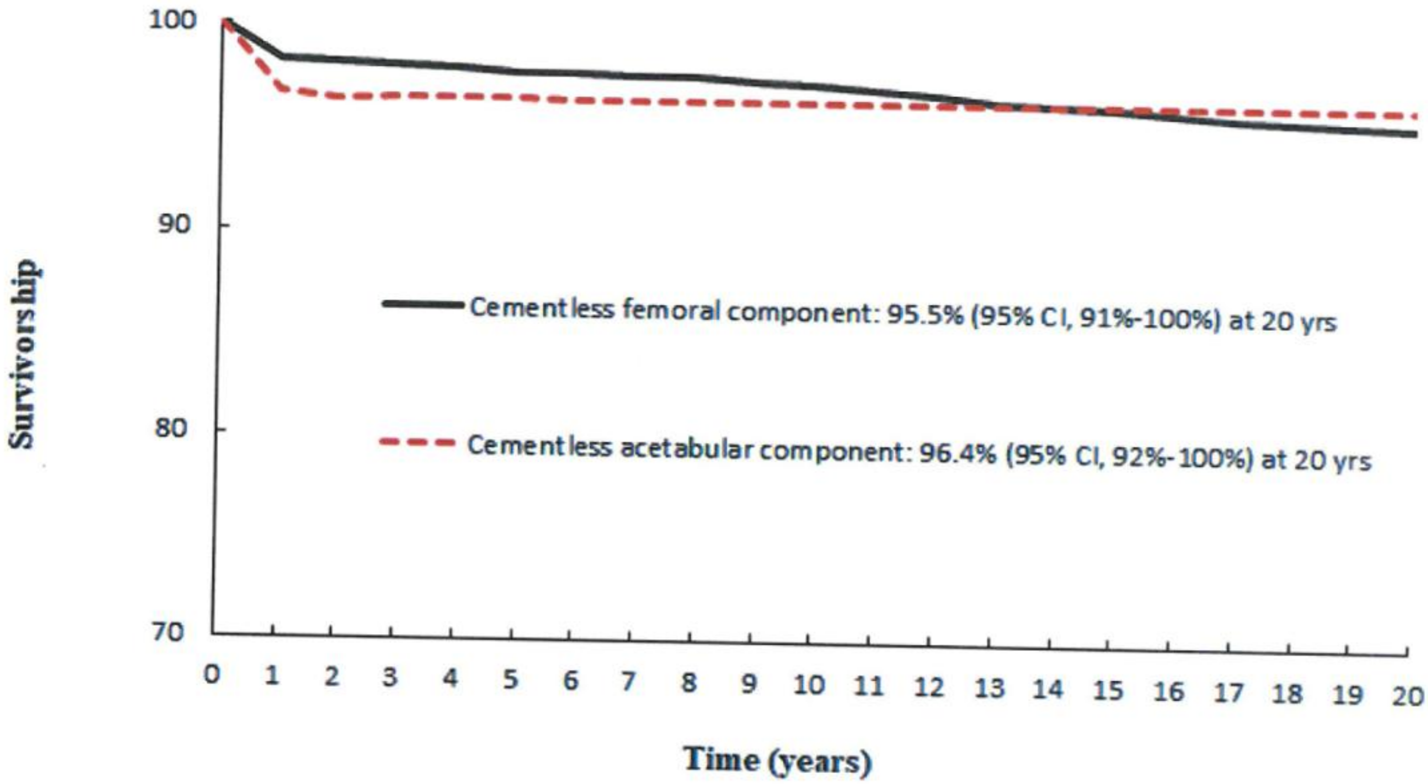

Figure 6: The Kaplan-Meier curve shows the acetabular and femoral components at a mean of 17.5 years in the cementless THA group.

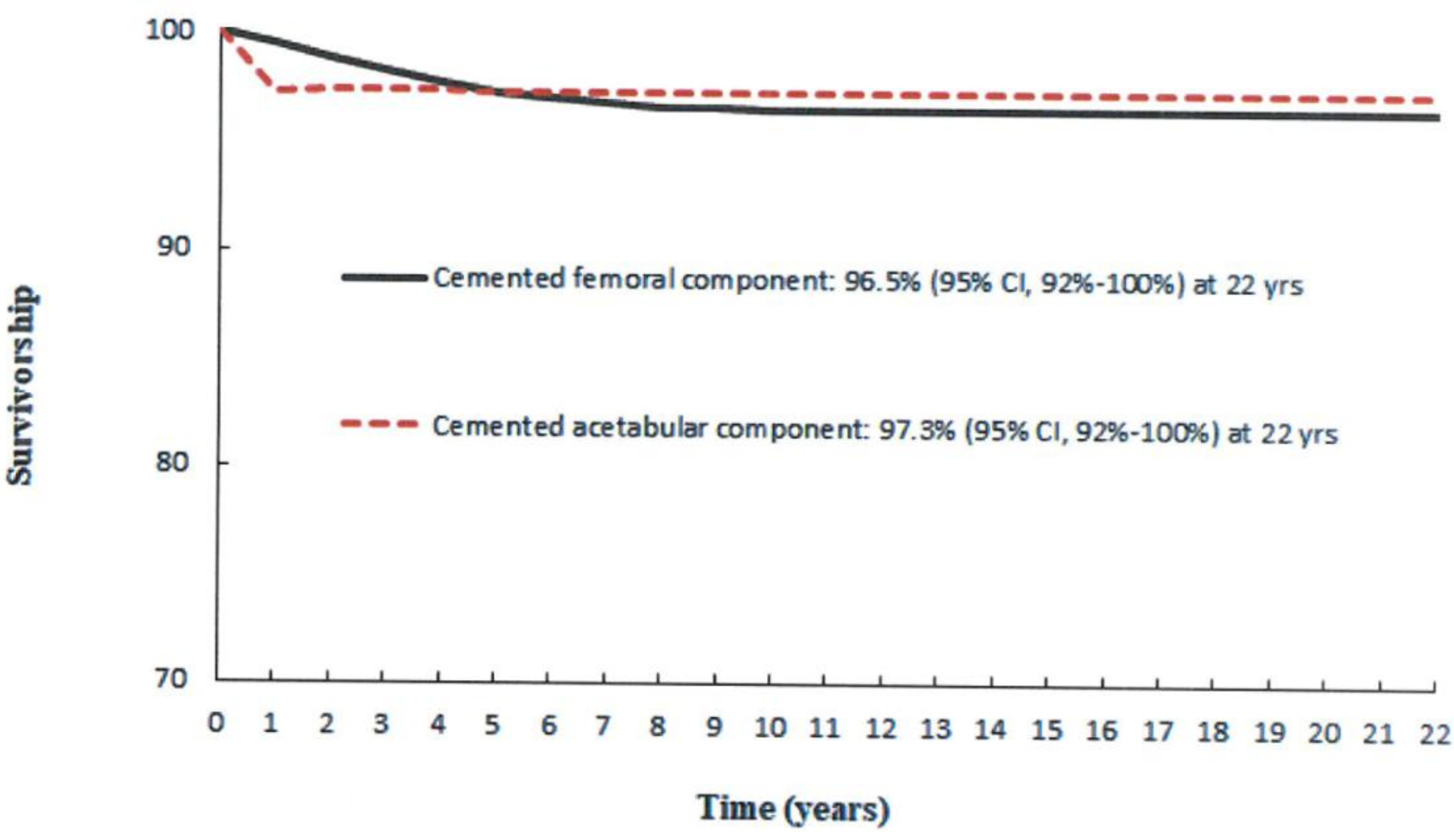

Figure 7: The Kaplan-Meier curve shows the acetabular and femoral component at a mean of 18.8 years in the cemented THA group.

Discussion

In this trial with extended follow-up to 20-22 years, both fixation strategies demonstrated favorable outcomes, including reliable implant stability, reduced adaptive bone resorption, low complication and revision rates, and excellent long-term survivorship. These findings align closely with previously published reports [2-7, 17-31]. Kim, et al., previously reported no significant differences in outcomes between cemented and cementless stems, a result echoed by our analysis [17]. Several factors likely contributed to these strong outcomes in our cohort: refinements in cementing technique (grades A, B, and C), improved stem designs, advances in implantation technique for the cementless stems, and the relatively small body size and weight of our patient population. Published literature on cementless tapered stems in Dorr type C femora remains limited and often involves small patient series with shorter follow-up [32-34]. Reitman, et al., reported favorable outcomes with the Mallory-Head (Zimmer Biomet, Warsaw, Indiana) stems in 81 patients followed for an average of 13.21 years, with no revision required for aseptic loosening [32]. Similarly, Kelly, et al., described their results using the hydroxyapatite-coated Omnifit HA stem (Stryker, Mahwah, New Jersey) in 15 patients followed for a mean of 11.5 years (9 to 14), with only one early revision for infection [33]. Dalury, et al., also demonstrated survivorship at 6 years using the proximally porous-coated Summit stem (DePuy Synthes, Warsaw, Indiana) in 40 patients (45 hips) [34]. Modern cementless stems, particularly straight-tapered models have provided excellent results when appropriately implanted in this challenging population. Kim, et al., observed consistent osseointegration even in patients with compromised bone quality, including femoral neck fracture, when treated with either a conventional cementless long stem (Solution stem; Zimmer, Warsaw, Indiana) or an ultra-short anatomic cementless design (DePuy, Leeds, UK). Our findings are consistent with these observations [35].

Although contemporary cemented stems have also demonstrated strong long-term outcomes, reports in Dorr type C femora remain mixed. Kobayashi, et al., documented a 16-year survival rate of only 81.6% with Charnley cemented stems, whereas Williams, et al., reported 100% survival of 325 Exter stems (Stryker) in this same bone type [36,37]. The Charnley Elite stem has been particularly debated: some authors report comparable performance to the original Charnley stem while others have suggested inferior durability [38-41]. In our series, we attributed our excellent cemented results to careful cementing technique combined with the smaller body habitus of our patient population. This investigation has several limitations. First, despite prospectively collected data, the analysis was retrospective. Second, unusually high follow-up rates at a minimum follow-up of 15 years strengthen our conclusions but may not be generalizable. Third, radiostereometric analysis was not utilized. Finally, the absence of interobserver assessments may introduce bias in radiographic interpretation.

Conclusion

In conclusion, our findings demonstrate that both proximally loading ultra-short anatomic cementless stems and contemporary cemented stems provide secure fixation and long-term durability in patients with Dorr type C femora. Concerns regarding compromised bone quality in this morphology did not translate into reduced implant stability or survivorship. These results indicate that either fixation approach can be reliably employed in this challenging bone type.

Conflict of Interests

The authors declare that there is no conflict of interest related to this study.

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