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Original article

Risk Factors for Perioperative Femoral Fractures: Cementless Femoral Implants and the Direct Anterior Approach Using a Fracture Table

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ABSTRACT

Background: With the increased popularity of the direct anterior approach, the issue of periprosthetic femur fractures has come into focus. The purpose of this article is to identify patient- and procedure-related characteristics that are associated with periprosthetic femur fractures in cementless total hip arthroplasties performed through a direct anterior approach using a fracture table.

Methods: Five hundred primary total hip arthroplasties performed using cementless femoral implants through a direct anterior approach using a fracture table were evaluated for characteristics associated with perioperative prosthetic femur fracture within the first 3 months of surgery.

Results: Twenty-three hips (4.6%) incurred fractures, 13 (2.6%) intraoperative and 10 (2.0%) postoperative. Bivariate analyses demonstrated females and a body mass index (BMI) >40 with a higher risk of fractures overall and postoperative fractures. A significant difference in DORR ratios was seen in patients with intraoperative fractures and a significant difference seen with implant sizes in patients with postoperative fractures. Multivariable regression analyses demonstrated an increased risk of postoperative fracture with a BMI >40. As the DORR ratio and implant size increased, there was a reduced odds of intraoperative fracture.

Conclusion: Concern for periprosthetic femur fractures using the direct anterior approach for total hip arthroplasty is high in female patients and in patients with morbid obesity (BMI >40), small DORR ratio, or small implant size.

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Arthroplasty treatment for osteoarthritis of the hip has proven a long-lasting and durable solution [1,2]. Periprosthetic fracture is a well-described complication in both cemented and noncemented operations [3,4].

The direct anterior approach for arthroplasty of the hip has grown in popularity with the hope of a low rate of dislocation and expedited recovery. Recent articles focusing on the direct anterior approach have highlighted the issue of periprosthetic fracture [5–7]. Several authors have previously identified factors related to periprosthetic fractures in total hip arthroplasty [8–11]. None have identified factors related to periprosthetic fractures in total hip

arthroplasty performed through a direct anterior approach using a fracture table. The purpose of the article is to identify patient- and procedure-related characteristics that are associated with periprosthetic femur fractures in cementless total hip arthroplasties performed through a direct anterior approach using a fracture table.

Materials and Methods

A retrospective evaluation was performed on a consecutive series of 500 primary cementless total hip arthroplasties (442 patients) performed by a single fellowship-trained surgeon through a direct anterior approach between June 2006 and January 2012. A fracture table was used in all cases (OSI ProFx and Hana Table, Union City, CA) with intraoperative fluoroscopy. During this time period for the surgeon, a total of 509 total hip arthroplasties were performed. Five were performed through a posterior approach during the early period of the learning curve because of the surgeon not feeling comfortable with the anterior approach because of the patients' large body habitus. Four anterior approaches were performed during this period using a cemented

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stem for reasons of advanced age of the patient. This series includes the surgeon's initial experience with the anterior approach. Before adopting the anterior approach, the surgeon's approach of preference was the Hardinge approach.

The patients were followed for 3 months postoperatively. Intraoperative and postoperative fractures were documented. Age, weight, gender, side, and implant type and size were documented, as well as disposition to home or skilled nursing facility. Preoperative anteroposterior radiographs of the pelvis of each patient were used to calculate the DORR ratio [12] by the surgeon. Data for weight and height were obtained from preoperative history and physicals as well as anesthesia records. The body mass index (BMI) was calculated from the height and weight using SAS 9.2 (SAS Institute Inc, Cary, NC).

Patient Demographics

Patient demographics for the entire series are displayed in Table 1, and implant type is displayed in Table 2.

Statistical Method

The dependent variables were intraoperative fracture, postoperative fracture, and overall fracture. The independent variables assessed were age (years), weight (lbs), gender, side, BMI >40 kg/m² (morbid obesity), DORR ratio, implant size, and disposition to home or skilled nursing facility.

Chi-square tests and *t* tests were used to assess bivariate associations between the independent variables and the odds of fracture. Variables that appeared associated with the odds of fracture in bivariate tests were included, where possible, in multivariate logistic regression models predicting the odds of outcomes. *P* values ≤.05 were considered significant. All analyses were conducted using SAS 9.2 (SAS Institute Inc, Cary, NC).

Results

Surgical Outcomes

Of the 500 cementless hip arthroplasties, 23 hips (4.6%) incurred fractures. Thirteen fractures (2.6%) were intraoperative and 10 (2.0%) were postoperative (Tables 3 and 4). The rate of fractures per 100 patients in the consecutive series is displayed in Figures 1-3. The rate of intraoperative fracture declined after the first 100 patients, whereas the rate of postoperative fracture stayed steady throughout the entire series of 500 patients. All fractures in the

Table 1
Patient Characteristics.

Gender	314 Females 186 Males
Diagnosis	468 Osteoarthritis 23 Avascular necrosis 3 Acute femoral neck fracture 2 Rheumatoid arthritis 2 Conversion of ORIF 1 DDH 1 Legg-Calvé-Perthes
Average age at operation	66 y (range, 29-93)
Average weight	177 lbs (range, 101-365)
Average height	68 inches (range, 56-78)
Average BMI	28.3 kg/m ² (range, 18.0-50.2)
Average DORR ratio	3.5 (range, 1.0-6.5)
Discharge disposition	353 (71%) Home 147 (29%) Skilled nursing facility

BMI, body mass index; DDH, developmental dysplasia of the hip; ORIF, open reduction internal fixation.

Table 2
Cementless Femoral Stem Types.

Depuy Corail (Warsaw, IN)	241
Zimmer ML Taper (Warsaw, IN)	250
Zimmer Fitmore (Warsaw, IN)	4
Depuy Triloc (Warsaw, IN)	3
Depuy Summit (Warsaw, IN)	1
Smith Nephew Richards Anthrology (Memphis, TN)	1

series went on to heal except for one intraoperative greater trochanter fracture treated with a figure-of-eight cerclage wire. This patient went on to nonunion, but abductor strength was adequate enough to not require revision of the open reduction internal fixation.

Among patients who sustained a fracture, 19 were female and 4 were male. Eleven fractures occurred in the left hip and 12 occurred in the right. The average age for the patients who incurred fractures was 69 years (range, 51-86). Ten (44%) of the implant types were ML Taper stems and 13 (56%) were Corail stems (*P* = .6). The average hospital stay was 3.7 days (range, 3-11 days). The average DORR ratio was 3.4 (range, 1.8-5.1). The average weight was 168 lbs (range, 108-250). The average height was 64 inches (range, 57-72), and the average BMI was 29.2 kg/m² (range, 21.1-45.7). Twelve patients were discharged to a nursing facility and 11 to home. Nineteen of the patients had a BMI ≤40 kg/m² and 4 had a BMI >40 kg/m². Nineteen had a weight of ≤200 lbs and 4 were >200 lbs. The average implant size was 10.9.

Of the 477 hips without fractures, 295 were female and 182 were male. Two hundred fourteen were left sided and 263 were right sided. The average age was 66 years (range, 27-93). The average DORR ratio was 3.5 (range, 1.0-6.5). The average height was 66 inches (range, 56-78). The average weight was 177 lbs (range, 101-365), and the average BMI was 28.2 (range, 18-50.2). Four hundred sixty-four had a BMI of ≤40 and 13 had a BMI of ≥40. Three hundred sixty-five weighed ≤200 lbs and 112 had weight > 200 lbs. The average implant size was 11.1.

The 4 patients who developed postoperative fractures with a BMI of >40 have been followed continuously since the initial operation. They are 48, 58, 75, and 90 months after the index operation. All have gone on to heal. Two developed postoperative infections. Both required 2-stage implant exchange, one at 1 month postoperatively and the other at 4 months postoperatively. Both are currently infection free. The other 2 have healed without further morbidity.

Bivariate Analyses

The results of bivariate analyses are shown in Table 5. There was no association between age and risk of fracture either overall, postoperative, or intraoperative. There was also no association between the procedure side (left or right) and the risk of fracture either overall, postoperative, or intraoperative.

A BMI >40 kg/m² was associated with an increased risk of overall fracture incidence (23.5%, *P* = .006) and specifically postoperative fractures (23.5%, *P* < .001), compared to patients with a BMI ≤40 kg/m². Higher BMI was not associated with increased risk of intraoperative fractures.

Weighing ≤200 lbs was not associated with a higher risk of intraoperative fracture (3.4%, *P* = .08) than patients weighing >200 lbs. When added to a logistic regression model, the results were not reliable. The model failed to converge because of a near-complete separation of response.

Females were more likely than males to have a fracture overall (6.1% vs 2.2%, *P* = .048) and specifically a postoperative fracture

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