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Intraoperative Proximal Femoral Fracture in Primary Cementless Total Hip Arthroplasty

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ABSTRACT

Intraoperative proximal femoral fracture is a complication of primary cementless total hip arthroplasty (THA) at rates of 2.95–27.8%. A retrospective review of 2423 consecutive primary cementless THA cases identified 102 hips (96 patients) with fracture. Multivariate analysis compared fracture incidences between implants, Accolade (Stryker Orthopaedics) and Tri-Lock (DePuy Orthopaedics, Inc.), and evaluated potential risk factors using a randomized control group of 1150 cases without fracture. The fracture incidence was 4.4% (102/2423), 3.7% (36/1019) using Accolade and 4.9% using Tri-Lock (66/1404) ($P = 0.18$). Female gender (OR = 1.96; 95% CI 1.19–3.23; $P = 0.008$) and smaller stem size (OR = 1.64; 95% CI 1.04–2.63; $P = 0.03$) predicted increased odds of fracture. No revisions of the femoral component were required in the fracture cohort.

The clinical success of cementless total hip arthroplasty (THA) depends upon initial stability at the prosthesis-bone interface. Stability is achieved through press-fitting of a femoral component compatible with the endosteal geometry of the bone [15]. Press-fitting may lead to an increase of intraoperative proximal femoral fractures for uncemented THA compared to cemented designs [9,15]. Fracture occurs during primary cementless THA at rates of 2.95–27.8% [2,3].

If recognized, intraoperative fracture can be addressed with cerclage wire techniques. Cerclage wires reduce the risk of crack propagation [8] and achieve satisfactory initial implant stability without compromising clinical outcome [1,2,7,14,15]. However, intraoperative fracture may lead to increased cost and intraoperative time as well as risk of vascular or nerve injury. Inadequate fixation or unrecognized fracture may lead to fracture displacement or nonunion, persistent thigh pain, poor bone ingrowth, and aseptic loosening of the femoral stem [6] necessitating further surgery.

Previously reported risk factors for fracture during femoral component implantation include use of press-fit cementless femoral stems [3,7,12,14], minimally invasive techniques, anterolateral approach [3], previous surgery on the ipsilateral hip, diagnoses other than osteoarthritis [1], revision surgery [15], and female gender [3,4,12].

In the largest single surgeon consecutive series reported, this study aims to (1) present the incidence of proximal femoral fracture during primary cementless THA, (2) describe the fracture cohort demographically and by radiographic femoral morphology (Dorr classification), (3) compare the fracture incidence between two femoral stem types and multiple stem sizes, and (4) identify risk factors for fracture.

Methods

The present study is a retrospective review of 2423 patients who underwent primary cementless THA between January 2000 and December 2013 performed by a single senior adult reconstruction fellowship-trained surgeon (J.J.P.). Over this thirteen year period, the surgeon documented 102 hips (96 patients) with an intraoperative proximal femoral fracture, defined as a nondisplaced or minimally displaced incomplete linear discontinuity along an approximately 90 degree arc of the medial calcar proximal to the lesser trochanter. Of twenty-two patients within the fracture cohort who underwent bilateral THA, six had bilateral fractures.

The 102 hips with intraoperative femoral fracture were matched by date of surgery (DOS) to 1150 patients who underwent primary cementless THA without fracture. Matching by DOS was intended to capture a control group of patients with similar demographics and surgical details, including implants utilized, as these variables could change over time. For all patients in each group, a chart review was performed to extract patient demographic data including: age at the time of surgery, gender, body mass index (BMI), preoperative diagnosis, operative side, and length of stay (LOS) (Table 1). Operative notes were reviewed to confirm femoral component type and size. Anteroposterior pelvis radiographs were retrospectively and independently reviewed by two authors for classification of the native proximal femoral morphology according to the Dorr classification [10]. Clinical outcomes were

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Table 1
Patient Demographics.

Demographic	Cohort (Fracture)	Control (No Fracture)	*P*-value
Patients (Hips)	98 (102)	1150	
Age (Years)	60.5 ± 13.4	63.1 ± 11.8	$P = 0.03$
Sex			
Female	68	544	$P < 0.001$
Male	30	520	
Operative Side			
Right	57	598	$P = 0.47$
Left	45	552	
Body Mass Index	29.1 ± 6.5	29.1 ± 5.1	$P = 0.67$
Length of Stay (Days)	3.3 ± 1.3	2.7 ± 1.7	$P < 0.001$

* Represents values that are statistically significant, $P < 0.05$.

determined by reviewing patient records to identify postoperative complications and need for reoperation.

All procedures were performed by one surgeon with consistent technique using a modified anterolateral (Hardinge) approach with the patient in the supine position on a standard radiolucent operating table. Femoral components were wedge-shaped, tapered, proximally porous coated, press-fit stem designs. In both the control and study groups, the Accolade (Stryker Orthopaedics, Kalamazoo, MI) was used from August 2000 until January 2008 and Tri-Lock (DePuy Orthopaedics, Inc, Warsaw, IN) was used from 2008 until the present time. Surgical technique for both stems includes femoral canal reaming followed by sequential broaching until stability of the implant is reached. All proximal femoral fractures were visually recognized in the operating room upon impaction of the final femoral component. No fractures occurred during reaming or broaching of the canal or during trial reductions. There were no periprosthetic fractures in the fracture or control cohorts at any time postoperatively. Fracture fixation involved removal of the prosthesis, cerclage of the proximal femur with a cable above the level of the lesser trochanter, impaction of the femoral component then final tightening of the cable and crimping of the fixation clip (Fig. 1). Visual and tactile implant stability was confirmed for all cases. Postoperatively, the patient was permitted to weight bear as tolerated in accordance with the surgeon's normal established protocol.

Fig. 1. Postoperative anteroposterior radiograph of the pelvis demonstrating bilateral primary cementless total hip arthroplasty complicated by intraoperative proximal femoral fracture treated with cerclage of the proximal femur with a cable above the level of the lesser trochanter.

Table 2
There Is No Significant Difference in Fracture Incidence between Two Implant Types.

	Accolade	Tri-Lock	Total
Annual Usage	2000–2008	2008–2013	2000–2013
Total Cases	1019	1404	2423
Cohort (Fracture)	36	66	102
Control (No Fracture)	983	1338	2321
Fracture Incidence	3.7%	4.9%	4.4%

* No significant difference in fracture incidence between implant types, $P = 0.18$.

Statistical Analysis

Univariate analyses were performed using Student's t-test and Fisher's exact test where appropriate (SigmaStat 4.0, San Jose, CA; IBM SPSS Statistics 21.0, Armonk, NY). Multivariate analyses were performed with logistic regression modeling (R project 3.0.0, Auckland, New Zealand). Significance was established at $P \leq 0.05$.

Source of Funding

No external source of funding was utilized.

Results

Intraoperative proximal femoral fractures were identified in 102 hips (96 patients) with an overall fracture incidence of 4.4% (Table 2). Of 22 patients undergoing bilateral THA, 6 patients, all female, had bilateral intraoperative proximal femoral fractures (Fig. 1). One patient received one of each implant type on either hip. The fracture incidence was similar using Accolade and Tri-Lock, 3.7% and 4.9%, respectively ($P = 0.18$). Patient demographics among the fracture group were similar between Accolade and Tri-Lock (Table 3). The majority of patients in the fracture cohort had a diagnosis of osteoarthritis (Table 4) and moderate bone quality, 50% Type B, as determined by the Dorr classification (Fig. 2). Most fractures occurred despite good bone quality, with 86% graded as type A or B. Interobserver reliability was excellent for radiographic assessment of the Dorr classification (Gamma = 0.893 ± 0.048).

Univariate analysis of the fracture cohort and control group was employed to identify potential risk factors for proximal femoral fracture during THA. Gender (female, $P < 0.001$) and younger age (mean of 60.5 years, $P = 0.03$) were statistically significant risk factors in the fracture cohort, whereas BMI and operative side were not. The fracture incidence increased over time with increasing volume of THA ($P = 0.008$) (Fig. 3).

Multivariate analysis using a logistic regression model of fracture incidence versus stem size was created. Covariates included BMI, gender, and age. Stem size and date of surgery were included as binary variables centered on the median value. Both Tri-Lock and Accolade have 11 gradations of sizing therefore data was compiled on a 0–10 scale for ease of analysis. Females (OR = 1.96, CI = 1.19–3.23), smaller stem sizes (OR = 1.64, CI = 1.04–2.63) (Fig. 4), and age (OR = 0.98, CI = 0.96–0.99) were significant and independent risk factors for proximal femoral fracture (Table 5). Date of surgery, potentially capturing a "learning curve" or "experience factor" effect did not achieve statistical significance in this model.

Table 3
Patient Demographics Are Similar between Two Implant Types.

	Accolade	Tri-Lock	*P*-value
Gender (Female/Male)	23/11	45/19	$P = 0.82$
Side (Right/Left)	25/11	32/34	$P = 0.06$
Age (Years)	62.5 ± 13.9	60.2 ± 12.2	$P = 0.82$
BMI	30.5 ± 7.6	28.5 ± 5.7	$P = 0.18$
Length of Stay (Days)	3.3 ± 1.0	3.4 ± 1.5	$P = 0.99$