The Journal of Arthroplasty 28 (2013) 1310–1313

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Intra-Operative Periprosthetic Fractures Associated With Press Fit Stems in Revision Total Knee Arthroplasty
Incidence, Management, and Outcomes

Cara A. Cipriano, MD [a], Nicholas M. Brown, MD [a], Craig J. Della Valle, MD [b], Mario Moric, MS [c], Scott M. Sporer, MD [b]

[a] Department of Orthopedic Surgery, Rush University Medical Center, Chicago, Illinois
[b] Orthopaedic Surgery, Rush University Medical Center, Chicago, Illinois
[c] Department of Anesthesiology, Rush University Medical Center, Chicago, Illinois

ARTICLE INFO

Article history:
Received 29 May 2012
Accepted 4 October 2012

Keywords:
periprosthetic
fracture
revision
knee
arthroplasty
complications

ABSTRACT

The purpose of this study is to report the incidence, management, and outcomes of periprosthetic fractures associated with the insertion of press-fit stems during revision total knee arthroplasty (TKA). Immediate and six week post-operative radiographs from 634 stemmed implants (307 femoral, 327 tibial) from 420 consecutive revision TKAs were reviewed. Sixteen tibial (4.9%) and 3 femoral (1%) fractures (combined incidence 3.0%) were identified. All healed uneventfully without operative intervention, with no evidence of implant loosening at a mean of 23 months (range 12 to 47 months). The technique of tightly press fitting stems into the diaphysis is associated with a small rate (3%) of periprosthetic fractures; most were non or minimally displaced, all healed uneventfully with non-operative management and were not associated with implant loosening.

As the age of the population and number of patients undergoing primary total knee arthroplasty (TKA) increases, revision arthroplasties are being performed more frequently [1,2]. Stemmed implants are often used in revision TKA to augment prosthetic stability as the bone available in the metaphysis may be compromised [3–5]. Although the use of stems is well accepted, the use of a fully cemented stem or a stem that is press fit into the diaphysis is controversial.

Cemented stems offer the advantages of antibiotic delivery to the canal, immediate rigid fixation and a simpler surgical technique, as minor adjustments in the position of the components can be made independent of the diaphysis; however they can be difficult to extract if required in the future. Advantages of a cementless stem include improvement of axial and sagittal alignment as well as relative ease of removal if required [6–13]. When using a cementless stem, diaphyseal engagement with a tight press fit is advocated to optimize stability; however, attempts to maximize cortical contact may lead to intra-operative periprosthetic fracture. Despite the widespread use of cementless stems that are tightly press fit into the diaphysis, we are unaware of prior reports of periprosthetic fracture associated with the use of cementless stem. The purpose of this study is to report the incidence, risk factors, and management of these fractures.

Methods

Four hundred twenty consecutive revision TKAs performed by two surgeons between May 2003 and February 2010 using the same surgical technique were reviewed. These cases included the use of 634 stemmed implants (307 femoral and 327 tibial); revisions performed during this time period utilizing either no stem (132 components) or a cemented stem (74 components) were excluded. The resulting cohort consisted of 276 females (65.7%) and 144 males (34.3%) with a mean age at time of revision of 64.9 years old (range 31 to 92 years old). The underlying diagnosis leading to primary TKA was osteoarthritis in the majority of cases and aseptic loosening was the most common diagnosis amongst the revision cases (Table 1).

Medical records from these patients were reviewed for demographic data including patient age, gender, and reasons for revision (Table 2), and operative reports reviewed to determine the diameter and length of the stems utilized for reconstruction. Immediate and 6 week post-operative radiographs for all knees were reviewed. Fractures identified on these studies were described as non-displaced, minimally displaced (<2 mm), or displaced (>2 mm). For cases in which a fracture was identified, all subsequent follow-up radiographs

The Conflict of Interest statement associated with this article can be found at http://dx.doi.org/10.1016/j.arth.2012.10.003.

Reprint requests: Scott M. Sporer, MD, 1611 West Harrison Street, Suite 300, Chicago, IL 60612.

0883-5403/2808-0015$36.00/0 – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.arth.2012.10.003

Table 1
Study Population Demographics.

Age (mean, range)		64.9 (31–92)
Gender (percent)	Females	283 (65.2%)
	Males	151 (34.5%)
Primary diagnosis (percent)	Osteoarthritis	388 (89.4%)
	Inflammatory arthritis	19 (4.5%)
	Post-traumatic arthritis	10 (2.3%)
	Ostenecrosis	8 (1.8%)
	Other	9 (2.1%)
Revision diagnosis (percent)	Aseptic loosening	232 (53.5%)
	Periprosthetic infection	62 (14.3%)
	Stiffness	39 (9.0%)
	Instability	31 (7.1%)
	Wear/osteolysis	13 (3.0%)
	Fracture	8 (1.8%)
	Other	49 (11.3%)

were reviewed. Fracture healing was defined as radiographic evidence of bridging callous seen on two orthogonal views for displaced fractures or a diminished fracture line for non-displaced fractures, along with absence of implant migration or fixation failure and the ability of the patient to fully bear weight without pain [14]. Follow-up radiographs were reviewed for evidence of prosthetic loosening using the evaluation defined by the Knee Society as modified by Whaley [11]. Implants were considered to be loose if they showed evidence of subsidence or other change in position. Any interventions (e.g. restricted weight bearing or the use of an orthosis) for fracture management were noted.

Revision components where a stem was utilized included 568 LCCK (Zimmer, Warsaw, IN; 84.7%), 30 Triatholon Revision (Stryker, Mahwah, NJ; 4.7%), 28 Genesis Revision (Smith & Nephew, Memphis, TN; 4.4%), four Proven Gen-Flex (Stelkast, McMurray, PA; 0.6%), two Vanguard SSK (Biomet, Warsaw, IN; 0.3%), and two Advance (Wright Medical, Arlington, TN; 0.3%). Offset stems were used in 246 of the tibial components (75.2%) and 69 of the femoral components (22.5%). The use of an offset stem was determined intra-operatively to maximize coverage of the metaphyseal bone, optimize joint stability and/or to optimize patellar tracking. Stems were categorized as either the short or the long model offered by each manufacturer and analyzed as a categorical variable. Among the tibial components, short stems ranged from 75–100 mm, and long stems from 130—155 mm; among the femoral components, short stems measured 95—105 mm, and long stems 130—155 mm. These dimensions refer to the length of the stem alone, not the entire implant.

The surgical technique utilized included hand reaming of the canal until cortical contact was obtained and the use of trials to gauge appropriate stem length and diameter. In general, the goal was to obtain a tight press fit in the diaphysis such that during final prosthetic implantation, the implant could not be advanced by hand for the last one to two centimeters and impaction with a mallet was required. While the stem itself was inserted without cement, a hybrid technique for component fixation was utilized, in which cement was placed in the metaphyseal bone and on the undersurface of the revision component up to and just past the modular junction of the stem.

Stepwise logistic regression modeling was used to evaluate independent predictors of fracture. Variables were selected based on clinical relevance and data availability; these included patient age and gender, as well as diameter, length, and offset for both tibial and femoral stem extensions as well as implant manufacturer. Tibial and femoral stem lengths refer to the combined length of the stem and the thickness of the tray. Selection criteria for the stepwise logistic regression were a p value$<$0.20 for entry and $p<0.10$ for retention. Analysis was stratified by component location (femoral or tibial); in addition, age and gender were included into the final model as covariates to more clearly evaluate the effects of implant factors. Interactions between potential risk factors were investigated, and standard diagnostic tests were used to check for violations of model assumptions. For calibration, the Hosmere—Lemeshow goodness-of-fit tests were performed and area under the curve (AUC) was used to assess discrimination.

Results

Sixteen tibial (4.9%) and three femoral (1%) stems were associated with intra-operative peri-prosthetic fractures (combined incidence 3.0%). Thirteen of these fractures were non-displaced (all tibial), two had cortical displacement <2 mm (both tibial), and four were displaced >2 mm (one tibial and three femoral) (Fig. 1). One displaced fracture associated with a femoral stem was recognized and fixed intra-operatively with cables; the remaining eighteen fractures were all treated non-operatively. The second displaced fracture of the femoral shaft occurred in a patient who underwent concomitant extensor mechanism allograft reconstruction at the time of revision and was casted for six weeks for healing of the allograft; the fracture showed radiographic evidence of healing by six weeks when the cast was removed and no further treatment was required. The final displaced femoral fracture was managed with protected weight bearing for six weeks. Two tibial fractures, one minimally displaced and one displaced, were braced for three months using a patellar tendon bearing brace because of pain with weight bearing. Twelve of the

Table 2
Demographic Data and Implant Characteristics for Patients Who Sustained Periprosthetic Fractures during Revision TKA Compared To Those Who Did Not.

		Fracture	No fracture	*p* Value
Age	(mean, range)	64.5 (48–70)	65.0 (31–92)	0.8503
Gender	Females	14 (5.1% fx rate)	269	0.3181
	Males	4 (2.6% fx rate)	147	
Location	Tibia	16	311	0.0042
	Femur	3	304	
Tibial implant (327 total)	Short (n, %)	15	209	0.1327
	Long (n, %)	1	64	
	Diameter (mean, range)	14.3 (10–18)	14.4 (10–18)	0.8701
	Offset	12 (5.0% fx rate)	230	0.5669
	No offset	3 (3.0% fx rate)	97	
Femoral implant (307 total)	Short (n, %)	3	145	0.1165
	Long (n, %)	0	154	
	Diameter (mean, range)	19.3, 14-24	16.0, 11-24	0.0223
	Offset	0 (0% fx rate)	69	1.000
	No offset	3 (1.2% fx rate)	238	

Mean age and range for patients with each outcome. Number and rate of fracture observed in females compared to males. Mean and range of implant sizes in each group; number and rate of fracture associated with offset and non-offset implants.