The Treatment of Periprosthetic Femur Fractures After Total Knee Arthroplasty

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KEYWORDS

• Periprosthetic • Femur fracture • Knee arthroplasty

KEY POINTS

- The incidence of periprosthetic femur fractures after total knee arthroplasty is 2.5%.
- Fracture displacement, implant stability, and the presence of osteoporotic bone are a few factors that help determine management.
- Open reduction internal fixation with locking plates and retrograde intramedullary nail fixation, each with their own advantages and disadvantages, are excellent treatment options that can yield favorable results.
- The primary complications from operative intervention include nonunion, malunion, hardware failure, infection, and refracture.

BACKGROUND

Total knee arthroplasty (TKA) outcomes have historically been largely positive; however, the increased activity of an aging baby boomer population has led to a notable presence of periprosthetic fractures, with an incidence as high as 5.5%.[1] Periprosthetic fractures after TKA are defined as fractures occurring in the femur, tibia, and/or patella and within 15 cm of the joint line or 5 cm of the intramedullary stem.[2,3] With the number of primary TKAs annually being greater than 300,000 a year in the United States,[4] the incidence of postoperative periprosthetic femur, tibia, and patella fractures have ranged from 0.3% to 2.5%, 0.4%, and 0.68%, respectively.[1,4,5] Risk factors have included osteoporosis, osteolysis, rheumatoid arthritis, anterior notching of the femoral cortex, poor knee flexion, neuromuscular disorders, corticosteroid therapy, cemented prostheses, and revision procedures.[5–9] After appropriate diagnostic workup and classification of these peri-implant failures, management often requires critical assessment of patient health, fracture location, bone quality, implant stability, presence of proximal femoral implants (arthroplasty, nail, plate), surgeon experience and training, operative costs, and reoperation rates.

Treatment options for periprosthetic supracondylar femur fractures, each with their own advantages and disadvantages, range from nonoperative to operative fixation (**Box 1**) in the form of skeletal traction, external fixation, plate fixation (nonlocked vs locked), flexible (Rush rods, Enders nails) or rigid intramedullary nails (IMNs), revision arthroplasty, and distal femoral replacement (DFR).[10–14] Each of

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Box 1
Operative options

Skeletal traction
External fixation
Open reduction internal fixation
Anterograde intramedullary nail fixation
Retrograde intramedullary nail fixation
Revision arthroplasty
Distal femoral replacement

these modalities can be augmented with cerclage wires, cement, and/or allograft. Alternative, less popular methods have included thin-wire external fixation, the so-called "nailed cementoplasty," fibular allograft supplementation of plate fixation, and upside down use of a proximal femoral nail.[7] In a 2008 systematic review by Herrera and colleagues[15] of 29 case series totaling 415 cases, analysis of various treatment methods (nonoperative, nonlocked and locked plating, retrograde IMN [RIMN], and external fixation) yielded an overall nonunion rate of 9%, fixation failure rate of 4%, infection rate of 3%, and revision surgery rate of 13%.

More recent literature has come to support operative intervention in the form of locked plating (LP) and RIMN fixation; however, much controversy remains on which is superior biomechanically and clinically.[4,7,16–28] A 2013 systematic review by Ristevski and colleagues[24] analyzed 44 studies (719 fractures) and found both LP and RIMN to offer significant advantages over nonoperative treatment and conventional (nonlocked) plating techniques. They also noted that LP trended toward increased nonunion rates compared with RIMN, whereas RIMN had a significantly higher malunion rate. No difference was seen with regard to need for secondary surgical procedures. Meneghini and colleagues[22] in 2014 compared modern RIMN with periarticular LP and found no significant difference in nonunion (9% in RIMN vs 19% in LP; $P = .34$) despite a significantly different mean number of screws in the distal fracture fragment (3.8 in RIMN vs 5.0 in LP; $P \leq .001$).

Nevertheless, regardless of treatment option, this era of personalized care requires that each patient be scrutinized not only from a fracture standpoint but also based on overall health goals. Because of patient age and baseline health status, complication rates and mortality can be expected to be high[29]; mortality rates are as high as 17% at 6 months and 30% at 1 year. A systematic, individualized approach to the management of periprosthetic femur fractures after a TKA can result in favorable outcomes.

CLASSIFICATION

Historically, classification systems for periprosthetic femur fracture after a TKA have focused exclusively on fracture displacement without assessing for implant involvement,[14] including those by Neer and colleagues[30] in 1967, DiGioia and Rubash[31] in 1991, and Chen and colleagues in 1994.[32] Since 1997, two systems (Figs. 1 and 2) have accounted for implant stability and the relationship of the fracture to the implant. Rorabeck and Taylor[33] described 3 types of periprosthetic distal femur fractures. Type I are nondisplaced fractures with a stable prosthesis, type II are 5 mm displaced or 5° angulated with a stable prosthesis, and type III are those with an unstable prosthesis.[32] As per the system by Su and colleagues,[14] the 3 types of fractures are type 1, which are proximal to the femoral component; type II, which start at the proximal end of the component and extend proximally; and type III, which extend distal to the proximal border of the femoral component. Additionally, the presence of an interprosthetic fracture, one that occurs between a hip and knee arthroplasty implant, can be classified by either the Vancouver or Rorabeck systems.[31,32] Implant stability and fracture location will guide utility of either classification system and subsequent treatment options.

DIAGNOSIS AND IMAGING

A thorough history and physical examination can help identify the cause and mechanism of a periprosthetic femur fracture. Each patient should be evaluated for cause of fracture (low vs high energy) and preexisting knee pain that may suggest loosening. Additionally, obtaining a detailed medical and surgical history is critical in identifying potential for poor healing and previous implant sizes. All fractures should be evaluated to document a neurovascular examination and rule out an open fracture. Occasionally, when a patient has clinical signs of infection, septic loosening cannot be excluded. Therefore, a microscopic (microbiological) analysis of the intra-articular fluid for white blood cells and bacteria may be recommended.[7,25]

From an imaging stand point, standard anteroposterior and lateral radiographic views can help classify the fracture and assess the stability of the prosthesis. Because implant stability may not be obvious on plain radiographs, a computed tomography scan may help find signs of loosening,