



Original research

Early femoral condyle insufficiency fractures after total knee arthroplasty: treatment with delayed surgery and femoral component revision

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ABSTRACT

Background: Periprosthetic fracture following total knee arthroplasty (TKA) is usually associated with a traumatic event and typically treated with fracture fixation techniques. However, we report on a series of patients with early atraumatic condyle fractures that occurred as a result of insufficiency of the unloaded preoperative femoral condyle treated with delayed reconstruction.

Methods: We retrospectively reviewed a series of 7 patients who sustained femoral condyle fractures following TKA and evaluated risk factors for insufficiency.

Results: There were 6 females and 1 male with an average age of 65.5 (range, 63–75) years and an average body mass index of 29.4 (range, 27–32). Fracture occurred on average 24.9 days from the index surgery and secondary to a low energy mechanism. Five patients had valgus alignment (mean, 15.2°) preoperatively and sustained fracture of the unloaded medial femoral condyle. Two patients had varus alignment (mean, 7.0°) preoperatively and both fractured the unloaded lateral condyle. One patient underwent early intervention requiring distal femoral replacement secondary to femoral bone loss. The remaining 6 patients underwent delayed surgery for an average of 6 weeks to allow for fracture healing followed by femoral component revision. At last follow-up (average, 48.5 months), 1 patient required a tibial component revision; however, no revision of the femoral component was required.

Conclusions: Early femoral condyle insufficiency fractures following TKA may be a risk in females with poor bone quality and preoperative valgus alignment. Delayed surgery and femoral component revision is a treatment strategy that prevented the need for other tertiary reconstruction.

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Introduction

Periprosthetic fracture following total knee arthroplasty (TKA) is a complication associated with significant morbidity and with a reported overall incidence ranging from 0.5% to 4% [1–6]. These fractures are typically the result of a low energy trauma [2,7,8] and often involve the supracondylar region of the femoral metaphysis [1,2,4–6,9].

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A number of risk factors have been identified that predispose patients to fracture. Intraoperative fractures are more commonly seen in female patients and with the use of posterior-substituting (PS) implant designs [10]. Patient-related risk factors include osteoporosis, chronic steroid use, and rheumatoid and neurologic disease [1,2,4,11–17]. In addition to systemic factors, stress risers related to local osteolysis, screw holes, and anterior femoral notching have been associated with increased fracture risk [4,12,13,16–20].

The treatment approach for these injuries is dictated by the patient's overall bone stock, the fracture pattern, and the stability of the prosthesis. Surgical management options range from fracture fixation techniques including plating and intramedullary nailing to reconstructive strategies including component revision and distal femoral replacement [2,4,9,12,17,19–24].

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Table 1
Patient demographic and radiographic data.

No. of patients	7
Female (%)	6 (86%)
Male (%)	1 (14%)
Mean patient age (y)	69.9 (63–79)
Mean BMI	29.0 (23–37)
Time of fracture (days)	24.9 (10–33)
Poor bone density (%)	5 (71%)
Osteopenia (%)	3 (60%)
Osteoporosis (%)	2 (40%)
Valgus alignment (%)	5 (71%)
Avg. angle (degrees)	15.2 (12–17)
Varus alignment (%)	2 (29%)
Avg. angle (degrees)	7.0 (6–8)

BMI, body mass index.

Several classification systems have been described to help guide management for these challenging injuries [3,8,11,25–27]; however, these algorithms do not include how to manage the atraumatic insufficiency fracture. The purpose of this study was to report on a single surgeon's experience with distal femoral condyle insufficiency fractures sustained after primary TKA in the acute postoperative setting and to identify any associated risk factors. Specifically, we report on the clinical and radiographic outcomes of a delayed treatment strategy.

Material and methods

An institutional arthroplasty database was reviewed to identify all patients who sustained a periprosthetic fracture following primary TKA. A retrospective chart review was performed to collect

clinical, radiographic, and operative report data. Patients who sustained intraoperative fracture during the index surgery or fracture secondary to traumatic injury were excluded. A minimum 1-year follow-up from the date of index surgery was required. Patients who had not been seen within 2 years from initiation of this study were contacted by phone to complete a questionnaire.

As part of the routine preoperative evaluation, all patients underwent standing full-length lower extremity radiographs which were used to measure mechanical axis alignment. Osteopenia was characterized based on bone density on anteroposterior (AP) and lateral plain radiographs. All index TKA procedures were performed by a single fellowship-trained orthopaedic surgeon using a medial parapatellar approach and a cemented PS prosthesis.

The date of injury was determined based on the date of radiograph taken after the index surgery. The fracture of the distal femoral metaphysis was classified as medial condyle, lateral condyle, or supracondylar based on AP and lateral radiographs. One patient underwent early intervention and required a distal femoral replacement secondary to significant femoral bone loss. The remaining 6 patients underwent delayed surgery for an average of 6 weeks to allow for fracture healing followed by revision of the femoral component.

The primary outcome variable was the requirement for a tertiary reconstructive surgery. Possible risk factors for insufficiency such as age, gender, preoperative alignment, and presence of osteopenia were evaluated as secondary variables.

Following the revision surgery, postoperative AP and lateral radiographs were taken to evaluate implant stability and overall mechanical alignment. Clinical knee range of motion and Knee Injury and Osteoarthritis Outcome Scores (KOOS Jr.) were measured.



Figure 1. (a) Preoperative anteroposterior (AP) knee radiograph demonstrating valgus alignment. (b) Postoperative AP radiograph demonstrating a medial femoral condyle fracture.

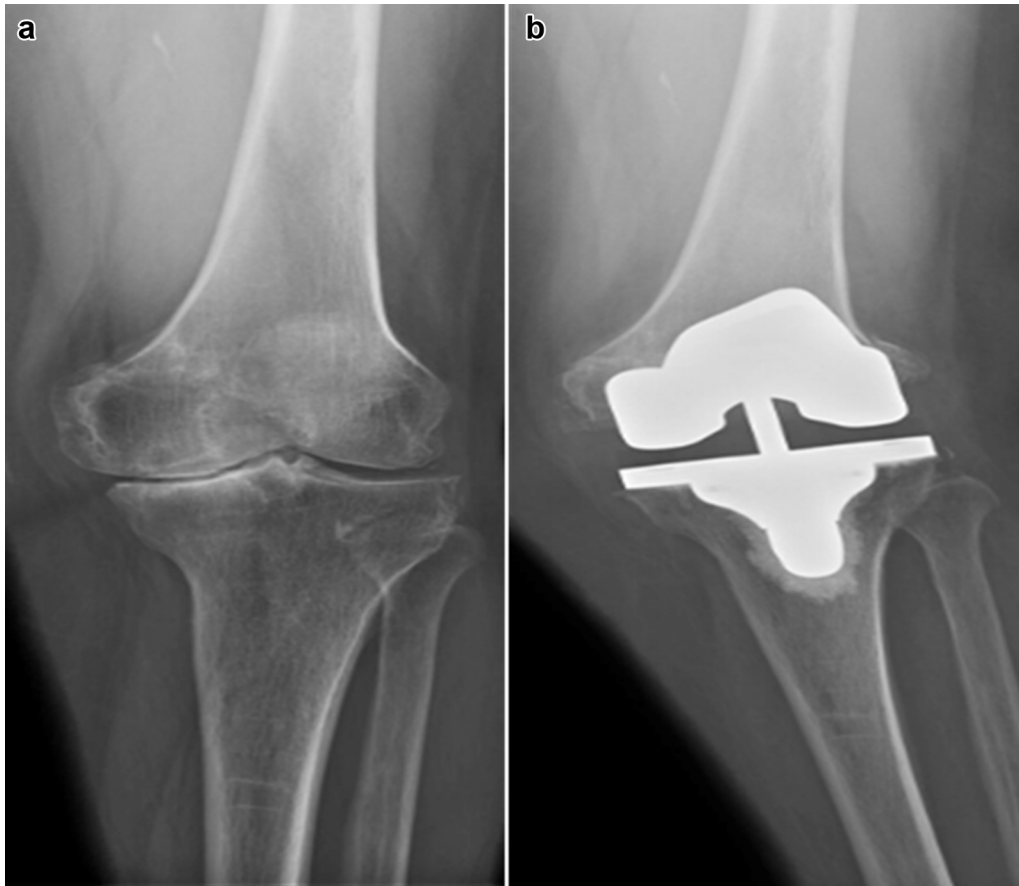


Figure 2. (a) Preoperative AP knee radiograph demonstrating varus alignment. (b) Postoperative AP radiograph demonstrating a lateral femoral condyle fracture.

An independent research assistant recorded demographic data and patient-reported outcomes scores. Standard descriptive statistics were calculated including frequency and proportion as well as measures of central tendency and variability.

Results

Seven patients (6 female, 1 male) sustained distal femoral insufficiency fractures in the acute postoperative setting following primary TKA (Table 1). The average patient age was 65.5 (range, 63–75) years and the average body mass index was 29.4 (range, 27–32). The majority (71%) of patients had a medical diagnosis of either osteoporosis (2) or osteopenia (3). Preoperatively, 5 (71%) patients had valgus alignment with an average angle of 15.2° (range, 12–17). Two (29%) patients had varus alignment with an average angle of 7.0° (range, 6–8).

The insufficiency fracture occurred on average 24.9 (range, 10–33) days from the index surgery. None of the patients reported any associated history of trauma. All 5 of the patients with valgus alignment sustained fracture of the preoperative unloaded medial femoral condyle (Fig. 1), and both patients with varus alignment fractured the unloaded preoperative lateral condyle (Fig. 2). One (14%) patient underwent early intervention and required a distal femoral replacement secondary to significant femoral bone loss. The remaining 6 (86%) patients underwent a delayed treatment protocol which included weight-bearing restriction with a walker until surgery to allow for bone healing. Following the initial diagnosis of fracture, the knee was immobilized for 2–4 weeks for pain control. The patients were then allowed to actively range the

knee as tolerated for 2–4 weeks to avoid excessive stiffness leading up to the revision surgery. The secondary revision surgery occurred on an average 42.7 days (range, 12–82) from the fracture diagnosis. Secondary surgery included femoral component revision with stemmed (most common, 12 mm × 75 mm) implants and with femoral augments as needed (Fig. 3). Postoperatively, patients were allowed to weight bear as tolerated and perform range of motion exercises per standard protocol.

The average follow-up from the time of revision surgery was 48.5 months (range, 12–93). The average flexion measured 120° (range, 95–125), and no flexion contracture was reported in any patient. The average KOOS Jr. score was 90.9 (range, 86–100). One (17%) patient required a tibial component revision; however, no tertiary revision of the femur was required.

Discussion

An increase in TKA procedures is projected to occur over the next decade [28]. As the overall life expectancy of the patient population increases, it is reasonable to expect that the number of periprosthetic fractures will also increase. Therefore, identifying effective treatment strategies is essential. While there are numerous reports on surgical management options for periprosthetic fractures [2,4,9,12,17,19–24], these treatment algorithms are mostly restricted to the traumatic injury and fail to include the atypical insufficiency fracture. In our series of patients, we found that the native condyle that was unloaded preoperatively due to alignment (medial compartment in valgus, lateral compartment in varus) was susceptible to this atraumatic fracture

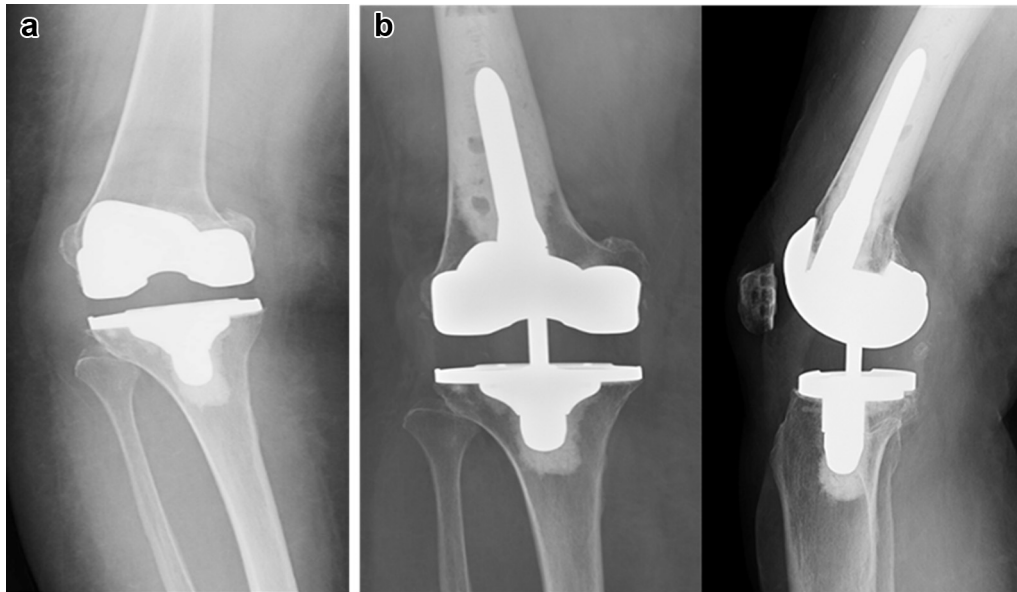


Figure 3. (a) Delayed surgery (avg. 6 weeks) for initial fracture healing. (b) Femoral component revised with a stemmed implant and femoral augments.

pattern (Fig. 4). Our management strategy, which involved delayed treatment for initial fracture healing followed by femoral component revision, was found to be an effective approach and prevented the further need for a distal femoral replacement.

The literature is sparse with regards to this particular atraumatic periprosthetic fracture pattern. Shahi et al. published their findings of isolated periprosthetic compression fractures following TKA [29]. They performed a retrospective review and identified 14 patients, all of whom sustained compression fractures of the lateral femoral condyle. All fractures were diagnosed within the first 21 days from the index surgery which was performed using cruciate-retaining implants. In their series, all patients had a varus deformity with a mean angle of 16.3° (10.3–23.1). Eleven (79%) of the patients in their cohort reported no history of trauma. Similar to our findings, the majority of patients were female (10, 71%), and all of their patients had osteoporosis. Two of their patients required a rotating hinge prosthesis, while the other patients had femoral components revised with stemmed implants. The authors did not comment on the timing of the revision surgery or whether they used a similar delayed treatment approach. In parallel with our study, they

suggested that the poor bone quality, which in their case involved the unloaded lateral condyle, resulted in the subsequent insufficiency fractures.

This study was not without limitations. No control group was used for comparison. A matched control of patients who underwent revision shortly after fracture diagnosis could help elucidate the efficacy of a delayed treatment approach. The date of injury was determined based on the date of radiograph taken after the index surgery which may have overestimated the average time to fracture. Although this retrospective case series has a small sample size, it is worth noting that the majority of the patients in the cohort were female and had abnormal bone density and valgus alignment with associated medial femoral condyle fractures.

It is well documented [17,21–24] that prosthesis stability and fracture pattern and complexity are factors to consider when determining the definitive treatment approach. Our findings emphasize the significance of bone stock as fracture fragility was identified in the osteopenic and “unloaded” femoral condyle. In addition, the majority of patients in this cohort were female who naturally have smaller femurs compared to males. This is an

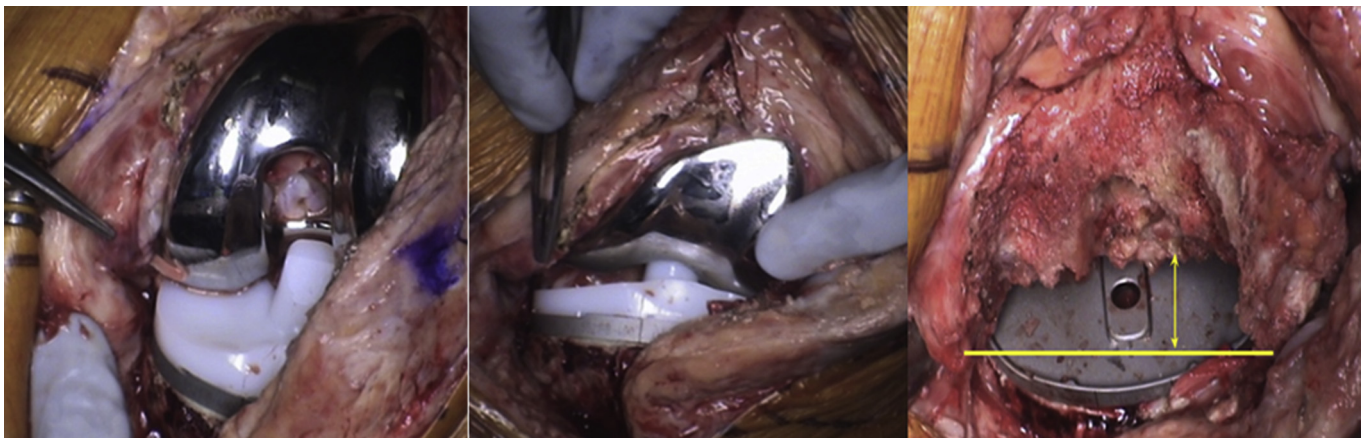


Figure 4. Intraoperative images illustrating the mechanism of failure seen with insufficiency and impaction of the unloaded condyle.

important variable to consider, particularly when using a PS implant. With regards to the housing preparation, many of the PS systems have a limited number of box cut guides which are used for multiple femoral component sizes. This can lead to a disproportionate amount of bone resected and a small bony bridge remaining at the metadiaphyseal junction which may be a concern in these higher risk patients. This introduces the question whether a stem should be used in a “prophylactic” fashion when performing primary TKA on female patients with poor bone stock and valgus deformity. A larger prospective comparative study is needed to elucidate if these are truly significant risk factors for this atypical fracture pattern. In conclusion, early femoral condyle insufficiency fractures following TKA may be a risk in females with poor bone quality and preoperative valgus alignment. Delayed surgery to allow for fracture healing followed by femoral component revision was a treatment strategy that prevented the need for complex reconstruction with segmental distal femoral hinge prosthesis.

Conclusions

Femoral insufficiency fractures following primary TKA involved impaction of the unloaded preoperative femoral condyle in the early postoperative setting. These atraumatic insufficiency fractures may be a risk in females with poor bone quality and preoperative valgus alignment. Delayed femoral component revision is a management strategy that prevented the need for other tertiary surgery.

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