

Case report

Femoral Condyle Insufficiency Fracture After Total Knee Arthroplasty Using a Stemless Femoral Component With a Midlevel Constraint Articular Surface

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ARTICLE INFO

Article history:

Received 25 June 2021

Received in revised form

30 November 2021

Accepted 2 December 2021

Available online 17 January 2022

Keywords:

Midlevel constraint prostheses

Total knee arthroplasty

Medical femoral condyle

Fracture

ABSTRACT

Midlevel constraint prostheses have provided increased varus/valgus and rotational stability for patients with severe deformity or ligamentous instability undergoing total knee arthroplasty (TKA). Here we present a series of 5 patients, 2 in detail, who underwent a primary TKA with a midlevel constraint articular surface and a primary femoral component without stem extension who all suffered isolated medial femoral condyle insufficiency fractures. All 5 TKAs were performed in females with both pre-operative valgus deformity and flexion contractures. Patients had an average age of 74.4 years, height 62.4 in, and weight 156.2 lbs. Revision TKA was performed in 4 of 5 cases. As a result of these cases, we now routinely consider implanting a stemmed femoral component in this population with osteoporotic medial femoral condyles.

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Introduction

Most primary total knee arthroplasties (TKAs) can be carried out utilizing standard cruciate-retaining (CR), posterior-stabilized (PS), medial congruent (MC), or ultra-congruent (UC) bearings. However, cases with severe deformity or ligamentous laxity can be difficult for the orthopaedic surgeon to obtain stability without large ligamentous releases and/or using a more constrained articular surface. Many modern primary TKA prostheses now allow for a midlevel constraint (MLC) articular bearing which have a wider post to provide increased varus/valgus and rotational stability. Compared with patients undergoing primary TKA with a PS insert, Dubin and Westrich [1] showed that patients undergoing primary TKA with MLC articular surfaces had similar outcome scores, range of motion, pain, and rates of revision surgery at 4-year follow-up. Although reasons for revision surgery included arthrofibrosis, aseptic loosening, and manipulation, none of the patients in this study suffered a periprosthetic fracture. Crawford et al [2] found that primary TKAs using stemless implants with MLC bearings showed good short-term to midterm results with regards for re-revision, clinical and functional scores, and

complications; none of the patients underwent revision surgery for aseptic failure or periprosthetic fracture.

Past studies have shown good results with a constrained articular surface without stemming the femoral component. Anderson et al [3,4] reported on the use of a constrained condylar knee (CCK) implant without stem extensions and found no cases of loosening or periprosthetic fracture at nearly 4 years postoperatively. Dayan et al [5] showed that there was no difference in clinical outcomes or failure rates between nonstemmed CCK prostheses and PS prostheses at midterm follow-up.

Here we present 2 of our series of 5 patients who underwent a primary TKA with a midlevel constrained articular surface and a primary femoral component without a stem extension who all suffered isolated medial femoral condyle insufficiency fractures.

Case histories

Case 1

A 72-year-old female (height = 64 inches, weight = 200 lbs, body mass index [BMI] = 34.3 kg/m²) with a preoperative range of motion (ROM) of 20°–80° and severe valgus deformity of 23° (Fig. 1) underwent a cemented primary left TKA with the Zimmer Biomet

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Figure 1. Preoperative radiographs of case 1.

Persona Knee System (Zimmer Biomet, Warsaw IN). At index surgery, a pie-crusting lateral release was performed alongside implanting a primary femoral component, a primary tibial component with a short and cemented stem, and a 12-mm MLC articular surface (Fig. 2).

The patient presented to the emergency department (ED) 6 days after surgery complaining of severe left knee pain that prevented her from weight-bearing. She stated the knee had buckled while standing. Radiographs demonstrated medial subsidence of the femoral component associated with a medial condylar fracture (Fig. 3). Intraoperatively, the fracture was noted to be more extensive, involving most of the medial femoral condyle and more comminuted than initially suspected on the radiograph. Secondary to the large amount of bone loss in conjunction with resultant

instability, the patient was ultimately revised to a distal femoral replacement. The patient tolerated the procedure well without complication (Fig. 4).

Case 2

An 82-year-old female (height = 63 inches, weight = 131 lbs, BMI = 23.2 kg/m²) underwent cemented simultaneous bilateral TKA. Preoperatively, the patient was ambulating using a forearm crutch. The right knee had a severe valgus deformity of 18° and a ROM of 20°-105°, whereas the left knee had a mild valgus deformity and a ROM of 5°-110° (Fig. 5). Stemless femurs, stemmed tibias, and MLC inserts were implanted into both knees. Lateral



Figure 2. Postoperative radiographs of case 1 showing a well-fixed and aligned total knee arthroplasty.



Figure 3. Radiographs of case 1 showing an insufficiency fracture of the medial femoral condyle with collapse and varus deformity of the knee.

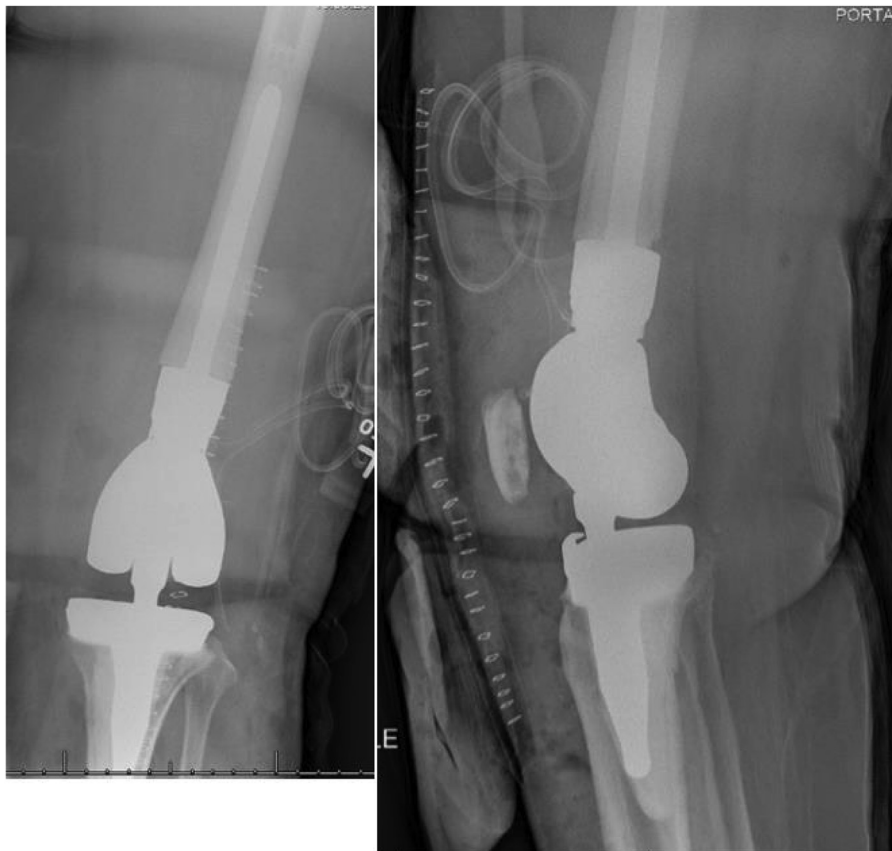


Figure 4. Postoperative radiographs of case 1 status after revision to a distal femur replacement.



Figure 5. Preoperative radiographs of case 2 with osteoarthritis of bilateral knees with severe valgus deformity of the right knee and mild varus deformity of the left knee.

releases of the posterolateral capsule and iliotibial band were performed during the surgery.

The patient was doing well until her 6-week visit at which point subsidence of the right femoral component into varus alignment was noted (Fig. 6). The patient reported increase in pain after a physical therapy session. Her ROM in the left knee was 0°-115° compared with 5°-100° in the right knee.

Despite the recommendation for surgical intervention, the patient initially opted for a period of observation and protected weight-bearing. Her symptoms did improve somewhat over time. She was last seen for a 24-month evaluation at which point radiographic evaluation showed further subsidence of the femoral component (Fig. 7). The patient remained reluctant to proceed with surgery despite warnings of possible further progression of the subsidence or worsening periprosthetic fracture as she was able to ambulate with a cane and had minimal pain.

Summary

We presented 2 of the 5 patients who suffered a nontraumatic isolated femoral condyle insufficiency fracture after TKA using a midlevel constraint. In total, 389 primary TKAs utilizing an MLC articular surface were performed during this period (November 2015 to December 2019). All index TKA procedures were performed by 2 fellowship-trained adult reconstruction surgeons using a medial parapatellar approach with a cemented PS prosthesis comprised of a stemless femoral component and a tibial component with a stemmed attachment (14 mm in diameter, 30 mm in length) (Table 1). The decision to implant a stemmed tibial

component was made at the time of surgery during which all 5 patients were noted to have poor bone quality.

As part of the routine preoperative evaluation, all patients underwent standing knee radiographs which were used to measure alignment and a goniometer was used to measure flexion deformity and ROM. Fractures of the distal femur was classified as medial condyle, lateral condyle, or supracondylar based on anteroposterior and lateral radiographs. Possible risk factors for insufficiency were evaluated including age, gender, height, weight, BMI, preoperative alignment, and preoperative ROM. Operative reports were also reviewed.

All 5 patients were female, of which 3 were Caucasian and 2 were Hispanic. Average patient age was 74.4 (range = 61-82) years, average BMI was 28.12 kg/m² (range = 23.2-34.3), average height was 62.4 (range = 60-64) inches, and average weight was 156 (range = 131-200) pounds (Table 2). Preoperatively, all patients had a valgus deformity with an average angle of 16.8° (range = 9-23). Average preoperative ROM was 17° (range = 15-20) to 99° (range = 80-115). None of the patients were receiving immunosuppressive therapy or steroids at the time of surgery or fracture presentation; 1 patient had a diagnosis of rheumatoid arthritis.

Average time to injury was 158.9 days (range = 6-548) (Table 3). All patients denied antecedent symptoms, and all reported the spontaneous onset of pain that disabled them from further ambulation and weight-bearing. All the fractures occurred in the medial femoral condyle. Plain radiographs showed pathologies in the medial femoral condyle in all reviewed fracture cases as well as increased varus deformity.

As expected, poor bone quality and severe bone loss were observed in the medial femoral condyle with associated loosening



Figure 6. Six-week postoperative radiographs of case 2 after bilateral TKA with a medial femoral condyle insufficiency fracture with varus collapse.



Figure 7. Four-month postoperative radiographs of case 2 showing progression of subsidence of the femoral component after medial femoral condyle insufficiency fracture diagnosis.

of the femoral component. Postoperative radiographic and intraoperative assessment in all cases revealed that there were no instances of anterior femoral notching, local osteolysis, polyethylene wear, or infection. The fractures did not extend past the anterior flange, and the bone at the fracture sites was noted to be soft and spongy.

Four of the five patients who suffered the medial condylar insufficiency fracture underwent revision TKA. One patient declined corrective surgery, and further subsidence of the femoral component was noted. Of the patients undergoing revision surgery, 2 were revised to a more constrained implant (LCCK, Zimmer, Warsaw, IN). One of these patients had only the femoral component revised, whereas the other had both components revised. Another patient was revised with a rotating hinge (RHK, Zimmer, Warsaw, IN), and the remaining patient was revised to a distal femoral replacement. All of the revision cases involved implanting long-stemmed femoral prostheses as well as femoral augments. None of the cases were treated with fracture fixation. After revision TKA (all 4 patients had between 10 and 23 months of follow-up), all knees continued to be stable with functional ROM and allowed for full weight-bearing, and no other procedures were required. The single patient who opted for nonoperative treatment also never underwent any further surgical treatment and was doing well, ambulating with an assistive device, at 24-month follow-up.

Discussion

Similar outcomes and rates of revision have been shown using midlevel constrained (MLC) bearings compared with standard articular surfaces when performing primary TKA. MLC articular surfaces have proven to be a valuable tool when treating knees with large preoperative deformity and/or ligamentous laxity. To the best

of our knowledge, this is the first case series to report on isolated medial femoral condyle insufficiency fractures after primary TKA using a femoral component without a stem extension with an MLC articular surface (Table 1).

Periprosthetic fracture after TKA is associated with significant morbidity and has an overall reported incidence ranging from 0.5% to 4% [6–11]. These fractures typically occur in the femoral supracondylar region and are associated with both surgical and patient-related factors [6,7,9–22]. Almost all of these fractures are treated surgically, including fracture fixation and/or revision total knee replacement [7,9,14,17–22].

Isolated femoral condyle insufficiency fractures status after primary TKA were first described by Shahi et al [23], reporting on a series of 15 patients. The TKAs were all performed using CR bearings. All of these fractures occurred in the lateral femoral condyle, and almost all of these patients had severe preoperative varus deformity as well as osteopenia or osteoporosis. More recently, Vestermark et al [24] described a series of 7 early femoral condyle insufficiency fractures after TKA using PS articular surfaces. Our study also noted an increased risk in females with poor bone quality, flexion contracture, and valgus deformity (Table 2).

Similar to previous reports of isolated medial femoral condyle insufficiency fractures, all patients in this case series were female with both a preoperative valgus deformity and flexion contracture leading to the relative unloading of the medial femoral condyle. Although all the fractures occurred without a history of trauma, the time to presentation varied considerably, ranging from 6 days to 21 months postoperatively (Table 3). Four of the five patients were treated with revision surgery, whereas one patient opted for nonoperative treatment. Lastly, all of the patients were of short stature with an average height of 62.4 inches, ranging from 60 to 64 inches.

Table 1
Implant details at index total knee arthroplasty.

Case number (n)	Femoral component size	Femoral stem (Y/N)	Tibial component size	Tibial stem (Y/N)	Articular surface	Releases
Case 1	6 narrow	N	D	14 × 30 mm	12 mm CPS	Pie Crusting, Lateral
Case 2	6 narrow	N	C	14 × 30 mm	10 mm CPS	Pie crusting, Lateral
Case 3	5 standard	N	D	14 × 30 mm	12 mm CPS	ITB and Posterolateral capsule
Case 4	6 narrow	N	D	14 × 30 mm	10 mm CPS	ITB and Posterolateral capsule
Case 5	8 narrow	N	D	14 × 30 mm	14 mm CPS	ITB and Posterolateral capsule

CPS, constrained posterior stabilized.

Table 2
Demographic characteristics for each patient.

Case number (n)	Age (y)	Gender	Race	Ht (in)	Wt (lbs)	BMI (kg/m ²)	Valgus	Comorbidities	Preoperative ROM
Case 1	72	Female	Hispanic	64	200	34.3	23	DVT, PUD, HTN, depression/anxiety	20-80
Case 2	81	Female	Hispanic	64	160	27.5	20	DVT, HTN, PUD, breast CA	15-90
Case 3	76	Female	Caucasian	61	150	28.3	15	Anemia, HTN, MI, DM, RA, hypothyroid	15-115
Case 4	61	Female	Caucasian	60	140	27.3	8	HTN, PUD, high cholesterol, depression, Parkinson's	15-105
Case 5	82	Female	Caucasian	63	131	23.2	18	Anemia, Crohn's	20-105

DVT, deep vein thrombosis; PUD, peptic ulcer disease; HTN, hypertension; CA, cancer; MI, myocardial infarction; DM, diabetes mellitus; RA, rheumatoid arthritis.

We hypothesize that the cause of this insufficiency fracture is multifactorial. All of the patients were postmenopausal females predisposed to osteoporosis. The preoperative valgus stress likely results in increased osteopenia in the relatively unloaded medial femoral condyle. After primary TKA using an MLC bearing surface, the increased stress at the host bone and prosthetic interface combined with the restoration of neutral alignment leads to increased load upon the medial tibiofemoral compartment, overwhelming already susceptible bone resulting in fracture. Furthermore, compared with a CR or PS TKA design, increased bone is resected from the femoral notch when using an MLC bearing, leaving a smaller bony bridge at the metadiaphyseal junction to load share at the medial distal femur and thus enhancing the risk for fracture. Suboptimal surgical technique may also lend itself to further increased risk of fracture as excessive medialization of the femoral component leads to a diminished weight-bearing surface area of the weakened medial femoral condyle. Although the appearance of the radiographs may be due to rotation, one could argue that there is a slight unintended medialization of the femoral component on the immediate postoperative films of the patient in case 1 (Fig. 2).

This study has several limitations, and our findings should be interpreted as such. First, the study is retrospective and is thus dependent on the completeness of the chart. Furthermore, it would be difficult to assess if anything intraoperative could have increased the likelihood of fracture such as an avulsion injury, a subtle condyle fracture that may have gone unseen, or slight overcut or medialization of the box cut for the femoral component. Second, the rarity of this type of insufficiency fracture resulted in a relatively small sample size despite a large number of charts and images that were reviewed. Third, the incidence of this fracture may be underreported because we may not be able to capture readmissions if they present to a different hospital. Fourth, given the relatively low incidence of this fracture pattern and the lack of a control group, it was difficult to determine if there were any other risk factors predisposing to this injury. Lastly, it is unknown how many patients of short stature with severe valgus deformity within this patient population did not suffer a fracture.

This MLC bearing surface is now compatible with a stemmed revision femoral component. Following these cases, we now routinely consider implanting a stemmed femoral component

when utilizing MLC surfaces in the older female patient population with preoperative valgus deformity and osteoporotic distal femoral condyles.

Summary

MLC prostheses have provided increased varus/valgus and rotational stability for patients with severe deformity or instability undergoing TKA. The 5 patients in this series suffered an isolated medial femoral condyle insufficiency fracture after TKA and highlight the importance for caution when using an MLC with an unstemmed femoral component in older females of shorter stature with both preoperative valgus deformity and flexion contractures. We recommend considering implanting a stemmed femoral component when using a midlevel constraint articular surface in this patient population.

Conflicts of interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: H. B. L., MD, is a committee member of the American Academy of Orthopaedic Surgery, is a paid consultant at Zimmer Biomet and Corentec USA, and receives royalties from Zimmer Biomet; A. S., MD, is a paid consultant at Zimmer Biomet and receives royalties from Zimmer Biomet; G. R. K., MD, is a committee member of the American Academy of Orthopaedic Surgery, is a board or committee member of the New Jersey Orthopaedic Society, is a paid consultant at Zimmer Biomet and Corentec USA, and receives royalties from Zimmer Biomet; A. M. O. declares no potential conflicts of interest.

For full disclosure statements refer to <https://doi.org/10.1016/j.artd.2021.12.002>.

Informed consent

Institutional review board approval for a retrospective review of 5 cases was obtained from our respective institutional review board.

Table 3
Details of nontraumatic isolated femoral condyle insufficiency fractures after TKA.

Case number (n)	Time to injury	Type of injury	Treatment /Implant	Intraoperative findings
Case 1	6 d	Medial condyle fracture	Revision to distal femoral replacement	Erosion of the entire medial femoral condyle and metaphysis
Case 2	3 wk	Medial condyle fracture	Revision femoral and tibial component	Collapsed comminuted medial femoral condyle
Case 3	20 mo	Medial condyle fracture	Revision femoral component only	1 cm of medial condylar subsidence/compression
Case 4	6 mo	Medial condyle fracture	Revision all components, rotating hinge	1 cm of medial condylar subsidence/compression
Case 5	6 wk	Medial condyle fracture	Nonoperative treatment	N/A

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