Case Report

A Case of Subchondral Insufficiency Fracture of the Knee at Lateral Femoral Condyle Treated With Unicompartmental Knee Arthroplasty

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ABSTRACT

Spontaneous insufficiency fracture of the knee is a potentially devastating yet poorly understood disease entity that can lead to secondary osteoarthritis. Most cases involve the medial femoral condyle, and the lateral femoral condyle is rarely affected. The optimal treatment for spontaneous insufficiency fracture of the lateral femoral condyle remains undetermined, and there are no previous dedicated reports on treatment outcome with unicompartmental knee arthroplasty. A middle-aged lady presented with subacute left knee pain and a locked knee. Subsequent imaging studies revealed a spontaneous insufficiency fracture of the lateral femoral condyle. In view of the isolated compartment involvement, unicompartmental knee arthroplasty was performed with satisfactory outcome. At 1 year postoperatively, the patient had complete resolution of knee pain and was able to resume working.

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Introduction

Spontaneous insufficiency fracture of the knee (SIFK) was initially termed spontaneous osteonecrosis of the knee (SONK) and was first described by Albläck et al. in 1968, where a group of patients with atraumatic severe knee pain were found to have primary osteonecrosis [1]. The disease was later classified into 3 different entities, namely spontaneous osteonecrosis, secondary osteonecrosis, and postarthroscopic osteonecrosis [2]. A latter study by Yamamoto et al. showed that the primary event is a subchondral insufficiency fracture, followed by secondary localized osteonecrosis, suggesting SONK was indeed a misnomer [3]. SIFK predominantly affects the medial femoral condyle, where lateral femoral condyle involvement is much less common [4]. The patients typically present with acute knee pain, which is exaggerated by mechanical load and relieved with rest. The pain frequently worsens at night. Physical examination is usually unremarkable except localized tenderness over the affected area. Conventionally, total knee arthroplasty (TKA) has been the final treatment for patients with a poor response to conservative treatment. However, as SIFK usually involves a single compartment, unicompartmental knee arthroplasty (UKA) is an appealing alternative with advantages in preservation of native joint kinematics and proprioception, particularly among younger patients [5].

Case history

A 66-year-old Chinese female cleaning worker, with a past history of hypertension and impaired fasting glucose, first presented to the emergency department with left knee pain and swelling for 1 month. Radiographs of the knee was performed, but the patient was only reported to have degenerative joint disease (Fig. 1a). She experienced persistent left knee pain afterwards and was only able to ambulate with a walking stick.
At 1 month after the initial emergency department presentation, the patient returned to the hospital again and was admitted to the orthopaedics and traumatology unit. Upon admission, the patient was found to have left knee tenderness, predominantly over the lateral joint line. She presented with a locked knee with the range of movement limited at 30 to 130 degrees. The patient’s pain was exacerbated with knee extension.

Radiograph of the left knee was repeated upon admission. Further progression of osteonecrosis at the lateral femoral condyle with a displaced curvilinear bony lesion was noted (Fig. 1b). Magnetic resonance imaging (MRI) scan revealed a displaced osteochondral lesion with secondary degenerative changes shown as a cortical defect at the inferior border of the lateral femoral condyle with extensive marrow edema. There was a displaced lateral meniscal tear as evidenced by the loss of a normal anterior horn and anterior body of the lateral meniscus (Fig. 2a-c). A subsequent plain computed tomography scan revealed an isolated subchondral bone defect at the weight-bearing surface of the lateral femoral condyle. A 1.5 × 5-cm intra-articular dislodged cartilage fragment was retrieved (Fig. 4a and b). There were only small areas of partial cartilage loss over the medial femoral condyle and patellofemoral joint. The anterior and posterior cruciate ligaments were intact.

At 2 weeks after the hospital admission, a left UKA for the lateral compartment was performed. A lateral parapatellar approach was used. Intraoperative joint inspection confirmed SIFK of the lateral femoral condyle. There was a 1.5 × 5-cm subchondral defect at the weight-bearing surface of the lateral femoral condyle. A 1.5 × 5-cm intra-articular dislodged cartilage fragment was retrieved (Fig. 4a and b). There were only small areas of partial cartilage loss over the medial femoral condyle and patellofemoral joint. The anterior and posterior cruciate ligaments were intact.

The lateral UKA was performed using the Zimmer® Unicompartmental High Flex Knee system (ZUK; Zimmer, Warsaw, IN). Soft-tissue dissection was limited to what was necessary for exposure only. We adopted the spacer block technique and resected the tibia first. The resection was ensured to be minimal and orthogonal, reproducing the native slope with about 10° internal rotation. The distal femoral cut was guided by the spacer block in extension. Despite the large central defect at the lateral femoral condyle, we could still identify the correct extension gap with the remaining bone. The lesion was resected during the distal femur cut (Fig. 4c), and the underlying bone appeared healthy. The remaining femoral cuts were completed, ensuring correct rotation and no oversizing of the prosthesis. The implants were fixed with cement and taken into account of the “screw-home” mechanism, with the tibial component placed at 10° internal rotation and the femoral component placed as lateral as possible. The thinnest available polyethylene insert was used. There was no overtension or impingement throughout the range of motion (Fig. 4d).
Postoperative radiographs of the knee and lower limb scanogram showed satisfactory alignment (Fig. 5a-c). The patient had an uneventful recovery and was self-ambulatory. A course of physiotherapy was completed with progressive improvement in knee mobility and muscle strength. The patient was highly satisfied with the outcome. Upon the latest follow-up at 1 year postoperatively, the patient experienced complete resolution of knee pain. The active range of movement of the knee was at 0-130 degrees, with extensor and flexor muscle power grade 5 on the Oxford Scale. The patient was able to walk unaided and resume her job as a cleaning worker. The preoperative Knee Society Knee Score was 32 points, and the preoperative Knee Society Function Score was 15 points. The postoperative 1-year Knee Society Knee Score and Knee Society Function Score improved to 99 points and 90 points, respectively. A written informed consent of participation in publication was obtained from the patient.

Discussion

In the initial description by Ahlbäck et al., a cohort of patients with knee osteonecrosis in the absence of other known clinical entities were first labelled as having SONK [1]. Lotke
and Ecker later proposed that microfractures in osteoporotic subchondral bone was a possible etiological mechanism [6]. Joint fluid could flow into the bone through broken articular cartilage, resulting in bone marrow edema, focal ischemia, and subsequent osteonecrosis [6]. Akamatsu et al. showed a positive correlation between low bone mineral density and the incidence of SONK among women older than 60 years [7]. Yamamoto and Bullough demonstrated the primary event of SONK was subchondral insufficiency fracture followed by secondary osteonecrosis between the fracture line and the subchondral bone plate, thus suggesting the shift of terminology into SIFK [3]. Historically, both SONK and SIFK have been used to describe the same disease, and the 2 terms were sometimes used interchangeably in the literature [8]. Some studies have challenged the term “spontaneous” in SONK does not reflect the actual pathophysiology and should be considered as a misnomer. The current literature generally supports that SONK is the end result of subchondral fracture and part of the SIFK disease spectrum [9].

In a review by Sibilska et al., the prevalence of SIFK is reported at 3.4% in elderly patients [10]. The major risk factors include advanced age, female sex, low bone mineral density, cartilage degeneration, and meniscus extrusion. The condition has a predominantly single compartment involvement in the knee joint. The medial femoral condyle is affected in up to 94% of cases, while lateral femoral condyle involvement is much rarer. A review by Pareek et al. showed the lateral femoral condyle was involved in 7.2% of SIFK cases [8]. Some studies attributed the difference in blood supply between the medial and lateral femoral condyles. From cadaveric studies, the medial femoral condyle has only intraosseous blood supply with watershed areas, whereas the lateral femoral condyle has rich intraosseous and extraosseous blood supply, making it less susceptible to osteonecrosis from bone ischemia. Clinically, patients with SIFK of the lateral femoral condyle may also have an atypical disease course. In a case series of 11 patients by Ohdera et al., the patients with lateral SIFK may have symptom onset in the middle age without osteoporotic bones. The knee pain is not usually abrupt nor worse at night, and the lower extremity is not always valgus-aligned, setting apart from the clinical features of medial SIFK [11]. Nonetheless, due to the scarcity of reported cases, the precise natural course of disease remains unclear.

Figure 5. Postoperative radiograph. (a) Anteroposterior and (b) lateral radiographs of left knee taken at 6 months postoperatively, and (c) scanogram of lower limbs taken on postoperative day 5, showing in situ UKA implants.
Regarding radiological investigations, the radiographs usually show no characteristic findings at early stages of the disease. Distinct radiolucent areas at the lateral femoral condyle may be observed in advanced cases with subchondral collapse. The imaging modality of choice is MRI with T2-weighted and proton-density-weighted sequences. The characteristic findings of SIFK include a hypointense line in the subarticular bone marrow representing a subchondral fracture and focal depression of the subchondral bone plate. There may be a fluid-filled cleft underlying the subchondral bone plate, indicating gross collapse and separation. The surrounding bone edema often involving the entire femoral condyle is in contrast to the more localized edema adjacent to cartilage loss observed in cases of osteoarthritis [12].

The treatment of SIFK can be nonoperative or operative depending on the size and radiological staging of the lesion. The Koshino classification was first described in 1979, where small radiolucent lesions measuring <3.5 cm² tend to regress with conservative treatment, while large lesions measuring >5 cm² are more likely to progress into subchondral collapse [4]. Another study by Lotke et al. utilized the size of a lesion as a percentage of the affected femoral condyle, where lesions involving more than 50% of the condylar area would quickly progress to collapse requiring arthroplasty [5].

The options of nonoperative treatment for early-stage SIFK include physiotherapy, analgesics, nonsteroidal anti-inflammatory drugs, and bisphosphonates [13–15]. In a case series of early-stage SIFK patients treated with nonoperative management, all cases had resolution of symptoms and MRI findings within 6 months [13]. For patients with larger SIFK lesions, or failed nonoperative treatment, surgical interventions are indicated. Several joint-preserving techniques have been described, including arthroscopic debridement, osteochondral graft, and high tibial osteotomy. Although the results from some trials demonstrated favorable outcomes in delaying the need of arthroplasty, the lack of high-quality evidence precludes widespread adoption of these interventions [16–19].

For the patients with advanced disease who failed conservative management, TKA has been the last-resort treatment. However, as SIFK is predominantly localized to a single compartment, and in view of the favorable outcome of treating unicompartmental osteoarthritis with UKA, there has been growing interest in treating SIFK with UKA as an alternative to TKA. The potential benefits include preservation of the native joint kinematics and proprioception, lower risk of deep vein thrombosis, and less total blood loss [5]. In a meta-analysis by Jauregui et al. involving 276 UKA cases performed for SIFK, favorable outcomes were found in the pain visual analog score, Knee Society Score, and Hospital for Special Surgery Knee Score at a mean follow-up of 6 years [5]. The 10-year survival rate was 93% with an overall revision rate of 5.5% [5]. However, the case cohort predominantly described medial UKA, where only 3 of the 276 included cases involved the lateral femoral condyle. Although there have been encouraging results for treating SIFK with UKA, as most cases recruited in the available literature involve the medial femoral condyle, whether these results are directly applicable to SIFK of the lateral femoral condyle remains uncertain. A few studies have compared the outcomes of TKA and UKA in advanced SIFK but with inconclusive results, mostly limited by a small cohort size and lack of contemporary implant designs. A more recent retrospective review by Flury et al. showed UKA had better functional outcomes than TKA in terms of the Western Ontario and McMaster Universities Osteoarthritis Index score with a similar complication rate [20]. The size of the osteonecrotic lesion and surrounding bone edema showed no correlation to the functional outcome nor implant failure rate in both groups [20]. However, whether the results were directly applicable to lateral SIFK cases remain uncertain, as only 3 out of 37 cases in the UKA cohort involved the lateral femoral condyle. Due to the rarity of the disease entity, there are no available studies of direct comparisons among the outcomes of surgical modalities for SIFK of lateral femoral condyle. There are no established clinical or radiological criteria to guide treatment decision between TKA and UKA. At the present stage, the choice of TKA vs UKA remains dependent to surgeons’ prior training, individual preference, and clinical experience.

Summary

In this case report, a middle-aged lady with SIFK of the lateral femoral condyle was successfully treated with UKA with satisfactory improvement in symptom and functional performance. UKA appears to be a favorable surgical option, while the optimal treatment modality of SIFK of lateral femoral condyle is still uncertain due to rarity of the disease entity and paucity of high-quality evidence.

Conflicts of interest

The authors declare that there are no conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j. artd.2022.04.002.

Informed patient consent

The author(s) confirm that informed consent has been obtained from the involved patient(s) or if appropriate from the parent, guardian, power of attorney of the involved patient(s); and, they have given approval for this information to be published in this case report (series).

References

[1] Ahlbäck S, Bauer GC, Bohne WH. Spontaneous osteonecrosis of the knee. Arthritis Rheum 1968;11:705–733.
[2] Zywiec MG, McGrath MS, Seyler TM, Marker DR, Bonutti PM, Mont MA. Osteonecrosis of the knee: a review of three disorders. Orthop Clin North Am 2009;40:193–211.
[3] Yamamoto T, Bullough PG. Spontaneous osteonecrosis of the knee: the result of subchondral insufficiency fracture. J Bone Joint Surg Am 2000;82:858–866.
[4] Karim AR, Cherian JJ, Jauregui JJ, Pierce T, Mont MA. Osteonecrosis of the knee: review. Ann Transl Med 2015;3:5.
[5] Jauregui JJ, Blum CL, Sardesai N, Bennett C, Henn 3rd RF, Adib F. Unicompartamental knee arthroplasty for spontaneous osteonecrosis of the knee: a meta-analysis. J Orthop Surg (Hong Kong) 2018;26:230949018770925.
[6] Lotke PA, Ecker ML. Osteonecrosis of the knee: J Bone Joint Surg Am 1988;70:470–473.
[7] Akamatsu Y, Mitsugi N, Hayashi T, Kobayashi H, Saito T. Low bone mineral density is associated with the onset of spontaneous osteonecrosis of the knee. Acta Orthop 2012;83:249–255.
[8] Pareek A, Parkes CW, Bernard C, Camp CL, Saris DBF, Stuart MJ, et al. Spontaneous osteonecrosis/subchondral insufficiency fractures of the knee: high rates of conversion to surgical treatment and arthroplasty. J Bone Joint Surg Am 2020;102:821–829.
[9] Ochi J, Nozaki T, Nimura A, Yamaguchi T, Kitamura N. Subchondral insufficiency fracture of the knee: differentiating the most common entities at MRI. Radiographics 2003;23:829.
[10] Ghodke T, Miyagi S, Tokunaga M, Yoshimoto E, Matsuoka S, Ikarie H. Spontaneous osteonecrosis of the lateral femoral condyle of the knee: a report of 11 cases. Arch Orthop Trauma Surg 2008;128:825–831.
[11] Gorbachova T, Melenevsky V, Cohen M, Cerniglialf BW. Osteochondral lesions of the knee: differentiating the most common entities at MRI. Radiographics 2018;38:1478–1495.
[12] Yates PJ, Calder JD, Stranks GJ, Conn KS, Peppercorn D, Thomas NP. Early MRI diagnosis and non-surgical management of spontaneous osteonecrosis of the knee. Knee 2007;14:112–116.
[14] Meier C, Kraenzlin C, Friederich NF, Wischer T, Grize L, Meier CR, et al. Effect of ibandronate on spontaneous osteonecrosis of the knee: a randomized, double-blind, placebo-controlled trial. Osteoporos Int 2014;25:359–366.

[15] Jureus J, Lindstrand A, Geijer M, Roberts D, Tägil M. Treatment of spontaneous osteonecrosis of the knee (SPONK) by a bisphosphonate. Acta Orthop 2012;83:511–514.

[16] Miller GK, Maylahn DJ, Drennan DB. The treatment of idiopathic osteonecrosis of the medial femoral condyle with arthroscopic debridement. Arthroscopy 1986;2:21–29.

[17] Tanaka Y, Mina H, Yonetani Y, Shiozaki Y, Nakamura N, Horibe S. Histological evaluation of spontaneous osteonecrosis of the medial femoral condyle and short-term clinical results of osteochondral autografting: a case series. Knee 2009;16:130–135.

[18] Tírico LEP, Early SA, McCauley JC, Bugbee WD. Fresh osteochondral allograft transplantation for spontaneous osteonecrosis of the knee: a case series. Orthop J Sports Med 2017;5:232596717730540.

[19] Akgun I, Kesmezacar H, Ogut T, Kebudi A, Kanberoglu K. Arthroscopic microfracture treatment for osteonecrosis of the knee. Arthroscopy 2005;21:834–843.

[20] Flury A, Weigelt L, Camenzind RS, Fritz B, Hasler J, Baumgaertner B, et al. Total and unicondylar knee arthroplasty are equivalent treatment options in end-stage spontaneous osteonecrosis of the knee, and the size of the lesion has no influence on the results. Knee Surg Sports Traumatol Arthrosc 2021;29:3254–3261.