

CASE REPORT

Diagnosis and Treatment of Schatzker Type II Tibial Plateau Fracture with An Isolated Bone Fragment: A Case Report and Literature Review

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Background: An isolated bone fragment from the posterolateral tibial plateau retrieved from the patellofemoral compartment is a rarely seen Schatzker type II tibial plateau fracture and is prone to misdiagnosis. To the best of our knowledge, this injury mechanism has not been previously described.

Case presentation: A 63-year-old female sustained left knee pain and activity limitation after falling off an electric bicycle. Local hospital ignored the intra-articular bone fragment and failed to provide effective treatment. This case described an uncommon Schatzker type II tibial plateau fracture with an isolated bone fragment, its physical examination and radiological findings, the potential injury mechanism, and surgical protocol.

Conclusions: Combining the physical examination and radiological findings to evaluate the potential injury mechanism is important for developing an appropriate surgical protocol.

Key words: Injury mechanism; Isolated bone fragment; Tibial plateau

Introduction

The tibial plateau fracture is potentially a complex intra-articular fracture with multiple subtypes. Soft tissue injuries coupled with tibial plateau fractures are commonly seen in clinical practice¹⁻³, particularly involving the structures of the lateral meniscus and the anterior cruciate ligament^{2,4}. The more forceful mechanism of trauma bears a greater likelihood of secondary issues, particularly involving the surrounding soft tissues, and a large percentage of such injuries are in need of operative repair⁵. Multiple cadaveric investigations of tibial plateau fractures revealed a correlation between certain fracture patterns and the injury force mechanism, including the orientation of force vectors and the knee position at the time of the injury⁶⁻⁹. As the complexities of fracture patterns vary, there is no gold standard for repair, and each patient requires unique consideration with operative planning¹⁰. Thus, identifying the fracture type and understanding the mechanism of injury are critical for surgical strategy and

rehabilitation protocol, and can even help to avoid risks and complications¹¹.

Herein, we describe a rare case of Schatzker type II tibial plateau fracture variant, and to the best of our knowledge, no similar clinical case has been described in the literature. The objectives of this study are to review the physical exam and radiological findings, to analyze the injury mechanism, and to discuss the surgical protocol.

Case Presentation

A 63-year-old female sustained left knee pain and activity limitation after falling off an electric bicycle. Details of the injury situation were unclear. The doctor of the local hospital ignored the intra-articular fragment, and the provided treatment included plaster immobilization, elevation to decrease swelling, and oral analgesics to alleviate pain. After conservative treatment for 7 days, she was transferred to our department. We found obvious swelling of left knee,

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positive local tenderness. Plain radiographs and computer tomography (CT) showed a posterolateral split and collapse type fracture of the tibial plateau (Schatzker type II) and a large isolated fracture fragment in the patellofemoral compartment (Figure 1A,B). Magnetic resonance imaging (MRI) showed injuries to the anterior cruciate ligament and lateral meniscus, but no damage to the medial or lateral collateral ligaments or the posterior cruciate ligament. In addition, severe bone contusions could be seen on the lateral femoral condyle, lateral tibial plateau, and in the fibula head (Figure 1C).

The patient underwent operation on the second day after admission (Figure 2A-D). The lateral knee approach was adopted (the incision starts at the level of the middle of the patella, 3 cm outside of the patella, and extends the incision downwards while continuing to flex the knee joint, to above the Gerdy tubercle of the tibia and 4–5 cm away from the joint line) and the fracture fragment behind the patella was removed. Partial compression of the articular cartilage

surface was found, and the fracture fragment exactly matched with posterolateral tibial plateau (Figure 1D). After anatomical reduction, two headless, cannulated, partially threaded screws (diameter 3.0 mm, Zimmer) were applied from proximal to distal, and freeze-dried cancellous allografts were introduced to the defect *via* a bone window and impacted with tamp to resist collapse of the articular surface. Because of the posterolateral split and collapse of the tibial plateau, the bone window was designed laterally above the tibial tuberosity which did not disturb the reconstruction of the ACL. Then, an anatomic lateral proximal tibia plate (Zimmer) was used to achieve surgical fixation (Figure 3). We used double-looped semitendinosus and gracilis to reconstruct the anterior cruciate ligament and an all-inside technique to repair the lateral meniscus. The incision was closed, and the patient returned to the wards. One week after surgery, the patient was discharged to home with non-weight-bearing advice, and the knee was immobilized with a hinged range-of-motion brace at 20° of flexion. After

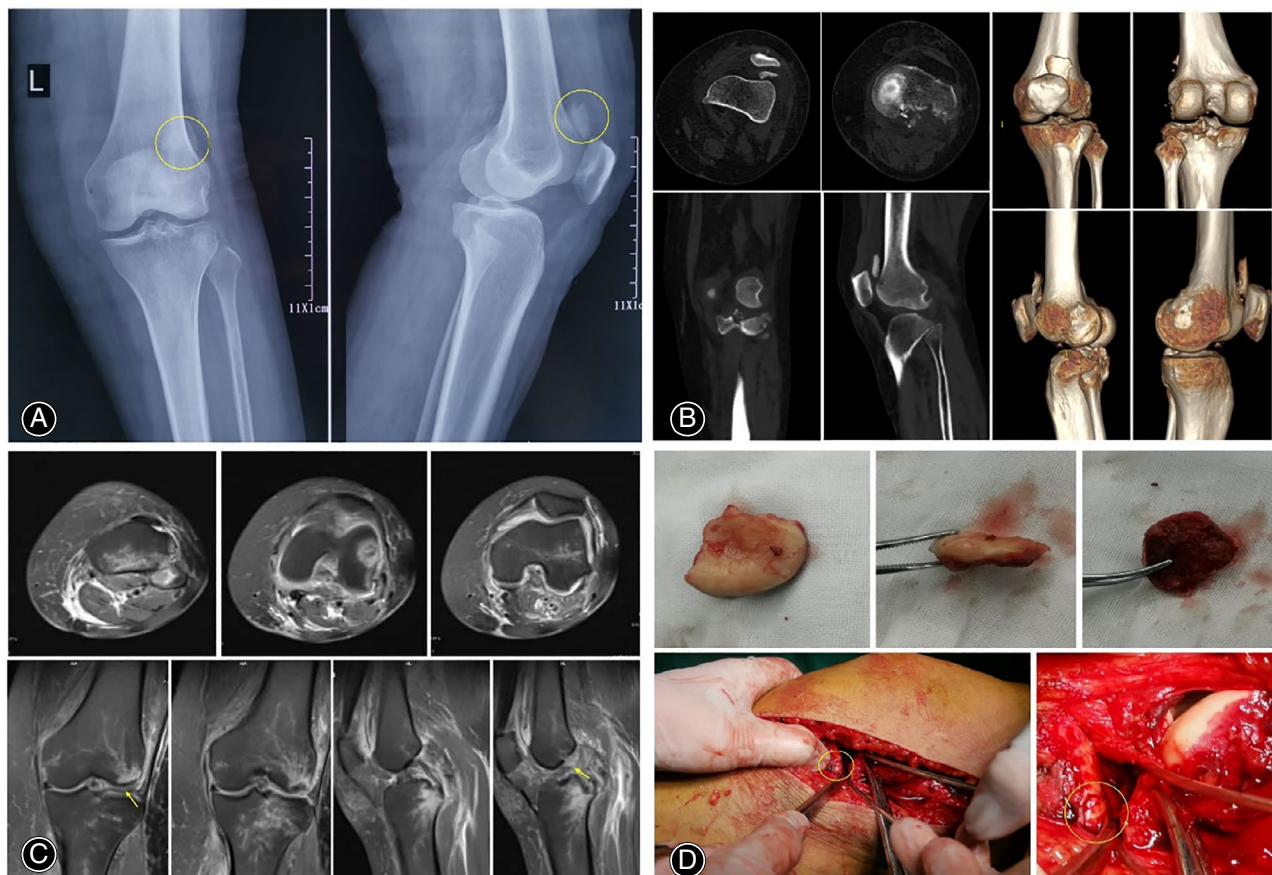


Figure 1 (A) Anteroposterior and lateral plain radiographs of the left knee showing tibial plateau fracture and an isolated fracture fragment. (B) Initial CT scans of the left knee showing fracture of the posterolateral tibial plateau and an isolated fracture fragment in the patellofemoral compartment. (C) Initial MRI scans showing anterior cruciate ligament rupture, lateral meniscus rupture with subluxation, and severe bone contusion in the lateral condyle of the femur and the lateral tibial plateau. (D) Removal and anatomical reduction of the isolated fracture fragment during surgery

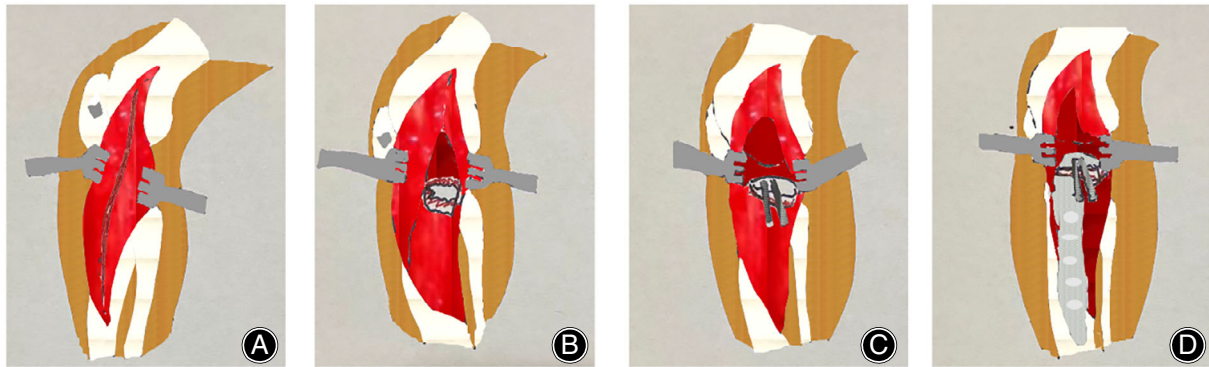


Figure 2 Schematic diagram of operation. (A) Surgical incision (The incision starts at the level of the middle of the patella, 3 cm outside of the patella, and extends the incision downwards while continuing to flex the knee joint, to above the Gerdy tubercle of the tibia and 4–5 cm away from the joint line). (B) Collapse of the posterolateral tibial plateau, articular surface defect and the fracture fragment behind patella were found. (C) The fracture fragment behind the patella was removed and it exactly matched with posterolateral tibial plateau. After anatomical reduction, two headless, cannulated, partially threaded screws (diameter 3.0 mm, Zimmer) were applied from proximal to distal. (D) The anatomic lateral proximal tibia plate (Zimmer) was used to achieve fixation



Figure 3 Anteroposterior and lateral plain radiographs of the left knee after surgery

4 weeks, the knee brace was removed, and range of motion exercises were initiated. However, the non-weight-bearing was continued for 12 weeks.

At the 12-month follow-up, the patient was walking with no pain. Through physical examination, good knee joint stability under anterior, posterior, valgus, and varus stress was confirmed, and the range of motion of the knee joint was 0°–120°.

Discussion

Speculation of Injury Mechanism

This type of fracture, with rotation of the isolated fracture fragment to the posterosuperior patella, is rarely seen in daily clinical and surgical practice. MRI is valuable for evaluating soft tissue injury throughout the knee and is beneficial to understand the injury mechanism and develop the surgical protocol¹². In this case, MRI showed rupture of the anterior cruciate ligament and lateral meniscus rupture with subluxation but no severe injury to other soft tissue throughout the knee. In addition, MRI also showed severe bone contusion in the lateral condyle of the femur and the lateral tibial plateau. Physical examination performed after anesthesia found that the anterior drawer test was positive, but the posterior drawer test and the varus and valgus laxity tests were negative. Due to the rarity of this fracture, to the best of our knowledge, this injury mechanism has not been previously described. Combining the physical examination and radiological findings, the injury mechanism could be speculated. Comprehensively understanding the mechanism of the injury is critical for planning the operation¹³. Understanding the injury mechanism, surgeons will not be easy to make mistakes during surgical exploration. And the thinking of reversing the injury mechanism makes surgeons more able to achieve the anatomical reduction and rigid internal fixation of fractures.

Different from the Segond fracture, which was conventionally described as an avulsion fracture of the anterolateral complex of the knee¹⁴, the isolated fragment fracture from the posterolateral tibial plateau was retrieved from the patellofemoral compartment. Given the severe bone contusion in the lateral condyle of the femur and the lateral tibial plateau, the characteristic mechanism causing the injury was probably hyperextension and forced valgus. The lateral

TABLE 1 The timing of surgical reconstruction of anterior cruciate ligament injuries reported in the literature

Authors	Treatment	Point	Reasons
Brambilla ¹⁹	Surgical treatment	≤1 year	The increased risk of meniscal tears and chondral injuries after this period
Smith ²¹	Surgical treatment	No significance	A sufficiently powerful, well-designed randomized controlled trial is required
Karuppiiah ²²	Surgical treatment	Early	Delayed meniscus repair associated with elective ACL reconstruction had a significant higher failure rate
De Campos ²⁵	Surgical treatment	Early	Early ACL reconstruction should reduce meniscal and chondral lesions
Granán ²⁶	Surgical treatment	Early	Every reconstruction surgery delayed for 1 month, the risk of cartilage damage increases by 1%

meniscal and anterior cruciate injuries suggest external rotation of the tibia on the femur with anterior subluxation of the lateral plateau. The subsequent relocation generated a horizontal posterior to anterior shear with displacement of the fragment in an anterior direction. Based on the speculative injury mechanism, the surgical strategy was developed for this case. Two cannulated, partially threaded screws were applied to counteract horizontal shear force, and allogeneic bone grafting was performed to restore the collapse of the articular surface and anatomic lateral proximal tibia plate to provide support to further resist the collapse of the articular surface.

Repair and Reconstruction of Soft Tissue Injury

In chronic knee instability after ACL injury, the incidence of surgical treatment cases is 8%–50% while conservative treatment cases is 75%–87%^{15,16}. According to meta-analyses and cohort studies, anterior cruciate ligament reconstruction can prevent secondary meniscal and cartilage injuries and restore previous activity levels^{17–19}. But there is not significant difference to patient's knee function between early and late ACL reconstruction²⁰. The timing of surgical reconstruction of ACL is still controversial and no consensus has been reached²¹. Clinical practice has shown that delayed surgical timing can lead to poor postoperative joint stability and increase the risk of long-term osteoarthritis and cartilage degeneration^{22,23}. De Campos *et al.* pointed out that the length of the interval from injury to surgery is positively correlated with intra-articular meniscus and cartilage damage²⁴. And studies by Granán *et al.* have shown that in patients with ACL injury, every reconstruction surgery delayed for 1 month, the risk of cartilage damage increases by 1%²⁵ (Table 1). In this case, the ACL injuries with lateral meniscus rupture indicated serious articular instability. For these patients, we tend to choose early ACL reconstruction to reduce postoperative articular instability and reduce the incidence of degeneration of articular cartilage and meniscus cartilage. Meniscus lesions were not observed in any of the Type 1 fractures. In 75% of the Type 2 fractures and 33.3% of the Type 3 fractures, meniscus lesions were determined²⁶.

The meniscus plays an important role in knee function, and repair and preservation are recommended for tibial plateau fractures²⁷. Therefore, we repaired the lateral meniscus in this case. The healing ability of the medial collateral ligament is strong, so the injury of the medial collateral ligament is generally treated conservatively while rupture of the lateral collateral ligament often requires surgery. Certainly, the tibial plateau fracture itself is a risk factor for developing post-traumatic osteoarthritis^{28,29}, the anatomical reduction of fracture plays a crucial role during an operation. Our surgical experience suggests the following principles. For simple Schatzker type I–IV tibial plateau fractures after internal fixation, ligament repair and plaster fixation should be given in the first stage, but for type V and VI complex tibial plateau comminuted fractures, the first stage should focus on fracture fixation, while ligament reconstruction should be performed in the second stage. The primary soft tissue repair or reconstruction is beneficial to functional exercises and reduces the incidence of knee joint stiffness. In this case, the knee brace was removed, and range-of-motion exercises were initiated 4 weeks after operation. The patient performed well regarding range of motion and stability of the knee joint 12 months after operation.

In summary, we showed a rare clinical case with an isolated fracture fragment from the posterolateral tibial plateau retrieved from the patellofemoral compartment that was managed with an individualized surgical approach, as described. Orthopaedists have to evaluate this uncommon fracture type in detail, as it can be underestimated by primary clinical examination, only to result in chronic pain, functional limitation, and joint instability. For example, when encountering this fracture, ACL injuries should not be ignored. Combining the physical examination and radiological findings to examine the possible injury mechanism is important for developing an appropriate surgical protocol.

Declarations of interest:

All authors declare that they have no conflict of interest.

References

1. Shepherd L, Abdollahi K, Lee J, Vangsness CT Jr. The prevalence of soft tissue injuries in nonoperative tibial plateau fractures as determined by magnetic resonance imaging. *J Orthop Trauma*. 2002;16:628–31.
2. Gardner MJ, Yacoubian S, Geller D, Suk M, Mintz D, Potter H, et al. The incidence of soft tissue injury in operative tibial plateau fractures: a magnetic resonance analysis of 103 patients. *J Orthop Trauma*. 2005;19:79–84.
3. Yoo JH, Kim EH, Yim SJ, Lee BI. A case of compression fracture of medial tibial plateau and medial femoral condyle combined with posterior cruciate ligament and posterolateral corner injury. *Knee*. 2009;16:83–6.
4. Abdel-Hamid MZ, Chang CH, Chan YS, Lo YP, Huang JW, Hsu KY, et al. Arthroscopic evaluation of soft tissue injuries in tibial plateau fractures: retrospective analysis of 98 cases. *Art Ther*. 2006;22:669–75.
5. Ramponi DR, McSwigan T. Tibial plateau Fractures. *Adv Emerg Nurs J*. 2018;40:155–61.
6. Kennedy JC, Bailey WH. Experimental tibial-plateau fractures. Studies of the mechanism and a classification. *J Bone Joint Surg Am*. 1968;50:1522–34.
7. Vanek J. Posteromedial fracture of the tibial plateau is not an avulsion injury. A case report and experimental study. *J Bone Joint Surg Br*. 1994;76:290–2.
8. Hirsch G, Sullivan L. Experimental knee-joint fractures. A preliminary report. *Acta Orthop Scand*. 1965;36:391–9.
9. Zhu Y, Meili S, Dong MJ, Zhai QL, Yao L, Wang JC, et al. Pathoanatomy and incidence of the posterolateral fractures in bicondylar tibial plateau fractures: a clinical computed tomography-based measurement and the associated biomechanical model simulation. *Arch Orthop Trauma Surg*. 2014;134:1369–80.
10. Kokkalis ZT, Iliopoulos ID, Pantazis C, Panagiotopoulos E. What's new in the management of complex tibial plateau fractures. *Injury*. 2016;47:1162–9.
11. Chang SM, Zhang YQ, Yao MW, Du SC, Li Q, Guo Z. Schatzker type IV medial tibial plateau fractures: a computed tomography-based morphological subclassification. *Orthopedics*. 2014;37:e699–706.
12. Stannard JP, Lopez R, Volgas D. Soft tissue injury of the knee after tibial plateau fractures. *J Knee Surg*. 2010;23:187–92.
13. Khoshnoodi P, Tehranzadeh AD, Dunn JM, Tehranzadeh J. Semimembranosus tendon avulsion fracture of the posteromedial tibial plateau associated with posterior cruciate ligament tear and capsular rupture. *Skeletal Radiol*. 2014;43:239–42.
14. Shaikh H, Herbst E, Rahnama-Azar AA, Bottene Villa Albers M, Naendrup JH, Musahl V, et al. The Segond fracture is an avulsion of the anterolateral complex. *Am J Sports Med*. 2017;45:2247–52.
15. Meuffels DE, Favejee MM, Vissers MM, Heijboer MP, Reijman M, Verhaar JA. Ten year follow-up study comparing conservative versus operative treatment of anterior cruciate ligament ruptures. A matched-pair analysis of high level athletes. *Br J Sports Med*. 2009;43:347–51.
16. Seitz H, Chrysopoulos A, Egkher E, Mousavi M. Long-term results of replacement of the anterior cruciate ligament in comparison with conservative therapy. *Chirurg*. 1994;65:992–8.
17. Mall NA, Chalmers PN, Moric M, Tanaka MJ, Cole BJ, Bach BR Jr, et al. Incidence and trends of anterior cruciate ligament reconstruction in the United States. *Am J Sports Med*. 2014;42:2363–70.
18. Brambilla L, Pulici L, Carimati G, Quaglia A, Prospero E, Bait C, et al. Prevalence of associated lesions in anterior cruciate ligament reconstruction: correlation with surgical timing and with patient age, sex, and body mass index. *Am J Sports Med*. 2015;43:2966–73.
19. Ajuied A, Wong F, Smith C, Norris M, Earnshaw P, Back D, et al. Anterior cruciate ligament injury and radiologic progression of knee osteoarthritis: a systematic review and meta-analysis. *Am J Sports Med*. 2014;42:2242–52.
20. Smith TO, Davies L, Hing CB. Early versus delayed surgery for anterior cruciate ligament reconstruction: a systematic review and meta-analysis. *Knee Surg Sports Traumatol Arthrosc*. 2010;18:304–11.
21. Karikis I, Åhlén M, Sernert N, Ejerhed L, Rostgård-Christensen L, Kartus J. The long-term outcome after early and late anterior cruciate ligament reconstruction. *Art Ther*. 2018;34:1907–17.
22. Karuppiah SV, Majeed H, Sigamoney K, Geutjens G. Failure of meniscal repair association with late anterior cruciate ligament reconstruction. *J Orthop*. 2016;13:106–9.
23. Gonçalves H, Steltzen C, Boisrenoult P, Beauflis P, Pujol N. High failure rate of anterior cruciate ligament reconstruction with bimeniscal repair: a case-control study. *Orthop Traumatol Surg Res*. 2017;103:943–6.
24. de Campos GC, Nery W Jr, Teixeira PE, Araujo PH, Alves WM Jr. Association between meniscal and chondral lesions and timing of anterior cruciate ligament reconstruction. *Orthop J Sports Med*. 2016;4:2325967116669309.
25. Granan LP, Bahr R, Lie SA, Engebretsen L. Timing of anterior cruciate ligament reconstructive surgery and risk of cartilage lesions and meniscal tears: a cohort study based on the Norwegian National Knee Ligament Registry. *Am J Sports Med*. 2009;37:955–61.
26. Tekin AÇ, Çakar M, Esenyel CZ, Adaş M, Bayraktar MK, Özcan Y, et al. An evaluation of meniscus tears in lateral tibial plateau fractures and repair results. *J Back Musculoskelet Rehabil*. 2016;29:845–51.
27. Barrington TW, Dewar FP. Tibial plateau fractures. *Can J Surg*. 1965;8:146–52.
28. Biz C, Maso G, Gambato M, Belluzzi E, Pozzuoli A, Favero M, et al. Challenging surgical treatment of displaced articular Tibial plateau fractures: do early knee radiographic features have a predictive value of the mid-term clinical functional outcomes. *Orthop Surg*. 2019;11:1149–62.
29. Mehni R, O'Brien P, Broekhuysen H, Blachut P, Guy P. Endstage arthritis following tibia plateau fractures: average 10-year follow-up. *Can J Surg*. 2012;55:87–94.