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Combined osteochondral fracture of the posterolateral tibial plateau and Segond fracture with anterior cruciate ligament injury in a skeletally immature patient

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Abstract A case of a 14-year-old boy with a rare injury—an osteochondral fracture of the posterolateral tibial plateau associated with the anterior cruciate ligament (ACL) rapture, and Segond fracture characterized by an avulsion fracture of the lateral tibial plateau—is reported. This case was noteworthy because it involved a rare combination of ACL injuries. This injury was thought to be caused by the impaction between the posterior aspect of the lateral tibial plateau and the lateral femoral condyle during internal rotational displacement of the knee joint at the time of injury, because the osteochondral fracture of the posterolateral tibial plateau matched the site where the bone bruise was observed.
Level of evidence IV.

Keywords Anterior cruciate ligament injury · Segond fracture · Osteochondral fracture

Introduction

Anterior cruciate ligament (ACL) rupture is a common injury of the knee joint especially among athletic population. Bone bruising of the femur or tibia and fracture of the lateral tibia (Segond fracture) are common complications associated with ACL injuries [2, 3, 10, 12, 13, 18–20, 22–24, 26], but the combined occurrence of an osteochondral fracture of the posterolateral tibial plateau, which seems to result from the same mechanism that caused the bone bruise, is unique. A case of a combined injury like this case, to the best of our knowledge, has not been previously reported.

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Case report

A 14-year-old boy sustained an injury to his left knee in a bicycle accident. He was diagnosed with an ACL injury combined with Segond fracture on the basis of radiographic and physical examinations conducted at another hospital. Apart from the injury, the patient was healthy; his body mass index (BMI) was 27.6 kg/m^2 at the time of the injury.

Physical examinations

Three days after injury, swelling and effusion were observed on his left knee. The knee alignment was normal. Manual instability tests produced a positive result for Lachman test (grade II, no end point), a negative one for posterior drawer test, and a negative one for the valgus instability test at 0 and 30° of the knee flexion. Pivot-shift test could not be performed due to patient anxiety.

Imaging evaluation

Plain radiographs obtained in the anteroposterior view and lateral view revealed an avulsion fracture of the lateral tibial plateau (Segond fracture) and the presence of a bone fragment in the lateral knee joint space (Fig. 1). These

findings were confirmed by computed tomography (CT), which also revealed an osteochondral bone defect on the posterolateral rim of the tibial plateau (Fig. 2). Magnetic resonance imaging (MRI) revealed a ruptured ACL, bone bruise of the lateral femoral condyle, and a longitudinal tear on the posterior portion of the lateral meniscus.

Surgical technique

Eighteen days after the patient sustained the injury, surgery was performed. The results of the manual instability tests, performed with the patient under general anesthesia, were similar to those of the presurgery physical examination. In addition, the pivot-shift test was positive (grade 2). Arthroscopic examination revealed an ACL injury, detached from the femoral insertion, a torn lateral meniscus, an osteochondral fracture of the posterolateral tibial rim, and a loose fragment of the osteochondral bone, measuring 1 cm × 2 cm (Fig. 3a). The PCL and medial meniscus were intact. The posterior portion of the lateral meniscus had a longitudinal tear in the vascular zone. We tried to fix the bony fragment back; however, it was too thin and too small for reduction and fixation. We removed the bony fragment (Fig. 3b) and performed suture repair of the lateral meniscal tear using an inside-out suture technique. ACL

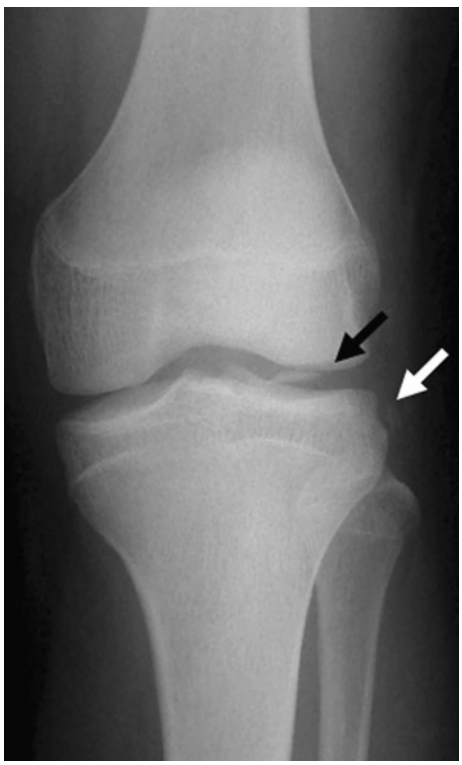

Fig. 1 Plain radiographs: osteochondral fracture (*black arrow*) and avulsion fracture of the lateral tibial plateau (Segond fracture; *white arrow*)

Fig. 2 Reconstructed computed tomographic (CT) image: sagittal view, thickness; 3 mm, pitch; 3.01 mm. Osteochondral fragment (*black arrow*) and bony defect of the posterolateral tibial plateau (*white arrow*)

reconstruction was decided two-stage procedure and did not perform because the patient was still skeletally immature with open physis in both femur and tibia.

Ten months after the initial surgery, we performed an anatomic double-bundle ACL reconstruction using a hamstring tendon graft, because there was no growth of height over 6 months after the injury, and epiphyseal lines of femur and tibia were getting unclear on plain radiograhs. Arthroscopic inspection revealed a fibrous tissue covering the site of the osteochondral fracture of the posterolateral tibial plateau (Fig. 4a). Any apparent instability of the posterior portion of the lateral meniscus was not observed.

A year after the ACL reconstruction, the patient has no pain, no symptom, and no joint effusion on his knee joint and was capable of participating in sports. A pivot-shift test, performed under general anesthesia, was negative. For the purpose of the material removal and diagnostic arthroscopy, subsequent arthroscopic examination revealed a taut reconstructed ACL and a smooth and firm fibrous tissue-like cartilage that covered the site of the osteochondral fracture (Fig. 4b).

Discussion

The most important finding of the present study was a presence of a rare complication, intra-articular osteochondral fracture with ACL injury. Several injuries are known

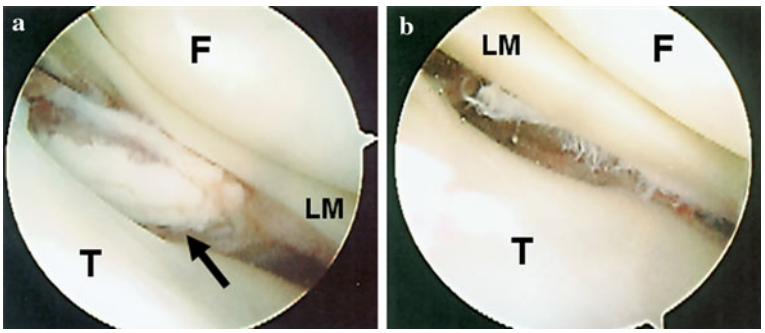

Fig. 3 Arthroscopic view obtained at the time of the initial surgery. **a** A fragment of the osteochondral bone, in the form of a loose body, was observed at the site of the posterolateral compartment (*black arrow*). (*F* femur, *LM* lateral meniscus, *T* tibia). **b** After the bony fragment was removed, we observed the osteochondral defect of the posterolateral tibial plateau. (*F* femur, *LM* lateral meniscus, *T* tibia)

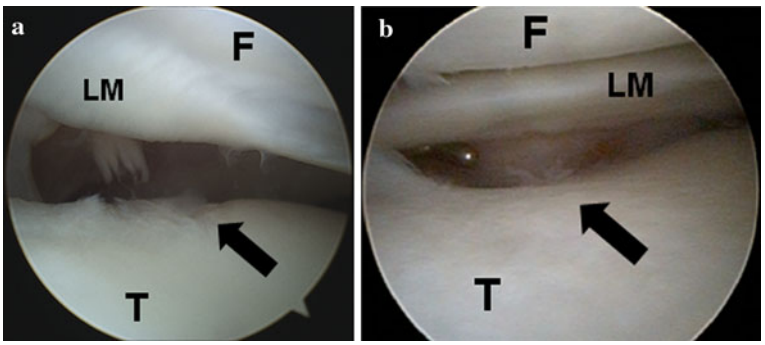

Fig. 4 **a** Ten months after the initial operation, we observed a fibrous tissue that covered the site of the osteochondral fracture of the posterolateral tibial plateau. (*F* femur, *LM* lateral meniscus, *T* tibia). **b** An year after anterior cruciate ligament (ACL) reconstruction (22 months after the injury), we observed a smooth and firm fibrous tissue-like cartilage that covered the site of the osteochondral fracture of the posterolateral tibial plateau. (*F* femur, *LM* lateral meniscus, *T* tibia)

to occur in conjunction with ACL tears. Medial collateral ligament (MCL) injury, which is often associated with torn ACL, is thought to occur because of valgus instability of the knee joint at the time of the injury [15, 24]. Avulsion fractures of the lateral tibial rim, also known as Segond fractures, are reported to occur in 9% of ACL disruptions [8, 13] and are typically caused by forced internal tibial rotation of the flexed knee [27]. This mechanism placed a tremendous force on the middle portion of the lateral capsule and the associated meniscotibial ligament, thereby resulting in a small bony avulsion at the lateral tibial plateau [6]. Bone bruises (occult osteochondral lesions) are found in 80% or more of the ACL injuries [1, 4, 5, 9, 20]. These bony injuries are most likely caused by the impaction between the posterior aspect of the lateral tibial plateau and the lateral femoral condyle, which occurs during the dislocation of the knee joint at the time of the injury [1, 7, 19]. The tibia subluxates forward on the externally rotated femur, and lateral compartment contusions occur as the ACL ruptures and the bones impact with each other [11]. A mechanism similar to the one causing bone bruises has been implicated in lateral meniscal tears, which are reported in about 50% of the ACL injuries [18, 25, 26]. Although complications associated with ACL injuries, such as avulsion fracture of the lateral tibial plateau and avulsion fracture of the tibial attachment of the ACL, have been previously presented in radiological literature [14, 27], an osteochondral fracture of the posterolateral tibial plateau recognized as intra-articular loose body with an ACL injury has not yet been reported. Here, a case of Segond fracture and osteochondral fracture of the posterolateral tibial plateau that occurred in combination with an ACL injury is reported. Arthroscopic examination revealed a loose body that was confirmed to be a fragment of the osteochondral fracture of the posterolateral tibial plateau. About the possible mechanism of this injury, it was thought to be caused by the impaction of the posterior border of the lateral tibial plateau and the lateral femoral condyle as a result of abnormal internal rotation (subluxation) of the knee joint at the time of injury, because the osteochondral fracture of the posterolateral tibial plateau matched the site where the bone bruise was observed. This mechanism is well known and explains the osteochondral bruises of the anterior aspect of the lateral femoral condyle and the corresponding bruises in the posterior part of the tibial condyle as "kissing lesions" during the subluxation [12, 16].

The new consideration in this case is the presence of an osteochondral fragment, which can be explained by the age of the patient. Similar to the mechanism of the patella dislocation in the adolescents [17, 21], osteochondral shear fractures can occur contrary to the adults in whom usually only cartilage lesions appear. It has to be considered an osteochondral fracture of the posterolateral tibial plateau when there is obvious bone bruise of the lateral femoral condyle on MRI especially in adolescent ACL ruptured patients.

Conclusion

A case of an osteochondral fracture of the posterolateral tibial plateau associated with the ACL rapture in a skeletally immature patient is reported. This injury was thought to be caused by the impaction between the posterior aspect of the lateral tibial plateau and the lateral femoral condyle during internal rotational displacement of the knee joint at the time of injury.

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