POSTEROMEDIAL FRACTURE OF THE TIBIAL PLATEAU IS NOT AN AVULSION INJURY
A CASE REPORT AND EXPERIMENTAL STUDY

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We report a case of an apparent avulsion fracture of the posteromedial margin of the medial plateau of the tibia. This was associated with a tear of the medial meniscus and rupture of the anterior cruciate ligament (ACL). This triad has been previously reported, and the plateau fracture was related to the insertion of the semimembranosus tendon.

The detailed investigation of our case and some experiments on cadaver knees showed that the injury was not an avulsion fracture but was produced by varus and external rotation forces on a flexed knee. It was due to the anterior subluxation of the medial tibial plateau after rupture of the ACL.

Received 6 July 1993; Accepted after revision 16 August 1993

Fracture of the posteromedial margin of the medial plateau of the tibia was shown by MRI in 1989 by Yao and Lee to have a close anatomical relation to the point of insertion of the tendon of the semimembranosus muscle and the injury, in the two cases which they reported, was considered to be an avulsion caused by muscular contraction. In both cases, there were associated ruptures of the posterior horn of the medial meniscus and of the anterior cruciate ligament (ACL).

We report a similar case, and have studied the mechanism of injury by experiments on cadavers.

CASE REPORT
A 41-year-old man fell from a ladder in a sitting position, twisting his right knee under his left leg. He complained of pain in the medial compartment of the right knee.

Clinical examination showed an effusion but no obvious laxity, despite a complaint of instability on descending stairs soon after the injury. Lateral radiographs showed a small fissure fracture of the posterior tibial plateau and CT scans confirmed marginal ‘avulsions’ both medially and laterally. After 17 days in a plaster cast, the patient rapidly regained normal mobility, but had persisting pain in the medial compartment. Examination three months later suggested a lesion of the medial meniscus and a rupture of the ACL with a positive Lachman test of 1 cm.

MRI five months after the injury confirmed a posterior horn tear of the medial meniscus and also showed the proximity of the posteromedial fracture fragment to the semimembranosus tendon (Fig. 1). The ACL was not well shown, but arthroscopy one month later showed fraying and laxity. Arthroscopic partial meniscectomy was performed. During this operation the irregularity of the articular surface caused by the posteromedial fracture was seen (Fig. 2). The symptoms settled well after operation and the patient reported adequate stability of the knee.

Fig. 1
T1-weighted sagittal MR image through the medial femorotibial compartment five months after the injury. The fractured fragment of the posterior border of the tibial plateau can still be distinguished, and is above the insertion of the semimembranosus tendon (arrow).

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©1994 British Editorial Society of Bone and Joint Surgery 0301-620X/94/2749 $2.00

THE JOURNAL OF BONE AND JOINT SURGERY
EXPERIMENTAL STUDY

Experiments were performed on the knees of part-frozen cadavers. Several attempts to avulse bone by a violent pull on the semimembranosus tendon all failed.

We then attempted to duplicate the mechanism of injury described by the patient on 19 knees in 12 cadavers of mean age 77 years with no advanced osteoarthritic changes. A varus load was applied manually with the knee flexed between 60° and 80°, against the resistance of a still-frozen hip (which was necessary to avoid causing hip dislocation).

In all 19 knees there was a loud crack, the Lachman test became positive and a medial arthrotomy revealed detachment of the femoral attachment of the ACL. The forced varus always caused external rotation of the tibia, and when pressure was continued there was a second crack when the medial condyle of the tibia moved anteriorly, usually with increased flexion. Each knee was then dissected to determine the state of the ligaments and the articular surfaces.

RESULTS

In 16 of the 19 knees, there were fractures of the posterior part of the medial plateau of the tibia. These were of four types as shown in Figure 3. In type A (n = 4 knees) the posterior edge of the plateau could be deflected by downward pressure due to cancellous bone crushing and there was a fissure fracture of the cortical wall, but no fracture of the subchondral plate. The fractures of types B, C and D were often comminuted. Type B (n = 3) was a subchondral fracture, and type C (n = 4) showed a
detached marginal fragment (Fig. 4). Type D (n = 5) was a combination of types B and C. An intra-articular view of this type of injury is shown in Figure 5. Other associated articular lesions were seen: there was rupture of the lateral collateral ligament in four knees, rupture of the posterior cruciate ligament in one, a compression fracture of the medial femoral condyle in one and a comminuted fracture of the entire medial plateau in one. In no knee did we see a fracture of the posterior margin of the lateral plateau, or a rupture of the medial meniscus.

DISCUSSION

The clinical case which we describe had identical pathology to the two cases originally reported by Yao and Lee (1989). The very similar bone lesion obtained in our cadaver experiments was caused by anterior subluxation of the medial tibial plateau and could not be reproduced by forcible traction on the semimembranosus tendon. The fractures which we produced were intra-articular and the tendon was not inserted directly into the main fragment as shown in Figures 1, 3 and 4.

Yao and Lee (1989) suggest that posteroemeral fractures of the tibial plateau originate in a valgus, externally rotated position near full extension, which is the most frequent mechanism causing ACL rupture. Our cadaver experiments appeared to show that the fracture can only occur after the ACL rupture, and in contrast, that it was due to a varus force.

It is accepted that when the ACL ruptures, the lateral tibial plateau may subluxate anteriorly. MRI may show traces of this pivot-shift phenomenon as occult trauma due to bleeding and oedema in the terminal sulcus of the lateral femoral condyle, and/or the posterior aspect of the lateral tibial plateau. These ‘kissing contusions’ were found by Rosen, Jackson and Berger (1991) in 83% and by Kaplan et al (1992) in 56% of knees with acute ACL rupture. Speer et al (1992) report an incidence of 83% and also noted posterolateral soft-tissue injury.

Such occult trauma associated with the acute rupture of an ACL has also been reported in the medial femorotibial compartment. An incidence of 27% was found by Rosen et al (1991) and of 7% by Kaplan et al (1992). Our experimental results indicate that their origin may be analogous to the kissing contusion of the lateral compartment, also being due to anterior tibial translation. The lack of a previous description of this fracture is perhaps principally due to the limited extent of the injury: it is almost impossible to diagnose it from standard radiographs. Our anatomical study should facilitate the accurate recognition and diagnosis of this fracture.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

REFERENCES


