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Impingement fracture of the anteromedial tibial margin: a radiographic sign of combined posterolateral complex and posterior cruciate ligament disruption

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Introduction

Marginal fractures of the tibial plateau associated with ligamentous injury of the knee are well recognised in the medical literature. In 1879, Segond [1] produced an avulsion fracture of the lateral tibial condyle posterior to Gerdy's tubercle, a fracture resulting from a flexed knee undergoing varus stress and internal rotation. The fracture occurs at the insertion of the lateral capsular ligament, and is associated with tears of the anterior cruciate ligament in up to 100% of cases [2]. A similar fracture of the medial tibial plateau has also been described [3], and is said to result from a flexed knee undergoing valgus stress and external rotation, in contrast to the mechanism producing the Segond fracture. This fracture was associated with complete disruption of the posterior cruciate

Abstract Marginal fractures of the tibial plateau are associated with a high incidence of soft tissue injuries to the stabilising structures of the knee joint. Injuries to the anterior cruciate ligament are associated with the Segond fracture and impingement fractures of the posteromedial tibial plateau. Recognition of these fractures aids diagnosis of these injuries. Marginal fractures of the tibial plateau associated with posterior cruciate ligament injuries are less

common, though recently a "reverse" Segond fracture has been recognised. We describe a fracture of the anteromedial tibial plateau associated with complete disruption of the posterior cruciate ligament and posterolateral complex.

Keywords Posterior cruciate ligament rupture · Posterolateral complex disruption · Tibial fracture · Impingement · Radiographs

ligament, partial tear of the anterior cruciate ligament and tears of the medial meniscus and medial collateral ligament. Although the above fractures are caused by an avulsion mechanism, Vanek [4] has described and classified an impingement fracture of the posteromedial margin of the tibial plateau due to anterior subluxation of the medial tibial plateau caused by rupture of the anterior cruciate ligament. This injury resulted from the application of a varus load to a flexed knee, resulting in external rotation, further flexion and anterior subluxation of the medial tibial plateau. Reversal of this mechanism would, in theory, result from rupture of the posterior cruciate ligament allowing an anteromedial tibial plateau fracture.

Case report

A 17-year-old male jumped over a wall 60 cm high, landing heavily on his right leg. He heard a "snap", following which his knee swelled rapidly and he was unable to weight-bear. Examination confirmed a tense haemarthrosis, with active flexion limited to 70°. Further examination was impossible because of pain. Radiographs showed a marginal fracture of the anteromedial tibial plateau (Fig. 1).

Examination under anaesthesia confirmed a posterior draw (++) , recurvatum deformity (+) and lateral instability (+++). Arthroscopy confirmed posterior cruciate ligament rupture, and rupture of the posterolateral capsule. The anterior cruciate ligament was intact, with the suggestion of intrasubstance injury. Chondral damage was noted on the medial



Fig. 1 Lateral radiograph of the right knee showing a fracture (*white arrow*) of the anteromedial tibial margin

tibial plateau and anteromedial femoral condyle, and the marginal fracture of the anteromedial tibial plateau was confirmed. The popliteus tendon was noted to be unstable. Open exploration of the lateral aspect of the knee confirmed avulsion of the iliotibial band from Gerdy's tubercle, avulsion of the biceps tendon insertion to the fibular head, rupture of the popliteus tendon from the femoral insertion and rupture of the lateral collateral ligament at the fibular end representing a grade III posterolateral complex disruption. Rupture of the posterior cruciate ligament was confirmed, and the anterior cruciate ligament was in continuity. Direct repair of these structures was undertaken, and a plaster of Paris cast applied.

Discussion

The combination of posterolateral complex and posterior cruciate ligament tears has been attributed either to a posterolaterally directed force on a flexed knee, resulting in rota-

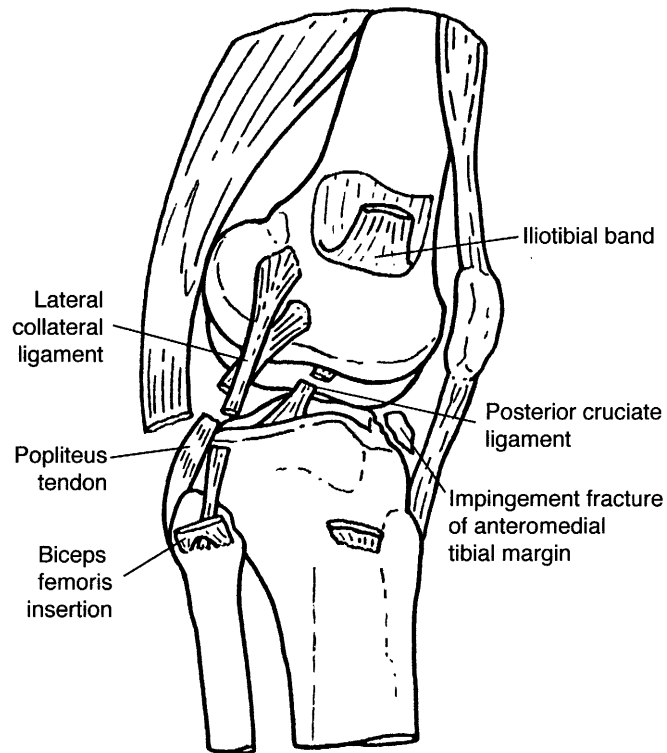


Fig. 2 Diagram illustrating how disruption of the structures contributing to the posterolateral complex and the posterior cruciate ligament can result in an impingement fracture of the anteromedial tibial margin. The intact anterior cruciate ligament is not shown for reasons of clarity

tion and sequential rupture of the posterolateral complex followed by the posterior cruciate ligament [5], or to a posteromedially directed varus force applied to an extended knee [6, 7, 8]. In such cases, a consistent anterior contusion of the medial femoral condyle has been demonstrated on MRI in the presence of a grade III posterolateral complex injury, but not with a grade II injury, suggesting that significant ligamentous disruption is required to produce the bone contusion [9]. The contusion must occur in order to produce the impingement required to fracture the anteromedial margin of the tibial plateau. Occult fractures of the medial tibial plateau were identified in two cases (40%). DeLee et al. [8] identified two non-displaced fractures of the tibial plateau in a series

of 10 patients sustaining a varus blow to an extended knee, and Eustace [10], in describing a similar fracture to ours, suggested hyperextension of the knee in association with disruption of the posterior cruciate ligament as the cause.

Our patient appears to have sustained a combination of hyperextension, varus rotation and significant posterior translation of tibia on femur. Varus rotation increases with sequential sectioning of the lateral collateral ligament, posterolateral capsule, popliteus tendon and posterior cruciate ligament, with maximum effect seen in extension [11, 12]. An increase in the range of posterior translation of tibia on femur of 20–25 mm is also seen at all angles of knee flexion when both the posterolateral complex and posterior cruciate ligament are sectioned. This translation is greater than when either structure is sectioned in isolation [12]. In full extension, the posterior cruciate ligament must rupture to allow any posterior translation even where the posterolateral complex has been sectioned. Although

increased external tibial rotation is well recognised, no increase in internal tibial rotation occurs, even after combined sectioning of the posterolateral complex and posterior cruciate ligament [12]. This suggests that axial rotation does not play a part in producing the fracture of the medial tibial plateau. The combination of varus rotation and posterior tibial translation occurring with the ligamentous disruption identified appears to have allowed the anteromedial femoral condyle to impinge on the anteromedial tibial plateau, resulting in the fracture of the anteromedial tibial plateau. Evidence for this is provided by the damage to the medial femoral condyle found at arthroscopy. The tibial translation required to produce this impingement fracture can only occur in the presence of a complete (grade III) rupture of the posterolateral complex and posterior cruciate ligament [11, 12], a mechanism of injury illustrated in Fig. 2.

We therefore suggest that the identification of an impingement fracture of the anteromedial tibial

margin, combined with the mechanism of injury and clinical findings noted in this case, indicate significant disruption to the posterolateral complex and posterior cruciate ligament. Early recognition of this radiographic appearance will therefore assist in planning the management of such severe injuries [13], particularly in settings where emergency MRI is not readily available.

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