ABSTRACT
Avulsion of the tibial tuberosity is uncommon. It is usually
an athletic injury, accounting for less than 3% of all
epiphyseal injuries. We report the case of an avulsion
fracture of the tibial tuberosity with unusual articular
involvement of the lateral tibial plateau treated with open
reduction and internal fixation using cancellous screws. The
result was excellent, with complete union of the fracture site,
full range of movement at three months and return to normal
athletic activity within six months with no complications.
Key Words:
tibial tuberosity; avulsion fracture; tibial plateau;
adolescent

INTRODUCTION
Avulsion fracture of the tibial tuberosity is a relatively
uncommon injury, with reported incidence ranging from
0.4% to 2.7%1. Such avulsion occurs when patellar ligament
traction exceeds the combined strength of cohesive forces
within the apophyseal cartilage, the surrounding
perichondrium and the adjacent periosteum2. Avulsion
typically involves one of two mechanisms of injury: violent
contraction of the quadriceps muscle against a fixed tibia as
occurs in jumping, or acute passive flexion of the knee
against the contracted quadriceps1. Associated injuries may
involve the surrounding ligaments, menisci and rarely a
tibial plateau fracture as reported in our case3.

CASE REPORT
A 16-year old male sustained an injury to his left knee during
a tackle whilst playing football. Although, he was unable to
recall the precise details of the mechanism of injury, he
thought his knee was straight at the time of the tackle and his
lower leg was forced externally. At presentation, the patient
was unable to weight bear and physical examination revealed
a closed injury with overlying skin contusions laterally. He
had a large knee haemarthrosis and was tender over the tibial
tuberosity and lateral joint line and was unable to perform a
straight leg raise. Radiographs revealed a Watson-Jones type
III avulsion fracture of the tibial tuberosity apophysis and an
Aitken type II fracture of the lateral tibial plateau with slight
malrotation (Figure 1a & 1b and Table I). Radiographs were
reviewed by two orthopaedic consultants and in view of their
good quality and subsequent intraoperative knee
arthroscopy, a computed tomography (CT) scan was not
requested.

We initially performed arthroscopy to assess the joint
surface, menisci and cruciate ligaments; this was followed
by open reduction and internal fixation via a midline
incision, and lateral parapatellar approach. The menisci and
ligaments were all intact following arthroscopic
examination. Intra-operatively, we found a tibial tuberosity
apophysis fracture with a large anterolateral tibial plateau
fragment, a single split and no comminution. We saw no
concomitant avulsion of the patella tendon from the
fragment, though there was significant disruption of the
retinaculum laterally. Definitive fixation was achieved with
five 4.5mm partially threaded cancellous screws placed
under fluoroscopic guidance (3 screws for the tibial
tuberosity and 2 for the lateral tibial plateau) with care taken
to ensure that the screws did not touch the physis.

Postoperatively, the patient was immobilised in a cylinder
plaster cast and allowed toe-touch weight bearing for six
weeks. Thereafter, a hinged knee brace was applied for the
following six weeks to allow weight bearing, controlled knee
flexion and physiotherapy. The patient regained full range of
motion by twelve weeks and went on to make an uneventful
recovery with a return to normal athletic activity at six
months with complete union of the fracture and no growth
plate damage or mal-alignment based on serial radiographs
and clinical examination over the next 24 months (Figure 2a
& 2b).

DISCUSSION
The tibial tuberosity develops from a secondary ossification
centre in the proximal tibia between 7 and 9 years of age.
The proximal tibial epiphysis develops in compression and
the tibial tuberosity, an apophysis, develops in traction4.
During ossification, columnated cartilaginous cells with poor
Table I: Watson Jones classification for tibial tuberosity fractures

| Type | Description |
|------|-------------|
| I    | Fracture is through the secondary ossification centre within the most distal portion of the tibial tuberosity |
| II   | Extension of the fracture line occurs into the proximal aspect of the tibia through the cartilage bridge but does not involve the articular surface |
| III  | Fractures are intraarticular, meaning that the fracture line extends into the joint |

Fig. 1a: Preoperative anteroposterior radiograph of the left knee.

Fig. 1b: Preoperative lateral radiograph of the left knee.

Fig. 2a: Post-operative anteroposterior radiograph of the left knee at 24 months.

Fig. 2b: Postoperative lateral radiograph of the left knee at 24 months.
tensile strength transiently replace the fibrocartilage, predisposing the tibial tuberosity to traction injury just before or during the later stages of physiologic epiphysiodesis1.

The aim of treatment for avulsion fractures of the tibial tuberosity is to restore the extensor mechanism and the joint surface1. This is even more important if there is an associated tibial plateau fracture. Improper surgical technique may predispose to fracture related complications such as genu recurvatum and/or leg length discrepancy as well as early degenerative changes. Genu recurvatum is a rare complication of this injury that occurs in patients close to skeletal maturity; in fact, only one case has been reported in the literature2.

Undisplaced fractures may be treated with cylinder cast immobilisation. Minimally displaced avulsions can also be treated conservatively with closed reduction in some cases2. Displaced fractures are best managed with open reduction and internal fixation to restore the anatomy and the quadriceps-patella mechanism. It has been suggested that open reduction provokes cartilaginous fusion of the tibial apophysis reducing the risk of recurrence. To accomplish fixation, a midline longitudinal incision is recommended to facilitate possible knee surgery in the future2.

In the present case, we used a lateral parapatellar approach via a midline incision to provide adequate exposure of the fracture site and avoid injury to the infrapatella branch of the saphenous nerve. Definitive fixation of tibial tuberosity avulsion fractures can be achieved by transfixing pins or screws, staples, tension bands or even direct suture2. We used only partially threaded cancellous screws for repair of the lateral retinaculum. Although internal fixation supplemented with tension band wiring theoretically provides greater fracture stability allowing early joint motion for isolated tibial tuberosity fractures, it is not recommended for use if the patient has associated tibial plateau fractures.

We agree with Ozer and colleagues about the possible mechanism of injury for an associated lateral tibial plateau fracture1. Above, we discussed the mechanism of injury for tibial tuberosity fractures that do not involve the plateau. After evaluation of the lateral anatomical structures and biomechanics of the knee they suggested that external rotation of the tibia relative to the femur along with knee hyperextension is the mechanism such an injury to the tibial plateau. They proposed that as weight is transferred from the lateral meniscus, an avulsion fracture of the lateral tibial plateau rim may occur during forceful hyperextension. Furthermore, the lateral retinaculum may also contribute to this injury through its insertion on the proximal tibial epiphysis by exerting force in extension, thereby explaining the reason for lateral retinaculum disruption in our patient1.

In our unit, we use the following protocol for all patients presenting with a tibial tuberosity fracture. We investigate the possibility of an associated tibial plateau fracture or other concomitant injury using plain radiographs and assume low threshold for further imaging or arthroscopy in cases of uncertainty. We would not recommend an open approach without such assessment. For displaced avulsion fractures of the tibial tuberosity associated with a tibial plateau fracture, we recommend open reduction and internal fixation with partially threaded cancellous screws in order to achieve anatomical reduction, rigid fixation and realignment of the extensor mechanism; this is followed by six weeks of cylinder cast immobilisation. Continuous screening with an image intensifier may be required as the leg is rotated in the coronal plane to avoid injury to the physis.

A hinged knee brace should be used for an additional six weeks to facilitate controlled knee flexion, physiotherapy and progressive weight bearing. Progressive rehabilitation of the quadriceps is required after cast immobilisation. Though, early mobilisation attenuates joint stiffness and weakness due to prolonged immobilisation, we do not recommend this before six weeks postoperatively. These patients should be followed up until maturity to ensure that there are no fracture-related complications.

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