



## CASE REPORT

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## Four Cases of Avulsion Fracture of the Anterior Tibial Tuberosity

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### ABSTRACT

This work is an observational study focusing on 4 cases of avulsion fracture of the anterior tibial tuberosity, collected between 2020 and 2022 at the orthopedic and trauma surgery department of Fattouma Bourguiba Hospital in Monastir in Tunisia.

The aim of this work is to study the epidemiological, clinical, radiological, therapeutic and evolutionary aspects of this pathology.

The patients in our series, all male, were aged between 14 and 17 years. Three of them had Osgood Schlatter syndrome preceding the lesion.

The clinical presentation was, in all cases, a swollen knee, with a deficit of active extension, a high patella, and pain on palpation of the ATT. X-Ray showed in lateral Knee view: 2 cases classified Ogden IIIB, one case Ogden IB and one case Ogden IIB. All our patients were treated surgically by screwing in one case, cerclage in two cases, and by screwing plus cerclage in one case. The progress was considered satisfactory at 12 weeks postoperative follow-up.

### ARTICLE HISTORY

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### Introduction

Avulsion fracture of the anterior tibial tuberosity (ATT) is rare. It affects athletic adolescents at the end of their growth, during a jump or sudden impulse. The acute clinical presentation is very suggestive. Standard comparative profile radiography allows the diagnosis to be made.

The Ogden classification identifies six types depending on the location of the fracture and the displacement [1]. It helps guide treatment, which is most often surgical.

Through a presentation of four cases of ATT avulsion fracture in adolescents, we attempt to

- Study the epidemiological, clinical and radiological aspects of this type of fracture
- Plan the exploration and management strategy for these fractures.

### Illustrative Cases

#### Case 1

A 16-year-old patient consulted the emergency department for total functional impotence of the right lower limb following a fall on the knee in hyperflexion during a football match.

Clinical examination found pain in the anterior aspect of the knee with a perception of a depression next to the patellar tendon. Active knee extension was impossible.

X-ray showed an avulsion of the Anterior Tibial Tuberosity (ATT) with an elevated patella (Figure 1). The diagnosis of a fracture of the ATT associated with a rupture of the patellar tendon was made.

Intraoperative exploration showed tearing of the patellar tendon at the level of its distal insertion with joint disruption. The procedure was a reinsertion of the ATT with two anteroposterior screws and reinsertion of the patellar tendon with a strong Vicryl, all protected by a tibio-patellar cerclage (Figure 2).

The cerclage wire being removed after 2 months, the rehabilitation allowed flexion up to 130° and complete active extension of the knee.

At final follow-up, knee mobility was complete with consolidation of the ATT fracture on the radiograph (Figure 3).



Figure 1: Avulsion of the ATT Ogden IIIB with an Elevated Patella

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**Figure 2:** Post-Operative X-Ray



**Figure 3:** X-Ray at the Last Follow-Up

### Case 2

A 15-year-old child consulted the emergency department for post-traumatic right knee pain and total functional impotence of the right lower limb following a sporting accident: fall on the knee in hyperflexion.

Examination found a swollen and globular knee (Figure 4), active extension of the knee was impossible, and palpation found an elevated patella with sub-patellar depression.

The x-ray revealed an abnormally high patella with visualization of a millimetric bone fragment next to the patellar tendon (Figure 5).

The diagnosis of subcutaneous rupture of the patellar tendon was made.

The patient underwent emergency surgery. The approach was median centered on the knee. Intraoperative exploration revealed distal disinsertion of the patellar tendon exposing the anterior tibial tuberosity which was intact (Figure 6).

Reinsertion of the patellar tendon using trans-osseous stitches reinforced with a strong nylon overlock was done (Figure 6).

Post-operative immobilization with a knee brace for 6 weeks was followed by rehabilitation allowing the patient to regain full active mobility of his knee after 4 months.

At the last follow-up of 9 months, the patient resumed his usual sporting activities with acceptable radiological control (Figure 7).



**Figure 4:** Preoperative Clinical Photograph of the Patient's Lower Limbs, Where Swelling of the Affected Knee (Left) can be Observed



**Figure 5:** Preoperative Radiograph showing an Abnormally High Patella as well as a Bone Fragment next to the Patellar Tendon.



**Figure 6:** Operative Views of Patellar Tendon Reinsertion



**Figure 7:** Post-Operative Radiograph Showing A Patella with Normal Height and A Tibial Fragment in Place

### Case 3

A 14-year-old child, with a history of Lobstein's disease, who presented to the emergency department for post-traumatic right knee pain, with total functional impotence following a domestic accident: fall from a height of 2 meters with landing on both knees in hyper flexion.

Clinical examination showed a swollen right knee, with impossible active extension, a high patella, and pain on palpation of the ATT.

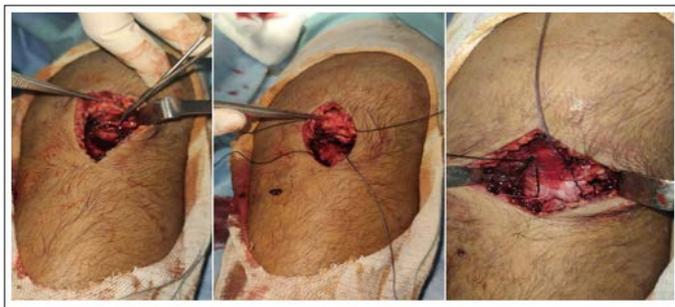
The X-ray as well as the CT scans showed an avulsion of the ATT with an elevated patella (Figure 8).

The patient was operated on using an anterior approach of the knee exposing an avulsion fracture of the patellar tendon which was treated with strong vicryl cerclage (Figure 9).

Immobilization with a knee brace for 45 days followed by rehabilitation allowed the patient, after 3 months, to regain full knee mobility.



**Figure 8:** Avulsion Fracture of the ATT Classified Ogden IIB



**Figure 9:** Patellar Tendon Avulsion-Fracture Treated with Strong Vicryl Cerclage

#### Case 4

A 14-year-old teenager, victim of a school accident, who suddenly presented violent pain in the left knee, during the practice of a jumping activity.

Emergency examination revealed a swollen knee with positive patellar tap test, skin integrity, and pain on palpation of the proximal tibia.

The knee x-ray showed an Ogden type IIIB avulsion-fracture of the ATT (Figure 10).

The patient underwent emergency surgery, via a median approach centered on the ATT, and underwent reduction and osteosynthesis of the fracture using 2 anteroposterior cancellous screws with washer (Figure 11) and immobilization using a knee brace for 45 days, followed by rehabilitation allowing him to have complete mobilization after 3 months.



**Figure 10:** Avulsion Fracture of the ATT classified Ogden IIIB



**Figure 11:** Postoperative Radiograph (Osteosynthesis Using 2 Anteroposterior Screws)

#### Discussion

Avulsion fractures of the TTA are rare, accounting for less than 1% of all physeal injuries and 0.4% to 2.7% of epiphyseal injuries [2].

Mayba and et al. were the first to report this pathology in 1982, and since then several cases and case series have been published. Kaneko and et al. conducted a review of six cases previously published in the literature. Subsequently, Mosier and al reported 19 cases of ATT avulsion fractures, 2 of which were associated with patellar tendon rupture. Youssef and al reported that the incidence of a combination of ATT avulsion and patellar tendon rupture was 4.2% in a retrospective study of 71 pediatric cases of knee extensor rupture [3-6].

Increased participation in sporting activities at a young age can explain the occurrence of this pathology, which predominantly affects adolescents aged 10 to 18 years, males, and mainly the left side.

The mechanisms of injury have been well described in jumping activities: an aggressive concentric contraction of a well-developed quadriceps or a vigorous eccentric contraction of this muscle with a flexed knee during landing on the ground.

Pandya and et al. retrospectively determined that these lesions are associated with sports that involve jumping (basketball 27%, football 22% and running 22%); other studies have shown that it can also occur in sports like wrestling, gymnastics, hurdles, running, and handball [7-10].

## Risk Factors

During adolescence, certain individual or combined factors are conducive to ATT avulsion fractures.

- Family predisposition: Deliyanis implies a familial predisposition by reporting a case of ATT avulsion in two brothers [11].
- Individual factors: A case of bilateral and symmetrical ATT avulsion fracture reported by Birch Madsen suggests that individual factors, in the absence of ATT abnormalities, may be involved.

Due to its particular histogenesis, the tibial tuberosity is susceptible to avulsion fractures in adolescence. The growth plate of the ATT has a unique histological structure adapted to the stresses generated by the patellar tendon, it is largely composed of fibrocartilage and resists traction forces very well.

Endochondral ossification of the ATT growth plate is similar to that of all epiphyseal cartilages. In the period preceding its closure, between 17 and 18 years of age, the growth cartilage undergoes a structural modification in which columnar cells replace most of the fibrocartilaginous elements. In this pre-closure period, therefore, the posterior base of the ATT is much less able to resist traction trauma and is very vulnerable. Several studies have reported that more than 80% of ATT avulsions occurred between 15 and 17 years of age.

-Osgood-Schlatter disease: The relationship between Osgood-Schlatter disease and ATT avulsion fractures is well documented and supported by several clinical studies: Ogden and al. Nine patients presented with clinical symptoms of Osgood-Schlatter apophysitis ipsilateral or contralateral to the ATT avulsion [12].

According to Ogden and Southwick, the histological change characteristic of Osgood-Schlatter disease weakens the growth plate which may be subject to avulsion in response to traction forces exerted by the patellar tendon.

In addition to complete avulsion of the ATT, these patients may also experience a distal rupture of the patellar tendon, taking with it a small bone fragment.

In our series, 3 had previously mentioned previous pain in the injured knee.

Other predisposing factors include patella-Baja, tight hamstrings, certain enzyme deficiencies, and obesity [13].

The clinical diagnosis of these injuries can be difficult, and the loss of active knee extension should increase the suspicion of patellar tendon rupture.

Radiographically, the presence of patella alta on lateral view of the knee flexed at 30° as well as calcified fragments under the patella may indicate the presence of rupture of the patellar tendon [9].

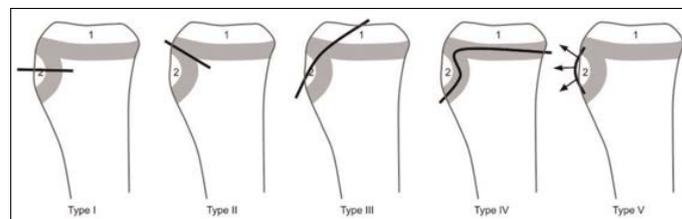
Tai and et al. mentioned that the Insall-Salvati index can be used, and that it had a value of 1.6 preoperatively in their study. However, we suggest using the Caton-Deschamps index, as it is more reliable and does not involve measuring the anterior tibial tuberosity, which may be fragmented or displaced from its original position, distorting the measurement [10].

MRI is indicated when the fracture extends to the articular surface, or when an associated meniscal, ligamentous or cartilaginous lesion is suspected [14].

Since MRI is not always available and has a high cost, CT can be useful for joint surface assessment and preoperative planning.

There are several classifications of ATT avulsion fractures, the first was proposed by Watson-Jones in 1955, and described 5 types: type I is characterized by an avulsion of the distal part of the ATT, downstream of the proximal tibial physis. In Type II, the avulsion is extended through the physis but does not reach the knee joint. Type III is characterized by an avulsion that continues into the knee joint. In type IV, the fracture extends posteriorly throughout the proximal tibia, while type V is distinguished by a periosteal avulsion of the secondary ossification center [1]. (Figure 12)

This classification was then modified by Ogden in 1980 by adding two subtypes: A to designate a non-displaced fracture and B for displaced fracture [1].



**Figure 12:** Ogden Classification

• **Gray:** Two Centers of Ossification of the Proximal Tibia: 1: The Primary Site: The Proximal Tibial Physis, 2: The Secondary Site: ATT

• **Black:** The Fracture Line

Other types were defined by Ryu and Debenham, who described a type IV fracture that extends posteriorly along the proximal tibial physis, creating an avulsion of the entire proximal epiphysis.

In 1990, Frankl and et al. proposed subtype C for patellar tendon avulsion fractures [15,16].

McKoy and Stanitski described another Type IV, which is a Type IIIB fracture with an associated Type IV fracture making an "Y" configuration. In our series, we had 2 cases classified Ogden IIIB, one case Ogden IB and one case Ogden IIB.

Several therapeutic methods have been proposed such as cast immobilization, percutaneous pinning in fractures classified Ogden I, lacing and screwing (conventional or cannulated AO screws, uni-cortical or bi-cortical, with or without washers) [2].

It has been shown that there is no difference in the number of cortical, using screws that measure 3.5mm, 4mm or 4.5mm, with full or partial thread. Generally, two screws are sufficient for fixation [14, 17].

The choice of method depends on the age of the patient, the size and comminution of the fragment, as well as the experience of the surgeon.

In our group, there was one case of screwing, two cases of cerclage, and one case of screwing plus cerclage.

It appears that the use of screws, compared to pins, can compromise the development of ATT (it's about a physal lesion). However, a statistical analysis by applying a correlation test, in a study established by Casas-López and al. did not show a statistically significant difference ( $p = 0.75$ ). In patients who underwent cerclage following patellar tendon rupture, neither clinical nor radiographic evidence showed alteration of ATT [18].

In the study by Moiser and Stanitski which included 19 cases of ATT avulsion, 79% were treated surgically.

In our group, we removed immobilization at 5 weeks on average, compared to the 6 weeks described in this study.

The same author reports the removal of the osteosynthesis material in three-quarters of the cases at 24 weeks of evolution, while in our group it was removed in all cases, at 16 weeks on average.

Moiser published that 20 week after surgery, 100% of patients had a satisfactory outcome. In our group, the evolution was considered satisfactory at 12 weeks postoperatively.

Avulsion fractures of the ATT can disrupt the growth cartilage, and lead to skeletal deformities such as genu-recurvatum in 4% of cases, or unequal length of the limbs in 5% of cases. It is therefore imperative to continue the follow-up of patients until bone maturity [19].

In our group at 6 months of follow-up, no complications were noted.

## Conclusion

Although rare, ATT avulsion- fractures are considered as serious injuries that require rapid diagnosis and early surgical management.

There are several classifications of these fractures, and the most popular is the Ogden classification which helps to guide treatment which can be surgical or orthopedic.

With adequate and early treatment, ATT avulsion- fractures have a high rate of union, and patients are generally able to return to their previous sporting activity.

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