



ORIGINAL REPORT

## Radiographic features of the development of the anterior tibial tuberosity<sup>☆</sup>



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### KEYWORDS

Tibia;  
Osteochondrosis;  
Growth plate

### Abstract

**Objective:** Few studies have evaluated the radiologic characteristics of the development of the anterior tibial tuberosity. This study aimed to evaluate the radiologic characteristics of the anterior tibial tuberosity in a pediatric population broken down into age groups.

**Material and methods:** We assessed 210 plain-film x-rays of the knee from patients aged from 10 to 17 years, divided into groups according to age and sex, for the presence of ossification of the anterior tibial tuberosity, the distance between the anterior tibial tuberosity and the metaphysis, and fusion with the epiphysis.

**Results:** At 10 years of age, the anterior tibial tuberosity was ossified in 50% of the girls but in only 25% of the boys. In all the girls, the anterior tibial tuberosity was ossified at 11 years, fusion of the anterior tibial tuberosity with the epiphysis had started at 12 years, and fusion was complete by 17 years. In boys, the process is delayed by one year compared to girls. A single center of ossification was found in all cases.

**Conclusion:** The ossification of the anterior tibial tuberosity starts distally, then the proximal part fuses with the rest of the epiphysis, and finally the distal part fuses with the tibia. The results of this study help enable a better analysis of the anterior tibial tuberosity in cases of knee pain.

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**PALABRAS CLAVE**

Tibia;  
Osteocondrosis;  
Placa de crecimiento

**Características radiológicas del desarrollo de la tuberosidad tibial anterior****Resumen**

**Objetivo:** Existen pocos estudios que evalúen las características radiológicas del desarrollo de la tuberosidad tibial anterior (TTA). El presente trabajo tiene por objeto evaluar las características radiológicas de la TTA en una población pediátrica de acuerdo a grupos de edad.

**Material y métodos:** Es un estudio llevado a cabo en 210 radiografías de rodillas de pacientes entre los 10 y 17 años, que fueron divididos por grupos de edad y sexo. Se evaluaron la presencia de osificación de la TTA, la distancia de esta a la metáfisis y la fusión con la epífisis.

**Resultados:** A los 10 años de edad, la TTA estaba osificada en el 50% de las mujeres y solo en el 25% de los hombres. A los 11 años todas las mujeres tenían osificada la TTA, a los 12 tenían fusión de la TTA y con la epífisis, y a los 17 años la fusión era completa. En los hombres este proceso se produce un año más tarde que en las mujeres. En todos los casos se encontró un solo núcleo de osificación.

**Conclusión:** La osificación de la TTA se inicia distalmente, posteriormente se fusiona su parte proximal con el resto de la epífisis y finalmente se fusiona en su parte distal a la tibia. Este estudio ayuda a un mejor análisis de la TTA cuando nos enfrentamos a un dolor de rodilla.

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**Introduction**

Anterior tibial tuberosity (ATT) is the main insertion area of the patellar tendon on the anterior and posterior part of the tibia. This tendon stretches to the perichondrium of the physis and the periosteum of the adjacent metaphysis.<sup>1-3</sup> Growth plates are divided in pressure and traction plates,<sup>4</sup> with functional and histological differences between them. The ATT is a traction plate since the patellar tendon is inserted into it; it supports a large mechanical load during knee extension, and it is mostly fibrocartilaginous.<sup>4</sup> Traction plates are located in the junction of the tendons to the bones and they are subjected to traction forces; they contribute to the development of bone morphology, but not to its longitudinal growth. Pressure plates are located on the ends of long bones, between the epiphysis and the metaphysis. Subject to pressure forces, they contribute to longitudinal growth and its ossification is endochondral. There are no clear radiographic differences between these types of growth plates. It is considered that traction plates take a little longer to ossify due to direct or indirect mechanical effects on them.

There are few studies about the development of ATT. Hughes and Sunderland<sup>5</sup> described a fibrous tissue posterior to ATT. Lewis<sup>3</sup> interpreted this zone as a "fibrous junction" between the epiphysis and diaphysis. Badi<sup>6</sup> showed ATT plate fibrous structure in rats. In humans there are few anatomical studies about the development of the ATT growth plate.<sup>7</sup> Ogden et al.<sup>7-10</sup> conducted radiographic and histomorphologic studies claiming that the development of ATT has seven stages based on the age of the patient.

When X-rays of children with anterior knee pain are analyzed it can be puzzling to assess ATT because there are few descriptions about what the normal radiographic development really is.

The goal of this article is to evaluate the radiographic features of ATT in a pediatric population based on age groups.

**Material and methods**

This study was conducted in compliance with the ethical principles based on the Helsinki declaration and it was approved by the hospital ethics committee. Since it is a study based on image archives and medical histories without any interventions on patients it did not require informed consent.

It is an observational, descriptive, retrospective study in which the information source used is digital anteroposterior and lateral X-rays of the knee taken without load using a Siemens Polymat Multix X-ray, on patients looking for medical assistance due to limb trauma, who according to the retrospective review of their medical history, did not have any clinical or radiographic compromises of the knee. The inclusion criteria were: X-rays of 10–17-year-old patients, without post-traumatic diseases or anomalies in the proximal third of the tibia and who in the lateral projection were at between 20° and 60° of flexion. The exclusion criteria were: X-rays taken with inadequate techniques, fractures of the patella, proximal tibia and/or distal femur, presence of osteosynthesis material in the proximal tibia, patients with a history of chronic pain in the knees in the previous 12 months, diagnosis of cerebral palsy, hemophilia, nephrotic syndrome, history of septic arthritis, presence of hemarthrosis, neoplasms around the knee and radiographic findings of anomalies in bone density.

The variables studied were: sex, laterality and age in years and months. The age groups were defined in the following manner. 10-year-old group: individuals who were between 10 years and 10 years and 11 months, 29 days, and so on with the following groups until the final group of 17-year-olds.

The radiographic variables determined for the study were: presence, number and size of the ATT ossification center, distance between the ossification center and the metaphysis as measured from the posterior edge of the

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