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## Review article

# Sports-related overuse injuries in children

F. Launay\*

Service de chirurgie orthopédique et pédiatrique, hôpital Timone-Enfants, 264, rue Saint-Pierre, 13385 Marseille cedex 5, France



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### ABSTRACT

Increased intensity of sports activities combined with a decrease in daily physical activity is making overuse injuries in children more common. These injuries are located mainly in the epiphyseal cartilage. The broad term for these injuries is osteochondrosis, rather than osteochondritis, which more specifically refers to inflammatory conditions of bone and cartilage. The osteochondrosis may be epiphyseal, physisal, or apophyseal, depending on the affected site. The condition can either be in the primary deformans form or the dissecans form. While there is no consensus on the etiology of osteochondrosis, multiple factors seem to be involved: vascular, traumatic, or even microtraumatic factors. Most overuse injuries involve the lower limbs, especially the knees, ankle and feet. The most typical are Osgood-Schlatter disease and Sever's disease; in both conditions, the tendons remain relatively short during the pubescent growth spurt. The main treatment for these injuries is temporary suspension of athletic activities, combined with physical therapy in many cases. Surgery may be performed if conservative treatment fails. It is best, however, to try to prevent these injuries by analyzing and correcting problems with sports equipment, lifestyle habits, training intensity and the child's level of physical activity, and by avoiding premature specialization. Pain in children during sports should not be considered normal. It is a warning sign of overtraining, which may require the activity to be modified, reduced or even discontinued.

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## 1. Introduction

When we draw up certificates of fitness or unfitness, we often use the term "physical and sports activities". Although it is true that sports activity is a physical activity, it is questionable whether physical activity is really a sport. In fact, physical activity ranges from a simple combination of bodily movements such as walking, to recreational physical activity and physical activity in school or in a club, to competitive physical activity in which the goal is to win. Analyzing a child's athletic activity is not simply a matter of adding up the number of hours spent each week in organized sports, but also the number of recreational physical activities in and out of school. This shows us that a certain number of children and adolescents may be overextending themselves physically, which may result in overuse injuries to the musculoskeletal system.

Moreover, there has been an overall decrease these days in daily physical activity such as walking to school or playing with friends [1]; these activities have been replaced with much more sedentary activities such as watching television or playing video games. That

leads to a lower baseline fitness level in children starting a sport, further increasing the risk of overexertion injuries [1].

This creates the perfect environment for an increase in musculoskeletal overuse injuries. We see this every day in our practices. There are even places, such as Boston, where dedicated children's sports medicine clinics have been set up. It is important for us to better grasp this problem to improve our understanding of why these injuries occur. Curative treatment should no longer mean suspending all sports activities until the child stops growing, but it must be adapted on a case-by-case basis. Preventive treatment should remain the main goal so that children can resume their favorite physical activities as quickly and as fully as possible under optimal exercise conditions.

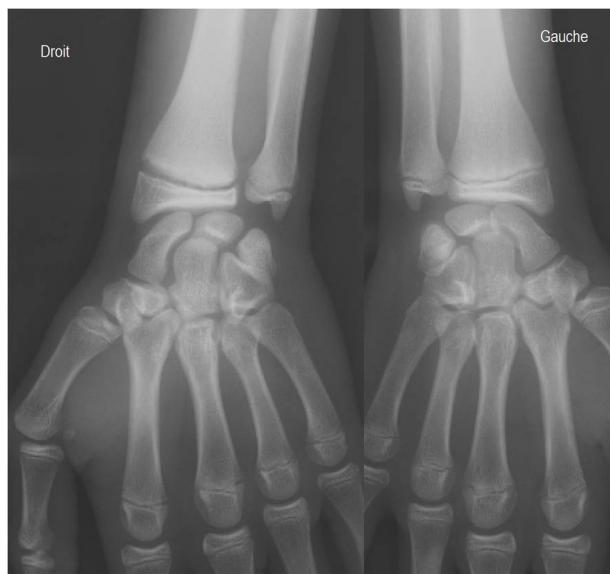
Legg-Calvé-Perthes disease, Scheuermann's disease and spondylolysis have intentionally been excluded from the scope of this work since they do not fall under the category of children's sports-related overuse injuries.

## 2. Pathophysiology

The epiphyseal cartilage is a mosaic of interacting growth plates. It is found in the epiphyses, apophyses, and physes. There is a certain vagueness that leads to confusion when naming growth diseases in this area. Strangely, we use the suffix "-itis", which

\* Correspondence. 1071, chemin des Rouvières, 13830 Roquefort-la-Bédoule, France. Tel.: +33 4 91 38 69 05, +33 6 84 50 17 97; fax: +33 4 91 38 42 27.

E-mail address: [franck.launay@ap-hm.fr](mailto:franck.launay@ap-hm.fr)



**Fig. 1.** Physeal elongation of the right distal radius compared with the left distal radius in a 13-year-old tennis player.

indicates the presence of infection or inflammation. Thus we speak of osteochondritis, apophysitis, or epiphysitis. It seems more accurate to use the generic term osteochondrosis [2], which is a disruption of endochondral ossification, including osteogenesis and chondrogenesis, in subjects with no initial growth disorder. Therefore, we can refer to epiphyseal, apophyseal, or physeal osteochondrosis.

The traumatic origin of physeal [3–5] and apophyseal osteochondrosis is not an issue. Apophyseal osteochondrosis is traumatic in origin. The bones and the myotendinous system grow at different rates [1,3], which sometimes leads to excessive traction on the secondary ossification centers, especially during the period of rapid pubescent growth when intense sports activities are performed. Microtears, inflammatory scar reactions, and ectopic ossifications have been found [2]. Physeal osteochondrosis is often found in the distal radius growth plate in gymnasts or tennis players with mineralization defects in the ossification area, resulting in metaphyseal cartilage inclusions, physis elongation (Fig. 1) and even secondary growth disorders [3–5]. Most of these injuries are reversible early on if the repetitive action causing the injury is stopped [4].

On the other hand, there is no consensus on the etiology of epiphyseal osteochondrosis. There are endocrine, genetic, vascular, and traumatic theories [2,6], leading to confusion. Thus, either the term “osteochondritis deformans” or “osteochondritis dissecans” is used, depending on the anatomical site and its presumed etiology. Osteochondritis deformans affects the entire primary ossification center in young children (Legg-Calvé-Perthes disease, Köhler's disease, Panner's disease), while osteochondritis dissecans affects a more limited bone and cartilage portion of weight-bearing areas in older children (femoral condyle, talus). It is customarily said that osteochondritis deformans has a vascular origin while osteochondritis dissecans has a traumatic origin [6]. The reality is probably more complex. If osteochondritis deformans was exclusively vascular in origin, this would not explain the high proportion of hyperactive children with Legg-Calvé-Perthes disease. Furthermore, if osteochondritis dissecans was exclusively traumatic in origin, this would not explain why it does not consolidate like a fracture when immobilized. Both pathologies seem to be caused by multiple factors, including vascular, traumatic, and even microtraumatic etiologies. Thus, it seems more appropriate to use the term epiphyseal osteochondrosis deformans for injuries affecting the

whole ossification center and the term epiphyseal osteochondrosis dissecans for osteochondral injuries confined to weight-bearing areas. Therefore, both forms of osteochondrosis can be found in the same anatomical location. The most widely known example is the lateral condyle of the elbow in Panner's disease, which corresponds to osteochondrosis in children between the ages of 6 and 10 (Fig. 2), and osteochondritis dissecans in gymnasts over age 10 (Fig. 3).

### 3. Diagnosis

History taking is essential to making a diagnosis. Most of all, it optimizes prevention while minimizing the recurrence of overuse injuries. Mechanical pain is the main sign of overuse injuries [2,4]. It allows injuries to be divided into 4 stages [7]:

- stage 1: pain after physical activity;
- stage 2: pain during physical activity with no impact on function (can continue participating in activities);
- stage 3: pain during physical activity that lasts all day and has an impact on function (need to decrease or even stop the activities);
- stage 4: pain during all physical activities, even basic musculoskeletal functions.

Pain is generally hard to pinpoint in epiphyseal and physeal osteochondrosis. On the other hand, a child can easily locate pain caused by apophyseal osteochondrosis.

It is necessary to know how to look for the earliest signs of overuse—fatigue and decreased sports performance [1,4,7]. It is also necessary to be able to analyze the sports activity and the conditions under which exercise is performed. This relates to the child, equipment, and sports technique: What is the child's level of athletic ability? Does the child participate in the right age group? How many hours per week does the child spend on sports? Is there a nutritional or sleep disorder? Is the child really motivated to play sports? What type of playing surface is used (e.g., dirt, synthetic or natural turf for soccer)? Is the child's footwear appropriate for the playing surface? What types of balls, rackets, and other equipment are used? Have there been recent changes in the sports technique? Could improper technique be causing the overuse injury?

The clinical exam seeks first of all to reproduce the pain by palpation. The patient should be checked for muscle and tendon stiffness, especially in the lower limbs. Conversely, hyperlaxity can also be a source of midfoot pain in runners [8].

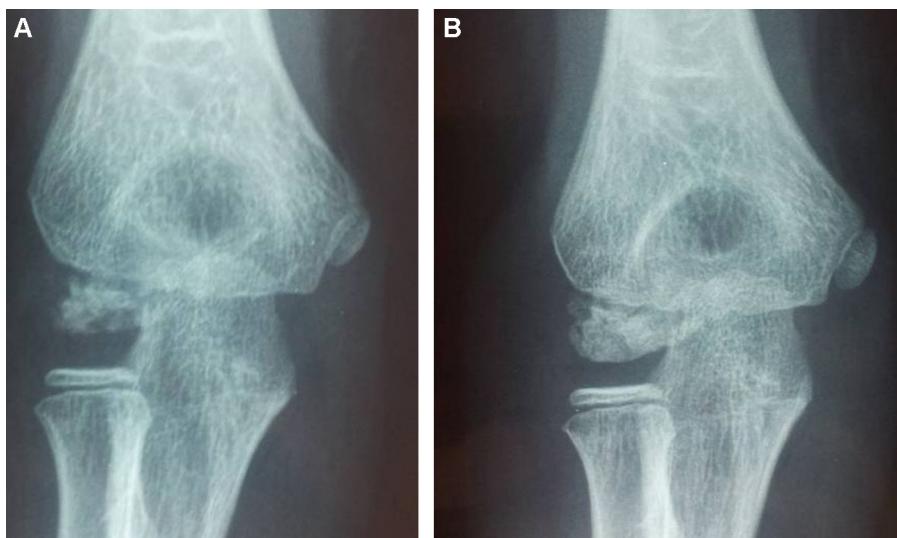
Imaging is rarely helpful in the diagnosis, but it should be requested in the case of unilateral injuries or unusual pain such as nighttime or inflammatory pain. There is a risk of too quickly assuming that the pain is caused by osteochondrosis when it could be the result of inflammation, infection, or even a tumor [2,9].

### 4. Major pathologies

#### 4.1. Upper limb

##### 4.1.1. Shoulder

Overuse injuries of the upper limbs are less common than that of the lower limbs. Shoulder injuries are even less common. Cases can be cited of rotator cuff injuries or subacromial impingement in patients who practice tennis, gymnastics, or handball intensively [10–12]. Physeal microtrauma can also be found in the proximal humerus with elongation of the proximal physis. These lesions are found mainly in baseball pitchers (Little Leaguer's shoulder) [12], but also in children who practice gymnastics, tennis, volleyball, or swimming [13].



**Fig. 2.** Panner's disease of the right elbow in an 8-year-old judo practitioner (A) with regeneration of the entire capitulum 8 months after stopping sports (B).

#### 4.1.2. Elbow

Elbow injuries most commonly occur in gymnasts, for whom the elbow is a weight-bearing joint. They are most common in the capitulum, which transmits 60% of the compression force [14].

Primary osteochondrosis, or Panner's disease, affects the entire capitulum in children from 6 to 10 years of age [4,6,14] (Fig. 2). Clinically, lateral pain and limited extension without locking are found. Radiographic changes progress toward fragmentation and then regeneration in 12 to 18 months as with any other primary osteochondrosis condition.

Osteochondritis dissecans affects only part of the capitulum in older children (Fig. 3). The right side is most often affected, once again pointing to the important role of trauma [6]. Lateral pain with extension limitation is also found, but episodes of elbow locking may occur. The osteochondral fragment is the site of avascular necrosis; this site will undergo the typical phases of repair with revascularization, invasion by granulation tissue, osteoclasia of the necrotic site, growth of a neoplastic osteoid, and finally remodeling.

Standard radiographs may show a lacuna, a loose body [4], or even enlargement of the radial head and accelerated bone maturation with early fusion of the epiphysis [6]. Magnetic resonance imaging (MRI) can be used to analyze the local vascularization, bone edema, and the articular surface.

Curative treatment consists of stopping the sport, maybe permanently if the symptoms persist. If there is no pain, resumption of the sport may be authorized, sometimes with motion protected by a splint and modification of movement [14]. Surgery with transchondral drilling, ablation of a loose body with curettage of the osteochondrosis site, or osteochondral autograft may be recommended if conservative treatment fails, if the MRI shows articular surface damage, or a loose body is present [14,15].

The prognosis should be guarded because the capitulum is a mature center with little remodeling capacity. In general, injuries that are obvious on standard radiographs do not have a good prognosis with conservative treatment and may lead to osteoarthritis [14].

#### 4.1.3. Wrist

The most common condition is physeal osteochondrosis of the distal radius in gymnasts [5].

Anatomically, adolescents tend to have a negative ulnar variance, meaning that the ulna is shorter than the radius. Therefore, carpal impingement in gymnasts tends to occur in the radius, which is a bit longer, leading to physeal injuries characterized by lack of mineralization in the ossification area of the growth plate. This appears on standard radiographs as physeal elongation followed



**Fig. 3.** Panner's disease of the right elbow 2 years after onset in a 14-year-old tennis player complaining of pain and joint locking. The radiograph shows a sequestered fragment while the MRI shows a loose body, which was surgically removed.



**Fig. 4.** Chronic pain of both iliac fossa in a high-level 15-year-old gymnast who presented with lesser trochanter avulsions.

by bone condensation on its metaphyseal slope [3–5], and on the MRI as metaphyseal edema and metaphyseal cartilage inclusions as a low signal on T1-weighted images.

Treatment is based on the temporary suspension of athletic activities and, especially, immobilization before the growth plate closes prematurely. At the physis elongation stage, immobilization for 4 to 6 weeks allows the clinical and radiological symptoms to disappear [4]. It is better to immobilize the site with a plaster case instead of a removable splint, as this avoids early removal of the splint under pressure from parents and/or the coach [4].

#### 4.2. Pelvis and the hip

Legg-Calvé-Perthes disease will not be discussed here, as it has been the subject of previous lectures and is not related to sports injuries.

##### 4.2.1. Apophyseal injuries

Most of these injuries are located in the iliac spines, or even the lesser trochanter (Fig. 4) or ischial tuberosity. These tend to be acute avulsion injuries because the tendon insertion area at this level is narrow, unlike in the tibial tuberosity where the patellar tendon also forms an anatomical continuum with the periosteum,

and the large tuberosity of calcaneus or the Achilles' tendon forms a continuum with the plantar aponeurosis.

These apophyseal avulsions occur in a skeleton towards the end of maturation [2] when the powerful muscles are often shortened. The mechanism corresponds to a lack of synchronicity between the sudden contraction of a biarticular agonist muscle and the elongation of the antagonist muscle.

Anterior superior iliac spine avulsion (Fig. 5) is linked to traction of the sartorius muscle, usually during a sprint [4]. The mechanism is either passive hip extension coupled with active knee flexion or active hip flexion coupled with knee extension [16]. Anterior inferior iliac spine avulsion is linked to sudden contraction of the femoris rectus during a kicking motion, often in soccer [16]. Lesser trochanter avulsion is linked to traction of the iliopsoas muscle during sudden active hip flexion. Ischial tuberosity avulsion by the hamstrings and the adductor magnus can occur during passive hip flexion combined with knee extension or during active hip extension combined with knee flexion. Apophyseal avulsion around the hip is visible on standard radiographs; therefore, additional CT scans or MRIs are typically unnecessary.

For most authors, treatment is non-surgical and relies mainly on complete bed rest for 7 to 10 days, positioning the patient so that the injured muscle is at rest [2] followed by gradual resumption of weight-bearing activities. Once the pain has disappeared, the patient should be checked for stiffness in the injured muscles that could require secondary stretching treatment. Sports are generally not resumed until the end of the second month. Surgical repositioning and apophyseal fixation remains rare and does not seem to accelerate the resumption of sports [2].

##### 4.2.2. Athletic pubalgia

Symptoms suggestive of athletic pubalgia, usually seen in adults, are becoming more frequent in adolescents. Athletic pubalgia is a painful syndrome located in and around the pubis, which includes the following pathologies:

- enthesopathy of the rectus abdominis;
- enthesopathy of the adductors;
- microtraumatic pubic osteopathy;



**Fig. 5.** Anterior superior iliac spine avulsion in a 14-year-old soccer player (A) with bone consolidation appearing on radiographs taken 3 months later (B).



**Fig. 6.** Osteochondritis dissecans of the medial femoral condyle in a 13-year-old boy.

- pathology of the inguinal canal.

Several of these pathologies generally occur together in the case of soccer injuries. History taking must look for predisposing factors such as a change in the type of training, a change in the type of playing surface, and a problem with physical preparation. The clinical exam should check for pain while testing the various muscles involved in order to better detect the problem. Treatment consists first and foremost of rest and then of reprogramming the muscles of the abdominopelvic wall.

#### 4.3. Knee

##### 4.3.1. Epiphyseal osteochondrosis

The most common form is osteochondritis dissecans of the femoral condyle or König disease. It affects boys more often (sex ratio of 4:1) between the ages of 10 and 13. A morphological abnormality of the anterior leg is thought to be a predisposing factor [17]. It is present in 75% of cases affecting the lateral slope of the medial femoral condyle (Fig. 6).

The clinical exam has little diagnostic value. Mechanical pain, which increases on exertion and subsides at rest, is hard to pinpoint. The child feels pain on the medial aspect of the knee. Atrophy of the quadriceps muscles and slightly limited knee flexion can be found. Knee locking related to an intra-articular loose body is rare. Pain may also be found upon direct palpation of the femoral condyle by positioning the knee at approximately 120° of flexion.

The baseline radiographic assessment includes A/P, lateral, and intercondylar radiographs to view any posterior injuries. The assessment is generally supplemented by an MRI to evaluate the fragment vitality, growth potential, joint surface, and the interface between the bone and fragment. The osteochondrosis based on its progression on radiographs. The Bédouelle scale divides osteochondrosis into 4 stages:

- stage I or lacunar stage: an image of a well-delineated space with dense edges;
- stage II or nodular stage: a clearly distinguishable bone fragment in the space, separated from it by a radiolucent band. At this stage, the edge of the cartilage is unaltered;

- stage III or sequestration stage: the edge of the condyle is no longer regular. The cartilage is fissured. The sequestered fragment remains attached in the recess (small, spherical image);
- stage IV or loose body stage: the sequestered fragment floats freely within the joint.

Treatment is initially based on stopping athletic activities for about 6 months, during which weight-bearing is to be avoided if significant pain is present or if it is difficult to actually stop playing sports. The best results with this type of treatment are obtained at stage I when the growth plates are still open and the osteochondrosis covers less than 2.5 cm<sup>2</sup>. In this situation, healing occurs within 6 months in 50% of cases and within 18 months in 90% of cases [18]. If conservative treatment fails, surgery must be performed to accelerate the natural healing of the disease. This will consist of transchondral perforations in stage 2 [19] or osteochondral fixation in stages 3 and 4 (Fig. 7). Transchondral perforation consists of arthroscopically making holes in the cancellous bone with a drill bit or pin, resulting in formation of a localized clot and fibrocartilage production [20]. However, the mid-term results do not seem as good [21] because the mechanical and biochemical properties of fibrocartilage are inferior to those of normal hyaline joint cartilage. Sports can usually be resumed 4 to 6 months after transchondral perforation.

##### 4.3.2. Apophyseal osteochondrosis

The most common form is Osgood-Schlatter disease involving the tibial tuberosity. The tuberosity appears on radiographs at around age 9 in girls and age 11 in boys [4]. There are four successive radiographic stages of maturation [4,22]:

- ages 0 to 11: cartilage stage;
- ages 11 to 14: apophyseal stage;
- ages 14 to 18: epiphyseal stage;
- after age 18: bone stage.

Osgood-Schlatter disease occurs during the apophyseal phase between ages 12 and 15 in boys and 8 and 12 in girls. During the maturation (apophyseal) phase, the cartilage cells of the proximal part of the tuberosity migrate distally, replacing the fibrocartilage in the middle part. This makes the tuberosity unable to withstand the force exerted by the quadriceps, resulting in micro-avulsions (Fig. 8), with secondary ossification [4,22]. These bone fragments are incorporated secondarily into the remainder of the tibial tuberosity, which can result in sequelae of an enlarged tuberosity [2]. In rare cases, the fragments are not incorporated and intratendinous bone fragments can remain after growth stops, which must then be surgically removed [2].

Understanding this mechanism allows us to picture this disease at the tendon-tuberosity junction and rare avulsions of the patellar tendon [23]. The disease is not at the junction between the secondary ossification center and the rest of the tibia. Therefore, we agree with Vreju et al. [23] and Bauer et al. [24] that Osgood-Schlatter cannot be considered a predisposing factor in traumatic tears of the tibial tuberosity. In addition, the wide insertion area of the patellar tendon on the tuberosity, which even forms an anatomical continuum with the adjacent periosteum, explains why osteochondrosis is more common than tears.

Clinically, we find pain upon palpation of the tibial tuberosity, which may protrude (Fig. 9), stiffness of the hamstrings and rectus femoris [2], and stiffness related to the difference in growth rate between the bones and the myotendinous structures. History taking should include asking about using the wrong athletic shoes for the playing surface, especially by studying the shoe's stiffness and cushioning.



**Fig. 7.** Fixation of stage-3 osteochondrosis of the femoral condyle in a 15-year-old handball player.

Knee radiographs should be performed right away in cases of unilateral pain or persistent pain suggestive of an intratendinous ossicle. Ultrasound or even MRI [23,25] has been used by some to define the various stages and thus monitor the progress of the disease.

In terms of treatment, Osgood-Schlatter disease responds well to temporary suspension of athletic activities combined with custom plantar orthotic devices to provide cushioning, and stretching exercises. Immobilization with a plaster knee cast may be helpful [2] for pain in the tuberosity during extension of the rectus femoris, even though the pain is usually located right in the muscle itself. Athletic footwear should also be readjusted if it is inadequate.

In any case, the disease resolves spontaneously when the limbs stop growing at around Risser stage 1. When excision of an intratendinous ossicle is necessary, the patient and his/her family should be told that it usually takes several weeks or several months for the pain to disappear [2,26].

#### 4.4. Ankle and foot

##### 4.4.1. Osteochondritis dissecans of the talus

The primary locations are anterolateral and posteromedial, but posteromedial osteochondrosis is the most common form (Fig. 10). Anterolateral osteochondrosis is typically said to be traumatic (and even “macrotraumatic”) in origin, involving a sprain mechanism [27]. The origin of posteromedial osteochondrosis is more controversial. Some authors support a microtraumatic origin [6] while others support an ischemic origin [27]. As with all types of osteochondrosis conditions, it seems more reasonable to say that multiple factors, both traumatic and vascular, are involved. In fact, it is quite possible to imagine a traumatic origin when a sprain occurs with a varus movement and inward rotation, leading to mechanical impingement between the posteromedial part of the arch and the distal tibial epiphysis. This impingement triggers osteochondrosis due to poor vascularization of the talus.

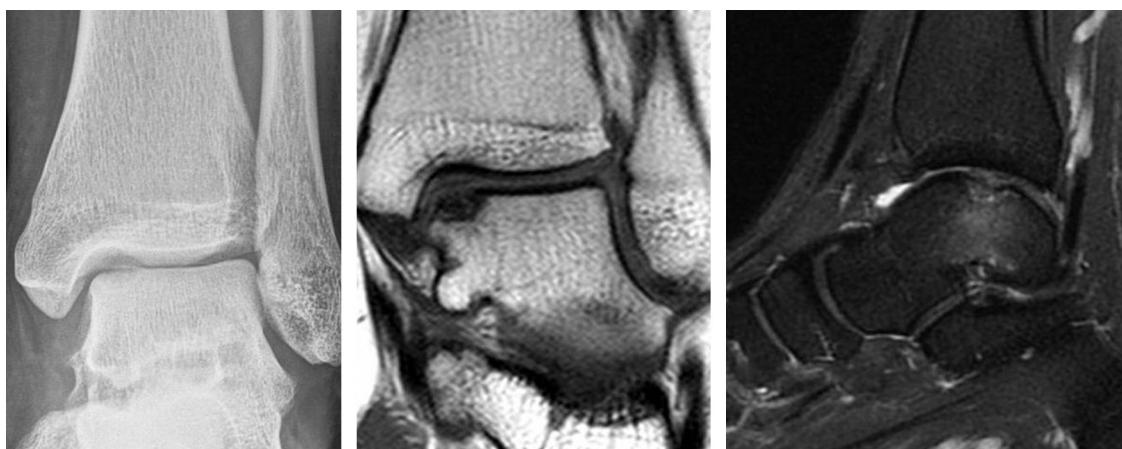
From a clinical point of view, it typically occurs in children over 10 years of age who practice court-based sports such as volleyball



**Fig. 8.** Ossification of a microavulsion of the tibial tuberosity.



**Fig. 9.** Prominent tibial tuberosity in a patient with Osgood-Schlatter disease.



**Fig. 10.** Posteromedial osteochondrosis of the talus in a 15-year-old girl.

or handball on a hard surface with inadequate footwear. Pain is mechanical in nature and medial. As with osteochondrosis of the femoral condyle, standard radiographs and MRI can be used to make a diagnosis and assess the articular surface. Treatment first consists of strict avoidance of sports [27] followed by possible surgical treatment using perforation, fixation, or even resection and curettage [28,29].

#### 4.4.2. Osteochondrosis of the calcaneus

Osteochondrosis of the calcaneus (Sever's disease) has the same pathophysiology as Osgood-Schlatter disease, that is, repeated traction of the Achilles' tendon at the secondary ossification center of the calcaneus. A shortened triceps surae is also found because of the difference in growth rate between the bone and the muscle, decreasing the cushioning between the foot and the ground. Moreover, the Achilles' tendon had a wide insertion area that is anatomically continuous with the plantar aponeurosis, preventing traumatic tears of the ossification center.

Clinically, it is found most often in boys between 8 and 12 years of age. Pain tends to be bilateral and asymmetrical. Shoe stiffness and cushioning must be evaluated to determine whether the shoes are appropriate for the type of playing surface. Radiographs are needed only for unusual forms such as a pure, unilateral condition. Treatment is based on a very brief suspension of athletic activities, plantar orthotic devices to provide cushioning [30], and exercises to stretch the plantar flexors and Achilles tendon [4].

#### 4.4.3. Other types of osteochondrosis

Osteochondrosis in other parts of the foot are rarer. Köhler's disease concerns children less than 8 years of age [30] with mechanical pain of the medial side of the foot. Radiographs show condensation and flattening of the navicular bone (Fig. 11). The navicular bone is completely restored within a few months. Treatment is symptomatic and based on suspension of athletic activities, plantar orthotic devices, or even short-term immobilization in a cast if pain is severe.

Other forms of osteochondrosis may affect the base of the fifth metatarsus (Iselin disease), the second or third metatarsal head (Freiberg's disease), or the sesamoid bones (Renandar disease). They are treated primarily by suspending athletic activities and using plantar orthotic devices, but an osteotomy of the metatarsal head may sometimes prove to be necessary in the case of Freiberg's disease.



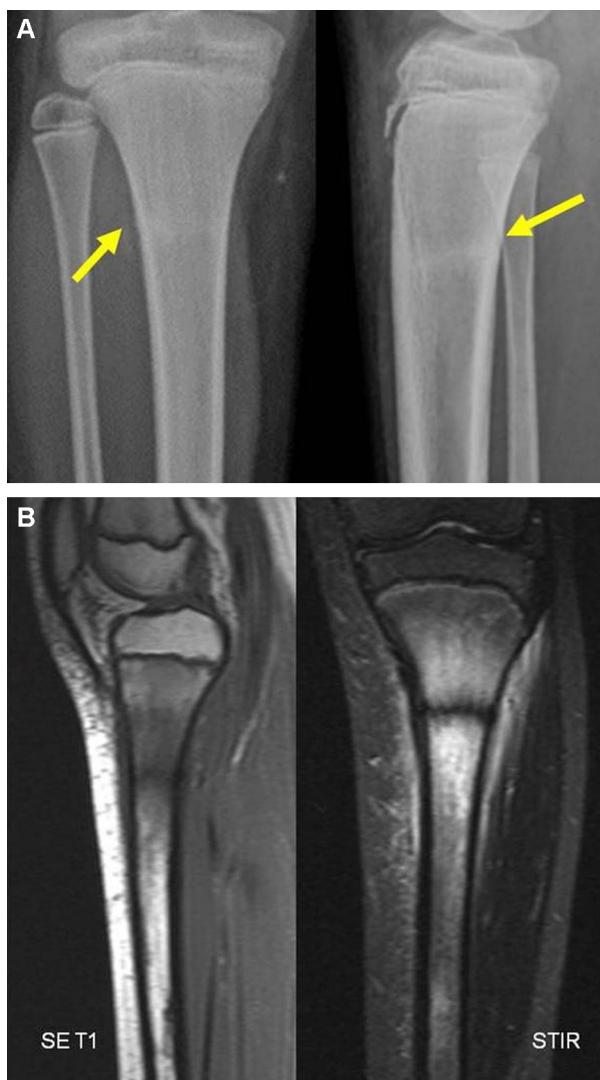
**Fig. 11.** Flattening and condensation of the navicular bone in a 5-year-old girl with Köhler's disease who practices dance.

#### 4.5. Stress fractures

There are no specific characteristics for pediatric stress fractures. They are caused by mechanical overload of a cortical bone, half of them occurring at the metaphyseal-diaphyseal junction of the upper end of the tibia [1,3]. Other common sites are the fibula and the metatarsals. Radiographic diagnosis is often delayed compared to the onset of pain. Most often, the first radiographic evidence is periosteal apposition that appears at the end of 3 weeks with bone condensation at the level of the fracture [3], which could suggest an infection or even a tumor. MRI allows a diagnosis to be made earlier since the symptoms appear as a markedly low signal on T1-weighted images (Fig. 12). The fracture usually heals with 1 to 2 months of strict sports avoidance.

#### 5. Prevention

Even if the child and the family request pain relief so the child can continue playing sports, it is important to implement



**Fig. 12.** Stress fracture of the proximal tibia in a 12-year-old soccer player. The fracture appears on radiographs as a linear condensation of cancellous bone (A). It appears as a low signal on T1-weighted MRI images (B).

preventive treatment to avoid repeated or chronic injury. Factors predisposing the child to overuse injuries need to be identified through extensive history taking.

First, it is important to insist on good lifestyle habits. Adult athletes need to have impeccable habits and there is no reason that the same should not apply for child athletes. Thus, a poor diet, inadequate hydration, and lack of sleep are factors that must be taken into account [7]. It is then important to identify the use of the wrong sports equipment, for example, soccer shoes that are too stiff for the usual playing field or tennis balls that are too hard for the child's age.

Next, the quantity and quality of sports practice must be analyzed. There is broad agreement on the 10% rule [1,3], which states that the workload should not be increased by more than 10% per week in order to allow good recovery. Depending on the sport, this means that training time, weight, distance, or speed should not be increased by more than 10%. With regard to the quality of athletic practice, it is important to involve the coach in order to better analyze the child's sports technique and any performance errors.

The child's level of physical fitness should also be taken into consideration. Flexibility greatly contributes to athletic performance and stiffness is a major factor in overuse injuries, which need to

be countered throughout the rapid growth phase of the limbs [12], even when pain is not present. Thus, it is important to insist on stretching exercises. All sports federations have agreed that passive stretching should be avoided before a practice session because it decreases muscle performance. Passive stretching should be done after practice sessions, but not right away, because passive stretches are eccentric stretches that could worsen the muscle microtears that normally occur during athletic practice. It would be best to organize sessions devoted specifically to stretching.

The child's stage of puberty must also be taken into account. Overuse injuries may be precipitated by parents or coaches who are unaware of the fragility of the cartilage structure before age 12. In the majority of cases, training for team sports is done with children in the same age range. However, this is a chronological age. Since the age at which puberty begins varies widely, it is understandable that when the workload is the same for everyone, is a bit too heavy for some. Thus, even if it is difficult in practice, the teacher or coach must be made aware of this problem in order to best adapt the workload to each child.

There is also a consensus that early sports specialization should be avoided [1,31] so that different muscle groups are worked. In any case, early specialization is no guarantee of athletic success, and even leads to an increase in the number of children dropping out of sports at around age 13.

Finally, the child needs to be engaged in preventive management. The child athlete must learn to listen to his or her body and express pain, which may allow the child to slow down, change, or stop the painful movement before overuse injuries become chronic. Even though this can be hard to get the child to do, the family must be involved. The early signs of overuse injury are fatigue and decreased performance, both in terms of quality and quantity [1].

## 6. Conclusion

Children can derive physical and psychological benefits from sports. Sports also play an undeniable role in socialization. Although the child's motivation is the first condition for practicing and pursuing a sport, pain remains the main factor limiting athletic performance. It is only under these conditions that children can minimize overuse injuries. The management of these injuries is not only medical—it must also involve the child, family, and coach. This makes the doctor's role easier and allows activities to be curtailed before they have to be completely prohibited.

## Disclosure of interest

The author declares that he has no conflicts of interest concerning this article.

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