Sports injuries in children

The number of children with sports injuries seen in sports medicine practices is increasing. The usual outcome is full recovery, but the consequence of a missed diagnosis of a more serious condition may be significant for the child.

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The important issue of encouraging children to be more active in an effort to improve their overall health is a complex public health problem.[1,2] Childhood sports participation in Australia has unfortunately declined over the past few decades. Some 86% of children aged 5 to 14 years were active in sport in 1985, but by 2003, the level of participation had fallen to 54% for girls and 69% for boys.[1] During this time period, the number of overweight and obese children had increased. At the other end of the spectrum, the more active children are now training in one or several sports more intensively and for longer periods of time than previously. In turn, the number of children with sporting injuries seen in sports medicine practices appears to be actually increasing.[1,2]

Fortunately, many of the sports injuries that occur in children are self-limiting and full recovery is the usual outcome. However, more serious conditions may occasionally occur and the consequence of a missed diagnosis, especially during the rapid pubertal growth phase, may be significant for the child.

Pain in a child should not be dismissed as 'growing pains'. If an informed systematic approach is followed, the clinical assessment of a child will be rewarding and straightforward and significant pathology should not be missed.

IN SUMMARY

- **The number of overweight children is increasing. However, children who are more active are training more intensively and for longer periods of time in one or several sports.**
- **There are significant differences in the types of injuries sustained by children and adults. These are due to the physiology of growing bones.**
- **Osteochondroses are conditions characterised by disordered endochondral ossification of the epiphyseal growth centre. Osgood–Schlatter's disease and Sever's disease are two relatively common osteochondroses. A less common osteochondrosis, osteochondritis dissecans, is discussed in detail here.**
- **The aphorism that 'not everything that presents as a sports medicine problem should be strictly regarded as a sports injury' is true in both adults and children. Differential diagnoses, such as tumours, infections, inflammatory conditions and serious hip pathologies masquerading as knee pain, should be considered in patients with atypical signs and symptoms.**
- **There are general guidelines that should be followed for training the young athlete and also more specific guidelines for particular sporting activities.**

Figure 1. Proximal right humerus greenstick fracture (arrow) in a 9-year-old girl.

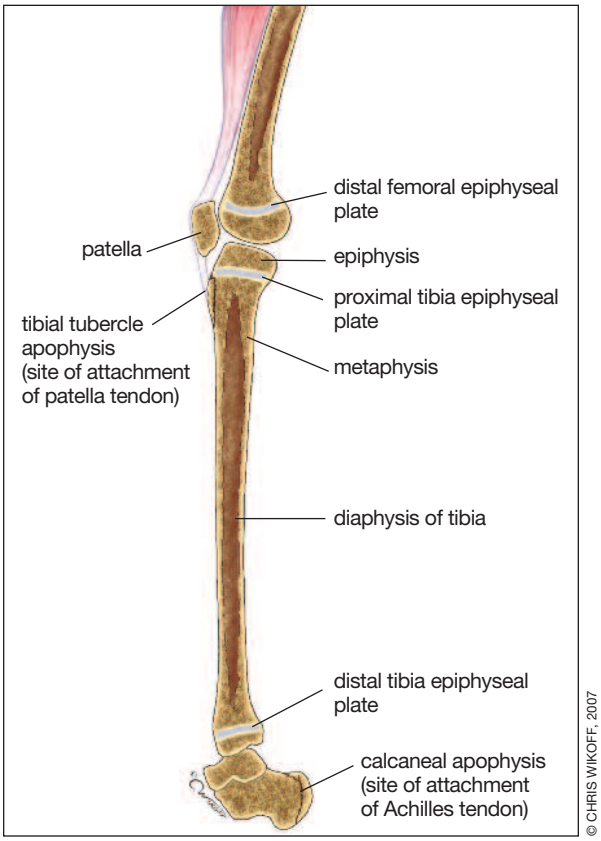

Figure 2. Growth cartilage in the knee and ankle region.

This article discusses the common paediatric sports medicine conditions and highlights the significant differences in the types of injuries that are sustained by children and adults.

History

The initial clinical approach to examining a child (especially a young child) requires emphasis on establishing rapport with the child so that an adequate history and examination may be performed.

The opportunity to observe a young child in the waiting room and when he or she walks into your office should be taken. A detailed history of a young child should be taken from his or her parents. Specific questions should address developmental milestones and also any relevant family history.[3] If a parent accompanies an older child, the clinician is advised to direct questions to the child first to develop rapport, and then to clarify any points at a later stage with the parent(s).

The growing skeleton

There are significant differences in the types of injuries that are sustained by children compared with adults. These are due to the physiology of growing bone. For example, the metaphysis in children is more elastic than in adults and hence fractures are often incomplete, such as greenstick fractures (Figure 1).

Both the metaphysis and the epiphysis, the areas either side of the growth plate (also known as the epiphyseal plate or physis) are vulnerable to injury, including macrotraumatic and microtraumatic events (Figure 2). Isolated ligament injury is rare in children younger than 14 years as the ligaments are stronger than the physes and epiphyses in this age group.[4] For example, avulsion of the tibial spine bony origin of the anterior cruciate ligament (ACL) may occur in a child (Figures 3a and b), whereas the same mechanism of injury in an adult will disrupt the ACL in its midsubstance. Therefore, it should be remembered that trauma resulting in

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Figure 3. Anteroposterior (a, left) and lateral (b, right) views of avulsion of the tibial spine bony origin (arrows) of the anterior cruciate ligament (right knee) in a 13-year-old boy.

Figure 4. Supracondylar femoral fracture (arrow), Salter-Harris II, in a 14-year-old boy.

ligament injuries in adults might, in children, result in bone or growth plate fractures (Figure 4) or ligamentous bony avulsions.[2,4-6] The spectrum of both macrotraumatic and microtraumatic injuries is therefore different in children compared with adults (Table).[1-7]

The apophysis, the site of tendon attachment to bone, is a cartilage site with a growth plate that is separate from the epiphyseal plate. It is relatively weak, particularly during the pubertal growth phase, and is known as the 'weakest link' in the musculotendinous unit in children. Injury often occurs at this site and is caused by either a macrotraumatic event (such as an acute injury that causes avulsion to a portion of the apophysis) or repeated

Table. Different types of sporting injuries in children and adults

Region	Mechanism	Injury type in child	Injury type in adult	Examples of provoking activities
Knee	Twisting/valgus force	Avulsion of the tibial spine origin of the anterior cruciate ligament, fracture of distal femoral or proximal tibial epiphysis	Anterior cruciate ligament disruption, +/- meniscal injury, +/- articular cartilage injury	Side step in football and netball
Knee	Overuse	Osgood–Schlatter's disease or Sinding–Larsen–Johannson disease[2,7]	Patellar tendinopathy	Running and jumping
Shoulder	Fall	Fracture of distal clavicle epiphysis	Acromio-clavicular joint disruption	Football and skiing
Shoulder	Fall	Fracture of proximal humeral epiphysis	Dislocated gleno-humeral joint	Football and skiing
Thumb	Valgus force	Fracture of proximal phalangeal epiphysis	Ulnar collateral ligament disruption	Football
Pelvis/hip	Acute flexor/ extensor strain	Apophyseal avulsion of anterior inferior iliac spine or ischial tuberosity	Quadriceps or hamstring strain	Running and jumping
Heel	Overuse	Sever's apophysitis	Achilles tendinopathy	Running and jumping

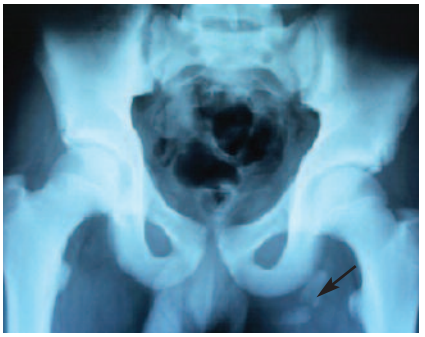

Figure 5. Left ischial tuberosity avulsion fracture (arrow) in a 14-year-old male sprinter.

microtraumatic events (such as repetitive overuse to the apophyseal area, which is termed apophysitis).[4] Microtraumatic events are more common than macrotraumatic events. An example of such an acute injury in children is avulsion of the ischial tuberosity of the pelvis (Figure 5). However, the same mechanism of acute injury in adults might result in a muscle strain injury, usually at the musculotendinous junction (e.g. a proximal hamstring muscle strain).[2,4,6] Another example of injury to the apophyseal area in children is avulsion of the medial humeral epicondyle (Figures 6a to c).

Elbow avulsion fracture in a 14-year-old baseball pitcher

Figure 6. a (top) Avulsion fracture of the left medial humeral epicondyle (arrow) in an elite 14-year-old male baseball pitcher caused by an acute on chronic mechanism. b (left) X-ray showing fracture (arrow). c (right) Follow up x-ray showing healing and remodelling of the medial epicondyle (arrow) 6 months after treatment, which included physiotherapy, relative rest, cross-training and graded return to sport. Errors in his pitching technique were also addressed to help minimise the risk of future injury.

Osteochondroses

Osteochondroses are conditions characterised by disordered endochondral ossification of the epiphyseal growth centre. The articular cartilages and the epiphyses of long bones are affected. There are over 70 osteochondroses and they are often named after the individuals who first described them.[2-7]

The causes of these conditions remain unclear although trauma (i.e. microtraumatic and macrotraumatic injuries), vascular and familial causes are hypothesised. These conditions usually present during periods of rapid growth, in particular the adolescent growth spurt. Osteochondroses are becoming more frequent and this is attributed to the increased training level of many children.[1,2,6,7]

Certain osteochondroses characteristically occur at different developmental times, determined mainly by the biological maturation of the affected anatomical site. Therefore, the underlying biology of the developing skeleton is the most important factor to consider.[3,7]

Osteochondroses have been broadly classified into three groups, crushing, splitting and pulling/traction osteochondroses. Examples of crushing osteochondroses are Perthes disease (affects the femoral head), Kienbock's disease (affects the lunate of the hand), Kohler's disease (affects the navicular bone of the foot), Panner's disease (affects the capitellum of the distal humerus at the elbow) and Freiberg's disease (affects the metatarsal head, usually the second). An example of a splitting osteochondrosis is osteochondritis dissecans (OCD), which results in a defined area of avascularity of the subchondral bone. Excessive traction from a large tendon may damage an unfused apophysis resulting in pulling/traction apophysitis. Examples in this group of osteochondroses are Osgood–Schlatter's disease (affects the tibial tubercle apophysis

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Figure 7. Romberg view of osteochondritis dissecans lesion (arrow), grade 3, in a 14-year-old male footballer.

Figure 8. MRI of osteochondritis dissecans lesion (arrow), grade 2, in a 14-year-old girl.

at the insertion of the patellar tendon), Sever's disease (affects the heel at the insertion of the Achilles tendon), Sinding–Larsen–Johannson disease (affects the inferior pole of the patella), Iselin's disease (affects the base of the fifth metatarsal) and Menelaus-Batten disease (affects the patella at the insertion of the quadriceps tendon).

Osgood–Schlatter's disease and Sever's disease are the relatively more common osteochondroses and have been discussed in a previous issue of *Medicine Today* (October 2005).[7] OCD of the knee is less common but nevertheless important in clinical practice and is discussed below.

Osteochondritis dissecans

OCD results in a defined area of avascularity (necrosis) of the subchondral bone and most commonly affects the convex articular surfaces of joints such as the knee, elbow, ankle, hip and talus.[4,5] The knee is the most commonly affected joint, followed by the talus and elbow.

OCD of the knee most often affects the following regions of the joint:

- lateral aspect of the medial femoral condyle (in about 75% of cases)
- lateral femur condyle
- patello-femoral joint (rarely affected).

OCD of the knee affects three times as many boys as girls, and is bilateral in approximately 25% of cases with an incidence of four cases per 1000 males, although this is increasing. Patients with OCD typically present between 10 and 20 years of age with poorly localised pain, swelling, catching and/or locking (OCD is the most common cause for an intra-articular loose body in children). Examination of the knee usually reveals associated effusion and quadriceps wasting.

Plain radiography findings usually define the OCD lesion. It is important to remember that a tunnel view of the intercondylar notch (Romberg view) is required to define the lesion, which is most often on the lateral aspect of the medial femoral condyle (Figure 7).[8] Some clinicians obtain a bone scan to demonstrate whether the lesion is 'active' and therefore potentially capable of healing. Results of a relatively 'cold' scan suggest there is unlikely to be any further healing.[4] A bone scan does, however, expose the child to a significant amount of ionising radiation and nowadays is generally considered unnecessary.[9] Most clinicians routinely use MRI in their diagnosis and management of these patients.[2] In most cases the articular cartilage remains intact

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Figure 9. Osteochondritis dissecans lesion (arrow), grade 4, with associated intra-articular loose body in a 18-year-old male.

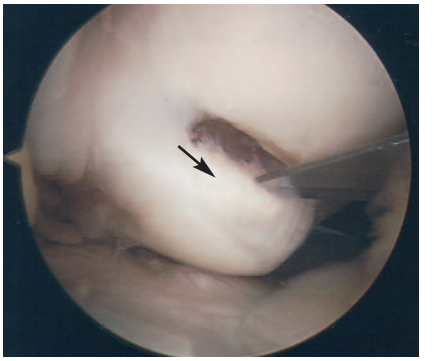

Figure 10. Osteochondritis dissecans lesion (arrow), grade 3, seen at arthroscopy in a 15-year-old girl.

Figure 11. Malignant chordoma (arrow) of the cervical spine in a 12-year-old girl.

(grade 1 to 2 OCD lesions) and there is a variable degree of separation of a fragment from the surrounding subchondral bone (Figure 8).[2-4]

The earlier the diagnosis is made and the patient restricted in his or her activity, the better the prognosis. However, some patients present late with frank separation of the osteochondral fragment or an intra-articular loose body, which are grade 4 OCD lesions (Figure 9).[2-4]

The goal of treatment is to achieve intra-articular congruity with normal viable subchondral bone. Unfortunately, more than 50% of patients with OCD fail conservative therapy, most often because of poor compliance with prescribed activity restriction. The management of a patient with OCD depends on clinical, radiological and, if necessary, arthroscopic findings (Figure 10). Those with high grade lesions (i.e. grades 3 and 4) are treated surgically. Some surgeons remove the OCD fragment and perform an osteoplasty/chondroplasty of the OCD 'crater', whereas others attempt to salvage the osteochondral fragment and internally fix it back *in situ* usually with an interference screw. Other salvage techniques, including osteochondral grafting/transplantation for larger lesions are not common practice in Australia.[2]

In general, the younger the patient with OCD, the better the prognosis. The prognosis is relatively good for those who are diagnosed with early stage lesions, with most returning to their normal level of activity level within four to six months of diagnosis. In these patients there is also a low incidence of subsequent premature osteoarthritis. In patients that present late with large lesions the prognosis is relatively poor, with a possibility of premature osteoarthrosis in adult life.[2]

'Red flag' conditions

The aphorism that 'not everything that presents as a sports medicine/musculoskeletal problem should be strictly regarded as a sports injury' is true in both adults and children.

Tumours

Benign and malignant (primary and metastatic) tumours occur in children. Local trauma that causes pain and swelling that is out of proportion to the mechanism of injury is often focused in the area in which a tumour is subsequently diagnosed (Figure 11) .

Children with tumours can present with pain, swelling or pathological fracture and this diagnosis should be kept in mind when the symptoms and signs are atypical.[4] Rest pain and night pain are 'red flags' for tumours that the clinician should enquire about.

Infection

The most common micro-organisms responsible for osteomyelitis are *Staphylococcus aureus, Streptococcus, Escherichia coli, Proteus* and *Pseudomonas*. Often no primary infective site is found and it is thought that the micro-organism is seeded to the bone or joint by haematogenous spread via the oropharynx. On other occasions the micro-organism spreads by direct extension from a wound.[4]

The most common presentation in children with osteomyelitis is pain (rest pain and night pain are again 'red flags'), warmth and tenderness of the affected part (usually metaphysis of a long bone) and an unwillingness of the child to move the adjacent joint. It is possible to get a sterile effusion in the nearby joint as the growth plate usually prevents the spread of infection into the joint. All children with this condition should be checked for diabetes or impaired immune function.[4]

Inflammatory conditions

Autoimmune conditions can occur in children and inflammatory arthritis should be part of the differential diagnosis for a sports injury, particularly when assessing a child with one or more atraumatic painful joint(s).[2,4]

Hip pathology masquerading as knee pain

The hip joint should be examined first in a child presenting with knee pain. Serious hip pathologies, such as Perthes disease and slipped capital femoral epiphysis, may present with knee pain only.

Considerations for training the young athlete

General guidelines for training young athletes are outlined below.[1-7]

- Specialisation of sporting activity is discouraged before 10 years of age. Young children are encouraged to participate in a wide variety of sports activities, with the emphasis on enjoyment.
- Organised sports activities require responsible adult supervision (e.g. protection of the child from dehydration, sunlight, being mismatched by physical size and dangerous sporting grounds and equipment).
- Children are more at risk of heat or cold illness than adults. Children have a greater surface area to body volume ratio and, in turn, are less efficient at thermoregulation – hydration and clothing are, therefore, important considerations.
- Coaching of children should be individualised to take into account differences in biological development, skill level, psychosocial maturation and enthusiasm. Children should never be ridiculed for mistakes. Constructive comments and coaching are essential as a negative experience for children may turn them off sport and exercise for life.
- Strength training is safe but should only be undertaken with light weights (e.g. the child should be able to easily perform more than 12 repetitions of a given weight without rest) and under adult supervision. In general, strength training will not arrest growth and therefore will not affect the genotypically determined maximal height for that particular child. Strength training before puberty leads to strength gains largely by neuromuscular facilitation because of low circulating levels of pubertal hormones. Strength training in adolescent boys enhances both neuromuscular facilitation and muscle hypertrophy because of higher levels of circulating testosterone.

There are guidelines for specific sports detailing the volume of training a child can undertake (e.g. the number of 'pitches' thrown in baseball or 'overs' bowled in cricket). This is to prevent the risk of repetitive overuse injury.

Nutrition for active children is essential for both appropriate growth and development and optimal sports participation. The growth and pubertal maturation of certain child athletes (e.g. gymnasts and ballerinas) is often delayed secondary to the mismatch between the calories consumed and calories needed for vigorous sporting demands, in addition to adequate growth. These children experience 'catch up' growth when they stop training and research shows that most do eventually reach their genotypically predetermined adult height. However, significant prolonged poor nutrition (chronic negative energy balance) during the growth period may result in menstrual/pubertal delay, growth retardation, disordered eating, poor bone health, excessive fatigue and increase risk of injury.

The 'ugly parent syndrome' creates a delicate situation for a clinician and all concerned. Signs of this syndrome may include the use of bad language and displays of physical aggression by parents watching their children participating in sporting events. Intervention is warranted if the child's health is at risk. An opportune time to confront this issue is at a consultation for an injury, but the issue should be discussed with the parent(s) alone, not in the presence of the child.

Conclusion

The management of musculoskeletal sporting injuries in children requires both an understanding of the biological differences between children and adults and the age-specific injuries children may suffer. With this knowledge the clinician will gain great satisfaction out of caring for these patients and their families. MT

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