

Common Lower Limb Sports-related Overuse Injuries in Young Athletes

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Abstract

Introduction: Sports injuries in children and adolescent present a unique challenge to the physician. They are often seen for clinical conditions unique to their age group. This paper highlights the epidemiological aspect of sports-related overuse injuries in this age group. **Materials and Methods:** This retrospective study reviewed all the paediatric patients diagnosed with overuse injuries during a 5 years and 7 months period. The overuse injuries were anterior superior iliac spine avulsion fracture, Osgood-Schlatter disease, Sinding-Larson-Johansson disease, osteochondritis dissecans and Sever's disease. We reviewed the literature and attempted to give an overview for each condition and the anatomical differences that contributed to their occurrence in this age group. **Results:** A total of 506 cases of the overuse injuries were seen during the study period. Seventy-three per cent were male patients. The knee joint was the commonest affected joint while the hip was the least affected joint. The mean age at diagnosis was younger in female compared to male for all conditions except in Sinding-Larson Johansson syndrome. Female was diagnosed at a mean age of 11.7 years while male at 10.8 years. Osgood-Schlatter disease was the commonest among the overuse injuries. There was no discernible racial predilection for these conditions except in the patients with anterior superior iliac spine avulsion. **Conclusions:** Overuse injuries are not uncommon in children and adolescent. An adequate understanding of the anatomy of the sports the children participated in as well as the anatomical differences between adult and children may assist the primary care providers better meet parents' and coaches' expectations.

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Introduction

Treating sports injuries in children and adolescent presents a unique challenge to the physician. They are different anatomically and physiologically from adults. It has been reported that 5% of mature athletes presented to the emergency departments to seek treatment for sports-related injuries.¹ The incidence is probably higher in young athletes, at 8% to 10%.² They are often seen for clinical conditions that are distinct to their age group. This paper highlights the epidemiology, clinical symptoms and treatment of sports-related overuse injuries in young athletes. In addition, we would like to draw the attention of readers to the developmental differences between adults and children that would contribute to the understanding of this entity.

Materials and Methods

All medical records of paediatric patients who had been

seen in the Orthopaedic Departments of KK Women's and Children's Hospital, Singapore (KKH) and National University Hospital, Singapore (NUH) with lower limb sports-related overuse injuries from January 2002 to July 2007 were reviewed for this retrospective study. The overuse injuries were anterior superior iliac spine (ASIS) avulsion fracture, Osgood-Schlatter disease (OSD), Sinding-Larson-Johansson syndrome (SLJS), osteochondritis dissecans (OCD) and Sever's disease. Patients were identified using a computer generated database system, which was used to record diagnosis on initial outpatient specialist consultation. The diagnosis was made by specialists in the field of Orthopaedics with the necessary qualifications (i.e. registrars or consultants) with the aids of imaging studies, usually a plain radiograph. Data extracted were age at diagnosis, race, gender, source of referral to the orthopaedic outpatient department, clinical features, bilaterality of symptoms,

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treatment received and whether hospitalisation was needed. The data were analysed using SPSS version 15.0 (Chicago, Illinois) software. Means and percentages were calculated. The student's *t*-test was used to compare the means between 2 groups of continuous data. $P < 0.05$ was considered statistically significant. We reviewed the literature and provided an overview of the musculoskeletal differences between adults and children; and the gender differences that contribute to the occurrence of overuse injuries in this group of patients. Each of the conditions was discussed individually.

Results

A total of 506 consecutive cases of sports-related overuse injuries were seen during the study period of 5 years and 7 months (Table 1). The mean duration of follow-up was 15 months. Most of the patients were male (73%). The mean age at diagnosis of overuse sports-related injuries was 11.5 years (Table 2). In male and female, it was 11.7 and 10.8 years respectively ($P = 0.001$). The age at onset was earlier in female for all conditions except SLJS. The most commonly affected area was the knee (66.9%) followed by the foot, while the hip was the least affected joint. Among the overuse injuries examined, the most common diagnosis was OSD. Sever's disease was diagnosed at the youngest mean age of 9.9 years, while avulsion of ASIS occurred at the oldest mean age of 12.8 years. There was no discernible racial predilection for these conditions except in the group with ASIS avulsion. The number of patients however ($n = 12$) was small.

Majority of the patients with tractional apophysitis were referred to the orthopaedic specialists by doctors from non-emergency departments that included specialists from other disciplines, private general practitioners or doctors from polyclinics. The reversal trend was seen in patients with ASIS avulsion and OCD (Table 3). Hospitalisation was required in patients with ASIS avulsion ($n = 5$) and OCD ($n = 3$). The rest of the patients were being treated on an

outpatient basis. Some of the patients had bilateral symptoms affecting both lower limbs either sequentially or concurrently. These were seen in OSD (35%) and Sever's disease (61%). The clinical features of overuse injuries are summarised in Table 4.

All patients with ASIS avulsion complained of hip pain with localised tenderness. Most had pain for less than a week's duration ($n = 8$). All patients admitted were seen in the emergency department and discharged the next day. Patients with pain for more than a week's duration ($n = 4$) were referred in from non-emergency departments. All were treated conservatively. They had bed rest followed by physiotherapy. All patients returned to normal activity at or before the last review.

In OSD, 80.6% had localised pain. None of them had effusion. Only 61.2% had knee pain. During the acute phase, patients were treated with rest, analgesia, and prohibited from jumping and running. One week later, quadriceps-stretching physiotherapy was started. They were allowed to return to sports as tolerated. In SLJS, clinical features observed were knee pain ($n = 7$), localised tenderness ($n = 12$) and effusion ($n = 0$). The patients were treated similarly to those who had OSD.

Table 1. Total Number of Overuse Injuries According to Race

Diagnosis	Race				Total
	Chinese	Malay	Indian	Others	
ASIS avulsion	4 (33%)	4 (33%)	4 (33%)	0 (0%)	12 (2.4%)
OSD	220 (71%)	48 (15%)	31 (10%)	11 (4%)	310 (61.3%)
SLJS	10 (72%)	2 (14%)	2 (14%)	0 (0%)	14 (2.8%)
OCD	4 (66%)	1 (17%)	1 (17%)	0 (0%)	6 (1.2%)
Sever's disease	123 (75%)	16 (10%)	16 (10%)	9 (5%)	164 (32.4%)

ASIS: anterior superior iliac spine; OSD: Osgood-Schlatter disease; SLJS: Sinding-Larson-Johansson syndrome; OCD: osteochondritis dissecans

Table 2. Mean Age at Diagnosis of Common Overuse Injuries According to Gender

Diagnosis	Age (y) (mean)		
	Male	Female	Overall
ASIS avulsion	13.3	11.7	12.8
OSD	12.7	11.5	12.4
SLJS	11.0	14.7	11.0
OCD	11.6	10.4	11.3
Sever's disease	10.0	9.4	9.9

ASIS: anterior superior iliac spine; OSD: Osgood-Schlatter disease; SLJS: Sinding-Larson-Johansson syndrome; OCD: osteochondritis dissecans

Table 3. Source of Referral to the Orthopaedic Outpatient Departments

Diagnosis	Source of referral	
	Children emergency (CE)	Non-CE
ASIS avulsion	67%	33%
OSD	18%	82%
SLJS	14%	86%
OCD	67%	33%
Sever's disease	23%	77%

ASIS: anterior superior iliac spine; OSD: Osgood-Schlatter disease; SLJS: Sinding-Larson-Johansson syndrome; OCD: osteochondritis dissecans

Table 4. Clinical Features of Diagnosed Overuse Injuries and Their Frequency

Diagnosis	Clinical features	Percentage observed
ASIS avulsion	Hip pain	100%
	Localised tenderness	100%
	Pain for <1 week	67% (8/12)
	Pain for >1 week	33% (4/12)
OSD	Anterior knee pain	61.2%
	Localised pain	80.6%
	Knee effusion	0%
SLJS	Anterior knee pain	50% (7/14)
	Localised tenderness	86% (12/14)
	Knee effusion	0%
OCD	Knee pain	67% (4/6)
	Knee effusion	50% (3/6)
	Localised tenderness	17% (1/6)
Sever's disease	Heel pain	76.2%
	Localised tenderness	83%

ASIS: anterior superior iliac spine; OSD: Osgood-Schlatter disease; SLJS: Sinding-Larson-Johansson syndrome; OCD: osteochondritis dissecans

In the lower limbs, all OCDs were found in the knees. The clinical features of OCD were knee pain ($n = 4$), knee effusion ($n = 3$) and localised tenderness ($n = 1$). All patients had lesions at the lateral aspect of the medial femoral condyles. Five patients had stage 1 (non-displaced) and 1 patient had stage 2 (loose but undisplaced) OCD. Stage 1 patients were treated with non-weight bearing cylinder cast for 6 weeks. Stage 2 patients ($n = 1$) were treated with antegrade drilling of loose but undisplaced fragment. All patients were asymptomatic at the last reviews.

Patients with Sever's disease presented with heel pain (76.2%) and localised tenderness (83%). They were treated with stretching of Achilles tendon. Heel cups were advised for a third of the patients. One hundred and thirty patients (79%) had their symptoms resolved within 3 months. The remaining 34 patients (21%) were symptomatic after a year.

All patients underwent conservative management initially. None of the patients with overuse injuries had surgical intervention except 1. This patient had OCD.

Discussion

Anatomy is an important consideration when explaining sports-related overuse injuries unique to the paediatric age group. Paediatric patients are different and they should not be treated as mini-adults. A growing child has a larger head

size proportionally and a larger body surface to mass ratio with shorter extremities. The immature skeletal system expands both circumferentially and longitudinally from the growth plates. The growths of musculotendinous units are stimulated by the longitudinal growths of the skeletal system. Each of the musculotendinous unit is attached to the bone by an apophysis, which is made up of fibrocartilage. The differential in growth of the skeletal system and the musculotendinous unit may result in disproportional length (myo-osseous disproportion) that subjects the apophysis to pronounced tensile force in particular during growth spurts. They are thus more susceptible to repetitive microtrauma or avulsion injuries.

The age at onset of sports-related overuse injuries is different for both genders. During childhood, both genders are comparable physically and physiologically. This starts to change with puberty. Girls enter puberty on average 2 years earlier than boys at 9 to 11 years old. This almost coincides with the mean age of overuse sports-related injured at presentation. During this stage, rapid gains in height and weight take place with increased speed, enabling them to generate more force and power. Adolescent girls develop broader pelvis with relatively greater varus at the hips and a greater valgus at the knees. This results in greater quadriceps angle. Muscle strength is less in girls compared to boys. The upper body strength is 30% to 50% of similarly trained male peers while the lower body strength is 70% that of male. Adolescent girls however are more flexible and better at balancing tasks than boys.³ This growth spurt which is primarily driven by sex hormones predisposes the male athletes to more aggressive and risky behaviour. The above reasons probably explained the significant number of male patients in this study.

Most of the injuries seen in this population were as a result of running and ball-type activities. The contribution of each is difficult to determine in this retrospective study. Schmidt compared the frequency of sports injuries with their physical location and found that 34.5% occurred in the lower extremity.⁴ The knee joints were commonly involved followed by the foot and ankle joints. We found a similar trend in the overuse injuries.

Hip pain is relatively uncommon as a presentation of sports injuries. The deep-seated hip joint is well protected by thick musculature. This made localisation of pain somewhat difficult. In ASIS avulsion fracture, we were able to localise the pain in all patients due to the subcutaneous nature of the anatomy. The pain may further be exaggerated with passive stretch or resisted contraction of the sartorius. The older age at presentation may suggest that larger forces are needed to cause damage. Two groups of patients were seen in our population. They have either pain for less than a week or more than a week. In the former, they were



Fig. 1. Anterior superior iliac spine avulsion (black arrow) was avulsed on the left hemi pelvis.



Fig. 3. Right knee AP radiograph showing osteochondral dissecans of the knee. The white arrow points to the osteochondral lesion at the medial femoral condyle, which is the commonest location.

admitted due to the severity of the pain or the displaced nature of the avulsed fragment (Fig. 1). Admission was probably not warranted in most of the patients. In the latter group, the pain may result from chronic tractional apophysitis or non-displaced ASIS avulsion due to the stronger periosteum. In our experience, conservative treatments with analgesia and rest were sufficient in both groups. Surgery is rarely indicated.⁵

Anterior knee pain is a frequent cause of complaint in young athletes. Among the overuse injuries around the knee, OSD occurs at the distal insertion of the patella tendon at the tibial tuberosity, while SLJS occurs at the proximal insertion of the patella tendon to the inferior pole of the patella. We diagnosed 22 cases of OSD for every SLJS. In OSD, the cause is thought to be secondary to the



Fig. 2. Radiograph on the left depicts a lateral knee with un-united free ossicle (black arrow) in a patient with Osgood-Schlatter syndrome. The radiograph on the right (white arrow) showed a patient with Sinding-Larson-Johansson syndrome.



Fig. 4. Right lateral calcaneum radiograph of a child showing increased radio-opacity over apophysis of the calcaneum (black arrow). He was diagnosed with Sever's disease.

tractional pull of the tibial tuberosity when the knee is flexed.⁶ The smaller number of patients with SLJS suggests the stronger apophysis in the distal patella. In addition, we noticed an earlier age at onset of SLJS in boys compared to girls. We postulate that the higher quadriceps angle in female couple with the less powerful muscle strength may be the reason behind its delayed onset. A larger number is needed to confirm these findings. Thirty-five per cent of our patients with OSD had symptoms on both knees, which is similar to other series.⁷ The examination localised tenderness and swelling to the tibial tubercle in most but not all the patients during the presentation. The symptoms had subsided due to the delay in referral. Radiographs often show fragmentation and irregular ossification at the tibial tubercle (Fig. 2). This study is limited by the lack of patients'

outcome in this subgroup. However, we believe quadriceps stretching, either actively or passively, is effective in helping patients with OSD and SLJS to alleviate the myo-osseous disproportion. Some authors suggest surgical treatment in OSD when the pain is persistent and chronic; by excising all intratendinous ossicles and removal of prominent tibial tubercle with good results.⁸ We did not find this necessary so far.

Juvenile OCD of the knee was uncommon in our population. Its typical appearance on radiograph is shown in Figure 3. Adjuvant imaging including magnetic resonance imaging (MRI) was used to determine the size and stability of the lesion. We treated all our patients (all stage 1 and 2 OCD) with non-weight bearing cylinder cast for 6 weeks in boys who were younger than 14 years and girls who were younger than 12 years as they had good remodelling potential. It has been suggested that, in patients with stage 1 OCD, the absence of sport activity without the need for immobilisation is sufficient.⁹ We feel that over treatment is a better strategy. All our patients did not suffer any adverse outcome from the immobilisation. In older patients with stage 2 OCD, we performed antegrade drilling. It is thought that channels created by antegrade drilling allow potential revascularisation. So far, the only patient who had open femoral physis responded well to this treatment.¹⁰

In this study, Sever's disease was the most common cause of heel pain in adolescent athletes. The mean age at diagnosis was the youngest among all the conditions, possibly reflecting the higher loading points at heel strike during locomotion when the gaiting is relatively immature. Radiographs of the calcaneum may appear normal or show fragmentation of apophysis (Fig. 4). In patients who have no pain on presentation, the diagnosis is often established by fragmented apophysis of calcaneum. The cause is contentious. It is often thought to be the result of tractional apophysitis secondary to the repetitive injury of the gastrocnemius-soleus complex attachment to the calcaneum. Ogden et al,¹¹ however, showed in a small series of patients on MRI that it may be a metaphyseal trabecular stress fracture rather than apophysitis as previously thought. The authors suggested MRI for patients whose symptoms did not resolve with conservative treatment. In our opinion, MRI remains a research tool due to its cost, availability and the limited intervention despite a positive finding. In our patients, treatments at the acute stage are similar to other types of apophysitis. Heel cups were underused in this series even though it was shown to be effective.¹²

Conclusions

Sports-related overuse injuries in young athletes are not uncommon. Localised tenderness is often found at the areas of apophysitis. The mainstays of treatments are symptomatic relief and passive stretching of the involved muscle to relieve tensile force acting across apophyseal plates. Surgery is rarely needed in these conditions. The World Health Organisation in conjunction with the International Federation of Sports Medicine issues a consensus statement on organised sports for children.¹³ It is recommended that health professionals should take steps to improve their knowledge and understanding of organised sports as well as risk and safety factors inherent to the sports participation. In addition, we also recommend physicians to be aware of developmental differences between young athletes and mature athletes in order to better treat the conditions and manage expectations of parents and coaches.

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