Literature Review

Childhood injuries in sport

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Abstract

An increasing number of children undergo intensive training and high level competition from an early age. Physical training may foster health benefits, but many children are injured as a result of it. Carefully controlled studies on the effects of training routines from childhood are however lacking. Measures to modify the present structure of competitive sport should avoid the possible deleterious effects of intensive physical activity on children.

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1. Introduction

The past decade has seen an explosion in the number of children participating in team and solo sports. At a young age, sport is for enjoyment, health and personal development. This balance changes as a competitive element intervenes. Subsequently, young athletes train harder and longer and participate in sport during the whole year. Injury patterns are changing, and overuse injuries are now becoming more prevalent.

It helps to classify injuries in terms of general or sports specific, especially when trying to improve safety. The scientific literature recognises training for optimum performance which invariably means starting at an earlier age. The scientific literature concentrates on optimum performance training, recognition of injury patterns and prevention. A number of good reviews exist although the number of basic longitudinal studies is limited (Castiglia 1995; Coulon et al. 2001; Crossley et al. 1999; Helms 1997; Kibler & Saran 2000; Landry 1992; Maffulli et al. 1996; Micheli 1983; Purvis & Burke 2001; Wickiewicz 1987). Relevant sporting bodies have discussed aspects of children in sport, producing ad hoc recommendations which are easily obtainable. Injuries can be due to either macro or repetitive micro-trauma (overuse).

This article reviews the current literature and summarises some of the more common sports specific injuries.

2. Incidence

The true incidence of sports related injuries is unknown as a result of differences in definitions and study design. It is perhaps reassuring that, despite the number of minor cuts and grazes, reported time off school or training is low. Indeed, Patel and Nelson (2000) state that many injuries are dealt with at home or in the primary care setting.

Sports risk is best represented as a ratio of hours of exposure and participation. This is better than recording hospital admission rates in relation to the local paediatric population or relying on retrospective recall as summarised by Junge and Dvorak (2000), Mcgrath and Beattie (1996).

The distinction of injury during recreation, training or competition is also valid; Stevenson et al. (2000) suggest that recreational sport is relatively safe.

Studies in the early 1980s reported injury rates of approximately 3–11% of school age children per year. This agrees with more recent evidence, and a recent Swedish study by Peterson et al. (2000) has quoted two severe injuries per player per year for football, half due to contact and half to foul play. Understandably, sports involving contact and jumping incur a higher rate (Hassan and Dorani, 2001; Maffulli and Baxter-Jones, 1995). This rate also increases with age. Children may be more prone to overuse injuries compared to adults due to a number of factors.
Young elite athletes, however, appear to have low rates of injury. This may reflect a different sub-population or better understanding and support. Severe or catastrophic injury rates are unknown and possibly unreported. Such injuries include commotio cordis, head injuries and spinal injuries resulting in permanent disability (Lateef 2000).

3. Financial aspects

Investment is necessary to deliver basic standards of physical education, maintenance of safety and development of talent. In the United Kingdom since the early nineteen-nineties, this vast challenge has been talked by a number of bodies including: the Youth Sport Trust, Sport England, Sports Coach UK, Department for Education and skills, Department of Culture, Media and Sport, New Opportunities Fund, British Association of advisors and lecturers in physical education and the Physical Education Association of the United Kingdom (Annual review of Youth Sports Trust, 2000–2001).

Other trusts and charitable organisations exist, all concentrating on specific aspects of childhood sport. Government and independent support is always welcomed to promote further interest and development whatever the level of ability. The incentive for finding the would-be hopeful of the future will always exist, but sponsorship deals benefit an extremely small minority. Coaches must balance demands to resources and research should be continuous. The drive to change must not be secondary to litigation following injury.

4. Pathophysiology

Any part of the musculoskeletal system is potentially at risk of injury (Micheli, 1983). Recognition and management of acute macro-trauma affecting the musculoskeletal system is well established. Luckily, the majority are minor and long-term effects of these injuries is minimal, following a short period of rest, analgesia and rehabilitation (Kelm et al. 2001). Fractures occur in a variety of configurations depending on the mechanism. Growth plate injuries (Fig. 1) require special attention and can result in growth arrest or angular deformity (Schwab 1988; Pappas 1982; Tolat et al. 1992).

Overuse injuries have become more apparent for example: stress fractures, tendinopathies or bursitis. These require careful evaluation and an understanding of the causal mechanism.

Failure occurs when abnormal loads are applied in a direction or frequency in excess of the rate of adaptive changes by the tissues. Injuries occur at the peak of the growth rate. Best (1995) explains that this is due to the relative inflexibility of the musculotendinous units at a time when the bone length increases the fastest in relation to surrounding tissues.

5. Risk factors

There are a number of well established risk factors for paediatric injury in sport (Micheli et al. 2000; Wilkins 1980) (Table 1). With growth spurts there is a decrease in flexibility due to relative bone lengthening which, without prophylactic stretching, can predispose to an increased risk of injury. Training in improper environments or with incorrect footwear equipment can also result in injury. Cross training and gradual change in training schedules are good practice. Players should ideally be matched with appropriate body protection and supervision.

The role of orthoses with the excessive supinators and pronators is understandable, but the benefits for more minor gait abnormalities is as yet unproven. Balanced nutrition is vital: the amenorrhoeic anorexic female with reduced bone mineral density is a classic example. Although sport is implicated in earlier osteoarthritis due to secondary growth plate changes this is based on retrospective data. The true prevalence of lower limb growth plate arrest secondary to

![Fig. 1. Salter-Harris II fracture of the distal radial epiphysis.](image_url)
overuse is rare. High resistance training may predispose children to an increased risk of injury if not properly supervised (Faigenbaum, 2000).

6. Assessment and treatment

Presentation for macro-trauma is invariably not delayed. There is typically a good clear history and mechanism of injury. On examination, there will be pain and depending on the area of the body, swelling and deformity. This will allow the examiner to determine a likely diagnosis and whether any further investigations are warranted. Luckily, the majority of injuries are minor and require a short period of rest, analgesia and compression prior to graduated formal rehabilitation.

Micro-trauma or overuse injuries invariably give a more insidious onset of symptoms that are typically activity related. These symptoms will obviously depend very much on the anatomical location, and in younger individuals may present purely with a reduced performance or a limp. Localisation of the anatomical area injured can be difficult. History and examination are vital. The exact sport may give extra clues to the likely diagnosis. Further investigations may be required to confirm the diagnosis. Management generally requires a period of so-called relative rest with the child partaking in a different sport to allow healing whilst maintaining general condition. If this fails, then rest must be absolute and referral for specialist assessment is advisable.

Coaches are appropriately advised to observe attitude, behaviour and development which may give clues to neglect or abuse. This may be evident acutely or present as if there is a chronic injury. A number of books are available, for example, ‘Protecting Children. A guide for Sportspeople’ produced in conjunction with the National Society for the Prevention of Cruelty to Children and the Sports Coach UK (2002).

7. Typical injuries

A number of reviews detail typical paediatric injuries (Maffulli 1992; Maffulli et al, 1996; Metzmaker & Pappas 1983; Micheli & Klein 1991). These must be kept in context, as they can be caused by a variety of mechanisms and not solely attributable to sport.

Shoulder injuries. Clavicular injuries are common to all sports. The younger the child, the less the ultimate deformity, due to the greenstick variant of injury and fractures within a thick periosteal tube; the basis of the classification by Rockwood (1996). Comparative radiographs are helpful if the injury affects an ossification centre. Soft tissue injuries are common especially affecting the cuff and biceps tendon. Excessive throwing can damage the labrum. Dislocation is uncommon prior to closure of the growth plate, as this is the weakest area in the event of a fall.

Dislocation in the adolescent is typically traumatic, but multidirectional instability must be looked for. Recurrence as followed by Hovelius (1987) is highly likely due to age and the traumatic nature of injury.

Elbow injuries in sport are common as report by Pappas (1982). Plain radiographs in children are often difficult to interpret (Fig. 2), damage to major vessels or nerves may occur, and some children require operative treatment. The elbow is liable to develop post-traumatic stiffness, and damage to the growth plate can result in subsequent deformity. The gunstock varus deformity following a supracondylar fracture is well recognised. Pitchers are also prone to problems secondary to repetitive valgus strain. Mirowitz and London (1992) state that Magnetic Resonance Imaging is useful in illustrating soft tissue components to these injuries as part of the investigation of elbow pain.

Dislocation of the elbow is common in gymnastics and football. It can be associated with fractures of the medial epicondyle of the humerus, fractures of the neck of the radius, or injury to the median or ulnar nerve. At all ages, they require prompt reduction. Rehabilitation should be active, and we discourage return to sporting activities before eight to twelve weeks. The child should have regained a full range of movement before resuming full sporting activity.

Traction apophysitis occurs at the insertion of the triceps into the olecranon epiphysis in gymnastics, diving, wrestling and hockey. The young athletes complain of local pain and tenderness around the insertion of the triceps tendon, exacerbated by supporting their body weight with the arms. Radiographs may show marked fragmentation of the epiphysis. However, they are difficult to interpret because of normal variants in this region. Treatment consists of a period of rest from upper limb activities, and symptoms usually settle over three months. Long-term problems are rare.

Osteochondritis dissecans (OCD) of the humeral capitellum is well documented, and can occur in non-athletic...
children. The dominant arm is affected in little league baseball pitchers, from repeated valgus loading during pitching compressing the lateral side of the joint. In gymnasts, compression and rotation during weight bearing through the arm, and loading of the lateral side of the elbow increased by the physiological valgus of the elbow can affect the joint surface. The athletes present with mild elbow pain and some swelling, and are often unable to fully extend the elbow, which is often tender laterally. Radiographs are often diagnostic, but early diagnosis may require MRI or CT. The damaged area of the articular epiphysis can break away to form an intra-articular loose body. If recognised early, conservative management may be successful, with prescription of weight bearing on the upper limbs or of stressing the elbow. Loose bodies should be removed surgically or arthroscopically. As the articular surface is damaged and the joint not congruous, early osteoarthrosis can ensue. OCD of the radial head is rare. Diagnosis and treatment are along the lines of OCD of the humeral capitellum.

The entire epiphysis of the humeral capitellum is affected in Panner’s disease. Pain, swelling and limitation of motion of the elbow are evident. Diagnosis is based on plain radiographic examination. The lesion will heal but deformity, incongruity and osteoarthrosis may occur.

Epiphyseal growth plate overuse injuries result from repeated micro-trauma. Stress fractures through the olecranon epiphysis, reported in adolescent baseball players, gymnasts and wrestlers, present with pain in the posterior aspect of the elbow with local tenderness over the olecranon and decreased elbow extension. The growth plate is widened, and conservative treatment is recommended. Stress-induced changes in the distal radial epiphysis are well recognised in gymnasts, who present with wrist pain associated with some swelling and local pain on weight bearing and rotation of the wrist. Radiographs show widening of the growth plate with failure of the zone of calcification. With rest, the epiphysis recovers. The prognosis is good, although growth can be impaired, and the child may present with slight shortening of the radius compared with the ulna (Tolat et al., 1992).

Hip injuries. Various sites around the hip are weak because of the presence of unfused epiphyses and developing apophyses (Metzmaker and Pappas, 1983). Large fragments of bone can be avulsed with sudden unexpected loads. The anterior inferior iliac spine tends to fail during when the kicking foot is suddenly blocked. More often, when the foot hits the ground, the anterior inferior iliac spine is pulled off by the reflected head of rectus femoris. In similar circumstances, the psosas muscle can avulse the lesser trochanter. The whole apophyseal plate of the ischium can separate through the powerful pull of the hamstrings. This can happen in cross-country running when the ditch being jumped is wider than expected, and the leading leg is overstretched. More rarely, the anterior superior iliac spine can be avulsed by the action of sartorius in a bad gymnastics vault landing. The whole iliac crest apophysis can also be pulled by the abdominal muscles, although displacement is uncommon.

Typically, the young athlete gives a history of severe, immediate and well localised pain, and radiographs confirm the diagnosis. As the avulsions are deep, cryotherapy is unhelpful, and analgesia is the preferred option for pain relief, with rest and gradual return to activity as pain permits. Immediate surgery is usually not indicated, and late surgery is exceptionally required despite occasional dramatic radiographic changes.

Quadriceps contusions reported by Jackson and Feagin (1973) are local muscle bleeds associated with injury. As per other muscle injuries this may be from a direct blow, sudden explosive action or occasionally a more trival action. Treatment includes rest, ice, compression and analgesia. Restriction of sport is essential followed by a graduated return to sport. Healing with fibrous tissue, the area may be prone to further injury. Occasionally a lump is palpable and if there are any concerns a MRI is a useful tool to exclude a sarcoma.

Knee injuries. In the child, the epiphyseal plate is weaker than the ligaments, and valgus and varus stresses result in growth plate injuries instead of tears of the medial and lateral collateral ligaments. The knee may be unstable, and plain radiographs appear normal, but stress radiographs, taken under anaesthesia if the pain is severe, will reveal the epiphyseal lesion. Management consists of a short period of immobilisation followed by rehabilitation thereafter. These injuries may be very unstable, and some authors recommend percutaneous or internal fixation.

A similar imbalance between muscle and ligaments on the one hand and epiphyseal strength on the other may produce the classical anterior cruciate ligament (ACL) avulsion lesion in children (Fig. 3(a)). Lipscomb and Anderson (1988) have reported on true ACL tears in adolescents. The mechanism of injury is a flexion, twisting, or hyperextension injury with immediate pain and haemarthrosis. Following radiographs, an arthroscopic washout of the joint is performed, and a small cannulated screw is used to fix the bone fragment back into its place (Fig. 3(b)). Some laxity and lack of full extension is commonly experienced even with anatomical reduction.

Although children were considered at low risk for mid-substance tear of the ACL, an increasing number of such lesions, often associated with a lesion of the medial collateral ligament, are being reported. MRI can be performed to ascertain whether an ACL tear has indeed occurred. However, clinical examination is still paramount. Arthroscopy remains the gold standard for diagnosis. If the ACL is torn, operative reconstruction should probably be carried out despite the young age of the patients to prevent secondary meniscal tears and articular cartilage injuries. The procedure would normally give good results with a low subsequent risk of growth abnormalities.

Meniscal problems in this age group are unusual, are generally associated with a discoid lateral meniscus with
are the lateral aspect of the medial femoral condyle, the femoral head and the talus. Management of OCD depends primarily on the stability of the fragment, location and age of the athlete. In the appropriate joints, arthroscopy is the procedure of choice although advances in magnetic resonance imaging have made this modality a more viable non-invasive technique. Non-operative treatment in skeletally immature young athletes may allow resolution in circumscribed stable lesions. Surgical or arthroscopic removal of symptomatic loose bodies resulting from late OCD is recommended.

Sinding–Larsen–Johannsson lesion is a syndrome of tenderness and radiographic fragmentation localised at the inferior pole of the patella. The lesion is a calcification tendinopathy in an avulsed portion of the patellar tendon, and is self-limiting. The pulling action on the ossification centre of the tibial tubercle by the patellar tendon may cause inflammation and pain, determining the clinical entity known as Osgood–Schlatter’s lesion. Both the Sinding–Larsen–Johannsson lesion and the Osgood–Schlatter’s lesion occur between 8 and 13 years in girls, and 10 and 15 years in boys. Boys are nearly twice as affected than girls, possibly because of their higher activity levels.

The leg. Overtraining increases the risk of tibial stress fractures (Fig. 4) (Crossley et al., 1999) and compartment

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**Fig. 3.** (a) Tibial tubercle avulsion fracture of the insertion of the ACL; (b) arthroscopically reinserted and held with a single screw.

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**Fig. 4.** T1 weighted sagittal MRI of a proximal tibial stress fracture in a runner.
syndrome. The differential diagnoses includes periostitis, muscle injury, tumour, growing pains and referred pain. Stress fractures occur especially in runners and compart-ment syndrome in all athletes when the muscle compartment pressure with exertion exceeds the capillary compartment perfusion. Symptoms are typically insidious but occasionally can be acute, usually but not always, associated with a fracture. The undisplaced fracture in the young footballer must be observed closely for the first few days following injury.

The ankle. The twisting injuries that cause a fracture in adults produce a different pattern of injury in the immature skeleton. In general, ankle fractures in children are minimally displaced. However, when involving the articular surface, they may require open reduction and internal fixation. The triplanar (Fig. 5(a)–(c)) and Tillaux variants of ankle fracture occur due to the orientation of the growth plate, the direction of ossification from posteromedial to anterolateral and the mechanism of injury.

Osteochondral injuries are also prevalent affecting the talus as classified by Berndt and Harty (1959), (Fig. 6).

The foot is the site of stress lesions more commonly than usually realised. Sever’s lesion presents with activity related pain at the tip of the heel, and radiographical fragmentation of the calcaneal apophysis. The lesion is probably a stress fracture, but there is often a similar radiograph of the other asymptomatic side. The pain responds to rest and a shock absorber under the heel. Kohler’s disease (Fig. 7) is an idiopathic avascular necrosis of the tarsal navicular, and is managed by rest and avoidance of jumping and hopping on the involved foot. Generally, it takes two to three years to return to normal.

Tarsal coalition is an important congenital condition which may present in the young athlete or go un-noticed. They are usually talo-navicular or calcaneocuboid. Pain is common and on examination a restricted range of movement may be noticed. Reduced subtalar movement is implicated as a cause of ankle sprain and recurrent injury.

Back lesions. Chronic back pain in children is rare. More serious conditions should therefore be considered, such as fractures, infections and tumours (Gerbino and Micheli, 1995). Adolescent athletes are more prone to disc prolapse, which is best diagnosed by MRI. The high-risk sports for acute spinal injuries are American Football, diving, skiing, gymnastics and trampolining. Rachbauer et al. (2001) have recently reported on radiographic abnormalities of the spine in elite skiers. Sports injuries account for 18% of paediatric cervical spine fractures. Following trauma, fractures of
the cervical spine are less common in children than in adults. Most spinal injuries below the age of 12 years involve the atlantoaxial or atlantooccipital joints, although all levels are encountered. Prevertebral soft tissue swelling greatly assists diagnosis on lateral films. Slight anterior vertebral wedging is normal in children due to incomplete ossification, and up to 2 mm of spondylolysis is acceptable in the upper cervical levels. The normally lax ligaments of children result in a greater prevalence of displacements than fractures. Down syndrome children have such lax atlantoaxial ligaments that it is recommended that sport activity be restricted if a lateral radiograph shows the distance between the anterior aspect of the dens and the posterior aspect of the arch of the atlas greater than 4.5 mm. This laxity predisposes to atlantoaxial rotary subluxation, with abnormal displacement between the facet joints, presenting as torticollis (Fig. 8). If this is suspected on plain radiographs, CT scanning with the head turned in both directions is required to assess whether this is fixed (a facet joint does not reduce with the head turned towards the direction of C2) or mobile. This is often seen in ballet due to rapid head rotation whilst pirouetting.

Spondylolysis (Fig. 9) is an osseous defect of the pars interarticularis between the superior and inferior facets of the vertebral body and spondylolisthesis is the slippage of the superior vertebra on the inferior. Both can be

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**Fig. 6.** Coronal T1 weighted MRI of an osteochondral defect affecting the talus.

**Fig. 7.** Kohler's disease of the navicular which can cause discomfort or be an incidental finding.

**Fig. 8.** Anteroposterior radiograph of the upper cervical spine revealing atlantoaxial subluxation: this can be difficult to differentiate between malposition of the head at the time of imaging or torticollis secondary to injury or neuromuscular imbalance. A careful history and further imaging may be required.

**Fig. 9.** Bilateral spondylolysis: healed on one side but still visible on the other.
related to hyperextension and axial loading, since there is an increased incidence in gymnasts (11%), ballet dancers, fast cricket bowlers, and American football. Spondyloysis is not always symptomatic.

A much less frequent factor of low back pain in adolescent athletes is lumbar disc protrusion, but the role of continuous micro-trauma is not clear. Not all children with a lumbar disc protrusion report low back pain, but most develop sciatica. The role of acute trauma as an etiological factor in the development of disc herniation in young patients has been stressed, but degenerative changes may play a leading role, with trauma acting just as a precipitating factor. This could explain the infrequency of the lesion in intensively trained young athletes. Finally, SCIWORA (spinal cord injury without radiological abnormality) must be considered in patients with ongoing problems despite normal preliminary radiology.

8. Prevention

Not only will the child have its own risk factors, but so does their sport. There has already been widespread involvement in assessing general risks and trends that result in children’s injuries (Gerbino 1995; Hackam et al. 1999; Heidt et al. 2000; Wickiewicz 1987). Sports specific studies, for example, skiing, baseball, skating, tennis or gymnastics all have similar conclusions regarding safety barriers or run-offs, adequate supervision, appropriate warm ups and protective equipment (Coulon et al. 2001; Kocher et al. 2000; Stanish 1995; Wyatt & Beattie 1995; Zetaruk 2000). Many guidelines are already in existence to help limit injuries as published by Sports Coach UK, for example (Coaching Young Performers 2001). Up to a third may be preventable. Many of these parallel adult sporting common sense issues. Perceived insight into injury risk has not been reported. Specific to children includes more fair matching of size, weight and height, appropriate supervision, properly fitting equipment of young individuals, limiting the external pressure imposed by their parents or coaches. This is a difficult balance to achieve.

The value of preparticipation screening is to limit the most susceptible individuals (Metzel, 2000; Reed, 2001), and continues to be evaluated. Balance, for example, can be used as a predictor of future ankle injury (McGuine et al., 2000). Prevention is based on defining the fitness and flexibility required as well as the general medical state. This needs to be appropriately measured and advice given to maintain or improve the physical status. Heidt et al. (2000) support the value of preseason conditioning saying that it works well to reduce early season injuries.

Well reported successful cases of injury prevention have followed a number of important working parties. Perhaps the most well known include reduction in the rates of quadriplegia following the banning of spearing in American football, the use of appropriate head and face guards in ice hockey, breakaway bases in baseball (Janda et al. 2001), appropriate ball selection, limiting repetitive actions for example, in throwing or bowling sports and appropriate fluid management in hot weather. Although the use of chest protectors in baseball gives extra protection according to Viano et al. (2000), commotio cordis is still reported.

9. Psychological aspects

For adults psychological distress following injury has been well reported, but invariably poorly recognised or overlooked in the initial stages. This not only relates to the injury, but continuing distress and disability and invariably loss of earnings. Practitioners will be well aware of this especially if involved in medico-legal work. With regards to children in sport following injury, information is scarce. If there is any suggestion of psychological distress following injury, appropriate referral early is warranted. Rowlie (1987) states that the primary factors include: family issues, peer pressure, emotional ability to cope with the competitive environment and the fear of failure. According to Ogilvie (1983), the balance relies on support, trust, self esteem and focusing on realistic goals.

10. Conclusion

Overall sports injuries in children are uncommon and although incidence increases with age most are self limiting and have no long term effects. We are never going to be able to eliminate risk from sport. Most children will select their own sport and it is important that all official bodies aim to limit injuries, without losing the competitive enjoyment.

We must keep in context the fact that the vast majority of injuries in children are not necessarily sports specific, but, at the same time appreciate that there may be a risk of overuse injury associated with the development of high level participation at a young age.

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References

Crossley, K., Bennell, K.L., Wrigley, T., Oakes, B.W., 1999. Ground
reaction forces, bone characteristics and tibial stress fracture in male
Hackam, D.J., Krelle, M., Pearl, R.H., 1999. Snow-related recreational
injuries in children: assessment of morbidity and management
Heidt, R.S. Jr, Sweeterman, L.M., Carlonas, R.L., Traub, J.A., Tekulve,
Helms, P.J., 1997. Sports injuries in children: should we be concerned?
Hovelius, L., 1987. Anterior dislocation of the shoulder in teenagers and
Relation of severity of injury to treatment and prognosis. J. Bone Joint
Surg. 95–105.
breakaway bases: an analysis of a preventative intervention for softball
and baseball for and ankle injuries. Foot Ankle Int. 22 (10), 810–816.
on the incidence of injuries in football. Am. J. Sports Med. 28 (Suppl 5),
S40–S46.
Orthop. 21 (2), 165–168.
Kocher, M.S., Waters, P.M., Micheli, L.J., 2000. Upper extremity injuries
165–168.
561–568.
30 (3), 218–221.
J. Sport Med. 10 (4), 239–244.
Micheli, L.J., Glassman, R., Klein, M., 2000. The prevention of sports
Br. J. Sports Med. 25 (1).
baseball pitchers: MR imaging evaluation. Radiology 185 (2),
573–576.
Ogilvie, B.C., 1983. The orthopaedists role in childrens sports. Orthop.
Pappas, A.M., 1982. Elbow problems associated with baseball during
North Am. 84 (4), 983–1007.
Incidence of football injuries and complaints in different age groups and
in the thoracolumbar spine in young elite skiers. Am. J. Sports Med. 29
(4), 446–449.
Med. Assoc. 97 (8), 342–346.
Rockwood, C.A. Jr, 1996. Fractures and dislocations of the ends of the
clavicle, scapulae and glenohumeral joint. In: Rockwood, C.A.,
Wilkins, K.E., Beatty, J.H. (Eds.), Fractures in children, vol. 3.
Lippincott, Philadelphia, PA.
117, 626–630.
Sport, age and sex specific incidence of sports injuries in Western
Wilkins, K., 1980. The uniqueness of the young athlete: musculoskeletal
757–780.