Overuse Injuries in Children and Adolescents

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ABSTRACT: Overuse injuries have become common as more and more children participate in sports. A careful history can identify risk factors; targeted patient education can lead to successful rehabilitation and prevent injuries. Thanks to the growing number of young people participating in sports at an early age, training year-round, and competing at specialized or elite levels, the incidence of overuse injuries has risen in the past decade. Recent studies estimate that 30% to 50% of pediatric sports injuries are caused by overuse, with the frequency of injury equal among boys and girls. For older patients, the proportion of injuries that are due to overuse is even higher.

KEY WORDS: Sports; Injuries; Overuse; Adolescent

INTRODUCTION

The benefits of regular exercise are not limited to adults. Youth athletic programs provide opportunities to improve self-esteem, acquire leadership skills and self-discipline, and develop general fitness and motor skills. Peer socialization is another important, though sometimes overlooked, benefit. Participation, however, is not without injury risk[1]. While acute trauma and rare catastrophic injuries draw much attention, overuse injuries are increasingly common. With the growth of youth sports programs, overuse injuries in young people have become common. Making the diagnosis can be challenging, but often the real hurdles are in identifying the causes of injury. Growth-related factors require special considerations in injury management. Recommendations for a successful return to activity and prevention of reinjury include avoiding heavy training loads and early sport-specific training, taking adequate rest periods, and ensuring proper supervision[2]. Diagnostic and treatment efforts should focus on how the injury developed and consider issues that are unique to growing athletes. An understanding of these concepts provides the basis for making specific injury-prevention recommendations.

The true magnitude of the problem in India is not yet officially documented. As per one study, in USA alone, approximately 35 million children and young adults between the ages 6 - 20 years participate in sports, including 6 to 8 million in school sports programs[3]. Because training has become more sport-specific and nearly continuous, overuse injuries are now common among young athletes. Recent data indicate that 30% to 50% of all pediatric sports injuries are due to overuse [4, 5, 6]. In a study[4] of children (aged 5 to 17) who presented to a sports injury clinic, South Africa, 49.5% of 394 sports injuries were classified as overuse, with boys and girls displaying a similar frequency. The relative percentage of overuse injuries varies by type of sports. In a 2-year study[5] of 453 young elite athletes, 60% of swimmers' injuries were due to overuse, compared to 15% of soccer players' injuries. Athletes who had overuse injuries lost 54% more time from training and competition than those who had acute injuries.

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THE PROBLEM DEFINED

In simple terms, overuse injuries can be defined as the product of "too much, too fast, and too soon"[6]. However, how much is too much? How fast is too fast? How soon is too soon? The answers vary from athlete to athlete. A program that overtaxes one participant may be acceptable to another of the same age and ability. Certain characteristics, however, can clue you in to possible over training or overuse. Mild discomfort or soreness after physical activity, rating no higher than 2 or 3 on a pain scale of 0 to 10, is common. If any amount of pain exists or persists during activity, or if post activity pain rates higher than 3 on a 0 to 10-visual pain scale, then that activity is perhaps "too much", "too fast", or "too soon" i.e. overuse activity for that particular athlete[6].

ETIOPATHOGENESIS OF OVERUSE INJURIES

Overuse injuries occur when a tissue is injured due to repetitive submaximal loading. The process starts when repetitive activity fatigues a specific structure such as tendon or bone. With sufficient recovery, the tissue adapts to the demand and is able to undergo further loading without injury. Without adequate recovery, microtrauma develops and stimulates the body's inflammatory response, causing the release of vasoactive substances, inflammatory cells, and enzymes that damage local tissue[7]. Cumulative microtrauma from further repetitive activity ultimately causes clinical injury. In chronic or recurrent cases, continued loading produces degenerative changes leading to weakness, loss of flexibility, and chronic pain[8]. Thus, in overuse injuries the problem is often not acute tissue inflammation, but chronic degeneration (i.e. tendinosis instead of tendinitis).

CONTRIBUTING FACTORS

Ideally, children should participate in sports for one reason i.e. *to have fun*[9]. Along with that fun, there should come the pride of acquiring and mastering new skills in a social environment. Regrettably, lack of fun is often a leading reason for dropping out now a day. An understanding of the risk factors contributing to overuse injuries is the cornerstone of prevention. These risk factors have typically been classified as intrinsic or extrinsic **(Table 1)**[10]. Understanding of both the intrinsic and extrinsic demands placed on the young athlete, can help to identify risk factors for overuse injuries. Always sport physician must maintain a high level of suspicion for problems caused by overuse. Even the most innocent-appearing injury may have elements of overuse[11].

Table 1: Factors Contributing to Overuse Injury

Intrinsic Factors	Extrinsic Factors
• Growth (susceptibility of growth cartilage to repetitive stress, inflexibility, muscle imbalance) • Prior injury • Inadequate conditioning • Anatomic malalignment • Menstrual dysfunction • Psychological factors (maturity level, self-esteem)	• Too-rapid training progression and/or inadequate rest • Inappropriate equipment/footwear • Incorrect sport technique • Uneven or hard surfaces • Adult or peer pressure

CLINICAL EVALUATION

History: A thorough history is one of the most important clinical tools[5,12]. A detective-like approach will not only help to establish the diagnosis, but will also suggest the severity of the injury and reveal many potential predisposing factors. Patients should describe when they first recognized the injury.

Once this is determined, one should ask the following detailed questions about training in the several weeks before the first sign of injury:

- Was there a change in training intensity, frequency, or duration?
- Was a new technique or piece of equipment introduced?
- Is the athlete involved in other activities such as resistance training or physical

education classes that could have contributed to the injury?
- When was the last athletic shoe purchase?
- Has there been a similar injury in the past, and does the patient have a history of other overuse injuries?
- How were past injuries treated?

In adolescent girls, inquiry about the age of menarche and whether cycles are regular or irregular; is very important[13]. The physician or specialist if any should evaluate menstrual dysfunction concurrently. Recording a patient's age and reviewing the growth pattern can determine if he or she is in a rapid growth period or not. The mean onset of the adolescent growth spurt is approximately 10 years for girls and 12 years for boys. Peak height velocity is reached, on average, at age 12 for girls and age 14 for boys. Injuries that occur without obvious training changes or contributing factors may simply be related to the musculoskeletal changes associated with accelerated growth[14].

Next, the patient should be asked to describe the location and quality of the pain and when it occurs during activity. Pain that occurs at the end of an activity and resolves before the next training session signals a relatively mild injury; pain during activity that impairs performance is more severe. One must always consider the possibility of occult tumors or rheumatologic conditions in young athletes who have chronic pain symptoms.

One has to observe patient-parent interaction in the examination room:
- Do the parents attempt to control the physician's encounter with the child?
- Does the child seem enthusiastic about the sport?
- Do parents place an inappropriate emphasis on competition?
- What are the athlete's and parents' hopes regarding future participation?
- Are there aspirations for national-level competition or college scholarships?

One should look into the fact that how the athlete, parents, or coaches have attempted to treat the injury. Those who have been to several physicians may have unrealistic expectations that should be addressed first.

Physical examination: The examiner should localize the complaint, identify injured tissue, and assess all structures that dissipate force in the involved extremity. For a patient who has anterior knee pain, for example, the exam should proceed from the ground up, beginning with foot and ankle alignment and continuing proximally. This method can identify underlying malalignment, inflexibility, muscle imbalance, abnormal joint laxity or restriction of motion. The examiner also should compare flexor-extensor muscle groups and the injured extremity to the uninjured.

Careful palpation of the painful area will often reveal the exact injury site. Recreating the loading pattern can help reproduce symptoms. Simple methods include having the patient run or hop in place or applying pressure over a musculotendinous structure while applying resistance at various joint angles. When provocative maneuvers are unsuccessful, examining the child immediately after the sports activity may be useful.

Occasionally, symptoms are difficult to localize. Poorly localized symptoms are not unusual for some overuse injuries, such as back pain in a dancer who has a stress reaction of the pars interarticularis. In other situations, the sport may be unmasking an underlying problem. Vague knee pain, for example, may be the presenting complaint of a patient who has osteochondritis dissecans, a hip disorder, or an osteosarcoma.

Imaging studies may be helpful in some situations. Radiographs can identify osteochondral lesions, stress fractures, tumors, and growth-plate widening. Additional studies, such as bone scans or magnetic resonance imaging, may be useful if plain radiographs are unrevealing. The specifics of each case guide the decision to obtain radiologic studies, and which to choose. The common overuse sports injuries are given in **Table 2**.

Table 2: Types of overuse injuries

Type of Overuse Injury	Symptoms	Possible cause
Jumper's Knee (Patellar Tendonitis)	Tenderness right below the knee or upper shin area.	The patellar tendon in the knee joint is repeatedly pulled on, causing inflammation and pain, especially during jumping activities.
Little Leaguers' Elbow or Shoulder	Pain in the elbow or shoulder area, especially after activity.	Repetitive overhead throwing maneuvers that cause damage and inflammation to the growth plates of the bones in the arm (or as a result of a fracture).
Osteochondritis Dissecans	Knee pain and swelling	A piece of the cartilage in the knee joint that separates from te joint surface. Theories suggest that it may run in families or be caused by a metabolic problem.
Sever's Disease	Heel pain with limping, especially after running activities	Repetitive running or jumping activities causes the Achilles tendon to pull on the heel bone.
Shin Splints	Pain and tenderness over the shin area	Excessive running, running on hard surfaces (concrete), and improper shoe wear often causes shin splints.
Sinding-Larsen-Johansson Disease	Knee pain, especially after jumping activities	This disease is caused by a fracture of the kneecap due to repetitive extension on the patellar tendon in the knee (the tendon pulls away from the bone).
Spondylolisthesis	Back pain	This condition is caused by excessive flexion and extension of the low back. X-rays show that a part of one vertebra in the low back slips forward on the vertebrae below it. It is commonly seen in football linemen, gymnasts, and ice skaters.
Spondylosis	Back pain	This condition is caused by excessive flexion and extension of the low back. It is commonly seen in football linemen, gymnasts, and ice skaters.

TREATMENT

The fundamental goal of treatment is to develop strong, flexible tissue that absorbs the forces of the sport[15,16]. The principal measures:

Relative rest: The initial phase of treatment involves protecting the injured site from a level of impact loading that perpetuates overuse by reducing training volume and using alternative activities to maintain aerobic conditioning and morale. The patient's clinical history provides a guide to the amount of rest needed from sport-specific training[17-,20]. Less severe injuries such as mild patellofemoral pain warrant a 25% to 75% decrease in training load; a more severe injury, such as a stress fracture, initially requires complete rest from the offending activity. Examples of alternate activities include pool running with or without a flotation vest, bicycling, rowing, and swimming. Patients may continue sports activities that do not stress the injured area[17-20,21,22].

Ice: Ice, an effective modality that should be used throughout treatment, reduces swelling and pain by causing vasoconstriction, slowing nerve conduction, and reducing cellular metabolism[22]. It should be applied lightly over a cloth or bandage for 10 to 20 minutes several times a day for the first 48 to 72 hours and after rehabilitation exercises. Ice massage, rubbing the ice in a circular motion over the injury, is another option.

Other modalities: Topical heat (i.e. moist heat packs) may help increase collagen extensibility and reduce stiffness. Other modalities such as ultrasound, iontophoresis, and electrical stimulation may be useful adjuncts. The clinical benefits of nonsteroidal anti-inflammatory drugs (NSAIDs) have not been clearly demonstrated[23]. When rest and ice have not relieved patients' pain, a short NSAID course may reduce pain and allow rehabilitation to proceed.

REHABILITATION

Once pain has been controlled, supervised rehabilitation can begin. The objectives of rehabilitation are to restore range of motion,

strength, flexibility, and proprioception. Returning to the sport before reaching these endpoints increases the risk of reinjury.

As range of motion is restored, pain-free resistance exercises may begin. Isometrics and limited isotonics are often part of this stage; these activities should be supervised to guard against improper technique and equipment misuse. Soft-tissue techniques can be used to reduce adhesions and loosen tight structures.

Gentle flexibility exercises are added when strength and range of motion improve. Overstretching should be avoided. Strengthening and flexibility exercises should also address adjacent uninjured structures. Aerobic conditioning is also initiated to prepare patients for their return to sport. The level of pain during activity and symptoms and findings the following day guide the progression. Significant improvement signals the time to add eccentric and isokinetic exercises, which require close supervision to ensure correct technique. Simultaneous increases in exercise resistance and velocity should be avoided.

After range of motion, strength, and flexibility improve, gradually adding sport-specific activities allows patients to regain proprioception and reacquaint themselves with the biomechanics of the sport. Patients can resume training and competition when they have recovered their muscular and aerobic endurance and can perform sport-specific activities without pain.

AVOIDING REINJURY

Athletes who complete a thorough rehabilitation may suffer reinjury if the risk factors that led to the problem are not addressed [24]. Athletes, parents, and coaches should be educated about training errors that may have occurred, the importance of scheduled rest periods, and the need to avoid excessive training volumes, especially during the adolescent growth spurt. To correct poor technique, the coach or trainer often must instruct athletes and provide reminders about possible relapses.

Patients may benefit from advice on appropriate footwear and equipment. Over-the-counter shoe inserts can help modify biomechanical malalignment. In some situations, such as marked pes planus in a patient who has refractory plantar fasciatis, custom orthoses may be needed.

PREVENTING OVERUSE

The American College of Sports Medicine estimates that 50% of overuse injuries in children and adolescents are preventable[24]. Preparticipation screening, required by most schools, should be encouraged for all children involved in organized athletics. This is an excellent opportunity to identify sport-specific injury risk factors and to assess young people's maturity, skill level, and motivation for the sport. Parents should ensure that their children would receive proper supervision and coaching. They can lobby local organizations to sponsor coaches' attendance at coaching and safety seminars.

Training programs should accentuate general fitness and avoid excessive volume. All programs for youngsters should include conditioning and flexibility. Early sport specialization should be eschewed. Adults may seize on an example of a child who began exclusive training for a sport and became a local or national success, but the daily repetition required to perfect sport-specific skills too often leads to injuries. Experimentation with different sports allows children to develop fitness and motor skills, enjoy the social aspects of sport, and choose the sports they prefer. Parents can be reassured that there are many examples of outstanding athletes who did not become involved in their sports until a relatively late age.

Because children rarely suffer overuse injuries when they control the intensity level, coaches and other adults should avoid setting rigid expectations about training intensity. Despite scarce data about training progression and injury, gradual progression should be stressed. A general guide is the "10% rule": Total training (intensity, frequency, duration, or any combination of these) should increase no more than 10% at a time[6,25]. Thus, a young runner who runs 20 miles per week would run 22 miles the next week, without changing pace. The rule is a useful starting point, but must be adjusted for each athlete.

Periodization may also help to reduce overuse injuries and prevent overtraining. This technique involves the systematic cycling of training loads over set periods of time with well-defined rest periods. Finally, training should be carefully monitored during the adolescent growth spurt. Because growth-related factors can predispose patients to injury, it may be appropriate to temporarily modify training during this period.

Children should never "play through" any pain or disability. Regrettably, because they fear being

removed from activity or disappointing parents and coaches, many young athletes continue painful activities. Parents and coaches must learn to temper their desire to "let the child continue to play" and seek early and appropriate care to prevent long-term consequences. When any athlete is experiencing pain, he or she should stop exercising and begin rehabilitation. Rehabilitation of any injury follows a three-step process **(Table 3)**. During this process, one should focus on what the athlete can do rather than what the athlete can't do. Complete cessation of activity is often unnecessary and unlikely to be followed by a child athlete committed to his sport[10,26].

Table 3: Stages of nonoperative rehabilitation

Acute Phase	Recovery Phase	Functional Phase
• Relative rest, immobilization if needed • Pain, anti-inflammatory medication (ice, NSAIDs) • Physical therapy: passive range of motion exercise *Criteria for advancement* • Adequate pain control and tissue healing • Near-normal range of motion Ability to handle increasing work demands	• Physical therapy: Active range of motion increased flexibility, proprioceptive and neuromuscular control training • Specific, progressive exercise *Criteria for advancement* • No pain with complete tissue healing • Essentially full range of motion • Good flexibility • 75%-80% of strength as compared with noninjured side	• Depending upon the recovery phase progress, gradually children should be encouraged to resume their pre-injury status gradually with precautions to avoid the re-injuries.

RETURN TO SAFE PLAY

A diligent search for contributing factors and an understanding of the issues that are unique to children are essential to injury management. Incorporating these elements into a comprehensive rehabilitation program usually results in a successful return to participation. Attention to preventive measures such as training progression and appropriate supervision will allow youngsters to continue to enjoy the many benefits of organized play.

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