

Below is a literature review on Sever's Disease and an article on treatment of Sever's in the young gymnast. Many thanks to Pediatric Sports and Fitness SIG member Talia Eubanks, PT for her time and expertise in putting this information together and sharing it with others.

Scharfbillig RW, Jones S, Scutter SD. (2008). Sever's Disease: What does the literature really tell us? *J Am Podiatr Med Assoc.* 98(3): 212-223.

BACKGROUND: Sever's disease is typical of many musculoskeletal conditions where observational annotations have slowly been accepted as fact with the passing of years. Acceptance of these nontested observations means that health professionals seeking information on this condition access very low-level evidence, mainly being respectable opinion or poorly conducted retrospective case series. METHODS: A comprehensive review of the literature was undertaken gathering available articles and book references relating to Sever's disease. This information was then reviewed to present what is actually known about this condition. RESULTS: Respectable opinion and poorly conducted retrospective case series make up the majority of evidence on this condition. CONCLUSION: The level of evidence for most of what we purport to know about Sever's disease is at such a level that prospective, well-designed studies are a necessity to allow any confidence in describing this condition and its treatment.

Lau LL, Madadey A, Hui JH. (2006). Common lower limb sport-related overuse injuries in young athletes. *Am Fam Physician.* Mar 15; 73(6): 1014-1022.

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 pediatric patients diagnosed with overuses 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. The authors 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.

Cassas KJ, Cassettari-Wayhs A. (1996). Childhood and adolescent sports-related overuse injuries. *Am Fam Physician*. Nov 1;54(6): 1995-2000.

The authors reviewed the literature on various common adolescent sports-related pathologies, including Sever's disease. Calcaneal apophysitis (or Sever's disease) is a common cause of heel pain in young athletes, presenting as pain in the posterior aspect of the calcaneus.

Madden CC, Mellion MB. (1995). Sever's disease and other causes of heel pain in adolescents. *J Pediatr Orthop B*. 4(1): 74-79.

Sever's disease, or apophysitis of the calcaneus, is a common but frequently undiagnosed source of heel pain in young athletes. This condition frequently occurs before or during the peak growth spurt in boys and girls, often shortly after they begin a new sport or season. Sever's disease often occurs in running and jumping sports, particularly soccer. Patients present with intermittent or continuous heel pain occurring with weight bearing. Findings include a positive squeeze test and tight heel cords. Sever's disease cannot be diagnosed radiographically. The condition usually resolves two weeks to two months after the initiation of conservative treatment, which may include rest, ice application, heel lifts, stretching and strengthening exercises, and, in more severe cases, nonsteroidal anti-inflammatory drugs.

Liberson A, Liberson S, Mendes DG, Shajrawi I, Ben Haim Y, Boss JH. Remodeling of the calcaneus apophysis in the growing child. (1990). *Clin Podiatr Med Surg*. Apr; 7(2): 377-84.

Radiography and computer-aided analysis of tomography of the os calcis in 35 children with Sever's disease and of 52 control children were concurrently evaluated with histologic appearance of six calcanei of victims of road accidents, which were radiographically compatible with the same syndrome. Histology showed abrupt interruption in continuity of the apophysis of perpendicular fibrous plates with evidence of an ongoing reparative process. Computer-aided analysis of orientation of the "fragmentation" lines and histologic data both support the hypothesis of a stress remodeling process owing to excessive bending forces acting on the calcaneal apophysis.

Szames SE, Forman WM, Oster J, Eleff JC, Woodward P. (1996). Sever's disease and its relationship to equinus: a statistical analysis. *Am Fam Physician*. Nov 1; 54(6): 1995-2000.

This study shows that equinus has a definite impact on predisposing a child to Sever's disease. The clinician may still need to rule out other possible causes of this condition, but equinus is a probable cause and must be treated appropriately.

Micheli LJ, Purcell L (eds). The Adolescent Athlete: A practical approach. Foot and Ankle Injuries. Springer, 2007, pp 376-77.

Sever's Disease is also known as calcaneal apophysitis. It is the inflammation of the tendon attachment of the Achilles to the calcaneus and occurs most commonly in males between the ages of 8-12 years old. It occurs during a time of rapid growth, where the physis is under stress, and the musculo-tendon complex becomes increasingly taut. This creates increased tension on the bony attachment and subsequent inflammation of the open apophysis. Young athletes with this condition often complain of heel or posterior foot pain which may be bilateral. The physical exam normally demonstrates tenderness to palpation at the superior and/or inferior pole of the posterior calcaneus. Often, the athlete may demonstrate an elevated BMI, pes planus, and decreased length of the gastroc-soleus complex. Radiographic findings typically show a fragmented or sclerotic apophysis. Physical therapy treatment may include activity modification, cryotherapy, and lower extremity stretching. Adjunct therapy such as heel cups, orthotics, and supportive shoes also may help to decrease the traction stress on the apophysis. Patients with persistent pain sometimes require a casting protocol.

Ogden JA, Ganey TM, Hill JD, Jaakkola JI. Sever's injury: a stress fracture of the immature calcaneal metaphysis. *J Pediatr Orthop*, 2004; 24(5):488-492.

Magnetic resonance imaging (MRI) in children with a presumptive diagnosis of Sever's apophysitis and with continuing pain after conservative treatment demonstrated bone bruising within the trabecular bone of the metaphyseal region adjacent to the calcaneal apophysis. Limited portions of the apophyseal secondary ossification center showed similar increased signal changes. MRI studies following treatment with immobilization showed subsidence or disappearance of the metaphyseal but not any apophyseal signal changes commensurate with improvement in symptoms. Accordingly, the disorder commonly referred to as Sever's "apophysitis" may be a metaphyseal trabecular stress fracture, similar to the toddler's calcaneal stress fracture that has minimal or no involvement of the apophyseal ossification center, and thus should not be referred to as an apophysitis. Rather, it appears to be an overuse injury causing microinjury within the developing metaphyseal "equivalent" trabecular bone that has not completely adapted to the changing biologic (biomechanical) requirements of the growing, athletically active child.

Wooten B, Uhi TL, Chandler J. (1990). Use of an orthotic device in the treatment of posterior heel pain. *J Orthop Sports Phys Ther*. 11(9): 410-3.

Posterior heel pain (PHP) presents a difficult clinical challenge. The causes of PHP include Haglund syndrome (pump bump deformity), Achilles tendinitis, and Sever's disease (retrocalcaneal bursitis, traction apophysitis). The purposes of this study were to 1) describe a new orthotic device used in the treatment of PHP and 2) evaluate the effectiveness of this device. The orthotic device consisted of a neoprene sleeve holding 1/4 inch PPT foam rubber horseshoe (Sports Supports, Inc., Dallas, TX). The horseshoe was placed directly over the injury to protect and relieve pressure or was inverted and used as a counterforce brace to reduce the tensile stress to the Achilles tendon. Eight patients (6 children, 2 adults) were evaluated at the time of application and after 1 month of use. Three criteria were considered: 1) subjective pain scale, 2) active goniometric measurements, and 3) toe raise test. The statistical analysis indicated a significant improvement in pain during activity from initial to follow-up and in pain after activity from initial to follow-up. All patients demonstrated improved strength and flexibility. It was concluded that this device may be an effective adjunct to the treatment of PHP.

Caspi I, Ezra E, Horoszowski H. (1989). Partial Apophysectomy in Sever's Disease. *J Orthop Sports Phys Ther.* 10(9): 370-3.

Sever's disease is an apophysitis or osteochondrosis of the calcaneal apophysis. Clinically, it includes painful heels and limitation of movement; and radiologically, fissuring and fragmentation of the calcaneal apophysis. Treatment is usually conservative, including physical therapy, NSAIDs, activity modification, and rarely immobilization. However, when migration of the apophysis occurs, either posterior or plantar, surgical treatment is sometimes indicated.

Marshall SW, Covassin T, Dick R, Nassar LG, Agel J. (2007) Descriptive epidemiology of collegiate women's gymnastics injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2003-2004. *J Athl Train.* Apr-Jun; 42(2): 234-40.

OBJECTIVE: To review 16 years of National Collegiate Athletic Association (NCAA) injury surveillance data for women's gymnastics and identify potential areas for injury prevention initiatives. **BACKGROUND:** In the 1988-1989 academic year, 112 schools were sponsoring varsity women's gymnastics teams, with approximately 1550 participants. By 2003-2004, the number of varsity teams had decreased 23% to 86, involving 1380 participants. Significant participation reductions during this time were particularly apparent in Divisions II and III. **MAIN RESULTS:** A significant annual average decrease was noted in competition (-4.0%, $P < .01$) but not in practice (-1.0%, $P = .35$) injury rates during the sample period. Over the 16 years, the rate of injury in competition was more than 2 times higher than in practice (15.19 versus 6.07 injuries per 1000 athlete-exposures; rate ratio = 2.5, 95% confidence interval [CI] = 2.3, 2.8). A total of 53% of all competition and 69% of all practice injuries were to the lower extremity. A participant was almost 6 times more likely to sustain a knee internal

derangement injury in competition than in practice (rate ratio = 5.7, 95% CI = 4.5, 7.3) and almost 3 times more likely to sustain an ankle ligament sprain (rate ratio = 2.7, 95% CI = 2.1, 3.4). The majority of competition injuries (approximately 70%) resulted from either landings in floor exercises or dismounts. **RECOMMENDATIONS:** Gymnasts with a previous history of ankle sprain should either wear an ankle brace or use prophylactic tape on their ankles to decrease the risk of recurrent injury. Preventive efforts may incorporate more neuromuscular training and core stability programs in the off-season and preseason conditioning to enhance proper landing and skill mechanics. Equipment manufacturers are encouraged to reevaluate the design of the landing mats to allow for better absorption of forces.

Caine DJ, NAssar L. (2005). Gymnastics injuries. *Med Sport Sci.* 48; 18-58.

OBJECTIVE: The purpose of this chapter is to review the distribution and determinants of injury rates as reported in the pediatric gymnastics injury literature, and to suggest measures for the prevention of injury and directions for further research. **DATA SOURCES:** An extensive search of Pubmed was conducted using the Text and MeSH words "gymnastics" and "injury" and limited to the pediatric population (0-18 years). The review focused on studies using denominator-based designs and on those published in the English language. Additional references were obtained from hand searches of the reference lists. Unpublished injury data from the USA Gymnastics National Women's Artistic Gymnastics Championships during 2002-04 were also analyzed. **MAIN RESULTS:** Comparison of study results was compromised due to the diversity of study populations, variability of injury definition across studies, and changes in rules and equipment across years. Notwithstanding, this review of the literature reveals a reasonably consistent picture of pediatric gymnastics injuries. The incidence and severity of injuries is relatively high, particularly among advanced level female gymnasts. Body parts particularly affected by injury vary by gender and include the ankle, knee, wrist, elbow, lower back, and shoulder. Ankle sprains are a particular concern. Overuse and nonspecific pain conditions, particularly the wrist and low back, occur frequently among advanced-level female gymnasts. Factors associated with an increased injury risk among female gymnasts include greater body size and body fat, periods of rapid growth, and increased life stress. **CONCLUSIONS:** Above all, this overview of the gymnastics injury literature underscores the need to establish large-scale injury surveillance systems designed to provide current and reliable data on injury trends in both boys and girls gymnastics, and to be used as a basis for analyzing injury risk factors and identifying dependable injury preventive measures.

Caine D, Cochrane B, Caine C, Zemper E. (1989). An epidemiologic investigation of injuries affecting young competitive female gymnasts. *Am J Sports Med.* Nov-Dec; 17(6): 811-20.

A prospective study of injuries affecting 50 highly competitive young female gymnasts was conducted over a period of 1 year. Many of the findings of this investigation were

consistent with previous studies and suggest particular injury trends in women's gymnastics. These results included injury location, injury severity, nature of onset, event, and activity at the time of injury. Some of the descriptive results, however, provided information that was heretofore unreported or inconsistent with previous investigations. These findings involved injury rate, reinjury rate, time loss, injury type, hours of practice, and incidence of physician-seen injuries. Some of these findings were disturbing and echo concerns registered in the professional literature. In particular, the reinjury rate is alarming and points to the need for complete rehabilitation before return to full participation. The results of the analytic component of the study alluded to the potential role of competitive level and maturation rate in the profile of the injury-prone gymnast. Specifically, rapid periods of growth and advanced levels of training and competition appeared to be related to injury proneness. Pursuant to the descriptive and analytic results of the investigation, recommendations for injury prevention and continued research are made.

Gymnastics Specific Prevention and Treatment Strategies: Sever's Disease

A literature review of gymnastics injuries shows that the lower extremity is most often injured in the competitive female gymnast, particularly in the pediatric population. The ankle is one of the most highly injured areas of the body in these athletes. Most likely because competitive gymnasts start at such a young age, particularly at the lower levels, the author has experienced a relatively high rate of Sever's disease while working closely with 2 local gymnastics clubs. However, a review of the literature on Sever's Disease demonstrates only low-level evidence involving causes and effective physical therapy treatment. In addition, there is no scientific evidence involving gymnastics specific physical therapy treatment. Therefore, although the author has experienced success with treatment and prevention strategies, it is purely anecdotal and based on clinical experience. Theoretically, Sever's disease in this population seems to be a combination of poor flexibility and strength of the soleus muscle. This, combined with poor landing strategies, creates poor shock absorption with landings. In addition, coaches and gymnasts tend to condition the gastrocnemius muscle only; focusing on calf raises and stretching only with the knee extended. Physical therapy treatment and prevention strategies should focus on gymnastics specific lower extremity flexibility, ROM, stability, neuromuscular reeducation, strengthening, and manual and/or self soft tissue release techniques. Be sure to assess and treat the entire lower extremity for any associated imbalances. However, this article will focus on the foot and ankle only.

Soft Tissue Techniques:

With muscular imbalance, soft tissue structures can become adhered to themselves or one another, compromising the normal gliding necessary for normal function. The author finds that the gastroc-soleus complex, peroneals, and foot intrinsics are most commonly involved. Self techniques can be done using a standard foam roller. The gymnast is instructed to roll a minimum of 10 times over each area,

focusing on areas of particular soreness. It is important that the gymnast performs these daily, particularly before and after practice or physical therapy sessions.

Flexibility:

It is the author's experience with gymnasts with Sever's disease that there tends to be a deficit in soleus length. Often, the muscle is completely neglected and/or the gymnast needs to be instructed in proper stretching technique. Also, there tends to be a lack of flexor hallucis longus length. This is usually noted functionally when the gymnast performs a calf raise, or releve', and "sickles" outward. It is important to stress to the gymnast and coaches the necessity of soleus stretching. Educate them on its significance in shock absorption during landings. Instruct the gymnast to keep the heel in contact with the floor and to gently "unlock" the knee so that it is slightly flexed. In addition, the gymnast should be taught proper lower extremity alignment, making sure that she maintains the hip and knee aligned over the ankle and avoids excessive pronation. Be sure to also include stretching of the great toe.

Range of Motion:

Often the gymnast will demonstrate a lack of talocrual joint mobility into dorsiflexion, particularly if the gymnast is older and/or the injury is chronic. Also, the 1st MTP joint can become hypomobile into extension. Be sure to address these with the appropriate joint mobilization technique as indicated.

Strengthening:

Gymnasts perform many skills that require them to maintain releve'. This is normally addressed during practice and conditioning with the knee extended, but not with the knee flexed to address the soleus. This can be done in a squat or lunge position. In the clinic, the gymnast can focus on soleus progressive resistive exercise by lying prone on a leg press machine and performing calf raises with the knee bent.

Neuromuscular Reeducation:

Many gymnasts will demonstrate poor basic functional movement strategies. If a gymnast cannot perform a squat or lunge correctly, this will carryover to her gymnastics skills. In addition, she will most likely demonstrate poor landing strategies. A simple squat and lunge progression can be done for all ages. Also, a focus on bilateral and unilateral eccentric landing, multidirectional to mimic gymnastics, can also be beneficial for form, technique, and reeducation of landing strategies in all ages.

Balance:

Not only is the ability to maintain single leg balance on all surfaces important, but the gymnast needs to be able to maintain balance in releve' without allowing sickling. It is beneficial to the gymnast to perform single leg balance activities with upper and lower extremity movements that are gymnastics specific. Also, it is simple to focus on the soleus if the gymnast balances on a surface where only her toes are in contact. The gymnast is then instructed to maintain the foot parallel to the ground. This

can be done unilaterally or bilaterally and all types of surfaces. It can also be progressed in conjunction with squats or lunges, although the younger gymnast may not be able to achieve this.

Activity Modification:

It is important to work as a team with the gymnast, parents, and coaches when it comes to modifying her gymnastics training. Normally, high impact activities such as vaulting, tumbling, and landing dismounts are the last activities to which the gymnast is able to return. However, if the dominant lower extremity is involved, unilateral landing activities such as leaps can be compromised as well. Instruct the gymnast in the “soreness rules”. She should return to baseline symptoms within 24 hours or by her next practice in order to continue progression. It is also helpful to count repetitions of vaults, tumbling passes, etc so that an objective measurement of activity can be done.