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## **Balancing Growth and Sports: The Impact of Sever's Disease on Young Athletes**

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## **ABSTRACT**

This article provides a comprehensive analysis of calcaneal apophysitis, or Sever's disease, a major cause of heel pain in children. This overuse injury stems from repetitive mechanical stress on the calcaneal apophysis, often intensified by rapid growth spurts and high physical activity. It is particularly prevalent among young athletes involved in sports with repetitive impact. The condition's pathophysiology involves microtrauma and inflammation at the calcaneus's secondary ossification center due to traction forces from the Achilles tendon. Diagnosis is primarily clinical while imaging is used to rule out other conditions. Symptoms include localized heel pain and tenderness, worsened by activity. Risk factors encompass intrinsic elements like limited ankle dorsiflexion and foot alignment issues, and extrinsic factors such as intense physical activity. Management mainly involves conservative treatments: rest, NSAIDs, stretching exercises, and orthotics. Physical therapy and proper footwear are also effective. Prevention focuses on maintaining a healthy weight, adequate rest, supportive footwear, low-impact activities, and regular stretching to reduce re-injury risk.

## **INTRODUCTION**

Physical activity has become a global trend, with individuals participating in sports for its myriad physical and mental health benefits. Regular involvement in sports is crucial not only for maintaining a healthy body weight but also for reducing the risk of cardiovascular diseases, osteoporosis, and diabetes. Additionally, consistent physical activity effectively mitigates stress, enhancing overall well-being [1],[2]. Sports also positively impact the nervous system, improving brain performance, concentration, memory, and cognitive functions. Furthermore, they play an essential role in developing interpersonal and communication skills [3],[4],[5]. However, despite the numerous benefits, sports inherently carry the risk of injury. Both professional athletes and amateurs are susceptible to injuries that can lead to permanent impairment. Common injuries often affect the lower and upper extremities as well as the spine and spinal cord [6],[7].

This review focuses on Calcaneal Apophysitis, commonly known as Sever's Disease (SVD), a condition accounting for a significant percentage of injuries among young athletes, particularly runners, soccer players, volleyball, and tennis players. In severe cases, SVD can be so debilitating that it forces young athletes to suspend sports activities for extended periods.

Drawing from professional literature, this review analyzes the causes, mechanisms, and symptoms of heel inflammation associated with Sever's Disease. It also explores diagnostic and treatment methods, along with preventive strategies. While regular physical activity is vital for health and fitness, it is equally important to engage in sports safely to minimize the risk of long-term injury. Understanding the intricacies of Sever's Disease and its prevention will enable physically active individuals to enjoy sports without the worry of chronic injury.

## **EPIDEMIOLOGY**

Overuse injuries are prevalent among athletes globally, particularly affecting young participants in sports [8], [9]. These injuries stem from repeated stress on tissues without adequate recovery time, leading to both immediate and prolonged interruptions in athletic activities. Research in the United States highlights that college and high school students are especially prone to these injuries, with college athletes experiencing a notably higher risk than their high school counterparts. Lower extremity injuries are most commonly affected, and college athletes tend to face longer periods of inactivity and a higher likelihood of requiring surgery compared to high school athletes [10].

Even younger athletes, such as those in elementary schools, are not immune to overuse injuries. A study focusing on soccer players aged 9-14 revealed that 46.8% reported issues related to overuse. The weekly prevalence of such injuries averaged 12.8%, with serious cases occurring at a rate of 6.0%.

Calcaneal apophysitis is the leading cause of heel pain in children and adolescents, representing 8% of all pediatric overuse injuries [11]. The occurrence of SVD among different musculoskeletal injuries has been reported to be between 2% and 16% [12]. The calcaneal apophysis first emerges around ages 7 to 9 and generally fuses between ages 15 and 17. Typically, the condition affects children and adolescents aged 8 to 15 years [11]. The condition is most prevalent in girls aged 7 to 12 and boys aged 8 to 15, with a peak incidence in both genders occurring between ages 10 and 12 [13].

## **PATHOMECHANISMS**

Overuse injuries, also known as chronic injuries, result from repeated stress and cumulative trauma to a body part over time. Unlike acute injuries, which occur from a single traumatic event, overuse injuries develop slowly due to continuous minor damage. These injuries arise when the body lacks adequate time for recovery between activities. They can lead to diminished performance, significant pain, psychological fatigue, and time away from sports. If not addressed, overuse injuries may cause lasting harm, including deformities and arthritis [14].

One contributing factor to calcaneal apophysitis is the rapid growth spurts that occur during adolescence, which can lead to imbalances between muscles and tendons. During these growth periods, muscles often lag behind the accelerated growth of bones, resulting in increased tension and strain on the tendons [15,16].

Sever's disease is a type of overuse syndrome caused by repeated microtrauma to the calcaneal apophysis. Although multiple mechanisms have been proposed, there is no single explanation that fully accounts for all cases [11,12]. This condition results mostly from excessive traction forces applied by the calf muscles through the Achilles tendon [11].

Histological studies indicate that Sever's disease involves inflammation or bone edema due to stress fractures at the secondary growth center of the calcaneus, not necrosis. This inflammation is due to the repetitive traction forces exerted by the triceps surae muscle on the calcaneal apophysis, which is mainly composed of hyaline cartilage. The combined effect of these traction forces and the vertical ground reaction forces on the calcaneus creates bending stresses on the medial side of the apophysis. During childhood, the calcaneal apophysis has an increased number of chondrocytes, making it less resilient to these bending forces [13].

In conclusion, Sever's disease results from repetitive microtrauma leading to inflammation and damage of the calcaneal apophysis. This condition arises from the interaction of traction forces from the calf muscles and ground reaction forces on the calcaneus, particularly affecting the immature apophysis. Understanding these underlying mechanisms is essential for devising effective treatment strategies for this prevalent pediatric overuse injury.

## **SYMPTOMATOLOGY AND DIAGNOSIS**

Calcaneal apophysitis is characterized by distinct clinical symptoms. This condition presents with pain localized to the posteroinferior aspect of the calcaneus, where the Achilles tendon attaches. Patients often report tenderness upon palpation of this area [12,15,16]. One of the key diagnostic maneuvers is the medial-lateral squeeze test. This involves compressing the heel from both sides to elicit pain, which can help confirm the diagnosis of Sever's disease [17].

The onset of symptoms in Sever's disease is often insidious, gradually developing over time. The pain is usually exacerbated by activities that involve high-impact stress on the heel, such as running or jumping. Symptoms may also intensify during periods of rapid growth or at the beginning of a sports season. In advanced cases, the pain can become severe enough to cause avoidance of heel load during walking, resulting in a limp or even pain at rest [12, 15, 16].

Clinical examination frequently reveals not only tenderness at the bony insertion site of the Achilles tendon but also tightness in the calf muscles and the Achilles tendon. Additionally, there may be weakness in ankle dorsiflexion, contributing to the overall clinical picture [11]. Although a structured history and physical examination are usually sufficient for diagnosing Sever's disease, MRI may be considered in some cases to exclude other potential differential diagnoses such as tumors or infections [11]. Despite the characteristic pain and tenderness, calcaneal X-rays typically appear normal. However, they can be useful in ruling out rare stress fractures or other anomalies [8].

The impact of Sever's disease on health-related quality of life is significant, highlighting the importance of timely and accurate diagnosis. Understanding the characteristic symptoms and employing appropriate diagnostic techniques are crucial for effective management and treatment of this common pediatric condition.

## **RISK FACTORS**

Sever's disease is influenced by a mix of intrinsic factors as well as extrinsic factors (such as midfoot stiffness, plantar pressures, associated conditions like Osgood-Schlatter disease, and physical activity levels). Understanding these risk factors emphasizes the importance of effective management and preventive measures for young athletes [18].

Intrinsic Factors are internal characteristics of an individual that influence injury risk, such as anatomical alignment, muscle strength, flexibility, and previous injury history. These factors are inherent to the person's physical and biomechanical state. The intrinsic risk factors of Sever's disease include: restricted ankle dorsiflexion, foot alignment issues, BMI, age, and gender [19].

Restricted Ankle Dorsiflexion is a prevalent factor identified in multiple studies, where restricted ankle movement is linked to increased stress on the heel, contributing significantly to Sever's disease [18].

Misalignment of the feet, particularly pronation, is associated with greater stress on the fascia and Achilles tendon, leading to the development of Sever's disease. [11, 18]. Elevated BMI, weight, and height are recognized as risk factors. [11, 18, 20]. One of the studies found that symptomatic children were taller than the general population [20]. The condition commonly appears in children aged 6 to 15 years. Some studies suggest an earlier onset in girls (around 11 years) compared to boys (around 12 years). There is some debate over the gender distribution, potentially influenced by differences in sports and physical activity habits between boys and girls [18].

Extrinsic Factors are external elements impacting injury risk, including environmental conditions, equipment, and the nature of the sport or activity. Examples of extrinsic risk factors include midfoot stiffness, plantar pressures, related conditions such as Osgood-Schlatter disease, and the intensity or frequency of physical activity [19]. Research found similar midfoot stiffness and mobility in children with and without Sever's disease, indicating no major differences in midfoot mobility [18]. Increased plantar pressures are often seen in children with Sever's disease, though it's unclear whether this is a cause or effect. Vertical ground forces were not found to be a contributing factor. Osgood-Schlatter Disease, linked with joint limitations, muscle imbalances, pronated feet, and microtrauma, shares similar risk factors with Sever's disease [18]. Engaging in sports is a significant risk factor for calcaneal apophysitis, especially for athletes who frequently jump, run, and engage in activities that involve plantar flexion. Sports such as soccer, gymnastics, dance, track, and basketball pose the highest risk for this condition [11]. Additionally, both high-frequency and high-intensity physical activities are noted risk factors. On the other hand, having fewer training sessions per week and lower activity levels might also be a risk due to potentially reduced pain tolerance in less active individuals [18].

## **TREATMENT**

Effective management of SVD typically requires a multi-faceted approach involving conservative treatments designed to alleviate symptoms and prevent recurrence. In the initial phase of treatment, applying cooling methods and administering non-steroidal anti-inflammatory drugs (NSAIDs) are recommended. This is followed by a stretching regimen aimed at the calf muscles to improve dorsiflexion of the ankle joint [11].

The cornerstone of managing Sever's disease includes relative rest and the use of specific interventions to manage acute symptoms and prevent future episodes. This approach often involves using heel cups at the outset and incorporating heel cord stretches to alleviate tension and discomfort in the Achilles tendon [18].

Different types of insoles, such as heel raises, elastic heel inlays, and custom-made orthoses, have shown beneficial effects in managing the symptoms of SVD in one of the studies. These insoles help reduce pain and improve ankle functionality by providing cushioning and lessening the impact forces on the calcaneus. Personalized insoles often yield better outcomes, likely due to their tailored fit and support [21].

A study involving 124 children with calcaneal apophysitis compared two types of heel inserts—shock-absorbing and polyurethane—with different types of footwear (existing vs. new athletic shoes). The results showed that heel inserts provided a slight, statistically significant reduction in pain but did not offer major clinical improvements.

Changes in footwear had no significant impact on pain levels [20]. Three smaller studies investigated different treatments and found that heel cups generally offered better pain relief compared to cork wedges and were preferred by patients. One study showed that heel cups significantly reduced pain compared to no treatment, although this effect lessened over time [20, 22, 23, 24].

Physical therapy has proven effective for managing SVD, especially when it includes targeted stretches and massages. This treatment addresses pain and enhances ankle function by targeting restrictions in ankle dorsiflexion, a common issue associated with SVD. One review underscores physical therapy's role in significantly decreasing pain and improving overall ankle functionality [25]. A separate trial with 101 patients comparing shock-absorbing heel inserts, physical therapy, and a wait-and-see approach found no significant differences in pain or patient satisfaction among these treatments [20].

Kinesio taping has been explored as a treatment for SVD, with some studies suggesting it may improve ankle dorsiflexion and reduce pain. However, the evidence is limited and should be interpreted cautiously, as improvements did not consistently increase over time. Despite this, Kinesio taping could be considered a component of a comprehensive treatment strategy [25]. Other conservative treatments with moderate evidence include low-level laser therapy and dry needling. High-quality evidence supports ultrasound-guided pulsed radiofrequency for reducing heel pain. These methods, along with physical therapy and stretching, also overlap with treatments for related conditions like Osgood–Schlatter disease [25].

## **PREVENTION**

Maintaining a healthy body weight is a critical factor in reducing the risk of Sever's disease, as excess weight imposes additional stress on the heel. A balanced diet combined with regular physical activity supports optimal weight management, thereby decreasing mechanical stress on the calcaneal apophysis [26].

Adequate rest between physical activities is essential for injury prevention. Repetitive stress without sufficient recovery time can exacerbate the risk of overuse injuries. Therefore, it is imperative for children to take breaks if they experience pain or swelling to facilitate effective recovery.

Proper footwear plays a significant role in the prevention of Sever's disease. Shoes should be supportive, well-fitting, and provide adequate cushioning, while avoiding high-pressure designs such as cleats. Tailoring footwear to the specific demands of different activities enhances protective benefits.

Incorporating low-impact activities, such as swimming or cycling, into a child's exercise routine can help mitigate the risk of overuse injuries by distributing physical stress more evenly across the body. Regular stretching exercises, especially targeting the Achilles tendon and calf muscles, are also beneficial for maintaining flexibility and preventing re-injury. Additionally, applying ice to the heel for 15 minutes following physical activity can help reduce inflammation and manage residual pain [26].

## **DISCUSSION AND CONCLUSIONS**

Calcaneal apophysitis, commonly known as Sever's disease, is a prevalent overuse injury among young athletes, particularly those participating in sports with repetitive impact. It is a primary cause of heel pain in children aged 6 to 15 years. This condition results from repetitive microtrauma and inflammation at the calcaneal apophysis, predominantly due to traction forces exerted by the Achilles tendon during phases of rapid growth. Diagnosis is primarily based on clinical evaluation, with the medial-lateral squeeze test being particularly diagnostic. Symptoms typically include localized heel pain and tenderness, exacerbated by physical activity. Although often mild, calcaneal apophysitis can lead to prolonged periods of immobilization, a decreased quality of life, and may compel young athletes to prematurely terminate their sports careers. Significant risk factors include restricted ankle dorsiflexion, improper foot alignment, high levels of physical activity, and elevated BMI and height. Treatment strategies are predominantly conservative, incorporating rest, NSAIDs, stretching exercises, orthotics, and physical therapy. The use of appropriate footwear is essential for managing and preventing symptoms. Preventive measures emphasize maintaining a healthy body weight, ensuring adequate rest between activities, utilizing supportive footwear, engaging in low-impact exercises, and performing regular stretching to enhance flexibility and mitigate re-injury risks. Continued research is necessary to elucidate the pathophysiology of Sever's disease and to develop more effective therapeutic interventions. Enhancing awareness among coaches, parents, and healthcare providers is critical for improving the management and outcomes for affected children.

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## REFERENCES

- [1] Iwamoto J, Sato Y, Takeda T, et al. Role of sport and exercise in the maintenance of female bone health. *J Bone Miner Metab.* 2009;27(5):530-537. doi:10.1007/s00774-009-0066-6.
- [2] Bramham P, Hylton K, Jackson D, eds. *Sports Development: Policy, Process and Practice.* 1st ed. Routledge; 2001. doi:10.4324/9780203187951.
- [3] Gleser J, Mendelberg H. Exercise and sport in mental health: a review of the literature. *The Israel Journal of Psychiatry and Related Sciences.* 1990 ;27(2):99-112. PMID: 2211073.
- [4] Biddle SJH, Ciaccioni S, Thomas G, Vergeer I. Physical activity and mental health in children and adolescents: An updated review of reviews and an analysis of causality. *Psychology of Sport and Exercise.* 2019;42:146-155. doi:10.1016/j.psychsport.2018.12.011.
- [5] Netz Y, Wu M-J, Becker BJ, Tenenbaum G. Physical activity and psychological well-being in advanced age: A meta-analysis of intervention studies. *Psychology and Aging.* 2005;20(2):272-284. doi:10.1037/0882-7974.20.2.272.
- [6] Abou Elmagd M. Common sports injuries. *International Journal of Physical Education, Sports and Health.* 2016;3:142-148.
- [7] Field LD, Savoie FH. Common Elbow Injuries in Sport. *Sports Med.* 1998;26:193-205. doi:10.2165/00007256-199826030-00005.
- [8] Ritzer EE, Yang J, Kistamgari S, et al. An epidemiologic comparison of acute and overuse injuries in high school sports. *Inj Epidemiol.* 2021;8:51. doi:10.1186/s40621-021-00344-8.
- [9] Schroeder AN, Comstock RD, Collins CL, Everhart J, Flanigan DC, Best TM. Epidemiology of Overuse Injuries among High-School Athletes in the United States. *The Journal of Pediatrics.* 2015;166(3):600-606. doi:10.1016/j.jpeds.2014.09.037.
- [10] Roos KG, Marshall SW, Kerr ZY, et al. Epidemiology of Overuse Injuries in Collegiate and High School Athletics in the United States. *The American Journal of Sports Medicine.* 2015;43(7):1790-1797. doi:10.1177/0363546515580790.
- [11] Belikan P, Färber LC, Abel F, et al. Incidence of calcaneal apophysitis (Sever's disease) and return-to-play in adolescent athletes of a German youth soccer academy: a retrospective study of 10 years. *J Orthop Surg Res.* 2022;17:83. doi:10.1186/s13018-022-02979-9.
- [12] Ceylan HH, Caypinar B. Incidence of calcaneal apophysitis in Northwest Istanbul. *BMC Musculoskelet Disord.* 2018;19:267. doi:10.1186/s12891-018-2184-6.
- [13] Nieto-Gil P, Marco-Lledó J, García-Campos J, et al. Risk factors and associated factors for calcaneal apophysitis (Sever's disease): a systematic review. *BMJ Open.* 2023;13 . doi:10.1136/bmjopen-2022-064903.
- [14] Yang J, Tibbetts AS, Covassin T, Cheng G, Nayar S, Heiden E. Epidemiology of overuse and acute injuries among competitive collegiate athletes. *J Athl Train.* 2012;47(2):198-204. doi:10.4085/1062-6050-47.2.198. PMID:22488286; PMCID: PMC3418132.
- [15] Wiegerinck JI, Zwiers R, Sierevelt IN, van Weert HC, van Dijk CN, Struijs PA. Treatment of calcaneal apophysitis: wait and see versus orthotic device versus physical therapy: a pragmatic therapeutic randomized clinical trial. *J Pediatr Orthop.* 2016;36(2):152-157.
- [16] Wiegerinck JI, Yntema C, Brouwer HJ, et al. Incidence of calcaneal apophysitis in the general population. *Eur J Pediatr.* 2014;173:677-679. doi:10.1007/s00431-013-2219-9.
- [17] Achar S, Yamanaka J. Apophysitis and Osteochondrosis: Common Causes of Pain in Growing Bones. *Am Fam Physician.* 2019;99(10):610-618. PMID:31083875.

- [18] Nieto-Gil P, Marco-Lledó J, García-Campos J, et al. Risk factors and associated factors for calcaneal apophysitis (Sever's disease): a systematic review. *BMJ Open*. 2023;13. doi:10.1136/bmjopen-2022-064903.
- [19] Stege JP, Stubbe JH, Verhagen EALM, et al. Risk factors for injuries in male professional soccer: a systematic review. *Br J Sports Med*. 2011;45:375-376.
- [20] James AM, Williams CM, Haines TP. Effectiveness of footwear and foot orthoses for calcaneal apophysitis: a 12-month factorial randomised trial. *Br J Sports Med*. 2016;50(20):1268-1275.
- [21] Bourke J, Munteanu S, Merza E, Garofolini A, Taylor S, Malliaras P. Efficacy of heel lifts for lower limb musculoskeletal conditions: A systematic review. *J Foot Ankle Res*. 2024;17(2). doi:10.1002/jfa.12031. PMID:38878299.
- [22] Perhamre S, Janson S, Norlin R, Klässbo M. Sever's injury: treatment with insoles provides effective pain relief. *Scand J Med Sci Sports*. 2011;21(6):819-823.
- [23] Perhamre S, Lundin F, Norlin R, Klässbo M. Sever's injury; treat it with a heel cup: a randomized, crossover study with two insole alternatives. *Scand J Med Sci Sports*. 2011;21(6).
- [24] Perhamre S, Lundin F, Klässbo M, Norlin R. A heel cup improves the function of the heel pad in Sever's injury: effects on heel pad thickness, peak pressure and pain. *Scand J Med Sci Sports*. 2012;22(4):516-522.
- [25] Hernandez-Lucas P, Leirós-Rodríguez R, García-Liñeira J, Diez-Buil H. Conservative Treatment of Sever's Disease: A Systematic Review. *J Clin Med*. 2024;13(5):1391. doi:10.3390/jcm13051391.
- [26] Scharfbillig RW, Jones S, Scutter S. Sever's disease: a prospective study of risk factors. *J Am Podiatr Med Assoc*. 2011;101(2):133-145. doi:10.7547/1010133. PMID:21406697.