

Literature Review of Sever's Disease: Radiographic Diagnosis and Treatment

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Abstract

Introduction:

The purpose of this study is to review the current radiographic diagnosis and treatment options for patients with Sever's disease (calcaneal apophysitis).

Study Design:

Qualitative Systematic Review of the Literature

Methods:

The authors searched Ovid and PubMed databases using the keywords 'Sever's disease,' 'calcaneal apophysitis,' and 'apophysitis.' MesH terms were 'calcaneus' and 'heel.' The searches returned 458 results, of which 29 articles were selected for inclusion. The authors reviewed articles published after the most recent literature review on Sever's disease, which was published in 2008. Articles published between June 2008 and December 2011 which address the diagnosis and treatment of Sever's disease were included in the review, while articles not relevant to these topics were excluded.

Results:

The authors found that there are multiple treatment plans available, but no gold standard of care in the diagnosis and treatment of Sever's disease.

Conclusions:

More studies are needed to provide proper data for physicians to best diagnose patients with Sever's disease and avoid misdiagnoses. Preferable studies to be performed include randomized clinical trials and quantitative systematic reviews since the literature does not contain a substantial amount of these formats.

Key Words: Sever's Disease, calcaneal apophysitis

Level of Evidence: 4

Introduction

The purpose of this study is to review the current literature on the radiographic diagnosis and treatment of Sever's disease, a condition first described a century ago.¹ Sever's disease, or calcaneal apophysitis, is an inflammation of the cartilaginous growth center upon which the calcaneal tendon inserts.^{2,3} More specifically, it is a traction epiphysitis^{4,5} characterized by a dull, achy pain located on the posterior and plantar aspects of the heel.^{6,7} Figure 1 depicts the common location of pain associated with Sever's disease. This condition is most commonly classified as an overuse injury in pediatric patients.⁶ It occurs in children during growth at the calcaneal epiphysis, between 5 to 13 years in girls and 7 to 15 years in boys.⁸

There are many potential causes of heel pain, including mechanical, neurologic, arthritic, and traumatic etiologies.⁹ Sever's disease is considered a common cause of heel pain in children. It comprises 2% to 16% of musculoskeletal injuries⁸ and between 16.3% and 22.7% of exertion injuries in children.^{10,11} Correctly identifying the source of the pediatric heel pain as Sever's disease is important for the course of treatment that should be followed.

The etiology of Sever's disease is controversial. It has been suggested that repetitive microtrauma during sporting activities leads to inflammation and pain.⁷ Other theories suggest that Sever's disease may be related to the percentage of body weight supported by the heel in affected patients or the presence of gastrocnemius equinus.^{7,12} There is also a possible correlation with a higher plantar pressure at the heel. Becerro et al's¹² case-control study found that high plantar pressures and gastrocnemius equinus are associated with Sever's disease. However, a case-control study by Scharfbillig et al⁸ suggested that forefoot and rearfoot malalignment are more strongly correlated with Sever's disease than are weight, activity, and limited ankle dorsiflexion. These conflicting findings make diagnosis and treatment more difficult, as physicians must still consider numerous factors as potential etiologies of Sever's disease.

Physicians originally believed that the diagnosis of Sever's disease through radiographic anatomy was not possible. Calcaneal apophysitis is most often diagnosed clinically, and radiographic evaluation is believed to be unnecessary by many physicians.¹³ In early radiologic studies, the increased density of

the apophysis has been emphasized as a characteristic feature of calcaneal apophysitis, but these studies were based on the subjective observations of the investigators.¹⁴ More recent studies using magnetic resonance imaging (MRI) have displayed that one can observe change in the calcaneal apophysis throughout the treatment of Sever's disease.^{3,15} Additionally, MRI has been used in patients whose pain continued after conservative treatment to locate different or additional sources of heel pain.^{3,15}

Once diagnosed, Sever's must be appropriately treated to limit negative consequences. Although Sever's is self-limiting and typically resolves with conservative treatment, recent studies have shown that there are potential negative effects of untreated cases, including avulsion fractures¹⁶ and diminished quality of life.¹⁷ While some physicians are now realizing the importance of treating this condition, they are met with literature expressing conflicting opinions. The proper treatment of Sever's disease has long been a source of debate⁶, for which a wide array of options have been suggested.

Scharfbillig et al's¹⁸ summarization of the numerous proposed treatment options reveals why the management of Sever's may be a rather daunting task for a physician. Even more concerning is that there is no definitive best treatment option, as the majority of evidence published prior to 2008 supporting any particular treatment was opinion-based or retrospective case series.¹⁸ Given the ambiguity in the diagnosis and treatment of Sever's disease, it is necessary to review the most recent literature involving scientific research to hone in on the most useful techniques.

Methods

Two authors conducted independent online database searches of Ovid and PubMed using the keywords 'Sever's disease,' 'calcaneal apophysitis,' and 'apophysitis.' Mesh terms were 'calcaneus' and 'heel.' Language limits were set to English only. The searches returned 458 results, of which 29 articles were selected. The authors reviewed articles published after the most recent literature review on Sever's disease.¹⁸ Results were limited to articles published between June 2008 and December 2011. Articles included and analyzed in this review were related to the radiographic diagnosis and treatment of Sever's disease. Articles excluded were not relevant to the diagnosis and treatment of Sever's disease.

Results

The lack of available clinical evidence in the form of randomized clinical trials makes it impossible to give objective results regarding the treatment and diagnosis of Sever's disease. The majority of information stated in the current literature is a compilation of case studies or case series with researchers giving their opinions on what comprises the best method of diagnosis and treatment.

Discussion



Figure 1. Arrows indicate where pain presents in Sever's disease, on the posterior and plantar heel.

Diagnosis

Calcaneal apophysitis is considered the most common cause of heel pain in children. It is critical to correctly diagnose this condition and rule out others. Individuals susceptible to Sever's disease include boys between the ages of 10 and 12 years, and girls between the ages of 8 and 10 years.¹⁹ Children in this age group that are more susceptible may have the risk factors listed in Table 1. Based on a newer study,⁸ children with forefoot and rearfoot malalignments may also display increased susceptibility. Upon presentation, these children may have a chief complaint of an antalgic gait including limping, tiptoeing, or walking on the outside of the foot.⁶

Traditionally, physicians have used clinical findings to make the diagnosis of Sever's disease. The patient's history and precise location of maximal tenderness are used to differentiate Sever's disease from other posterior heel pain problems.^{18,19, 20, 21} Additionally, non-diagnostic radiographs can be evaluated to verify the diagnosis and rule out other conditions. However, there still exists controversy regarding interpretation and usefulness of radiographs related to Sever's disease. Three recent studies^{13,14,22} attempted to

address the debate over whether or not radiographs can be used as reliable diagnostic tools for identifying Sever's disease.

A recent prospective study¹³ analyzed anteroposterior and lateral weight-bearing foot radiographs of 61 patients diagnosed with calcaneal apophysitis. The radiographs altered the diagnosis of only one patient. The author concluded that because neither sclerosis nor fragmentation of the apophysis could be used to establish the diagnosis of calcaneal apophysitis, using radiographs as the primary diagnostic tool is not useful.

A similar study conducted by Kose et al¹⁴ analyzed the inter-observer and intra-observer reliability of diagnosing Sever's using only radiographs, with increased sclerosis and fragmentation of the calcaneal apophysis as diagnostic criteria. Based upon their findings on inter-observer agreement and intra-observer reproducibility, the authors concluded that assessment of bone density on plain radiography is subjective and thus is an unreliable indicator. It was also noted that fragmentation is a normal variant related to growth. Therefore, neither sclerosis nor fragmentation are validated findings which should be used to diagnose Sever's. Ultimately, this study found that radiographic evidence neither excludes nor supports the diagnosis of Sever's, and as such, radiographic assessment is unnecessary.

While it is not surprising that two studies conducted by the same author came to the same conclusion, a third recent study²² opposes these findings and instead suggests that plain film radiography is in fact important when assessing cases of clinically diagnosed calcaneal apophysitis. This retrospective case study, by Rachel et al,²² found that radiographs altered the diagnosis and management of 5.1% of patients, leading to more aggressive treatment. These results are in contrast to the findings of Kose¹³ that radiographic evidence altered diagnosis in only 1.4% of the patients evaluated. Furthermore, Rachel et al²² suggested that lateral radiographs should be used to assess a diagnosis of Sever's and rule out other conditions, but that additional orthogonal views are unnecessary. The study emphasized that if a diagnosis is made without obtaining radiographs, a lesion requiring more aggressive treatment could be missed. According to Rachel et al,²² routine radiographic evaluation of the calcaneus in children diagnosed with calcaneal apophysitis is common in many pediatric orthopedic practices. Despite the lack of studies on abnormal findings and

concerns about radiation exposure of the patient, these evaluations are conducted to rule out other potential causes of pediatric heel pain, such as stress fractures or bone cysts.

Jung et al²³ provided two case reports in which the patients were treated with a Sever's disease regimen but actually had calcaneal apophyseal fractures. The patients were a 12-year-old female gymnast and a 13-year-old male gymnast. These patients showed no abnormal findings on radiographs, but presented with pain typical of Sever's disease. After resting and icing appeared to solve the problem, they both returned to their activities, only to again develop pain when active. Upon MRI evaluation during the second course of diagnosis, avulsion fracture of the calcaneus was discovered, rather than evidence of Sever's disease. This misdiagnosis using radiographs led to inappropriate treatment regimens.

Arnaiz et al¹⁵ state that while radiographs are non-specific and unnecessary for patients with clinical evidence of apophysitis, MRI is useful in atypical cases or for patients who do not respond to conservative therapy. In apophysitis, MRI findings include a widening of the apophysis. There is also increased signal intensity on T2-weighted images in the apophysis, underlying bone marrow, and adjacent soft tissue. Arnaiz et al recommend conducting MRI evaluation in the axial plane and either the sagittal or coronal plane. Additionally, they suggest using a combination of T1-weighted and T2-weighted sequences.¹⁵

While the use of radiographic evaluation remains controversial, and MRI for calcaneal apophysitis is rare, another mode of diagnosis has been recently investigated by Hazany et al.²⁴ The authors acknowledge limitations of radiographs and suggest the use of bone scans as an alternative diagnostic method for cases of pediatric heel pain in which clinical evaluation and radiography don't provide a clear diagnosis. This method of diagnosis is often used in adults, but rarely has been used in the pediatric population. Analysis of 49 cases of pediatric foot pain of unclear etiology revealed that bone scans were diagnostically useful in 77.6% of cases. The bone scans helped establish new diagnoses and directed the treatment in 63% of cases. Bone scans identified one case of early Sever's disease that had been missed on initial plain radiography.²⁴ This study provides only minimal evidence that bone scans may be useful in diagnosing Sever's disease. Additionally, bone scans may be inferior to other imaging techniques for diagnosing bone pathology around growth plates,²⁴ a key area for

examination in Sever's disease. As such, it remains unclear whether there is any benefit to using bone scans for assessing children with symptoms of Sever's disease.

Table 1. Proposed Risk Factors for Sever's Disease

High activity level

Scharfbillig et al¹⁸

Clemow et al¹⁹

Improper footwear

Clemow et al¹⁹

Running on hard surfaces

Clemow et al¹⁹

Overweight

Sever¹

Scharfbillig et al¹⁸

High plantar heel pressure

Becerro et al¹²

Gastrocnemius equinus

Becerro et al¹²

Scharfbillig et al⁸

Biomechanical deformity

Scharfbillig et al⁸

Micheli and Ireland²⁵

Treatment

Although there is no general consensus on diagnostic protocol aside from clinical evaluation, Sever's disease must be treated when identified. Unsurprisingly, just as opinions on appropriate diagnostic tools vary, so too do opinions on appropriate treatment. Widely accepted as a self-limiting condition,^{19,21,25} symptoms of Sever's resolve upon fusion of the calcaneal apophysis,²¹ which is around 14 in girls and 16 in boys.^{4,6} Before this fusion occurs, however, a patient may experience a reduced quality of life¹⁷ due to pain or avulsion fractures.¹⁶ Thus, it is important to treat Sever's to alleviate pain and prevent complications^{7,21} so that children may return to normal daily activities.

The major course of treatment most recently described in the literature is considered self-management, which includes rest from sports^{7,16,19,20} and avoidance of walking barefoot.⁷ Included in the current conservative treatment guidelines are icing the heel and anti-inflammatory medicine for pain.^{7,16,19} Rehbock⁷ states that icing should be in the area of pain for 10 minutes, 2 to 3 times per day until pain

subsides. Typically, symptoms resolve within 2 weeks to 2 months of initiating conservative treatment.¹⁶

Immobilization of the lower leg and foot with a cast in cases of severe injury and pain has also been indicated.⁷ The exact conditions that are so severe as to require casting are not specifically stated in Rhebock's⁷ article. However, not all physicians agree on when or even if it is necessary to cast. For example, Chiodo and Cook⁶ prefer to use a CAM walker and implement partial weight bearing for 2 weeks. A completely different method is preferred by Toomey,²⁰ who describes the use of silicone heel cups to treat Sever's disease. Toomey advises patients to wear the heel cup for two months on both the affected and non-affected heels to avoid complaints due to leg length inequality. The use of heel lifts and gel heel cups is also suggested by Clemow et al.,¹⁹ while orthotics may be used for flat feet to control foot function.⁷

Recently, a series of studies examined the efficacy of insoles in relieving pain associated with Sever's disease.^{26,27,28} The first study²⁶ demonstrated that two types of insoles, heel pads and heel cups, provide pain relief while allowing boys to maintain their normal activity level. The second study,²⁷ a randomized crossover study, revealed that heel cups were preferred over heel pads by more than 75% of the participants. The third study²⁸ then displayed that the heel cups improved heel pad thickness and reduced heel peak pressure, thereby alleviating pain. Overall, these studies provide more reliable evidence supporting the use of heel cups than have past articles^{19,20} describing personal preferences and clinical experiences.

Once symptoms have resolved, several physicians suggest a stretching protocol.^{6,7} Clemow et al¹⁹ describe the treatment plan as a stretching program with heel lifts. However, Rhebock⁷ states that heel lifts should not be started until the calcaneal apophysitis has fully healed. A current treatment involves stretching and elongation of the gastrocnemius-soleal complex.^{6,29} Chiodo and Cook⁶ recommend stretching 3 to 5 times per day, holding each stretch for 10 seconds. The stretching includes passive dorsiflexion at the ankle using a towel, belt, or band while sitting with the knee extended. Additionally, they suggest calcaneal tendon and calf stretches while leaning against a wall with the heel on the ground.⁶ After symptoms have resolved, the physician must assess whether the use of orthotics and modification of athletic shoe gear is necessary.⁶

While all of these methods have been suggested by individual physicians, our review found only minimal quantitative literature regarding the effectiveness of these treatments, and no comparative studies exist to illuminate which methods work most effectively. The current evidence for treatment of Sever's remains heavily based on opinion and clinical experience.

Conclusion

Clearly, there is still much to be learned regarding the radiographic diagnosis and treatment of Sever's disease. The contrasting findings on radiographic evidence and the limited number of recent studies suggests further investigation is necessary to properly determine the most useful diagnostic tools. Additionally, studies focusing on the use of bone scans specifically for the diagnosis of Sever's will more clearly determine whether this is a valid method that could be used in the future.

It is important that physicians come to a better consensus regarding diagnostic methods, as Sever's disease has been shown to diminish quality of life¹⁷ and potentially cause avulsion fractures.¹⁶ Proper diagnosis and treatment are critical to limiting pain and preventing complications caused by this condition. Yet, there is still no "gold standard" of care, and the current approaches to treatment vary widely and are based primarily on opinion rather than reliable clinical trials. Therefore, further research is justified in the form of randomized clinical trials in order to determine which treatments are most successful at alleviating pain caused by Sever's disease.

Author's Contributions

HL conceived the topic and design of the study, independently performed a literature search, drafted the methods, discussion, and conclusion sections of the narrative review, and participated in adding information to the abstract and introduction. ES performed an independent literature search, participated in the design of the study, drafted the abstract and introduction to the narrative review, and participated in adding additional information to the methods and discussion section. Both authors read and approved the final manuscript.

Statement of Competing Interests

The authors declare that they have no competing interests.

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