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Is extracorporeal shockwave therapy an effective treatment for calcaneal spur? A literature review

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Abstract
Introduction: Calcaneal spurs are common osteophytic outgrowths from the heel bone, found in up to 21% of the population, with prevalence increasing significantly with age. While often asymptomatic, they can cause severe, disabling heel pain, particularly aggravated by weight-bearing. Their development is often linked to chronic traction by soft tissues and associated with plantar fasciitis, though they are also observed in asymptomatic individuals. Risk factors include age, weight, gender, and certain arthritic conditions, underscoring the need to differentiate calcaneal spurs from other causes of heel pain for effective treatment.
Aim: The aim of this article is to explore the underlying mechanisms of calcaneal spur and assess the effectiveness of treating it through extracorporeal shockwave therapy.
Review methods: A comprehensive analysis of research papers available on PubMed and Google Scholar was conducted using keywords: calcaneal spur, heel spur, bone spur, extracorporeal shockwave therapy, calcaneal spur pathophysiology.
Conclusion: Plantar calcaneal spurs, often resulting from chronic mechanical stress and degenerative changes, can significantly impact quality of life. This review indicates that Extracorporeal Shockwave Therapy (ESWT) is a promising non-invasive treatment for symptomatic spurs, effectively reducing pain and inflammation when conservative methods fail. However, further high-quality research is needed to definitively establish its optimal role and protocols.

Keywords: calcaneal spur/ heel spur/ extracorporeal shockwave therapy/ calcaneal spur pathophysiology

Introduction

Calcaneal spurs (commonly known as heel spurs) are an osteophytic outgrowth originating from the calcaneal tuberosity [1]. They are commonly found in the general population, observed in up to 21% of individuals. This rate significantly increases with age, reaching as high as 55% in those over 62 years old [2]. There are two main types of calcaneal spur: inferior calcaneal spur and posterior calcaneal spur. An inferior type is positioned on the bottom surface of the calcaneus (the heel bone). Typically it develops as a result of chronic plantar fasciitis but can also be linked to ankylosing spondylitis, particularly in children. A posterior type is found at the back of the heel, where the Achilles tendon inserts. Typically it arises due to repetitive stress or inflammation at the site of Achilles tendon attachment. Usually the only abnormal physical

sign is localized tenderness beneath the calcaneus. The condition may be asymptomatic or, in some cases, become extremely painful and even disabling. Weight-bearing may aggravate the pain. Calcaneal spurs are most often identified through X-ray imaging [1,3]. According to some authors [4] heel spurs develop as a result of continuous traction by adjacent soft tissues, leading to chronic inflammation, periostitis, and osteogenesis of the spur. Plantar calcaneal spurs are also considered by some to be either a primary cause or a contributing factor to plantar heel pain in individuals with plantar fasciitis [5]. Other investigators [2,6] have reported a significant number of patients with painless plantar heel spurs. Calcaneal spurs have been observed in 45% to 85% of patients with plantar fasciitis, but also in 10% to 63% of asymptomatic individuals. Several risk factors have been identified that may lead to calcaneal spur such as age, weight, gender, types of arthritis, plantar fasciitis, and foot posture [7]. Calcaneal spurs in populations <50 years old are more common in women than in men [8]. Some researchers [9] claim that symptomatic calcaneal spurs are ten times more frequent in elderly, female, overweight patients as well as those with a prior diagnosis of osteoarthritis or currently experiencing heel pain. When dealing with heel pain, it is crucial to look beyond just heel spurs and consider other possible causes such as plantar fasciitis, achilles tendinitis, stress fractures, bursitis or tarsal tunnel syndrome. Differentiating between these conditions is key to getting the right treatment. There are also some medical conditions that may increase an individual's predisposition to developing calcaneal spurs such as ankylosing spondylitis, rheumatoid arthritis or gout [10].

Materials and methods

A comprehensive analysis of research papers available on PubMed and Google Scholar was conducted using search terms encompassing the following keywords: calcaneal spur/ heel spur/ extracorporeal shockwave therapy/ calcaneal spur pathophysiology.

Anatomy

A plantar calcaneal spur (PCS) is a bony outgrowth originating from the calcaneal tuberosity of the heel bone, most commonly from its medial process. Morphologically, it can be simple (triangular, with smooth borders) or irregular (with poorly defined borders). A key anatomical structure in the context of a heel spur is the plantar fascia (PF). This dense connective tissue begins at the calcaneal tuberosity and inserts into the toes. The fascia plays a fundamental role in maintaining the medial longitudinal arch of the foot and absorbing loads. In patients with heel spurs, the plantar fascia is typically significantly thicker. The relationship between the PF and the spur is variable; it may be partially, fully, or not at all connected to it, although

histological studies indicate that the PF inserts into the spur's periosteum in almost half of the cases [7].

The heel spur is also closely associated with the intrinsic muscles of the foot. Superficial layer muscles, such as the abductor hallucis (AH), flexor digitorum brevis (FDB), and abductor digiti minimi (ADM), attach to the calcaneal tuberosity [7,11]. FDB and ADM often directly connect with the spur [7]. Additionally, the quadratus plantae muscle, part of the deeper muscle layer, attaches near the spur. Beyond the muscles, the long plantar ligament also connects to the inferior surface of the heel bone [7,11]. All these structures can exert a traction force on the heel bone, particularly under conditions of excessive pronation [11].

Pathophysiology

The pathophysiology of a heel spur (PCS) remains unclear. According to Kosmahl et al. [11] it is a process where bones, ligaments, and tendons remodel their structure in response to mechanical stress. A spur develops as an osteophyte at the site where ligaments or tendons exert traction forces on their bone attachments.

The primary contributing factor is the pull of the plantar fascia (PF), especially intensified during excessive pronation of the foot. This fascia supports the foot's arch and absorbs loads. Increased PF tension (known as the windlass mechanism) magnifies stress on its attachment to the heel bone [11,12]. Chronic overload then leads to plantar fasciitis. Prolonged inflammation triggers repair processes, including fibrosis and ossification at the attachment point, ultimately resulting in spur formation. Histological studies suggest this is more of a fasciosis (degenerative condition) than a typical inflammatory process [11].

The spur can also be associated with the attachments of muscles (flexor digitorum brevis, quadratus plantae, abductor digiti minimi) and the long plantar ligament [11]. These structures collectively exert traction forces on the heel bone, especially with excessive pronation [7]. Kumai and Benjamin [13] suggested an alternative explanation that calcaneal spurs could develop in response to repetitive compression. This explanation aligns with research showing a higher prevalence of calcaneal spurs in overweight individuals.

Treatment

Many treatments for calcaneal spur have been described, and since so many are commonly used, it suggests that no single treatment stands out as definitively superior.

Conservative treatment options:

While these methods can lessen or even eliminate pain symptoms, they typically don't address the underlying cause. Rest, nonsteroidal anti-inflammatory drugs and cryotherapy reduce pain and inflammation [4,10]. Some orthotic devices such as heel cups or modified shoes with silicon shoe implants may be helpful [14]. Furthermore, a home stretching program, manual therapy and strength training exercises are considered to be an important part of the treatment [10,15]. In a case report, Boob et al. [15] examined the therapeutic efficacy of ankle mobilization and advanced physiotherapy in alleviating heel spur. The aims of the intervention were to improve range of motion, reduce pain and prevent symptoms from returning. The intensity of exercises had to be gradually increased to match the patient's tolerance, consistency was crucial. In this case report a heel spur was successfully treated using an advanced physical therapy intervention (specifically Mulligan joint mobilization).

Advanced treatment options:

In cases where conservative methods are not enough more advanced treatments may be considered. Corticosteroid injections are a common approach for heel spur treatment, they are known for their anti-inflammatory effects, aiming to reduce pain in the heel and can be administered directly into the painful area [10,16]. Despite their frequent use, the injections' effectiveness compared to other conservative methods remains debated. Studies show inconsistent results, some indicate quick but short-lived relief [16]. Furthermore, repeated injections are generally discouraged due to the significant risk of damaging local tissues. Multiple steroid injections can degrade the heel's fat pad and make the plantar fascia more vulnerable to tearing [10]. According to some studies, treating calcaneal spurs by use of intralesional pulsed radiofrequency (PRF) or conventional radiofrequency (CRF) may also be effective [17,18].

When no other method is sufficient and the patient still suffers from symptoms of calcaneal spur, surgical intervention may be considered. Some studies indicate that surgical interventions like isolated spur excision or a combined approach of plantar fascia release and spur excision may effectively improve foot functions [19,20].

Extracorporeal shockwave therapy

Extracorporeal Shockwave Therapy (ESWT) operates by producing pressure waves that are then precisely focused onto targeted anatomical areas. These waves impact tissues at both

cellular and mechanical levels. A key effect is the temporary disruption or increased permeability of neuronal cell membranes, which helps explain ESWT's analgesic effect. It is a non-invasive method with a very low complication rate. Currently, it is used with a positive effect in various musculoskeletal diseases [9].

Extracorporeal shockwave therapy in calcaneal spur

According to Mohseni et al. [10] extracorporeal shockwave therapy (ESWT) is considered to be among more advanced treatment approaches. It involves applying shockwaves to the problematic area leading to tissue regeneration and reduction of the pain. In recent years it has become the recommended treatment for patients with symptomatic calcaneal spurs, particularly when other conservative treatments haven't worked [9].

According to Hayta et al. [9] ESWT can successfully reduce the calcaneal spur length and reduce pain. In a clinical trial conducted by Cosentino et al. ESWT proved effective in reducing pain in patients with painful heel spurs, and also reduced inflammatory oedema [21].

According to Öztürk et al. [22] ESWT can result in significant improvement in patients with heel spurs but moreover, the effect may be even more significant with the addition of pulsed electromagnetic field therapy (PEMFT) to ESWT.

Yalcin et al. [23] in their study used a radial ESWT. Shockwaves were applied to the painful spot, every patient received five treatments. Researchers took X-rays of the affected heels before and after the treatment. Results showed that ESWT is an effective treatment for reducing pain in symptomatic calcaneal spurs but radiographic results were not significantly effective.

In a prospective study Othman et al. [24] compared two methods of treating calcaneal spur. The first group of patients was treated by endoscopic plantar fasciotomy (EPF) while the second group was treated by ESWT. The results showed that EPF was a more effective method, however, with the potential for minor complications. ESWT also showed beneficial effects and is still the first choice of treatment after conservative methods fail.

However there are also some publications that suggest that ESWT is not efficient in treating heel spurs. In a randomised controlled multicentre trial Haake et al. [25] reported success rates of treatment as 81% in the ESWT group, and 76% in the placebo group.

Conclusion

Plantar calcaneal spur is a common condition that can significantly impact the quality of life. This review comprehensively discusses the pathophysiology of PCS, various treatment methods, and specifically focuses on the efficacy of extracorporeal shockwave therapy (ESWT) as a

therapeutic option. Our findings confirm that calcaneal spurs primarily result from chronic mechanical stress and degenerative changes in the plantar fascia and intrinsic foot muscles. The evidence suggests that ESWT is a promising non-invasive treatment for symptomatic calcaneal spurs, particularly after conservative methods fail. Multiple studies indicate its effectiveness in pain and inflammation reduction. However, conflicting results from some trials highlight the need for further high-quality research to fully establish ESWT's definitive role and optimal protocols in calcaneal spur management.

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