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Research Article

Relationship between Ankle Muscle Strength and Pain and Calcaneal Spur Length in Individuals with Exercise Habit: A Pilot Study

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Abstract

Background: A Calcaneal Spur (CS) is an osteophytic outgrowth just anterior to the tuberosity of the calcaneus. CSs are common causes of heel pain, which can affect the ankle muscle strength. In spite of the many treatment alternatives available for CSs, the associations between the CS length and pain and muscle strength have not yet been sufficiently researched.

Aim: The aim of this study was to evaluate the relationship between the CS length and the pain and muscle strength of the ankle in individuals who exercise habit.

Materials and Methods: The sociodemographic characteristics, duration of symptoms, activity and resting pain, and dorsal and plantar flexor muscle strength of the ankle were evaluated. Computer-aided linear measurements were conducted to determine the spur length (mm) from the tip to the base. The pain intensity was assessed using a Visual Analog Scale (VAS), while the muscle strength was determined using a hand-held dynamometer.

Results: Twenty individuals (13 females and 7 males) diagnosed with CSs were included in this study. The mean age of the patients was 45.25±10.16 years old (range 30–65), while the mean CS length was 3.45±3.12 mm (range 0.5–12.2). The CS length was significantly correlated with the age (p=0.012), activity pain (p=0.015), resting pain (p=0.021), dorsal flexor muscle strength (p=0.034), plantar flexor muscle strength (p=0.041), and body mass index (BMI) (p=0.001).

Discussion: Our results indicate that the CS length is significantly correlated with the age, BMI, dorsal and plantar flexor muscle strengths, and activity and resting pain.

Conclusion: In light of the study results, the CS length is an important parameter that is correlated with ankle pain and muscle strength.

Keywords: Calcaneal spur; Pain; Muscle strength

Introduction

Bone spurs, also described asenthesopathy, can be seen in most bone attachment surfaces. These are bone projections that extend to the soft tissue [1], with spurs forming spindle-like structures at the locations where the muscles attach to the bone [2]. Bone spurs develop on the edges of the fibrocartilaginous attachment sites of the entheses, and usually form on the dorsal or plantar side of the calcaneus [3]. The formation of a bony projectile on the plantar side of the calcaneus was first defined as a Calcaneal Spur (CS) in 1900 by Plettner [4], and is a common cause of heel pain in adults. A plantar CS is a bony formation of the plantar fascia and muscles at the plantar insertion points, while a dorsal CS is an exostotic bony formation at the insertion point of the Achilles tendon. A dorsal CS is less common and usually asymptomatic. Both dorsal and plantar CSs can present in the same person [5].

Anatomically, the plantar fascia originates from the tubercle of the medial calcaneus [4]. The apex of the spur is located on the superior aspect of the plantar fascia, inside the flexor digitorum superficialis muscle [6]. Repetitive microtraumas are important in the pathogenic formation of a CS. In addition, other risk factors, such as obesity, aging, structural foot deformities (pes planus and pes cavus), or exercise habits (e.g., sports like running or ballet that put the feet in stressful anatomical positions), are factors that can accelerate the formation of a CS [7]. Because 80% of the total body weight is transferred to the heel while walking normally, based on biomechanical walking analyses, obesity is another factor that can accelerate CS formation. Weight gain with repetitive traumas and ligamentous problems can contribute to this condition, while structural problems, such as pes planus and pes cavus, can play a role in relation to load transfer and mobilization. Moreover, a CS might develop after the neovascularization and ossification of scarred tissue [7].

In some previous studies, it has been shown that CSs do not always

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Table 1: Inclusion and exclusion criteria of the study.

Inclusion criteria	Exclusion criteria
-Heel pain with calcaneal spur -Calcaneal spur in lateral calcaneal x-ray -Age between 18-65 years old -Agree to be included in the study - Individuals who exercising at least150 min. per week	-Past medical history of surgery or fracture of the heel or ankle -Conditions that affect the muscular force of the ankle, such as lumbar radiculopathy, Achilles tendinopathy, or Morton's neuroma -Presence of inflammatory joint disease -Presence of ankylosing spondylitis or other inflammatory spondyloarthropathy

present with heel pain, but recent studies have reported CS pain rates of 75.9–89% in individuals with CSs [8,9]. However, these studies did not evaluate the relationship between the spur length and pain. In their study, Kuyucu, et al. evaluated the relationship between the spur length and foot functions, and their results showed that the size of the spur might affect those functions [10]. The above-mentioned studies have not explained the relationship between the CS length and the pain and muscular force of the ankle; therefore, the current literature is unclear with regard to this relationship. Although many different techniques have been used in the management of a CS, the relationship between the CS length and pain and muscular force is not well-defined. It is essential to analyze this relationship with regard to clinical parameters; therefore, this study aimed to evaluate the relationship between the CS length and the muscle strength and pain of the ankle in individuals who exercise intensively.

Figure 1: Calcaneal spur length measurement.

Materials and Methods

Thirty-two cases presenting with heel pain to the Orthopedics and Traumatology Outpatient Clinic of Ahi Evran University Training and Research Hospital between September 2015 and March 2016 were diagnosed with CSs by an orthopedist, based on their medical history, risk factors (structural foot deformities, aging, obesity, sedentary lifestyle, etc.), and physical examinations. Four of these patients chose not to participate, so a total of 28 cases were considered for inclusion in this research. When we evaluated these cases based on the inclusion and exclusion criteria shown in (Table 1), we identified four cases of inflammatory joint disease, two cases of Achilles tendinopathy, and two cases of lumbar radiculopathy. Therefore, this study was initiated with a total of 20 cases. Written and verbal consents were obtained from all of the participants before the study began. This research was conducted in accordance with Helsinki declaration.

The demographic characteristics of the study subjects (age, gender, educational background, and occupation), dominant and affected sides, and duration of symptoms were obtained and recorded. In addition, the bodyweights and heights of the subjects were recorded, and the Body Mass Indexes (BMIs) were calculated. A heel pressure test was performed to diagnose the presence of a CS. This test was performed by applying pressure to the midpoint of the heel while the subject was in a facedown position, the knee was flexed to 90°, and the ankle was in a neutral position. If the pain is increased when compared to resting, the test result was considered to be positive [10]. The strain on the plantar fascia was evaluated bilaterally, while neuroma, entrapment neuropathy, and calcaneus stress tests were conducted for the differential diagnosis. Extensive physical and neurological examinations were done to rule out lumbar radiculopathy and myofascial pain syndrome, which both can cause heel pain.

Each patient's activity and resting pain was evaluated using a Visual Analog Scale (VAS) on which the subjects indicated their level of pain on a scale of 0–10. The higher numerical values reflected higher pain levels in the VAS scores [10]. The muscle strength of the patients' ankles was evaluated using a hand-held dynamometer (Hydraulic Push-Pull Dynamometer; Baseline Evaluation Instruments, White Plains, New York, USA). The plantar flexor muscle test was conducted while the patient was in a prone position, with the knee flexed to 90°, and the ankle in a neutral position. After placing the dynamometer on the plantar side of the foot at the level of metatarsal head, the patient was asked for strong plantar flexion and the measurement was recorded. For the dorsal flexor muscle test, the measurement was done by placing a cylinder under the knee while the patient was in a supine position. The dynamometer was placed on the dorsal side at the level of the metatarsal head, and the patient was asked for strong dorsal flexion. The same measurement was repeated three times, and the arithmetic mean was calculated; thus, we determined the dorsal and plantar flexor muscle strengths of the patient [11].

A lateral calcaneal X-ray was used to evaluate the size of the CS [12]. We measured the length of the CS from its base to its apex using the computer-assisted linear measurement method for the calcaneal margin as defined by Johal, et al. [8,9] (Figure 1). All of the measurements and analyses were done by the same researcher.

Statistical analysis

The statistical analysis was done using SPSS software version 21.0 for Windows (SPSS Inc., an IBM Company, and Chicago, IL, USA). Standard descriptive statistics were used to calculate the mean values and standard deviations for the continuous variables, and the percentage values for the categorical variables. A Spearman correlation test was used to analyze the relationships between the CS length and the age, gender, symptom duration, BMI, and dorsal and plantar flexor muscle strength tests of the patients. A p value <0.05 was considered to be statistically significant.

Table 2: Demographic characteristics of the participating individuals.

		n	%
Gender	Female	13	65
	Male	7	35
Educational background	Primary school graduate	5	25
	Secondary school graduate	3	15
	High school graduate	5	25
	Bachelor's degree or higher	7	35
Employment status	Not working	5	25
	Retired	6	30
	Working	9	45
Dominant side	Right	13	65
	Left	7	35
Affected side	Right	12	60
	Left	6	30
	Bilateral	2	10
Body mass index (kg/m²)	Normal weight (18.5-24.9)	2	10
	Overweight (25-29.9)	8	40
	Obese (>30)	10	50

Results

Of the 20 patients included in this study, seven were male (35%), 13 were female (65%), and their mean age was 45.25±10.16 years old (range 30–65).The demographic characteristics of the patients involved in this study are shown in (Table 2). The CSs were identified on the right and left sides and bilaterally in 12, six, and two cases, respectively. The mean duration of symptoms was 31.02±6.32 weeks. The mean CS length was 3.45±3.12 mm, mean activity pain was 5.32±2.31 and mean resting pain was 4.35±1.25. The analysis of the plantar flexor muscle strength resulted in a mean of 12.36±8.12 kg/f, while the dorsal flexor muscle strength was 10.21±8.65 kg/f.

The relationships between the CS length and the activity and resting pain, dorsal and plantar flexor muscle forces, symptom duration, and BMI were calculated in each patient. A statistically significant relationship was found between the CS length and the age (r=0.678, p=0.012), activity (r=0.345, p=0.015) and resting pain (r=0.215, p=0.021), dorsal (r=-0.421, p=0.034) and plantar (r=-0.654, p=0.041) flexor muscle forces, and BMI (r=0.458, p=0.001). However, there was no statistically significant relationship between the CS length and the duration of symptoms (r=0.123, p=0.063) (Table 3).

Discussion

This study showed that there were significant relationships between the CS length and the age, activity and resting pain, dorsal and plantar flexor muscle strengths, and BMI. The clinical and radiological effects of a CS have been shown in previous studies; however, studies that evaluate the relationship between the spur length and muscle force and pain are scarce [7,8,12]. The study by Akkaya, et al. that analyzed the relationships between heel pain and radiological and clinical variables showed no significant relationship between the presence of a CS and age, nor relationships between a CS and BMI or gender [9]. Additionally, Irving, et al. researched the risk factors associated with chronic heel pain in a systematic review. They included 16 different papers and found that the age and BMI were related to the incidence of CSs [13]. Consistent with the literature, we found that the CS length was statistically significant when related to the BMI and age in this study.

In a recent CS paper, heel pain causing plantar fasciitis and the associated factors were studied, and statistically significant relationships were found between the CS incidence and VAS scores [10]. In our study, we also found that the CS length was significantly related with both the activity and resting pain VAS scores.

Table 3: Analysis of the relationship between the CS length and activity and resting pain, muscle force, BMI, and duration of symptoms.

	CS length	
Parameter	**r**	**p**
Age (year)	0.678	0.012
Activity pain (cm)	0.345	0.015
Resting pain (cm)	0.215	0.021
Dorsal flexor muscle strength (kg/f)	-0.421	0.034
Plantar flexor muscle strength (kg/f)	-0.654	0.041
BMI (kg/m²)	0.458	0.001
Duration of symptoms (weeks)	0.123	0.063

CS: Calcaneal Spur; BMI: Body Mass Index.

In a study by Karagounis, et al. that aimed to analyze two different treatment methods in recreational athletes with CSs, it was found that the structure of the ankle and muscle strength was two important parameters of treatment success, and that the CS length was related to the dorsal and plantar flexor muscle strengths [14]. Overall, the dorsal and plantar flexor muscle forces are important for preserving the structures of the foot and the continuation of the arches [15]. In this study, there was a statistically significant relationship between a CS and the dorsal and plantar flexor muscle forces.

Its prospective design, sufficient inclusion and exclusion criteria, and measurements and evaluations done by a physiotherapist and orthopedist experienced in their fields are the strength of this study. However, there were some limitations, including the absence of a three-dimensional CS analysis with ultrasonography to determine the CS thicknesses and measure the plantar fascia tension.

Conclusion

Based on the results of this study, CSs affect the activity and resting pain and ankle muscle strength of patients suffering from this condition.

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