Ann Med Res

Current issue list available at AnnMedRes

Annals of Medical Research

journal page: www.annalsmedres.org

Effectiveness of extracorporeal shock wave therapy according to plantar calcaneal spur types

Turkan Tuncer[a], Emel Sabaz Karakeci[a,*]

[a] *University of Health Sciences, Fethi Sekin City Hospital, Department of Physical Medicine and Rehabilitation, Elazig, Türkiye*

ARTICLE INFO

Keywords:
Heel pain
Calcaneal spur
Extracorporeal shock wave therapy

Received: Dec 16, 2022
Accepted: May 24, 2023
Available Online: 26.05.2023

DOI:
10.5455/annalsmedres.2022.12.372

Abstract

Aim: The aim of this study is to group patients with plantar heel pain and calcaneal spurs detected via lateral foot x-rays based on the angle between the spur and the calcaneus and compare the efficacy of an Extracorporeal shock wave therapy (ESWT) treatment between these groups.

Materials and Methods: The patients were divided into three groups based on the measurement the angle between the plantar calcaneal spur and the calcaneus. Those with a measured angle of <30° were classified as Group 1, ranging between 30–60° as Group 2, and >60° as Group 3. Demographic characteristics, spur length, visual analog scale (VAS) and foot function index score (FFI), and pain and function evaluation were used as the pre-and posttreatment data in each group.

Results: Out of the 170 patients, 96 (56.5%) were included in Group 1, 65 (38.2%) were in Group 2, and 9 (5.3%) in Group 3. The posttreatment VAS and FFI scores of the patients were significantly lower than the pretreatment scores ($p<0.001$). It was determined that the highest and lowest VAS and FFI score changes in the posttreatment period was in Group 3 and Group 1, respectively. In the correlation analysis, a positive correlation was found between the measured angle value and pretreatment VAS and FFI scores, age, and spur length.

Conclusion: ESWT is an effective treatment method for calcaneal spurs, but further studies are needed on PCS classifications and the efficacy of the treatment selected based on these classifications.

Introduction

Plantar heel pain is a frequently encountered condition that occurs at varying rates among people from different ethnicities and impairs quality of life of people [1-3]. It is usually seen in women aged between 40–50 years and the incidence rate is increasing among obese individuals [4, 5]. The pathology of plantar calcaneal spurs (PCS) includes inflammation of the plantar fascia after exposure to chronic microtraumas as a result of predisposing factors and calcification in plantar fascia proximal after such inflammation [6]. Although plantar fasciitis appears to be the most common pathological factor, it is not known whether PCSs directly cause plantar fasciitis [7-10]. In many studies, it has been observed that a PCS originates from a calcaneal tuberosity and takes shape toward the plantar posterior fascial surface [11]. However, in histological studies of plantar fasciitis, it has been found that PCSs can cause fragmentation and degeneration of the plantar fascia base [12-15].

Zhou and et al. [10] identified two types of PCS. Type A was localized to the plantar fascia insertion, while Type B was localized within the plantar fascia. In another study, PCSs were classified according to their shape (horizontal, vertical, or hook) and size. While the shape and size of the spur before treatment were not related to symptom severity, the greatest improvement in post treatment function and pain was observed in large and hook-shaped PCSs [16]. Zhang et al. [16] classified PCSs according to the angle between the calcaneus and the spur. Based on the angle between two directions—one parallel to the central axis of the calcaneus and the other parallel to the central axis of the PCS—an angle <30° was classified as Type I, between 30–60° as Type II, and >60° as Type III. In the present study, Type II was the most commonly observed type, where the highest pre-and postoperative visual analog scale (VAS) scores and the lowest postoperative The American Orthopaedic Foot and Ankle Society (AOFAS) score were also found in Type II [16].

Different conservative, medical, and surgical methods are available for the treatment of plantar heel pain and cal-

*Corresponding author:
Email address: emelsabaz@gmail.com (Emel Sabaz Karakeci)

caneal spurs. Among the conservative treatment methods, the extracorporeal shock wave therapy (ESWT) has become increasingly widespread [17]. ESWT is a non-invasive method that uses high amplitude sound waves focused on a desired body area to treat conditions, such as plantar fasciitis, medial and lateral epicondylitis, tendinopathies, and calcaneal spur. The American Food and Drug Administration approved the application of ESWT for the treatment of chronic proximal plantar fasciitis in 2000 [18]. However, the results of studies on the efficacy of ESWT treatment are contradictory [19-23]. Based on a meta-analysis, it has been argued that it should be considered before surgical methods, especially due to its symptomatic healing efficacy [24]. In another study, ESWT was found to be effective in the treatment of chronic plantar fasciitis compared to pain, especially in the first six months compared to other conservative treatment methods [25]. A common feature of the studies, which are reported to be ineffective on pain, is the application of ineffective doses of ESWT to the control group in the form of a placebo [19, 20].

There are different opinions on the classification of calcaneal spurs and this study was planned due to the deficiency in the literature. In the present study, we aimed to classify the PCS types using the angle measurement between PCS and the calcaneus and assess then efficacy of the ESWT treatment according to the PCS types in patients that presented with heel pain.

Materials and Methods

A total of 170 patients, between April and November 2021, who presented to Physical Therapy and Rehabilitation outpatient clinic with heel pain, were diagnosed with calcaneal spurs, and subsequently, received ESWT treatment, a total of five sessions were performed three days a week, were evaluated retrospectively. The study involved 125 female and 45 male patients. Treatment was given to the right and left heels of 106 and 64 patients, respectively.

The approval of the Ethics Committee was obtained (Fırat University Non-Invasive Clinical Research Ethics Committee, approval no. 2021/12/26). The patients were informed about the procedure and their informed consent was obtained. The study was carried out in accordance with the principles of the Helsinki Declaration.

The clinical evaluation of the patients before and after the treatment was evaluated with the pain intensity VAS. Foot Function Index (FFI) was used to measure the impact of foot pathology on function in terms of pain, disability and activity restriction.

The angle between the PCS and the calcaneus was analyzed by a radiologist using a lateral direct x-ray and a computer-assisted program. In the computer-aided linear spur length measurement, the angle between the two directions—one parallel to the center axis of the calcaneus and the other parallel to the central axis of the PCS—were evaluated, where patients with an angle of $<30^\circ$ were classified into Group 1, between 30–60° into Group 2, and $>60^\circ$ into Group 3 (Figure 1a, 1b, 1c) [16].

Patients aged <18 and >70 years and who had neurological diseases that involve the foot area, neuropathy, peripheral vascular diseases, inflammatory rheumatic diseases, arthritis in the foot and ankle, cardiac arrhythmia or pacemakers, cancer or tumor formation anywhere in the body, surgical operation in the foot area, outpatient deformities due to paralysis, history of acute trauma in the foot area, and had been administered steroids or any other local injection in the last six months due to heel pain were excluded from the study.

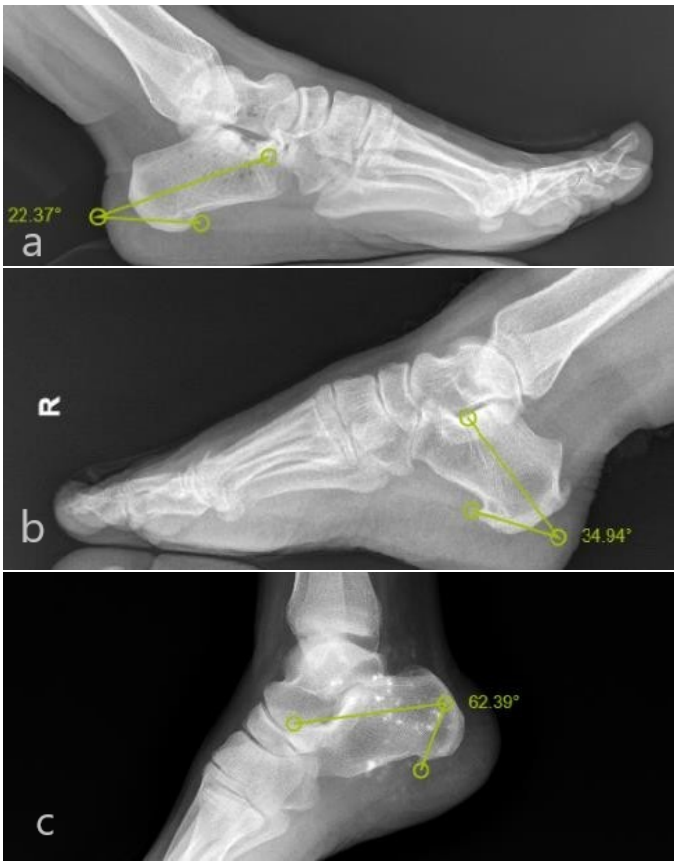

Figure 1. X-rays of classification of plantar calcaneal spurs. Type I, angle was less than 30° (a). Type II, angle was from 30° to 60° (b). Type III, angle was more than 60° (c).

Application protocol; Using ESWT device (Intelect® RPW, Chattanooga, USA) and a 9 mm application apparatus, a total of five sessions were performed three days a week with frequency, 12 Hz; energy density, 2 bar; and number of beats, 2000.

Statistical analysis

We performed power analysis for the sample size estimation. Type I error (α) was set at 0.05 and power of the test was selected 0.95 and calculated sample size appropriate to test the hypothesis and have confidence was 69. Statistical analyses were performed using the SPSS (Statistical Package for Social Sciences; SPSS Inc., Chicago, IL) 22 package software. In the present study, descriptive data were shown as values n, categorical data as percentages, and continuous as mean ± standard deviation, median, and interquartile range (IQR) (25–75 percentile values). Chi-square analysis (Pearson Chi-square) was applied to compare categorical variables between groups.

The Kolmogorov-Smirnov test was used to evaluate the conformity of continuous variables to normal distribution. The Wilcoxon test was performed to compare measurable data in the pre- and posttreatment period. The Kruskal-Wallis test was applied to run a comparison between more than two groups. The Spearman correlation test was used to examine the relationship of continuous variables. The change scores for VAS and foot function index score (FFI), for pre- and posttreatment were calculated. Statistical significance level in analyses was accepted as $p<0.05$.

Results

The present study included 170 patients with an average age of 49.4 ± 10.1 year (23–76). 125 (73.5%) of the patients were female and 45 (26.5%) were male. 96 (56.5%) of the patients were in Group 1, 65 (38.2%) were in Group 2, and 9 (5.3%) were in the Group 3 patient group. The mean angle of the patients was 28.0 and the median spur length was 8.7 mm. (Table 1).

The VAS and FFI score of the patients in the posttreatment period were significantly lower than the pretreatment scores ($p<0.001$) (Table 2). In the correlation analysis, a positive correlation was found between the angle between the PCS and the calcaneus and pretreatment VAS and FFI scores and spur length (Table 3).

There was a significant difference between the groups in terms of VAS change, FFI change, and spur length ($p<0.001$). Accordingly, it was determined that both the highest and lowest VAS and FFI changes and the maximum and minimum spur length were in Group 3 and Group 1, respectively (Table 4).

Table 1. Characteristics of patients diagnosed with calcaneal spurs.

		Number	(n) %
Age (year)		49.4±10.1	
Gender	Female	125	73.5
	Male	45	26.5
Group	Group 1	96	56.5
	Group 2	65	38.2
	Group 3	9	5.3
Angle, Median (IQR)(°)		28.0 (20.0-36.0)	
Spur Length, Median (IQR)(mm)		8.7 (4.3-12.3)	

IQR: interquartile range.

Table 2. Comparison of VAS, and FFI scores of patients in the pre- and posttreatment periods.

	Pretreatment Median (IQR)	Posttreatment Median (IQR)	p*
VAS	6.0 (5.0-7.0)	4.0 (3.0-5.0)	**<0.001**
FFI	56.0 (44.0-82.0)	25.5 (20.0-31.0)	**<0.001**

IQR: interquartile range, VAS: visual analog scale FFI: foot function index score *Wilcoxon analysis was performed.

Table 3. Correlation analysis of parameters of patients.

		Pretreatment VAS	Posttreatment VAS	Pretreatment FFI	Posttreatment FFI	Angle
Angle	R	<440	<049	**.304**	<023	
	P	**.000**	<527	**.000**	<765	
Spur length(mm)	R	<530	<107	<449	<130	<511
	P	**.000**	<166	**.000**	<092	**.000**

VAS: visual analog scale FFI: foot function index score *Wilcoxon analysis was performed.

Table 4. Comparison of VAS and FFI changes, plantar calcaneal spurs angle, and spur lengths of patients according to groups.

	Group 1 Median (IQR)	Group 2 Median (IQR)	Group 3 Median (IQR)	p*
VAS change	-1.0 (-2.0-.0)	-2.0 (-3.0--1.0)	-4.0 (-5.0--4.0)	**<0.001**
FFI change	-23.5 (-36.0--8.0)	-30.0(-57.0--16)	-59.0 (-66.0--57.0)	**<0.001**
Spur length(mm)	5.3;3.0-10.8	10.5;8.1-12.6	12.7;12.6-14.0	**<0.001**

IQR: interquartile range, VAS: visual analog scale FFI: foot function index score *Kruskal Wallis test was performed.

Discussion

The aim of our study was to analyze the efficacy of ESWT treatment in patients diagnosed with a PCS, based on the angle between the PCS and the calcaneus. In the pathology of a heel spur, inflammations of the plantar fascia after exposure to chronic microtraumas with the effect of predisposing factors and calcification in the proximal plantar fascia after this inflammation are involved [6].

In studies carried out so far, the calcaneal spurs were classified as Type A or Type B according to their position to the plantar fascia, as well as their shape (horizontal, vertical, or hook) and size. Okçu et al. In their study, patients were evaluated in 4 different types according to their spur shapes. (Type 0 normal, type 1 hook-shaped, type 2 horizontal and type 3 vertical). No relationship was found between pain and spur type in the study. The mean pain score, which was 8 before treatment, was 5 in the first week after treatment and 3.5 in the 12-week follow-up. In addition, vertical spurs were associated with worse treatment outcomes in the study. Patients with longer spurs provided more pain relief, and smaller spurs with ESWT provided more relief. In our study, a significant correlation was found with spur length and pain and FFI [26]. This study is the first to evaluate the efficacy of ESWT therapy based on the angular measurement of spur. There are few studies examining the connection between spur type and pain intensity. Ahmad et al. demonstrated that there was no connection between spur kinds and pain or function [15]. Ahmad et al.'s study was the only one to attempt to address the issue of whether treatment outcomes were impacted by the existence, size, or kind of spurs. They discovered that CAM walking boots and therapeutic physiotherapy improved horizontal and hook spurs more than vertical spurs [15].

The variations in the structures that the spurs arise from

are related to the variations in the types of spurs. The medial process of the tuberosity is where the majority of spurs develop, however in some people, they can also come from the lateral processes and sulcus [9]. As a result, disagreements in treatment outcomes across types may be related to differences in the structures from which the spurs emerge. There is proof suggesting that bigger spurs exhibit more cortical thickening than smaller spurs [28]. İn this study, spur length, pre- and post-treatment VAS and FFI changes were the highest in group 3 with the largest angle value. It is unclear, however, whether the improved prognosis of bigger spurs is related to the difference in cortical thickness. More research on this subject is required.

ESWT decreased calcaneal spur lengths and discomfort in individuals with symptomatic calcaneal spurs, according to Hayta et al. [27]. Mishra et al. demonstrated that ESWT and methylprednisolone injections were both beneficial in relieving pain in PF patients, although ESWT was more effective than methylprednisolone injections [28]. Yalçın et al. investigated the radiological changes due to ESWT in spurs. They discovered that the radiological alterations that occurred with ESWT were unrelated to clinical outcomes [21]. Although studies have shown that ESWT may be beneficial for PF and calcaneal spurs treatment. In this study, the difference in VAS and FFI values before and after treatment shows the effectiveness of ESWT treatment. The significant correlation between spur length and pretreatment VAS and FFI was consistent with the literature.

The significant correlation between the angle value and the pre-treatment VAS score could not be determined by FFI. This shows that the effect of ESWT on functional recovery may take longer. Its effectiveness on pain may be earlier than functional recovery. We could not find a study in the literature related to the efficacy of ESWT treatment with angle typing.

However, Zhang et al [10,16-17]. recently reclassified calcaneal spurs into three categories (Types) according to the angle between the calcaneus and the spur . This lack of consensus on classification in the literature can also cause problems in the planning and cost of treatment. Based on the classification used by Zhang et al. [16] in the present study, the Type 1 PCS exhibited by patients in Group 1 (56.5%) was most frequently observed, while the Type II PCS exhibited by patients in Group 2 (40.8%) was most frequently observed in the study by Zhang et al. Plantar calcaneal spur is known to be seen at varying rates in patients with different ethnicities [1]. Therefore, the difference seen in the present study and the study by Zhang et al. may be due to the fact that they have worked on patients from different ethnicities.

In the study by Zhang et al [16]. the preoperative VAS score was the highest in patients with Type II PCS, while it decreased at a similar rate in all three groups in the postoperative period. Furthermore, the decrease in VAS score was also observed in the patients with Type II PCS in the 12-month postoperative follow-up period [16]. In the present study, it was determined that the highest and lowest VAS and FFI changes, based on calculating the changes before and after ESWT treatment, were in Group 3 and Group 1, respectively.

Kuyucu et al. [29] reported that spur length is an important parameter that correlates with pain and foot function index.. In our study, we found a significant correlation between spur length, age, and pretreatment VAS and FFI scores, which is similar to previous studies. In addition, Group 3 patients with the highest mean spur length had the highest rate of posttreatment pain and function recovery.

The fact that we have detected significant differences in pain scores and foot function scales in the pre- and post-treatment period in all patient groups suggests that ESWT is an effective treatment for PCS. However, much more participatory studies are required on classification and treatment efficacy based on the measurement between the calcaneus and the spur.

The limited number of patients, especially in Group 3, and the lack of long-term follow-up results are among the limitations of the present study. There may also be errors in measurements during x-ray imaging on the computer-aided program. Studying the differences between different types of PCSs without investigating the differences between body weight and gender is another limitation of the study.

Conclusion

The primary endpoint of our study was that ESWT treatment was effective in all groups. However, it is important to predict the result of the treatment that the most change after treatment is in group 3, where the spur length and angle value are the highest.

The results of the present study indicate that ESWT is an effective treatment method for calcaneal spurs, but further studies are needed on PCS classifications and the efficacy of the treatment selected based on these classifications.

This study is important because it is the first study to investigate the effectiveness of ESWT treatment from this angle.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Ethical approval

This study was approved by the Fırat University Non-Interventional Clinical Research Ethics Committee, approval no: 2021/12/26).

Funding

The authors received no financial support for the research and/or authorship of this article.

References

1. Van Leeuwen KD, Rogers J, Winzenberg T, van Middelkoop M. Higher body mass index is associated with plantar fasciopathy/'plantar fasciitis': systematic review and meta-analysis of various clinical and imaging risk factors. Br J Sports Med. 2016;50:972-81.
2. Fernández-Rodríguez T, Fernández-Rolle Á, Truyols-Domínguez S, et al. Prospective Randomized Trial of Electrolysis for Chronic Plantar Heel Pain. Foot Ankle Int. 2018;39:1039-1046.

3. Hill CL, Gill TK, Menz HB, Taylor AW. Prevalence and correlates of foot pain in a population-based study: the North West Adelaide health study. J Foot Ankle Res. 2008;1:2.
4. Hanada M, Takahashi M, Matsuyama Y. The effect of extracorporeal shock wave therapy for the treatment of plantar fasciitis in regard to middle-aged patients' activity level and pain localization. Shock Waves. 2019;29:321-326.
5. Hill JJ Jr, Cutting PJ. Heel pain and body weight. Foot Ankle. 1989;9:254-6.
6. Özdemir H, Özdemir A, Bilbaşar H, Akyıldız F. Topuk ağrısında non-invaziv konservatif tedavi sonuçları ve epin kalkaneinin topuk ağrısındaki rolü. J Arthroplasty Arthroscop Surg. 2002;13:247-255.
7. Orchard J. Plantar fasciitis. BMJ. 2012;345:e6603.
8. Schwartz EN, Su J. Plantar fasciitis: a concise review. Perm J. 2014;18:e105-7.
9. Kirkpatrick J, Yassaie O, Mirjalili SA. The plantar calcaneal spur: a review of anatomy, histology, etiology and key associations. J Anat. 2017;230:743-751.
10. Zhou B, Zhou Y, Tao X, et al. Classification of Calcaneal Spurs and Their Relationship With Plantar Fasciitis. J Foot Ankle Surg. 2015;54:594-600.
11. Roland O. Pathogenesis of spur formation on the os calcis. The Journal of Bone and Joint Surgery. 1912;2:257–274.
12. Riel H, Cotchett M, Delahunt E, et al. Is 'plantar heel pain' a more appropriate term than 'plantar fasciitis'? Time to move on. Br J Sports Med. 2017;51:1576-1577.
13. Johal KS, Milner SA. Plantar fasciitis and the calcaneal spur: Fact or fiction? Foot Ankle Surg. 2012;18:39-41.
14. Uematsu D, Suzuki H, Sasaki S, et al. Evidence of validity for the Japanese version of the foot and ankle ability measure. J Athl Train. 2015;50:65-70.
15. Ahmad J, Karim A, Daniel JN. Relationship and Classification of Plantar Heel Spurs in Patients With Plantar Fasciitis. Foot Ankle Int. 2016;37:994-1000.
16. Zhang L, Cheng HW, Xiong LJ, et al. The Relationship between Calcaneal Spur Type and Plantar Fasciitis in Chinese Population. Biomed Res Int. 2020;2020:5679629.
17. Lizis P. Chosen conservative treatments on the symptoms of calcaneal spur: a short review. Int J Foot Ankle. 2018;2:1-6.
18. Speed CA. Extracorporeal shock-wave therapy in the management of chronic soft-tissue conditions. J Bone Joint Surg Br. 2004;86:165-171.
19. Buchbinder R, Ptasznik R, Gordon J, et al. Ultrasound-guided extracorporeal shock wave therapy for plantar fasciitis: a randomized controlled trial. JAMA. 2002;288:1364-1372.
20. Haake M, Buch M, Schoellner C, et al. Extracorporeal shock wave therapy for plantar fasciitis: randomised controlled multicentre trial. BMJ. 2003;327:75.
21. Yalcin E, Keskin Akca A, Selcuk B, et al. Effects of extracorporal shock wave therapy on symptomatic heel spurs: a correlation between clinical outcome and radiologic changes. Rheumatol Int. 2012;32:343-347.
22. Moretti B, Garofalo R, Patella V, et al. Extracorporeal shock wave therapy in runners with a symptomatic heel spur. Knee Surg Sports Traumatol Arthrosc. 2006;14:1029-1032.
23. Cosentino R, Falsetti P, Manca S, et al. Efficacy of extracorporeal shock wave treatment in calcaneal enthesophytosis. Ann Rheum Dis. 2001;60:1064-7.
24. Ogden JA, Alvarez RG, Marlow M. Shockwave therapy for chronic proximal plantar fasciitis: a meta-analysis. Foot Ankle Int. 2002;23:301-308.
25. M, Sönmez MM, Uğurlar ÖY, Adıyeke L, et al. Effectiveness of Four Different Treatment Modalities in the Treatment of Chronic Plantar Fasciitis During a 36-Month Follow-Up Period: A Randomized Controlled Trial. J Foot Ankle Surg. 2018;57:913-918.
26. Okçu M, Tuncay F, Koçak FA, Erden Y, Ayhan MY, Kaya SS. Do the presence, size, and shape of plantar calcaneal spurs have any significance in terms of pain and treatment outcomes in patients with plantar fasciitis? Turk J Med Sci. 2023 Feb;53(1):413-419. doi: 10.55730/1300-0144.5598. Epub 2023 Feb 22. PMID: 36945957.
27. Mishra BN, Poudel RR, Banskota B, Shrestha BK, Banskota AK. Effectiveness of extra-corporeal shock wave therapy (ESWT) vs methylprednisolone injections in plantar fasciitis. Journal of clinical orthopaedics and trauma 2019;10(2):401- 406. doi:10.1016/j.jcot.2018.02.011.
28. Hayta E, Salk I, Gumus C, Tuncay MS, Cetin A. Extracorporeal shock-wave therapy effectively reduces calcaneal spur length and spur-related pain in overweight and obese patients. Journal of back and musculoskeletal rehabilitation 2016, May 20. doi:10.3233/BMR-160708.
29. Kuyucu E, Koçyiğit F, Erdil M. The association of calcaneal spur length and clinical and functional parameters in plantar fasciitis. Int J Surg. 2015;21:28-31.