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Extracorporeal shock-wave therapy effectively reduces calcaneal spur length and spur-related pain in overweight and obese patients

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Abstract.
OBJECTIVE: We aimed to evaluate the effects of extra corporeal shock-wave therapy (ESWT) on the calcaneal spur length and pain severity in overweight and obese patients with symptomatic calcaneal spur.
METHODS: In eighty patients with symptomatic calcaneal spur, ESWT was administered on days 0 and 7, and visual analog scale (VAS) scores and calcaneal spur lengths (CSLs) before and 3 months later after treatment were recorded. A lateral heel radiograph was used for computer-aided linear measurements of CSL.
RESULTS: Of 80 patients, 59 (73.7%) were female and 21 were male (26.3%); age was 45.9 $\pm$ 8.3 years; BMI was 31.6 $\pm$ 4.4 kg/m^2; and symptom duration was 2.3 $\pm$ 2.4 years. The CSL and VAS score after treatment were significantly lower than those before treatment (CSL before vs. after: 5.7 $\pm$ 1.0 vs. 4.4 $\pm$ 0.9, $p = 0.001$; VAS score before vs. after: 8.3 $\pm$ 1.4 vs. 4.6 $\pm$ 2.2; $p = 0.03$). The CSLs before and after treatment had a significant strong correlation ($r = 0.832$, $p = 0.001$). The VAS scores before and after treatment presented a significant mild correlation ($r = 0.242$, $p = 0.03$).
CONCLUSIONS: In overweight and obese patients with symptomatic calcaneal spur, ESWT reduces the CSL and pain severity during a follow-up of three-month duration.

Keywords: Calcaneal spur, extracorporeal shock wave therapy, pain X-ray imaging

1. Introduction

Plantar heel pain, considerably deteriorating walking and mobility, is related to the calcifications known as calcaneal spur that is seen in the proximal parts of plantar fascia in approximately 50% of the patients [1]. Symptoms are generally characterized with burning and pain that originates from the bottom of the heels and spread to the lower legs. It can be seen in every age, but it is more prevalent in middle-aged women, and male athletes [2]. Symptomatic calcaneal spur is more frequently seen in overweight, elderly, and female patients, and in patients with a previous diagnosis of osteoarthritis or present heel pains [3].

Calcaneal spur is a self-limiting clinical condition, and majority of the patients are healed by conservative treatments as a first choice [4–6], such as resting, non-steroidal anti-inflammatory drugs (NSAID), orthotics, and local injections of corticosteroids [7]. Physical therapy modalities like iontophoresis, microwaves, and ultrasound applications are widely used therapeutic in-

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terventions. A;proximately 10% of the patients need further therapeutic interventions [8,9]. Open or endoscopic surgical techniques are being used for patients who do not benefit from conservative methods. But, surgical interventions must be considered carefully due to the reports about long periods of wound healing, deterioration of foot biomechanics, probabilities of relatively rare complications, and recurrences [10]. All these limitations and complication probabilities in treatment options yielded a research towards a less risky and effective alternative treatment. ESWT has become the recommended modality in recent years in patients with symptomatic calcaneal spur, especially resistant to conservative treatment [11]. American Food and Drug Association approved the application of ESWT in calcaneal spur after the successful results of Ogden et al. [12] and Buch et al. [13].

ESWT utilizes pressure waves of microsecond lengths, which are produced outside and focused to specific parts of body [14]. Unit of the energy produced is millijoule (mJ) and it presents the pressure/time function per unit area. Shock wave energy that concentrated on unit area is described by energy flux density that shows the shock wave stream which is reflected perpendicularly to the source of production, and this term represents the dosage of the shock waves [15]. Pressure waves of ESWT pass through fluids and soft tissues, and expose their effects on areas of impedance changes such as bones and soft-tissue interfaces. These waves have effects at cellular level, as well as their mechanical effects. Most important of these effects is transient damage on neuronal cell membrane or increased permeability. These mechanisms can explain the analgesic effects of ESWT, that is, neovascularization in tissues may facilitate the cellular regeneration. In recent years, ESWT has become to be used successfully in various musculoskeletal diseases [14,15].

The calcaneal spur length (CSL) is measured reliably in weight-bearing lateral heel radiographs with the help of computer-aided linear measurement technique [16,17]. According to our knowledge, there was not enough study on the effect of ESWT on the CSL and pain severity measured objectively in overweight and obese patients whose calcaneal spurs measured on lateral foot X-ray. There is a clinical need to know whether there are associations between the decrease in CSL and pain severity in overweight and obese patients. The aims of this study were to evaluate the effects of ESWT on the CSL and pain severity in overweight and obese patients.

2. Material and methods

This prospective study included 95 patients who admitted to our outpatient service, and who had moderate or severe heel pain due to calcaneal spur diagnosed with clinical and X-ray examination. The approval of Human Ethics Committee of our university and informed consent was obtained from all the participants. The exclusion criteria included having additional pathologies in clinical and radiological data in patient's charts, relieving of symptoms with conservative therapies, taking medications (NSAIDs, steroids, analgesics) in preceding three months, and unwillingness to receive ESWT. Age, gender, BMI, affected side, and duration of symptoms were noted from each patient. The measurements of pain severity and calcaneal spur lengths were performed before and 3 months later after ESWT. ESWT was applied for 6 minutes on days 0 and 7 as performed with a 25 mm probe, 0.2 mJ/mm^2, and with a 15 mm probe, 0.2 mJ/mm^2, each treatment consisting of 1200 shocks with a frequency of 120 shocks/min, respectively, in two sessions by the same physician with applications of radial shockwaves. ESWT administration was completed without any event in all the participants. During study period, no orthotics was used by study subjects.

Pain intensity was measured by using a 10-cm visual analogue scale (VAS) (VAS score expressed in centimeters; zero point of the scale = no pain, endpoint = intolerable pain). In the measurements before and after treatment, the VAS scoring was performed by same physician (E.H.)

2.1. Radiographic measurements

In a blind manner, the CSLs were measured by senior Radiologists (C.G., I.S.). A weight-bearing lateral heel radiograph was used for computer-aided linear measurements of CSL defined from the tip to the base of the spur delineated by a line presenting the calcaneal border, as defined previously [17] (Fig. 1). In brief, two lines were drawn on the weight-bearing lateral heel radiograph: an inclined boundary line presenting the calcaneal border and a horizontal lines showing the peak of the spur to the calcaneal border. CSL was described from the edge to base of the spur, as defined by a line boundary line the calcaneal border. Before performing the experimental measurements, interobserver reliability for the Radiologists was determined as Kappa coefficient of 0.83, and intraobserver reliability was more than that value.

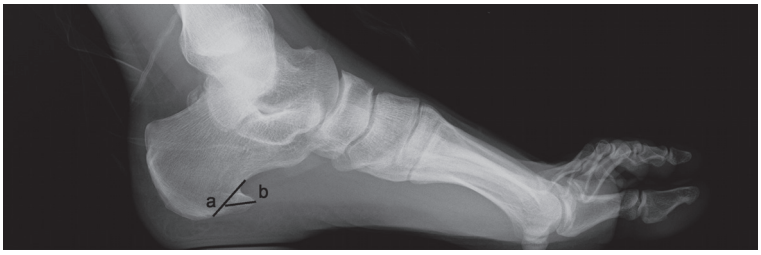

Fig. 1. A representative lateral X-ray radiograph of weightbearing heel used for computer-aided linear measurements of calcaneal spur size defined from the tip to the base of the spur (b) delineated by a line demarcating the calcaneal border (a).

2.2. Statistical analysis

Data were presented as mean ± SD. All data were analyzed using IBM SPSS ver. 21 (IBM Co., Armonk, NY, USA). The VAS score and calcaneal spur length before and after ESWT were analyzed with paired t test. Pearson's correlation coefficients were calculated between VAS scores and calcaneal spur lengths before and after ESWT, and between BMI and calcaneal spur length before ESWT. A p value of less than 0.05 was accepted as significant. A post hoc power analysis revealed that the trial had a power of > 0.99 according to the CSL and VAS score as the primary outcomes of this study.

3. Results

This study was completed with 80 patients; 15 patients were excluded since they did not attend at the scheduled time for follow-up examination and they expressed that they had no complaints related to ESWT administration. The ESWT treatment was performed uneventfully without any fracture of the spurs. Of 80 patients, 59 (73.7%) were female and 21 were male (26.3%). Affected foot was right in 39 patients (48.7%), and left in 41 patients (51.3%). Of 80 patients, age was 45.9 ± 8.3 (29–69; only one patient > 65 years of age) years; BMI was 31.6 ± 4.4 (22.6–48.3) kg/m^2; and symptom duration was 2.3 ± 2.4 (0.5–15) years.

Figures 2 and 3 present the CSL and VAS scores of participants before and after treatment. Of the participants, the CSL and VAS score after treatment were significantly lower than those before treatment (CSL before vs. after: 5.7 ± 1.0 vs. 4.4 ± 0.9, $p = 0.001$; VAS score before vs. after: 8.3 ± 1.4 vs. 4.6 ± 2.2; $p = 0.001$).

The CSLs before and after treatment had a significant strong correlation ($r = 0.832$, $p = 0.001$). The

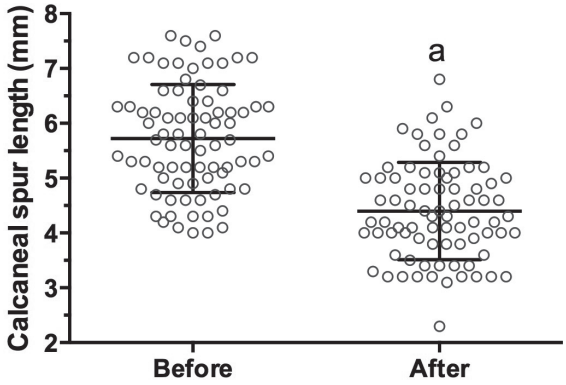

Fig. 2. Calcaneal spur lengths measured before and three-months later after extracorporeal shock-wave therapy. Data were expressed as mean ± SD ($n = 80$). $^aP = 0.001$, after vs. before. Median line indicates mean value and whiskers indicate SD values.

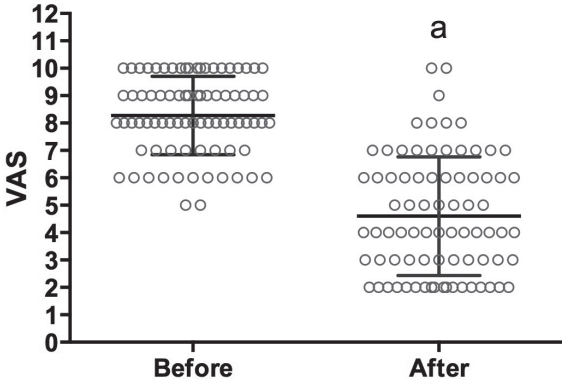

Fig. 3. Visual analog scale scores assessed before and three-months later after extracorporeal shock-wave therapy ($n = 80$). Data were expressed as mean ± SD. $^aP = 0.001$ after vs. before. Median line indicates mean value and whiskers indicate SD values.

VAS scores before and after treatment presented a significant mild correlation ($r = 0.242$, $p = 0.03$). There is no significant correlations between the CSL and VAS scores before and after treatment ($p > 0.05$). There is no significant correlations between the CSL and BMI values before treatment.

4. Discussion

According to findings of this study, ESWT reduced the CSL and pain severity in overweight and obese patients. Since there is a strong relationship between the CSL values before and after ESWT, our findings supports that ESWT can successfully decreases the CSL in the clinical settings of this study. The VAS scores before and after ESWT appeared as correlated slightly; this was in accordance with the data of literature [18–20]. Moreover, ESWT in the overweight and obese patients with symptomatic calcaneal spur resulted in a decrease in the length of calcaneal spur measured as an objective technique first time in the present study. The CSL may be insignificant for patients with symptomatic calcaneal spur whose spur are on the side with no weight load. However, in many patients with calcaneal spur, there is no direct correlation between calcaneal spur and pain severity [21].

ESWT is a good alternative option to surgery and steroid therapy in patients with chronic plantar fasciitis, particularly resistant to conservative methods [22]. Its analgesic effects their biological mechanisms are still controversial [23]. Various studies reported that ESWT causes internal micro-deteriorations in fascia tissues, and accelerates tissue healing and neovascularization [24–26]. ESWT is a non-invasive method with very low complication rate. Many clinical trials reported successful outcomes of ESWT in plantar fasciitis. Success rates were between 75% and 94% in non-placebo controlled clinical series. Rompe et al. [27] evaluated the effects of shock wave counts in ESWT on treatment outcomes, and reported a 47% superiority of high impulse rates, when compared with low impulse rates. Krischek [28] and colleagues also reported that low-energy shock waves should be applied with a 3×500 impulse rate for an effective treatment.

Lee et al. [29] applied ESWT to patients with chronic plantar fasciitis and calcaneal spur, but could not achieve any radiological chance after the treatment. However, when the clinical results at 12^{th} months were reviewed, an 82% of improvement was obtained in patient with calcaneal spur, whereas this rate was 79% in patients without calcaneal spurs. çYalcin et al. [30] analyzed radiological and clinical findings of 108 patients with calcaneal spur. They defined their radiological findings as decrease in the angle of spur (17.6%), decrease in dimensions of spur (21.3%), and breakage of spur (0.9%). They did not give details of measurements and assessments of the spur angle and presented their findings as nominal data. They noted that there was no correlation between radiological and clinical findings. In our study, to determine the association of radiological and clinical findings, calcaneal spur length was determined in an objective way to provide a base for further studies. On the other hand, Cosentino et al. [31] reported that ESWT therapy might improve plantar heel pain symptoms, and caused ultrasonographic and radiologic structural changes in calcaneal spurs. As presented in that study and found in our study, a correlation may not found between spur size and clinical symptoms. We also presented in this study that ESWT therapy was an effective method on pain relief and radiological improvement in calcaneal spur. According to our results, VAS scores were remained same in 24.4%, and increased only in 6.7% of patients. These stable or increased values of VAS in 31.1% of our patients may be a result of high BMI values. Our results also revealed the fact that efficiency of ESWT therapy in calcaneal spur also related with not only anti-inflammatory and edematous effects, but also with breakage of calcaneal spurs. This effect needs to be confirmed with further studies including control groups. However, according to present results, ESWT therapy has important effects in calcaneal spur. Moreover, there are no reports of serious and irreversible side effects. As many of the clinical trials suggested, ESWT should be considered before surgical options in patients with calcaneal spur that resistant to conservative treatments.

There are also many clinical trials, which suggest that ESWT is inefficient in heel spur. Haake et al. [32] conducted a placebo controlled one year follow-up study, and reported success rates as 81% in ESWT group, and 76% in placebo group. They concluded that inefficiency of ESWT in calcaneal spur may be related to spontaneous remission of disease in these patients, additional conservative methods, or prolonged placebo effect. Other investigators, such as Buchbinder et al. [33] and Speed et al. [34] also reported in their randomized, double-blind and placebo controlled studies that ESWT had indifferent effects from placebo. In another meta-analysis, six randomized controlled studies that included 897 patients were analyzed, and authors concluded that ESWT has not a statistically significant effect on calcaneal spur [35].

Although many clinical trials reported beneficial effects of ESWT in symptomatic calcaneal spur in recent years, failures in the ESWT in some studies may be related with positioning and localization of the patients, variations in the device selection and the dosages, recruiting patients with symptoms lasting more than 3

weeks, and some other factors that could not be determined yet.

Limitations of this study was the 3-month duration of the follow-up. Follow-up of longer duration could show the long-term effects of ESWT in patients with symptomatic calcaneal spur. If pain severity was measured with algometry, it may be possible to measure pain severity in a more reliable manner. Further studies evaluating the role of CSL in normal and obese patients selected according to their lifestyle, occupation, side of foot weight load, and footwear type may be beneficial to determine the indications and administration of ESWT in patients with calcaneal spur.

As conclusion, ESWT reduces the CSL and pain severity in overweight and obese patients with symptomatic calcaneal spur. ESWT is a good alternative method for the treatment of symptomatic calcaneal spur resistant to conservative treatment in overweight and obese patients.

Conflict of interest

The authors declare that there is no conflict of interest.

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