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Comparison of Three Different Treatment Modalities in the Treatment of Chronic Plantar Fasciitis: Corticosteroid Injection, Extracorporeal Shock Wave Therapy and Radiofrequency Nerve Ablation

Kronik Plantar Fasiit Tedavisinde Üç Farklı Tedavi Yönteminin Kıyaslanması: Kortikosteroid Enjeksiyonu, Ekstrakorporeal Şok Dalga Tedavisi ve Radyofrekans Sinir Ablasyonu

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ABSTRACT

Aim: In this study, it was aimed to compare the clinical and functional outcomes of three popular conservative treatment options in the treatment of chronic plantar fasciitis (PF): corticosteroid injection (CSI), extracorporeal shock wave therapy (ESWT) and radiofrequency nerve ablation (RFNA).

Material and Methods: Patients with chronic PF refractory to other conservative treatment methods were included in this retrospective study. From January 2017 to February 2019, all the patients with the diagnosis of chronic PF who were treated with conservative treatment modalities were evaluated. Forty eight patients who met our eligibility criteria and treated either with CSI, ESWT or RFNA methods were included in the study. Clinical and functional assessments of the patients were done by American Orthopaedic Foot and Ankle Society (AOFAS) scoring system and Visual Analogue Scale (VAS) just before the treatment, at 6^{th} and at 12^{th} weeks of the last session.

Results: There was a statistically significant difference in terms of VAS scores between the groups both for before treatment and for 6^{th} week (both $p<0.001$), but there was not a statistically significant difference between the groups in terms of VAS scores at 12^{th} week ($p=0.436$). Also, there was not a statistically significant difference between the three groups in terms of AOFAS scores before treatment, 6^{th} and 12^{th} week assessments ($p=0.076$, $p=0.081$, $p=0.478$ respectively).

Conclusion: Although the three treatment modalities showed significant improvements in the chronic PF treatment, no differences were found among effectiveness of them at the final follow-up period.

Keywords: Corticosteroids; extracorporeal shockwave therapy; plantar fasciitis; ablation techniques.

ÖZ

Amaç: Bu çalışmada kronik plantar fasiit (PF) tedavisinde kullanılan üç farklı popüler konservatif tedavi yöntemi olan kortikosteroid enjeksiyonu (KSE), ekstrakorporeal şok dalga tedavisi (ESWT) ve radyofrekans sinir ablasyonu (RFSA) tedavi yöntemlerinin klinik ve fonksiyonel sonuçlarının karşılaştırması amaçlanmıştır.

Gereç ve Yöntemler: Bu retrospektif çalışmaya diğer konservatif tedavi yöntemlerine dirençli olan kronik PF'li hastalar dahil edildi. Ocak 2017 ile Şubat 2019 arasında konservatif tedavi yöntemleriyle tedavi edilmiş olan kronik PF tanılı tüm hastalar incelendi. Uygunluk kriterleri ile uyumlu olan ve KSE, ESWT veya RFSA yöntemlerinden biri ile tedavi edilen kırk sekiz hasta çalışmaya dahil edildi. Hastaların klinik ve fonksiyonel değerlendirmeleri tedaviden hemen önce ve son seansın 6. ve 12. haftalarında, Amerikan Ortopedik Ayak ve Ayak Bileği Birliği (AOFAS) skorlama sistemi ve görsel analog skala (VAS) ile yapıldı.

Bulgular: Gruplar arasında hem tedavi öncesi hem de 6. Hafta için VAS skorları bakımından istatistiksel olarak anlamlı düzeyde bir farklılık vardı (her iki $p<0,001$), ancak 12. hafta VAS skorları bakımından gruplar arasında istatistiksel olarak anlamlı bir farklılık yoktu ($p=0,436$). Ayrıca üç grup arasında, tedavi öncesi, 6. ve 12. hafta değerlendirmelerindeki AOFAS skorları açısından da istatistiksel olarak anlamlı bir fark yoktu (sırasıyla $p=0,076$, $p=0,081$, $p=0,478$).

Sonuç: Üç tedavi yöntemi de kronik PF tedavisinde önemli iyileşmeler göstermesine rağmen, son takip döneminde bu tedavilerin etkinlikleri açısından aralarında anlamlı bir fark bulunamamıştır.

Anahtar kelimeler: Kortikosteroidler; ekstrakorporeal şok dalga tedavisi; plantar fasiit; ablasyon teknikleri.

INTRODUCTION

Plantar fasciitis (PF) is one of the most frequent causes of heel pain occurring commonly in the middle aged to elderly patients and related to reduction in quality of life of the patients (1). The exact cause is unknown in most of the cases but some intrinsic and extrinsic risk factors have been well defined. The intrinsic factors include age (middle age), obesity, tightness in the Achilles tendon, pes planus and pes cavus and also the extrinsic factors include prolonged weight bearing, running, walking on hard surfaces and poor footwear (2).

The pathology of the PF usually results from collagen damage to the plantar fascia due to repetitive microtrauma. The normal fascia is replaced by a fibroblastic tissue that became spread to the surrounding tissue. A soft tissue ossification can also be seen at the origin of the plantar fascia named as heel spur (3). The patients usually feel pain near the medial side of the calcaneal tuberosity. This heel pain generally occurs in the morning with first steps or after a prolonged sitting. The diagnosis of plantar fasciitis usually based on a detailed medical history and physical examination (4).

There are many treatment modalities for PF without any consensus on clinical approach. The literature is lacking for a single treatment option supported by a highest level of evidence (5). The reason for this can be due to the fact that most of the treatment options are used in combination (6). Stretching exercises, orthoses, night splints, physical therapy, corticosteroid (CS), platelet-rich plasma (PRP) and botilunum toxin A injections, extracorporeal shock-wave therapy (ESWT) and radiofrequency nerve ablation (RFNA) have been employed in the treatment of PF (7-12). CS injection (CSI) acts as reducing the soft tissue inflammation and the swelling around the plantar fascia (13). The mechanism of action of ESWT is not understood completely but neovascularization, suppressive effects on nociceptors and hyperstimulation mechanism blocking the gate-control system have been described to explain its effects (14). An alternative conservative treatment option in PF is RFNA; an electrode is placed on the sensitive region of the heel and electromagnetic energy is transmitted to the tissues through this electrode leading to protein denaturation and ablation of the injured nerve endings (12). It has been using since 1990's with a success rate of more than 90%.

The purpose of this current study was to compare the clinical and functional outcomes of three popular conservative treatment options; CSI, ESWT and RFNA in the treatment of chronic PF.

MATERIAL AND METHODS

Patients with chronic PF refractory to other conservative methods were included in this study. From January 2017 to February 2019, all the patients with the diagnosis of chronic PF who were treated with conservative treatment modalities were followed up. The ethics committee of Düzce University approved the study with a number of 2019/124, and all the patients were provided informed consent about the study prior to treatment. The data of all the patients were analyzed and finally 48 patients who met our eligibility criteria and treated either with CSI, ESWT or RFNA were included in the study. The inclusion and exclusion criteria of the patients are listed in Table 1.

Table 1. Inclusion and exclusion criteria of the patients

Inclusion Criteria
- Patients who accept to participate in the study
- Patients with unilateral PF
- Between the ages of 18-55
- Heel spur on lateral radiograph of the foot
- Pain on palpation of medial calcaneal tubercle for >6 months
- Failure to respond to conservative treatment modalities other than CSI, ESWT and RFNA
- Patients treated with
- One CSI
- Three sessions of ESWT weekly
- One session of RFNA
Exclusion Criteria
- Patients who withdrawn from the study
- Patients with bilateral PF
- Age <18 and >55
- Pregnancy or lactation
- Neurological foot problem, clubfoot, pes cavus or pesplanovalgus
- Coagulopathy and any previous injection (PRP, prolotherapy, etc.)
- Previous foot trauma or any infection of the affected limb

PF: Plantar Fasciitis, CSI: Corticosteroid Injection, ESWT: Extracorporeal Shock Wave Therapy, RFNA: Radiofrequency Nerve Ablation, PRP: Platelet Rich Plasma

Diagnoses of the patients were confirmed with a detailed physical examination and radiographic evaluations (lateral X-Rays of the feet and ankles). All the patients were refractory to a minimum of 6 months of standardized traditional non-operative treatment modalities like muscle stretching exercises, nonsteroidal anti-inflammatory drugs (NSAIDs), heel cups, arch supports, night splints and PRP injection.

Treatment Protocol

The patients have been treated with either single dose CSI, three sessions of ESWT or single session of RFNA.

Corticosteroid Injection (CSI) Group: 1 mL of betamethasone (40 mg/mL) and 2 mL of bupivacaine (5 mg/ml) were injected into the site of the maximal tenderness.

Extracorporeal Shock Wave Therapy (ESWT) Group: Three sessions of radial ESWT (2000 pulses per a session in a dose of 10 Hz and 3 bar) were administered weekly for three weeks in every patient with a Swiss Dolorclast Master® ESWT machine (EMS SA, CH-1260, Nyon, Switzerland).

Radiofrequency Nerve Ablation (RFNA) Group: The most sensitive points and the possible traces of the tibial, medial calcaneal (MCN), lateral plantar (LPN) and medial plantar (MPN) nerves were marked on the heel with marker pen. Under sterile conditions the skin of the medial border of the heel was anesthetized with 0.5 mL of lidocaine HCl (20 mg/ml). The radiofrequency probe was advanced to the medial border of calcaneal tuberosity under fluoroscopy. Low-energy impulses were applied at 2 Hz and the occurrence of fasciculation or toe movements was checked to exclude the presence of the probe near a motor nerve. After making sure we're not near the motor nerve, to find the appropriate position we started at 50 Hz from 0 V and gradually increased the voltage until the patient experienced a tingling sensation. Then, the voltage was reduced and the probe was considered to be close to the

sensory nerve where the tingling sensation continued at levels <0.5V. At this point the sensory nerve was ablated at a temperature of 90 °C for 90 seconds. The CoATherm AK-A304 (Gyeonggi-do, South Korea) multi-channel pain control system was used in this procedure.

Clinical Assessment

Functional scores and pain were measured by American Orthopaedic Foot and Ankle Society (AOFAS) and Visual Analogue Scale (VAS) scoring systems respectively. The scoring records were subsequently obtained before the treatment, at 6th and at 12th weeks of the last session. AOFAS measures function (50 points), pain (40 points) and alignment (10 points) with the 100 points representing the best result. VAS is a scale and is useful for measuring pain that is believed to range across a continuum of values and cannot easily be directly measured.

Statistical Analysis

In this study, statistical analysis was done by NCSS (Number Cruncher Statistical System) 2007 Statistical Software (Utah, USA) package program. Distribution of continuous variables were analyzed by Shapiro-Wilk test. One-way analysis of variance was used for inter-group comparisons of variables with normal distribution, while Kruskal Wallis test followed by Dunn's multiple comparison test was used for comparison of groups in terms of variables that did not show normal distribution. Friedman Test was used for comparison of variables not show normal distribution measured in different times. Pearson Chi-square and Fisher-Freeman-Halton tests were used for comparison of qualitative data. A p value of less than 0.05 was considered statistically significant.

RESULTS

A total of 48 patients with unilateral chronic PF were randomly assigned to the CSI, ESWT or RFNA groups. No patients were withdrawn from the study. The baseline demographic data of the groups were similar and there were no statistically significant differences in terms of age, gender, body mass index (BMI), side and dominant extremity distributions (Table 2).

There was a statistically significant difference in terms of VAS scores between the groups both for before treatment and for 6th week (both p<0.001). According to post hoc test results, there were statistically significant differences between CSI and RFNA groups (p<0.001), and ESWT and RFNA groups (p=0.006) while there was no difference between CSI and ESWT groups (p=0.293) for before treatment comparisons. Similarly, at the 6th week assessment, there were statistically significant differences between CSI and RFNA groups (p<0.001), and ESWT and RFNA groups (p=0.002) while there was no difference between CSI and ESWT groups (p=0.518). However, at 12th week there was not a statistically significant difference between three groups in terms of VAS scores (p=0.436). The change of VAS scores for before treatment, 6th and 12th week assessments in each group (all p<0.001) were also statistically significant (Table 3).

Although there was no statistically significant difference in the before treatment, 6th and 12th week AOFAS scores of the groups (p=0.076, p=0.081, p=0.478 respectively), the before treatment, 6th and 12th week AOFAS score differences in each group (all p<0.001) were statistically significant (Table 4).

Table 2. Subject characteristics in groups

	CSI (n=16)	ESWT (n=16)	RFNA (n=16)	p
Age	41.38±9.32	40.25±11.06	45.00±8.48	0.358
BMI	27.93±4.59	28.87±4.81	26.31±3.48	0.252
Gender				
Male	5 (31.25)	6 (37.50)	3 (18.75)	0.619
Female	11 (68.75)	10 (62.50)	13 (81.25)	
Side				
Right	8 (50.00)	9 (56.25)	8 (50.00)	0.920
Left	8 (50.00)	7 (43.75)	8 (50.00)	
Dominant Extremity				0.999
Right	15 (93.75)	15 (93.75)	16 (100.0)	
Left	1 (6.25)	1 (6.25)	0 (0.00)	

CSI: Corticosteroid Injection, ESWT: Extracorporeal Shockwave Therapy, RFNA: Radiofrequency Nerve Ablation, BMI: Body Mass Index, values presented as mean±standard deviation and frequency (percentage)

Table 3. Comparison of VAS scores

VAS	CSI (n=16)	ESWT (n=16)	RFNA (n=16)	p
Before treatment	9.31±0.48 9 (9-10)	8.75±0.86 9 (8-9)	7.44±0.96 7 (7-8)	**<0.001**
6th week	8.50±1.26 9 (8-9)	7.56±1.59 8 (6-9)	5.13±1.36 5 (4-6)	**<0.001**
12th week	3.63±2.19 4 (2-6)	3.88±2.92 4 (1-7)	2.69±1.49 3 (2-3)	0.436
p	**<0.001**	**<0.001**	**<0.001**	

CSI: Corticosteroid Injection, ESWT: Extracorporeal Shockwave Therapy, RFNA: Radiofrequency Nerve Ablation, VAS: Visual Analogue Scale, values presented as mean±standard deviation and median (interquartile range)

Table 4. Comparison of AOFAS scores

VAS	CSI (n=16)	ESWT (n=16)	RFNA (n=16)	p
Before treatment	55.13±9.92 58 (55-61)	58.75±4.91 59 (55-61)	61.5±4.82 62 (58-64)	0.076
6th week	75.31±7.96 72 (70-83)	72.19±6.41 73 (68-77)	77.19±5.27 78 (75-81)	0.081
12th week	85.25±7.27 85 (79-90)	87.19±9.36 89 (79-95)	88.19±8.48 88 (83-95)	0.478
p	**<0.001**	**<0.001**	**<0.001**	

CSI: Corticosteroid Injection, ESWT: Extracorporeal Shockwave Therapy, RFNA: Radiofrequency Nerve Ablation, AOFAS; American Orthopaedic Foot and Ankle Society, values presented as mean±standard deviation and median (interquartile range)

Percentage changes of VAS and AOFAS scores between the groups were also analyzed. There was a statistically significant difference in the before treatment/6th week change of VAS scores between the groups (p<0.001), but the before treatment/12th week and 6th week/12th week changes of VAS scores between the groups showed no statistically significant difference (p=0.773, p=0.656 respectively). Although there was not a statistically significant difference between the groups in terms of before treatment/6th week and before treatment/12th week changes of AOFAS scores (p=0.323 and p=0.761, respectively), the difference between 6th/12th week change of AOFAS scores showed statistically significant differences (p=0.036).

DISCUSSION

In this retrospective study we compared the effectiveness of the three treatment modalities which have been using widely for the treatment of chronic PF; local CSI, ESWT and RFNA. We have encountered significant improvements both in VAS and AOFAS scores in each group. Although the RFNA showed better VAS scores at 6th week, the VAS at the 12th week and AOFAS scores at the 6th and 12th weeks did not show any statistically significant difference. These findings indicate that these common treatment methods have a potential to improve the symptoms of chronic PF that is irresponsive to other conservative treatment modalities without superiority to each other.

Local CSI have been using as a popular method to treat the PF since 1950s (15). CSI has some advantages like low cost, low complexity and rapid pain relief but it is not without complications like tendon rupture, local skin atrophy and hypersensitivity reactions (16). The therapeutic benefit of CSI was shown to be nearly 90% and its effectiveness could last for about 1 year (17). But according to a systematic review by Crawford et al. (18) CSI can be useful only in short term. In a recent meta-analysis evaluating the randomized controlled trials; it is proposed that the CSI are effective in reducing heel pain in PF patients and their effects are usually short term lasting about 4-12 weeks (5). In our study CSI were found to be effective at the 6th and 12th week follow-ups.

ESWT has success rates changing from 48% to 88% and a potential to improve the VAS and activity scores in patients with chronic PF (19). Therapeutic benefits of ESWT usually starts about 2 weeks after the application and according to Kudo et al. (20), ESWT offers benefits on pain and activity levels for more than 3 months after treatment. Buch et al. (21) and Rompe et al. (22) reported significant improvements in the ESWT group compared with the placebo. But in some other studies the effectiveness of ESWT over placebo could not be shown (23,24).

Because the pain in any part of the body is transmitted by a nerve, RFNA can be used in various types of heel pain like nerve entrapments, classic plantar fasciitis or calcaneal bursitis (25). Whereas, RFNA is not recommended for some conditions like diabetic neuropathy, regional pain syndrome and pain including large areas (26). In this present study, we report the results of patients with chronic heel pain associated with only plantar fasciitis. The success rates with RFNA treatment have been reported as much as 90% in some studies and no difference between the plantar or medial calcaneal approaches was observed (26-28). We applied RFNA through medial calcaneal approach in this study.

There are some studies in the literature comparing the effectiveness of various conservative treatment modalities for chronic PF. In a study by Xiong et al. (29), ESWT was found to be a better alternative than CSI for the management of chronic PF at the 12 week post treatment evaluations. In a recent randomized controlled trial, Uğurlar et.al. (30) evaluated the CSI, ESWT, PRP and prolotherapy effectiveness in the management of chronic PF. They reported that the CSI was found to be more effective at the 3 months of follow-up, the effects of prolotherapy and PRP were seen within 3-12 months. But at the 36 month follow-up; they did not found any differences among 4 treatments. In another prospective study by Ozan et.al. (31), the ESWT and RFNA were compared for the management of chronic PF and both of the treatment modalities were found to be safe and effective without superiority to each other.

The present study is not without some limitations. First, we had a small number of patients which resulted from eligibility criteria of the study. The follow-up time could have been longer. The study could also include a placebo control group. Aside, the aim of this study was not to show the individual effects of the treatment modalities, but to compare their effectiveness.

CONCLUSION

Although the three treatment modalities showed significant improvements in the chronic PF treatment, we found no differences among them at the final follow-up period. The results of this study need replication in the future prospective, randomized, placebo-controlled and double-blinded researches that would focus on the long-term effectiveness.

REFERENCES

1. Riddle DL, Schappert SM. Volume of ambulatory care visits and patterns of care for patients diagnosed with plantar fasciitis: a national study of medical doctors. Foot Ankle Int. 2004;25(5):303-10.
2. Schwartz EN, Su J. Plantar fasciitis: a concise review. Perm J. 2014;18(1):e105-7.
3. Böddeker R, Schäfer H, Haake M. Extracorporeal shockwave therapy (ESWT) in the treatment of plantar fasciitis-a biometrical review. Clin Rheumatol. 2001;20(5):324-30.
4. Thomas JL, Christensen JC, Kravitz SR, Mendicino RW, Schuberth JM, Vanore JV, et al. The diagnosis and treatment of heel pain: a clinical practice guideline-revision 2010. J Foot Ankle Surg. 2010;49(3 Suppl):S1-19.
5. Ang TW. The effectiveness of corticosteroid injection in the treatment of plantar fasciitis. Singapore Med J. 2015;56(8):423-32.
6. Crawford F, Atkins D, Young P, Edwards J. Steroid injection for heel pain: evidence of short-term effectiveness. A randomized controlled trial. Rheumatology (Oxford). 1999;38(10):974-7.
7. Roos E, Engström M, Söderberg B. Foot orthoses for the treatment of plantar fasciitis. Foot Ankle Int. 2006;27(8):606-11.
8. Kalaci A, Cakici H, Hapa O, Yanat AN, Dogramaci Y, Sevinç TT. Treatment of plantar fasciitis using four different local injection modalities: a randomized prospective clinical trial. J Am Podiatr Med Assoc. 2009;99(2):108-13.
9. Peerbooms JC, van Laar W, Faber F, Schuller HM, van der Hoeven H, Gosens T. Use of platelet rich plasma to treat plantar fasciitis: design of a multi centre randomized controlled trial. BMC Musculoskelet Disord. 2010;11:69.
10. Placzek R, Deuretzbacher G, Buttgereit F, Meiss AL. Treatment of chronic plantar fasciitis with botulinum toxin A: an open case series with a 1 year follow up. Ann Rheum Dis. 2005;64(11):1659-61.

11. Thomson CE, Crawford F, Murray GD. The effectiveness of extra corporeal shock wave therapy for plantar heel pain: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2005;6:19.
12. Sollitto RJ, Plotkin EL, Klein PG, Mullin P. Early clinical results of the use of radiofrequency lesioning in the treatment of plantar fasciitis. J Foot Ankle Surg. 1997;36(3):215-9.
13. Porter MD, Shadbolt B. Intralesional corticosteroid injection versus extracorporeal shock wave therapy for plantar fasciopathy. Clin J Sport Med. 2005;15(3):119-24.
14. Buchbinder R, Ptasznik R, Gordon J, Buchanan J, Prabaharan V, Forbes A. Ultrasound-guided extracorporeal shock wave therapy for plantar fasciitis: a randomized controlled trial. JAMA. 2002;288(11):1364-72.
15. Lapidus PW, Guidotti FP. Local injections of hydrocortisone in 495 orthopedic patients. Ind Med Surg. 1957;26(5):234-44.
16. Speed CA. Fortnightly review: Corticosteroid injections in tendon lesions. BMJ. 2001;323(7309):382-6.
17. Tsai WC, Wang CL, Tang FT, Hsu TC, Hsu KH, Wong MK. Treatment of proximal plantar fasciitis with ultrasound-guided steroid injection. Arch Phys Med Rehabil. 2000;81(10):1416-21.
18. Crawford F, Thomson C. Interventions for treating plantar heel pain. Cochrane Database Syst Rev. 2003;(3):CD000416.
19. Ogden JA, Alvarez RG, Marlow M. Shockwave therapy for chronic proximal plantar fasciitis: a meta-analysis. Foot Ankle Int. 2002;23(4):301-8.
20. Kudo P, Dainty K, Clarfield M, Coughlin L, Lavoie P, Lebrun C. Randomized, placebo-controlled, double-blind clinical trial evaluating the treatment of plantar fasciitis with an extracoporeal shockwave therapy (ESWT) device: a North American confirmatory study. J Orthop Res. 2006;24(2):115-23.
21. Buch M, Knorr U, Fleming L, Theodore G, Amendola A, Bachmann C, et al. Extracorporeal shockwave therapy in symptomatic heel spurs. An overview [Article in German]. Orthopade. 2002;31(7):637-44.
22. Rompe JD, Küllmer K, Vogel J, Eckardt A, Wahlmann U, Eysel P, et al. Extracorporeal shock-wave therapy. Experimental basis, clinical application [Article in German]. Orthopade. 1997;26(3):215-28.
23. Speed CA, Nichols D, Wies J, Humphreys H, Richards C, Burnet S, et al. Extracorporeal shock wave therapy for plantar fasciitis. A double blind randomised controlled trial. J Orthop Res. 2003;21(5):937-40.
24. Vulpiani MC, Trischitta D, Trovato P, Vetrano M, Ferretti A. Extracorporeal shockwave therapy (ESWT) in Achilles tendinopathy. A long-term follow-up observational study. J Sports Med Phys Fitness. 2009;49(2):171-6.
25. Landsman A. Radiofrequency nerve ablation for the treatment of heel pain. Tech Foot Ankle Surg. 2011;10(2):76-81.
26. Liden B, Simmons M, Landsman AS. A retrospective analysis of 22 patients treated with percutaneous radiofrequency nerve ablation for prolonged moderate to severe heel pain associated with plantar fasciitis. J Foot Ankle Surg. 2009;48(6):642-7.
27. Arslan A, Koca TT, Utkan A, Sevimli R, Akel İ. Treatment of chronic plantar heel pain with radiofrequency neural ablation of the first branch of the lateral plantar nerve and medial calcaneal nerve branches. J Foot Ankle Surg. 2016;55(4):767-71.
28. Erken HY, Ayanoglu S, Akmaz I, Erler K, Kiral A. Prospective study of percutaneous radiofrequency nerve ablation for chronic plantar fasciitis. Foot Ankle Int. 2014;35(2):95-103.
29. Xiong Y, Wu Q, Mi B, Zhou W, Liu Y, Liu J, et al. Comparison of efficacy of shock-wave therapy versus corticosteroids in plantar fasciitis: a meta-analysis of randomized controlled trials. Arch Orthop Trauma Surg. 2019;139(4):529-36.
30. Uğurlar M, Sönmez MM, Uğurlar ÖY, Adıyeke L, Yıldırım H, Eren OT. 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(5):913-8.
31. Ozan F, Koyuncu Ş, Gürbüz K, Öncel ES, Altay T. Radiofrequency thermal lesioning and extracorporeal shockwave therapy: A comparison of two methods in the treatment of plantar fasciitis. Foot Ankle Spec. 2017;10(3):204-9.