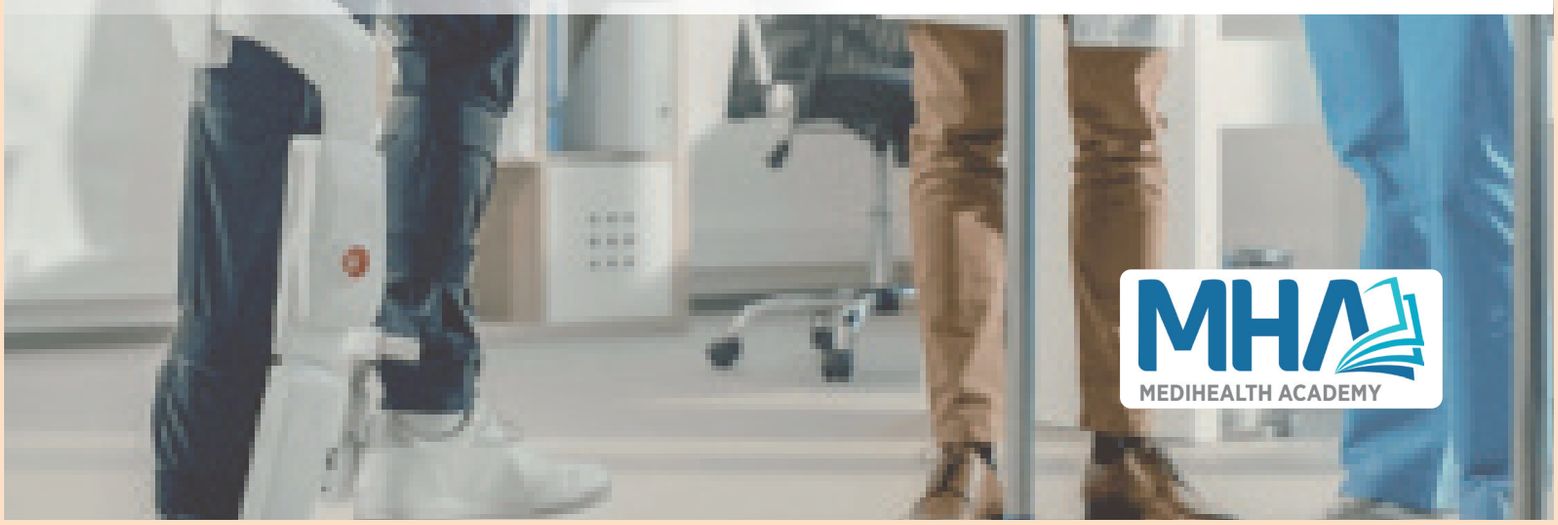
e-ISSN: 2980-0560

Volume: 4 Issue: 1 Year: 2026

Journal of Orthopedics Research and Rehabilitation



MHA
MEDIHEALTH ACADEMY

Journal of Orthopedics Research and Rehabilitation

EDITORIAL BOARD

EDITOR-IN-CHIEF

Assoc. Prof. Mahmut KALEM
Department of Orthopedics and Traumatology, Faculty of Medicine, Ankara University, Ankara, Turkiye

ASSOCIATE EDITORS-IN-CHIEF

Assoc. Prof. Aysun GENÇ
Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Ankara University, Ankara, Turkiye

Assoc. Prof. Okan ASLANTÜRK
Department of Orthopedics and Traumatology, Facult of Medicine, İnönü University, Malatya, Turkiye

EDITORIAL BOARD

Assoc. Prof. Ahmet Emre PAKSOY
Department of Orthopedics and Traumatology, Faculty of Medicine, Atatürk University, Erzurum, Turkiye

Prof. Alberto GRASSI
Department of Orthopedics and Traumatology, Istituto Ortopedico Rizzoli, Bologna, Italy

Assoc. Prof. Ayşe Gülşen DOĞAN
Department of Physical Medicine and Rehabilitation, Hitit University Erol Olçok Training and Research Hospital, Çorum, Turkiye

Prof. Barış KOCAOĞLU
Department of Orthopedics and Traumatology, Faculty of Medicine, Acıbadem University, İstanbul, Turkiye

Prof. Burcu DUYUR ÇAKIT
Department of Physical Medicine and Rehabilitation, Ankara Training and Research Hospital, University of Health Sciences, Ankara, Turkiye

Assoc. Prof. Caner KARARTI
Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Kırşehir Ahi Evran University, Kırşehir, Turkiye

Asst. Prof. Cristian INDINO
Department of Orthopedics and Traumatology, Humanitas San Pio X Hospital, Foot Ankle Clinics, Milano, Italy

Asst. Prof. Doruk AKGÜN
Division of Shoulder and Elbow, Department of Orthopedics and Traumatology, Center for Musculoskeletal Surgery, Charité University Hospital, Berlin, Germany

Prof. Durmuş Ali ÖÇGÜDER
Department of Orthopedics and Traumatology, Ankara City Hospital, Faculty of Medicine, Yıldırım Beyazıt University, Ankara, Turkiye

Prof. Gökhan KOCA
Department of Nuclear Medicine, Ankara Training and Research Hospital, University of Health Science, Ankara, Turkiye

Journal of Orthopedics Research and Rehabilitation

EDITORIAL BOARD

Prof. Gül BALTACI
Department of Physiotherapy and Rehabilitation, Professor Doctor Gül Baltacı Physiotherapy and Exercise Counseling Center, Ankara, Turkiye

Prof. Güzelali ÖZDEMİR
Department of Orthopedics and Traumatology, Ankara City Hospital, Ankara, Turkiye

Prof. Hakan BAŞAR
Department of Orthopaedics and Traumatology, Gaziosmanpaşa Training and Research Hospital, University of Health Science, İstanbul, Turkiye

Assoc. Prof. Hakan KOCAOĞLU
Department of Orthopedics and Traumatology, Faculty of Medicine, Ankara University, Ankara, Turkiye

Prof. Hakkı Çağdaş BASAT
Department of Orthopedics and Traumatology, Faculty of Medicine Kırşehir Ahi Evran University, Kırşehir, Turkiye

Assoc. Prof. İzzet BİNGÖL
Department of Orthopedics and Traumatology, Ankara Bilkent City Hospital, Ankara, Turkiye

Assoc. Prof. Levent HOROZ
Department of Orthopedics and Traumatology, Faculty of Medicine, Kırşehir Ahi Evran University, Kırşehir, Turkiye

Prof. Mehmet DEMİRTAŞ
Department of Orthopedics and Traumatology, Faculty of Medicine, Ankara University, Ankara, Turkiye

Assoc. Prof. Mehmet Fevzi ÇAKMAK
Kırşehir Ahi Evran University School of Medicine, Kırşehir, Turkiye

Prof. Mehmet Müfit ORAK
Department of Orthopaedics and Traumatology, Faculty of Medicine, Atlas University, İstanbul, Turkiye

Assoc. Prof. Mehmet Orçun AKKURT
Department of Orthopedics and Traumatology, Ankara City Hospital, Ankara, Turkiye

Prof. Osman TECİMEL
Department of Orthopedics and Traumatology, Ankara City Hospital, Faculty of Medicine, Yıldırım Beyazıt University, Ankara, Turkiye

Assoc. Prof. Özge VERGİLİ
Department of Physiotherapy, Faculty of Health Sciences, Kırıkkale University, Kırıkkale, Turkiye

Prof. Özgür ÇİÇEKLİ
Department of Orthopedics and Traumatology, Adatıp Hospital, Sakarya, Turkiye

Prof. Safa GÜRSOY
Department of Orthopedics and Traumatology, Faculty of Medicine, Acıbadem University, İstanbul, Turkiye

Prof. Turan Cihan DÜLGEROĞLU
Department of Orthopedics and Traumatology, Faculty of Medicine, Kütahya Health Sciences University, Kütahya, Turkiye

Journal of Orthopedics Research and Rehabilitation

EDITORIAL BOARD

Assoc. Prof. Uğur BEZİRGAN
Division of Hand Surgery, Department of Orthopedics and Traumatology, Facultyof Medicine, Ankara University, Ankara, Turkiye

ENGLISH LANGUAGE EDITOR

Assoc. Prof. Esra GÜZEL TANOĞLU
Department of Molecular Biology and Genetics, Hamidiye Health Sciences Institute, University of Health Sciences, İstanbul, Turkiye

STATISTICS EDITOR

Assoc. Prof. Turgut KÜLTÜR
Department of Physical Therapy and Rehabilitation, Faculty of Medicine, Kırıkkale University, Kırıkkale,

LAYOUT EDITOR

Şerife KUTLU
Engineer, MediHealth Academy Publishing, Ankara, Turkiye

Journal of Orthopedics Research and Rehabilitation

CONTENTS

Volume: 4 Issue: 1 Year: 2026

ORIGINAL ARTICLES

Age-dependent outcomes of secondary surgical and complementary rehabilitation interventions in children with brachial plexus birth injury: a one-year follow-up study..... 1-7

Özkan S, Evrendilek H, Berköz Ö, Akel BS.

Comparison of the effectiveness of medium-and low-intensity ESWT in patients with plantar fasciitis..... 8-15

Kılıç N, Şekerci Bİ, Çankaya T.

Investigation of the effect of fibromyalgia frequency on quality of life, daily living activities, disease perception, and clinical parameters in patients with chronic kidney failure undergoing dialysis treatment..... 16-21

Öztürk H, Öztürk ZN, Varlıbaş A, Ceyhan Z, Kültür T, Çifci A.

CASE REPORT

Bilateral femoral avascular necrosis in a 28-year-old male: a case report 22-24

Taylor Z.

A rare case of lipoma in the big toe: a case report..... 25-27

Kıyak E, Pehlivan O, Soy F.

Journal of Orthopedics Research and Rehabilitation

Original Article

DOI: 10.51271/JORR-0062

Age-dependent outcomes of secondary surgical and complementary rehabilitation interventions in children with brachial plexus birth injury: a one-year follow-up study

Safiye Özkan[1], Halenur Evrendilek[2], Ömer Berköz[1], Burcu Semin Akel*[2]

[1]Department of Plastic Hand Surgery, Faculty of Medicine, İstanbul University İstanbul, Turkiye
[2]Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, İstanbul Kültür University, İstanbul, Turkiye

Cite this article as: Özkan S, Evrendilek H, Berköz Ö, Akel BS. Age-dependent outcomes of secondary surgical and complementary rehabilitation interventions in children with brachial plexus birth injury: a one-year follow-up study. *J Orthop Res Rehabil.* 2026;4(1):1-7.

Received: 22.07.2025 • **Accepted**: 11.10.2025 • **Published**: 31.01.2026

ABSTRACT

Aims: To determine the one-year functional gain following secondary transfer surgery in children with BPBI and analyse the outcomes in relation to surgical timing and clinical changes over time after rehabilitation.

Methods: Forty-seven children, aged 3 to 18 years, who underwent transfer surgery and completed a 3-month rehabilitation program post-surgery, participated in this study. Active shoulder range of motion and Modified Mallet Scoring were assessed preoperatively and at 3, 6, and 12 months postoperatively. Children were grouped as having surgery younger and older than 7 years old and the results were compared. The repeated measures analysis was completed for comparison, along with post-hoc tests. Cohen's d formula is used for effect size calculation.

Results: The increase in shoulder flexion, abduction and external rotation was significant for all groups. However, the children having surgery older than 7 years demonstrated greater effect sizes for all shoulder motion ranges except internal rotation at 3-month follow-up while the younger group had higher effect sizes for flexion and abduction at 6-month follow-up. In general, only abduction, internal rotation and hand-to-mouth parameters increase were significant at 12 months follow-up. Additionally, the increase in external rotation started to decrease after 6 months.

Conclusion: The Hoffer technique increased shoulder flexion, abduction, and external rotation regardless of the onset of the surgery. However, hand-to-head function did not increase after 3 months and external rotation started to decrease after 6 months in general. It is important to develop strategies to maintain the gain after surgeries, especially in rotation angles.

Keywords: Brachial plexus, rehabilitation, tendon transfer

INTRODUCTION

Brachial plexus birth injury (BPBI) is a traction injury in the brachial plexus during birth, which causes muscle weaknesses, soft tissue contractures and progressive glenohumeral joint deformity and/or instability.[1] In BPBI, the clinical symptoms and prognosis differ according to the mechanism of injury, affected area, and applied treatment.[1] Children classified as I and II according to the Narakas System demonstrate 64% spontaneous recovery of biceps function at 3 months of age.[2] But primary care providers may overestimate recovery, residual musculoskeletal deficits may be underestimated and children who do not fully recover often face lifelong functional challenges.[3] Microsurgical exploration and reconstruction of the brachial plexus is usually undertaken at 3 to 9 months of age in children who have shown no apparent improvement.[4] The shoulder frequently remains in an internal rotation position[5] and the most limited motions that need a secondary surgical procedure are shoulder elevation and external rotation.[6,7] The reconstruction procedures might have a positive impact on shoulder functions such as reaching head or back, arm appearance and hand functions.[6]

The Modified Hoffer technique is a tendon transfer method that encompasses the transfer of the internal rotator muscles (latissimus dorsi&teres major) to the major tubercle of the humerus to increase shoulder abduction and external rotation.[8] Rehabilitation has a critical role after this surgery to prevent contractures and to improve muscle-tendon function and strength, re-education and limb awareness by including muscle strength and power training, ROM exercises and functional activities.[9,10] Increased abduction and external rotation at varying degrees after the operation and following rehabilitation have been shown.[8,11] However, the timing of the second measurement, rehabilitation results and techniques were heterogeneous with lower sample size.[12]

The main goal of the team working with BPBI is to facilitate optimal functioning avoiding developmental deficits.[13] Even

***Corresponding Author:** Burcu Semin Akel, akelsemin@gmail.com

This work is licensed under a Creative Commons Attribution 4.0 International License.

though there are some guidelines on management, the indications and timing for secondary surgical intervention may vary among institutions.[3] There is ongoing debate regarding the optimal age for performing such surgeries.[14] Surgery age-related post-operative rehabilitation results were not assessed before. An objective knowledge on clinical change and functional gain in time after secondary surgeries following rehabilitation according to age is missing. The main purpose of our study is to state the a-year follow-up results of the physiotherapy program following surgery in children with BPBI who underwent tendon transfers to the shoulder for the management of deficits of abduction and external rotation of the shoulder according to the onset age of surgery.

METHODS

Ethics

This prospective clinical study was conducted with the approval of the İstanbul University İstanbul Faculty of Medicine Clinical Researches Ethics Committee (Date: 19.08.2019, Decision No: 1017). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Participants and their parents were informed about the study, and parents signed an informed consent form.

Participants

Children aged between 3-18 years with BPBI who underwent a modified Hoffer procedure by the same 2 surgeons in a team were invited to participate in the study. Children who had any other surgery related to BPBI; other musculoskeletal, or neurologic disorder that affects hand use were not included in the study. Data excluded if children could not complete the assessment and rehabilitation protocol. All participants were recruited from the plastic and reconstructive surgery clinic of the same Medicine Hospital.

Outcome Measurements

Demographic and clinical characteristics related to BPBI were recorded. The active flexion, extension, and abduction of the shoulder were assessed with a basic goniometer while the child was standing to prevent any movements from the trunk. Meanwhile, the internal and external rotation range of the shoulder was assessed while the children were lying prone to prevent any compensatory movements. The Modified Mallet Scoring System was used to assess the outcome following the procedure. The assessments were conducted preoperatively and at the 3rd, 6th, and 12th months postoperatively. All measurements were performed by the same physiotherapist, and the total duration of the measurements was approximately 30-40 minutes.

The Modified Mallet Scoring System was used as a reliable method for evaluating the functional abilities of children with BPBI.[15] It assesses the global shoulder function with the following five criteria: active shoulder abduction and external rotation, placing the hand to the mouth, behind the neck and as high as possible on the spine. Each parameter was scored between 1 (no function) and 5 (normal function). During the assessment, children were asked to replicate the movements shown by the therapist. The test takes an average of 51 seconds when testing bilaterally.

Surgery

The surgical technique is as follows: In the lateral decubitus position, a zigzag incision is made along the posterior axillary line in order to expose the latissimus dorsi and teres major muscles. The conjoined tendon, which represents the common tendon of these muscles, is then identified. Subsequently, the conjoined tendon is detached from its insertion on the humerus and prepared for transfer. A marking is placed on the greater tubercle of the humerus at the insertion site of the rotator cuff muscles by entering through the plane between the long head of the triceps and the deltoid muscle. With the shoulder in 90 degrees of abduction and maximum external rotation, an anchor suture is placed at the marked site, and a 2/0 Ethibond polyester suture is passed through the conjoined tendon. Subsequently, the conjoined tendon is secured to the greater tubercle by tying the suture, thereby achieving the tendon transfer. Once the surgical incisions have been closed, the patient is placed in a body-supported shoulder abduction and external rotation orthosis, previously prepared for this purpose, in order to ensure that the shoulder posture is maintained. No tendon release procedure was performed for joint contractures.

Physiotherapy Intervention

Participants were taken to a standardised physiotherapy program for 12 weeks after the surgery. All individuals had face-to-face sessions 2 times a week and performed home exercises every day. The program was carried out by the same therapist different from the therapist performing the assessments.

After the surgery, initially, a circular cast was used for 6 weeks then children used full time shoulder abduction orthosis with trunk support to protect transferred muscles from elongation. During the immobilization period, active-assisted hand and wrist mobility exercises were applied. In the 6th week, active-assistive elbow flexion extension, and forearm rotation exercises started. Active assistive shoulder abduction, mobilization-based shoulder active/passive range of motion exercises, and bringing the hand back to the neck while the shoulder in 90° abduction exercises were added. At 7-9th weeks, the active shoulder abduction and external rotation, scapular adduction and inferior rotation, and pectoral stretching exercises were introduced. Electrical stimulation was applied if a child had difficulty in motor learning and/or had insufficient muscle strength. In the 10th week, controlled active shoulder abduction movements were performed with the elbow supported in extension. Active functional internal rotation exercises were tailored if the limitation was present. Resistive exercises were given with 300 gr weights for all shoulder movements. At the 12th week, stretching for transferred muscles and shoulder capsule, full resistive exercises for shoulder muscles, and functional activities were included in the physical therapy program.

Statistical Analysis

SPSS software (version 25.0, Chicago, IL) was used for analysis and data distribution was verified by the Shapiro-Wilk test. Collected data were divided into two groups for statistical analysis based on the age at which surgery was performed: “Group I (G1)” aged lower than 7 years, “ Group II (G2)” aged between 7 and 16 years. The cut-off age was determined

as 7, due to its recommended effective maximal age for this surgery.[16] The Friedman test to state the functional difference between groups and One-way repeated measurement was also used to state change in time for all individuals. The Wilcoxon matched-pairs signed-ranks test was used for post-hoc paired comparison with Bonferroni correction. For the group-based comparison analysis, independent t-test and Mann Whitney U test were used. The significance threshold was $p<0.05$. The effect size was calculated with Cohen's d formula, while "d=0.2 was considered a small effect, d=0.5 was a medium effect and d=0.8 was a large effect".

RESULTS

Forty-seven participants (mean age:7.01±3.27 years) with BPBI were included in this study. Surgery was performed at the mean age of 4.75±0.87 years for G1 (n=27) and 10.05±2.81 years for G2 (n=20). The demographic and clinical characteristics of the participants are in **Table 1**. The birth information for 11 children could not be documented.

Table 1. The demographic and clinical characteristics of the participants

	Group I		Group II	
	Mean (SD)	**Min-max**	**Mean (SD)**	**Min-max**
Age (year)	4.7 (SD 0.8)	3-6	10 (SD 2.8)	7-16
Follow-up (month)	35.9 (SD 17.3)	9-65	25.9 (SD 17.2)	11-84
Birth weight (g)	4396.2 (SD 825.1)	3200-6600	4334.3 (SD 849.6)	3000-5500
Gender	**n**	**%**	**n**	**%**
Girl	10	37.04	10	50.00
Boy	17	62.96	10	50.00
Effected limb	**n**	**%**	**n**	**%**
Right	15	55.56	11	55.00
Left	12	44.44	9	45.00
Narakas classification	**n**	**%**	**n**	**%**
1	6	22.22	4	20.00
2	8	29.63	5	25.00
3	11	40.74	11	55.00
4	2	7.41	0	0.00
Birth	**n**	**%**	**n**	**%**
Vaginal	16	88.89	14	77.78
Vaginal& vacuum	2	11.11	4	22.22

SD: Standart deviation, Min: Minimum, Max: Maximum g: Grams

Range of Motion

All shoulder motion ranges changed significantly for all participants 3 months after surgery ($p<0.05$) (**Table 2, Table 3**). Furthermore, there was a significant increase in shoulder flexion, abduction, and internal rotation between the 3-month and 6-month follow-ups (**Table 2, Table 3**). Only the abduction and internal rotation ranges showed a significant increase between the 6-month and 12-month follow-ups in comparison of all participants ($p<0.05$). Comparison analysis showed more shoulder flexion and abduction angle change between first and last assessments for G2 (**Table 4**) however there were no significant differences of final assessments between groups ($p>0.05$).

In group-based analysis, except for internal rotation, the G2 demonstrated greater effect sizes for all shoulder ranges of motion acquired at the 3-month follow-up. At 6-month follow-up, the G1 group had higher effect sizes for flexion and abduction, but lower effect size for internal rotation angle. Specifically, the effect sizes at 3-month follow-up were 32.4%, 47%, 47.2% higher for the G2 group in flexion, abduction and external rotation respectively while 17.9% lower for internal rotation angle (**Table 3**). During the 6 to 12-month period, groups did not show any significant change except internal rotation angle.

The Mallet Scoring System

There were significant changes in all five parameters between the pre-operative and 3-month follow-up ($p<0.05$) (**Table 5, Table 6**). There was a significant change in abduction and hand-to-mouth parameters during the 6-month follow-up period, with just the hand-to-mouth parameter being altered between 6-month and 12-month follow-up for all participants ($p<0.05$) (**Table 5**). In group-based analysis, only the hand-to-mouth parameters significantly increased between the 3-month and 6-month follow-ups in G2 (**Table 6**). The comparison analysis revealed no significant differences between the gains of the two groups. ($p>0.05$).

DISCUSSION

Our study aimed to evaluate the shoulder motion and function in children with BPBI who underwent a 12-week rehabilitation program after Modified Hoffer Technique according to the onset age of surgery. We hypothesised that the timing of surgery and the time passed from the treatment could affect the results. However, our first hypothesis was disproved as the results of children who had surgery at the age of 7 years or older had similar gains to those who had surgery earlier. After surgery followed by 12 weeks of specialised rehabilitation, we found a significant increase in all assessments. Moreover, significant changes continued in shoulder flexion, abduction, and internal rotation, as well as abduction and hand-to-mouth parameters of the Mallet score, after six months. However, only shoulder abduction and internal rotation range and hand-to-mouth parameter of Mallet score significantly increased on 12-month follow-up. One noteworthy finding was that the increase in external rotation started to decrease after 6 months.

Although the optimal age for surgery in children with BPBI has not yet been determined, there is a growing body of literature on having surgery at a younger age, around two years old, which may have a superior effect due to the prevention of fixed deformities.[17,18] One discussion is that glenohumeral remodelling may be better with balancing the shoulder by early secondary surgery. From a functional perspective, Ozben et al.[16] previously reported a higher increase in shoulder abduction and external rotation motion in children who had surgery younger than 7 years. However, their study did not present the onset values of the participants and the rehabilitation program. Covey et al.[19] reported that secondary surgery is commonly recommended for patients under the age of 7, and 3-4 years of age was the best for

Table 2. Comparison of the shoulder range assessments of all participants

	Range of motion	Flexion (°)	Extension (°)	Abduction (°)	External rotation (°)	Internal rotation (°)
	n	47	47	47	47	47
Pre-rehab	Mean (SD)	83.26 (SD 26.26)	14.04 (SD 11.26)	84.47 (SD 31.48)	27.21 (SD 19.19)	24.32 (SD 13.69)
After-rehab (3M follow-up)	Mean (SD)	118.51 (SD 18.9)	4.15 (SD 9.69)	124.04 (SD 19.69)	77.55 (SD 19.69)	-12.62 (SD 17.72)
6M follow-up	Mean (SD)	129.36 (SD 20.66)	5 (SD 9.9)	135.11 (SD 22.64)	78.72 (SD 16.47)	-0.96 (SD 19.47)
12M follow-up	Mean (SD)	134.49 (SD 24.47)	4.15 (SD 7.96)	137.77 (SD 24.36)	76.91 (SD 14.98)	2.87 (SD 16.96)
Friedman test	χ^2	99.57	49.61	92.34	83.89	75.29
	p value	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*
Wilcoxon test	Assesment no (p value)	1-2 (<0.01*) 2-3 (<0.01*)	1-2 (0.00*)	1-2 (<0.01*) 2-3 (<0.01*) 3-4 (<0.01*)	1-2 (0.00*)	1-2 (<0.01*) 2-3 (<0.01*) 3-4 (0.035*)
Effect size	Assesment no (cohen's d)	1-2 (1.54) 2-3 (0.54)	1-2 (0.94)	1-2 (1.50) 2-3 (0.52) 3-4 (0.11)	1-2 (2.77)	1-2 (2.33) 2-3 (0.62) 3-4 (0.20)

Pre-rehab: Pre-rehabilitation, After-rehab: After-rehabilitation, SD: Standart deviation

Table 3. Comparison of the shoulder range assessments of each group

		Range of motion	Flexion (°)		Extension (°)		Abduction (°)		External rotation (°)		Internal rotation (°)	
		Group	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II
		n	27	20	27	20	27	20	27	20	27	20
1	Pre-rehab	Mean (SD)	90.93 (SD 24.02)	72.9 (SD 26.15)	11.85 (SD 11.7)	17 (SD 10.18)	95.19 (SD 28.06)	70 (SD 30.65)	29.41 (SD 20.92)	24.25 (SD 16.65)	26.22 (SD 15.43)	21.75 (SD 10.79)
2	After-rehab (3M follow-up)	Mean (SD)	119.81 (SD 17.12)	116.75 (SD 21.42)	4.44 (SD 10.03)	3.75 (SD 9.44)	126.11 (SD 18.1)	121.25 (SD 21.82)	74.44 (SD 17)	81.75 (SD 16.41)	-14 (SD 16.54)	-10.75 (SD 19.49)
3	6M follow-up	Mean (SD)	131.3 (SD 19.54)	126.75 (SD 22.32)	4.07 (SD 6.94)	6.25 (SD 12.97)	139.07 (SD 21.03)	129.75 (SD 24.14)	79.63 (SD 16.05)	77.5 (SD 17.36)	-4.44 (SD 15.53)	3.75 (SD 23.39)
4	12M follow-up	Mean (SD)	136.48 (SD 24.21)	131.8 (SD 25.17)	3.15 (SD 7.36)	5.5 (SD 8.72)	137.41 (SD 25.81)	138.25 (SD 22.9)	77.41 (SD 14.5)	76.25 (SD 15.97)	3.15 (SD 17.05)	2.5 (SD 17.28)
Friedman test		χ^2	54.94	44.67	28.16	21.94	46.65	47.95	44.96	41.74	47.98	28.50
		p value	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*
Wilcoxon test		Assesment no (p value)	1-2 (<0.01*) 2-3 (<0.01*)	1-2 (<0.01*) 2-3 (<0.01*)	1-2 (0.03*)	1-2 (<0.01*)	1-2 (<0.01*) 2-3 (<0.01*)	1-2 (<0.01*) 2-3 (<0.01*)	1-2 (<0.01*)	1-2 (<0.01*)	1-2 (<0.01*) 2-3 (<0.01*) 3-4 (0.01*)	1-2 (<0.01*) 2-3 (<0.01*)
Effect size		Assesment no (cohen's d)	1-2 (1.38) 2-3 (0.62)	1-2 (1.83) 2-3 (0.45)	1-2 (0.67)	1-2 (1.34)	1-2 (1.3) 2-3 (0.66)	1-2 (1.92) 2-3 (0.36)	1-2 (2.36)	1-2 (3.47)	1-2 (2.51) 2-3 (0.59) 3-4 (0.46)	1-2 (2.06) 2-3 (0.67)

Pre-rehab: Pre-rehabilitation, After-rehab: After-rehabilitation, SD: Standart deviation, x^2: Chi-square

Table 4. Comparison of the change of shoulder range of motions according to the groups

Range of motion	Group	n	Pre-rehab / 3M follow-up	Pre-rehab/12M follow-up
			Mean (SD)	Mean (SD)
Flexion (°)	Group I	27	28.89 (SD 20.6)	45.56 (SD 20.1)
	Group II	20	43.85 (SD 20.93)	58.9 (SD 24.25)
p value			0.019*	0.022*
Extension (°)	Group I	27	-7.41 (SD 9.84)	-8.7 (SD 9.67)
	Group II	20	-13.25 (SD 12.9)	-11.5 (SD 11.13)
p value	p value		0.042*	0.18
Abduction (°)	Group I	27	30.93 (SD 23.33)	42.22 (SD 25.66)
	Group II	20	51.25 (SD 25.22)	68.25 (SD 28.4)
p value	p value		0.003*	<0.001*
External rotation (°)	Group I	27	45.04 (SD 26.22)	48 (SD 25.27)
	Group II	20	57.5 (SD 20.16)	52 (SD 21.11)
p value	p value		0.042*	0.284
Internal rotation (°)	Group I	27	-40.22 (SD 20.32)	-31.92 (SD 22.37)
	Group II	20	-32.5 (SD 21.8)	-19.25 (SD 20.8))
p value			0.11	0.28

Pre-rehab: Pre-rehabilitation, SD: Standart deviation

Table 5. Comparison of the Mallet Scores assessments for all participants

		Mallet classification	Abduction	External rotation	Hand to head	Hand to back	Hand to mouth
		n	47	47	47	47	47
1	Pre-rehab	Mean (SD)	3.13 (SD 0.65)	2.55 (SD 0.68)	2.47 (SD 0.58)	2.68 (SD 0.78)	2.89 (SD 0.84)
2	After-rehab (3M follow-up)	Mean (SD)	3.83 (SD 0.38)	3.55 (SD 0.69)	3.57 (SD 0.58)	2.06 (SD 0.32)	3.3 (SD 0.62)
3	6M follow-up	Mean (SD)	3.91 (SD 0.28)	3.66 (SD 0.63)	3.66 (SD 0.56)	2.13 (SD 0.4)	3.53 (SD 0.62)
4	12M follow-up	Mean (SD)	3.98 (SD 0.15)	3.79 (SD 0.51)	3.77 (SD 0.48)	2.23 (SD 0.52)	3.68 (SD 0.52)
Friedman test		χ^2	88.09	86.62	103.278	40.84	56.05
		p value	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*
Wilcoxon test		p value	1-2 (<0.01*) 2-3 (0.046*)	1-2 (<0.01*)	1-2 (<0.01*)	1-2 (<0.01*)	1-2 (<0.01*) 2-3 (<0.01*) 3-4 (0.02*)

Pre-rehab: Pre-rehabilitation, After-rehab: After-rehabilitation, SD: Standart deviation, x^2: Chi-square

Table 6. Comparison of the Mallet Scores assessments of each group

		Mallet classification	Abduction		External rotation		Hand to head		Hand to back		Hand to mouth	
		Group	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II	Group I	Group II
		n	27	20	27	20	27	20	27	20	27	20
1	Pre-rehab	Mean (SD)	3.3 (SD 0.61)	2.9 (SD 0.64)	2.63 (SD 0.69)	2.45 (SD 0.69)	2.48 (SD 0.64)	2.45 (SD 0.51)	2.63 (SD 0.79)	2.75 (SD 0.79)	2.96 (SD 0.81)	2.8 (SD 0.89)
2	After-rehab (3M follow-up)	Mean (SD)	3.93 (SD 0.27)	3.7 (SD 0.47)	3.52 (SD 0.64)	3.6 (SD 0.75)	3.52 (SD 0.58)	3.65 (SD 0.59)	2.11 (SD 0.32)	2 (SD 0.32)	3.33 (SD 0.62)	3.25 (SD 0.64)
3	6M follow-up	Mean (SD)	3.96 (SD 0.19)	3.85 (SD 0.37)	3.7 (SD 0.54)	3.6 (SD 0.75)	3.63 (SD 0.56)	3.7 (SD 0.57)	2.11 (SD 0.32)	2.15 (SD 0.49)	3.48 (SD 0.7)	3.6 (SD 0.50)
4	12M follow-up	Mean (SD)	4 (SD 0)	3.95 (SD 0.22)	3.85 (SD 0.36)	3.7 (SD 0.66)	3.7 (SD 0.54)	3.85 (SD 0.37)	2.22 (SD 0.51)	2.25 (SD 0.55)	3.67 (SD 0.55)	3.7 (SD 0.47)
Friedman test		χ^2	44.76	43.69	47.10	40.84	55.81	47.56	15.60	26.31	26.07	30.48
		p value	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*
Wilcoxon test		p value	1-2 (<0.01*)	1-2 (<0.01*)	1-2 (<0.01*)	1-2 (<0.01*)	1-2 (<0.01*)	1-2 (<0.01*)	1-2 (<0.01*)	1-2 (<0.01*)	1-2 (0.013*)	1-2 (0.013*) 2-3 (<0.01*)

Pre-rehab: Pre-rehabilitation, After-rehab: After-rehabilitation, SD: Standart deviation, x^2: Chi-square

improving function. In our study, we did not follow glenoid dysplasia but found that the mean motion gain of shoulder abduction and external rotation was similar regardless of age at surgery. Effect sizes of pre-operative and 3-month follow-up were very high for the G2 for all shoulder ranges of motions except for internal rotation. This means that children respond to intervention programs even if they have some stiffness or dysplasia.

In our study, we found that the children in G2 had more evident soft tissue stiffness as the onset shoulder movement ranges were lower. Muscle stiffness was previously found to be higher than non-affected side muscles in children with BPBI.[20] After the rehabilitation program, children older than 7 years had similar gains. However one should keep in mind that, the children who underwent a secondary surgery already have decreased myofascial tissue mobility, increased hyaluronic acid viscosity and glenohumeral deformities,[21] meaning a soft tissue problem that may decline the success of motion gain may occur after a period of surgery. The joint stiffness and deformities also affect the central nervous system as the system regulates the overall accuracy of movement based on the interpretation of hierarchical muscle activation pattern.[22,23] We may suggest that physiotherapy or exercise habits should continue until tissue maturation is completed.

One of the most remarkable results of our study is the significant gain in external rotation showed a decrease in follow-up assessments. Younger age had a significant effect in gain of external rotation till 6 months follow up. Unfortunately, even if it is a small range, external rotation started to decrease in G2 after 3 months. Safoury et al.[11] showed a significant increase in the external rotation angle of the shoulder during 6 months of rehabilitation duration in their study. A fall-off in postoperative improvement over 10 years was reported by Cohen et al.[24] Despite the short-term results of the surgery being encouraging, it is shown that the gain diminishes over time after the surgery in 7.64 years (range, 2-16.5 years).[25] Soldado et al.[26] confirmed a significant decrease especially in shoulder external rotation due to thickness and weight of denervated muscles. Clinicians should give more attention to rotation and develop strategies to maintain the gained external rotation movement, especially in children who underwent surgery late.

In the study internal rotation angles decreased after surgery, as it is expected.[27] Delioğlu et al.[28] determined that 30° of active and 41° of passive glenohumeral internal rotation motion is necessary for hand-to-back parameter. Mostly used daily living activities that required hand-to-back motion such as “tuck in shirt behind back”, and “wash the middle of the back” possibly had a positive effect on the gain of internal rotation motion.[29] Therapists should focus on functional

glenohumeral rotation and not disregard internal rotation motion in their treatment.[28]

Hoffer technique has a positive effect on abduction motion due to the mechanism that enables the deltoid muscle to be more active.[17,27] Despite the significant gain in the shoulder range of movement, the functional gain measured with Mallet score was only significant in the first 3 months. A long-term follow-up study reported a deterioration of shoulder abduction after 10 years in children who underwent tendon transfer surgery and explained the results with a lack of rehabilitation compliance and not using the involved arm actively.[30] Motivational rehabilitation and therapeutic options that are adapted to children's routine life to increase functional gain and prevent further soft tissue rebalancing procedures would be helpful.

A kinematics analysis study showed hand-to-neck parameter needs more external rotation and abduction motion than the hand-to-mouth parameter.[31] Limited external rotation motion affects the gain of hand-to-head function. A better hand-to-back score for Mallet Classification needs higher glenohumeral extension and internal rotation due to representing a coordinated multiplanar motion.[32] Even though there is a slight increase in internal rotation, a decrease in the glenohumeral extension might cause limited functional gain for participants in this study. It may be also because home exercises do not involve multiplanar functional movements.

Limitations

One limitation of the study is our results are limited to range of motion and Mallet Scoring results, which present data on body structures and functioning. Additionally, glenohumeral joint dysplasia screening would give valuable results; however, we could not collect the data.

CONCLUSION

As a result our results revealed that Hoffer technique increases shoulder flexion, abduction, and external rotation. The gain in external rotation started to decrease after 6 months and hand-to-head function did not increase after 3 months. Clinicians should give more attention to rotation and develop strategies to maintain the gained external rotation movement especially in children who underwent surgery late. The functional multiplanar use of the extremity should be encouraged in daily life.

ETHICAL DECLARATIONS

Ethics Committee Approval

This prospective clinical study was conducted with the approval of the İstanbul University İstanbul Faculty of Medicine Clinical Researches Ethics Committee (Date: 19.08.2019, Decision No: 1017).

Informed Consent

Informed consent was obtained from the legal guardians of the pediatric patient(s) described in this report. Where developmentally appropriate, assent was also sought from the child. The inclusion of vulnerable populations in this study adhered to national and international ethical guidelines. Extra care was taken to ensure voluntary participation, understanding, and protection of participant dignity and autonomy.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

Author Contributions

Concept: S.Ö., H.Ö.B.; Design: S.Ö., H.Ö.B.; Control: S.Ö.; Data collection and/or processing: S.Ö., H.Ö.B.; Analysis and/or interpretation: S.Ö., H.E., B.S.A.; Literature review: H.E., B.S.A.; Article writing: S.Ö., H.E., B.S.A.; Critical review: All authors.

Acknowledgments

We sincerely thank all the children and their families participating in this study. Your invaluable contribution and dedication made this research possible.

REFERENCES

1. Yang LJ. Neonatal brachial plexus palsy-management and prognostic factors. *Semin Perinatol*. 2014;38(4):222-234. doi:10.1053/j.semperi.2014.04.009
2. Foad SL, Mehlman CT, Foad MB, Lippert WC. Prognosis following neonatal brachial plexus palsy: an evidence-based review. *J Child Orthop*. 2009;3(6):459-463. doi:10.1007/s11832-009-0208-3
3. Coroneos CJ, Voineskos SH, Christakis MK, et al. Obstetrical brachial plexus injury (OBPI): Canada's national clinical practice guideline. *BMJ Open*. 2017;7(1):e014141. doi:10.1136/bmjopen-2016-014141
4. Daly MC, Bauer AS, Lynch H, Bae DS, Waters PM; Treatment and Outcomes of Brachial Plexus Birth Injury (TOBI) study group. Outcomes of late microsurgical nerve reconstruction for brachial plexus birth injury. *J Hand Surg Am*. 2020;45(6):555.e1-555.e9. doi:10.1016/j.jhsa.2019.10.036
5. Terzis JK, Kokkalis ZT. Primary and secondary shoulder reconstruction in obstetric brachial plexus palsy. *Injury*. 2008;39(3):S5-S14. doi:10.1016/j.injury.2008.06.001
6. Javid M, Shahcheraghi GH. Shoulder reconstruction in obstetric brachial plexus palsy in older children via a one-stage release and tendon transfers. *J Shoulder Elbow Surg*. 2009;18(1):107-113. doi:10.1016/j.jse.2008.06.013
7. Hulleberg G, Elvrum AK, Brandal M, Vik T. Outcome in adolescence of brachial plexus birth palsy. 69 individuals re-examined after 10–20 years. *Acta Orthop*. 2014;85(6):633-640. doi:10.3109/17453674.2014.964614
8. Hoffer MM, Wickenden R, Roper B. Brachial plexus birth palsies. Results of tendon transfers to the rotator cuff. *J Bone Joint Surg Am*. 1978;60(5):691-695.
9. Hale HB, Bae DS, Waters PM. Current concepts in the management of brachial plexus birth palsy. *J Hand Surg Am*. 2010;35(2):322-331. doi:10.1016/j.jhsa.2009.11.026
10. Brochard S, Alter K, Damiano D. Shoulder strength profiles in children with and without brachial PLEXUS PALSY. *Muscle Nerve*. 2014;50(1):60-66. doi:10.1002/mus.24099
11. Safoury YA, Eldesoky MT, Abutaleb EE, Atteya MR, Gabr AM. Postoperative physical therapy program for latissimus dorsi and teres major tendons transfer to rotator cuff in children with obstetrical brachial plexus injury. *Eur J Phys Rehabil Med*. 2017;53(2):277-285. doi:10.23736/S1973-9087.16.03910-1

12. Diop B, Daffe M, Dembele B, et al. Treatment of obstetrical brachial plexus palsy sequelae: preliminary results about 18 cases. *Ann Med Surg (Lond)*. 2022;80:104339. doi:10.1016/j.amsu.2022.104339
13. Bellew M, Kay SP, Webb F, Ward A. Developmental and behavioural outcome in obstetric brachial plexus palsy. *J Hand Surg Br.* 2000;25(1): 49-51. doi:10.1054/jhsb.1999.0331
14. Bhardwaj P, Varadharajan V, Salyan S, Venkatramani H, Sabapathy SR. Forearm deformities in birth brachial plexus palsy - patient profile and management algorithm. *J Hand Surg Asian Pac Vol*. 2023;28(6):624-633. doi:10.1142/S2424835523300025
15. Bae DS, Waters PM, Zurakowski D. Reliability of three classification systems measuring active motion in brachial plexus birth palsy. *J Bone Joint Surg Am*. 2003;85(9):1733-1738. doi:10.2106/00004623-200309000-00012
16. Ozben H, Atalar AC, Bilsel K, Demirhan M. Transfer of latissmus dorsi and teres major tendons without subscapularis release for the treatment of obstetrical brachial plexus palsy sequela. *J Shoulder Elbow Surg.* 2011; 20(8):1265-1274. doi:10.1016/j.jse.2011.01.004
17. Alluri RK, Lightdale-Miric N, Meisel E, et al. Functional outcomes of tendon transfer for brachial plexus birth palsy using the Hoffer technique. *Bone Joint J.* 2020;102-B(2):246-253. doi:10.1302/0301-620X.102B2.BJJ-2019-0999.R1
18. Aydin A, Ozkan T, Onel D. Does preoperative abduction value affect functional outcome of combined muscle transfer and release procedures in obstetrical palsy patients with shoulder involvement?. *BMC Musculoskelet Disord*. 2004;5:25. doi:10.1186/1471-2474-5-25
19. Covey DC, Riordan DC, Milstead ME, Albright JA. Modification of the L'Episcopo procedure for brachial plexus birth palsies. *J Bone Joint Surg Br.* 1992;74(6):897-901. doi:10.1302/0301-620X.74B6.1447254
20. Riquier-Le Chatelier M, Giai J, Lallement-Dudek P, Herisson O, Fitoussi F. Muscle elasticity in patients with neonatal brachial plexus palsy using shear-wave ultrasound elastography. Preliminary results. *J Pediatr Orthop B*. 2021;30(4):385-392. doi:10.1097/BPB.0000000000000781
21. Kodama Y, Masuda S, Ohmori T, et al. Response to mechanical properties and physiological challenges of fascia: diagnosis and rehabilitative therapeutic intervention for myofascial system disorders. *Bioengineering (Basel)*. 2023;10(4):474. doi:10.3390/bioengineering10040474
22. Mulla DM, Keir PJ. Neuromuscular control: from a biomechanist's perspective. *Front Sports Act Living.* 2023;5:1217009. doi:10.3389/fspor.2023.1217009
23. Stanev D, Moustakas K. Stiffness modulation of redundant musculoskeletal systems. *J Biomechanics*. 2019;85:101-107. doi:10.1016/j.jbiomech.2019.01.017
24. Cohen G, Rampal V, Aubart-Cohen F, Seringe R, Wicart P. Brachial plexus birth palsy shoulder deformity treatment using subscapularis release combined to tendons transfer. *Orthop Traumatol Surg Res*. 2010; 96(4):334-339. doi:10.1016/j.otsr.2010.02.004
25. Werthel JD, Wagner ER, Elhassan BT. Long-term results of latissimus dorsi transfer for internal rotation contracture of the shoulder in patients with obstetric brachial plexus injury. *JSES Open Access*. 2018;2 (3):159-164. doi:10.1016/j.jses.2018.05.002
26. Soldado F, Fontecha CG, Marotta M, et al. The role of muscle imbalance in the pathogenesis of shoulder contracture after neonatal brachial plexus palsy: a study in a rat model. *Journal of Shoulder and Elbow Surgery*. 2014;23(7):1003-1009. doi:10.1016/j.jse.2013.09.031
27. Thamer S, Kijak N, Toraih E, Thabet AM, Abdelgawad A. Tendon transfers to restore shoulder function for obstetrical brachial plexus palsy: a systematic review of the literature. *JBJS Rev.* 2023;11(1):10.2106/JBJS.RVW.22.00165. doi:10.2106/JBJS.RVW.22.00165
28. Delioğlu K, Uzumcugil A, Öztürk E, Bıyık KS, Ozal C, Gunel MK. Cut-off values of internal rotation in the glenohumeral joint for functional tasks in children with brachial plexus birth injury. *J Hand Surg Eur Vol*. 2023;48(8):738-746. doi:10.1177/17531934231154362
29. Namdari S, Yagnik G, Ebaugh DD, et al. Defining functional shoulder range of motion for activities of daily living. *J Shoulder Elbow Surg.* 2012;21(9):1177-1183. doi:10.1016/j.jse.2011.07.032
30. Pagnotta A, Haerle M, Gilbert A. Long-term results on abduction and external rotation of the shoulder after latissimus dorsi transfer for sequelae of obstetric palsy. *Clin Orthop Relat Res.* 2004;(426):199-205. doi:10.1097/01.blo.0000138957.11939.70
31. Herisson O, Maurel N, Diop A, Le Chatelier M, Cambon-Binder A, Fitoussi F. Shoulder and elbow kinematics during the Mallet score in obstetrical brachial plexus palsy. *Clinical Biomechanics*. 2017;43:1-7. doi:10.1016/j.clinbiomech.2017.01.006
32. Russo SA, Kozin SH, Zlotolow DA, Nicholson KF, Richards JG. Motion necessary to achieve mallet internal rotation positions in children with brachial plexus birth palsy. *J Pediatr Orthop*. 2019;39(1):14-21. doi:10.1097/BPO.0000000000001010

Journal of Orthopedics Research and Rehabilitation

Original Article

DOI: 10.51271/JORR-0063

Comparison of the effectiveness of medium-and low-intensity ESWT in patients with plantar fasciitis

Nazlı Kılıç[1], Besna İrem Şekerci*[2], Tamer Çankaya[3]

[1] Department of Physiotherapy and Rehabilitation, Dr. Nafiz Körez Sincan State Hospital, Ankara, Turkiye
[2]Department of Physiotherapy and Rehabilitation, Institute of Postgraduate Education, Bolu Abant İzzet Baysal University, Bolu, Turkiye
[3]Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Bolu Abant İzzet Baysal University, Bolu, Turkiye

Cite this article as: Kılıç N, Şekerci Bİ, Çankaya T. Comparison of the effectiveness of medium-and low-intensity ESWT in patients with plantar fasciitis. *J Orthop Res Rehabil.* 2026;4(1):8-15.

Received: 15.08.2025 • **Accepted**: 11.01.2026 • **Published**: 31.01.2026

ABSTRACT

Aims: Plantar fasciitis (PF) is caused by inflammation or microtrauma of the plantar fascia, leading to heel pain. Extracorporeal shock wave therapy (ESWT) is a non-invasive method that reduces pain via acoustic waves. This study compared medium- and low-intensity ESWT effects on pain and quality of life in PF patients.

Methods: Forty-two PF patients without recent conservative treatment were randomized into low-intensity ESWT (L-ESWT), medium-intensity ESWT (M-ESWT), and placebo groups. All received cold packs and a standardized exercise program. Outcomes included Visual Analog Scale (VAS), algometry, Roles and Maudsley (RM) score, joint range of motion, Foot Function Index (FFI), and Nottingham Health Profile (NHP), assessed at baseline, post-treatment, and six weeks.

Results: L-ESWT and M-ESWT groups showed significant pain reduction and improved joint mobility and function after treatment and at six weeks ($p<0.05$). NHP subdomains of pain, energy, and sleep also improved ($p<0.05$). L-ESWT yielded greater RM score improvement ($p=0.01$). No significant differences were found between ESWT groups in overall effectiveness ($p>0.05$).

Conclusion: The positive effects of ESWT persisted at six weeks, supporting its short-to mid-term benefit in managing PF-related symptoms.

Keywords: Extracorporeal shockwave therapy, pain, plantar fasciitis, rehabilitation

INTRODUCTION

The plantar fascia is a fibrous layer in the subcutaneous tissue, extending from the calcaneus to the forefoot's deep soft tissues, including proximal phalanges and superficial dermis.[1] It maintains the medial longitudinal arch during weight-bearing, absorbs shock, and aids the windlass mechanism in gait's push-off phase[2,3] PF is a degenerative and inflammatory condition at the fascia's attachment on the inferomedial calcaneus due to repetitive microtrauma. It is a leading cause of adult heel pain.[4,5] Pain worsens with passive toe dorsiflexion, peaks during the first morning steps after rest, may lessen with movement, but often persists and worsens with prolonged walking or activity.[6] When conservative treatments fail and surgery outcomes are inconsistent, ESWT offers a non-invasive alternative for PF management.[7]

ESWT uses electrohydraulic shock waves-high-energy acoustic waves generated by high-voltage spark discharge between electrodes. The device works on the principle that the body's acoustic impedance is similar to water's, so shock waves are produced in water and transmitted via a coupling medium, focusing energy at the therapeutic point (F2) while reducing reflection losses.[8,9] ESWT's effect depends on cavitation, where microbubbles form and move in fluid, causing microtrauma. This triggers healing, promoting neovascularization and pain reduction. Pain relief results from enzyme release and new vessel formation.[3]

ESWT is a proven effective and safe conservative treatment for PF and ranks among the most successful compared to other methods.[10] A 2024 meta-analysis found ESWT improved pain and FFI scores more than placebo, but showed no superiority over other treatments.[11]

A study with gradually increased ESWT intensity showed greater pain and biomechanical improvements than controls.[12] While the optimal ESWT energy level is debated, medium-energy ESWT consistently reduces PF pain; low-and high-energy effects versus control are unclear.[13] A 5-session ESWT protocol also improved quality of life.[14]

Although numerous studies have investigated the use of ESWT in the treatment of PF, uncertainty remains regarding the effectiveness of different energy levels. This study aims to evaluate and compare the effects of medium-and L-ESWT on pain and quality of life in patients with PF.

***Corresponding Author:** Besna İrem Şekerci, besnairemsekerci@gmail.com

This work is licensed under a Creative Commons Attribution 4.0 International License.

METHODS

This study has been approved by the Clinical Researches Ethics Committee of Abant İzzet Baysal University (Date: 17.06.2014, Decision No: 2014/45). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. A total of 42 participants presenting with heel pain, diagnosed with PF by a physical medicine and rehabilitation specialist, and who voluntarily signed informed consent forms were included in the study. Inclusion criteria were: a confirmed PF diagnosis by a specialist physician, no history of conservative treatment for PF within the last six months, and voluntary participation. Exclusion criteria included the use of non-steroidal anti-inflammatory drugs or conservative treatments for PF within the past six months, presence of inflammatory arthropathies, pregnancy, pacemaker implantation, skin ulcerations, or coagulation disorders.

Participants were assigned into three groups: L-ESWT (n=20), M-ESWT (n=20) and placebo ESWT (n=20)-using a stratified random sampling method that considered age, sex, and sociodemographic characteristics. The allocation was performed by an independent researcher who was not involved in the intervention. Group 1 received L-ESWT, Group 2 received M-ESWT, and Group 3 received placebo ESWT. During the intervention phase, a total of 17 participants discontinued the study: six from the L-ESWT group, three from the medium-intensity group, and nine from the placebo group. Withdrawals were mainly due to mild discomfort during treatment sessions and logistical challenges, such as scheduling conflicts or difficulty attending follow-ups. The final analyses were conducted on the 42 participants who completed the study. All groups also received a 15-minute cold pack application and a standardized exercise program. The ESWT intervention was administered once a week for a total of three sessions.

Measurements

Demographic data of patients with PF were recorded. Assessments were performed at three time points: before treatment, immediately after treatment, and six weeks post-treatment.

Pain Assessment

Pain intensity was evaluated using the VAS, a 10-cm line with endpoints labeled '0' (no pain) and '10' (worst possible pain).[15] Patients were asked to mark their pain level at rest, in the morning, at night, during palpation, and in daily activities. The distance from the line's start to the mark was measured in centimeters and recorded.

Pressure algometry quantitatively measures pressure pain thresholds, providing an objective assessment of tenderness typically evaluated by palpation. Fischer et al.[16] noted that algometry can aid in diagnosing trigger and hypersensitive points. In this study, a Baseline mechanical pressure algometer with a spring-loaded, rubber-tipped cylindrical probe of 1 cm^2 area was used. Before measurement, pressure was gradually applied by the examiner's thumb to the pain site until blanching of the nail bed (approximately 4 kg). Subsequently, increasing pressure was applied until the participant reported pain, distinguishing it from pressure sensation. This procedure was repeated three times per site, and the average value was recorded. A 10-15 second interval was maintained between measurements.

Assessment of Normal Joint Range of Motion (ROM)

Ankle dorsiflexion, plantarflexion, eversion, and inversion ROM values were measured using a goniometer at baseline, post-treatment, and at 6 weeks follow-up.

Foot Function Assessment

The FFI was used to evaluate functional status. The FFI is a widely used self-reported questionnaire designed to assess the impact of foot pathologies like PF on pain, disability, and activity limitation. It consists of 23 items grouped into three subscales: pain, functional limitation, and activity restriction. Each item is scored from 0 (no problem) to 10 (severe problem). Subscale means are calculated, and the total score ranges from 0 to 100, with higher scores indicating worse function.[17]

Roles and Maudsley Score

The RM score is a four-grade subjective scale assessing pain level and treatment response. Scores are classified as: 1-no pain (excellent), 2-marked improvement (good), 3-partial improvement (acceptable), and 4-persistent or worsening symptoms (poor). Patients with scores of 1 or 2 are considered treatment successes.[8]

Quality of Life Assessment

The NHP was used to assess quality of life. The NHP evaluates patient-perceived emotional, social, and physical health problems. Each section is scored from 0 to 100, with questions answered as "yes" or "no." The best possible total score is 0, indicating no problems, while the worst is 100. The questionnaire consists of 38 items across six categories: energy, pain, physical mobility, sleep, emotional reactions, and social isolation.[19]

In this study, various assessment tools were applied at three time points: before treatment, immediately after treatment, and six weeks post-treatment. Before treatment, VAS, pressure algometry, ROM, NHP, FFI, and RM scales were used. Post-treatment assessments included VAS, pressure algometry, ROM, FFI, and RM. At six weeks, all scales-VAS, pressure algometry, ROM, NHP, FFI, and RM-were administered.

Treatment Procedure

In the current literature, it is generally observed that ESWT is effective when administered two or three times at intervals of one week (or longer).[20] Participants received a total of three ESWT sessions once weekly using the Roland Serie-ESWT device. The low-intensity group was treated with 1.8 bar (0.05 mJ/mm^2), the medium-intensity group with 2.1 bar, and the placebo group with a minimal dose of 0.5 bar to simulate the treatment without delivering a therapeutic effect. All groups received 1,000 pulses per session at a frequency of 5 Hz. Following each treatment, a 10-minute ice application was administered, and patients were instructed on an exercise program. Exercises included rolling a cold bottle under the foot, towel gathering with toes, and gastrocnemius-soleus stretching against a wall and with a sheet. Patients were advised to perform the exercises three times daily with 10 repetitions each.

Statistical Analysis

Data were analyzed using SPSS 24.0. Normality of continuous variables was assessed with the Shapiro-Wilk test. For normally distributed repeated measures, Repeated Measures ANOVA was used; for non-normal data, the Friedman test was applied. Post-hoc pairwise comparisons after Friedman were conducted using the Wilcoxon Signed-Rank test. For significant Repeated Measures ANOVA results, paired t-tests were performed. Between-group comparisons for continuous variables used One-Way ANOVA (parametric) or Kruskal-Wallis H test (non-parametric). Significant Kruskal-Wallis results were further examined with Mann-Whitney U tests; significant ANOVA results with Tukey HSD post-hoc tests. A p-value <0.05 was considered statistically significant. Post-hoc power analysis was conducted using G*Power (v3.1) with an ANOVA repeated measures, within-between interaction model. Parameters included effect size=0.25, alpha=0.05, sample size=42, correlation among repeated measures=0.66, and sphericity correction epsilon=1.0. The calculated statistical power was 57.91%.

RESULTS

A total of 42 participants were included: 14 in the L-ESWT group, 17 in the M-ESWT group, and 11 in the placebo ESWT group. No statistically significant differences were found among the groups regarding age (p=0.492), gender (p=0.444), body mass index (BMI) (p=0.773), or dominant side (p=0.340). The flow diagram is presented in **Figure**.

Table 1 presents the analyses conducted for pain assessment.

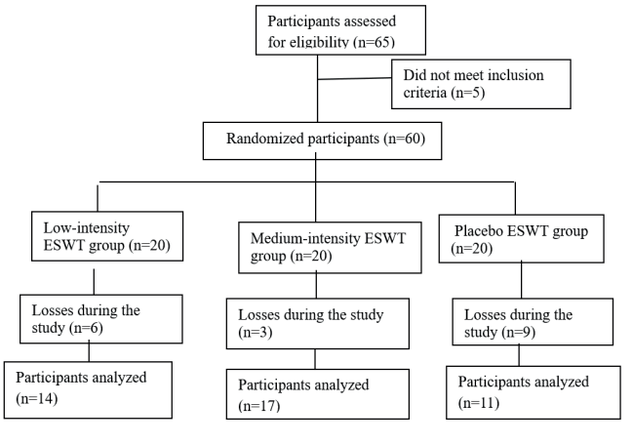


Figure. Flow diagram

The comparison of normal joint range of motion is presented in **Table 2**.

When examining the subcomponents of the FFI, significant improvements were observed in pain and disability scores in all groups at 6 weeks compared to baseline (p<0.01). Although a decreasing trend was noted in activity levels across all three groups, this change was not statistically significant (p>0.05) (**Table 3**).

According to the RM functional assessment results, significant improvement was observed at 6 weeks post-treatment in the low-intensity and placebo groups (p=0.002 and p=0.021, respectively), while the change in the medium-intensity group approached significance (p=0.056) (**Table 4**).

Table 1. Comparison of pain assessments

		Pre-treatment	Post-treatment	6 Weeks post-treatment	p-value
VAS at rest	Low-intensity	4.3 (0-10)	3.09±2.77	1.15 (0-7.7)	0.377‡
	Medium-intensity	4.5 (0-10)[a]	4.91±3.11[a]	0 (0-6.7)[b]	0.02‡
	Placebo	6.1 (0-10)[a]	4.89±2.98[a]	0.9 (0-3.6)[b]	0.01‡
	p-value	0.338[#]	0.261†	0.757[#]	
VAS in the morning	Low-intensity	10 (0-10)[a]	7.35 (0-10) [b]	3.4 (0-10)[c]	0.00‡
	Medium-intensity	7.8 (2.5-10)[a]	8.6 (5-10)	1.5 (0-9.2)[b]	0.00‡
	Placebo	8.3 (1.6-10)[a]	6 (1.5 -10)	1.5 (0-7.7)[b]	0.01‡
	p-value	0.611[#]	0.360[#]	0.466[#]	
VAS at night	Low-intensity	4.3 (0-10)[a]	2.35 (0-8.5)	0 (0-7.6)[b]	0.045‡
	Medium-intensity	2 (0-10)[a]	4.6 (0-10)[a]	0 (0-7.9)[b]	0.001‡
	Placebo	5.8 (0-10)	5.4 (0-8.2)	0 (0-7.7)	0.105‡
	p-value	0.770†	0.298†	0.99[#]	
VAS during palpation	Low-intensity	5.65 (0-10)[a]	5.67±2.98[b]	2.15 (0-9)[c]	0.022‡
	Medium-intensity	9 (4.7-10)[a]	7.01±2.49[b]	2.1 (0-10)[c]	0.00‡
	Placebo	10 (2.5-10)[a]	6.92±2.00[a]	3.9 (0-10)[b]	0.001‡
	p-value	0.238[#]	0.371†	0.853†	
VAS during daily activities	Low-intensity	8.2 (0-10)[a]	4.9 (2.4-10)[b]	3.15 (0-10)[b]	0.002‡
	Medium-intensity	9 (1.7-10)[a]	7.8 (0-10)[b]	3 (0-10)[c]	0.00‡
	Placebo	8.5 (5-10)[a]	7.2 (1.3-10)[a]	4 (1.5-10)[b]	0.007‡
	p-value	0.686[#]	0.377[#]	0.627[#]	
Algometer	Low-intensity	8.46±1.86[a]	9.39±2.10	10.36±2.81[b]	0.03†
	Medium-intensity	10.04±2.60	10.42±1.81	11.9±3.68	0.067†
	Placebo	8.80±2.73[a]	10.27±2.47[b]	11.13±2.85[c]	0.00†
	p-value	0.172†	0.369†	0.418†	

Data are presented as mean±standard deviation ($\bar{x}$±SD) and median (min–max). Median: Median value, Min: Minimum value, Max: Maximum value, $\bar{x}$: Mean; SD: Standard deviation; p: Repeated Measures ANOVA, One-Way ANOVA†, Friedman test, Wilcoxon Signed-Rank test‡, Kruskal-Wallis test[#]. Small letters a, b, and c indicate post-hoc test results, representing significant differences between groups. VAS: Visual Analog Scale

Table 2. Comparison of normal joint range of motion

		Pre-treatment	Post-treatment	6 Weeks post-treatment	p-value
Ankle dorsiflexion	Low-intensity	8 (0-20)[a]	7 (-5,20)	20 (-5-20)[b]	0.005‡
	Medium-intensity	8 (0-20)	8 (0-20)	20 (0-20)	0.05‡
	Placebo	8 (0-20)[a]	20 (0-20)	20 (5-20)[b]	0.009‡
	p-value	0.884#	0.487#	0.724#	
Ankle plantarflexion	Low-intensity	45 (10-45)	45 (18-45)	45 (30-45)	0.06‡
	Medium-intensity	45 (20-45)	45 (25-45)	45 (25-45)	0.368‡
	Placebo	35 (20-45)[a]	45 (25-45)	45 (35-45)[b]	0.008‡
	p-value	0.388#	0.484#	0.720#	
Ankle inversion	Low-intensity	18.5 (10-35)[a]	20 (2-35)[x]	20 (15-35)[b]	0.019‡
	Medium-intensity	15 (8-30)[a]	20 (11-35)[x]	20 (2-35)[b]	0.003‡
	Placebo	20 (12-25)[a]	25 (20-35)[b,y]	30 (20-35)[c]	0.00‡
	p-value	0.176#	0.010#	0.063#	
Ankle eversion	Low-intensity	12 (9-20)[x]	15 (9-20)[x]	17.5 (10-20)	0.018‡
	Medium-intensity	12 (10-20)[a,x]	5 (11-20)[b,x]	17 (13-22)[b]	0.00‡
	Placebo	20 (13-25)[y]	20 (15-20)[y]	20 (15-20)	0.717‡
	p-value	0.002#	0.001#	0.075#	

Data are presented as median (min–max). Median: Median value, Min: Minimum value, Max: Maximum value. p: Friedman test, post-hoc: Wilcoxon Signed-Rank test‡. For Kruskal-Wallis test#, post-hoc analysis was performed using the Mann-Whitney U test. Small letters a, b, c, x, and y indicate post-hoc test results, showing significant differences between groups

Table 3. Comparison of the foot function index

		Post-treatment	6 Weeks post-treatment	p-value
Foot function index-pain	Low-intensity	83.85 (11.1-100)	42.78±20.14	0.001‡
	Medium-intensity	81.4 (46.6 -94.2)	45.23±26.06	0.00‡
	Placebo	82.8 (43.30-100)	49.27±25.53	0.006‡
	p-value	0.712#	0.800†	
Foot function index-disability	Low-intensity	82.15 (0-95.5)	33.85 (13.30-90)	0.008‡
	Medium-intensity	78.84 (32.20-100)	37.7 (0-93.3)	0.002‡
	Placebo	91.1 (31.1-100)	26.6 (8.8-83.3)	0.003‡
	p-value	0.615#	0.845#	
Foot function index-activity	Low-intensity	22 (0-40)	9 (0-36)	0.169‡
	Medium-intensity	20 (0-60)	0 (0-60)	0.060‡
	Placebo	21 (0-42)	6 (0-32)	0.050‡
	p-value	0.854#	0.446#	

Data are presented as median (min–max). Median: Median value, Min: Minimum value, Max: Maximum value. p: One-Way Anova†, Wilcoxon Signed-Rank test‡. Kruskal-Wallis test#

Table 4. Roles and maudsley scores by group

		1 and 2 (%) excellent and good	3 and 4 (%) acceptable and poor	p-value
L-ESWT	Post-treatment	2 (14.3)	12 (85.7)	0.031
	6 Weeks post-treatment	8 (57.1)	6 (42.9)	
M-ESWT	Post-treatment	6 (35.3)	11 (64.7)	0.125
	6 Weeks post-treatment	11 (64.7)	6 (35.3)	
Plasebo	Post-treatment	1 (9.1)	10 (90.9)	0.070
	6 Weeks post-treatment	7 (63.6)	4 (36.4)	
Between-group difference over time, p				
Post-treatment			0.186	
Post-treatment			0.903	

Data are presented as n (%), where n represents frequency and % represents percentage. p-values were calculated using McNemar and Chi-square tests. L-ESWT: Low-intensity extracorporeal shock wave therapy, M-ESWT: Medium-intensity extracorporeal shock wave therapy

In the NHP assessments, significant improvements were observed in the pain subscale across all groups, and in the energy and sleep subscales in the low-and medium-intensity groups ($p<0.05$). Total NHP scores decreased post-treatment in all groups ($p<0.05$) (**Table 5**).

DISCUSSION

The aim of this study was to evaluate and compare the effectiveness of L-ESWT and M-ESWT on pain and quality of life in PF treatment. Significant reductions in morning, night, rest, and palpation pain, alongside notable improvements in FFI scores, were observed in both ESWT groups. The M-ESWT group particularly stood out with improvements in physical activity levels and quality of life. Although some improvements in joint range of motion parameters were noted across all groups, only eversion and inversion angles showed significant differences between groups post-treatment. These findings suggest that ESWT provides therapeutic benefits for pain and functional disability in PF and may be an effective intervention for improving the physical components of quality of life.

Meta-analyses have shown that ESWT is effective in improving pain and functional outcomes, particularly in individuals with chronic PF.[20-22] It has been reported that moderate and high-intensity exercise is more effective in reducing overall pain and activity-related pain, and also provides significant improvement in functional outcomes.[20] It has also been emphasized that ESWT is superior to placebo in short- and medium-term follow-ups in terms of pain control and may be one of the most suitable options among various conservative treatment options.[21,22] Our study also found that low- and M-ESWT applications had positive effects on pain and quality of life and provided functional improvement. The M-ESWT group, in particular, stood out with increases in physical activity levels and quality of life. These findings support that ESWT offers therapeutic effects on pain and functional impairment in PF and may be an effective intervention for improving the physical components of quality of life.

L-ESWT and M-ESWT have been reported as effective treatments for PF.[23,24] Use of L-ESWT has been associated with reductions in morning VAS scores[25] and 1,000 pulses have led to improvements in VAS scores at rest, during palpation, and walking, with effects lasting up to five years and reducing the need for surgery.[24] After three sessions of M-ESWT, improvements in morning, activity, and rest VAS scores were observed at three months, with continued improvement in VAS scores from 1 to 12 months.[26,23] In our

Table 5. Comparison of nottingham health profile scores

		Pre-treatment	6 Weeks post-treatment	p-value
NHP-pain	Low-intensity	97.08 (8.96-100)	42.75 (0-100)	0.004‡
	Medium-intensity	87.09 (36.5-100)	53.22 (0-87.09)	0.001‡
	Placebo	76.6 (38.92-100)	18.95 (0-70.27)	0.009‡
	p-value	0.552#	0.553#	
NHP-energy and sleep	Low-intensity	69.6 (0-100)	50 (0-100)	0.017‡
	Medium-intensity	100 (0-10)	60.8 (0-100)	0.008‡
	Placebo	63.2 (0-100)	63.2 (24-100)	0.623‡
	p-value	0.249#	0.632#	
NHP-emotional reactions	Low-intensity	30.09 (0-69.62)	13.95 (0-100)	0.594‡
	Medium-intensity	30.93 (0-100)	16.98 (0-100)	0.224‡
	Placebo	29.54 (0-59.15)	7.22 (0-31.68)	0.008‡
	p-value	0.529#	0.246#	
NHP-sleep	Low-intensity	19.24 (0-72.74)	12.57 (0-100)	0.964‡
	Medium-Intensity	27.16 (0-100)	16.1 (0-100)	0.722‡
	Placebo	55.93 (0-100)	12.57 (0-56.64)	0.012‡
	p-value	0.572#	0.426#	
NHP-physical mobility	Low-intensity	32.83 (11.2-54.55)	21.99 (11.2-63.16)	0.119‡
	Medium-intensity	52.59 (11.2 -100)	34.6 (0-82.26)	0.012‡
	Placebo	20.5 (10.79 -100)	11.2 (0-32.56)	0.123‡
	p-value	0.040#	0.143#	
NHP-social isolation	Low-intensity	20.13 (0-80.64)	0 (0-100)	0.168‡
	Medium-intensity	0 (0-100)	0 (0-100)	0.446‡
	Placebo	0 (84.03)	0 (0-84.03)	0.066‡
	p-value	0.908#	0.426#	
NHP-total score	Low-intensity	256.01±108.88	180.44 (11.2-514.86)	0.022‡
	Medium-intensity	330.89±148.36	196.77 (0-553.1)	0.010‡
	Placebo	266.67±119.66	131.22 (52.25-372.49)	0.008‡
	p-value	0.232†	0.347#	

Data are presented as mean±standard deviation ($\bar{x}$±SD) and median (min–max). $\bar{x}$: mean; SD: Standard deviation, Median: Median value, Min: Minimum value, Max: Maximum value. p-values were calculated using One-Way ANOVA†, Wilcoxon Signed-Rank test‡, and Kruskal-Wallis test# NHP: Nottingham Health Profile

study, improvements in morning, night, palpation, and daily activity VAS scores were seen in both L-ESWT and M-ESWT groups, with the M-ESWT group also showing improvement in rest VAS scores. These improvements were maintained at six weeks follow-up across all groups. The observed reductions in VAS scores in both ESWT groups support the effectiveness of ESWT in pain management for PF.

In individuals with PF, normal range of motion (ROM) in the ankle and foot complex decreases, along with a decline in the quality of lower extremity movements.[27] It has been suggested that combining PF stretching and Achilles-gastrocnemius exercises with ESWT may enhance treatment effectiveness.[28] In our study, although dorsiflexion showed limited significance only in the M-ESWT group, improvements in dorsiflexion and inversion were observed across all groups; plantar flexion improved in the placebo group, while eversion improved in both L-ESWT and M-ESWT groups. The fact that significant differences between groups were observed only in eversion and inversion angles suggests that ESWT may have an exercise-independent effect on these parameters. Conversely, changes in dorsiflexion and plantar flexion appear to be primarily influenced by the stretching exercises applied.

After three sessions of M-ESWT treatment, improvements in foot function were observed in all groups[23] and ESWT was shown to have positive effects on foot function regardless of energy level.[29] ESWT has been suggested as a promising intervention to aid in improving foot function in individuals with PF.[30] In our study, functional disability improvements were seen in both ESWT and placebo groups; however, activity level improvements were limited to the placebo group. These results support the positive effects of ESWT on function, while also highlighting the importance of considering the placebo effect.

Improvements in RM scores have been reported in patients treated with L-ESWT and M-ESWT,[25,31,32] with faster and more sustained recovery compared to the placebo group (33). In our study, the improvements observed in RM scores in the ESWT groups suggest that ESWT may be effective in functional recovery. The sustained improvement at 6 weeks in L-ESWT group indicates that treatment efficacy may increase over time and highlights the importance of long-term follow-up. These results support the therapeutic effect of ESWT on functional outcomes.

M-ESWT significantly improved quality of life, enhancing general health perception and physical functionality.[31] High-dose and long-duration ESWT protocols have been shown to produce positive changes in physical function, general health, and daily living activities.[34] While improvements in pain and foot function following ESWT contributed to increased physical components of quality of life, no significant changes were observed in psychological dimensions.[35] In our study, persistent improvements in pain, energy/sleep, and physical activity were seen in the ESWT groups, with the M-ESWT group standing out in physical activity and overall NHP scores. However, no changes were detected in psychological subdomains such as emotional reactions and social isolation within the ESWT groups. This situation may be due to the 6-week follow-up period being insufficient to reflect psychosocial improvements. In the placebo group, only limited and short-term improvements in pain and sleep quality were observed. These findings demonstrate that ESWT is an effective and durable treatment for physical functionality and pain management.

There remains uncertainty in the literature regarding the dose-dependent effects of ESWT.[31,33,36] M-ESWT has been reported to provide significant early and long-term improvements in pain and function compared to sham treatment,[33] while L-ESWT demonstrated higher treatment success than placebo in morning first-step pain, daily pain, total pain, and quality of life in both short- and long-term follow-ups.[31,36] Conversely, no significant differences were found among low-, medium-, and high-intensity ESWT groups regarding pain and foot function.[29] It has also been suggested that although L-ESWT initially showed greater improvement, this difference diminished with additional sessions in the low-intensity group.[32] In our study, both medium-and L-ESWT produced significant improvements in pain and function, with no significant difference observed between the two intensities overall. Post-treatment, significant differences between groups were observed only in eversion and inversion angles, with similar results obtained in other range of motion parameters. These findings suggest that the clinical efficacy of ESWT may be closely related to the applied dose and number of sessions. Although the rate of functional improvement was slightly higher in the low-intensity group according to the RM scores, this difference did not reach a statistically significant level.

Limitations

The main limitation of this study is the relatively small sample size, which reduced the statistical power and may have hindered the detection of small to moderate effects. Additionally, conducting the study at a single center and the short follow-up period limit the generalizability of the results and the evaluation of long-term effects. Variations in participants' adherence to the exercise program may also have influenced treatment outcomes. Future studies with larger sample sizes, multicenter designs, and longer follow-up periods are recommended.

CONCLUSION

This study demonstrates that ESWT is an effective method for reducing pain, improving foot function, and enhancing the physical dimensions of quality of life in individuals with PF. M-ESWT produced particularly notable results. However, no significant changes were observed in the psychological aspects of quality of life. The findings suggest that ESWT may be a beneficial intervention for symptom management in PF, including pain control, improvement of functional capacity, and support of joint range of motion.

ETHICAL DECLARATIONS

Ethics Committee Approval

This study has been approved by the Clinical Researches Ethics Committee of Abant İzzet Baysal University (Date: 17.06.2014, Decision No: 2014/45).

Informed Consent

Written informed consent was obtained from all individual participants prior to their inclusion in the study. Participants were fully informed about the study's aims, procedures, potential risks and benefits, and their rights-including the right to withdraw at any time without consequence. All participants voluntarily signed a written informed consent form.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

Author Contributions

Concept: N.K., T.Ç.; Design: N.K., T.Ç.; Control: N.K., T.Ç.; Data collection and/or processing: N.K.; Analysis and/or interpretation: B.İ.Ş.; Literature review: B.İ.Ş., N.K.; Article writing: B.İ.Ş., N.K., T.Ç.; Critical review: All authors.

REFERENCES

1. Kitaoka HB, Luo ZP, Growney ES, Berglund LJ, An KN. Material properties of the plantar aponeurosis. *Foot Ankle Int*. 1994;15(10):557-560. doi:10.1177/107110079401501007
2. Bartold SJ. The plantar fascia as a source of pain-biomechanics, presentation and treatment. *J Bodyw Mov Ther*. 2004;8(3):214-26. doi:10.1016/S1360-8592(03)00087-1
3. Othman AM, Ragab EM. Endoscopic plantar fasciotomy versus extracorporeal shock wave therapy for treatment of chronic plantar fasciitis. *Arch Orthop Trauma Surg*. 2010;130(11):1343-1347. doi:10.1007/s00402-009-1034-2
4. Roxas M. Plantar fasciitis: diagnosis and therapeutic considerations. *Altern Med Rev*. 2005;10(2):83-93.
5. Martin JE, Hosch JC, Goforth WP, Murff RT, Lynch DM, Odom RD. Mechanical treatment of plantar fasciitis. A prospective study. *J Am Podiatr Med Assoc*. 2001;91(2):55-62. doi:10.7547/87507315-91-2-55
6. Cutts S, Obi N, Pasapula C, Chan W. Plantar fasciitis. *Ann R Coll Surg Engl*. 2012;94(8):539-542. doi:10.1308/003588412X13171221592456
7. Metzner G, Dohnalek C, Aigner E. High-energy Extracorporeal Shock-Wave Therapy (ESWT) for the treatment of chronic plantar fasciitis. *Foot Ankle Int*. 2010;31(9):790-796. doi:10.3113/FAI.2010.0790
8. Wang CJ. Extracorporeal shockwave therapy in musculoskeletal disorders. *J Orthop Surg Res*. 2012;7:11. doi:10.1186/1749-799X-7-11
9. Ogden JA, Tóth-Kischkat A, Schultheiss R. Principles of shock wave therapy. *Clin Orthop Relat Res*. 2001;387:8-17.
10. Ovchynnikov OM, Bludova MO, Merkulova TV. Effectiveness of extracorporeal shock wave therapy in comparison with other methods of treatment of patients with plantar fasciitis: literature review. *Medicni Perspektivi*. 2024;29(3):20-26. doi:10.26641/2307-0404.2024.3.313479
11. Tung WS, Daher M, Covarrubias O, Herber A, Gianakos AL. Extracorporeal shock wave therapy shows comparative results with other modalities for the management of plantar fasciitis: a systematic review and meta-analysis. *Foot Ankle Surg*. 2025;31(4):283-290. doi:10.1016/j.fas.2024.11.005
12. Szajkowski S, Pasek J, Cieślar G. Dose escalation can enhance the therapeutic potential of radial extracorporeal shock-wave therapy in the treatment of plantar fasciitis in runners. *Medicina (Kaunas)*. 2024;60(5):766. doi:10.3390/medicina60050766
13. Wang YC, Chen SJ, Huang PJ, Huang HT, Cheng YM, Shih CL. Efficacy of different energy levels used in focused and radial extracorporeal shockwave therapy in the treatment of plantar fasciitis: a meta-analysis of randomized placebo-controlled trials. *J Clin Med*. 2019;8(9):1497. doi:10.3390/jcm8091497
14. Alkan G, Elbasti MS, Akgol G, Gulkesen A, Ulusoy H. Ultrasonographic and pedobarographic evaluation of the effectiveness of extracorporeal shock wave therapy in patients with plantar fasciitis. *J Back Musculoskelet Rehabil*. 2025;38(1):121-131. doi:10.1177/10538127241291665
15. Langley GB, Sheppeard H. The visual analogue scale: its use in pain measurement. *Rheumatol Int*. 1985;5(4):145-148. doi:10.1007/BF00541514
16. Andrew A. Fischer. Algometry in diagnosis of musculoskeletal pain and evaluation of treatment outcome: anUpdate. *J Musculoskelet Pain*. 1998;6(1):5-32. doi:10.1300/J094v06n01_02
17. Yaliman A, Şen Eİ, Eskiyurt N, Budiman-Mak E. Turkish translation and adaptation of foot function index in patients with plantar fasciitis. *Turk J Phys Med Rehabil*. 2014;60(3):212-223.
18. Martinelli N, Marinozzi A, Carnì S, Trovato U, Bianchi A, Denaro V. Platelet-rich plasma injections for chronic plantar fasciitis. *Int Orthop*. 2013;37(5):839-842. doi:10.1007/s00264-012-1741-0
19. Mcewen J. The Nottingham Health Profil. Quality of life assessment: key issues in the 1990s. 1993;111-130. doi:10.1007/978-94-011-2988-6_5
20. Dizon JN, Gonzalez-Suarez C, Zamora MT, Gambito ED. Effectiveness of extracorporeal shock wave therapy in chronic plantar fasciitis: a meta-analysis. *Am J Phys Med Rehabil*. 2013;92(7):606-620. doi:10.1097/PHM.0b013e31828cd42b
21. Tung WS, Daher M, Covarrubias O, Herber A, Gianakos AL. Extracorporeal shock wave therapy shows comparative results with other modalities for the management of plantar fasciitis: a systematic review and meta-analysis. *Foot Ankle Surg*. 2025;31(4):283-290. doi:10.1016/j.fas.2024.11.005
22. Li H, Lv H, Lin T. Comparison of efficacy of eight treatments for plantar fasciitis: a network meta-analysis. *J Cell Physiol*. 2018;234(1):860-870. doi:10.1002/jcp.26907
23. Morral A, Urrútia G, Gich I, Ruiz R, Bonfill X. Radial extracorporeal shock wave device appearance does not influence clinical outcomes: a randomized controlled trial. *J Rehabil Med*. 2019;51(3):201-208. doi:10.2340/16501977-2516
24. Rompe JD, Schoellner C, Nafe B. Evaluation of low-energy extracorporeal shock-wave application for treatment of chronic plantar fasciitis. *J Bone Joint Surg Am*. 2002;84(3):335-341. doi:10.2106/00004623-200203000-00001
25. Vahdatpour B, Mokhtarian A, Raeissadat SA, Dehghan F, Nasr N, Mazaheri M. Enhancement of the effectiveness of extracorporeal shock wave therapy with topical corticosteroid in treatment of chronic plantar fasciitis: a randomized control clinical trial. *Adv Biomed Res*. 2018;7:62. doi:10.4103/abr.abr_40_17
26. Bicer M, Hocaoglu E, Aksoy S, İnci E, Aktaş İ. Assessment of the efficacy of extracorporeal shockwave therapy for plantar fasciitis with magnetic resonance ımaging findings. *J Am Podiatr Med Assoc*. 2018;108(2):100-105. doi:10.7547/15-106
27. Harutaichun P, Boonyong S, Pensri P. Differences in lower-extremity kinematics between the male military personnel with and without plantar fasciitis. *Phys Ther Sport*. 2021;50:130-137. doi:10.1016/j.ptsp.2021.04.007
28. Siriphorn A, Eksakulkla S. Calf stretching and plantar fascia-specific stretching for plantar fasciitis: a systematic review and meta-analysis. *J Bodyw Mov Ther*. 2020;24(4):222-232. doi:10.1016/j.jbmt.2020.06.013
29. Güzel Ş, Şenlikçi HB, Bal HS, Haberal B. Comparison of plantar pressure distribution and ultrasonographic and clinical features after application of different energy levels of extracorporeal shockwave therapy in patients with plantar fasciitis: a randomized, prospective, double-blind clinical trial. *J Am Podiatr Med Assoc*. 2024;114(2):22-047. doi:10.7547/22-047
30. Melese H, Alamer A, Getie K, Nigussie F, Ayhualem S. Extracorporeal shock wave therapy on pain and foot functions in subjects with chronic plantar fasciitis: systematic review of randomized controlled trials. *Disabil Rehabil*. 2022;44(18):5007-5014. doi:10.1080/09638288.2021.1928775
31. Gerdesmeyer L, Frey C, Vester J, et al. Radial extracorporeal shock wave therapy is safe and effective in the treatment of chronic recalcitrant plantar fasciitis: results of a confirmatory randomized placebo-controlled multicenter study. *Am J Sports Med*. 2008;36(11):2100-2109. doi:10.1177/0363546508324176
32. Lee SJ, Kang JH, Kim JY, Kim JH, Yoon SR, Jung KI. Dose-related effect of extracorporeal shock wave therapy for plantar fasciitis. *Ann Rehabil Med*. 2013;37(3):379-388. doi:10.5535/arm.2013.37.3.379
33. Ibrahim MI, Donatelli RA, Hellman M, Hussein AZ, Furia JP, Schmitz C. Long-term results of radial extracorporeal shock wave treatment for chronic plantar fasciopathy: a prospective, randomized, placebo-controlled trial with two years follow-up. *J Orthop Res*. 2017;35(7):1532-1538. doi:10.1002/jor.23403

34. Gezginaslan Ö, Başar G. Comparison of effectiveness of density and number of sessions of extracorporeal shock wave therapy in plantar fasciitis patients: a double-blind, randomized-controlled study. *J Foot Ankle Surg.* 2021;60(2):262-268. doi:10.1053/j.jfas.2020.08.001

35. Wheeler PC, Tattersall C. Extracorporeal shockwave therapy plus rehabilitation for patients with chronic plantar fasciitis might reduce pain and ımprove function but still not lead to ıncreased activity: a case-series study with multiple outcome measures. *J Foot Ankle Surg.* 2018;57(2):339-345. doi:10.1053/j.jfas.2017.07.001

36. Rompe JD, Decking J, Schoellner C, Nafe B. Shock wave application for chronic plantar fasciitis in running athletes. A prospective, randomized, placebo-controlled trial. *Am J Sports Med*. 2003;31(2):268-275. doi:10.1177/03635465030310021901

Journal of Orthopedics Research and Rehabilitation

Original Article

DOI: 10.51271/JORR-0064

Investigation of the effect of fibromyalgia frequency on quality of life, daily living activities, disease perception, and clinical parameters in patients with chronic kidney failure undergoing dialysis treatment

Hakkı Öztürk[1], Zekiye Nur Öztürk[2], Artuner Varlıbaş[2], Zafer Ceyhan[3], Turgut Kültür*[4], Aydın Çifci[2]

[1]Infectious Diseases Epidemiologist, Private Ankara Dialysis Center, Ankara, Turkiye
[2]Department of Internal Medicine, Faculty of Medicine, Kırıkkale University, Kırıkkale, Turkiye
[3]Deprtment of Physical Medicine and Rehabilitation, Samsun Physical Medicine and Rehabilitation Hospital, Samsun, Turkiye
[4]Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Kırıkkale University, Kırıkkale, Turkiye

Cite this article as: Öztürk H, Öztürk ZN, Varlıbaş A, Ceyhan Z, Kültür T, Çifci A. Investigation of the effect of fibromyalgia frequency on quality of life, daily living activities, disease perception, and clinical parameters in patients with chronic kidney failure undergoing dialysis treatment. *J Orthop Res Rehabil.* 2026;4(1):16-21.

Received: 02.01.2026 ◆ **Accepted**: 30.01.2026 ◆ **Published**: 31.01.2026

ABSTRACT

Aims: Fibromyalgia syndrome (FMS) may be under-recognized in hemodialysis populations, where chronic inflammation, musculoskeletal complaints, and reduced health-related quality of life (HRQoL) frequently overlap. This study evaluated the prevalence of FMS in hemodialysis and examined its associations with pain, activities of daily living, HRQoL, and routine dialysis/laboratory parameters.

Methods: In this cross-sectional study, 127 adults were analyzed: 69 patients receiving maintenance hemodialysis (dialysis group) and 58 non-dialysis patients with FMS diagnosed using the ACR 2011 criteria and the 2016 revision (FMS group). Within the dialysis cohort, participants were stratified as FMS(+) (n=38) and FMS(–) (n=31). Pain intensity was assessed using a 0–10 Visual Analog Scale (VAS), functional independence with Katz Activities of Daily Living (ADL), and HRQoL with SF-36 (domain scores and summary measures). Dialysis/laboratory variables included pre- and post-dialysis blood urea nitrogen (BUN), Kt/V, parathyroid hormone (PTH), sodium (Na), and calcium (Ca). The primary outcome was SF-36 Role LimitationsEmotional. Multivariable logistic regression (dialysis cohort) and ROC analyses were performed to evaluate predictors of FMS.

Results: The prevalence of FMS within the hemodialysis cohort was 55.1% (38/69). Between-group comparisons (dialysis vs FMS) showed higher BMI in the FMS group (28.7±4.8 vs 25.3±5.7; p<0.001), while VAS pain and Katz ADL scores were similar. SF-36 summary scores were higher in the FMS group (PCS, p=0.039; MCS, p=0.008; Total, p=0.012). At the domain level, General Health (45.1±16.1 vs 38.6±13.5; p=0.015) and Role Limitations–Emotional (62.0±40.2 vs 28.5±38.4; p<0.001) were higher in the FMS group. Within the dialysis cohort, Role Limitations–Emotional remained higher in FMS(+) patients (36.8±39.3 vs 18.2±35.3; p=0.024), and post-dialysis BUN was higher in FMS(+) patients (27.5±13.4 vs 19.8±4.3; p=0.008). In multivariable analysis, only post-dialysis BUN was independently associated with FMS (OR=1.10; 95% CI 1.02–1.19; p=0.012). Discrimination was moderate for post-dialysis BUN alone (AUC=0.684) and improved slightly with the multivariable model (AUC=0.726).

Conclusion: FMS was common among hemodialysis patients and was associated with differences in emotional role functioning and higher post-dialysis BUN. These findings support a multidimensional approach to screening in dialysis care that integrates symptom-based FMS assessment with HRQoL profiling and selected biochemical signals.

Keywords: Fibromyalgia, hemodialysis, chronic kidney disease, SF-36, activities of daily living, quality of life

INTRODUCTION

FMS is a chronic condition characterized by widespread pain, fatigue, sleep disturbances, and cognitive dysfunction; it is more common in women and significantly reduces quality of life. It can occur alone or in conjunction with other pain syndromes and neuropsychiatric disorders.[1] In pathophysiology, a bidirectional interaction between the nervous and immune systems is prominent; neuroinflammation is characterized by microglial activation and the release of proinflammatory mediators. These mediators engage with nociceptors and neurons, enhancing

***Corresponding Author:** Turgut Kültür, kurgut@hotmail.com

This work is licensed under a Creative Commons Attribution 4.0 International License.

excitability and substantially augmenting pain processing pathways.[2]

The prevalence of FMS in the general population is reported to be between 0.5% and 6%; environmental, psychological, and genetic determinants are considered to contribute.[3] Chronic kidney disease (CKD) is closely associated with musculoskeletal disorders, and approximately two-thirds of hemodialysis patients develop musculoskeletal problems. The frequency of rheumatic findings increases with dialysis duration; therefore, the differential diagnosis of fibromyalgia should be carefully considered in this population. Current studies have yielded conflicting results regarding the prevalence of FMS in patients undergoing hemodialysis and peritoneal dialysis: some reports are similar to those in the general population, while others report higher frequencies.[4] FMS in peritoneal dialysis and kidney transplant patients may have similar prevalence rates to healthy individuals; the presence of FMS has been shown to be associated with more pronounced impairment in depressive symptoms, anxiety, and HRQoL in CKD.[5]

FMS diagnosis is challenging in hemodialysis patients; FMS should be considered if high inflammation parameters are present alongside widespread musculoskeletal pain. FMS pain often worsens with movement, reduces physical activity, and limits sun exposure, which increases the risk of osteoporosis and complicates the diagnosis and treatment of both bone mineral disorders and FMS.[6] Inflammatory biomarkers-neutrophil/lymphocyte ratio (NLR), platelet/lymphocyte ratio (PLR), mean platelet volume (MPV), red blood cell distribution width (RDW), C-reactive protein (CRP), monocyte/lymphocyte ratio (MLR), CRP/albumin ratio, and lymphocyte/CRP ratio-have been investigated in the context of CKD and FMS.[7] Hemodialysis patients are known to be in a chronic inflammatory state; approximately half of patients with a GFR of 15-60 mL/min may have CRP>2.1 mg/dl. The uremic environment, decreased clearance, increased proinflammatory cytokines, oxidative stress, and acidosis, as well as acute/chronic stressors specific to the dialysis process, infection dynamics, dialysis water purity, and membrane compatibility, contribute to inflammation. Current evidence suggests that inflammation may be more pronounced in the FMS group undergoing hemodialysis.[8]

End-stage renal disease (ESRD) and dialysis care reduce HRQoL in physical, emotional, and social domains. The specific impact of FMS on HRQoL, activities of daily living, and routine clinical parameters in dialysis cohorts has not yet been comprehensively defined.[9] The heterogeneity in the literature regarding FMS prevalence and clinical/laboratory correlates may be attributed to differences in diagnostic criteria, sampling frameworks, and outcome selection.[10-11]

Therefore, studies evaluating rehabilitation-focused robust data on functionality (e.g., Katz Activities of Daily Living), HRQoL profiles (e.g., SF-36 components), and routine dialysis indicators (e.g., pre/post-dialysis BUN, Kt/V) together are needed. The current study aims to determine the prevalence of FMS in dialysis and to evaluate the relationships between FMS and pain intensity, Katz ADL, and SF-36 HRQoL, as well as laboratory and dialysis parameters. The hypothesis of this study is that the presence of FMS in hemodialysis patients negatively affects HRQoL and has a distinctive profile associated with certain clinical-laboratory variables. The findings are intended to provide a basis for targeted assessment and rehabilitation approaches in dialysis follow-up.

METHODS

Ethics

The study was approved by the Ethics Committee of Kırıkkale University Faculty of Medicine (Date: 10.06.2021, Decision No: 2019.06.30). Informed consent was obtained from all participants. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

A total of 127 adult participants were included in this study. The sample consisted of two groups: (i) 69 patients undergoing hemodialysis due to chronic renal failure (dialysis group) and (ii) 58 patients diagnosed with FMS according to the 2011 criteria and 2016 revision of the American College of Rheumatology (ACR) 2011 criteria and 2016 revision and who were not receiving dialysis treatment (FMS group).

Inclusion criteria were being 18 years of age or older, meeting the relevant group's diagnostic/treatment criteria (being monitored in a hemodialysis program or having a diagnosis of FMS according to the 2016 revision of the ACR 2011 criteria), and providing written informed consent. Active infection, malignancy, advanced cognitive impairment, or severe psychiatric illness; concomitant rheumatologic disease (e.g., active inflammatory arthritis) or acute exacerbation; and lack of baseline data/scale scores required for the primary outcome analysis were defined as exclusion criteria.

Comparisons were planned on two axes. On the first axis, the dialysis group and the FMS group were compared as two independent cohorts. On the second axis, the dialysis cohort was analyzed by dividing it into FMS(+) (n=38) and FMS(–) (n=31) subgroups based on the presence of FMS according to the ACR 2011/2016 criteria.

The FMS diagnosis was evaluated according to the ACR 2011 criteria and the 2016 revision (Widespread Pain Index [WPI] and Symptom Severity Scale [SSS]). Pain intensity was measured on a 0–10 range using the Visual Analog Scale (VAS). Daily living activities were assessed using the Katz ADL (0-18); a higher score indicates greater independence, and the Turkish validity and reliability of the scale have been published. HRQoL was measured using the SF-36 (8 domains; 0–100; higher scores indicate better quality of life); additionally, the Physical Component Summary (PCS), Mental Component Summary (MCS), and the sum of the 8 domains were reported as the "Total" score. Demographic and sociodemographic data (age, gender, marital status, education, employment, smoking, etc.) were recorded. Body mass index (BMI, kg/m^2) was calculated as an anthropometric measurement. In the dialysis group, routine laboratory/dialysis parameters (pre- and post-dialysis BUN, Kt/V, parathyroid hormone [PTH], sodium [Na], and calcium [Ca]) and dialysis-related clinical information were also evaluated.

The primary outcome was defined as the SF-36 "Role Emotional" domain score, focusing on rehabilitation-related emotional functioning. Secondary endpoints included SF-36

General Health, PCS, MCS, and Total scores; VAS, Katz GYA, and BMI; as well as dialysis/laboratory indicators (pre- and post-dialysis BUN, Kt/V, PTH, Na, and Ca).

Statistical analyses were performed using IBM SPSS 21.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as mean±SD or median (interquartile range) according to distribution; categorical variables were summarized as n (%). Normality was assessed using Shapiro–Wilk tests. For comparisons between the two groups, the independent samples t-test or Mann–Whitney U test was used for continuous variables, depending on the distribution; the chi-square test or Fisher's exact test, when appropriate, was used for categorical variables. To evaluate factors associated with FMS within the dialysis cohort, a multivariate logistic regression model was constructed with the dependent variable "FMS present/absent," and BUN output, PTH, Na, Ca, and Kt/V were included in the model; results were reported as odds ratio (OR), 95% confidence interval, and p-value. Discriminative performance in predicting FMS was evaluated using ROC analysis; threshold/classification criteria were reported based on AUC and the Youden index for univariate BUN output and multivariate models. For missing data, the complete data (listwise) approach was applied in primary/secondary analyses, and the two-tailed significance level was set at α=0.05.

RESULTS

Participants

A total of 127 participants were analyzed: 69 patients on hemodialysis and 58 fibromyalgia (FMS) patients not on dialysis; within the dialysis cohort, they were classified as FMS(+) n=38 and FMS(–) n=31 according to the ACR 2011/2016 criteria (Table 1).

Table 1. Baseline characteristics of dialysis and fibromyalgia groups (concise)

Characteristic	Dialysis (n=69)	Fibromyalgia (n=58)	p-value
Age, years (mean ± SD)	56.1±12.6	55.5±9.1	0.76
Female, n (%)	25 (36.2)	21 (36.2)	1.00
Married, n (%)	54 (78.3)	56 (96.6)	0.006
Education, n (%)			
≤Primary	50 (72.4)	15 (25.9)	
Secondary (middle)	11 (15.9)	15 (25.9)	
≥High school	8 (11.7)	28 (48.3)	<0.001 (overall)
Employed, n (%)	5 (7.2)	31 (53.4)	<0.001
Current smoker, n (%)	23 (33.3)	10 (17.2)	0.06
BMI, kg/m² (mean±SD)	25.3±5.7	28.7±4.8	<0.001
VAS pain (0–10)	5.54±2.49	6.02±1.67	0.33
Katz ADL (0–18)	16.7±2.9	16.9±1.9	0.14
SF-36 PCS (0-400)	159.8±79.3	176.1±60.0	0.039
SF-36 MCS (0-400)	186.8±75.8	219.8±72.6	0.008

Values are mean±SD or n (%). p-values from independent t-test or Mann-Whitney U test (continuous) and χ^2/Fisher's exact test (categorical), as appropriate. Education compared across three categories (overall p). PCS/MCS are SF-36 component summaries (higher=better). BMI: Body mass index, VAS: Visual Analog Scale, ADL: Activities of Daily Living, PCS: Physical Component Summary, MCS: Mental Component Summary

Comparison of Dialysis and FMS Groups

Age was similar (56.1±12.6 vs. 55.5±9.1; p=0.76), and gender distribution was equal; the proportion of married individuals was higher in the FMS group (96.6% vs. 78.3%; p=0.006) (Table 1).

BMI was higher in the FMS group (28.7±4.8 vs. 25.3±5.7; p<0.001); VAS (6.02±1.67 vs. 5.54±2.49; p=0.33) and Katz GYA (16.9 ± 1.9 vs. 16.7 ± 2.9; p=0.14) did not differ (Table 1).

In the SF-36 summaries, PCS (176.1±60.0 vs. 159.8±79.3; p=0.039), MCS (219.8±72.6 vs. 186.8±75.8; p=0.008), and Total (396.0±113.0 vs. 346.6±145.3; p=0.012) were higher in the FMS group (Table 1).

By domain, General Health (45.1±16.1 vs 38.6±13.5; p=0.015) and Role Limitations–Emotional (62.0±40.2 vs 28.5±38.4; p<0.001) favored FMS; there were no significant differences in other domains (Table 2).

Table 2. Health-related quality of life (sf-36) domain scores by group

SF-36 domain (0-100;higher=better)	Dialysis (n=69), mean±SD	Fibromyalgia (n=58), mean±SD	p-value (Mann-whitney U)
Physical functioning	42.8±29.3	52.4±21.5	0.061
Role physical	20.6±35.3	25.0±32.4	0.138
Bodily pain	57.6±19.7	53.6±15.1	0.332
General health	38.6±13.5	45.1±16.1	0.015
Vitality	44.8±18.2	43.4±17.2	0.658
Social functioning	54.1±24.6	59.0±21.6	0.227
Role emotional	28.5±38.4	62.0±40.2	<0.001
Mental health	59.3±17.7	55.3±12.5	0.182
SF-36 total (0–800)	346.6±145.3	396.0±113.0	0.012

Values are mean±SD. Higher scores indicate better health status. p-values from Mann-Whitney U test. To avoid redundancy with Table 1, VAS, Katz ADL, BMI, and SF-36 component summaries (PCS/MCS) are reported in Table 1. SD: Standard deviation

Within the dialysis cohort, FMS(+) and FMS(–) VAS (5.7±2.3 vs. 5.3±2.6; p=0.614) and Katz GYA (16.7±2.9 vs. 16.8±3.0; p=0.870) were similar; Role Limitations-Emotional was higher in the FMS(+) group (36.8±39.3 vs. 18.2±35.3; p=0.024), and the total score difference was not statistically significant (359.5±150.5 vs. 330.7±139.4; p=0.527) (Table 3).

Laboratory/dialysis indicators showed that BUN-output was higher in the FMS(+) group (27.5±13.4 vs 19.8±4.3; p=0.008); there were no differences in BUN-in (p=0.126), Kt/V (p=0.921), PTH, Na, and Ca (Table 3).

Multivariate Analysis

In the logistic regression model established for the dialysis cohort (dependent variable: presence/absence of FMS), BUN output, PTH, Na, Ca, and Kt/V were included in the model together; only BUN output was independently associated with FMS (OR=1.10; 95% CI 1.02-1.19; p=0.012) (Table 4).

ROC Analysis

AUC=0.684 was calculated for the univariate BUN-output model and AUC=0.726 for the multivariate model in predicting FMS; comparative curves were presented, and sensitivity/specificity values based on the Youden index for BUN-output were reported (Figure).

This study reveals the pattern of FMS comorbidity in dialysis patients on clinical and patient-centered outcomes using a comparative and multivariate approach. In between-group

Table 3. Dialysis cohort stratified by fibromyalgia (FMS): clinical outcomes and key laboratory indices

Outcome	Dialysis+FMS (n=38), mean±SD	Dialysis without FMS (n=31), mean±SD	Mean diff.	Test	p-value
VAS pain (0–10)	5.7±2.3	5.3±2.6	+0.4	MWU	0.614
Katz ADL (0–18)	16.7±2.9	16.8±3.0	-0.1	MWU	0.870
SF-36 role emotional (0-100)	36.8±39.3	18.2±35.3	+18.6	MWU	0.024
SF-36 total (0–800)	359.5±150.5	330.7±139.4	+28.8	MWU	0.527
BMI (kg/m²)	25.2±6.1	25.4±5.1	-0.2	MWU	0.495
BUN pre-dialysis (mg/dl)	75.1±19.9	69.1±11.7	+6.0	t-test	0.126
BUN post-dialysis (mg/dl)	27.5±13.4	19.8±4.3	+7.7	MWU	0.008
Kt/V	1.30±0.34	1.34±0.33	-0.04	MWU	0.921

Values are mean±SD. Mean diff.=(FMS+)-(FMS–). MWU: Mann-Whitney U. Higher scores indicate better status for SF-36 scales. To minimize redundancy, additional domains and labs are provided in Supplementary Table S1. FMS: Fibromyalgia syndrome, VAS: Visual Analog Scale, ADL: Activities of Daily Living, BMI: Body mass index, BUN: Blood urea nitrogen

Table 4. Multivariable logistic regression within dialysis cohort (outcome: FMS)

Predictor	OR (95% CI)	p-value
BUN post-dialysis	1.10 (1.02-1.19)	0.012
PTH	1.00 (1.00-1.00)	0.162
NA	0.99 (0.94-1.03)	0.589
CA	1.02 (0.56-1.84)	0.954
KT_V	0.64 (0.12-3.44)	0.604

Multivariable logistic regression within dialysis cohort (outcome: FMS). Predictors entered: BUN post-dialysis (mg/dl), PTH (pg/ml), Sodium (mmol/L), Calcium (mg/dl), Kt/V. Results reported as odds ratios (OR) with 95% confidence intervals and p-values. FMS: Fibromyalgia syndrome, BUN: Blood urea nitrogen, PTH: parathyroid hormone, Na: Sodium, CA: Calcium

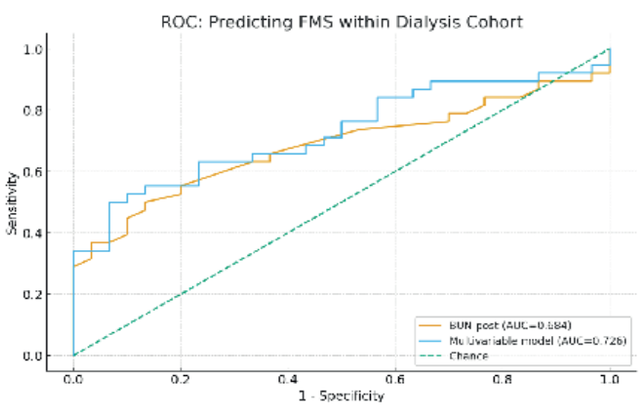


Figure. ROC curves predicting fms within the dialysis cohort

Univariate BUN post-dialysis vs multivariable model (BUN-post, PTH, Na, Ca, Kt/V). AUC values are shown in the legend of the plot.

analyses, BMI was found to be higher in FMS patients; SF-36 summary scores (PCS, MCS) and total score favored FMS; and at the domain level, general health and role limitations–emotional dimensions were found to be particularly higher (**Table 1, Table 2**). When looking at the dialysis cohort itself, the Role Limitations–Emotional score was higher in the FMS(+) subgroup; among laboratory indicators, the BUN-output level was significantly higher in FMS(+) cases (**Table 3**).

Multivariate modeling revealed that BUN output in dialysis patients showed an independent relationship with FMS (OR≈1.10). This finding strengthens hypotheses suggesting that the FMS phenotype may be associated with persistent post-dialysis urea/solute load, metabolic stress, or inflammation/catabolism. However, indicators such as PTH, Na, Ca, and Kt/V did not show an independent relationship; this situation is shown in **Table 4**.

In the discriminatory performance analysis, BUN-output alone presented a moderate AUC, while the AUC of the multivariate model including BUN-output+PTH/Na/Ca/Kt/V was relatively higher. This table suggests that, in clinical practice, a multidimensional assessment (biochemistry+clinical/functional measurements) approach may be more rational than screening with a single biomarker (**Figure**).

Two implications of the findings stand out in terms of rehabilitation. First, in dialysis patients, FMS screening (symptom inquiry, WPI/SSS-based assessment) should be considered together with HRQoL profiling (especially emotional role functioning). Second, in cases where elevated BUN output is detected, the presence of accompanying FMS should be considered, and a multidisciplinary approach (nephrology–physical therapy/rehabilitation–psychosocial support–pain management) can be planned, thus enabling more selective application of targeted exercise prescriptions, behavioral strategies, and pharmacological interventions if necessary (**Table 3 ,Table 4 and Figure**).

The findings of this study suggest that FMS may constitute a significant comorbidity in the dialysis population, affecting not only "increased pain" but also emotional role functioning and overall health perception. Furthermore, the presence of biological burden (BUN-output) associated with post-dialysis urea clearance in this phenotype may add a perspective that incorporates a metabolic/solute kinetics component to the biopsychosocial framework of FMS (**Table 2, Table 4**).

DISCUSSION

Our study found that the presence of fibromyalgia was associated with higher scores on the primary outcome measure, SF-36 "Role Limitations-Emotional," both when comparing the two independent groups and within the dialysis cohort alone. Although this finding may initially appear to contradict the expectation of "decreased emotional and social functioning" in the fibromyalgia literature, it presents a meaningful picture when sample characteristics and contextual factors are considered: Higher rates of employment/marriage in the fibromyalgia group, the absence of multiple biological stressors associated with chronic kidney failure and hemodialysis, and similar levels of pain intensity between groups may explain the relative preservation of emotional role functioning. In short, the emotional role domain here may reflect a relative advantage compared to the global burdens of dialysis (fatigue, treatment regimen, comorbidities, time constraints) rather than a "fibromyalgia-specific limitation."

Second, the absence of significant differences in pain (VAS) and functional independence (Katz GYA) measures suggests that the divergence in emotional role scores cannot be explained solely by pain intensity. This situation implies that cognitive-emotional processes shaping the pain experience in fibromyalgia (coping styles, expectations, self-efficacy, social support) and the "treatment-imposed lifestyle" in dialysis may produce different effects on emotional functioning.[12] In other words, while the total pain burden appears similar in both conditions, its reflection on role performance may be context-sensitive.

In a multivariate analysis within the dialysis cohort, post-dialysis BUN level showed an independent association with fibromyalgia. The lack of significance for Kt/V, PTH, sodium, and calcium suggests that classic "dialysis adequacy" parameters are not independently associated; however, the post-session residual solute load (or the metabolic/catabolic processes representing it) may be more closely associated with the fibromyalgia phenotype.[13] This relationship raises several possible mechanisms: (i) the effects of residual uremic toxins on central sensitivity and sleep ecology, (ii) inflammation-related neuromodulatory responses, and (iii) indirect effects on affect and role performance via post-session fatigue/exhaustion.[14] In the discriminant performance analysis, the fact that BUN-output alone showed moderate discriminant power, while the multivariate model showed slightly higher discriminant power, suggests that it is more realistic to consider biological and psychosocial signals together rather than a single biomarker in clinical practice.

Indicators such as PTH, Na, Ca, and Kt/V did not show an independent relationship; this is not surprising given the biopsychosocial nature of FMS and its relationship with pain neuromodulation processes.[15] CKD-MBD variables (PTH, Ca) may relate more to bone pain, cramps, or neuropathic phenotypes than to an FMS-defined central sensitivity syndrome; null findings here may reflect limited power, treatment effects (e.g., phosphate binders/vitamin D), or the need for more granular pain phenotyping (neuropathic vs nociplastic).[16,17]

The pattern obtained conveys three messages for rehabilitation practices: First, when screening for fibromyalgia in dialysis patients, the systematic assessment of emotional role functioning is as important as pain intensity; this domain may differ from expectations and alter intervention targets.[18] Second, monitoring post-session metabolic load (e.g., BUN-output trend) may provide clinicians with additional warning regarding fibromyalgia risk or severity; it is not diagnostic on its own but may trigger a multi-faceted assessment.[19,20] Third, comprehensive protocols (individualized exercise, sleep hygiene, behavioral strategies, pain education, and pharmacotherapy when indicated) for planned interventions should be designed in sync with dialysis session timing and fatigue patterns.[21]

The findings reframe the heterogeneous reports in the literature: HRQoL losses attributed to fibromyalgia can be broken down into different components in the dialysis context; the expected "decrease" in the emotional role domain may not always be observed.[22] This can be explained by sample selection (type of clinical referral, being under active treatment/supervision), sociodemographic profile, and level of social support. Additionally, differences in cultural factors and the sustainability of work/family roles may particularly affect emotional role scores.[23] Cross-cultural measurement studies also suggest that the SF-36 Role Emotional domain may behave differently across regions, partly because some respondents are less inclined to attribute role limitations to emotional states, which can shift observed scores independent of symptom severity.[24] In addition, international dialysis cohort data and qualitative research describe systematic cross-national differences and "response shift" phenomena in HRQoL appraisal, indicating that emotional role scores may be shaped by cultural norms and adaptation processes beyond biomedical determinants.[25,26]

Conceptually, fibromyalgia is a prototypical nociplastic pain condition, and dialysis-related pain often reflects a mixture of nociceptive, neuropathic, and nociplastic mechanisms. Recognizing and phenotyping this mix may improve rehabilitation targeting (exercise, sleep, psychological strategies) and reduce over-reliance on analgesics in a population where medication harm is a real constraint.

Limitations include the cross-sectional design (no causal interpretation possible), single-center sample (limited generalizability), failure to model all psychosocial co-determinants (mediators/confounders such as anxiety, depression, and sleep disorders), and the nature of self-report scales. Multiple field tests may increase the risk of type I error; however, the primary endpoint was predefined, and the results were interpreted within a hypothesis-generating framework. Strengths include the two-axis comparison design (independent cohort+dialysis subgroups), the joint reporting of biological and psychosocial measures, and the support of findings by multivariate/discriminant analyses.

In conclusion, this study suggests that fibromyalgia may affect emotional role functioning in a "different than expected" way in the dialysis context and that post-dialysis solute load may be associated with the fibromyalgia phenotype. In clinical practice, screening and intervention plans should be designed to be sensitive not only to pain intensity but also to emotional role performance and post-session biological load. Furthermore, prospective, multicenter studies should be conducted to elucidate metabolic-neuromodulatory interactions.

Limitations

The cross-sectional nature of the design limits causal inferences; the direction/intermediate mechanisms of the FMS and BUN-output relationship should be investigated in prospective studies. The single-center sample and sample size (particularly degrees of freedom in multivariate models) may limit generalizability. Psychosocial variables (anxiety, depression, and sleep quality) were not included in the model; these may play mediating/confounding roles. Finally, there is a risk of type-I error in the multiple comparisons of SF-36 domains; however, the primary outcome of the study was pre-specified, and findings are presented in a hypothesis-testing manner (**Table 1, Table 4**).

Strengths include the fact that FMS was addressed in the dialysis context with both HRQoL and clinical and laboratory indicators and structured tables; furthermore, a predictive framework for clinical applicability was presented using

logistic regression and ROC analyses. This approach may help rationalize screening/monitoring strategies in the field (**Table 3, Table 4 and Figure**).

CONCLUSION

The independent relationship between BUN-output and FMS in the dialysis cohort indicates the intersection of biological burden and pain/emotional functioning in rehabilitation-focused care. In clinical practice, considering post-dialysis solute load alongside FMS screening and HRQoL profiling may facilitate targeted interventions. Prospective and multicenter studies are needed to elucidate the causal pathways, metabolic and neuromodulatory mechanisms, and intervention response of these findings (**Table 4 and Figure**).

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was approved by the Ethics Committee of Kırıkkale University Faculty of Medicine (Date: 10.06.2021, Decision No: 2019.06.30).

Informed Consent

Written informed consent was obtained from all individual participants prior to their inclusion in the study. Participants were fully informed about the study's aims, procedures, potential risks and benefits, and their rights-including the right to withdraw at any time without consequence. All participants voluntarily signed a written informed consent form.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

Author Contributions

Concept: T.K., A.Ç.; Design: T.K., A.Ç., H.Ö.; Control: T.K., A.V., A.Ç.; Data collection and/or processing: T.K., Z.C., H.Ö., A.,Ç.,; Analysis and/or interpretation: T.K., A.V., Z.N.Ö., Z.C.; Literature review: T.K., Z.C., A.V., A.Ç.; Article writing: T.K., A.V., Z.N.Ö., Z.C., A.Ç.; Critical review: All authors.

REFERENCES

1. Clauw DJ. Fibromyalgia: a clinical review. *JAMA*. 2014;311(15):1547-1555. doi:10.1001/jama.2014.3266
2. Findeisen K, Guymer E, Littlejohn G. Neuroinflammatory and immunological aspects of fibromyalgia. *Brain Sci*. 2025;15(2):206. doi: 10.3390/brainsci15020206
3. Queiroz LP. Worldwide epidemiology of fibromyalgia. *Curr Pain Headache Rep*. 2013;17(8):356. doi:10.1007/s11916-013-0356-5
4. Troutman AD, Arroyo E, Lim K, Moorthi RN, Avin KG. Skeletal muscle complications in chronic kidney disease. *Curr Osteoporos Rep*. 2022;20(6):410-421. doi:10.1007/s11914-022-00751-w
5. Çağlıyan Türk A, Özkurt S, Doğan İ, Şahin F. Fibromyalgia syndrome and related factors in hemodialysis, peritoneal dialysis, and renal transplant patients: a cross-sectional study. *Arch Rheumatol*. 2021;37(1): 67-76. doi:10.46497/ArchRheumatol.2022.8227
6. Kidney Disease: Improving Global Outcomes (KDIGO) CKD-MBD Update Work Group. KDIGO 2017 Clinical Practice Guideline Update for the Diagnosis, Evaluation, Prevention, and Treatment of Chronic Kidney Disease-Mineral and Bone Disorder (CKD-MBD). *Kidney Int Suppl (2011)*. 2017;7(1):1-59. doi:10.1016/j.kisu.2017.04.001
7. Kocyigit I, Eroglu E, Unal A, et al. Role of neutrophil/lymphocyte ratio in prediction of disease progression in patients with stage-4 chronic kidney disease. *J Nephrol*. 2013;26(2):358-365. doi:10.5301/jn.5000152
8. Wang Y, Gao L. Inflammation and cardiovascular disease associated with hemodialysis for end-stage renal disease. *Front Pharmacol*. 2022; 13:800950. doi:10.3389/fphar.2022.800950
9. Feroze U, Noori N, Kovesdy CP, et al. Quality-of-life and mortality in hemodialysis patients: roles of race and nutritional status. *Clin J Am Soc Nephrol*. 2011;6(5):1100-1111. doi:10.2215/CJN.07690910
10. Arnold LM, Bennett RM, Crofford LJ, et al. AAPT diagnostic criteria for fibromyalgia. *J Pain*. 2019;20(6):611-628. doi:10.1016/j.jpain.2018.10.008
11. Galvez-Sánchez CM, Reyes Del Paso GA. Diagnostic criteria for fibromyalgia: critical review and future perspectives. *J Clin Med*. 2020;9 (4):1219. doi:10.3390/jcm9041219
12. Häuser W, Bernardy K, Arnold B, Offenbächer M, Schiltenwolf M. Efficacy of multicomponent treatment in fibromyalgia syndrome: a meta-analysis of randomized controlled clinical trials. *Arthritis Rheum*. 2009;61(2):216-224. doi:10.1002/art.24276
13. National Kidney Foundation. KDOQI clinical practice guideline for hemodialysis adequacy: 2015 update. *Am J Kidney Dis*. 2015;66(5):884-9 30. doi:10.1053/j.ajkd.2015.07.015
14. Vanholder R, Pletinck A, Schepers E, Glorieux G. Biochemical and clinical impact of organic uremic retention solutes: a comprehensive update. *Toxins (Basel)*. 2018;10(1):33. doi:10.3390/toxins10010033
15. Magagnoli L, Cozzolino M, Evans M, et al. Association between chronic kidney disease-mineral and bone disorder biomarkers and symptom burden in older patients with advanced chronic kidney disease: results from the EQUAL study. *Clin J Am Soc Nephrol*. 2024;19(10):1240-1252. doi:10.215/CJN.0000000000000510
16. Bouchachi FZ, Al Wachami N, Iderdar Y, Arraji M, Elgot A, Chahboune M. Bio-sociological and clinical factors of chronic pain and pain interference in patients undergoing hemodialysis: a cross-sectional study. *BMC Nephrol*. 2025;26(1):83. doi:10.1186/s12882-025-03987-7
17. Ji RR, Nackley A, Huh Y, Terrando N, Maixner W. Neuroinflammation and central sensitization in chronic and widespread pain. *Anesthesiology*. 2018;129(2):343-366. doi:10.1097/ALN.0000000000002130
18. Pagels AA, Söderkvist BK, Medin C, Hylander B, Heiwe S. Health-related quality of life in different stages of chronic kidney disease and at initiation of dialysis treatment. *Health Qual Life Outcomes*. 2012;10:71. doi:10.1186/1477-7525-10-71
19. Kalantar-Zadeh K, Ikizler TA, Block G, Avram MM, Kopple JD. Malnutrition-inflammation complex syndrome in dialysis patients: causes and consequences. *Am J Kidney Dis*. 2003;42(5):864-881. doi:10. 1016/j.ajkd.2003.07.016
20. Şirali, SK, Büberci R. The relationship between fibromyalgia syndrome and inflammation parameters in hemodialysis patients. *Eur Res J*. 2024; 1-8. doi:10.18621/eurj.1361155
21. Bossola M, Di Stasio E, Marzetti E, De Lorenzis K, Pepe G, Vulpio C. Fatigue is associated with high prevalence and severity of physical and emotional symptoms in patients on chronic hemodialysis. *Int Urol Nephrol*. 2018;50(7):1341-1346. doi:10.1007/s11255-018-1875-0
22. Çağlıyan Türk A, Özkurt S, Doğan İ, Şahin F. Fibromyalgia syndrome and related factors in hemodialysis, peritoneal dialysis, and renal transplant patients: a cross-sectional study. *Arch Rheumatol*. 2021;37(1): 67-76. doi:10.46497/ArchRheumatol.2022.8227
23. Macfarlane GJ, Kronisch C, Dean LE, et al. EULAR revised recommendations for the management of fibromyalgia. *Ann Rheum Dis*. 2017;76(2):318-328. doi:10.1136/annrheumdis-2016-209724
24. Tseng HM, Lu JF, Gandek B. Cultural issues in using the SF-36 Health Survey in Asia: results from Taiwan. *Health Qual Life Outcomes*. 2003;1: 72. doi:10.1186/1477-7525-1-72
25. Fukuhara S, Lopes AA, Bragg-Gresham JL, et al. Health-related quality of life among dialysis patients on three continents: the dialysis outcomes and practice patterns study. *Kidney Int*. 2003;64(5):1903-1910. doi:10.1046/j.1523-1755.2003.00289.x
26. Elliott BA, Gessert CE, Larson PM, Russ TE. Shifting responses in quality of life: people living with dialysis. *Qual Life Res*. 2014;23(5):1497-1504. doi:10.1007/s11136-013-0600-9

Journal of Orthopedics Research and Rehabilitation

Case Report

DOI: 10.51271/JORR-0065

Bilateral femoral avascular necrosis in a 28-year-old male: a case report

Zachary Taylor

Department of Physical Medicine and Rehabilitation, Mission Community Hospital, California, USA

Cite this article as: Taylor Z. Bilateral femoral avascular necrosis in a 28-year-old male: a case report. *J Orthop Res Rehabil.* 2026;4(1):22-24.

Received: 19.09.2025 ◆ **Accepted**: 27.01.2026 ◆ **Published**: 31.01.2026

ABSTRACT

This case report discusses bilateral avascular necrosis, or osteonecrosis, of the femoral head in a 28-year-old male lacking associated risk factors. This condition is marked by insufficient blood supply to the femoral head, which can lead to joint collapse, necessitating total hip arthroplasty (THA), as in our patient. Our case presents a challenging diagnosis, emphasizing the need for comprehensive understanding of the presence, or absence, of risk factors, and the role of early detection in optimal patient outcomes. Treatment options range from conservative modalities to surgical interventions, with THA as a definitive solution. We also consider potential complications of treatments, particularly the unique challenges brought on by THA performed in younger patients.

Keywords: Avascular necrosis, total hip arthoplasty, orthopedic surgery, avascular necrosis of the femoral head

INTRODUCTION

Osteonecrosis of the femoral head (ONFH) occurs due to inadequate blood supply to the femoral head, leading to osteocyte death. This process can result in the collapse of the femoral head and progressive deterioration of the joint, making ONFH a prevalent cause of hip arthroplasty in young patients.[1] About 10% of all total hip arthroplasties (THAs) in the United States are associated with this diagnosis. The incidence of ONFH in the United States is between 20.000 to 30.000 new cases annually, primarily affecting men between 30 and 50 years old.[2,3] Bilateral presentations are not uncommon, with a higher prevalence in males, as the contralateral hip may be involved in approximately 55% of patients within 2 years.[4] Many of these patients present with groin pain that radiates to the knee, restricted range of motion, pain with abduction and internal rotation, and tenderness to palpation of the hip.

The causes of ONFH and the pathophysiological mechanisms behind them are frequent subjects of ongoing research. ONFH etiologies are classified as traumatic or non-traumatic. Traumatic etiologies include fractures and dislocations of the hip, causing an interruption in femoral head blood supply. On the other hand, non-traumatic cases are often associated with corticosteroid use, alcoholism, HIV, sickle cell disease and Gaucher's disease, where impairment of vascular supply occurs in the absence of trauma.[1,5] This paper highlights a unique case involving bilateral, non-traumatic ONFH (NONFH) in a patient who lacks the associated risk factors.

CASE

A 28-year-old male presented to the emergency department for persistent left hip pain that left him unable to ambulate without crutches. Computed tomography (CT) of the pelvis taken at the time showed signs of bilateral ONFH that was much worse on the left, including femoral head collapse and subchondral bone flattening (**Figure 1**). The patient was referred for MRI and an orthopedic surgeon consultation for further evaluation.

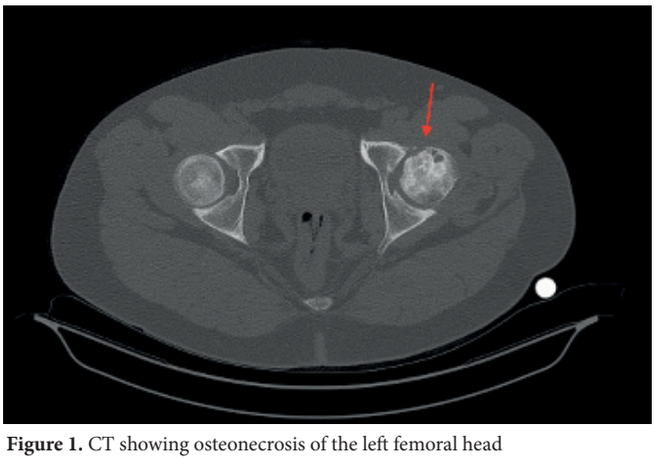


Figure 1. CT showing osteonecrosis of the left femoral head

One month later, he presented to the orthopedic surgeon complaining of bilateral hip pain, with worse pain in the left hip. The patient's MRI showed bilateral ONFH that was worse

***Corresponding Author:** Zachary Taylor, taylor.zachary182@gmail.com

This work is licensed under a Creative Commons Attribution 4.0 International License.

in the left hip. The patient believed the pain was related to a soccer injury 3 years prior, but it never required a hospital visit. His pain progressively worsened for 2-3 years since onset, culminating in his inability to walk without crutches. The patient's past medical history included iron deficiency anemia and hypothyroidism, for which he was taking iron supplements and levothyroxine, respectively. He was slightly overweight and had no history of prolonged corticosteroid use or any additional systemic conditions. The patient stated that he consumed alcohol occasionally and denied smoking tobacco but did admit to smoking marijuana occasionally. On physical examination, the patient had a significantly antalgic gait while walking without crutches. The anterior left hip was tender to palpation and had. restricted internal rotation. Both Stinchfield and log roll tests were positive for both hips, and the left hip was found to be impinged. The right hip was not nearly as symptomatic and showed no signs of impingement or restricted range of motion. Distal neurovascular exam revealed intact sensation and reflexes bilaterally.

After discussion with the orthopedic surgeon, the patient agreed to undergo an anterior approach total hip arthroplasty (THA) of the left hip. Two months after orthopedic surgery consultation, he underwent a successful THA and did not experience any intraoperative or postoperative complications (**Figure 2**).

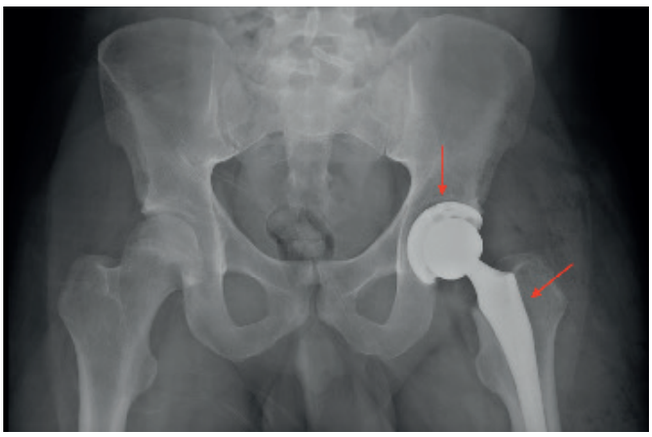


Figure 2. Total left hip arthroplasty in anatomic alignment

The patient was seen for a postoperative follow-up visit 2 weeks after surgery and is progressing well in his recovery. He reports diminished left hip pain and improved range of motion. He was advised by the orthopedic surgeon to return for evaluation if he develops worsening symptoms in his right leg.

All authors declare that informed consent was obtained from the patient for publication of this case report and accompanying images.

DISCUSSION

The occurrence of bilateral NONFH in a patient without associated risk factors is a rare and intriguing clinical presentation. While the exact etiology remains unclear, genetic predisposition, vascular factors, and undiagnosed systemic conditions should be considered in the evaluation of such cases.

Due to its prevalence and potential complications, ONFH poses a significant clinical challenge. Reports indicate between 300.000 and 600.000 people in the United States experience this condition, with varying rates worldwide, making it a substantial public health concern.[6] Idiopathic cases of ONFH, occurring without identifiable risk factors such as the case discussed above, present a challenge in diagnosis and understanding. The etiology and pathogenesis behind NONFH are not entirely clear, potentially involving multifactorial origins or genetic predisposition.[3,7] One primary risk factor for identified NONFH cases is prolonged corticosteroid use. However, the spectrum of other factors contributing to the development of disease is not entirely clear. Various guidelines and publications highlight the importance of early diagnosis and effective treatment, emphasizing the need for a comprehensive understanding of prevalence and incidence to improve patient outcomes.[7]

Early detection of ONFH is crucial as the disease, if left untreated, often leads to joint collapse, affecting younger, active individuals between 20 and 40 years old.2 Diagnosing this condition involves a combination of X-rays, CT scans, MRI, and scintigraphy. Confirmatory diagnosis of ONFH involves initial X-rays or CT followed by MRI, which is considered the most accurate benchmark.[8] Once diagnosis is confirmed, the various treatments for ONFH focus on delaying disease progression, relieving symptoms, and preventing collapse of the femoral head, aiming to preserve joint function and avoid total hip replacement if possible.

Conservative treatment might be effective in early-stage NONFH, improving pain and functional outcomes. These treatments include physical activity modification, medication, hyperbaric oxygen treatment, and electrical stimulation. However, these options are limited in halting disease progression, helping patients achieve full recovery, and their long-term effectiveness.[2,5]

Nonconservative interventions offer a spectrum of options for different stages of ONFH. The effectiveness of these procedures is mainly dependent on the stage of the disease. Current surgical interventions for ONFH range from prevalent core decompression for symptomatic pre-collapse stages to total hip replacement in post-collapse stages. Joint-preserving surgeries such as core decompression, corrective osteotomy, and joint resection have shown promise in the early stages of ONFH, but require further research on their long-term effectiveness. Additional treatments include vascularized and non-vascularized bone grafts, hemi-arthroplasty, osteotomy, and arthrodesis. Advanced cases require THA, as it is considered a definitive treatment.[2,7]

A study of the long-term effectiveness of THA has shown excellent outcomes for up to 10 years in patients younger than 30 years old. However, all patients in the study required a revision at some point after surgery due to aseptic loosening.[9] Younger patients who undergo THA, as in the above case, have been shown to experience higher rates of revision than older patients.[10] The underlying factors contributing to this observable difference include higher activity level and a higher proportion of younger candidates with inflammatory arthritis and congenital hip disease.[11,12] Our patient, a 28-year-old, will require thorough follow-up to ensure appropriate survival course of the implants and determine the necessity of revision.

While many effective treatment options exist for patients with ONFH, it is still important to consider the diverse complications associated with the management of this condition. Surgical interventions especially pose inherent risks. Complications can include infection, implant loosening, blood clots, nerve or blood vessel damage, and improper wound healing.[5,13]

Early detection of ONFH is crucial for initiating effective treatments and preserving joint function, thereby preventing further joint damage. Early identification also allows for a thorough evaluation for the presence or lack of risk factors, aiding in the implementation of appropriate interventions. Prompt intervention prevents further hip joint deterioration and lessens the necessity for invasive treatments such as joint replacements.[7] This early detection and intervention could also enhance treatment responses by minimizing pain and preserving hip function, subsequently giving patients a better quality of life.[5] Given the benefits of early detection, it is imperative for clinicians to maintain a heightened level of suspicion in cases where symptoms persist without apparent risk factors, as this leads to timely detection and treatment.[7]

CONCLUSION

Our young patient with bilateral NONFH and no identifiable risk factors provides a unique clinical scenario. With complex etiological origins and substantial incidence rates, this condition is a significant health concern not only in the U.S., but worldwide. Treatment options range from conservative measures to more invasive, surgical interventions, with THA as a definitive solution for advanced cases like ours. Although effective, THA in younger patients may require thorough long-term follow-up to assess for revisions or impaired implant survival. The case underscores the importance of early detection and suspicion as both are paramount for prompt treatment, joint preservation and maintaining quality of life.

ETHICAL DECLARATIONS

Informed Consent

Written informed consent was obtained from the patient(s) included in this report. Signed consent forms are retained by the authors and are available upon request.

Peer Review Process

This report underwent external peer review.

Conflict of Interest

The author declare no conflicts of interest.

Financial Disclosure

This case report did not receive any financial support.

Author Contributions

The author is solely responsible for the conception, data collection, analysis, and writing of this manuscript.

REFERENCES

1. Swarup I, Lee YY, Movilla P, et al. Common factors associated with osteonecrosis of the femoral head in young patients requiring total hip arthroplasty. *Hip Int*. 2015;25(3):232-236. doi:10.5301/hipint.5000225
2. Moya-Angeler J, Gianakos AL, Villa JC, et al. Current concepts on osteonecrosis of the femoral head. *World J Orthop*. 2015;6(8):590-601. doi:10.5312/wjo.v6.i8.590
3. Mankin HJ. Nontraumatic necrosis of bone (osteonecrosis). *N Engl J Med*. 1992;326(22):1473-1479. doi:10.1056/NEJM199205283262206
4. Assouline-Dayan Y, Chang C, Greenspan A, Shoenfeld Y, Gershwin ME. Pathogenesis and natural history of osteonecrosis. *Semin Arthritis Rheum*. 2002;32(2):94-124.
5. Tripathy SK, Goyal T, Sen RK. Management of femoral head osteonecrosis: current concepts. *Indian J Orthop*. 2015;49(1):28-45. doi: 10.4103/0019-5413.143911
6. Aldridge JM 3rd, Urbaniak JR. Avascular necrosis of the femoral head: etiology, pathophysiology, classification, and current treatment guidelines. *Am J Orthop (Belle Mead NJ)*. 2004;33(7):327-332.
7. Arbab D, König DP. Atraumatic femoral head necrosis in adults. *Dtsch Arztebl Int*. 2016;113(3):31-38. doi:10.3238/arztebl.2016.0031
8. Grimm J, Hopf C, Higer HP. Die Femurkopfnekrose. Diagnostik und morphologische analyse mittels röntgen, szintigraphie, computertomographie und magnetresonanztomographie [femur head necrosis. diagnosis and morphologic analysis using roentgen, scintigraphy, computerized tomography and magnetic resonance tomography]. *Z Orthop Ihre Grenzgeb*. 1989;127(6):680-690. doi:10.105 5/s-2008-1040312
9. Pakos EE, Paschos NK, Xenakis TA. Long term outcomes of total hip arthroplasty in young patients under 30. *Arch Bone Jt Surg*. 2014;2(3):15 7-162.
10. Dorr LD, Kane III TJ, Conaty JP. Long-term results of cemented total hip arthroplasty in patients 45 years old or younger. A 16-year follow-up study. *J Arthroplasty*. 1994;9(5):453-456. doi:10.1016/0883-5403 (94)90090-6
11. Clohisy JC, Oryhon JM, Seyler TM, et al. Function and fixation of total hip arthroplasty in patients 25 years of age or younger. *Clin Orthop Relat Res*. 2010;468(12):3207-3213. doi:10.10 07/s11999-010-1468-4
12. Learmonth ID, Heywood AW, Kaye J, Dall D. Radiological loosening after cemented hip replacement for juvenile chronic arthritis. *J Bone Joint Surg Br*. 1989;71(2):209-212. doi:10.1302/0301-620X.71B2.2925736
13. Hwang SK. Experience of Complications of Hip Arthroplasty. *Hip Pelvis*. 2014;26(4):207-13. doi:10.5371/hp.2014.26.4.207. doi:10.5371/hp. 2014.26.4.207

Journal of Orthopedics Research and Rehabilitation

Case Report

DOI: 10.51271/JORR-0066

A rare case of lipoma in the big toe: a case report

Erkan Kıyak, Ozan Pehlivan, Furkan Soy*

Deparment of Orthopedics and Traumatology, Faculty of Medicine, Kırıkkale University, Kırıkkale, Turkiye

Cite this article as: Kıyak E, Pehlivan O, Soy F. A rare case of lipoma in the big toe: a case report. *J Orthop Res Rehabil.* 2026;4(1):25-27.

Received: 01.01.2026 • **Accepted**: 27.01.2026 • **Published**: 31.01.2026

ABSTRACT

Lipomas are the most common benign mesenchymal tumors; however, they are rarely encountered in the foot, particularly in the toes. This case report presents a lipoma located at the base of the right great toe, which progressively enlarged and caused difficulty in wearing shoes. A 57-year-old female patient presented with a painful subcutaneous mass that had been present for 16 months and had shown rapid growth during the last 3 months. Clinical examination and magnetic resonance imaging findings were consistent with a lipoma. Marginal surgical excision was performed, and histopathological evaluation confirmed the diagnosis of a benign lipoma. The postoperative course was uneventful, and no recurrence was observed during the 6-month follow-up period. Although rare, lipomas should be considered in the differential diagnosis of subcutaneous masses of the foot, and surgical excision with histopathological examination is essential for definitive diagnosis and treatment.

Keywords: Toe lipoma, foot lipoma, benign tumor

INTRODUCTION

Lipomas are benign tumors composed of mature fat cells.[1] These tumors represent by a far the most common mesenchymal neoplasm. They account for approximately 50% of all soft tissue masses and approximately 4% of all benign tumors.1 The subcutaneous form of lipomas alone accounts for one-quarter to one-half of all soft tissue tumors.[2]

Lipomas are commonly found in areas with abundant fatty tissue, such as the body, chest, upper extremities and shoulders.[3] However, the feet, lower extremities and especially the toes are uncommon sites for lipomas.[3] Digital (finger) lipoma cases are quite rare in the literature and therefore attract attention.[4] Lipomas typically become apparent between the fourth and seventh decades of life (ages 40-70).[5]

Although the etiology of lipomas remains unclear, they can rarely undergo malignant transformation into liposarcoma.[6] A post-traumatic lipoma may be a pseudolipoma resulting from herniation of adipose tissue.

CASE REPORT

A 57-year-old female patient presented to our clinic with a mass on her right big toe that she had noticed approximately 16 months ago but which had progressively grown over the last 3 months, accompanied by increasing pain. The pain was characterized by increasing intensity, especially when standing and wearing shoes. The patient stated that she couldn't wear shoes anymore because the mass had grown.

Physical examination revealed a mass measuring approximately 4 cm x 4 cm extending from the base of the right big toe to the first interdigital space (**Figure 1**). On palpation, the mass was painless, spherical, and soft in consistency. During the examination, clinical findings characteristic of subcutaneous lipomas were present, such as slipping sign and positive transillumination when pressure was applied to the edge of the mass. The patient's neurovascular examination was normal, and no enlargement of the inguinal lymph nodes was detected.

Figure 1. Appearance of the mass on the patient's right foot, first toe, from the dorsal and plantar angles

Magnetic Resonance Imaging (MRI) was requested to determine the relationship between the mass and the metatarsophalangeal joint. MRI reported a mass measuring approximately 36x12 mm at its widest point on the dorsal

***Corresponding Author:** Furkan Soy, dr.furkansoy@gmail.com

This work is licensed under a Creative Commons Attribution 4.0 International License.

aspect of the first metatarsophalangeal joint, appearing T1 hyperintense and suppressed in fat-suppressed sequences, which could be a lipoma. The MR image of the mass, which was preliminarily diagnosed as a lipoma, is shown in Figure 2.

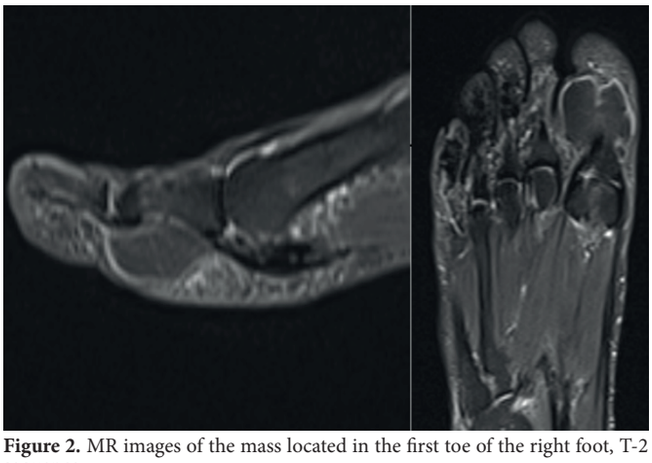


Figure 2. MR images of the mass located in the first toe of the right foot, T-2 sequence

As surgical treatment for the patient, marginal local excision was performed after spinal anesthesia and tourniquet application. The excised mass was approximately 3.5 x 3.5 cm in size (Figure 3). The mass was encapsulated and soft, with no invasion into surrounding tissues (skin, fascia, tendon sheath, and bone). The skin was sutured with 2/0 Prolene (Figure 4). Histopathological examination revealed mature fat cells, confirming the diagnosis of benign lipoma. The postoperative period was uneventful. The patient has been followed up for 6 months without recurrence.

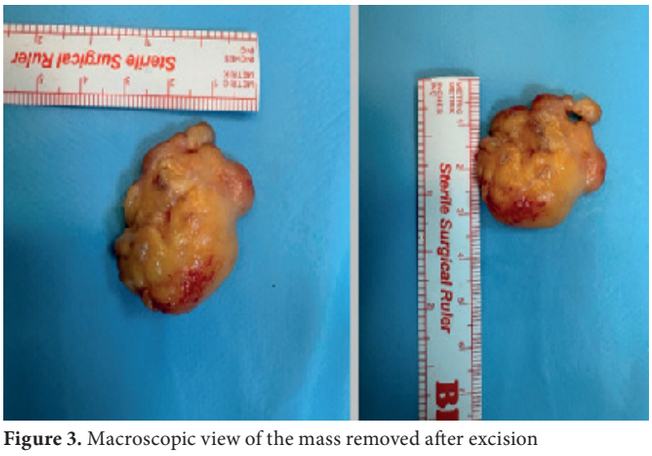


Figure 3. Macroscopic view of the mass removed after excision

DISCUSSION

The thumb is an area where subcutaneous tissue is more difficult to feel, both because of the less surrounding fatty tissue and because of the keratinized skin tissue. Although lipomas are common in the adult population, the big toe (first toe) is a very rare site.[4] The literature reports cases of lipomas in different areas of the foot, such as the plantar heel, dorsal foot, and second, fourth, and fifth metatarsal regions.[4,7]

There are reports of giant lipomas in the toes. For example, a rapidly expanding giant lipoma completely enveloping the third toe and the space between the third toes, reaching 10 cm in diameter, was reported in a 56-year-old man.[3] Additionally,

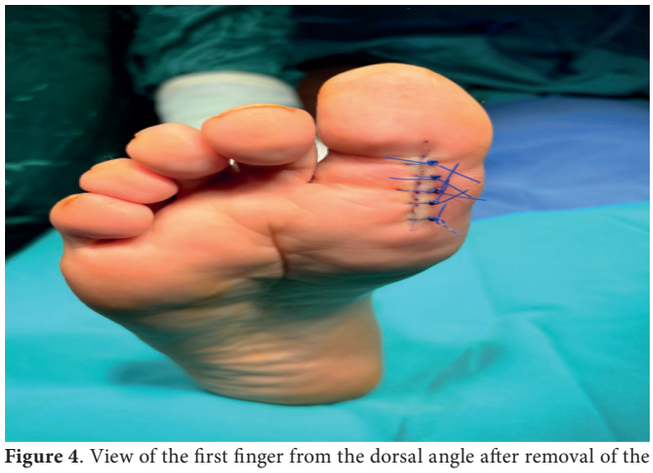


Figure 4. View of the first finger from the dorsal angle after removal of the mass

a mass reaching 13 cm in circumference on the right big toe and enlarging the toe approximately tenfold was reported in a 35-year-old woman.[7] These large masses can cause difficulties in walking and wearing shoes. Our case also highlights the importance of this rare location, as the mass was located at the base of the thumb, preventing the patient from wearing shoes.

CONCLUSION

This case report presents a rare case of lipoma located on the base of the big toe, presenting with positive slippage sign and transillumination findings, making shoe wearing difficult, and showing no recurrence after successful surgical excision and 6-month follow-up. Lipomas, although rare, should always be considered in the differential diagnosis of subcutaneous masses in the foot. The importance of differentiation from other benign soft tissue masses lies in the fact that large and deeply located lipomas carry a high risk of malignant transformation. Furthermore, early diagnosis is crucial, as surgical excision and pathological examination are necessary for definitive diagnosis.

ETHICAL DECLARATIONS

Informed Consent

Written informed consent was obtained from the patient(s) included in this report. Signed consent forms are retained by the authors and are available upon request.

Peer Review Process

This report underwent external peer review.

Conflict of Interest

The authors declare no conflicts of interest.

Financial Disclosure

This case report did not receive any financial support.

Author Contributions

Author Contributions Concept: F.S., O.P., E.K.; Design: O.P., E.K.; Control: F.S.; Data collection and/or processing: O.P., E.K.; Analysis and/or ınterpretation: F.S., O.P.; Literature review: F.S., O.P., E.K.; Article writing: F.S., O.P., E.K.; Critical review: F.S., O.P., E.K.

REFERENCES

1. Aust MC, Spies M, Kall S, et al. Lipomas after blunt soft tissue trauma: are they real? Analysis of 31 cases. *Br J Dermatol*. 2007;157(1):92-99. doi: 10.1111/j.1365-2133.2007.07970.x
2. Phalen GS, Kendrick JI, Rodriguez JM. Lipomas of the upper extremity. A series of fifteen tumors in the hand and wrist and six tumors causing nerve compression. *Am J Surg*. 1971;121(3):298-306. doi:10.1016/0002-9610(71)90208-x
3. Azam A, Rajagopalan S, Niezywinski WA. A rapidly expanding massive lipoma of the toe. *J Foot Ankle Surg*. 2007;46(6):499-501. doi:10.1053/j.jfas.2007.06.001
4. Ozdemir A, Ozden NS, Aydinli Y, Kaya B. A rare tumor of the toes: lipoma. *Turk J Plast Surg* 2020;28:130-1. doi:10.4103/tjps.tjps11_19
5. Copeland CL, Kanat IO. A large lipoma involving the foot. *J Foot Ankle Surg*. 1991;30(6):571-573.
6. Johnson CN, Ha AS, Chen E, Davidson D. Lipomatous soft-tissue tumors. *J Am Acad Orthop Surg*. 2018;26(22):779-788. doi:10.5435/JAAOS-D-17-00045
7. Olaoye IO, Adesina MD. Solitary massive lipoma in the planter aspect of great toe presenting as two masses. *SAGE Open Med Case Rep*. 2017;5:2050313X17730265. doi:10.1177/2050313X17730265