



DOI: 10.4274/gulhane.galenos.2025.27122
Gulhane Med J 2026;68(1):54-58

Evaluation of the efficacy of reirradiation therapy in patients with refractory bilateral heel spur

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Cite this article as: Beyzadeoğlu MM, Uysal B, Dinçoğlu F, Sağer Ö, Demiral S, Gamsız H, et al. Evaluation of the efficacy of reirradiation therapy in patients with refractory bilateral heel spur. *Gulhane Med J*.

Date submitted:

24.06.2025

Date accepted:

25.12.2025

Publication Date:

18.03.2026

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Keywords: Calcaneal spur, heel spur, plantar fasciitis, reirradiation, recurrent pain management

ABSTRACT

Aims: Calcaneal spurs and plantar fasciitis cause intractable plantar pain amenable to radiation therapy (RT). However, because of individual variations in neural capillaries within the spurs, reirradiation may be needed to relieve recurrent pain from irradiated heel spurs and thereby achieve a better quality of life. The aim of this study is to document the benefit of reirradiation for recurrent heel spur pain.

Methods: This single-center retrospective study included patients who underwent reirradiation between November 2016 and December 2024 for recurrent calcaneal spur pain after the first radiotherapy course. Patient inclusion criteria included a previous history of irradiation with recurrent pain; patients younger than 35 years or weighing more than 120 kg were excluded. A total RT dose of 8 Gy was delivered over 2 consecutive days. Treatment response was assessed at the eighth week after completion of reirradiation. The primary endpoint was pain relief for recurrent calcaneal spur, assessed using the Numeric Rating Scale pain intensity score at 6 months post-irradiation.

Results: A total of 103 patients with calcaneal spur who were irradiated for recurrent pain were included in the study. The ages of the study group ranged from 36 to 77 years with a median age of 52 years (range 36-77, interquartile range: 14) and male to female ratio was 1:4. Most patients with a spur size of 6 mm or greater required reirradiation for recurrent pain. Reirradiation resulted in a complete response in 58 patients (56%), a partial response in 31 patients (30%), and no response in 14 patients (14%); no radiation-related adverse effects were observed.

Conclusions: Reirradiation for recurrent calcaneal spur pain is an effective treatment option to relieve pain in selected patients where other treatment options do not work.

Introduction

Painful benign lesions have been intensively treated with low-dose radiotherapy since the 1950s. A better understanding of the mechanism of low-dose radiotherapy has been facilitated by advances in radiobiology related to radiotherapy. Currently, low-dose radiotherapy applied to benign target tissues in the

management of refractory pain produces an effective anti-inflammatory response (1).

The German surgeon Plettner first described the calcaneal spur in 1900 as an abnormal plantar bony formation that can be visualized radiologically on the medial surface of the calcaneus. Chronic microtrauma and damage caused by pressure from



the spur on the sural and posterior tibial nerves induce pain (2). Its incidence varies between 8% and 88% in the general population (3,4). Obesity, female gender, and advanced age are major risk factors associated with increased incidence (5). Its typical symptom is a localized stinging pain in the heel region, increasing in intensity, especially in the morning when walking or standing. Although it is often asymptomatic, surgical treatment is occasionally used in cases of severe pain that do not respond to physiotherapy, steroid injections, or radiotherapy. Laser, ultrasound, and microwave treatments are alternative methods (6).

Reirradiation of heel spurs may be necessary when the capillaries supplying the sural and posterior tibial nerves are not adequately damaged during the initial irradiation to achieve complete neural blockade and pain relief. In this study, we aimed to document the benefit of reirradiation for recurrent heel spur pain.

Methods

Study design, participants and ethics

This single-center retrospective study included patients who underwent reirradiation between November 2016 and December 2024 for recurrent calcaneal spur pain after completion of the first radiotherapy course. Patients with a previous history of irradiation who developed recurrent pain and had at least 6 months of follow-up after the initial treatment were included. Patients younger than 35 years or weighing more than 120 kg were excluded.

The study was conducted in accordance with the Declaration of Helsinki, the World Medical Association's Code of Ethics, and the Uniform Requirements for Manuscripts Submitted to Biomedical Journals. The study was approved by the University of Health Sciences Türkiye Institutional Ethics Committee (decision no.: 2025-409, dated: 19.08.2025). All patients were provided with detailed treatment information, and informed consent was obtained from all patients.

Data collection

Among 1949 patients who underwent reirradiation for recurrent heel spur pain during the study period, 103 met the eligibility criteria and were included in the analysis. Recorded variables included, age, gender, the time between two radiotherapy treatments, pre- and post-treatment Numeric Rating Scale (NRS) scores for pain, and spur size. The distribution of patients by heel spur size is shown in Figure 1.

Radiotherapy protocol

Based on two-dimensional (2D) simulation, both calcaneal spurs were included in the treatment field and 8 Gy was delivered in two consecutive daily fractions via anteroposterior and posteroanterior portals using a Co-60 unit (Theratronics-Theratron 780-E serial nr: 672-1, Co-60 Teletherapy Machine).

A pre-treatment radiograph of a patient diagnosed with a heel spur who received radiotherapy is shown in Figure 2. Figure 3 shows a 2D simulation image on the 2D simulator scopy screen in which the treatment portal covers bilateral heel spurs. Treatment response was assessed at the eighth week after completion of reirradiation.

Outcome assessment

NRS scores were recorded by questioning patients before reirradiation treatment and at two and six months after treatment, using a pain intensity scale ranging from 0 to 10. The primary endpoint was pain relief at 6 months following reirradiation.

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences for Windows, version 20 (IBM Corp., Armonk, NY, USA). Pre- and post-treatment 6-month NRS scores were compared using the non-parametric Wilcoxon signed-rank test. Multivariate logistic regression analysis was performed to determine independent predictors of a complete pain response

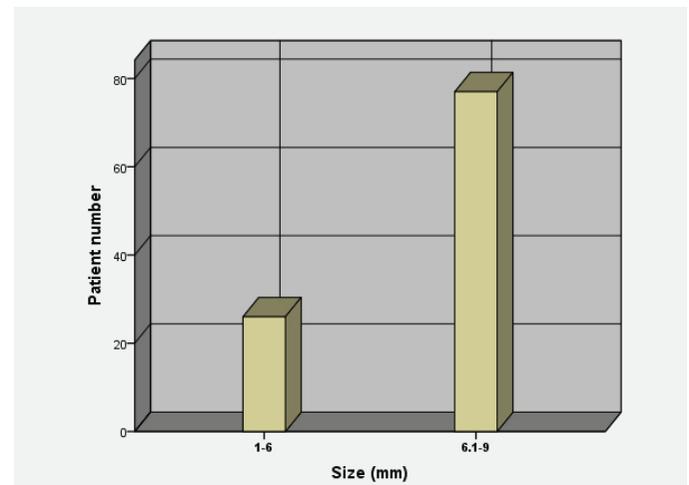


Figure 1. Distribution of patients by heel spur size



Figure 2. Plantar heel spur of a patient shown on radiograph

at 6 months. Variables with $p < 0.05$ in univariate analyses were included in the model. Odds ratios (OR) and 95% confidence intervals (CI) were calculated. Correlations between pre-treatment NRS scores, heel spur size, and pain duration were assessed using Spearman's correlation test. A chi-square test was used to evaluate the association of heel spur size, pre-treatment pain intensity, and pain duration with response rate. A two-sided p -value less than 0.05 was considered statistically significant.

Results

A total of 1949 patients were treated with radiotherapy for a heel spur between 2016 and 2024; 103 of these patients (5.2%) required reirradiation for recurrence.

The median follow-up of the 103 recurrent patients was 24 months (range, 6-99 months). Of the 103 patients, 83 (80.6%) were female and 20 (19.4%) were male, with a F/M ratio of 4.2:1. Median age was 52 years (range, 36-77 years). Other details about patient characteristics are shown in Table 1. Adequate pain relief was achieved in 89 patients (86.4%). The median NRS score decreased from 6 (range 3-9) before reirradiation to 4 (range 2-7) at 2 months post-treatment and to 2 (range 1-5) at 6 months post-treatment. Changes in NRS scores before and after the second RT are shown in Figure 4.

A statistically significant difference in pain relief was observed between pre-reirradiation and 6-month post-treatment pain levels ($Z = -8.854$, $p < 0.001$). No statistically significant correlation was observed between heel spur size and pre-treatment pain intensity ($p > 0.05$). By contrast, analysis of response rates revealed a statistically significant association between pre-reirradiation pain intensity and complete response [$\chi^2(2) = 10.692$, $p = 0.005$] (Table 2). The results show that patients with mild to moderate pain before reirradiation had a higher rate of complete pain relief compared with patients with severe

pain (66.7% vs. 41.9%), and patients before reirradiation had a higher "no response" rate than those with mild to moderate pain (25.6% vs. 5.0%). Additionally, variables that were significant in the univariate analysis [pre-treatment pain intensity and pain recurrence interval from first radiotherapy (RT)] were entered into the multivariate logistic regression model, which showed that both pre-treatment pain intensity (OR=0.35, 95% CI: 0.15-0.80, $p = 0.013$) and pain recurrence interval from first RT (OR=0.31, 95% CI: 0.13-0.77, $p = 0.011$) were independent predictors of complete response (Figure 5). Patients with severe pre-treatment pain and those with a recurrence interval longer than 24 months were significantly less likely to achieve a complete response. No patient-reported acute or late toxicities were recorded in the patient files according to the Common Terminology Criteria for Adverse Events v5.0 toxicity assessment method.

Table 1. Characteristics of the reirradiated patients

Characteristics	Category	n (%)
Sex	Female	83 (80.6)
	Male	20 (19.4)
Age, years	≤50	45 (43.7)
	>50	58 (56.3)
	Median (range)	52 (36-77)
Pain duration before 2 nd RT, months	≤12	69 (67.0)
	>12	34 (33.0)
Relapse duration, months	≤12	43 (41.7)
	>12	60 (58.3)
Spur size, millimeters	≤6	26 (25.2)
	>6	77 (74.8)

RT: Radiation therapy

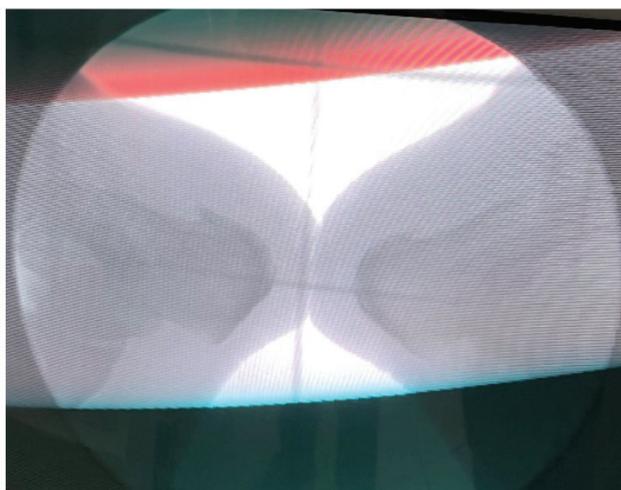


Figure 3. 2D simulation image showing treatment portal covering bilateral heel spur on 2D Simulator Scopy Screen
2D: Two-dimensional

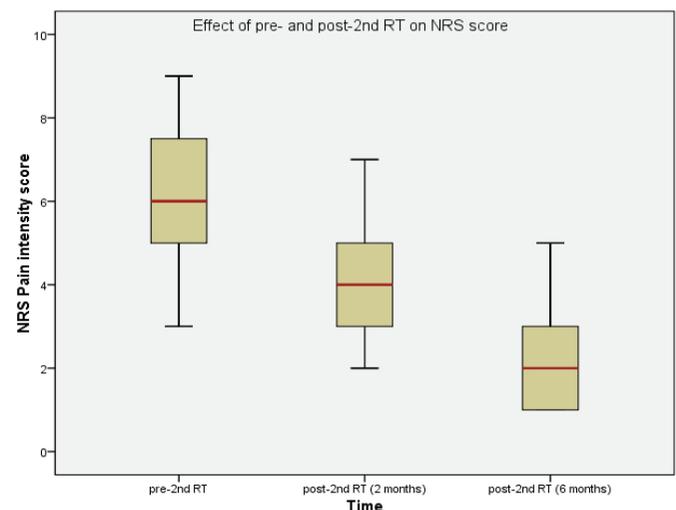
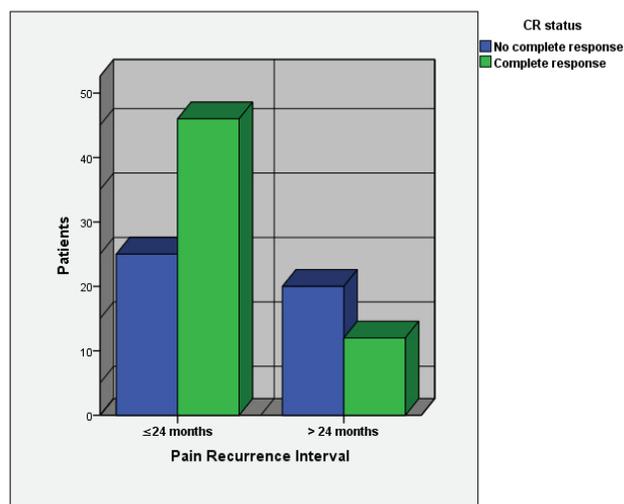


Figure 4. Comparison of NRS scores before and after the second radiotherapy
RT: Radiation therapy, NRS: Numeric Rating Scale

Table 2. Association between pre-2nd RT pain intensity and response to treatment

Response rate	Mild-moderate pain (n=60)	Severe pain (n=43)	p-value	Total (n=103)
Complete response, n (%)	40 (66.7)	18 (41.9)	0.005	58 (56.3)
Partial response, n (%)	17 (28.3)	14 (32.6)	0.645	31 (30.1)
No response, n (%)	3 (5.0)	11 (25.6)	0.07	14 (13.6)

RT: Radiation therapy

**Figure 5.** Distribution of complete response by pain recurrence interval
CR: Complete response

Discussion

Reirradiation for recurrent calcaneal spur pain demonstrated favorable clinical outcomes in this study. More than half of the patients achieved complete response, with additional patients experiencing partial improvement, and no radiation-related adverse effects were observed. The need for reirradiation was more common in patients with spur size ≥ 6 mm, suggesting a possible association between larger spur size and recurrent symptoms.

Non-malignant diseases do not always exhibit clinically benign features and may cause dysfunction and significant symptoms. The initial use of ionizing radiation for non-malignant diseases dates back centuries and was directed at traditional benign lesions amenable to radiotherapy, which were classified as hyperproliferative, degenerative, inflammatory, and functional. However, acute and late effects of radiotherapy have changed treatment concepts and indications. Achieving lasting pain relief and improved quality of life may justify the use of low-dose ionizing radiation for analgesic and anti-inflammatory effects. RT is a non-invasive option for patients with painful calcaneal spurs. Although the mechanism of pain relief after radiotherapy is not yet clearly defined, it has been suggested that radiation may exert analgesic effects through damage to small nerve endings or capillaries, thereby reducing nociceptive signaling. However,

this explanation is not yet fully supported by experimental data (7). Sural and posterior tibial blockade achieved by radiation-induced occlusion of nourishing capillaries may result in partial or complete pain relief.

Numerous studies support the efficacy of low-dose irradiation in relieving pain from calcaneal spurs. In the study by Heyd et al. (7) evaluating two groups that received total doses of 3 Gy and 6 Gy, the pain response rate exceeded 80%, and there was no statistically significant difference in analgesic effect between the dose groups at the 6-month follow-up. In the large-scale study by Hermann et al. (8), which included 250 patients, the subgroup with the most pronounced analgesic effect was identified among patients with a spur size of ≤ 6.5 mm and those reporting pain for more than 12 months before treatment.

Data on reirradiation for recurrent calcaneal spur pain are limited (9,10). As reported in Hermann et al.'s (8) study, most refractory patients requiring reirradiation in our study had spur sizes of 6 mm or greater, while we did not observe a statistical correlation between spur size and pain intensity.

Radiation exerts its effect through endothelial damage, causing capillary microthrombosis and activating the coagulation system, which leads to hypoxia and ischemia in the capillaries. Radiation can also trigger endothelial cell death and cause thrombus formation on the exposed matrix, resulting in small vessel occlusion. Microangiopathy after radiation can lead to vascular insufficiency and infarction. The primary targets for pain relief are the nerves that transmit pain signals (11,12). The rationale for pain relief in heel spur patients may involve occlusion of the capillaries supplying the sural and posterior tibial nerves, thereby producing neural blockade of these nerves and alleviating pain (13,14). However, larger spurs measuring 6 mm or greater may have neural vasculature irregularities, such that occlusion of nerve-nurturing capillaries may not be achieved completely with the initial application of radiotherapy for nerve blockade to relieve pain, necessitating reirradiation for recurrence (12-14).

This study has several limitations. Firstly; due to its retrospective nature, there is a risk of selection bias in patient selection and data collection. Secondly; the study is single-center, which may limit the generalizability of the results. Thirdly; NRS scoring was used for pain assessment, as the primary endpoint; which is based on patients' subjective perceptions and is not supported by an objective biomarker. Furthermore, while a 6-month follow-up period is sufficient to assess the

effectiveness of radiotherapy, longer follow-up periods are needed to determine lengthy long-term recurrence rates and other late radiation-related side effects. Future prospective and randomized controlled trials will contribute to the validation of these findings.

Conclusion

Reirradiation with a total dose of 8 Gy delivered over two consecutive days appears to be an effective and well-tolerated approach for managing recurrent calcaneal spur pain. It offers a reliable, non-invasive treatment alternative for patients who do not respond adequately to conventional medical therapies.

Ethics

Ethics Committee Approval: This study was approved by the Gülhane Scientific Research Ethics Committee of the University of Health Sciences Türkiye (decision number: 2025/409, dated: 19.08.2025).

Informed Consent: Informed consent was obtained from all patients.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.M.B., B.U., F.D., Ö.S., S.D., H.G., A.N.U., G.D.D., A.O.T., E.G., B.D., Concept: M.M.B., B.U., F.D., Ö.S., S.D., H.G., A.N.U., G.D.D., A.O.T., E.G., B.D., Design: M.M.B., B.U., F.D., Ö.S., S.D., H.G., A.N.U., G.D.D., A.O.T., E.G., B.D., Data Collection or Processing: M.M.B., B.U., F.D., Ö.S., S.D., H.G., A.N.U., G.D.D., A.O.T., E.G., B.D., Analysis or Interpretation: M.M.B., B.U., F.D., Ö.S., S.D., H.G., A.N.U., G.D.D., A.O.T., E.G., B.D., Literature Search: M.M.B., B.U., F.D., Ö.S., S.D., H.G., A.N.U., G.D.D., A.O.T., E.G., B.D., Writing: M.M.B., B.U., F.D., Ö.S., S.D., H.G., A.N.U., G.D.D., A.O.T., E.G., B.D.

Conflict of Interest: The authors declared no conflict of interest.

Financial Disclosure: The authors declare that this study received no financial support.

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