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Sciatic nerve pulsed radiofrequency treatment in coccydynia

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ABSTRACT

Aims: Coccydynia is a pain felt around the coccyx that limits functionality. Interventional treatment options are available in cases that do not respond to conservative methods. This study is aimed to reduce pain by retrograde neuromodulation of the sciatic nerve with pRF in coccydynia.

Methods: 22 patients with coccydynia were treated with bilateral sciatic nerve pulsed radiofrequency (pRF). Followed for 8 weeks. Visual analog scale (VAS) measurements were performed before and 2-4-6-8 weeks after the procedure.

Results: At 4 weeks in 16 (73%) patients and at 8 weeks in 11 (27%) patients, pain had decreased by 50% compared to baseline. When the changes in the VAS scale over 8 weeks were analyzed, the change in baseline-2,4,6 weeks was statistically significantly reduced ($p<0.001$).

Conclusion: Interventional methods have been described in the treatment of coccydynia and retrograde neuromodulation of the peripheral nerve pRF was tried for the first time. The fact that the perforating cutaneous branches and sciatic nerve originate from common nerve roots explains the pain reduction with pRF applied to the sciatic nerve. Randomized controlled trials are needed to evaluate the efficacy of treatment.

Keywords: Coccydynia, radiofrequency, sciatic nerve, coccyx pain, pain treatment

INTRODUCTION

Coccydynia is a condition marked by discomfort around the coccyx, which can result from musculoskeletal issues, infection, or cancer. Trauma or childbirth is often identified as a contributing factor. Additional risk factors include gender, obesity, rapid weight loss, variations in coccygeal morphology, and coccygeal hypermobility. It is more prevalent in middle-aged women.[1,2]

In refractory patients to conservative treatment, interventional procedures such as steroid injections, caudal epidural injection, impar ganglion block, spinal cord stimulation can be performed prior to coxigectomy.[3] Successful results with coccygeal nerve block and pulsed radiofrequency (pRF) have been reported in recent publications.[4,5]

The coccygeal nerve is composed of the coccygeal plexus and is responsible for receiving sensation from the coccyx region. The coccygeal plexus is formed within ischiococcygeus from the ventral rami of S4, S5, and Co1 with a contribution (gray rami communicantes) from the sacral sympathetic trunk. It gives rise to anococcygeal nerves which pierce ischiococcygeus and the sacrospinous ligament to supply the subcutaneous tissue on the dorsal aspect of the coccyx.[6]

The perforating cutaneous nerve is the other nerve responsible for the sensory innervation of this region. The perforating cutaneous nerve, usually arising from the posterior aspects of the S2 and S3 ventral spinal rami, supplies the skin over the inferomedial aspect of the gluteus maximus muscle.[7-9]

Since these are thin and scattered nerve branches, it is very unlikely that the nerve can be identified and blocked. However, it originates from common roots with the sciatic nerve, the largest nerve in the human body. The sciatic nerve is derived from spinal nerves L4 to S3. Since S2 and S3 share roots with perforating cutaneous branches, we aimed that retrograde neuromodulation of the sciatic nerve with pRF may reduce coccygeal pain.

pRF is a method of neuromodulation in which a cannula electrode is used to approach the nerve with imaging methods such as ultrasound or fluoroscopy and conducts from a generator that produces an electric field to reduce pain expression in the central nervous system through a series of reactions occurring in neural substrates. In unlike conventional radioofrequency, pulsed mode does not cause

permanent damage to the nerve as the heat does not exceed 42 degrees.[10-12]

In this study, we aimed to evaluate the improvement in coccydynia pain with sciatic nerve pRF. Our findings are promising and are reported in the following.

METHODS

This study was conducted as a retrospective clinical trial. Ethics committee approval was obtained from the Ankara Etlik City Hospital Ethics Committee (Date:26.06.2024, Decision No: 2024-438). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Pre-procedure and post-procedure Visual analog scale (VAS) scores were obtained from patient file records. Missing data were completed by a telephone call.

Participants

Between January-June 2024, 28 patients who underwent pRF to the sciatic nerve due to coccydynia were evaluated. Twenty-two patients who met the diagnostic criteria were included in the study. Patients with coccydynia for more than 3 months were evaluated by physical examination. Pathologies such as trigger points, L5-S1 radiculopathy, rheumatic diseases were excluded. Imaging modalities were used to evaluate the associated anatomical regions in the coccyx region that may cause pain or reflected pain. Causes such as malignancy, mass, abscess, systemic infection were excluded.

Inclusion criteria; age between 18-70 years, Coccydynia >3 months, unresponsive to conservative treatment. Confirmation of the diagnosis of coccydynia by MRI. Exclusion criteria; concomitant malignancy, infection, pregnancy, rheumatological diseases, L4-L5-S1 discopathy, the addition of oral medication or other interventional procedures after treatment of sciatica pRF.

The study design is described in **Figure 1**.

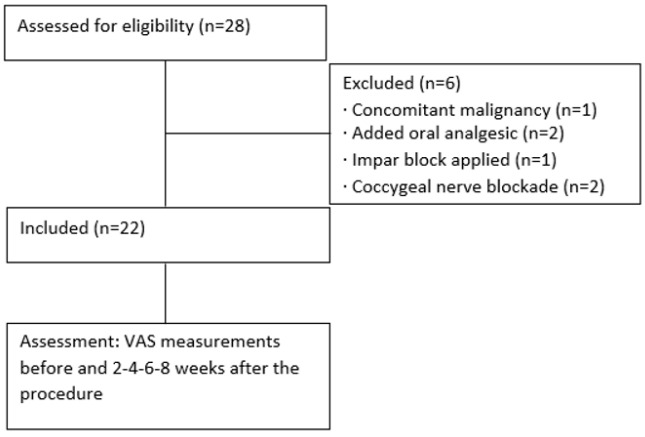

Figure 1. Study design

Intervention

All procedures were performed without sedation, under local anesthesia, with full patient monitoring, under sterile conditions. Under US guidance, bilateral sciatic nerve pRF was performed in the intervention room. The patient was positioned prone and covered with a sterile drape. Using a curve US probe (LOGIQ P9, GE Ultrasound, Sunhwan-ro, Jungwon-gu, Seongnam-si, Gyeonggi-do, Korea), the ischial tuberosity and thoracanter major are visualized at the transgluteal level. The most superficial muscle connecting these two hyperechoic bone images is the gluteus maximus. The sciatic nerve is located just deep to the gluteus maximus muscle and on the surface of the quadratus femoris muscle. It appears as an oval or triangular hyperechoic structure and is closer to the ischial tuberosity.

Using the in-plane technique, a 22-gauge 10 cm 5 mm active hybrid electrode (Equip, FIAB SPA, Italy) was inserted. After confirming that we are close to the sciatic nerve with sensory and motor stimuli a pRF current was applied for 8 minutes (5 Hz at 45 V, 5 ms at a temperature of 42 °C). Since the procedure was performed bilaterally, the same procedure was applied to the other sciatic nerve 8 minutes later. Patients were monitored for possible complications for 2 hours after the procedure (Figure 2).

Radiofrequency therapy was applied by means of a device that produces radiofrequency waves and a cannula electrode connected to it with a cable.

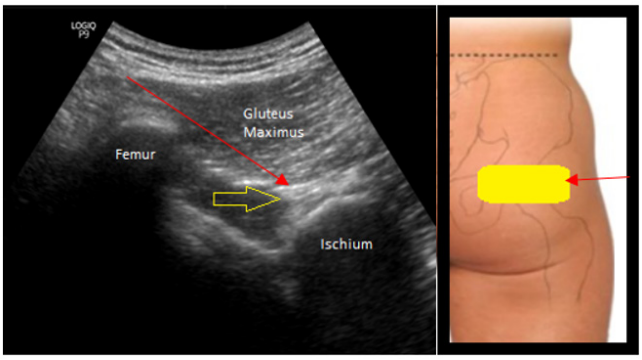

Figure 2. Intervention of Sciatic pRF treatment
Yellow arrow: Sciatic nerve, Red arrow: Needle tracing, Yellow rectangle: Linear probe

Outcome Assessment

We assessed all patients using the VAS scores before and 2-4-6-8 weeks after treatment. Our primary objective was to ascertain the impact of treatment on pain intensity using VAS scores.

Statistical Analysis

All analyses were conducted using Jamovi Project (2022, Jamovi Version 2.3, Computer Software). The findings of this study are expressed as frequencies and percentages. Normality analysis was performed using the Shapiro-Wilk test, skewness kurtosis, and histograms. Normally distributed variables are presented as means and standard deviation (SD). Categorical variables were compared using the chi-square test. Repeated measures were analyzed using Friedmann test. Statistical significance was set at $p<0.05$.

RESULTS

Seventeen of the participants were female and 5 were male. The mean age was 43.36±10.43 years. When classified according to etiology, 10 patients were idiopathic, 12 were traumatic and 2 were due to rapid and excessive weight loss. When comorbidities were evaluated, 8 patients had diabetes mellitus, 5 had hypertension, 2 had cardiovascular disease and 3 had obesity. When continuous analgesic treatment for at least three months was questioned, 8 patients were using NSAIDs, 4 patients were using gabapentinoids and 6 patients were using duloxetine (Table 1).

When the VAS scale change was analyzed, the change found within 8 weeks was statistically significant (Friedman test;

Table 1. Clinical and demographic data

Variables		Mean±SD	Median (min-max)
Age		43.36±10.43	45.50 (29-63)
Gender	Female	17 (77.27%)	
	Male	5 (22.72%)	
Etiology	Idiopathic	10 (45.45%)	
	Trauma	12 (54.54%)	
	Weight loss	2 (9.09%)	
Comorbidity	DM	8 (36.36%)	
	HT	5 (22.72%)	
	CAD	2 (9.09%)	
	Obesity	3 (13.63%)	
Analgesic usage	NSAID	8 (36.36%)	
	Gabapentinoid	4 (18.18%)	
	Duloksetin	6 (27.27%)	
VAS basal		8.64±1.00	9.00 (7-10)
VAS week 2		4.27±2.60	3.00 (1-9)
VAS week 4		3.91±2.65	3.00 (1-9)
VAS week 6		4.09±2.75	3.00 (1-9)
VAS week 8		5.32±2.35	5.00 (2-10)

SD: Standard deviation, Min: Minimum, Max: Maximum, DM: Diabetes mellitus, HT: Hypertension, CAD: Coronary artey disease, NSAID: Non-steroidal antiinflammatory drug

p<0.001). When all measurement times were analyzed separately, baseline-2. Week, basal-4. Week and basal-8. The decrease in VAS between basal-2 weeks and basal-4 weeks and between basal-8 weeks was statistically significant (Bonferroni correction; p<0.001) The change in VAS between other times was not significant.

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Table 2. Temporal change of VAS variable

	Median(min-max)	Mean rank	test st	p
VAS basal	9.00(7-10)	4.68		
VAS week 2	3.00(1-9)	2.50		
VAS week 4	3.00(1-9)	2.11	52.931	<0.001
VAS week 6	3.00(1-9)	2.27		
VAS week 8	5.00(2-10)	3.43		

Related Samples Friedman's two-way analysis of variance by ranks

The lowest mean VAS was obtained at the 4th week after treatment. At weeks 6 and 8, VAS measurements increased, even though they remained below baseline. At 4 weeks in 16 (73%) patients and at 8 weeks in 11 (27%) patients, pain had decreased by 50% compared to baseline (Figure 3).

No side effects or complications were observed in any patient.

Table 3. Change in VAS between two measurement time points

VAS average ranks	Test st.	p
Basal-week 2	-4.577	<0.001
Basal-week 4	-5.387	<0.001
Basal- week 6	-5.053	<0.001
Basal - week 8	-2.622	0.087
Week 2-week 4	-0.810	1.000
Week 2-week 6	-.0.477	1.000
Week 2-week 8	-1.955	0.506
Week 4-week 6	-0.334	1.000
Week 4-week 8	-2.765	0.057
Week 6- week 8	-2.431	0.150

Asymptotic significances (2-sides tests) are displayed. The significance level is 0.05. Significance values have been adjusted by the Bonferroni correction for multiple tests, VAS: Visual analog scale

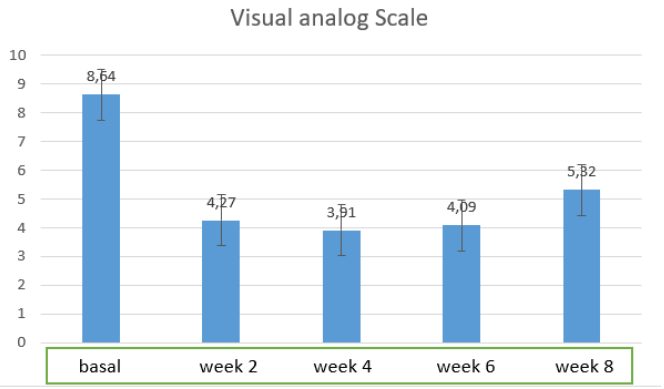

Figure 3. Temporal change of the visual analog scale scale

DISCUSSION

With sciatic nerve pRF treatment, 73% of 22 patients improved more than 50% at week 4 and 27% at week 8. This is the first study to evaluate the effect of sciatic nerve pRF in the treatment of coccidynia.

Peripheral nerve pRF treatments are a widely used method for chronic pain relief. Applications to the greater occipital nerve in chronic migraine, median nerve in carpal tunnel syndrome, posterior tibial nerve in heel spurs, and dorsal root ganglion in radicular pain have taken their place in the literature and clinical practice.[13-17]

Neuromodulation mechanisms of pRF have been implicated in nociceptive signalling. This modification occurs through a variety of mechanisms, including neurotransmitters, ion channels, postsynaptic receptors, immune activity, microglial markers, inflammatory cytokines and intracellular proteins.[11]

In animal studies, histological and biochemical changes in both sciatic nerve and dorsal root ganglia were emphasized with pRF application to the sciatic nerve.

In these studies, changes in calcitonin gene-related peptide, brain-derived neurotrophic factor, substance P, transient receptor potential vanilloid subtype-1 receptors and histochemical improvement in axon diameter, number and myelin sheaths were found after pRF applied to the sciatic nerve. Sciatic nerve pRF applications, which are very rich in

terms of experimental animal studies in the literature, have not been so popular in the treatment of chronic pain.[18-21]

There is a case report of successful treatment of phantom pain with sciatic nerve pRF. There is a case report on the treatment of complex regional pain syndrome after femoral fracture. In a 4-week follow-up of 25 patients, pRF was found to be effective in the treatment of chronic knee pain. In a case with sciatic neuropathic pain due to a lesion in the sciatic nerve in the priformis muscle shiza, the pain was relieved.[22-25]

In a case report, sciatic nerve pRF application was reported to be successful in the treatment of femoral pain due to sacral bone metastasis.[26]

It remains unclear which of the interventional methods for coccydynia is the most effective. There are conflicting data in the literature on this subject. Pericoccygeal injections are easy to administer and can be performed with blind technique or US. The efficacy of this treatment with local anesthetics and steroids around the coccyx is controversial.[27,28]

Caudal epidural block and ganglion impar block are methods that can be applied with fluoroscopy and USG. However, fluoroscopy is preferred for safety. Ganglion impar block has been found more effective than caudal epidural block.[29,30]

Recently, there have been reports in the literature on the treatment of coccydynia with coccygeal nerve blockade and conventional radiofrequency.[4,31,32]

The perforating cutaneous nerve, which we targeted, is responsible for the sensory innervation of the coccyx region like the coccygeal nerve. This nerve originates from the S2-S3 spinal roots and we tried to retrograde modulate it with pRF via the sciatic nerve. Our results showed a decrease in coccygeal pain with sciatic nerve pRF. We only utilized the pRF effect during this treatment, which stands as a clinical indicator of retrograde neuromodulation.

Limitations

The limitations of this study were the lack of a comparison group and the failure to analyse the change in analgesic consumption of the patients.

CONCLUSION

Sciatic pRF applied from the transgluteal level under ultrasound guidance is a safe and easy method. It may be an alternative to caudal epidural steroid injection, impar ganglion block, pericoccygeal injection and coccygeal nerve block for coccydynia. These findings should be supported by randomized controlled trials.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Ethical Committe of Ankara Etlik City Hospital (Date:26.06.2024, Decision No: 2024-438).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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