



# The Effects of Virtual Reality-based Wii Fit Yoga on Pain, Functionality and Trigger Points in Non-specific Chronic Low Back Pain Patients: A Randomized Controlled Trial

Non-Spesifik Kronik Bel Ağrılı Hastalarda Sanal Gerçekliğe Dayalı Wii Fit Yoga'nın Ağrı, Fonksiyonellik ve Miyofasyal Tetik Noktalar Üzerine Etkisi

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## ABSTRACT

**Objectives:** This study aims to investigate whether or not there was a difference in the efficacy of conventional exercise (CE) treatment and virtual reality (VR)-based Wii Fit yoga applications on the parameters of pain, functionality and myofascial trigger points (MTrP) in patients with non-specific chronic low back pain (nCLBP).

**Methods:** This study was conducted on a total of 34 patients separated into two groups as the Wii Fit Yoga group and the CE group. In the Wii Fit group, yoga was performed with the Nintendo Wii device for 45 mins, five days a week, for six weeks. The yoga poses included the half-moon, lunge, single-leg extension, torso-twist, tree, and warrior directed at the lower back area. For the CE group, a home exercise program was prescribed comprising stretching, strengthening and posture exercises to be performed at the same frequency and for the same duration as the yoga group. Pain, MTrP's and functionality parameters were evaluated before and after treatment.

**Results:** Following treatment, a statistically significant improvement was observed in all the pain scores, functionality parameters and algometer measurements compared to the baseline values in both groups ( $p < 0.001$ ). No statistically significant difference was determined between the groups.

**Conclusion:** The application of VR-based Wii Fit Yoga was effective on pain, functionality and MTrP in patients with nCLBP and should be considered as an alternative approach to CE treatment. There is a need for further studies on this subject with larger patient populations and a longer follow-up period.

**Keywords:** Chronic low back pain; myofascial trigger point; yoga.

## ÖZET

**Amaç:** Bu çalışmada, non spesifik kronik low back pain (nCLBP) tanılı hastalarda Virtual Reality (VR)-based Wii Fit Yoga uygulamaları ile konvansiyonel egzersiz tedavisinin ağrı, fonksiyonellik ve miyofasyal trigger point (MTrP) parametreleri üzerine etkinliklerinde bir farklılık olup olmadığını değerlendirmeyi amaçladık.

**Yöntem:** Bu çalışma, 34 hasta üzerinde gerçekleştirildi. Hastalar, Wii Fit Yoga uygulaması grubu ve konvansiyonel egzersiz grubu olmak üzere ikiye ayrıldı. Wii Fit Yoga grubuna; haftada beş gün, günde 45 dk ve altı hafta boyunca Nintendo Wii (Nintendo, Kyoto, Japan) ile bel bölgesine yönelik the half-moon pose, lunge pose, single leg extension, torso-twist pose, tree pose, warrior pose gibi hareketleri içeren yoga uygulaması yaptırıldı. Aynı süre ve frekansta konvansiyonel egzersiz grubuna germe, güçlendirme, postur egzersizlerinden oluşan ev egzersizi programı reçete edildi. Tedavi öncesi ve sonrası ağrı, fonksiyonellik parametreleri değerlendirildi. MTrP'ler algometre ile kantitatif olarak ölçüldü.

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**Bulgular:** Tedavi öncesi ve tedavi sonrası bütün ağrı skorlarında, fonksiyonellik parametrelerinde, algometre ölçümlerinde; her iki grupta da istatistiksel olarak anlamlı bir düzelme görülürken ( $p<0.001$ ), gruplar arası kıyaslama yapıldığında istatistiksel olarak anlamlı bir farklılık görülmemiştir.

**Sonuç:** nCLBP tanılı hastalarda VR-based Wii Fit Yoga uygulamasının ağrı, fonksiyonellik, MTrP parametreleri üzerine etkili olduğu, konvansiyonel egzersiz tedavilerine alternatif bir yaklaşım olabileceği akılda tutulmalıdır. Bu konuda daha fazla hasta popülasyonu ile ve daha uzun takip sürelerinin olduğu çalışmalara ihtiyaç duyulmaktadır.

**Anahtar sözcükler:** Kronik bel ağrısı; miyofasyal tetik nokta; yoga.

Low back pain of a mechanical nature that lasts for longer than 12 weeks is defined as chronic low back pain.<sup>[1]</sup> While 10-20% of the patients receives a specific diagnosis of chronic low back pain, the remaining group of approximately 85% of the patients is diagnosed as non-specific low back pain (nCLBP). In the pathophysiology of nCLBP, impaired spinal biomechanics are known to cause a muscle spasm, resulting in a vicious circle of pain- muscle spasm-pain. Over time, active myofascial trigger points (MTrPs) emerge in the lumbar region muscles, primarily the multifidus muscles that are responsible for lumbar spinal stabilization.<sup>[2]</sup> Active MTrPs are also known to be frequently seen in the gluteus medius and quadratus lumborum muscles in nCLBP patients.<sup>[2]</sup> In the treatment of nCLBP, to date, conservative methods have been recommended, such as physical therapy modalities, exercise therapy, patient education and low back school programs, injections, manual therapy, and dry needling.<sup>[2, 3]</sup>

Although the most effective treatment method is not clearly known, the treatment program to be applied should be patient-specific.<sup>[3]</sup> Current studies have shown that a multimodal and multidisciplinary approach is more effective. There is strong evidence of the efficacy of exercise therapy in the treatment of nCLBP, although there is no clear recommendation about what type of exercise should be applied and for how long.<sup>[4]</sup> Yoga, which has recently seen a great increase in popularity, is known to have been applied in the treatment of chronic low back pain.<sup>[5]</sup>

The use of virtual-reality (VR) applications of exercise programs is a new method but is thought to be more advantageous than conventional treatments in respect of increasing patient motivation and participation. There are reports in the literature on the use of VR applications both in an approach to the treatment of chronic pain and in the rehabilitation of patients with neurological and orthopedic diseases.

The present study aims to investigate whether or not there was a difference in the efficacy of conventional exercise

treatment and VR-based Wii Fit yoga applications on the parameters of pain, functionality and MTrPs in patients diagnosed with nCLBP.

## Methods

This study included 40 patients aged 18-45 years, who presented at the Physical Medicine and Rehabilitation Department of outpatient clinic between May 2019 and August 2019 with complaints of low back pain lasting longer than three months and were diagnosed with nCLBP. Approval for this study was granted by the Local Ethics Committee. All procedures were conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from all participants.

Inclusion criteria for this study were that the patient was aged 18-45 years, had at least a 3-month history of symptoms, accepted that they would take no anti-inflammatory treatment during the treatment process, was diagnosed with nCLBP, had no abnormal findings in routine blood tests, had no known acute or chronic inflammatory disease, and had a level of education (primary school and above) to be able to complete the forms related to the treatment, interventions and evaluations.

Patients were excluded from this study if they had any malignancy, infection, a history of widespread inflammatory rheumatic disease, a trauma in the spinal area, skin lesion, infection, open wound, radiculopathy, a peripheral circulation disorder, the use of warfarin because of coagulopathy, arthropathy, congenital or acquired spinal pathology, or pregnancy.

Taking patients in order of presentation at the clinic, the list was randomly separated into two groups of 24. Four patients excluded (not meeting inclusion criteria n: 3, refused to participate n: 1). During the study period, five patients from each group dropped out. The final evaluations were completed with a total of 34 patients. The details of included and

excluded subject numbers into this study through final data analysis are provided in Figure 1 as a flowchart.

### The following parameters were used in the evaluations:

1. Sociodemographic and clinical characteristics of the patients,
2. Subjective pain severity [Visual Analog Scale (VAS)],
3. Level of functionality [Oswestry Disability Index (ODI)],
4. Evaluation of the MTrPs with an algometer.

**Evaluation of the Demographic Characteristics:** A record was made for each patient of age, gender, height, weight, occupation, and duration of complaints.

**Evaluation of the Pain with VAS:** A VAS was used in the evaluation of pain levels. The VAS scores were evaluated before and immediately after treatment when getting up in the morning, at rest and during activity. Patients were instructed to mark the level of pain felt on a 10cm scale where 0=no pain and 10=intolerable pain.

**ODI:** This Index is used to measure the performance of activities required in daily life and to define what a person can do and what limitations they have. The ODI measures pain severity and functional deficiencies in daily living activities, such as personal care, getting up from bed, walking, sitting, standing, sleeping, sex life, social life and travelling. The form consists of 10 questions, each with six alternative responses, scored from 0-5. The maximum points range from 0-50, with 1-10 points indicating mild functional disability, 11-30 points moderate, and 31-50 points a severe level.<sup>[6]</sup>

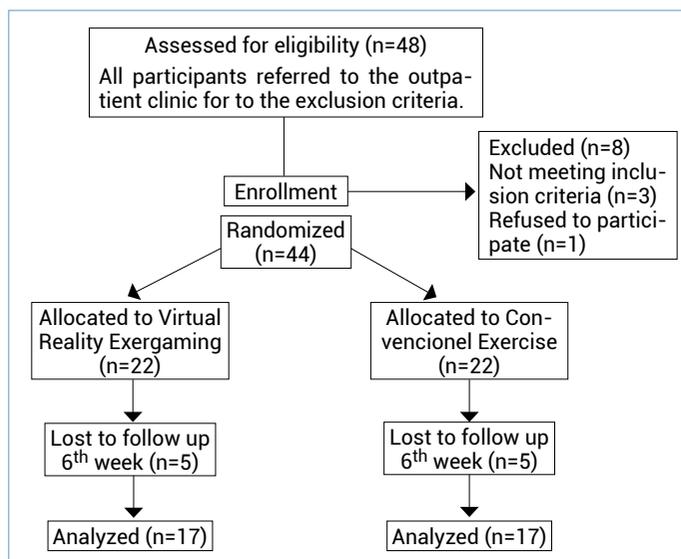


Figure 1. Flow diagram for study participants.

### Evaluation of MTrPs with an Algometer

**Multifidus muscle:** Measurements were taken at L3-L4-L5 levels on the symptomatic side. The algometer was applied perpendicularly from approximately 1 cm lateral of the spinous process.<sup>[7]</sup>

**Gluteus medius muscle:** The anatomic localization of the gluteus medius muscle and the potential MTrPs, as defined in literature, were marked with a pen, and a perpendicular measurement was taken from here.<sup>[8]</sup>

**Quadratus lumborum muscle:** In the lateral lying position, the anatomic localization of the 12<sup>th</sup> rib with the iliac crest was marked with a pen. The potential MTrPs, as defined in literature, were marked with a pen and measurement was made by determining the muscle localization towards posterior and inferior.<sup>[9]</sup>

### Treatments Applied

**Group 1:** A home exercise program was prescribed to be performed for 45 mins, five days a week, for six weeks. Stretching exercises were recommended for the lumbar extensors, hamstring muscle group, hip flexors, hip abductor and adductors, and the gastro-soleus muscle group. Strengthening exercises were applied to the abdominals, lumbar extensors, and hip extensors. Therapeutic exercises were applied, comprising posture exercises and exercises to provide spinal stability. Patients were followed up with telephone calls from the physician twice a week.

**Group 2:** The yoga application was performed with the Nintendo Wii device (Nintendo, Kyoto, Japan) for 45 mins, five days a week for six weeks. The yoga poses included the half-moon, lunge, single-leg extension, torso-twist, tree, and warrior, directed at the low back area (Fig. 2).<sup>[10]</sup> The VR program applying the exercises is a 3-dimensional, computer-assisted system creating VR. The Nintendo Wii Fit comprises a system console, a balance platform, a remote-control providing control of the activity and sensors that perceive a change in movements. The video monitor provides visual feedback about the approximate location of the pressure center of the sole of the foot (Fig. 2).

### Statistical Analysis

Data obtained in this study were analyzed statistically using SPSS V22.0 software. In the descriptive statistics of the data, mean±standard deviation, median, minimum, maxi-



Figure 2. Half-moon pose (a), lunge pose (b), single leg extension (c), torso-twist pose (d), tree pose (e), warrior pose (f).

imum, number (n) and percentage (%) values were used. The conformity of the data to normal distribution was assessed using the Kolmogorov-Smirnov test. In the analysis of independent quantitative values, the Independent Samples t-test and the Mann-Whitney U test were used. The Wilcoxon test was applied in the analysis of dependent quantitative data. The chi-square test was used in the analysis of qualitative independent data. A value of  $p < 0.05$  was accepted as statistically significant.

## Results

The sociodemographic and clinical characteristics of the patients are shown in Table 1.

Comparisons were made of pain scores, at rest, during activity and at night, before treatment and at the end of the 6th week of treatment. A statistically significant improvement was seen in all the VAS scores of both groups ( $p < 0.001$ ). No difference was determined between the groups (Table 2). When the comparison was made of the evaluations of MTrPs of the multifidus, gluteus medius and quadratus lumborum muscles before and after treatment, there was seen to be a statistically significant improvement in both groups (Table 3). A statistically significant improvement was seen in the functional parameters with similar results in both groups (Table 3).

Table 1. Demographic parameters of the participants (n=34)

Parameters	Wii (n=17)	Conventional (n=17)	p
Age (year), mean (SD)	20.8 (0.7)	20.8 (0.7)	0.812
BMI (kg/m <sup>2</sup> ), mean (SD)	23.6 (3.2)	23.4 (3.2)	0.717
Gender, n (%)			0.724
Man	10 (21.7)	11 (66.7)	
Woman	7 (78.3)	6 (33.3)	
Occupation, n (%)			
Housewife	4 (41.3)	3 (40)	
Student	10 (2.2)	10 (2.2)	
Officer	3 (41.3)	4 (57.8)	
Pain duration, month, mean (SD)	5 (1)	5 (1)	0.955

BMI: Body mass index; SD: Standard deviation.

Table 2. Changes in pain parameters from baseline to 6 weeks

Parameters	Wii (n=17)	Conventional (n=17)	p
VAS resting, mm			
Baseline, mean (SD)	7.1 (1.0)	7.5 (1.2)	0.538
After treatment, mean (SD)	3.1 (0.5)	3.5 (0.7)	0.089
p	<b>&lt;0.001</b>	<b>&lt;0.001</b>	
VAS activity, mm			
Baseline, mean (SD)	7.4 (1.2)	7.5 (1.2)	0.912
After treatment, mean (SD)	3.3 (0.6)	3.6 (0.7)	0.283
p	<b>&lt;0.001</b>	<b>&lt;0.001</b>	
VAS night, mm			
Baseline, mean (SD)	6.5 (2.1)	7.4 (1.2)	0.344
After treatment, mean (SD)	2.8 (1.0)	3.5 (0.7)	0.049
p	<b>&lt;0.001</b>	<b>&lt;0.001</b>	

VAS: Visual analog scale; SD: Standard deviation.

## Discussion

Low back pain, which is frequently seen in modern living conditions, constitutes a significant societal problem entailing economic and labor force losses. In interventions for chronic low back pain, educational programs, functional adaptation, exercise, movement and activity modifications, and psychological approaches are used.<sup>[11]</sup> Exercise is one of the indispensable approaches in physical therapy and rehabilitation applications in the treatment of several musculoskeletal system problems and chronic diseases.<sup>[12]</sup> Exercise is extremely important, both as a part of protective rehabilitation and in the restoration of motor functions with control of the pain resulting from microtrauma and movement

Table 3. Changes in pain pressure threshold, disability parameters from baseline to six weeks

Parameters	Wii (n=17)	Conventional (n=17)	p
<b>Multifidus muscle (right)</b>			
Baseline, mean (SD)	16.8 (3.2)	16.3 (3.2)	0.647
After treatment (SD)	22.8 (4.4)	23.1 (4.1)	0.929
p	<b>&lt;0.001</b>	<b>&lt;0.001</b>	
<b>Multifidus muscle (left)</b>			
Baseline, mean (SD)	12.8 (6.4)	12.1 (5.9)	0.457
After treatment (SD)	16.7 (8.4)	16.8 (8.4)	0.944
p	<b>0.005</b>	<b>0.001</b>	
<b>Quadratus lumborum (right)</b>			
Baseline, mean (SD)	14.7 (3.9)	17.1 (5.6)	0.260
After treatment (SD)	23.1 (6.7)	24.1 (5.4)	0.447
p	<b>&lt;0.001</b>	<b>0.004</b>	
<b>Quadratus lumborum (left)</b>			
Baseline, mean (SD)	16.3 (4.5)	15.4 (2.4)	0.829
After treatment (SD)	22.8 (4.6)	22.8 (3.8)	0.861
p	<b>0.004</b>	<b>0.007</b>	<b>&lt;0.001</b>
<b>Gluteus medius (right)</b>			
Baseline, mean (SD)	16.8 (4.6)	15.7 (2.9)	0.648
After treatment (SD)	21.8 (2.8)	22.3 (2.3)	0.915
p	<b>0.005</b>	<b>&lt;0.001</b>	
<b>Gluteus medius (left)</b>			
Baseline, mean (SD)	15.6 (2.8)	14.7 (1.3)	0.549
After treatment (SD)	20.2 (2.3)	20.5 (1.6)	0.970
p	<b>0.004</b>	<b>&lt;0.001</b>	
<b>Ostwestry Disability Index (0-50 points)</b>			
Baseline, mean (SD)	15.3 (4.8)	12.3 (5.9)	0.064
After treatment (SD)	5.0 (2.8)	8.7 (4.7)	0.821
p	<b>&lt;0.001</b>	0.514	<b>&lt;0.001</b>

deg: Degree; SD: Standard deviation.

restriction.<sup>[11, 13]</sup> Exercise therapy increases the endorphin level and accelerates tissue healing with mechanoreceptor stimulation and biomechanical stress.<sup>[13]</sup> In the literature, there is no definitive evidence about which type of exercises should be used in nCLBP treatment. Among the treatment methods used are core stabilization exercises, conventional exercises, Williams exercises, Pilates and yoga applications.<sup>[12, 14]</sup> Intervention for chronic pain is important for the economy of a country. In the USA, acute and chronic pain constitute a major problem in terms of cost, with reported costs of 650 million lost working days and 650 billion USD.<sup>[15]</sup> When examined from this perspective, as yoga and Pilates can be applied as a group exercise, they can be evaluated as a more economic treatment method than other exercises.<sup>[16]</sup>

Yoga, which has increased in popularity in recent years, has been reported in the literature to be effective on several diseases and symptoms, such as rheumatologic, orthopedic and neurologic diseases, cancer, stress, and cardiopulmonary system diseases, due to the lifestyle modifications presented to patients.<sup>[17]</sup> Yoga has been reported to achieve core stabilization with mental and physical exercises, increase flexibility, and control pain with relaxation exercises.<sup>[17]</sup> It has also been shown in the literature that with the neurophysiological effect,  $\beta$ -endorphin is increased, and there is a change in the brain neurotransmitter level.<sup>[17]</sup> In a 2016 review in the literature, yoga applications in the treatment of nCLBP were reported to be just as effective and reliable on pain, functionality and depression parameters as other non-pharmacological treatments.<sup>[18]</sup> Tekur et al.<sup>[19]</sup> applied a 1-week program of conventional exercise to one group and a 1-week yoga program to the other group of a total of 80 patients diagnosed with nCLBP. The evaluation was carried out for the treatment applied for a short period of one week with intense content. A statistically significant improvement was determined in the functional scores of the yoga group compared to the conventional group. While improvement was seen in the spinal flexibility measurements of both groups, the flexion, extension, right lateral flexion and left lateral flexion parameters of the yoga group were seen to be statistically significantly better.<sup>[19]</sup> Although the follow-up period of the current study was longer than that of the above-mentioned study, spinal flexibility measurements were not taken.

Evans et al.<sup>[20]</sup> applied a 6-week yoga program to 53 patients with CBLP with the target of restoration of the functionality of the lumbar and abdominal muscles in comparison with a physiotherapy group. A statistically significant improvement was determined in the pain and functionality scores of both groups after treatment compared with the pre-treatment values. In that study, the protocol of the exercise treatment applied to the control group was different from that of the conventional exercise group in the current study. Furthermore, a more intensive treatment protocol was applied in the current study as five days per week for six weeks. The treatment results showed similarity to those of that study.

In a randomised controlled study of 156 nCLBP patients by Tilbrook et al.,<sup>[21]</sup> one group was applied with yoga and the other group with classic treatment for a total of 12 sessions throughout three months. The results demonstrated that the yoga application was statistically significantly superior in respect of the functionality parameters. The content of clas-

sic treatment has been reported to consist of manual therapy, exercise and cognitive-behavioral therapies. Although the number of patients was high, there was no control group of a standard treatment was a limitation of the study.<sup>[21]</sup> In the current study, although there were fewer patients, the treatment protocols of both groups were standardized and the yoga application was not observed to be superior to the conventional exercise treatment.

In a study with 228 nCLBP patients, Sherman et al.<sup>[22]</sup> applied a 12-week treatment program of yoga to one group, stretching exercises to the second group and a self-care book was given to the third group. In the evaluations at the end of 12 weeks, the yoga group was statistically significantly better than the self-care book group. However, no statistically significant difference was determined between the yoga group and the stretching exercise group in respect of the functionality parameters. Likewise, in the current study, no difference was seen between the groups in respect of the functionality parameters.<sup>[22]</sup>

In another study with 95 nCLP patients, which evaluated the contribution to the treatment of the frequency of the yoga application, Saper et al.<sup>[23]</sup> applied yoga at the frequency of 1x60-min session per week for 12 weeks to one group and at 2x60 min sessions to the other group. At the end of the treatment, improvements were seen in both groups in the pain and functionality parameters, and the results obtained were similar in both groups.<sup>[23]</sup>

VR-based exercise applications in the treatment of nCLBP have entered literature with studies where different protocols and devices have been used.<sup>[24]</sup> These exercise programs are types of new and useful exercises created in 3-D, computer-assisted VR. By creating a mirror effect, the system provides uniformity of the movement of the subject. There is a high level of visual and sensory feedback during the exercise. The avatar created on the screen demonstrates to the subject and perceives movement through the remote control. Only one study in the literature has reported the use of VR-based Wii Fit Yoga in patients diagnosed with nCLBP. In that study, a total of 12 sessions of VR-based exercises were applied throughout 12 weeks to middle-aged female patients. The control group received a conventional exercise treatment program. A significant improvement was determined in the pain and functionality parameters of both groups after treatment. In the comparison of these parameters between the groups, the yoga group was determined to be statistically significantly superior. However, limitations of that study can be considered

to be that the patient sample was formed of females only in a specific age range, and that no information was provided about the frequency and duration of the exercise treatment in the control group.<sup>[10]</sup> In the current study, both genders were evaluated and the exercise program applied to the control group was clearly defined. Unlike the previous study, no difference was determined between the groups in the current study in respect of pain and function. Another difference of the current study was that algometer evaluations were carried out before and after treatment of the MTrPs in the muscles most affected in nCLBP.

In studies in the literature that have evaluated the efficacy of treatments, such as dry needling and extra-corporeal shock-wave therapy in nCLBP treatment, the active MTrPs in the multifidus, quadratus lumborum and gluteus medius muscles have been evaluated with an algometer before and after treatment.<sup>[7-9]</sup> In all the patients applied with exercise in the current study, the spasms were resolved in these muscles and the sensitivity of MTrPs was seen to have reduced. Thus, it was considered that evaluations made with an algometer are quantitative and objective evaluations of the efficacy of treatment. There is only one study in the literature in which the effects of yoga on neck pain were evaluated with algometer measurements of the MTrPs.<sup>[25]</sup> Therefore, to our knowledge, the current study is the first study in the literature to have evaluated the MTrPs in the multifidus, gluteus medius and quadratus lumborum muscles with an algometer.

A diagnosis of nCLBP is not a condition that can achieve full remission, and recurrences may develop at a high rate. Therefore, in the treatment process of this disease, adverse events may occur. Although rare, adverse events, such as lumbar disc herniation, headache and an increase in the severity of low back pain, have been reported in studies where yoga has been applied in the treatment of nCLBP.<sup>[22]</sup> None of these side-effects mentioned in the literature were encountered in the current study. This could be attributed to the slightly low number of patients included in this study compared to previous studies.

A limitation of the current study could be said to be that yoga was applied as group treatment to be more cost-effective, although the patients performed the yoga on a single-person board. In addition, as the follow-up period was shorter than that of some previous studies, spinal flexibility, balance, endurance, posture, muscle strength and sleep quality, which have been evaluated in most of the previous yoga studies, were not evaluated.

## Conclusion

In conclusion, the application of VR-based Wii Fit Yoga was seen to be effective on pain, functionality and MTrP parameters in patients diagnosed with nCLBP and should be considered as an alternative approach to conventional exercise treatment. However, there is a need for further studies on this subject with larger patient populations and a longer follow-up period.

## Disclosures

**Ethics Committee Approval:** The Ethics Committee of Kafkas University Faculty of Medicine provided the ethics committee approval for this study (30.04.2019-80576354-050-99/118).

**Peer-review:** Externally peer-reviewed.

**Conflict of Interest:** None declared.

**Authorship Contributions:** Concept – F.B., S.B.; Design – F.B., S.B.; Supervision – F.B.; Materials – F.B.; Data collection &/or processing – F.B.; Analysis and/or interpretation – S.B.; Literature search – F.B., S.B.; Critical review – F.B.

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