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Original Article PHYSICAL MEDICINE & REHABILITATION

The effect of the duration of transcutaneous electrical nerve stimulation on pain and functionality in the treatment of lumbar spondylosis

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ABSTRACT

OBJECTIVE: This study aimed to evaluate whether different durations of transcutaneous electrical nerve stimulation (TENS), specifically 20 and 30 min, produce distinct effects on pain and functionality in individuals diagnosed with lumbar spondylosis.

METHODS: A retrospective analysis was conducted involving 42 patients with lumbar spondylosis. Participants were assigned to two treatment groups. In addition to therapeutic ultrasound, superficial heat therapy, and exercise, Group 1 received TENS for 20 min, whereas Group 2 underwent the same treatment protocol with a 30-min TENS application. Pain intensity and functional status were assessed using the visual analog scale (VAS) and the Oswestry disability index (ODI) before treatment initiation and after completion of a 3-week intervention period. Outcomes were analyzed both within and between groups.

RESULTS: Following treatment, both groups exhibited significant reductions in VAS and ODI scores compared with baseline values ($p<0.001$). Comparison of treatment-related improvements revealed no significant differences between groups for either ΔODI or ΔVAS ($p=0.052$ and $p=0.943$, respectively). Although the between-group difference in ΔODI did not reach statistical significance, a moderate effect size favoring the 30-min TENS group was identified (Cohen's $d=0.618$). In contrast, the effect size for ΔVAS was minimal (Cohen's $d=0.022$).

CONCLUSION: The findings indicate that extending TENS application from 20 to 30 min does not provide additional benefits in terms of pain relief or functional recovery in patients with lumbar spondylosis. Given the comparable clinical outcomes, a 20-min TENS protocol may represent a more practical and cost-conscious approach for managing lumbar spondylosis-related low back pain.

Keywords: Low back ache; mechanical low back pain; physical therapy; transcutaneous electrical nerve stimulation.

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Lumbar spondylosis is a degenerative condition affecting the lumbar spine and is characterized by progressive changes involving the intervertebral discs, facet joints, and vertebral structures [1]. As a major source of chronic low back pain (LBP) and functional limitation, it contributes substantially to the global burden on healthcare systems. [2] The underlying mechanisms of lumbar spondylosis are complex and multifactorial, encompassing age-associated degeneration, hereditary influences, and long-term biomechanical stress exerted on the lumbar region [3–6].

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Non-pharmacological treatment strategies play an important role in the management of chronic musculoskeletal disorders, including persistent LBP. Among these approaches, electrical stimulation therapies have gained widespread acceptance due to their non-invasive nature and potential analgesic effects. Transcutaneous electrical nerve stimulation (TENS) remains one of the most extensively utilized electrical stimulation modalities in clinical rehabilitation settings [7–9].

The therapeutic action of TENS is believed to be mediated through modulation of nociceptive transmission at the spinal level as well as stimulation of descending inhibitory pain control mechanisms [7]. The widespread availability, ease of use, and ability for independent application have contributed to its popularity in routine clinical practice. Typically, TENS devices are compact, battery-operated systems designed to deliver electrical stimulation through surface electrodes positioned over or adjacent to the painful region of intact skin [10].

Although TENS has been widely investigated as a treatment option for chronic LBP, uncertainty remains regarding the optimal treatment parameters required to maximize its clinical benefits. Recent evidence syntheses have emphasized the necessity for additional studies exploring the impact of treatment variables such as stimulation intensity, frequency, dosage, and application duration [9]. Accordingly, the present study was designed to compare the clinical effects of 20-min and 30-min TENS sessions on pain intensity and functional status in patients experiencing LBP associated with lumbar spondylosis.

Highlight key points

- This study is, to the best of our knowledge, the first to directly compare 20-min and 30-min TENS application durations in individuals with lumbar spondylosis.
- Increasing the duration of TENS application from 20 to 30 min did not yield statistically superior clinical benefits.
- A 20-min TENS session may offer a more time-efficient and cost-effective option in routine clinical practice.
- These findings may contribute to the optimization of TENS application protocols for patients with lumbar spondylosis.

MATERIALS AND METHODS

This retrospective study included 42 patients with a diagnosis of lumbar spondylosis who were evaluated in the outpatient clinic between January 2023 and October 2025. Only individuals fulfilling the predefined eligibility criteria were enrolled in the analysis.

Eligible participants were men and women between 40 and 70 years of age who experienced LBP attributable to lumbar spondylosis, with or without radiation to the lower extremities, for a duration of at least 3 months. In addition, radiographic confirmation of degenerative lumbar spine changes was required for inclusion. Patients were excluded if they presented with lumbar disc herniation accompanied by neurological findings requiring surgery, pregnancy, spondylolysis, spondylolisthesis, degenerative listhesis, vertebral fractures, osteoporosis, suspected malignant disease, previous spinal surgical procedures, or any diagnosed rheumatologic, neurological, or psychiatric disorder. Individuals with contraindications to TENS treatment, including the presence of a cardiac pacemaker, were also not considered eligible.

This study was approved by the University of Health Sciences Hamidiye Non-Interventional Scientific Research Ethics Committee on August 19, 2025. (Decision number: 2025-16-2). The research was carried out in compliance with the ethical guidelines established by the 1964 Declaration of Helsinki and later updated versions. Written informed consent had been obtained from all patients whose records were retrospectively evaluated.

Treatment Protocol

Based on the treatment protocols documented in their medical records, the patients were divided into two groups. The rehabilitation program in Group 1 consisted of 20 min of TENS combined with therapeutic ultrasound, superficial heat application, and exercise therapy. Group 2 received an identical treatment regimen, with the only difference being a TENS duration of 30 min.

TENS was administered through four self-adhesive electrodes placed bilaterally at spinal levels corresponding to the patient's pain location. Stimulation settings included a pulse frequency ranging from 70 to 100 Hz, a pulse duration of 100 μs, and an intensity adjusted to the maximum level comfortably tolerated by each participant.

In addition to TENS, all patients underwent 20 min of infrared superficial heat therapy, 6 min of therapeutic ultrasound, and 15 min of core stabilization exercises during each treatment session. The rehabilitation program was delivered 5 times weekly for 3 consecutive weeks. Throughout the treatment period, the use of non-steroidal anti-inflammatory medications and other analgesics was prohibited, whereas medications prescribed for coexisting medical conditions were continued without modification.

Table 1. Demographic and clinical characteristics of the study groups

	Group 1 (n=21) Mean±SD (min-max)	Group 2 (n=21) Mean±SD (min-max)	p
Age	52.0±10.1 (40–70)	48.1±8.81 (40–69)	0.186
Gender (%)			
Female	52.4	61.9	0.533
Male	47.6	38.1	
Weight (kg)	76.90±14.00 (55–100)	81.00±16.06 (52–100)	0.333
Height (cm)	171.86±9.45 (157–188)	173.00±9.27 (156–188)	0.694
BMI	25.91±4.89 (17.20–35.20)	27.10±5.46 (18.60–39.50)	0.462
Duration (years)	4.38±2.06 (2–8)	5.24±2.19 (2–9)	0.174
ODI baseline	24.24±3.85	26.48±3.50	0.056
VAS baseline	6.14±1.74	5.95±1.99	0.743

SD: Standard deviation; BMI: Body mass index; ODI: Oswestry disability index; VAS: Visual Analog Scale.

Outcome Assessment

Clinical evaluations were performed before treatment initiation and on completion of the 3-week intervention period.

Assessment of pain was performed with the visual analog scale (VAS). Patients rated their pain at rest and during activity on a numerical continuum ranging from 0 to 10, with higher scores indicating greater pain severity [11].

Functional disability was assessed using the Oswestry disability index (ODI). This questionnaire comprises 10 domains. Each item is scored on a six-point scale from 0 to 5. The ODI percentage score was calculated according to the following formula:

ODI (%) = [Total score/(number of completed items×5)]×100

Higher ODI values indicate greater disability, whereas lower scores reflect better functional performance [12].

Outcome Measures

The primary endpoint of the study was the treatment-related change in VAS score. Changes in ODI score following the intervention were evaluated as the secondary endpoint.

Statistical Analysis

Sample size estimation was performed before data analysis using G*Power software (version 3.1.9.7, Düsseldorf, Germany). Based on a projected moderate effect size (Cohen's d=0.5), a two-sided significance level of 0.05, and a statistical power of 90%, the minimum required sample size was calculated as 40 participants.

All statistical analyses were conducted using the Statistical Package for the Social Sciences version 21.0. Continuous variables were reported as mean±standard deviation or median with interquartile range according to their distribution characteristics, while categorical variables were expressed as counts and percentages.

Distribution normality was assessed using the Shapiro–Wilk test. Comparisons of categorical variables between groups were performed with the Chi-square test. Baseline differences in continuous variables were evaluated using either the independent samples t-test or the Mann–Whitney U-test, depending on data distribution. Changes within each group from baseline to post-treatment were examined using paired samples t-tests. Treatment-related changes (Δ values calculated as post-treatment minus baseline scores) were compared between groups using the independent samples t-test or Mann–Whitney U-test where appropriate. Effect sizes were quantified using Cohen's d statistic. Statistical significance was defined as p-value below 0.05.

RESULTS

No statistically significant differences were identified between the groups regarding demographic characteristics at baseline (Table 1).

Baseline clinical assessments are summarized in Table 1. The two groups demonstrated comparable initial ODI and VAS scores, with no statistically significant differences observed prior to treatment (ODI: p=0.056; VAS: p=0.743).

Table 2. Within-group changes following treatment in Group 1 and Group 2

Group	Baseline, Mean±SD	Post-treatment, Mean±SD	Mean difference (%95 CI)	p	Cohen's d
ODI					
1	24.24±3.85	14.76±2.41	9.48 (7.63, 11.32)	<0.001	2.34
2	26.48±3.50	14.48±1.89	12.00 (10.12, 13.88)	<0.001	2.91
VAS					
1	6.14±1.74	2.76±1.09	3.38 (2.51, 4.25)	<0.001	1.77
2	5.95±1.99	2.62±1.02	3.33 (2.26, 4.40)	<0.001	1.42

SD: Standard deviation; ODI: Oswestry Disability Index; VAS: Visual Analog Scale.

Table 3. Between-group comparison of treatment-induced change

	Group 1, Mean±SD	Group 2, Mean±SD	p	Cohen's d
ΔODI (post-pre)	9.48±4.04	12.00±4.12	0.052	-0.618
ΔVAS (post-pre)	3.38±1.91	3.33±2.35	0.943	0.022

SD: Standard deviation; ODI: Oswestry Disability Index; VAS: Visual Analog Scale.

Evaluation of within-group changes revealed significant clinical improvement following the intervention in both treatment groups. In Group 1, mean ODI and VAS scores were significantly lower after treatment compared with baseline measurements ($p<0.001$ for both comparisons). Similarly, patients in Group 2 experienced significant reductions in both disability and pain scores at the end of the treatment period ($p<0.001$ for both outcomes) (Table 2).

The magnitude of treatment-related improvement was further examined by comparing the changes in ODI and VAS scores between groups. Analysis of ΔODI and ΔVAS values demonstrated no statistically significant differences between the 20-min and 30-min TENS protocols ($p=0.052$ and $p=0.943$, respectively) (Table 3).

Although the between-group comparison for ΔODI did not reach the predefined threshold for statistical significance, the observed effect size favored Group 2 and was within the moderate range (Cohen's $d=0.618$). This finding may indicate a potentially relevant clinical trend toward greater functional improvement with the 30-min TENS protocol. In contrast, the effect size calculated for ΔVAS was negligible (Cohen's $d=0.022$), suggesting that extending TENS duration had little influence on pain reduction outcomes.

DISCUSSION

The present study evaluated whether different TENS application durations influence treatment outcomes in patients with lumbar spondylosis. Although no significant difference was observed between the 20-min and 30-min TENS protocols regarding pain reduction or functional improvement, both treatment approaches resulted in significant improvements compared with baseline values. Furthermore, the reduction in pain scores exceeded the minimum clinically important difference (MCID) threshold in both groups, while the improvement in functional status surpassed the MCID threshold only in the group receiving 30-min TENS sessions. Overall, these findings support previous evidence demonstrating the beneficial effects of TENS on pain control and functional recovery in patients with LBP associated with degenerative lumbar conditions.

Despite the widespread clinical use of TENS, limited evidence is available regarding the optimal duration of treatment sessions in patients with lumbar spondylosis. Therefore, the present study focused specifically on comparing two commonly used application durations. By evaluating the clinical outcomes of 20-min and 30-min TENS protocols under otherwise identical treatment conditions, this study contributes to the ongoing effort to establish more standardized treatment parameters for TENS therapy.

The improvements observed in this study are consistent with the literature. Ezgi Aydın et al. [13] demonstrated significant reductions in pain intensity and disability scores following a treatment program that included 20-

min TENS sessions administered over 15 treatment visits, with no treatment-related adverse effects reported. Similarly, the addition of TENS to conventional kinesitherapy has been associated with meaningful improvements in both pain and functional capacity among individuals with chronic non-specific LBP [14]. In another study, Alizadeh and Ahmadizad [15] compared medical treatment alone, exercise combined with medical treatment, and TENS combined with medical treatment, reporting superior clinical outcomes in the group receiving TENS.

Evidence supporting the analgesic effects of TENS has also been reported in placebo-controlled studies. Dias et al. [16] found that 30-min TENS applications delivered at different stimulation frequencies produced significant pain relief compared with placebo treatment in patients with chronic LBP. Likewise, Elserty et al. [17] observed significant improvements in pain and functional performance after 40-min TENS sessions when compared with exercise alone. Similar findings were reported by Ezema et al. [18], who demonstrated greater pain reduction in patients receiving active TENS than in those receiving sham stimulation. Furthermore, Kibar et al. [19] showed that combining TENS with interferential current therapy resulted in better functional outcomes and reduced activity-related pain compared with interferential current alone, although no superiority was demonstrated over TENS monotherapy. Yaksi et al. [20] also concluded that 30-min TENS treatment was an effective and safe option for short-term pain management in patients with chronic LBP.

Although the between-group comparison of ΔODI did not achieve statistical significance ($p=0.052$), a moderate effect size favoring the 30-min TENS group was observed (Cohen's $d=0.618$). This finding suggests that the absence of statistical significance may be attributable, at least in part, to the relatively small sample size of the present study. Consequently, the possibility of a clinically relevant difference between treatment durations cannot be completely excluded and should be further examined in larger-scale studies.

Previous studies have employed a wide range of TENS treatment durations, highlighting the lack of consensus regarding the optimal application time [13, 18, 20–22]. A recent systematic review concluded that TENS may provide short-term pain relief in individuals with chronic LBP; however, the authors also emphasized the need for additional research investigating the influence of stimulation parameters such as intensity, frequency, dosage, and treatment duration [9]. In the present study, stimulation frequency and treatment dose were kept constant, allowing the isolated evaluation of treatment duration. A review of the available evidence identified a gap in the literature regarding direct comparisons of 20-min and 30-min TENS application periods in patients with lumbar spondylosis-related LBP.

Study Limitations

Only treatment duration was examined, whereas other potentially influential TENS parameters, including stimulation frequency and dosage, were not investigated. Future prospective studies with larger patient populations and varying stimulation protocols are warranted to further optimize and standardize TENS treatment strategies.

Conclusion

The present results demonstrated that extending TENS application from 20 to 30 min did not result in additional benefits in terms of pain reduction or functional improvement among patients with lumbar spondylosis. Given the comparable clinical outcomes observed between the two intervention durations, a 20-min TENS session may represent a more time-efficient and cost-effective treatment option in routine clinical practice. The adoption of shorter treatment sessions may also improve resource utilization and increase patient access to rehabilitation services without compromising therapeutic effectiveness.

Ethics Committee Approval: This study was approved by The University of Health Sciences Hamidiye Non-Interventional Scientific Research Ethics Committee on August 19, 2025. (Decision number: 2025-16-2).

Informed Consent: Written informed consents were obtained from patients who participated in this study.

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