Transcutaneous Electrical Nerve Stimulation in Dysphonic Patients: A Systematic Review

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Summary: Objective. This paper aims to systematically review the application methods and clinical outcomes of transcutaneous electrical nerve stimulation (TENS) in the rehabilitation of dysphonic patients.
Methods. The study consists of a systematic review performed in the Medline (via PubMed), Cochrane Library, Scopus and Lilacs databases, using a search strategy related to the research theme. Inclusion criteria involve experimental studies that investigated the effects of TENS on dysphonic patients, published in the last 15 years in Portuguese, English or Spanish. The Physiotherapy Evidence-Based Database was used to evaluate the methodological quality of the articles.
Results. In the first search, 100 publications were found, 57 of which were duplicated and 23 did not address TENS as an intervention. According to the exclusion criteria of the remaining 20 studies, eight were selected for this review. The studies showed a pattern regarding the application of TENS. Of the studies analyzed, 87.5% had effective results after the intervention. Regarding pain, studies have found a reduction of this symptom in the neck, shoulders, back, masseter, and larynx. In the perceptual analysis, an improvement was verified in the parameters of tension, breathiness, roughness, instability, and asthenia. In addition, different types of vocal symptoms such as pain, burning, lump in the throat and effort to speak were reduced after TENS.
Conclusion. Although the studies included in this review indicate that there were changes related to the reduction of vocal symptoms, reduction of pain and improvement of vocal quality after the application of TENS in dysphonic patients, studies with a higher level of evidence and rigorous assessments of methodological quality are necessary so that findings are more robust and replicable in clinical practice.
Key Words: Voice−Larynx−Voice disorders−Dysphonia−Transcutaneous Electrical Nerve Stimulation.

INTRODUCTION

Proper vocal production requires the balance of all muscles involved in the breathing, phonation, articulation and resonance processes.[1−3] Therefore, muscle tension and imbalance of the muscle structures surrounding the larynx have a great influence on vocal quality.[2] Muscle tension dysphonia (MTD) occurs due to excessive tension of the laryngeal extrinsic muscles.[1,4,5]

MTD characteristics involve medial vocal fold compression, vestibular fold approximation, presence of triangular gaps, elevation of the larynx in the neck, deviations in head and neck posture, and cervical rotation.[6−8] Symptoms include throat clearing, irritation, and sore throat, neck and shoulder pain, and short, compressed breathing.[7,8] Individuals who manifest this type of dysphonia usually have hoarse, breathy, and/or tense voice quality, resonance disorders, and sudden vocal attacks.[4,6,7]

The literature emphasizes indirect vocal therapy as a treatment for MTD, with approaches to everyday practices that favor the acquisition of healthy vocal habits, and direct therapy through vocal techniques that have scientifically proven effects.[1,9,10] In addition, due to muscle hyperactivity found in these cases, techniques that focus on muscle relaxation, such as manual laryngeal therapy[1,8,9] and transcutaneous electrical nerve stimulation (TENS), have been used in speech therapy for patients who have MTD diagnosis.[2,11,12]

TENS is a noninvasive resource used to decrease pain symptoms in different clinical settings, promote muscle relaxation, improve local vascularization and reduce muscle and pain hyperactivity.[11,13,14] This resource began to be used by physiotherapy and has recently been introduced into clinical speech therapy practice.[11,12] Two types of TENS are used: low frequency (≤10 Hz) and high frequency (≥50 Hz). Both types work with different mechanisms. Low-frequency TENS generates muscle contractions, while high-frequency TENS generates paresthesia, but both cause similar effects of analgesia.[13,15] Several studies have been conducted in this area, showing the increasing use of new resources in speech therapy. Studies have shown positive effects in the treatment of patients with speech-language diagnoses of swallowing disorders and MTD.[11]

In the rehabilitation of dysphonic patients, TENS is used to relax the cervical and perilaryngeal muscles, leading to an improvement in vocal quality.[4,16] However, research reinforces the effectiveness of TENS as a complement to vocal therapy. A study by Mansuri[16] comparing the effects of combined and noncombined vocal therapy with TENS showed better results in vocal quality and decreased pain-

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related complaints in the group of individuals receiving TENS as a complement to vocal therapy.

Due to the demand of patients with dysphonia associated with muscle tension and the use of new technologies in therapeutic methods, it is important to verify new methods of muscular and vocal rehabilitation to be used in the voice clinic. This study aims to systematically review the application methods and clinical outcomes of TENS on the rehabilitation of dysphonic patients and thus contribute to the clinical practice of speech therapy.

MATERIALS AND METHODS

Study design

A systematic literature review study was conducted in accordance with the Prisma protocol guidelines for systematic reviews and meta-analyzes and recorded in the PROSPERO systematic review record database under number CRD42019126425. The study aims to answer the following question: How is TENS applied and what are its effects in comparison to other therapeutic approaches on dysphonic patients?

Search strategies

The search was performed on February 18, 2020, on Medline platforms (via PubMed), Cochrane Library, Scopus and Lilacs. The MeSH terms used were "voice," "larynx," "dysphonia" and "voice disorders" associated with the term "transcutaneous electric nerve stimulation" using the Boolean term "AND" for Pubmed and other databases. Equivalent search strategies were adopted for each database.

Eligibility criteria and data extraction

The selection of articles was initiated by the search for titles, which excluded duplicate studies and those that were unrelated to the keywords defined in the search strategy. After reading the abstracts, we selected the experimental studies that described the application methods and clinical outcomes of TENS in dysphonic individuals, published in the last 15 years, in Portuguese, English or Spanish. The exclusion criteria were studies that included individuals younger than 18 years old, with psychiatric, neurological, syndromic and head and neck cancer diagnoses. The selected studies were read in full and analyzed to include those that met the eligibility criteria. The following information was taken from the full-text reading: title, year, journal, author, study design, purpose, sample characteristics, voice assessment methods, intervention, and intervention effects. Title analysis, abstracts, and full article reading were performed by three independent, blinded judges, and discrepancies were resolved by consensus.

Methodological evaluation

The Physiotherapy Evidence-Based Database (PEDro) is used to assess the methodological quality of experimental studies.[17,18] It consists of 11 items and each item contributes to the total scale score. Items 2 through 9 are used to assess the internal validity of the study and items 10 and 11 assess whether the study contains minimal statistical information so that the results can be interpreted. The PEDro scale is based on the Delphi scale developed by Verhagen and colleagues.[19] The PEDro scale score ranges from 0 to 10, since item 1 of the scale, which evaluates the external validity of the study, was kept only to represent the criteria of the Delphi scale, so it is not computed in the final score.

The methodological quality of the studies included in this review was assessed by three independent and blinded researchers. PEDro evaluators analyzed only what was reported in the manuscripts. Criteria that were not clearly described in the studies were not scored.

RESULTS

Through the search strategy adopted, 100 studies were found. Of these, eight studies were included in the review according to the eligibility criteria. The stages of study selection and analysis are described in Figure 1, as recommended by Prisma.

Characterization of the studies

Table 1 shows the characterization of the studies. Participants were between 18 and 55 years old, 207 female and 10 male. Regarding the diagnosis, 50% of the studies presented subjects with vocal nodules, 25% presented in the sample subjects diagnosed with TMD and 25%, behavioral dysphonia. Of the eight studies, two (25%) are clinical trials and six (75%) are randomized controlled trials.

Application methods of TENS

The characteristics of TENS application can be identified in Table 2. The most commonly used device for TENS application was Duaplex 916 in 62.5% of the studies, followed by ELPHA II 3000 in 25% of the studies and Neurodyn II at 12.5%. Regarding frequency and pulse width patterns, 7 (87.5%) studies used the values of 10 Hz and 200 μs, except for the study by Mansuri et al,[20] which investigated the effects of high-frequency TENS. Of the studies analyzed, 87.5% used the duration of 20 minutes of TENS application, and the electrode placement sites varied according to the study. All authors used two pairs of electrodes, one of which was applied to the trapezius muscle in all studies. The electrodes were placed on the upper part of the trapezius muscle in six studies,[4,14,16,20–22] one study[12] used the electrodes on the bottom and another[23] applied the electrodes in a muscle area established by the therapist after palpation. The other pair of electrodes were applied to both sides of the submandibular region (50%), the lateral center of the thyroid cartilage- infrahyoid muscles (37.5%) or sternocleidomastoid muscle (12.5%).

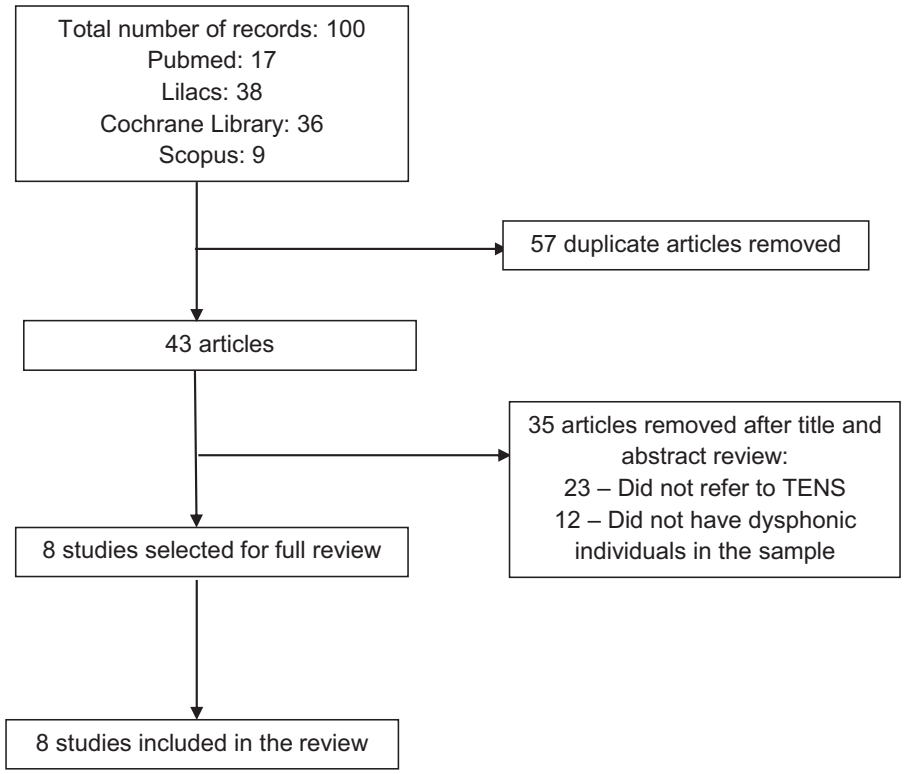

FIGURE 1. Study flowchart.

Assessment methods

To verify the clinical outcomes of TENS, some parameters stood out for being frequently used in the analyzed studies. Six studies (75%) used auditory perceptual analysis, seven studies performed acoustic analysis (87.5%), five studies (62.5%) used some vocal symptoms questionnaire, five (62.5%) used methods to evaluate musculoskeletal pain and one study (12.5%) made use of electromyographic examination. In the analysis of vocal symptoms, two studies[16,20] used the Vocal Tract Discomfort Scale, one study[14] used a Visual Analog Scale and two other studies[4,22] used questionnaires elaborated by the authors themselves. To evaluate musculoskeletal pain, the Extended Nordic Musculoskeletal Symptoms Questionnaire[16,20] was utilized, two used the Musculoskeletal Pain Investigation questionnaire,[22] one used the Pressure Pain Threshold measurement using the pressure algometry technique, to measure the perception and tolerance to muscle pain in the trapezius region[23] and a Visual Analog Scale,[4,16,20,22] with a length of 100 mm, in which the subject marked a vertical line crossing at the point corresponding to the pain level.

Clinical outcomes of the intervention

Table 3 shows the interventions performed, the frequency and results of the interventions, also comparing the use of TENS with other treatment methods such as Manual Laryngeal Therapy and Vocal Therapy. Of the studies analyzed, 87.5% showed effective results after TENS application. The interventions were divided into ten sessions (25%), 12 sessions (37.5%) or performed in one session (37.5%).

Studies[4,16,20,22,23] that assessed individuals' musculoskeletal pain after TENS application showed reduction in neck pain,[4,16,20, 22,23] shoulders,[4,16,22,23] upper back,[4,16,22] trapezius,[23] masseter[16,22,23] and larynx.[20,23] Moreover, in the study by Guirro et al,[12] the electromyographic evaluation showed reduced activity of the muscles analyzed after the intervention.

Only one study[16] showed significant results in acoustic analysis, with improvement in the shimmer parameter. In the perceptual analysis, the studies found improvement in the parameters of tension,[4,12,16] breathiness,[12,14,16] roughness,[12,14,16] instability[22] and asthenia.[20] Studies[4,14,16,20,22] that applied vocal symptom questionnaires had positive responses with improvement in different types of symptoms such as pain, burning, lump in the throat[16,20] and effort to speak.[4,14]

Three studies[4,21,22] compared the effects of TENS with the effects of Manual Laryngeal Therapy and obtained different results for each technique, both positive. Two studies[14,16] used TENS as a complement to vocal therapy. The study by Mansuri et al,[16] analyzed the effects of isolated and combined vocal therapy with TENS, showed better results in the group that used TENS as a complement to vocal therapy.

The study by Siqueira et al[23] analyzed the effects of placebo TENS combined with vocal therapy and TENS in conjunction with vocal therapy, did not find a statistically significant difference, although the data trended in the expected direction. The study by Santos et al,[14] which verified the effects of TENS alone and combined with the

TABLE 1.
Sample Characterization

Author	TItle	Sample	Age	Gender	Study Type
Siqueira et al (2019)	Effects of Transcutaneous Electrical Nervous Stimulation (TENS) Associated With Vocal Therapy on Musculoskeletal Pain of Women With Behavioral Dysphonia: A Randomized, Placebo-Controlled Double-Blind Clinical Trial	Patients with behavioral dysphonia (30)	18–45	27 Female	Randomized clinical trial
Mansuri et al (2019)	Application of High-Frequency Transcutaneous Electrical Nerve Stimulation in Muscle Tension Dysphonia Patients With the Pain Complaint: The Immediate Effect	Patients with MTD (30)	Average 36.40	20 Female 10 Male	Randomized clinical trial
Conde et al (2018)	Transcutaneous Electrical Nerve Stimulation (TENS) and Laryngeal Manual Therapy (LMT): Immediate Effects in Women With Dysphonia	Patients with behavioral dysphonia (30)	18–45	Female	Randomized clinical trial
Mansuri et al (2018)	Transcutaneous Electrical Nerve Stimulation Combined With Voice Therapy in Women With Muscle Tension Dysphonia	Patients with MTD (20)	25c45	Female	Randomized clinical trial
Siqueira et al (2017)	Effects of laryngeal manual therapy (LMT) and transcutaneous electrical nerve stimulation (TENS) in vocal folds diadochokinesis of dysphonic women: a randomized clinical trial	Patients with vocal nodules or mucosa thickening and phonation gap (20)	18–45	Female	Randomized clinical trial
Santos et al (2016)	Evaluation of Electrostimulation Effect in Women With Vocal Nodules	Patients with vocal nodules or mucosa thickening and phonation gap (60)	18–55	Female	Comparative prospective randomized clinical trial
Silvério et al (2015)	Effect of Application of Transcutaneous Electrical Nerve Stimulation and Laryngeal Manual	Patients with bilateral vocal nodules (20)	18–45	Female	Clinical trial

(*Continued*)

TABLE 1. (*Continued*)

Author	TItle	Sample	Age	Gender	Study Type
	Therapy in Dysphonic Women: Clinical Trial				
Guirro et al (2008)	Transcutaneous electrical nerve stimulation in dysphonic women	Patients with vocal nodules or bilateral mucosa thickening and phonation gap (10)	18–50	Female	Clinical trial

tongue vibration technique, showed better results in vocal symptoms in the group using both combined techniques.

Methodological quality

Table 4 shows the assessment of methodological quality by applying the PEDro Scale. All studies obtained scores equal to or greater than 4, except for one study, which contained only one group in the sample and, therefore, could not score on criteria 3, 4, 8, and 10. Of the studies analyzed, 62.5 % presented[4,16,20-22] clear criteria for the inclusion of subjects. The randomized and secret allocation of subjects was performed in 75% of the studies[4,14,16,21,20,23] and in 87.5% of them,[4,14,16,20-23] the groups were similar regarding the most important prognostic indicators.

The evaluation of at least one key outcome was performed blinded and results of intergroup statistical comparisons were reported in 87.5% of the studies.[4,14,16,20-23] Seven studies had problems meeting the blinding criteria of the subjects and therapists and did not present measures of precision and variability for key outcomes. Criteria 8 and 9 were not scored in any of the studies, as no specific information was provided regarding the loss of subjects during the interventions.

DISCUSSION

This review analyzed the application and effects of TENS in dysphonic patients. As for the clinical outcomes, there were changes in vocal quality, and improvement in qualitative parameters after the intervention with the use of TENS.

Of the total number of study participants, 180 subjects were female and only 10 male. Other studies[2,9,24,25] that investigated the effects of techniques for muscle relaxation on MTD also showed in most or all of their samples female individuals, showing their prevalence in the diagnosis of dysphonia caused by muscle hyperfunction. Studies[26,27] point out that the predominance of dysphonic women due to muscle tension and vocal nodules has biological and behavioral factors, such as the difference in thickness and size of male and female vocal folds. Because they are shorter and thinner, female vocal folds suffer more collisions during

TABLE 2.
TENS Application Characteristics

Author	Device	Frequency	Pulse width	Time	Location of the Electrodes	Types of Electrodes
Siqueira et al (2019)	Duaplex 961	10 Hz	200 μs	20 min	Trapezius and submandibular region	2 pairs (3 cm x 5 cm)
Mansuri et al (2019)	ELPHA II 3000	100 Hz	50 μs	20 min	Trapezius and thyroid cartilage	2 pairs (5 cm x 5 cm)
Conde et al (2018)	Duaplex 961	10 Hz	200 μs	20 min	Trapezius and submandibular region	2 pairs (5 cm x 4 cm)
Mansuri et al (2018)	ELPHA II 3000	10 Hz	200 μs	20 min	Trapezius and thyroid cartilage	2 pairs (5 cm x 5 cm)
Siqueira et al (2017)	Duaplex 961	10 Hz	200 μs	20 min	Trapezius and submandibular region	2 pairs (3 cm x 4 cm)
Santos et al (2016)	NEURODYN II	10 Hz	200 μs	20 min	Trapezius (two electrodes in the same channel) and thyroid cartilage	2 pairs (3 cm x 5 cm)
Silverio et al (2015)	Duaplex 961	10 Hz	200 μs	20 min	Trapezius and submandibular region	2 pairs (5 cm x 5 cm)
Guirro et al (2008)	Duaplex 961	10 Hz	200 μs	30 min	Trapezius (one electrode from each channel) e sternocleidomastoid	2 pairs (4 cm x 4 cm)

TABLE 3.
Effects of TENS Application

Author	Intervention	Results				
		Auditory Perceptual Analysis	Acoustic Analysis	Vocal Symptoms	Musculoskeletal Pain	Pressure Pain Threshold
Siqueira et al (2019)	G1—TENS + Vocal therapy G2—TENS Placebo + Vocal therapy	Parameter not analyzed	Parameter not analyzed	Parameter not analyzed	G1—pain intensity improvement in the shoulders, anterior neck, masseter and larynx regions . G2- improvement of pain frequency in anterior neck and larynx regions.	G1– Reduction of pain intensity in the trapezius region.
Mansuri et al (2019)	G1—High frequency TENS G2—SHAM	G1—improves asthenia	No significant difference	G1—improves pain, burning, itching and lump in throat and dry throat	G1—Neck and larynx pain reduction	Parameter not analyzed
Conde et al (2018)	G1—TENS G2—LMT	G1—improves instability G2—improves tension, worsens breathiness in some cases	No significant difference	G1—reduction of symptoms related to voice and larynx G2—Voice and articulation symptoms	G1 e G2—Reduction of pain in the anterior and posterior neck, shoulders, upper and lower back and masseter regions	Parameter not analyzed
Mansuri et al (2018)	G1—TENS + Vocal therapy G2—Vocal therapy	G1 e G2—improves in all parameters of the CAPE-V, without differences between groups	G1—improves in the Shimmer parameter	G1 e G2—improves in all items of the VTD, higher in G1.	G1—decreased pain anterior, posterior, larynx, masseter, shoulder, and upper back	Parameter not analyzed
Siqueira et al (2017)	G1—TENS G2—LMT	Parameter not analyzed	G1—No significant difference G2—improves instability /i/	Parameter not analyzed	Parameter not analyzed	Parameter not analyzed
Santos et al (2016)	G1—TENS G2—TENS + Tongue vibration CG	G1 e G2—improves in the parameters of roughness, breathiness and overall severity	No significant difference	G1 e G2—Improved vocal effort compared to CG, higher in G2.	Parameter not analyzed	Parameter not analyzed

(*Continued*)

TABLE 3. (*Continued*)

Author	Intervention	Results				
		Auditory Perceptual Analysis	Acoustic Analysis	Vocal Symptoms	Musculoskeletal Pain	Pressure Pain Threshold
Silverio et al (2015)	G1—TENS G2—LMT	G1—improves tension	No significant difference	G1—improvement in "thin voice" symptoms and "effort to speak" G2—improvement in "sore throat" symptom	G1—Decreased pain in the back of the neck, shoulder, and upper back G2—Decreased pain in anterior and posterior neck regions	Parameter not analyzed
Guirro et al (2008)	G—TENS	Improves hoarseness, breathiness and tension	No significant difference	Parameter not analyzed	Parameter not analyzed	Parameter not analyzed

Abbreviations: CG, control group; G, group.

phonation, presenting less tissue to absorb vibratory forces. In addition, it is believed that women talk more than men, and that they are more likely to experience emotional stress, which can cause musculoskeletal tension throughout the body. This body tension often extends to the extrinsic muscles of the larynx and contributes to the appearance of excessive tension in that organ.

The diagnosis of vocal nodules prevailed in the research participants. Vocal nodules are associated with repetitive lesions in the vocal fold mucosa generated by laryngeal hyperfunction and vocal abuse[6,28,29] and appear predominantly in females.[29–32]

In the studies analyzed in this review, it was possible to notice a pattern in relation to the parameters used in the application of TENS. Low-frequency TENS with parameters of 200 μs and 10 Hz was used for 20 minutes in 87.5% of the studies.[13] The intensity of the stimulus varied according to the sensitivity of each subject and was increased when the patient reported decreased sensation.[12,14,20] As for the electrode application site, all studies used one of the electrode pairs on the trapezius muscle. Previous studies state that women are more likely to suffer from trigger points in this region due to excessive tension.[7,14,16,33] Research differed in electrode distribution. Most authors[4,12,21–23] used one channel for placement of two electrodes on the right side and the other channel for placement of two electrodes on the left side. The other studies positioned each canal individually, in specific regions such as submandibular, trapezius and sternocleidomastoid.[14,16,20] The region of stimulation varies with the placement of the electrodes and may cause different effects. When one electrode of each channel is distributed by region, an electrostimulation field is formed so that all perilaryngeal muscles are stimulated. This configuration of the electric current, therefore, generated by both channels, leads to bilateral electrostimulation of the muscle groups, providing strong passive mechanical vibration of the larynx and trapezius muscle, besides relaxation.[21] However, the studies analyzed in this review showed similar results, regardless of electrode distribution.

Several studies indicate the presence of musculoskeletal pain in dysphonic individuals.[33–35] This pain may occur due to cervical and laryngeal tension caused by inadequate vocal behavior.[1,9,33,36] TENS has been used in patients with these characteristics aiming at laryngeal relaxation, pain reduction and vocal quality improvement.[12] All studies showed a reduction in pain symptoms after TENS application. The most benefited body regions were the anterior and posterior neck, shoulder and upper back. One study used the "Pressure Pain Threshold" measurement to verify the symptom of pain in the trapezius region. Improvement of pain perception and tolerance in this region was found in the group in which TENS was applied.[23] The reduction of the pain symptom in the regions where the electrodes are applied can be justified by the TENS application method. TENS stimulation causes contractions in the stimulated muscle, generating muscle relaxation and pain reduction.[4,13] Pain reduction in regions that were not directly stimulated

TABLE 4.
Methodological Quality Assessment

	Siqueira et al (2019)	Mansuri et al (2019)	Conde et al (2018)	Mansuri et al (2018)	Siqueira et al (2017)	Santos et al (2016)	Silvério et al (2015)	Guirro et al (2008)
1. Eligibility criteria	Yes	Yes	No	Yes	Yes	No	Yes	No
2. Randomized Allocation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
3. Secret Allocation	Yes	Yes	No	Yes	Yes	Yes	Yes	No
4. Similarity of groups in prognosis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
5. Blinding of all subjects	Yes	No	No	No	No	No	No	No
6. Blinding of all therapists	Yes	No	No	Yes	No	No	No	No
7. Blinding of assessors	Yes	Yes	Yes	No	No	Yes	Yes	No
8. Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups	No	No	No	No	No	No	No	No
9. Analysis of "intention to treat"	No	No	No	No	No	No	No	No
10. Between-group statistical comparisons	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
11. Precision and variability measures	Yes	No	No	Yes	No	No	No	No
Total Point	8/10	5/10	4/10	6/10	4/10	5/10	5/10	0/10

may be related to the stimulation current formed by the placement of the electrodes. In addition, it can also be caused by stimulation performed on the trapezius muscle descending fiber, which is a myofascial trigger point and can minimize pain in related areas.[21,22]

Studies also show improvement in the roughness, breathiness, tension and instability parameters in the perceptual analysis. The study by Pereira, 2017[9] claims that the presence of roughness is characteristic of the clinical picture of MTD. This statement agrees with the results of this study, which presented a significant number of individuals with rough voice quality. In three of the analyzed studies,[12,14,16] the roughness parameter received a positive impact after TENS application. Improvement in these parameters of auditory-perceptual analysis may occur due to vibrations generated in the larynx by electrical stimulation, which promotes balance in the extrinsic and intrinsic muscles of this organ, generating proper closure of vocal folds and balance of aerodynamic and myoelastic forces.[22] This factor may also explain the improvement in the shimmer parameter—found in one of the analyzed studies. One of the studies obtained as a result in the perceptual evaluation an improvement of the asthenia parameter after the application of high-frequency TENS. Asthenia or vocal hypofunction is correlated with the perception of vocal weakness and low energy in the emission, as seen in neurological cases.[6,37,38] Therefore, the appearance of the parameter and asthenia is not common in patients with dysphonia due to muscle tension, which normally present tense vocal quality.[4,6,7]

Similar effects of low-frequency and high-frequency TENS have been found in relation to vocal symptoms and musculoskeletal pain. However, in relation to vocal quality, studies that analyzed the effects of low-frequency TENS, reported changes in tension parameters,[4,12,16] roughness,[12,14,16] breathiness[12,14,16] and instability[22] after the intervention, and the study that used high-frequency TENS[20] found improvement in the asthenia parameter after using the technique.

The reduction in symptoms of sore throat and effort to speak were reported by research participants and may be attributed to analgesic action, muscle relaxation and improvement in vocal quality caused by TENS. These effects are attributed to balanced muscle action, reducing the symptoms caused by muscle contraction in these regions.

The methodological quality of the studies was assessed using the PeDRO scale, which revealed some necessary aspects to be absent from the methodological descriptions of the studies. The description of these aspects in the methodology is recommended for further studies so that the effectiveness of the technique used is better evidenced. Given the small number of studies evaluated, concentrated mainly in two laboratories, there is an understanding of the importance of more evidence in the area. These future studies should involve larger samples, applied in different populations and with therapist and double-blinding to better verify the effects of TENS on aspects related to voice.

All the studies analyzed in this review presented similar results regarding the application methods and clinical outcomes of TENS, indicating that there are emerging protocols regarding the use of this method for managing voice disorders and that it shows promise for producing positive effects as an adjunctive therapeutic approach in patients with muscle tension dysphonia.

CONCLUSION

Although the studies included in this review indicate that there were changes related to the reduction of vocal symptoms, pain reduction and improvement in vocal quality after the application on TENS on dysphonic patients, studies with a high scientific evidence level and rigorous methodology are necessary so that findings are more robust and replicable in clinical practice.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDICES

Search Strategies

Pubmed

(((((transcutaneous electric nerve stimulation[MeSH Terms]) AND dysphonia[MeSH Terms])) OR ((transcutaneous electric nerve stimulation[MeSH Terms]) AND voice disorders [MeSH Terms])) OR ((transcutaneous electric nerve stimulation[MeSH Terms]) AND larynx[MeSH Terms])) OR ((transcutaneous electric nerve stimulation[MeSH Terms]) AND voice[MeSH Terms])

Lilacs

(tw:((tw:(Transcutaneous Electrical Nerve Stimulation)) AND (tw:(voice)))) OR (tw:((tw:(Transcutaneous Electrical Nerve Stimulation)) AND (tw:(dysphonia)))) OR

(tw:((tw:(Transcutaneous Electrical Nerve Stimulation)) AND (tw:(voice disorders)))) OR (tw:((tw:(Transcutaneous Electrical Nerve Stimulation)) AND (tw:(larynx))))

Scopus

(TITLE-ABS-KEY (transcutaneous AND electric AND nerve AND stimulation) AND TITLE-ABS-KEY (voice) OR TITLE-ABS-KEY (transcutaneous AND electric AND nerve AND stimulation) AND TITLE-ABS-KEY (larynx) OR TITLE-ABS-KEY (transcutaneous AND electric AND nerve AND stimulation) AND TITLE-ABS-KEY (voice AND disorders) OR TITLE-ABS-KEY (transcutaneous AND electric AND nerve AND stimulation) AND TITLE-ABS-KEY (dysphonia))

Cochrane Library

1# ("transcutaneous electric nerve stimulation"):ti,ab,kw AND (voice):ti,ab,kw
2# ("transcutaneous electric nerve stimulation"):ti,ab,kw AND (larynx):ti,ab,kw
3# ("transcutaneous electric nerve stimulation"):ti,ab,kw AND (voice disorders):ti,ab,kw
4# ("transcutaneous electric nerve stimulation"):ti,ab,kw AND (dysphonia):ti,ab,kw

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