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Evaluation of Mandibular Deprogramming Using TENS (Transcutaneous Electrical Nerve Stimulation) in Patients at the Specialty Clinic of the Juarez Autonomous University of Tabasco from 2022 to 2024

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Abstract

Temporomandibular disorders (TMD) negatively affect quality of life, causing pain and restricted jaw movements. This study evaluates the effectiveness of Transcutaneous Electrical Nerve Stimulation (TENS) on TMD patients before orthodontic treatment at the Juarez Autonomous University of Tabasco. A quantitative, quasi-experimental study was conducted with 30 patients who met the inclusion criteria: aged 18 to 65 years, with TMJ pain symptoms, diagnosed with temporomandibular disorders using the Helkimo index, and who had provided informed consent for the study. The range of mandibular movement and the Visual Analog Scale (VAS) were measured to record values before therapy. The electrodes of the TENS therapy were positioned on both sides of the jaw in the preauricular area and the masseter muscle, the therapy was administered for 40 minutes, utilizing a frequency of 2 - 4 Hz and a pulse duration of 300 microseconds. Following this, the range of mandibular movement and the VAS were reassessed to evaluate the outcomes., significantly improved maximum mouth opening (37.7 ± 6.4 mm to 44.6 ± 5.88 mm), right laterality (3.86 ± 1.57 mm to 5.43 ± 1.21 mm), left laterality (3.13 ± 1.63 mm to 4.53 ± 1.61 mm), protrusion (4.01 ± 1.7 mm to 5.36 ± 1.32 mm), and pain perception (4.56 ± 2.045 to 2.03 ± 1.5) ($P < 0.01$). TENS therapy enhances mandibular movement and reduces pain, making it a well-tolerated, non-invasive complementary treatment for TMD.

Keywords

TENS, Opening, Deprogramming, Electrostimulation, TMJ (Temporomandibular Joint)

1. Introduction

Temporomandibular disorders affect the quality of life, causing pain and limitations in jaw movements [1]. After dental pain, temporomandibular disorders are the most common cause of orofacial pain and have the potential to produce chronic pain [2]. The temporomandibular joint (TMJ) is a complex anatomical structure that plays an important role in the ability to speaking, chewing, and swallowing [3] This is achieved through mandibular movements, these are the displacements that the jaw can perform thanks to the dynamics of rotations and translations in a three-dimensional manner [4].

Transcutaneous Electrical Nerve Stimulation (TENS) has been studied as a non-invasive therapy for these disorders, demonstrating effectiveness in relieving pain and relaxing muscles [5], this is achieved through the use of functional low-voltage electrical impulses delivered via electrodes on the skin, which reduce the sensation of pain and allow for physiological muscle elongation [6]. TENS inhibits nociceptive impulses from nerve fibers, thereby activating endogenous mechanisms known as "diffuse inhibitory controls" [7]. TENS for TMJ works through electrical stimulation, which allows the muscles involved in the TMJ, such as the masseter and temporalis, to relax and improve mobility by reducing stiffness. Additionally, it increases blood circulation, helping to reduce inflammation and promote healing of this condition. Contraindications for TENS include patients with pacemakers, as the electrical impulses can interfere with their functioning, and patients with infections or neoplasms, as it can worsen their condition. The risks of the therapy include irritation in the area where the electrodes are placed and overstimulation, which can cause muscle fatigue. Therefore, it should be performed professionally to ensure correct application. However, its specific use in TMJ disorders requires further research.

Aurelié *et al.*, compared TENS with low-level laser therapy, ultrasound therapy, and occlusal splints, finding that 67% of patients treated with TENS no longer experienced discomfort while chewing and opening their mouths, compared to only 53% with occlusal splints. No significant differences were found with ultrasound therapy [8].

This study explores the impact of TENS on patients with temporomandibular disorders before orthodontic treatment, aiming to contribute to the scientific literature. It evaluates maximum mouth opening, mandibular lateralization, and pain perception before and after TENS. The results are expected to enrich scientific knowledge and offer more effective treatments for these disorders.

2. Objective

Evaluate the effectiveness of transcutaneous electrical nerve stimulation in mandibular deprogramming in patients at the Orthodontics Clinic of the Juarez Autonomous University of Tabasco.

3. Material and Method

3.1. Methodological Design

The focus of this research project is quantitative, quasi-experimental, and longitudinal. It aims to test the proposed hypothesis with theoretical and scientific support to achieve the expected results and meet the objectives.

3.2. Method

A non-probabilistic convenience sampling technique was utilized, enrolling a total of 30 patients who met the inclusion criteria, which were: patients aged between 18 and 65 years, patients with symptoms of TMJ pain, patients diagnosed with temporomandibular disorders using the Helkimo index, and patients who had signed the informed consent for the study; patients were excluded from this study if they were undergoing therapy with analgesics or anti-inflammatory drugs, had pacemakers or defibrillator implants, were pregnant, or had an infection or neoplastic process in the area.

Patients underwent the Helkimo index [9], this index is subdivided into two parts, the dysfunction index and the clinical index. The dysfunction index evaluates the severity of temporomandibular disorders using five clinical criteria: pain in the temporomandibular joint (TMJ), tenderness to palpation, limitation of mandibular movement, alteration of mandibular movement, and TMJ noises. Each criterion is scored from 0 to 5, where 0 indicates the absence of symptoms and 5 indicates maximum severity. These scores are summed to classify the severity of TMD from 0 (no dysfunction) to 25 (severe dysfunction). The clinical index assesses the patient's clinical state through a series of observations and tests conducted by the clinician. This includes evaluation of mouth opening, lateral and protrusive movements of the jaw, as well as the presence of pain or joint noises during these movements.

Mandibular movement (Maximum mouth opening, right laterality, left laterality, protrusion) ranges were measured using the Active Range of Motion (AROM) scale. A digital Vernier caliper was used as follows: the caliper was positioned perpendicular to the plane of jaw movement, ensuring precise alignment with the direction of the movement being measured. The patient was asked to perform the movement to their maximum capacity to record the range of motion; for example, for maximum opening, the caliper was adjusted so that the lower part rested on the top of the lower teeth and the upper part on the bottom of the upper teeth. The measurement was read and recorded. To assess the therapy's effectiveness, measurements of each movement were taken after applying TENS. This helps determine if there is improvement in the range of motion.

The patient's pain perception was assessed using the Visual Analog Scale (VAS). A horizontal line close to 10 cm in length is shown, where the beginning represents "no pain" (0) and the end the worst pain [10]. The patient is instructed to mark on the line to indicate their current pain intensity level. This mark can be a line, dot, or cross. After TENS therapy, the VAS is applied again to determine if there is an improvement in pain perception. There is bias associated with the VAS due to the variability of evaluations, as they are subjective and dependent on each patient's individual pain perception. Additionally, interpretation and marking on the scale can be influenced by emotional, cultural factors, or even the timing of the measurement, potentially impacting the consistency and accuracy of the results obtained.

Electrodes were placed bilaterally in the preauricular area and the masseter muscle, and TENS was applied for 40 minutes at a frequency of 2 - 4 Hz with a pulse duration of 300 microseconds. Subsequently, mandibular movement range was measured again to evaluate the results.

For the application of Transcutaneous Electrical Nerve Stimulation (TENS), the TENS 7000 TM device was chosen for bilateral stimulation of the V and VII cranial nerves. Two self-adhesive electrodes measuring 2 inches by 2 inches were placed for low-frequency nerve stimulation using two channels. IBM SPSS Statistics 2.0 software was selected for statistical analysis and variable description.

4. Results

A paired samples T-test analysis was conducted for before/after measurements for each of the variables before and after the application of TENS. A significant difference was found for mouth opening with a P-value less than 0.001. It was observed that the mean value of mouth opening before the application of TENS was 37.7 ± 6.4 mm, and after using TENS, the value found was 44.6 ± 5.88 mm (**Table 1**). These values indicate an improvement in the maximum mouth opening movement of 18.3%.

Additionally, due to the high correlation coefficient found, it was decided to explore whether there was a model explaining the relationship between the values before and after. Thus, a simple linear regression method was applied, and it was found that the scatter plot followed a linear trend (**Figure 1**), Equation (1) serves as a predictive model for the before and after relationship. Moreover, Equation (2) shows the coefficient of determination that indicates the explained variation is up to 90.5% accurate; the remaining 9.5% is due to unexplained variations, which may be attributed to factors such as the level of temporomandibular disorder and the individual anatomy of each patient.

$$Y = 0.8705x + 11.79. \quad (1)$$

$$R^2 = 0.905. \quad (2)$$

The average value of right laterality before the application of TENS was 3.86 ± 1.57 mm, and after the therapy, an average of 5.43 ± 1.21 mm was found (**Table 1**). The results for left laterality improved from an average of 3.13 ± 1.63 mm to

a value of 4.53 ± 1.61 mm (Table 1). Protrusion was 4.01 ± 1.7 mm and after 40 minutes of therapy, its value was 5.36 ± 1.32 mm (Table 1).

Pain perception showed a significant difference with a confidence level of 99% and a significance level of 1%. It was observed that the mean value before the application of TENS was 4.56 ± 2.045 mm, and after the use of TENS, it was 2.03 ± 1.5 mm (Table 1).

Table 1. Comparison of the mean before and after TENS therapy.

	Before	After	P-Value
Maximum mouth opening	37.7 ± 6.4 mm	44.6 ± 5.88 mm	P < 0.01
Right laterality	3.86 ± 1.57 mm	5.43 ± 1.21 mm	P < 0.01
Left laterality	3.13 ± 1.63 mm	4.53± 1.61 mm	P < 0.01
Protrusion	4.01 ± 1.7 mm	5.36 ± 1.32 mm	P < 0.01
Pain perception	4.56 ± 2.045 mm	2.03 ± 1.5 mm	P < 0.01

a. Comparison of the mean before and after TENS therapy.

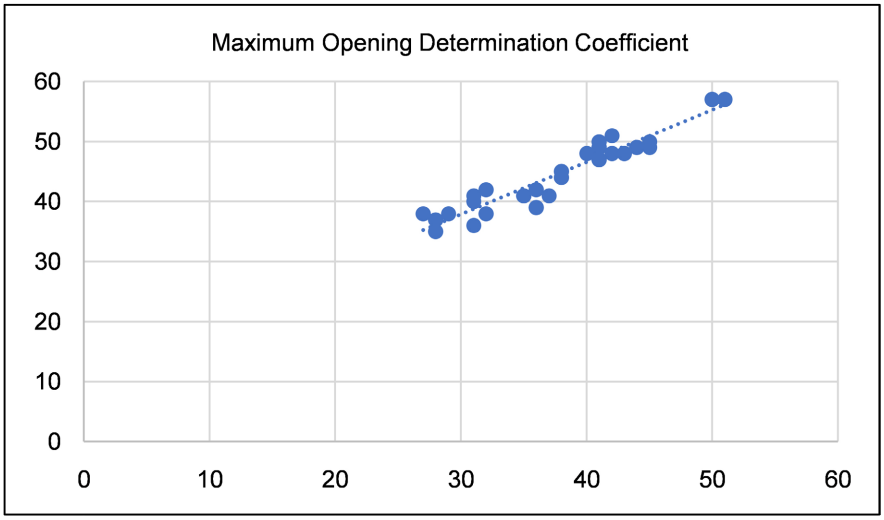

Figure 1. Maximum opening determination coefficient (millimeters (mm)).

5. Discussion

Regarding the consulted scientific literature, there are articles evaluating the outcomes of transcutaneous electrical nerve stimulation in the TMJ. It is important to note that within the limitations of this study, there was no control group to ensure that the intervention is responsible for patient improvement, as placebo effects were not verified. Similarly, the bias that may exist with the VAS is due to the variability of evaluations, as they are subjective and dependent on each patient's individual pain perception. Similar studies have sought to determine the effectiveness of TENS. Authors such as Zhang *et al.* found that pain reduction and increased range of opening were better following the application

of TENS (P = 0.007). Compared to the results of this study, it can be determined that the results are consistent, as our confidence level was 99% [10].

Other authors, like Barile, analyzed the effects of TENS application with an emphasis on pain through recruited clinical trials; similar to this project, there is a decrease in pain intensity, suggesting that TENS can also be included in therapies for treating TMD [11].

Additionally, in other research such as that by Aurélie *et al.*, it was found that there is a significant functional improvement in mandibular opening movement, achieving values up to 19.46% higher. In this study, the improvement in the range of this movement was 18.3% [8].

6. Conclusions

After the observation and analysis of the obtained data, it can be concluded that applying transcutaneous electrical nerve stimulation (TENS) at ultra-low power for 40 minutes, with a duration of 300 microseconds and a frequency of 4 Hz, resulted in a significant difference before and after using the device in terms of maximum opening, as well as lateral and protrusive movements. In patients with Temporomandibular Disorders (TMD), TENS proves to be effective in providing short-term pain relief, significantly contributing to the reduction of painful symptoms experienced by these patients.

In addition to its analgesic effects, TENS produces immediate muscle relaxation, which can improve patients' quality of life. However, it is important to consider that this technique should be viewed as a complementary therapy, as it does not address or correct the underlying etiology of TMD. Despite this limitation, TENS therapy stands out as a non-invasive treatment that does not require surgery and is not painful, making it a generally well-tolerated option for most patients. This acceptance and tolerability favor its incorporation into comprehensive therapeutic regimens for managing Temporomandibular Disorders.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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