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Effect of transcutaneous electrical nerve stimulation therapy on condylar position and myofascial pain in patients with temporomandibular joint disorders—A pilot clinical trial

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Abstract

OBJECTIVE: Temporomandibular joint disorders (TMD) are a type of disorder that affects the temporomandibular joint, muscles, and nerves leading to persistent facial pain. Transcutaneous electrical nerve stimulation (TENS) therapy is an alternative treatment for pain relief in TMD patients. The aim of the study was to assess the condylar position changes and pain levels occurring in TMD patients after TENS therapy.

MATERIALS AND METHODOLOGY: According to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) criteria, a total of seven patients with TMD were included in this study. Routine diagnostic investigations were taken for each patient along with joint vibration analysis (JVA), electromyography (EMG), and a cone beam computed tomography (CBCT) at rest position. Using the Dolphin software (version 11.95), the temporomandibular joint spaces were measured on the CBCT for the right and left sides individually for each patient. These patients were then subjected to TENS therapy, and an EMG reading was taken post-TENS therapy to evaluate the effect on muscle strain. A CBCT was taken after the TENS therapy to assess its effect on the condylar position. The statistical significance of the pre- and post-temporomandibular joint spaces and the EMG readings post-TENS therapy were assessed using paired t-tests, respectively.

RESULTS: There was a change in the anterior, middle, and posterior dimensions observed radiographically, before and after TENS. However, the results were found to be statistically significant only in the anterior region on the right joint space ($P = 0.03$) and posterior region of the left joint space ($P = 0.04$).

CONCLUSION: TENS therapy has been found to bring about a change in the condylar position and pain intensities by relieving inadvertent muscle activity in the temporomandibular region. Therefore, further studies with larger sample sizes and control are required to fully ascertain the role of inadvertent muscle activity on the TMJ.

Keywords:

CBCT, clicking, condyle, pain, temporomandibular joint

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Introduction

Temporomandibular joint disorders (TMD) are a group of degenerative musculoskeletal diseases that impact the muscles, nerves, and temporomandibular joint, resulting in morphologic, functional abnormalities and chronic facial pain.[1] This multifactorial disorder can be caused by various neuromuscular, neurobiological, biopsychosocial, and biomechanical factors.[2] In this condition, pain mainly

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occurs due to strain in the muscles during jaw movements. When the muscles of the jaw move along the hard tissues in the head and neck region, they get strained and eventually put pressure on the local nerves and other muscles, which in turn forms a cascade effect causing persistent pain.[3] The incidence of TMDs in the world population is about 34%, most commonly within the age group of 18 to 60 years.[4] Literature suggested that the disorder is 1.5–2 times more prevalent in women than in men. The gender and age distribution of TMD suggests a possible link between its pathogenesis and the female estrogen hormonal axis with an incidence ranging from 21.5% to 50%.[5-7] The most relevant signs of TMD include joint sounds, such as clicking and crepitation, reduced mouth opening, and disrupted jaw movements. TMD has considerable prevalence, with a significant impact on physical and psychosocial factors which would further lead to deterioration in the patient's quality of life.[6,8]

A number of supportive therapies, involving education, occlusal splint fabrication, medication, and physical therapy, have been adopted for the management of the same.[9,10] Recently, the American Academy of Craniomandibular Diseases regarded physical therapy as the main treatment modality for TMD management.[11] Hence, various physical therapy interventions have been employed, such as exercises, massages, thermal therapy, transcutaneous electrical nerve stimulation (TENS), ultrasound, and low-level laser therapy.[12] Among these, TENS therapy has gained a lot of significance in recent years. It is characterized by the process of applying electrical stimulation to the skin to reduce pain. The electrical stimulation inhibits the transmission of painful impulses in the spinal cord and stimulates the release of endogenous opioids in the brain.[13] Hence, it has been proven to be one of the most effective means of non-invasive management for patients with TMD. TENS therapy has a proven ability to lessen patient-reported pain intensity in acute pain situations, but its effectiveness in treating chronic pain is debatable. TENS has been reported to be successful as a therapeutic modality for TMD, either alone or in conjunction with other modalities. It is not only safe to use, but it also reduces pain and electromyographic (EMG) activity of muscles of mastication.[14]

However, the effect of TENS therapy on condylar position and function has not yet been researched extensively. Therefore, the condylar position alterations in TMD patients before and after TENS therapy were assessed in this study. Thus, the aim of this study was to assess the effect of TENS therapy on condylar position and myofascial pain in patients with TMJ disorders.

Materials and Methods

Study setup

This pilot study was approved by the Institutional Review Board and Human Ethical Committee with the ethical clearance number of IHEC/SDC/ORTHO-2101/22/087. It included patients with TMD complaining of pain in the joint and muscle in the head and neck region. The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) questionnaire was used to evaluate the presence of signs and symptoms in the patients.[15] This questionnaire is based on the DC/TMD protocol which is intended for use within any clinical setting to support diagnostic activities from screening to definitive evaluation and diagnosis. The answers were discussed with the patients before clinical examination. The sample size calculation was conducted based on a previous study by Verghese *et al*.[16] and was found to be 6 with an alpha level and power set at 0.05 and 80%, respectively. Based on the DC/TMD criteria, seven patients within the age group of 20–40 years comprising both females and males were included in the study. Patients without a clicking sound or absence of pain were not included in the investigation.

Diagnostic procedure

The included patients were subjected to basic diagnostic procedures and routine clinical examinations. The patients were also advised for a cone beam computed tomography (CBCT) (Kodak Carestream CS 9600) at rest position during the initial examination. They were later subjected to joint vibration analysis (JVA) (BioJVA™, BioRESEARCH, Inc.) to assess the temporomandibular joint and EMG (BioEMG, BioRESEARCH, Inc.) to assess the muscle strain as shown in Figure 1. After the diagnostic examinations, patients were individually subjected to TENS therapy.

TENS therapy

The setup for the TENS therapy involved the placement of electrodes in the respective regions to complete the circuit. The electrodes were attached to the muscle bundles, found by palpating in the temporalis and masseter region bilaterally and adhered to the skin surface by surgical plastic strips as shown in Figure 2. The settings included a frequency of 40 Hz, in "Bursting" mode for a duration of 45 minutes with a pulse width of 100 as shown in Figure 3. After the therapy, patients were again assessed for muscle activity using EMG and a post-treatment CBCT at rest position. The pain scores were assessed using a visual analog scale (VAS), and the values were compared before and after TENS therapy [Figure 4].

CBCT measurements

The CBCT of the patients before and after TENS therapy was uploaded to the Dolphin software (version 11.95),

Figure 1: EMG readings

Figure 2: Patient subjected to TENS therapy

Figure 3: TENS therapy settings

and the joint spaces were analyzed as shown in Figures 5-8. The joint space width was measured similarly to a previous study by Ahmed *et al*. where the joint spaces were assessed in coronal and sagittal sections and measured as anterior, middle, and posterior joint spaces individually on the left and right sides.[14] The points used for the measurement of joint spaces included the anterior-most condyle point, superior mandibular condyle, and posterior-most condyle point. The distance between the superior condyle and superior fossa was measured as superior joint space. A perpendicular line to the tangent connecting the most convex anterior and posterior parts of the condyle was measured as anterior space and posterior space. These values were noted for all the patients pre- and post-TENS therapy. The Statistical Package for Social Sciences (SPSS) software (IBM SPSS Statistics version 23) was used to analyze the acquired data. The Shapiro-Wilk test was conducted to assess the normality of the measured data. As the data were found to be normal, the results were obtained using the paired *t*-test to determine the statistical significance of the joint spaces, EMG activity, and the pain levels. The results were obtained using the paired *t*-test to determine the statistical significance ($P < 0.05$) of the measured data.

Results

Based on the condylar space measurements, there was a difference in the position of the right and left condyles of each patient before and after TENS therapy when measured radiologically. The results were found to be statistically significant only in the anterior region on the right joint space ($P = 0.03$) and posterior region of the left joint space ($P = 0.04$) as described in Table 1. There was a decrease in the inadvertent muscle activity in all patients after TENS therapy with significant decrease in the right ($P = 0.015$) and left temporalis (0.021) and right masseter ($P = 0.034$) activity as mentioned in Table 2. The VAS pain scores were also noted and tabulated as mentioned in Table 3.

Discussion

The main goal of prior research was majorly to assess the effect of TENS therapy on pain intensities.[15-18] Abe *et al*. showed a significant reduction in pain levels after TENS therapy which eventually led to an increase in the bite forces and maximum mouth opening.[18] Jung *et al*. advocated immediate TENS treatment to reduce

Table 1: Paired *t*-test of the CBCT measurements of the joint spaces (measured in mm)

Side	Right side			Left side		
Joint spaces (mean±SD)	Anterior	Middle	Posterior	Anterior	Middle	Posterior
Before TENS	3.17±0.30	3.73±1.20	3.32±0.76	3.28±0.36	3.62±0.85	3.37±0.59
After TENS	2.85±0.25	3.71±1.78	3.38±0.70	3.14±0.19	4.3±1.19	3.75±0.38
P	0.03*	0.48	0.42	0.22	0.06	0.04*

*Level of significance at $P<0.05$

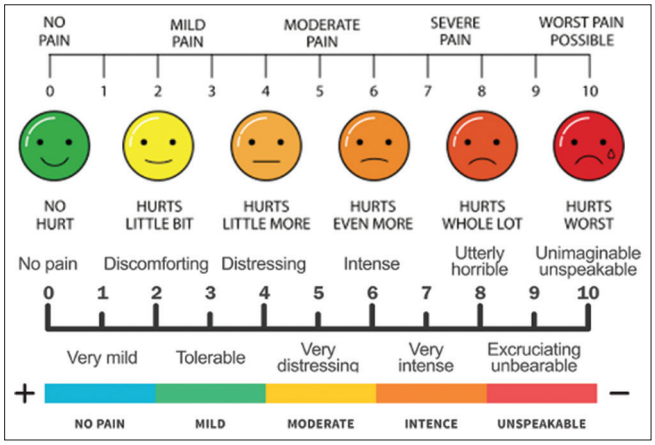

Figure 4: Visual analog scale for pain assessment

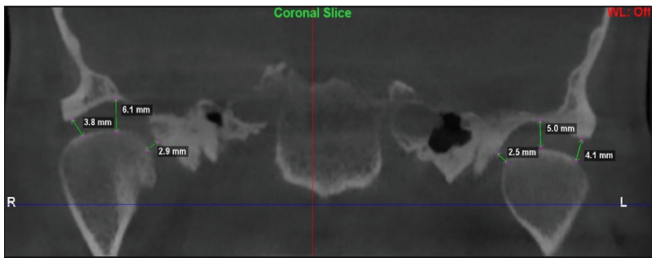

Figure 6: Post-joint space measurements in the transverse section

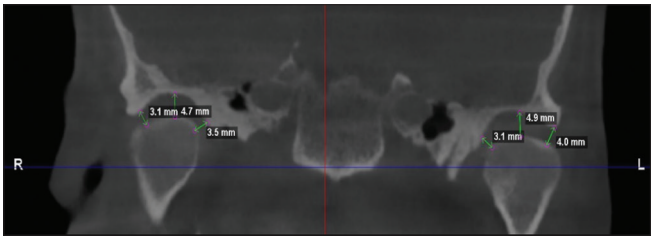

Figure 5: Pre-joint space measurements in the transverse section

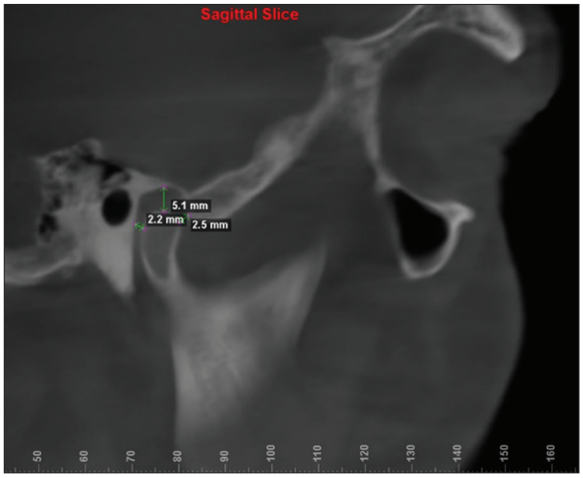

Figure 7: Pre-joint space measurements in the sagittal section

muscle pain which resulted in increased muscle activity in the stomatognathic area.[19] The VAS and Helkimo scores for pain were significantly lower in patients receiving TENS therapy, according to a clinical trial conducted by Rezazadeh *et al*.[20] Adjuvant TENS therapy was found to be more effective than medication alone in managing pain in a trial conducted by Shanavas *et al*. ($P = 0.019$).[21] These results were consistent with those of this study, which found that all patients experienced a reduction in pain intensity following TENS therapy.

TENS therapy was also known to cause muscular changes in TMD patients. In a study by Rodrigues *et al*., TENS therapy reduced the EMG activity of the anterior portion of the temporal muscle, increasing the activity of the masseter muscles during maximum voluntary clenching with a decrease in pain intensities.[22] Wessberg *et al*. utilized the TENS therapy regime to evaluate the short- and long-term consequences of myofascial pain dysfunction syndrome. He obtained an initial success rate of 95% and 86% after a follow-up period of 1 year.[23] According to Giessler *et al*., TENS therapy resulted in pain relief for 63.6% of patients with joint and muscle pain.[24] Prior literature had also suggested using ultra-low frequency TENS therapy (ULF-TENS) to get the patient in a more physiological position before the maxillomandibular record.[25] Kamyszek *et al*. discovered that the effects of ULF-TENS on muscle relaxation were insufficient to significantly enhance the efficacy of manipulation techniques at the centric relation or to facilitate larger condylar displacement.[25] Contrarily, Monaco *et al*. demonstrated that a single ULF-TENS session decreased EMG activity in TMD patients and increased inter-occlusal distance, restoring physiological free space and being consistent with the stomatognathic system.[26] The aforementioned findings were similar to that of this study which resulted in a decrease in the inadvertent muscular activity of the masseter and temporalis muscles in patients with TMD after being subjected to TENS therapy, which have been substantiated by EMG readings as given in Table 3.

Various studies advocated the use of CBCT for the visualization of the bony elements in the TMJ region.[27-29]

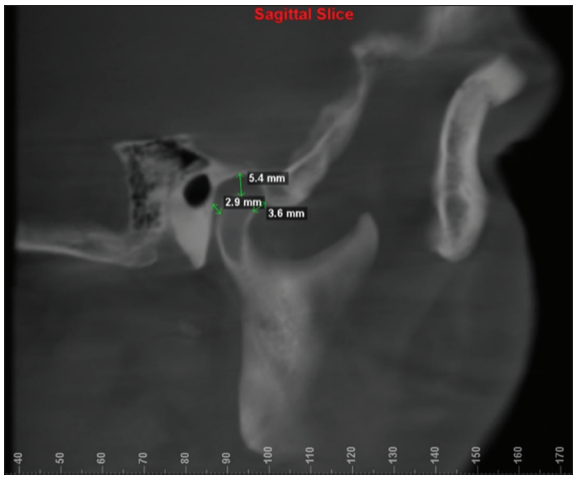

Figure 8: Post-joint space measurements in the sagittal section

Lascala *et al*.,[27] confirmed that the CBCT technique could be used in a variety of clinical settings, including the placement of dental implants, orthognathic procedures, as well as evaluation of joint spaces. According to Ahmed *et al*.,[17] the volume and width of the linear condylar measurements were significantly different between the left and right sides. Moreover, the linear dimensions of the anterior, posterior, and superior joint spaces decreased over time as the age of the patients increased. Suomalainen *et al*. and Kobayashi *et al*. also supported the accuracy of CBCT for linear measurements.[28,29] The evidence from the aforementioned studies led to the use of CBCT in this study for measuring the differences in the joint spaces before and after TENS therapy. There have not been many studies on changes in the condylar position of patients subjected to TENS therapy. Hence, this study evaluated and confirmed the changes in condylar position in TMD patients before and after TENS therapy. However, the significance of this change could be ascertained in the presence of larger samples as well as a control group of normal patients as a comparator. Thus, TENS therapy could be considered one of the successful treatment modalities in the management of TMD thereby making a positive attempt in the placement of condyle in a more physiologically stable position.

Limitations

The main drawbacks of the study included a limited sample size and the absence of a control group of normal patients which could have been used as a comparator group. Hence, it is important to conduct this study in a large group of samples to check the effects of the TENS therapy on condylar position and pain levels in TMD patients.

Conclusion

TMD are multifactorial in origin, although most are related to problems with masticatory muscles and ligaments. An increase in muscle strain can influence the condylar position. There was a significant change in the condylar position after the TENS therapy with an improvement in the pain levels and muscle strain in the affected region. Thus, patients with TMJ issues who primarily experience discomfort from muscle strain may benefit from TENS therapy as a treatment option. This study observed that TENS therapy has a significant role in not only relieving myofascial pain but also altering the condyle position in TMD patients.

Table 2: EMG readings pre- and post-TENS therapy measured in microvolts (μV)

	Right temporalis (Mean±SD)	Right masseter (Mean±SD)	Left temporalis (Mean±SD)	Left masseter (Mean±SD)
Before TENS	60.1±24.16	61.94±22.4	51.84±6.84	62.04±9.33
After TENS	59.2±23.76	59.84±21.24	50.21±6.54	60.90±8.42
P	0.015*	0.034*	0.021*	0.05*

*Level of significance at *P*<0.05

Table 3: VAS scores

Pain intensity (mean±SD)		*P*
Before TENS	After TENS	
2.57±0.78	1.71±0.75	<0.01*

*Level of significance at *P*<0.05

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Conflicts of interest

There are no conflicts of interest.

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