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Comparison And Evaluation Of Interferential Current Therapy And Transcutaneous Electrical Nerve Stimulation In Temporomandibular Joint Disorders: A Prospective Interventional Study

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Abstract
***Aim**: This study evaluated the effectiveness of transcutaneous electrical nerve stimulation (TENS) and interferential current therapy (IFT) to decrease jaw pain and muscle tenderness, improve maximum vertical mouth opening, and compare intra-operative patient comfort.*

Methodology: *This comparative study was conducted in the outpatient oral and maxillofacial surgery department of the SRM Kattankulathur Dental College and Hospital. Twenty participants with chronic or recurrent jaw pain were randomly assigned to either Group A or Group B for the study. IFT and TENS were administered to Groups A and B. They were evaluated for intra-operative comfort, muscle tenderness, mouth opening, and pain over three treatment sessions.*

Results: *Both groups showed improvement in pain, muscle tenderness, and mouth opening after three follow-up sessions. Compared to TENS, IFT significantly improved patient comfort ($p<0.05$). While there was no significant difference in pain and muscle tenderness reduction between the two groups at 5% significance level ($p<0.05$), IFT demonstrated slightly better improvement in vertical mouth opening.*

Conclusion: *IFT is frequently employed to treat musculoskeletal disorders; however, its effectiveness in alleviating pain associated with temporomandibular disorders is still poorly understood. This study observed significant pain reduction in both IFT and TENS groups, along with a decrease in masticatory muscle and TMJ tenderness and improvement in mouth opening. Compared to TENS, IFT provided superior intra-operative comfort hence overcoming the drawback associated with TENS. These findings suggest that IFT may serve as an effective therapeutic option for temporomandibular disorder.*

Keywords*: Temporomandibular joint disorders; Electrotherapeutic modalities; Interferential current therapy; Transcutaneous electrical nerve stimulation.*

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I. Introduction

Temporomandibular Disorder (TMD) is a collection of related disorders in the masticatory system that are distinguished by a variety of symptoms and signs. These symptoms include muscle tenderness in the temporomandibular joint (TMJ), a reduction in the range of motion of the mandible, clicking, stiffness, pain, and fatigue in the facial muscles, diversion of the jaw to the affected side during opening, and jaw locking during opening and closing [1]. Additionally, we observe neurological symptoms such as vertigo, tinnitus, and congestion [2, 3].

There are many different treatment modalities for TMDs, including mechanical, physiological, pharmacological, placebo, and physical methods [2]. Physical therapy is regarded as an essential measure for alleviating musculoskeletal pain, reducing inflammation, and rehabilitating oral motor function; hence, several physical modalities may be beneficial in managing temporomandibular disorders (TMDs). This encompasses electrotherapeutic modalities, exercise, manual treatment techniques, posture correction, relaxation, biofeedback, moist heat, and cryotherapy. Electrotherapeutic methods encompass ultrasound (US), microwaves, low-level laser therapy, transcutaneous electrical nerve stimulation (TENS), and interferential therapy (IFT) [3, 4].

TENS and IFT are well-known physical therapy modalities used for management of various musculoskeletal disorders. Stimulation of low- and medium-frequency currents is commonly used in pain management [5]. TENS utilizes controlled, low-voltage electrical pulses and is directed directly to pain areas via surface electrodes, which reduces or eliminates pain [5]. IFT uses surface electrodes to apply two medium-frequency biphasic currents simultaneously through the transcutaneous route. The two medium-frequency currents "interfere" at deeper tissue depths, generating an amplitude-modulated low "beat" frequency, which represents the difference between the values of the two applied currents [4, 6].

TMD, a complex musculoskeletal disorder with multifactorial etiology, is the most common non-dental cause of orofacial pain. Both TENS and IFT have been employed in managing degenerative musculoskeletal conditions. Studies have shown that TENS effectively treats TMD [6], while IFT has shown benefits in conditions such as knee osteoarthritis and chronic lower back pain [7–11]. However, there is only one study evaluating its efficacy for TMD-related pain [4]. Given that TMD-related pain arises from fatigue in deeper facial muscles and IFT targets deeper tissues through medium-frequency currents, this study aimed to assess the effectiveness of TENS and IFT in 20 individuals with TMD pain.

II. Materials And Methods

Subjects

Twenty subjects of either sex in the age group of 15–65 years reporting to the Department of Oral and Maxillofacial Surgery with the complaint of TMJ pain volunteered to participate in the study.

Inclusion criteria: Subjects identified with TMJ pain disorders through a clinical examination and panoramic x-ray of the TMJ (bilaterally) to exclude any osseous alterations according to Wilkie's classes I and II for internal derangement were deemed eligible. The study included patients exhibiting orofacial pain, particularly in the pre-auricular area, during functional activities and palpation, tenderness in one or more masticatory muscles, muscle tension or stiffness, and/or restricted mouth opening.

Exclusion criteria: Patients with radiographic abnormalities, TMJ pathology, Wilkies stage III, IV, V, or other systemic disorders were excluded from the study. The study excluded patients with cardiac pacemakers, cardiac arrhythmia, pregnancy, history of seizures and vascular disorders, brain tumors or neurological diseases with head and neck involvement like Bell's palsy, bleeding disorders, and undiagnosed dental pain or facial abrasions, especially at site of electrode placement.

Procedure

In order to diagnose TMD based on signs and symptoms, a comprehensive examination of the TMJ was conducted prior to the initial therapy session. We requested that the individuals complete a questionnaire regarding the duration of their symptoms, any past or ongoing treatment, and any circumstances that could potentially impede the use of IFT/TENS.

Clinical characteristics, including pain, masticatory muscle tenderness, and TMJ pain, were assessed using the Visual Analogue Scale (VAS) and palpation, respectively. The maximal inter-incisal distance, referring to the maximum mouth opening without discomfort, was measured in millimeters (mm). The participants indicated a 10-cm VAS, reflecting their subjective pain level for that day. The left end of the VAS was designated as "no pain," whereas the right end was designated as "unbearable pain." Measurements were obtained from the tip of the right upper incisor to the tip of the right lower incisor. These measurements were made three successive times. If one of the TMJ's exhibited pain, that side was utilized in the investigation. When TMJ was affected bilaterally, the side with the greatest discomfort is chosen.

Relevant muscles and the TMJ on the ipsilateral side of the tender jaw were palpated lightly to deeply. We employed standardized methods for every subject. Palpation of the sternocleidomastoid muscle, masseter, medial pterygoid, and temporalis muscles was done when the patient was upright. The TMJ was palpated extra-orally and intra-meatally, while the lateral pterygoid muscle was palpated intraorally. Subsequently, we inquired whether the individuals experienced any distress, local pain, or pressure in locations other than the one being palpated. The assessment procedure was consistent across all three treatment sessions.

Patients of either sex fulfilling the inclusion criteria were divided into two equal groups of 10. We subjected Group A to IFT and Group B to TENS.

Group A:

Subjects received IFT for 30 minutes, with the base frequency set to 90 Hz. Patients were positioned in a supine posture and instructed to relax, ensuring that their upper and lower teeth did not touch. Four electrode leads were positioned extraorally, roughly 1 to 1.5 cm anterior to the tragus of the ear, focusing on the area where the four principal muscles of mastication (masseter, temporalis, lateral pterygoid, medial pterygoid) insert, along with a segment of the temporomandibular joint (TMJ) [Fig. I].

***Group B*:**

Subjects received TENS for 30 minutes while lying in a supine position. The stimulation was administered using surface electrodes positioned over the sigmoid notch area and the posterior neck to complete the circuit [Fig II]. The intensity for both groups was calibrated to each patient's comfort level, with the objective of eliciting minimal observable facial muscle contractions. Participants were instructed to indicate the first time they perceived a "buzzing" or "tingling" sensation beneath the electrode lead. For each participant, the intensity was progressively elevated until it reached a level deemed "comfortable" yet not "excessive." Once the tingling feeling diminished, the intensity was increased again until the patient regained comfort.

At the conclusion of each treatment session, subjects were instructed to assume an upright position. Vertical jaw opening, pain levels, and intra-operative comfort were assessed in mm and VAS scores, while muscle tenderness was evaluated through palpation. These assessments were conducted across three consecutive sessions, and the data were recorded. The interval between treatment sessions ranged from 24 to 72 hours. Subjects were recalled for follow-up treatment on the 4th and 7th days following the initial session.

Fig. I and II depicting electrode placement in IFT and TENS respectively

Statistical Analysis

The gathered data were organized and analyzed utilizing SPSS version 22. Frequency and percentage were employed to characterize categorical data, while mean and standard deviation (SD) were utilized to represent continuous data. The paired t-test and independent t-test were employed for within-group and between-group analyses, respectively. Repeated measures ANOVA was employed for intra-group comparisons across several time intervals.

The significance level for each test statistic was maintained at 5%. If the computed value exceeded the tabular value, then $P < 0.05$, indicating a significant difference was found. If the calculated value was inferior than the tabular value, then $P > 0.05$, indicating no significant difference between groups at the 5% threshold of significance.

III. Results

Table I: Gender distribution among two groups A and B

Gender	Group TENS N (%)	Group IFT N (%)
Female	8 (80)	6 (60)
Male	2 (20)	4 (40)
Total	10 (100)	10 (100)

Table II: Comparison age between two groups A and B

	Group	Mean (in years)	Std. Deviation	P value[a]
Age	TENS	28.20	14.536	0.496
	IFT	32.50	13.125	

a. independent t test *. Statistically Significant at the level of 0.05

Table I & II shows descriptive statistics of study population. Gender distribution measured in frequency, percentage and age is described as mean and standard deviation (in years). There is no significant difference between age of the study population on both groups (P value – 0.496).

Table III: Comparison of post-treatment VAS score between groups A and B

	Group	Mean	Std. Deviation	Mean difference	P value [a]
Day 0 - Pain	TENS	4.10	1.370	-0.100	0.877
	IFT	4.20	1.476		
Day 4 - Pain	TENS	3.80	1.619	0.600	0.398
	IFT	3.20	1.476		
Day 7 - Pain	TENS	2.80	1.751	0.400	0.558
	IFT	2.40	1.174		

a. independent t test *. Statistically Significant at the level of 0.05

Table III describes the comparison of post treatment VAS scores between two study groups using independent t test. As the table shows there is no significant difference between the two groups in the 0- day, 4th day, 7th day of post treatment in terms of VAS scores.

Table IV: Comparison of post treatment comfort score between groups A and B

	Group	Mean	Std. Deviation	Mean difference	P value [a]
Day 0 Comfort	TENS	4.40	1.350	2.300	**0.000***
	IFT	2.10	.994		
Day 4 - Comfort	TENS	3.60	1.647	2.200	**0.002***
	IFT	1.40	.966		
Day 7 - Comfort	TENS	3.60	1.174	2.500	**0.000***
	IFT	1.10	.738		

a. independent t test *. Statistically Significant at the level of 0.05

Table IV describes the comparison of post treatment comfort scores between two study groups as shown here; there is statistically significant difference between the two groups on 0- day, 4th day, 7th day of post treatment.

Table V: Comparison of pre and post treatment mouth opening between groups A and B

	Group	Mean (in mm)	Std. Deviation	Mean difference	P value [a]
Day 0 - Mouth opening	TENS	37.70	8.220	-0.800	0.801
	IFT	38.50	5.462		
Day 4- Mouth opening	TENS	38.20	7.598	-0.600	0.848
	IFT	38.80	6.125		
Day 7 - Mouth opening	TENS	38.70	7.349	-1.000	0.721
	IFT	39.70	4.692		

a. independent t test. *. Statistically Significant at the level of 0.05

Table V shows even though the IFT group have slightly better mouth opening compared to TENS groups, there is no statistically significant difference in mouth opening between two groups.

Table VI: Frequency table of muscle tenderness in group A and B

	Muscle Tenderness	Pre treatment N (%)	0-day post op N (%)	4th day post op N (%)	7th day post op N (%)	P value[a]
TENS	Absent	4 (40)	5 (50)	5 (50)	7 (70)	**0.033***
	Present	6 (60)	5 (50)	5 (50)	3 (30)	
IFT	Absent	4 (40)	5 (50)	5 (50)	7 (70)	**0.033***
	Present	6 (60)	5 (50)	5 (50)	3 (30)	

Table VI shows two groups within comparison of presence of muscle tenderness in pre treatment and post treatment. As p value shows there is significant decrease in muscle tenderness in both groups after treatment.

Table VII: Comparison of two groups A and B on muscle tenderness

Test Statistics				
	Pre treatment tenderness	Day 0 Tenderness	Day 4 Tenderness	Day 7 Tenderness
Chi-Square	.800[a]	.000[a]	.000[a]	3.200[a]
df	1	1	1	1
Asymp. Sig[b].	.371	1.000	1.000	.074

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 10.0.
b. Chi - square test

Table VII shows comparison between two groups on pre-treatment and post-treatment muscle tenderness presence, as there is no significant difference between two groups in decreasing the muscle tenderness on post treatment.

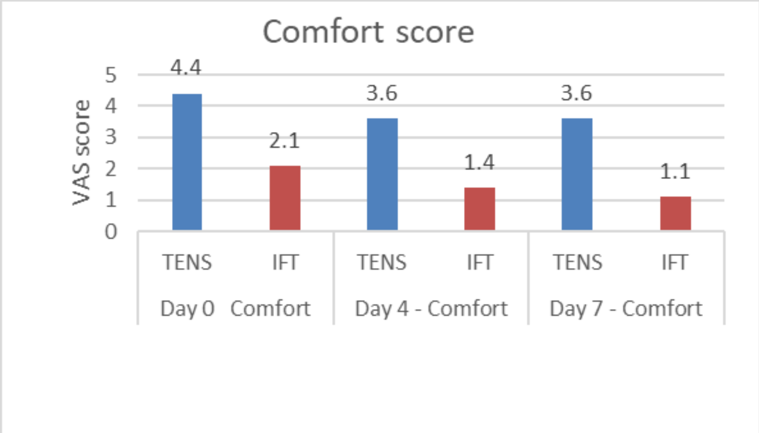

Fig. III Comfort score comparison between TENS and IFT group

All values for TMJ pain, patient comfort during the procedure, muscle tenderness, and vertical mouth opening were presented as Mean ± SD. Both groups demonstrated individual improvements in TMJ pain, muscle tenderness, and mouth opening across three follow-up sessions. In comparison between the two groups, IFT demonstrated superior outcomes relative to TENS in terms of patient comfort. The vertical mouth opening was slightly better, but it was not statistically significant. No significant difference in pain and muscle tenderness reduction was observed between the two groups at the 5% significance level ($p<0.05$).

IV. Discussion

Pain, muscle tenderness, and restricted mandibular movement are the primary symptoms of TMJ dysfunction [1]. Although various therapeutic modalities have been suggested for its treatment, there is a lack of clinical trials providing conclusive evidence that any one approach is superior. Multiple treatments tend to yield comparable improvements in pain and dysfunction, emphasising the need for caution when considering invasive or irreversible interventions. TENS and IFT are believed to work through neurological, psychological, and physiological mechanisms. IFT is able to penetrate deeper tissue by utilizing high-frequency currents, and thus helps overcome high skin and subcutaneous impedance, as skin resistance is inversely proportional to the frequency of the applied current [7]. This mechanism mitigates the likelihood of skin irritation , that is prevalent in other electrical stimulation methods [4, 5].

IFT is a commonly employed treatment for the alleviation of pain both acute and chronic in a variety of musculoskeletal disorders, including neck pain, phantom limb pain, back pain. Nevertheless, there is a scarcity of research on the efficacy of this treatment in alleviating orofacial pain [12]. The only study where IFT was used to manage TMD-associated pain was conducted by Taylor et al. in 1987, which compared IFT with placebo for TMJ pain relief and found no significant difference, concluding that IFT was no more effective than placebo in reducing TMJ-associated pain [4]. The current study aimed to assess the effectiveness of TENS and IFT in 20 individuals with TMD pain.

The age of the patients in the current study ranged from 15 to 60 years of either sex. However, most patients were of age ranging from 30 to 40 years. A total of 20 volunteers participated, out of which 14 were females, 8 were given TENS, and 6 were given IFT [Table I, II]. Out of the 6 males that participated in the study, 2 were assigned to TENS and 4 were given IFT. This data about age and sex distribution aligns with the findings of Okeson et al. and Juniper et al. (1986), who indicated that TMD pain frequently manifests in the second and third decades of life, predominantly impacting middle-aged females more than males [13, 14].

Both Group A and Group B showed a significant reduction in pain during the intergroup comparison. After the first session, the TENS group demonstrated a 33% reduction in pain, while IFT showed a 35% reduction. After subsequent treatment sessions, by the 7th day follow-up, the pain reduction was 62.5% in TENS and 49% in IFT [Table III]. Thus, TENS appears to be a better modality for managing continuous TMJ pain. There is no significant difference between the two groups on 0-day, 4th day, and 7th day post-treatment. The results of our study align with previous literature reviews, which found that the effects of TENS and IFT on pain outcomes are nearly similar [15, 16].

Patient comfort levels were evaluated through the use of VAS scores. Patients receiving IFT exhibited significantly lower VAS scores, reflecting a greater level of comfort in comparison to those treated with TENS [Table IV] [Fig. III]. This indicates that IFT may offer enhanced comfort. This aligns with the study by Mark et al., which asserted that IFT reduces skin impedance through the application of low-frequency current, thereby alleviating the discomfort typically linked to electrotherapeutic treatments [17].

No statistically significant difference was observed in mouth opening values between the two treatment modalities [Table V]. IFT demonstrated a marginally superior enhancement in mouth opening relative to TENS. The study by Taylor et al. concluded that short-term treatment with IFT was not more effective than placebo in enhancing mouth opening [4].

Both treatment modalities demonstrated effectiveness in reducing muscle tenderness [Table VI]. Prior to treatment, 60% of patients in each group presented with tenderness in various masticatory muscles, with the majority exhibiting tenderness in the masseter muscle, a smaller number in the temporalis, and two patients in the sternocleidomastoid muscle. By the 4th day post-treatment, only 50% of patients reported tenderness upon palpation of these muscles, and by the 7th day, the proportion had further decreased to 30%, reflecting a progressive reduction in muscle tenderness over time. In a study conducted by Geissler et al. (1981) [18], muscle pain associated with mandibular dysfunction was found to result from a combination of continuous muscle contraction and micro-occlusion of blood vessels. This sustained contraction is thought to trigger the release of chemical agents responsible for pain when their local concentration becomes sufficiently elevated. However, when blood flow is restored, these substances are washed away, leading to pain relief. IFT and TENS therapy operate on this principle, as it directly stimulates the muscles, promoting increased blood flow and alleviating pain [19].

IFT and TENS demonstrate comparable efficacy in the management of pain associated with TMD. IFT can be utilized independently or as an adjunct in the treatment of TMJ dysfunction [20]. Additional research is required to assess the effectiveness of IFT in comparison to other conservative treatment modalities in the management of TMD pain within a larger and more diverse sample population.

V. Conclusion

Both treatment modalities, IFT and TENS, have been shown to be effective in managing TMJ pain associated with TMD along with improvement in muscle tenderness and maximal mouth opening. However, when comparing the two treatments, the differences in pain relief and muscle tenderness were statistically insignificant. Similarly, while the difference in improvement in mouth opening did not reach statistical significance between the groups, IFT demonstrated a slight advantage. Importantly, IFT provided significantly greater patient comfort during treatment compared to TENS.

In conclusion, this study suggests that IFT is an effective treatment modality for TMD-associated pain and addresses the limitation of patient discomfort often experienced with TENS.

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