EFFICACY OF TENS THERAPY, THERAPEUTIC ULTRASOUND AND STABILIZATION SPLINT AS AN ADJUVANT TO PHARMACOTHERAPY FOR TEMPOROMANDIBULAR DISORDERS

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ABSTRACT

INTRODUCTION

This study aims to assess the effectiveness of adjunctive treatments like transcutaneous electric nerve stimulation (TENS), therapeutic ultrasound (ThUs), and stabilization splint (SS) in combination with pharmacotherapy (PT) in enhancing pain relief, mouth opening, lateral excursion, joint sound reduction, muscle tenderness improvement, and jaw deflection in patients with temporomandibular disorders (TMDs), affecting the temporomandibular joint and masticatory muscles.

MATERIAL AND METHODS

The study involved 90 patients divided into three groups. Pharmacotherapy (Tab. Myospaz) was prescribed to all patients, each group received either TENS, ThUs, or SS as adjunctive treatment. Outcomes were measured at baseline and various intervals post-treatment.

RESULTS

TMDs were more prevalent in younger age group (21-30 years) with female predilection (F:M =2.21:1). Significant differences were observed in pain scores, with TENS and ThUs groups showing greater reductions compared to SS. ThUs demonstrated superior results in mouth opening, while TENS showed better outcomes in lateral excursion and muscle tenderness reduction.

CONCLUSION

This study concluded that both TENS and therapeutic ultrasound effectively reduced pain with therapeutic ultrasound showing better results in improving mouth opening, and TENS demonstrating better results in lateral excursion and muscle tenderness reduction. No significant difference among three groups were found in reducing joint sounds and deviation/deflection.

KEYWORDS

Pharmacotherapy, Stabilization splint, Temporomandibular disorders, Therapeutic ultrasound, Transcutaneous electric nerve stimulation

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INTRODUCTION

Temporomandibular disorders (TMDs) are complex, painful illnesses affecting the temporomandibular joint (TMJ) and surrounding structures. They present with symptoms like orofacial pain, joint dysfunction, muscle tenderness, and jaw mobility restrictions. TMDs are prevalent in 21.5% to 51.8% of the population, with females being twice as common.[1] Peripheral sensitization and localized inflammation can cause pain.[2] TMDs are a major cause of non-dental discomfort and strain healthcare systems worldwide.

Diagnosis and management are challenging due to their multifaceted nature and overlapping symptoms. Advancement in diagnostic techniques and therapy strategies have improved the efficiency of treating TMDs. A comprehensive clinical examination, including medical history, pain patterns, joint motions, and muscle palpation is essential for identifying the underlying cause. Diagnostic imaging, such as panoramic radiography and MRI, complements the examination and aids in treatment choices.

Non-invasive treatments, such as pharmacotherapy, TENS, therapeutic ultrasound, and occlusal stabilization splints are generally considered the best options. Pharmacotherapy, including analgesics like NSAIDs and opioids has been the primary treatment for TMDs.[3] Transcutaneous electrical nerve stimulation (TENS) is a non-pharmacological intervention that stimulates the central nervous system's inhibitory mechanisms to reduce hyperalgesia.[4] Ultrasound therapy, a non-invasive technique, uses vibrations over 16,000 rpm to speed up healing, reduce joint stiffness, and reduce pain.[5] Occlusal splint therapy is a common treatment for TMD patients, but its effectiveness and mode of action are still debated.[6] The study aims to evaluate whether these adjunctive treatments can offer enhanced pain relief, increased functional improvement, and overall better outcomes in TMDs.

MATERIAL AND METHODS

This prospective observational study took place at the Department of Oral and Maxillofacial Surgery, UCMS-CODS, Bhairahawa, from October 2021 to May 2023. Approval was obtained from the Institutional Review Committee (IRC no. 155/21). Patients with TMDs fulfilling DC/TMD criteria,[7] seeking treatment including TENS, therapeutic ultrasound, or splint therapy alongside pharmacotherapy were eligible for study. Informed written and verbal consent was taken. Dentulous patients who agreed for regular follow up, aged between 18 to 70 years and who were not under any other drug therapy for TMD were included in the study. In a study by Rokaya Dinesh et al[8] (2016), a 31% prevalence of TMJ dysfunction was found among Nepalese subjects. Using this prevalence as a reference, the sample size for this study was calculated using formula:

$$n=z^2\,pq/d^2$$

where, n = sample size, z = confidence limit (approx. 1.96 for a 95% confidence level),
p = prevalence (0.31 in this case), q = 1- prevalence (0.69 in this case), d = permissible error (0.1)

A sample size of 90 was chosen and equally divided into 3 groups, with 30 patients in each group. The study involved collecting demographics, conducting a comprehensive dental examination, and evaluating patients for TMDs. Clinical diagnosis was made using DC/TMD criteria. OPG was performed to identify underlying bone abnormalities. Patients were fully briefed about the proposed treatment approach and provided informed consent. They were then allocated to one of three treatment groups based on the discretion of the attending surgeon.

Group A: TENS with pharmacotherapy (TENS with PT)
Group B: Therapeutic ultrasound with pharmacotherapy (ThUs with PT)
Group C: Stabilization splint with pharmacotherapy (SS with PT)

Technique
The study involved measurement of variables which included pain in numeric rating scale (NRS), maximum mouth opening (interincisal distance) in millimeters and maximum lateral excursion in millimeters measured using digital vernier caliper, deviation/deflection, TMJ clicking/popping/crepitus and tenderness in muscle of mastication on palpation. Values of variables were recorded in proforma a day before therapy. Patients were given standardized pharmacotherapy, including a combination drug "Myospaz" with chlorzoxazone 250 mg and paracetamol 325 mg, three times a day for five days. Patients were monitored for compliance and excluded from the study if they did not follow the prescribed medication.

Each group received additional adjunctive treatments:
Group A (TENS with pharmacotherapy): Participants underwent transcutaneous electrical nerve stimulation (TENS) therapy once daily for one week. The TENS unit delivered electrical stimulation at a frequency of 80-150 Hz, pulse width of 50-250 µs targeting the temporomandibular joint (TMJ) and anterior temporal muscle with each session lasting for 15-20 minutes. Treatment progress was monitored weekly.

Group B (Therapeutic ultrasound with pharmacotherapy): Participants received therapeutic ultrasound therapy once daily for one week. Ultrasound was applied directly over the TMJ area with intensity ranging from 1 to 1.25 W/cm2. Each therapy session lasted for 15-20 minutes. Treatment compliance was monitored weekly.

Group C (Stabilization splint with pharmacotherapy): Participants were provided with a custom-made stabilization splint to be worn continuously 24 hours a day. The splint aimed to stabilize occlusion and reduce occlusal discrepancies contributing to TMDs. The splint fabrication followed established protocols and was adjusted as needed during weekly clinic visits.

Patients were recalled on 1st, 7th, 14th and 21st post-operative day for measurements and evaluation of treatment outcomes.
Data collection and analysis: The study collected data using MS Excel Sheet 2013 and SPSS 25.0, analyzing normality using Kolmogorov-Smirnov test, t-test, ANOVA, repeated measure ANOVA, and chi square test for categorical variables.

Ethical considerations: Informed consent, patient confidentiality, and approval from the Institutional Review Committee of Universal College of Medical Sciences.

RESULTS

The study comprised 90 patients, evenly distributed among three groups: TENS with pharmacotherapy (Group A), therapeutic ultrasound with pharmacotherapy (Group B), and stabilization splint with pharmacotherapy (Group C). Most participants were female (68.9%). Age distribution was similar across groups ($p > 0.05$), with TMDs predominantly occurring in the 21-30 age group. Analysis revealed significant differences in pain scores on the numeric rating scale (NRS) among groups on Days 7, 14, and 21, with Group A consistently reporting lower scores. Maximum mouth opening was significantly different across all groups on Days 7 and 14, while maximum lateral excursion showed significant differences on Days 14 and 21. Comparing pain scores between groups throughout the study duration, Group A consistently showed lower scores compared to Groups B and C. Group B also exhibited lower pain scores compared to Group C. Significant differences in maximum mouth opening were observed between Group B and Group C on Days 7 and 14. Maximum lateral excursion comparisons revealed significant differences between Group B and Group A before treatment. However, by Days 14 and 21, Group A demonstrated significantly higher maximum lateral excursions compared to Group C. Tenderness was present in all patients before treatment, significantly reducing in all groups by Day 7. On Day 14, a majority of patients in Groups A and B had no tenderness, while many in Group C still experienced tenderness. There was no significant improvement in deviation/deflection or clicking/popping/crepitus across all treatment groups even after Day 21.

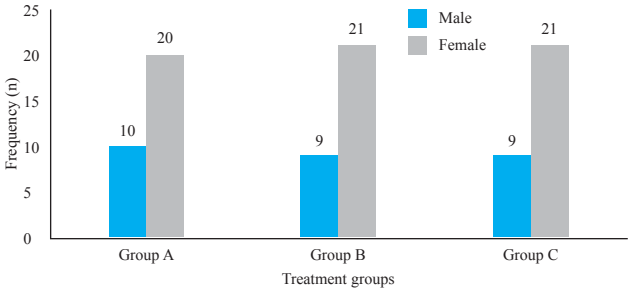

Figure 1. Gender-wise distribution of treatment groups

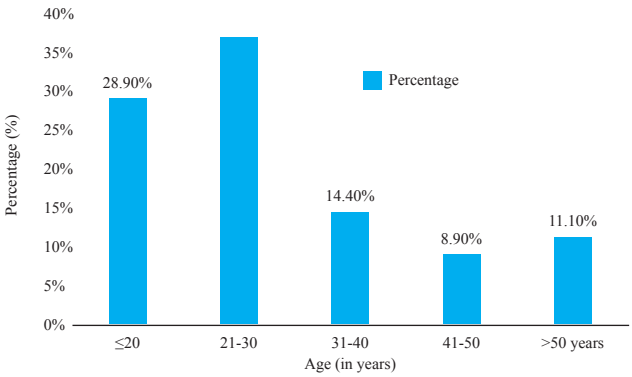

Figure 2. Age-wise distribution

Table 1. Pain scores, maximum mouth opening, and maximum lateral excursion among treatment groups

Numerical parameters		Treatment groups			*p*-value
		Group A	Group B	Group C	
Pain Score in NRS	Pretreatment	5.73 ± 0.94	5.70 ± 1.05	5.80 ± 0.99	0.925
	Day 1	5.23 ± 0.89	5.23 ± 1.13	5.70 ± 0.95	0.120
	Day 7	3.43 ± 1.00	4.07 ± 1.17	5.07 ± 1.04	< 0.001
	Day 14	2.30 ± 0.83	3.07 ± 1.23	4.27 ± 1.04	< 0.001
	Day 21	1.37 ± 0.55	1.93 ± 0.90	3.13 ± 1.07	< 0.001
Maximum mouth opening (mm)	Pretreatment	30.13 ± 9.79	33.33 ± 8.81	30.10 ± 8.53	0.289
	Day 1	32.17 ± 8.95	35.07 ± 8.38	31.03 ± 8.03	0.170
	Day 7	36.17 ± 8.21	38.50 ± 7.35	33.30 ± 7.30	0.035
	Day 14	39.43 ± 7.29	40.33 ± 6.71	35.70 ± 6.97	0.029
	Day 21	41.87 ± 5.40	42.13 ± 5.37	39.40 ± 5.39	0.102
Maximum lateral excursion (mm)	Pretreatment	6.07 ± 1.84	7.27 ± 2.05	6.77 ± 1.85	0.056
	Day 1	6.07 ± 1.80	7.47 ± 1.99	6.80 ± 1.85	0.236
	Day 7	8.17 ± 1.82	7.77 ± 1.81	7.10 ± 1.73	0.071
	Day 14	8.73 ± 1.44	8.07 ± 1.68	7.47 ± 1.50	0.008
	Day 21	8.87 ± 1.36	8.33 ± 1.52	7.73 ± 1.44	0.012

Data expressed in Mean ± S.D. p-values obtained from the one-way ANOVA; $p < 0.05$ considered statistically significant.

Table 2. Post hoc analysis of pain scores among treatment groups

Pain Score in NRS		Mean difference	*p*-value
Pretreatment	Group A vs. Group B	0.03	0.991
	Group A vs. Group C	-0.07	0.964
	Group B vs. Group C	-0.10	0.921
Day 1	Group A vs. Group B	0.00	0.997
	Group A vs. Group C	-0.47	0.173
	Group B vs. Group C	-0.47	0.173
Day 7	Group A vs. Group B	-0.64	0.065
	Group A vs. Group C	-1.64	< 0.001
	Group B vs. Group C	-1.00	0.002
Day 14	Group A vs. Group B	-0.77	0.016
	Group A vs. Group C	-1.77	< 0.001
	Group B vs. Group C	-1.20	< 0.001
Day 21	Group A vs. Group B	-0.56	0.036
	Group A vs. Group C	-1.76	< 0.001
	Group B vs. Group C	-1.20	< 0.001

p-values obtained from Post Hoc Tukey HSD; $p < 0.05$ considered statistically significant

Table 3. Post hoc analysis of maximum mouth opening among treatment groups

Pain Score in NRS		Mean difference	*p*-value
Pretreatment	Group A vs. Group B	-3.20	0.362
	Group A vs. Group C	0.03	0.997
	Group B vs. Group C	3.23	0.355
Day 1	Group A vs. Group B	-2.90	0.384
	Group A vs. Group C	1.14	0.863
	Group B vs. Group C	4.04	0.161
Day 7	Group A vs. Group B	-2.33	0.466
	Group A vs. Group C	2.87	0.318
	Group B vs. Group C	5.20	0.026
Day 14	Group A vs. Group B	-0.90	0.872
	Group A vs. Group C	3.73	0.103
	Group B vs. Group C	4.63	0.032
Day 21	Group A vs. Group B	-0.26	0.980
	Group A vs. Group C	2.47	0.185
	Group B vs. Group C	2.73	0.127

p-values obtained from Post Hoc Tukey HSD; $p < 0.05$ considered statistically significant

Table 4. Post hoc analysis of maximum lateral excursion among treatment groups

Maximum lateral excursion (mm)		Mean difference	*p*-value
Pretreatment	Group A vs. Group B	-1.20	0.045
	Group A vs. Group C	-0.70	0.337
	Group B vs. Group C	0.50	0.572
Day 1	Group A vs. Group B	-0.77	0.261
	Group A vs. Group C	-0.10	0.977
	Group B vs. Group C	0.67	0.362
Day 7	Group A vs. Group B	0.40	0.663
	Group A vs. Group C	1.07	0.153
	Group B vs. Group C	0.67	0.536
	Group A vs. Group B	0.66	0.221
Day 14	Group A vs. Group C	1.26	0.006
	Group B vs. Group C	1.60	0.293
	Group A vs. Group B	0.54	0.327
	Group A vs. Group C	1.14	0.008
Day 21	Group B vs. Group C	0.60	0.245

p-values obtained from Post Hoc Tukey HSD; $p< 0.05$ considered statistically significant

Table 5. Tenderness across treatment groups before and after treatment

Tenderness		Treatment groups			*p*-value
		Group A	Group B	Group C	
Pretreatment	Absent	0	0	0	N/A
	Present	30	30	30	
Day 1	Absent	0	1	2	0.242**
	Present	30	29	28	
Day 7	Absent	24	9	3	< 0.001*
	Present	6	21	27	
Day 14	Absent	28	25	14	< 0.001*
	Present	2	5	16	
Day 21	Absent	30	28	27	0.110**
	Present	0	2	3	

N/A- Not applicable. *p*-values obtained from chi-square analysis.
(** Likelihood ratio, * Pearson's chi square) $p< 0.05$ considered statistically significant

DISCUSSION

Temporomandibular disorders (TMDs) are characterized by pain in the temporomandibular joint (TMJ) area, masticatory muscles, and associated musculoskeletal structures in the head and neck.[9] Patients with these conditions experience pain, functional limitations of the mandibular movements, or clicking in the TMJ region during motion.[10]

TMDs were more prevalent in females with a ratio of 2.21:1 which is in accordance with the study done by Rai S et al[4] and Shanavas M et al.[11] In contrast, Beaton RD et al[12] and Patil S et al[13] did not find any gender-wise difference.

In this study, the age of the patients ranged from 18 to 70 years with a mean of 30.8 years. The most common age group affected by TMDs in our study was 21-30 years (36.7%). This is in accordance with a study done on the prevalence of TMD by Jensen et al[14] who also found that the prevalence of TMD was higher in the second and third decades of life.

Groupwise comparison of reduction in pain in NRS showed significant reduction in pain scores in TENS (mean NRS 5.73 to 1.37) and ThUs (mean NRS 5.7 to 1.93) when compared between pretreatment to last visit. However, the TENS group showed an earlier response in pain reduction than ThUs. This is supported by a study conducted by Singh H et al[15], and Sarayana B et al[16] where they found that TENS therapy showed a significant difference in reducing pain. Contrary to this, the observation of Madani and Mirmortazavi[17] showed that anterior positioning splint therapy appears to be the best treatment method for the reduction of pain and joint sounds in patients with TMD, compared with the other two methods (TENS and ThUs therapy).

Improvement in the maximum mouth opening after treatment was statistically significant in the ThUs group compared to the SS group on day 7 and day 14. Similar to this finding, Handa et al[18] in their prospective clinical study found statistically significant improvement in mouth opening after ThUs. Similarly, Mishra N et al[19] also found a statistically significant increase in mouth opening after ThUs therapy. However, Nagata K et al[20] in their randomized controlled trial to determine the efficacy of stabilization splint therapy also found statistically significant improvement in mouth opening.

There was a significant improvement in maximum lateral excursion in the TENS group on days 14 and 21 when compared to the splint group. A randomized controlled trial conducted by Batra S et al[21] on the effectiveness of TENS in alleviating TMD symptoms and improving function, found a progressive increase in maximum lateral excursion after TENS therapy but it did not reach statistical significance. Meanwhile, Zhang Y et al[22] in their study on the effect of TENS on jaw movement evoked pain in TMJ disc displacement without reduction and healthy controls found statistically significant improvement in horizontal jaw movement.

Tenderness in muscles of mastication decreased and reached statistical significance on day 7 in the TENS group when compared to other groups in this study. This is in accordance with the study conducted by Farheen Jahan et al[3] and Linde C et al.[23]

There was no statistically significant improvement in deviation/deflection even after 21 post-treatment days in any of the three groups. Similarly, a decrease in joint sounds (clicking/popping/crepitus) also did not reach a statistical significance level after the completion of the study duration in any group. Eraslan R et al[24] also did not find any statistical significance in the decrease in the joint sounds after splint therapy. In contrast to this study, Najafi S et al[25] found a statistically significant decrease in joint sounds following TENS therapy.

This study has compared the different patient important outcomes in prospective manner. The outcomes were measured at different time intervals and compared with baseline. This is the strength of our study. However, few limitations of the study should also be noted. They are: single centric study, limited sample size, non-probability sampling, and absence of placebo-controlled group.

CONCLUSION

This study showed that both TENS and therapeutic ultrasound were effective in terms of reducing pain, however, TENS showed an earlier response. In terms of mouth opening, therapeutic ultrasound showed better results than TENS and splint therapy. In addition, improvement in maximum lateral excursion and reduction in the tenderness in the muscles of mastication was better in the TENS group. Furthermore, there was no difference in the reduction of joint sounds (clicking/popping/crepitus) and deviation/deflection following any of the treatment modalities.

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