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Research Article

Evaluation of Effectiveness of Ultrasound and Transcutaneous Electrical Nerve Stimulation on Pain in Temporomandibular Disorder

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Abstract: ***AIM:*** The purpose of this study was to evaluate and compare the effectiveness of TENS and Ultrasound in reduction of pain in TMJ dysfunction and improvement in mouth opening. ***Materials and methods:*** Total 40 subjects with 54 joints were included in the study in which 20 subjects (28 joints) were treated by TENS for a duration of 30 min (8 patients had bilateral involvement) and 20 subjects (26 joints) by Ultrasound therapy (6 patients had bilateral involvement) which was given for duration of 10 min. Pain evaluation was done using VAS score at baseline and after the respective 6 consecutive sittings in both the groups. Mouth opening was evaluated using divider and scale at pre and post-operative sittings. ***Results:*** Pain reduction was more in TENS group than in Ultrasound with an improvement of 5.43 in TENS and 3.31 in Ultrasound on comparing baseline and 6th sitting and the difference was highly significant. A significant improvement in mouth opening was seen in TENS group with mean value of 2.15 mm. ***Conclusion:*** Both treatment modalities can be advised in TMD cases but the effect of TENS therapy has proved to be better than the effect of Ultrasound therapy in terms of reduction of pain intensity as well as in improving interincisal mouth opening.

Keywords: Temporomandibular Disorder (TMD); Pain; Ultrasound; Temporomandibular Joint(TMJ); Transcutaneous Electrical Nerve Stimulation (TENS); Interincisal opening; Myofacial pain; Muscle spasm.

INTRODUCTION

Temporomandibular Disorder (TMDs), also known as craniomandibular disorders, comprises of a group of pathologies affecting the masticatory muscles, the temporomandibular joint (TMJ) and related structures [1, 2]. TMD is characterized by one or more of the following signs or symptoms: pain, joint sounds, and limitation in joint movement, muscle tenderness and joint tenderness [3]. It is also associated with other symptoms such as headache, ear related symptoms and cervical spine disorders [4, 5]. Of all temporomandibular disorders, the most common are myofascial pain and dysfunction, internal derangement and osteoarthrosis. Of these, myofascial pain and dysfunction has the highest prevalence [6]. MPDS is a condition commonly encountered in dentistry whereby muscular contraction or overextension caused by various factors leads to muscle fatigue, thus causing muscle pain.

Main aim of management of TMD is to reduce pain, restore normal jaw movements and function, and thereby restoring the normal life style functioning. Various treatment options for TMJ disorder ranges from physical therapy and nonsurgical treatment to various surgical procedures. Usually the conservative treatment is opted first; and considering surgery as the last treatment option [7]. TMD handling may be simple

or may include a multidisciplinary approach. Dentists, physicians, psychologists and physical therapists work together to deal with such patients. Electrophysical modalities, such as shortwave diathermy, ultrasound, laser, and transcutaneous electrical nerve stimulation (TENS), are commonly opted for management of temporomandibular joint (TMJ) disorders. Electrophysical modalities aim at reducing inflammation, promoting muscular relaxation, and increasing blood flow by altering capillary permeability. Physical therapy interventions often include therapeutic exercises for the masticatory or cervical spine muscles for improving the strength and mobility in the concerned region [8]. Thus, manual therapy techniques are used to reduce pain and restore mobility.

Transcutaneous electrical nerve stimulation (TENS) is an analgesic technique which is non-invasive in nature and is used to relieve nociceptive, neuropathic and musculoskeletal pain [9]. In broad term, TENS can be defined as anything that delivers electricity across the intact surface of the skin to activate the underlying nerves [10]. Analgesic action of TENS is based on two main theories- Gate control theory of pain and Endogenous opiod theory. The purpose of ultrasound treatment are to achieve an accelerated healing, increase the extendibility of collagen fibers, decrease joint stiffness, provide pain relief, improve mobility, and reduce muscle spasm [11]. Therapeutic ultrasound is available with a frequency range of 0.75-3 MHz, however, most of the machines are set at a frequency of 1 or 3 MHz.

However, literature elicits lack of studies correlating the efficacy of TENS therapy and therapeutic ultrasound with pre and post treatment changes in the treatment of TMD.

Thus, present study was devised to evaluate the efficacy of TENS and ultrasound in patients having pain with TMD. The study also aims to compare the effect of both these treatment modalities on pain in patients with TMD as well as improvement in mouth opening.

MATERIAL AND METHODS

This study includes (n=40) subjects with (54 joints) presenting one or more signs and symptoms of TMD. Age criteria included was 20-60 yrs of age. Both the genders were included. Patients were randomly selected and divided into the following two groups.

Group A- treated with TENS (20 patients with 28 joints)
Group B- treated with ultrasound (20 patients with 26 joints)

Study was approved from institutions ethical committee. Subjects were informed about the study procedure and consent was obtained.

INCLUSION CRITERIA

1) Those who were attending the OPD and willing to participate in the study.
2) Patients with signs/symptoms of temporomandibular disorders(As per Research Diagnostic Criteria)
3) Patients being treated with other drug therapy were considered provided a washout period of atleast 1 week was allowed before inclusion in this study.

Exclusion Criteria: Patients with history of trauma or injury around TMJ, rheumatoid arthritis, history of dislocation of jaw, metabolic disease, vascular disease, neoplasia, bell's palsy, psychiatric disorder, bleeding disorder, heart disease and cardiac pacemakers, pregnancy

TENS and Ultrasound treatment were given to the patients for 6 sittings on alternate days with the TENS being given for 30 minutes and ultrasound for 10 minutes. Pain evaluation was done after each sitting with the help of visual analog scale. Mouth opening was evaluated at pre-operative and post-operative sessions using divider and scale. For TENS, the machine was set on burst mode with pulse width adjusted at 80 µS and pulse rate at 20 Hz. The amplitude was altered according to the tolerance of the patient. Ultrasound was adjusted on 1 MHz, gel was then applied over the TMJ area. The ultrasound probe was then moved continuously over the surface in circular motion or figure of eight.

Paired Students t test was applied to compare the VAS score value and mouth opening within the TENS and Ultrasound group respectively. For comparison between the TENS and Ultrasound group, Unpaired Students t test has been applied.

RESULTS

In the present study, a total of 40 subjects were selected. Out of 40 subjects, 16 (40%) were males and 24 (60%) were females; thus, showing female predominance. [Table 1] In Group A (TENS), out of 20 patients; 12 (60%) patients had unilateral joint involvement and 8(40%) had bilateral joint involvement. In Group B (ULT), 14 (70%) patients had unilateral joint involvement and 6 (30%) had bilateral joint involvement, thus summing to a total of 20 patients [Table 2]. 16 (40%) patients were in age group 21-30 yrs, followed by 14 patients in age group of 31-40 yrs. 7 (17.5%) patients were in 41-50 age group and only 3 (7.5%) in 51-60 age group. Thus, patients in 2nd, 3rd and 4th decade were commonly affected. Mean age of all 40 subjects was

33 ± 8.36 yrs. [Table 3]. A total of 15 (53.6%) right joints and 13 (46.4%) left joints were included in TENS group. On the other hand, in Ultrasound group, 15 (57.7%) right joints and 11(42.3%) left joints were treated making to a total of 26 joints [Table 4].

On calculating the intragroup comparison of all the sessions in TENS group, the mean baseline VAS score value was 8.11 ± 1.257 which reduced to 6.29 ± 1.863 at the time of 1st sitting and further gradually reduced to 2.68 ± 1.701 till 6th sitting. On comparing the baseline value with consecutive sittings, a significant difference was found with the p value < 0.05. The mean difference between the baseline and 6th sitting was 5.53 ± 1.854 indicating a significant reduction in pain [Table 5]. On calculating the intragroup comparison of all the sessions in Ultrasound group, the mean baseline VAS score value was 7.96 ± 1.076 which further gradually reduced in the consecutive sittings and reached to a value of 4.65 ± 1.522 at the time of 6th sitting. On comparing the baseline VAS mean value with the subsequent sittings, the mean difference between baseline and 6th sitting was 3.308 ± 1.320 which was considered to be significant with p value <0.05 except for the first sitting where the mean difference between baseline and 1st sitting was 0.85 ± 0.613 . The mean difference between the baseline and last 6th sitting was 3.31 ± 1.320 [Table 6].

In TENS group, the mouth opening increased to a value of 41.80 ± 0.768 mm post treatment from the baseline value of 39.65 ± 1.694 ; depicting the p value to be <0.01; indicating that the difference was highly significant. [Table 7] However, in Ultrasound group, there was no significant increase seen with the p value being 0.55 [Table 8].

On intergroup comparison of vas score between TENS and Ultrasound, it was found that the mean value decreased in both the groups. However, the mean difference between the baseline and consecutive sittings was more in TENS group than in Ultrasound. Mean difference between baseline and 6th sitting in TENS was 5.43 ± 1.854 whereas in case of ultrasound, it was 3.31 ± 1.320. On comparing mean differences of the two groups, p value was<0.01 suggesting that difference is highly significant. Thus, pain reduction was more in TENS than in Ultrasound group.[Table 9] In case of mouth opening, the mean value increased in both the groups. However, in TENS group the post treatment mean value was more than the Ultrasound group and this difference was highly significant with the p value being <0.01.The mean difference between pre and post treatment mouth opening was 2.150 ± 1.725 mm in TENS group and 0.85 ± 0.8127 mm in Ultrasound group. [Table 10]

Table 1: Distribution of subjects by gender

	Male	Female	Total
Group A (TENS)	9 (45%)	11 (55%)	20 (100%)
Group B (ULT)	7 (35%)	13 (65%)	20 (100%)
Total Patients (Male/Female)	16 (40%)	24 (60%)	40 (100%)

Table-2: Distribution of subjects as per treatment modality

	Patients with unilateral joint involvement	Patients with bilateral joint involvement	Total
Group A (TENS)	12 (60%)	8 (40%)	20 (100%)
Group B (ULT)	14(70%)	6(30%)	20 (100%)

Table-3: Distribution of subjects by age in TENS and Ultrasound group

Age Group	Number Of Patients (TENS + ULTRASOUND)	Percentage	Mean Age±SD
21-30	16	40%	33 ± 8.364
31-40	14	35%	
41-50	7	17.5%	
51-60	3	7.5%	
Total	40	100%	

Table 4: Distribution of subjects as per the joints involved in TENS and Ultrasound group

	Right Joint	Left Joint	Total
Group A (TENS)	15 (53.6%)	13 (46.4%)	28 (100%)
Group B (ULT)	15 (57.7%)	11 (42.3%)	26 (100%)

Table 5: VAS score in TENS grou

Sessions	Mean ± SD	Mean Difference (Baseline – consecutive sittings)	P value
Baseline	8.11 ± 1.257	-	
1st sitting	6.29 ± 1.863	1.82 ± 1.25	<0.05*
2nd sitting	5.43 ± 1.550	2.68 ± 1.278	<0.05*
3rd sitting	4.64 ± 1.660	3.46 ± 1.374	<0.05*
4th sitting	3.93 ± 1.609	4.18 ± 1.565	<0.05*
5th sitting	3.21 ± 1.707	4.89 ± 1.750	<0.05*
6th sitting	2.68 ± 1.701	5.43 ± 1.854	<0.05*

*significant

Table 6: VAS Score in Ultrasound group

Sessions	Mean ± SD	Mean Difference (Baseline – consecutive sittings)	P value
Baseline	7.96 ± 1.076	-	-
1st sitting	7.12 ± 1.275	0.85 ± 0.613	0.39
2nd sitting	6.50 ± 1.364	1.46 ± 0.706	<0.05*
3rd sitting	6.00 ± 1.386	1.96 ± 0.958	<0.05*
4th sitting	5.50 ± 1.364	2.46 ± 0.948	<0.05*
5th sitting	4.88 ± 1.423	3.08 ± 1.129	<0.05*
6th sitting	4.65 ± 1.522	3.31 ± 1.320	<0.05*

*significant

Table-7: Mouth opening in TENS group

Sessions	Mean ± SD	Mean Difference	P value
Pre treatment	39.65 ± 1.694 mm	2.150 ± 1.725	<0.01**
Post treatment	41.80 ± 0.768 mm		

**highly significant

Table 8: Mouth opening in Ultrasound group

Sessions	Mean ± SD	Mean Difference	P value
Pre treatment	40 ± 1.338 mm	0.85 ± 0.8127	0.55
Post treatment	40.85 ± 1.182 mm		

Table-9: Comparison of TENS and Ultrasound group on basis of VAS score

Sessions	TENS		ULTRASOUND		
	Mean ± SD	Mean Difference	Mean ± SD	Mean Difference	P value
Baseline	8.11 ± 1.257	-	7.96 ± 1.076	-	
1st sitting	6.29 ± 1.863	1.82 ± 1.25	7.12 ± 1.275	0.85 ± 0.613	<0.01**
2nd sitting	5.43 ± 1.550	2.68 ± 1.278	6.50 ± 1.364	1.46 ± 0.706	<0.01**
3rd sitting	4.64 ± 1.660	3.46 ± 1.374	6.00 ± 1.386	1.96 ± 0.958	<0.01**
4th sitting	3.93 ± 1.609	4.18 ± 1.565	5.50 ± 1.364	2.46 ± 0.948	<0.01**
5th sitting	3.21 ± 1.707	4.89 ± 1.750	4.88 ± 1.423	3.08 ± 1.129	<0.01**
6th sitting	2.68 ± 1.701	5.43 ± 1.854	4.65 ± 1.522	3.31 ± 1.320	<0.01**

**highly significant

Table-10: Comparison of TENS and Ultrasound group on basis of mouth opening

Sessions	TENS		ULTRASOUND		
	Mean ± SD	Mean Difference	Mean ± SD	Mean Difference	P value
Pre treatment	39.65 ± 1.694	-	40.00 ±1.338	-	0.23
Post treatment	41.80 ± 0.768	2.150 ± 1.725	40.85 ± 1.182	0.85 ± 0.8127	<0.01**

**highly significant

Fig-1: TENS Machine used

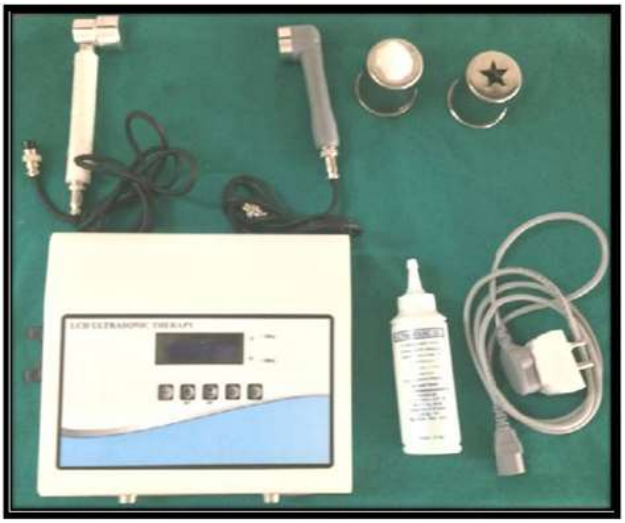

Fig-2: Ultrasound machine used

DISCUSSION

Treatment plan for TMD is not only decided as per the patient's disorder but also according to the need of the patient [12]. A number of different therapeutic modalities are opted in management of TMD which result in similar improvement in pain and dysfunction. However, caution needs to be taken with regard to the use of invasive and other irreversible treatment options, especially in the initial management of TMD patients [13]. Although a wide variety of therapeutic modalities have been offered in treatment of TMD, yet there is a lack of clinical trials to suggest appropriate management in these cases. Present study was thus carried out to evaluate the efficacy of TENS and Ultrasound in the treatment of TMD. A total of 40 subjects were included in the study and were randomly divided into two groups wherein 20 subjects received TENS treatment out of which 8 patients had bilateral involvement , thus treated total 28 joints. Similarly, 20 subjects received Ultrasound treatment in which 6 patients had bilateral involvement, thus total 26 joints were treated in this group.

The study comprised a total of 40 subjects, of which there were 16 (40%) male and 24 (60%) female. Results were in accordance with studies conducted by Dworkin *et al*. [14], Isacsson *et al*. [15] and Juniper *et al*. [16] who also reported female predominance, whereas contrary to this, the observations of Beaton *et al*. [17] revealed that there was no significant gender difference in their study.

Age range of subjects was 20-60 yrs which was further subdivided into four subgroups. Overall it was found that mainly, patients in 2nd and 3rd decade were more affected followed by 4th and 5th decade respectively. These results were in accordance to study conducted by Jensen *et al*. [18] who stated that TMJ pain disorders are common in second and third decade of life. Similarly, in study conducted by Singh H *et al*. [19], it was found that 60% of patients with TMJ pain were in age group between 20 and 30 yrs.

Mean age of all patients in present study was 33 yrs which was in consistent with study conducted by Rai *et al*. [12] where the mean age of patients of two groups was 34.93 and 32 yrs respectively. The lower prevalence of TMD signs and symptoms in older age group patients suggests that there is a probability that some portion of TMDs is self-limited [20].

On evaluating the effectiveness of TENS on pain in TMD, a significant pain reduction was found from the baseline to the last 6th sitting with the mean difference being 5.43 ± 1.85 which was statistically significant with the p value being<0.01.However, there was no significant difference between the consecutive sittings. The results were in accordance with study conducted by Patil S *et al*. [21] who found a highly significant improvement in pain reduction after TENS therapy. In study conducted by Wesberg GA *et al*. [22], a 95% success rate was observed after TENS therapy in patients with myofascial pain dysfunction.

The VAS score evaluation in Ultrasound group in which there a significant improvement in pain reduction from baseline to 6th sitting with the mean difference of 3.31± 1.320 which was statistically significant. However, there was no significant difference between baseline and 1st sitting and also between the consecutive sittings. The results were in compliance with study conducted by Esposito *et al*. [11] who stated that Ultrasound was more effective in relieving muscle symptoms than symptoms associated with disc. Grieder *et al*. [23] suggested that Ultrasound therapy was not much effective in relieving symptoms of TMD.

There was an improvement of 2.15±1.72 mm of mouth opening in TENS group which was statistically significant. The results were in accordance with study conducted by Patil S *et al*. [21] and Moger *et al*. [13]. However, in Ultrasound group, there was no significant difference found between pre and post-operative mouth opening. On comparing the effectiveness of TENS and Ultrasound on pain in TMD it was found that TENS therapy was a more effective treatment modality than Ultrasound in TMJ pain disorders.

Singh H *et al*. [19] stated that the reduction in pain in case of TENS is attributed to its neurologic, physiologic, pyschologic and pharmacologic mechanism. Patil S *et al*. [21] concluded that it works on the gate control theory, resulting in suppression of pain signals which is its neurologic action. Physiologically, it affects muscle movements, the twitching of muscle may result in increased circulation, decrease in edema and a decrease in resting muscle activity. Moreover, pharmacologically it involves the stimulated release of endorphins, which are endogenous morphine like substances. Their analgesic efficacy is even more than that of morphine. Hence, TENS therapy gave better results in pain reduction because of its multiple mechanism of action and thus it should be utilized in cases of TMD, helping in relieving muscle pain. On the other hand, Ultrasound increases vascular and fluid circulation resulting in washout of pain mediators, increasing cell permeability and break in pain cycle;

thus causing a decrease in inflammation and this contributes to its action in pain reduction in TMD.

On comparison of mouth opening between TENS and Ultrasound group, a significant improvement in mouth opening was seen in TENS group with a mean value of 2.15mm. The results were in contrary to study conducted by Rai *et al*. [12], wherein there was no significant difference in improvement of mouth opening in both the groups. The reason for this difference might be because of the more pain relief achieved in TENS group in our study which in turn contributes to improvement in mouth opening. Thus, the results show that both TENS and Ultrasound are effective in pain reduction in case of TMD with TENS showing more significant results than Ultrasound. However, the sample size was small. Thus, more studies with a larger sample size and longer followup period needs to be carried out to evaluate the comparison between the two.

CONCLUSION

Present study analysed the efficacy of TENS and Ultrasound in TMJ dysfunction. Both treatment modalities can be advised in TMD cases considering them to be a definite and noninvasive option. However, the effect of TENS therapy has proved to be better than that of Ultrasound therapy in reduction of pain intensity as well as in improving interincisal mouth opening. Thus, both these options should be opted as initial modality in all TMD cases for symptomatic relief, progression and as therapeutic intervention for patients.

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