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**Edited by Yogesh Singh Bisht & Ruby Singh**
**E-mail: yogeshbishttech@gmail.com & bioinformationruby@gmail.com**
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# Therapeutic ultrasound, TENS and trigger point injections for myofascial pain: A comparative clinical study

**Shivani Kapurwan[1,*], S. Karpagavalli[2], Ranjeeta Mehta[1], Chetna Joshi[1], Vashishtha Singh[3] & Jyotsna Seth[4]**

[1]Department of Oral Medicine and Radiology, Seema Dental College and Hospital, Rishikesh 249203, Uttarakhand, India; [2]Department of Oral Medicine, Radiology and Orofacial Pain, Cranio Facial Clinic Pvt Ltd, Chennai, India; [3]Department of Oral Medicine & Radiology, Ekdanta Smile Hub, Haridwar, Uttarakhand, India; [4]Department of Prosthodontics and Crown & Bridge, Seema Dental College and Hospital, Rishikesh 249203, Uttarakhand, India; *Corresponding author

**Affiliation URL:**
https://www.seemadentalcollege.org/index.php/en/

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https://www.dentalclinic.in/

**Author contact**:
Shivani Kapurwan - E-mail: drshivanikap06@gmail.com
S. Karpagavalli - E-mail: drkarpax27@gmail.com
Ranjeeta Mehta - E-mail: ranjeetamehta20@gmail.com
Chetna Joshi - E-mail: myselfchetnajoshi@gmail.com
Vashishtha Singh - E-mail: vashishthasingh97@gmail.com
Jyotsna Seth - E-mail: drjyotsnaseth64@gmail.com

**Abstract:**
Therapeutic ultrasound, TENS and trigger point injections are widely used for myofascial pain syndrome (MPS), but their comparative efficacy is unclear. This prospective randomised study allocated 27 patients with MPS equally to therapeutic ultrasound, TENS or trigger point injections. Pain was assessed on the Visual Analogue Scale at baseline and weekly and groups were compared using ANOVA and the chi-square test. Trigger point injections gave significantly greater pain reduction in the first week (P = 0.039), but all three modalities were comparable by weeks two and three. Thus, trigger point injections provide rapid relief, while ultrasound and TENS are equally effective, non-invasive alternatives over time.

**Keywords:** Myofascial pain syndrome (MPS), trigger point injections, therapeutic ultrasound, transcutaneous electrical nerve stimulation, temporomandibular disorders, visual analog scale (VAS)

**Background:**
Myofascial pain syndrome (MPS) is a common but frequently under-recognized musculoskeletal disorder that markedly affects quality of life and accounts for a substantial proportion of patients presenting with regional pain **[1].** It is characterized by myofascial trigger points - hyperirritable taut bands within skeletal muscle that produce localized and referred pain and functional limitation **[2].** These trigger points are thought to arise from muscle overuse, sustained poor posture, psychological stress, trauma or occlusal discrepancies, with impaired local perfusion and energy depletion perpetuating the taut band **[3].** MPS frequently coexists with temporomandibular disorders, which commonly present with jaw pain, headache and difficulty in mastication **[4].** TENS is widely used in the management of temporomandibular disorders because of its non-invasive, analgesic effects **[5].** Electrical stimulation techniques have been shown to reduce pain and tenderness at the myofascial trigger point **[6].** Therapeutic ultrasound reduces pain and improves muscle function by enhancing blood flow and tissue extensibility through both thermal and non-thermal effects **[7].** Both continuous and pulsed ultrasound has been reported to reduce pain in MPS **[8].** Ultrasound is also effective against trigger points of the upper trapezius, a frequently involved muscle **[9].** For refractory trigger points, needling and injection techniques, including local anaesthetic and botulinum toxin, are used to deactivate the taut band **[10].** Therefore, it is of interest to evaluate the efficacy of therapeutic ultrasound, TENS and trigger point injections in the management of patients with myofascial pain in a tertiary-care setting.

**Materials and Methods:**
**Study design and ethics:**
This prospective randomized interventional study was conducted in the Outpatient Department of Oral Medicine and Radiology at a tertiary care dental institution. The study was approved by the Institutional Ethics Committee (Approval No.: SDCH/MDS/IEC/7/2023) and conducted in accordance with the Declaration of Helsinki and written informed consent was obtained from all participants before inclusion.

**Sample size and participants:**
The sample size was calculated using G*Power (version 3.1.9.7) based on an F-test for comparing three independent groups, using an effect size (f = 0.755) derived from a previous comparable study, an alpha of 0.05 and 80% power, giving 21 participants; allowing for 20% attrition, the final sample was 27 participants (n = 9 per group). Patients aged 20-70 years with myofascial pain diagnosed according to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), Group I Axis I, were included. Eligible patients had persistent, recurrent or chronic myofascial pain lasting more than one month and not relieved by analgesics, fewer than 10 active trigger points and no medical or pharmacological treatment other than NSAIDs in the preceding month. Medically compromised patients, those with known allergy to adhesive tapes or TENS electrodes and those previously treated with TENS without improvement were excluded.

**Statistical analysis:**
Continuous variables were tested for normality using the Shapiro-Wilk test; normally distributed variables were compared using one-way ANOVA followed by Tukey's post hoc test and repeated-measures ANOVA assessed changes in pain scores over time within each group. The chi-square test compared categorical variables, including gender, DC/TMD diagnosis distribution and pain-free status during follow-up. Statistical significance was set at $p< 0.05$.

**Randomization and intervention:**

The 27 eligible patients were allocated to three groups (n = 9 each) using computer-generated randomization; operator blinding was not feasible, but outcome assessment was standardized to minimize bias. Group a received therapeutic ultrasound at 1-3 MHz in continuous mode for 5 minutes per session for 14 days. Group B received TENS at 70-80 Hz in pulsed mode for 20 minutes per session for 14 days. Group C received 0.5 mL of plain lignocaine injected into the trigger point once weekly for two weeks. All patients were followed up post-therapy at weekly intervals for three weeks.

**Results:**

A female predominance was observed across all groups; the ultrasound group comprised 55.6% females and 44.4% males, with a similar pattern in the TENS and trigger point injection groups and the difference in gender distribution was not significant (P = 0.25). Myofascial pain was recorded in 66.7%, 55.6% and 55.6% of participants in the ultrasound, TENS and trigger point injection groups respectively, with the remainder having myofascial pain with referral; the difference in diagnostic distribution was not significant (P = 0.50). At week 1, mean VAS scores differed significantly among the groups (P = 0.039), with the ultrasound group showing the highest and the trigger point injection group the lowest scores; post hoc analysis showed a significant difference between the ultrasound and trigger point injection groups. At weeks 2 and 3, mean VAS scores varied but the differences were not statistically significant (P > 0.05), with no significant intergroup differences on post hoc analysis **(Table 1).** In the trigger point injection group, the number of active trigger points fell significantly over time (P = 0.001): at week 1, 55.6% of participants had three active trigger points and the remainder one; by week 2, 44.4% had one or two and 11.1% had none; and by week 3, 55.6% were completely free of active trigger points while 44.4% retained one. Pain-free status improved progressively in the TENS and ultrasound groups during follow-up **(Table 2).** No participant was pain-free up to the fourth visit; from the fifth to seventh visits both groups improved gradually without significant differences. From the eighth to thirteenth visits the TENS group showed a slightly higher proportion of pain-free participants than the ultrasound group, though the differences were not significant and by the fourteenth visit 77.8% of participants in both groups were pain-free (p = 0.99).

**Table 1:** Comparison of mean VAS scores between the groups at different time intervals

| Time point | Group | N | Mean | SD | F (P value) |
|---|---|---|---|---|---|
| **VAS, week 1** | Ultrasound | 9 | 6.44 | 1.2 | 3.72 (P = 0.039*) |
| | TENS | 9 | 5.56 | 0.8 | |
| | Trigger point injections | 9 | 4.89 | 1.4 | |
| **VAS, week 2** | Ultrasound | 9 | 2.33 | 1.5 | 1.15 (P = 0.33, NS) |
| | TENS | 9 | 2.11 | 1.5 | |
| | Trigger point injections | 9 | 3.11 | 1.2 | |
| **VAS, week 3** | Ultrasound | 9 | 0.44 | 0.88 | 1.50 (P = 0.24, NS) |
| | TENS | 9 | 0.44 | 0.88 | |
| | Trigger point injections | 9 | 1.11 | 1.05 | |

*SD: standard deviation; NS: not significant. One-way ANOVA was used for intergroup comparison. *Statistically significant (P < 0.05).*

**Table 2:** Distribution of participants reporting no pain (VAS score 0) following treatment in the TENS and ultrasound groups

| Visit | TENS, N (%) | Ultrasound, N (%) | Total, N | P value |
|---|---|---|---|---|
| **1** | 0 | 0 | 0 | – |
| **2** | 0 | 0 | 0 | – |
| **3** | 0 | 0 | 0 | – |
| **4** | 0 | 0 | 0 | – |
| **5** | 1 (11.1) | 0 | 1 | 0.30 |
| **6** | 1 (11.1) | 1 (11.1) | 2 | 0.99 |
| **7** | 2 (22.2) | 2 (22.2) | 4 | 0.99 |
| **8** | 3 (33.3) | 2 (22.2) | 5 | 0.60 |
| **9** | 3 (33.3) | 2 (22.2) | 5 | 0.60 |
| **10** | 3 (33.3) | 3 (33.3) | 6 | 0.99 |
| **11** | 5 (55.6) | 3 (33.3) | 8 | 0.34 |
| **12** | 6 (66.7) | 4 (44.4) | 10 | 0.30 |
| **13** | 7 (77.8) | 5 (55.6) | 12 | 0.30 |
| **14** | 7 (77.8) | 7 (77.8) | 14 | 0.99 |

*N: number; %: percentage. Chi-square test; P < 0.05 considered significant.*

**Discussion:**

The present study showed a progressive reduction in pain intensity across all three treatment modalities, supporting their effectiveness in the management of MPS. Although the onset and degree of pain relief differed, the longer-term outcomes were largely comparable, reflecting the complex and multifactorial nature of MPS. A female predominance was observed across all groups, consistent with the greater susceptibility of women to myofascial pain and temporomandibular disorders reported previously **[11]** and plausibly attributable to hormonal influences and differences in pain perception. Trigger point injections produced the most rapid pain relief, particularly in the first week, in agreement with Wangnamthip *et al.* (2024) **[12]**, who reported immediate analgesic effects following lidocaine-based injections; the rapid onset likely reflects sodium-channel blockade by lignocaine and mechanical disruption of the taut band, while the loss of superiority thereafter is consistent with persistence of the underlying aetiology. TENS produced a gradual but consistent improvement, supported by Graff-Radford *et al.* **[13]**, who demonstrated significant pain reduction with high-frequency TENS, an effect attributable to gate-control and endogenous-opioid mechanisms. Therapeutic ultrasound likewise produced a steady reduction in pain, consistent with Chen *et al.* **[14]**, who reported improved pain and functional outcomes with therapeutic ultrasound through thermal and non-thermal effects on blood flow and tissue extensibility. Importantly, post-therapy evaluation revealed no statistically significant differences among the three groups, indicating a convergence of outcomes over time. This is consistent with Cangelosi *et al.* **[15]**, who reported comparable long-term pain reduction across different interventions and with the comparative study of Gębska *et al.* **[16]**, who found significant improvement in pain and mandibular function following both therapeutic ultrasound and TENS without clear superiority of either non-invasive modality. Taken together, these findings suggest that treatment selection may be guided by patient preference, cost, invasiveness and availability rather than by any difference in efficacy: trigger point injections may be preferred when rapid relief is required,

whereas TENS and ultrasound suit longer-term management and better compliance. Certain limitations should be acknowledged. The relatively small sample (n = 9 per group) may have limited statistical power to detect modest differences and the three-week follow-up may not capture long-term pain control or recurrence. The study was single-centre, blinding was not feasible and the predominance of female participants and absence of a placebo or untreated control group may affect generalizability. Newer modalities such as low-level laser therapy and combination protocols were not evaluated. Larger multicentric randomized controlled trials with longer follow-up and multimodal protocols are therefore required before definitive clinical recommendations can be made.

**Conclusion:**
All three treatment modalities were effective in reducing pain associated with myofascial pain syndrome, with trigger point injections providing rapid short-term relief and TENS and therapeutic ultrasound producing gradual but sustained improvement. No significant differences were observed in long-term outcomes among the groups. Treatment selection should be individualized according to clinical requirements, patient preference and accessibility and larger multicentric studies with longer follow-up are recommended to establish standardized protocols.

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**Author contributions:**
All authors contributed to study conception, data collection, manuscript preparation and final approval of the manuscript.

**Consent to participate:**
Written informed consent was obtained from all participants prior to inclusion in the study.

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