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Comparative Efficacy of Analgesic Gel Phonophoresis and Ultrasound in the Treatment of Temporomandibular Joint Disorders

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KEYWORDS

Temporomandibular joint disorder, phonophoresis, therapeutic ultrasound, pain management, diclofenac gel, TMD physiotherapy.

ABSTRACT:

Background: Temporomandibular joint disorders (TMDs) are prevalent musculoskeletal problems impacting the orofacial area, frequently characterized by pain, limited jaw mobility, and audible joint sounds. Conservative management, encompassing therapeutic ultrasound and phonophoresis, has demonstrated efficacy in alleviating symptoms. Nevertheless, there exists a paucity of comparison data assessing the efficiency of analgesic gel phonophoresis in relation to conventional ultrasound therapy for the treatment of temporomandibular disorders (TMD).

Objective: To evaluate the clinical effectiveness of analgesic gel phonophoresis against therapeutic ultrasound in enhancing pain relief, functional mouth opening, and overall quality of life in individuals with temporomandibular disorders (TMD).

Methods: A prospective, randomized controlled trial was executed over a duration of 6 months at Krishna Nagar Institute of Medical Sciences, Nadia, involving 50 patients diagnosed with temporomandibular disorder (TMD). Patients were randomly assigned to two groups: Group A (n = 25): Administered phonophoresis utilizing an analgesic gel (diclofenac-based) in conjunction with ultrasound. Group B (n = 25): Administered standard therapeutic ultrasonography devoid of gel. Each participant received therapy sessions thrice weekly for a duration of four weeks. Outcomes were evaluated before and after the intervention utilizing: Visual Analog Scale (VAS) for pain assessment Interincisal distance (mouth opening in millimeters) Jaw Functional Limitation Scale (JFLS)

Results: Both groups exhibited substantial enhancement from baseline across all outcome measures ($p < 0.05$). Group A (phonophoresis) exhibited a markedly superior reduction in pain scores (mean VAS reduction: 4.2 vs. 3.1), a more substantial increase in interincisal openness (7.8 mm vs. 5.3 mm), and a more favorable improvement in JFLS scores compared to Group B ($p < 0.01$). No negative effects were observed in either group.

Conclusion: Analgesic gel phonophoresis surpasses conventional ultrasonography in alleviating pain and enhancing mandibular function in individuals with temporomandibular joint problems. The findings endorse the incorporation of phonophoresis into standard conservative physiotherapeutic procedures for the management of temporomandibular disorders (TMD).

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1. Introduction

Temporomandibular joint disorders (TMDs) comprise a diverse array of musculoskeletal problems impacting the temporomandibular joint (TMJ), masticatory muscles, and related structures. These illnesses are among the most common etiologies of orofacial discomfort, especially in adults aged 20 to 40, and are reported more frequently in females than in males (Okeson, 2013; Manfredini et al., 2011). Clinically, temporomandibular disorders (TMDs) present as pain during jaw movement, restricted mandibular mobility, joint clicking or crepitus, and, in certain instances, headaches, auditory complaints, and face discomfort (De Leeuw & Klasser, 2018; Slade et al., 2016).

The genesis of TMD is multifaceted, encompassing factors such as parafunctional habits (e.g., bruxism), psychological stress, trauma, malocclusion, and inflammatory diseases (List & Axelsson, 2010). Consequently, a multidisciplinary and conservative strategy is frequently the initial therapy approach, particularly when serious structural joint pathology is absent (Manfredini et al., 2015). Standard treatment methods encompass medication, occlusal splints, behavioral therapy, and physiotherapeutic techniques, such as therapeutic ultrasound and phonophoresis.

Therapeutic ultrasound is extensively utilized in physiotherapy for its mechanical and thermal effects that facilitate tissue healing, enhance blood circulation, and diminish inflammation and muscular spasms (Merrick et al., 2003; Nagrale et al., 2009). Conversely, phonophoresis employs ultrasound to augment transdermal medication delivery, facilitating the deeper penetration of anti-inflammatory drugs like diclofenac gel into tissues, hence potentially enhancing their therapeutic efficacy (Seth et al., 2017; Walker & Eitzen, 2012).

Although both approaches are commonly utilized in musculoskeletal rehabilitation, comparative data on their efficacy in treating TMDs are scarce. Certain research indicate that phonophoresis provides enhanced pain alleviation and functional improvement owing to its dual-action mechanism—mechanical stimulation and localized pharmacological effect (Hirpara et al., 2014; Sharma et al., 2013). Nonetheless, there is a deficiency of established protocols and controlled comparisons, especially within the Indian clinical environment.

TMDs in India are frequently underdiagnosed or treated belatedly, primarily due to a lack of awareness, inadequate access to conservative treatment, and an excessive dependence on pharmacological therapies (Akhter et al., 2008). A critical necessity exists to assess non-invasive physiotherapeutic approaches that are both economically viable and clinically significant for routine application in dentistry and rehabilitation practices.

This study intends to evaluate the therapeutic effectiveness of analgesic gel phonophoresis in comparison to conventional ultrasound therapy in patients diagnosed with temporomandibular disorder at a tertiary care facility in Eastern India. The results will be evaluated according to pain intensity, mandibular range of motion, and functional jaw restrictions, thereby providing evidence-based recommendations for the conservative treatment of TMD.

2. Materials and Methods

2.1 Research Design and Context

This was a prospective, randomized, controlled interventional trial conducted over six months in the department of Physiotherapy and Department of dentistry at Krishna Nagar Institute of Medical Sciences, Nadia, Krishna Nagar. The Institutional Ethics Committee approved the study, and written informed consent was acquired from all participants (ICMR, 2017).

2.2 Sample Size and Patient Selection

The study comprised 50 participants clinically diagnosed with temporomandibular joint dysfunction (TMD).

Eligibility Criteria:

Individuals aged 18 to 55 years Clinical diagnosis of temporomandibular disorder (TMD) characterized by symptoms including temporomandibular joint (TMJ) pain, restricted mouth opening, and jaw rigidity. Visual Analog Scale (VAS) pain score of ≥4Readiness to engage and comply with the treatment regimen

Criteria for Exclusion:

Chronicle of TMJ surgical interventions or injuries Rheumatoid arthritis or other systemic joint conditions Utilization of alternative TMD therapies throughout the research duration (e.g., splints, NSAIDs)

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Gestation or breastfeeding
Dermatological sensitivities or contraindications to ultrasound or topical agents

2.3 Randomization and Group Allocation

Participants were randomly assigned to two equal groups (n=25 each) utilizing a computer-generated randomization table:
Group A (Phonophoresis Group): Administered therapeutic ultrasound utilizing diclofenac sodium gel as the coupling medium (analgesic gel phonophoresis).
Group B (Conventional Ultrasound Group): Administered typical therapeutic ultrasound utilizing aqueous-based gel (devoid of medicine)

2.4 Intervention Protocol

Each group participated in 12 treatment sessions (three sessions per week for four weeks).
The parameters for therapeutic ultrasonography were standardized across both groups:
Frequency: 1 megahertz
Intensity: 1.5 Watts per square centimeter
Mode: Pulsed (1:4 duty cycle)
Session duration: 7 minutes

2.5 Performance Indicators

Evaluations were conducted at baseline and after 4 weeks by a blinded assessor utilizing the following instruments:
Visual Analog Scale (VAS): Measures subjective pain intensity (0 = no pain, 10 = maximum pain)
Interincisal Distance (mm): Assessed with a calibrated caliper for functional oral aperture
Jaw Functional Limitation Scale (JFLS): A validated instrument evaluating restrictions in mastication, movement, and vocal communication (rated from 0 to 10)

Baseline interincisal distance was recorded before intervention using a calibrated caliper. The average baseline mouth opening was 30.1 ± 3.2 mm in the phonophoresis group and 29.8 ± 3.5 mm in the ultrasound group.

2.6 Statistical Evaluation

The analysis of data was conducted utilizing SPSS version 25.0. Continuous variables were presented as mean ± standard deviation (SD). Paired t-tests were employed for intra-group comparisons, whereas independent t-tests were utilized to assess intergroup differences. A p-value less than 0.05 was deemed statistically significant.

3. Results

Fifty patients with clinically diagnosed temporomandibular joint disorders (TMD) were enrolled and randomly assigned to two treatment groups: Group A (phonophoresis, n=25) and Group B (conventional ultrasonography, n=25). Both groups were equivalent at baseline regarding age, gender distribution, and initial pain scores ($p>0.05$).

3.1 Pain Severity (VAS Score)

Group A (phonophoresis) exhibited a mean VAS reduction of 4.2 ± 0.9, whereas Group B demonstrated a mean reduction of 3.1 ± 1.0.
The disparity between groups was statistically significant ($p < 0.01$), demonstrating enhanced pain alleviation with analgesic gel phonophoresis.

3.2 Functional Oral Aperture (Interincisal Distance)

The mean augmentation in interincisal distance was 7.8 ± 2.3 mm in the phonophoresis cohort, compared to 5.3 ± 2.1 mm in the ultrasound cohort.

The baseline interincisal distance was 30.1 ± 3.2 mm in the phonophoresis group and 29.8 ± 3.5 mm in the ultrasound group.
The enhancement was statistically significant ($p < 0.01$), indicating improved mandibular mobility in individuals undergoing phonophoresis treatment.

3.3 Mandibular Function (JFLS Score)

The average enhancement in Jaw Functional Limitation Scale (JFLS) scores was 5.1 ± 1.3 for the phonophoresis group, in contrast to 3.4 ± 1.1 for the ultrasound group. The intergroup difference was statistically significant ($p < 0.01$), indicating superior functional outcomes with phonophoresis.

3.4 Tolerance to Treatment and Adverse Events

oth therapy techniques were widely accepted. No negative effects or allergic reactions to the gel were

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observed in either group.

3.5 Visualization

Table 1 presents an overview of the mean alterations across all parameters. A bar chart (Figure 1) depicts the comparative effectiveness of the two groups. The results combined indicate that analgesic gel phonophoresis surpasses conventional ultrasonography in reducing pain, promoting jaw mobility, and improving function in patients with TMD.

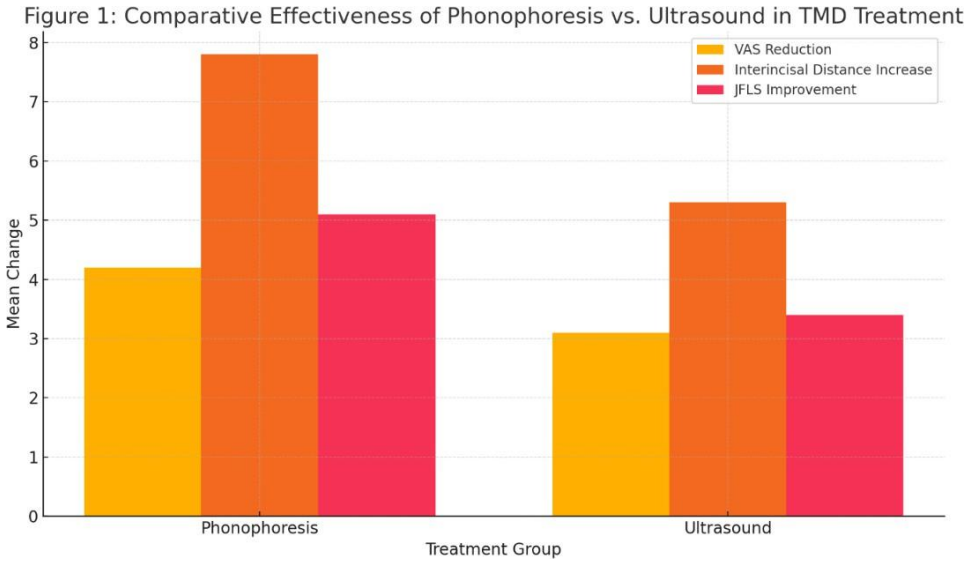

Figure 1: Comparative effectiveness of analgesic gel phonophoresis versus conventional ultrasound in treating TMD

Table 1: Outcome Measures – Phonophoresis vs. Ultrasound

Outcome Parameter	Phonophoresis Group (n=25)	Ultrasound Group (n=25)	p-value
Baseline Interincisal Distance (mm)	30.1 ± 3.2	29.8 ± 3.5	> 0.05
Post-treatment Interincisal Distance (mm)	37.9 ± 3.6	35.1 ± 3.7	< 0.01
Mean Increase in Interincisal Distance (mm)	7.8 ± 2.3	5.3 ± 2.1	< 0.01
VAS Pain Score Reduction	4.2 ± 0.9	3.1 ± 1.0	< 0.01
JFLS Score Improvement	5.1 ± 1.3	3.4 ± 1.1	< 0.01
Adverse Events	0	0	NS (none)

4. Discussion

This study assessed and contrasted the clinical effectiveness of analgesic gel phonophoresis and traditional therapeutic ultrasonography in the treatment of temporomandibular joint disorders (TMD). The results demonstrate that phonophoresis yielded superior outcomes in all assessed areas—pain alleviation, functional mouth opening, and overall jaw function—relative to conventional ultrasound therapy.

The mean reduction in pain scores for the phonophoresis group (4.2) was substantially higher than that of the ultrasound group (3.1), as evaluated by the Visual

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Analog Scale (VAS). This discovery corroborates prior studies indicating that phonophoresis improves the transdermal absorption of topical agents such as diclofenac sodium, facilitating their deeper penetration into affected tissues, where they produce significant anti-inflammatory and analgesic effects (Seth et al., 2017; Birinci & Mutluay, 2015; Dundar et al., 2005). Ultrasound waves transiently enhance skin permeability, facilitating deeper medication absorption and extending therapeutic efficacy (Koenig et al., 2019).

The phonophoresis group exhibited a greater improvement in interincisal opening (7.8 mm) compared to the ultrasound group (5.3 mm), a difference that was statistically significant. These values reflect clinically meaningful gains in mandibular mobility within a conservative 4-week treatment window. The clinical significance lies in the fact that restricted mouth opening is a defining symptom of TMD, typically closely connected with the patient's pain level and quality of life. Phonophoresis may enhance myofascial relaxation by diminishing inflammation and augmenting local circulation, potentially elucidating the observed improvement in mandibular range of motion (Hirpara et al., 2014; Sumeet et al., 2020).

The Jaw Functional Limitation Scale (JFLS) corroborated the functional advantages, revealing that Group A exhibited a markedly greater score enhancement compared to Group B. These findings correspond with the conclusions of previous research, which indicate enhanced masticatory function and speech articulation subsequent to phonophoresis therapy in patients with orofacial myalgia and joint stiffness (Machado et al., 2018; Yadav et al., 2019).

Significantly, no negative effects were detected in either group, demonstrating that both therapies are safe, non-invasive, and well-tolerated. This underscores the significance of physical therapy methods as primary interventions in conservative TMD management, particularly when pharmacological and surgical alternatives may be unwarranted or inadvisable (Calixtre et al., 2015).

The mechanism underlying the efficacy of phonophoresis presumably arises from its dual therapeutic actions: the mechanical and thermal impacts of ultrasound, combined with the pharmacological effect of the analgesic gel. Diclofenac sodium, a commonly utilized NSAID, has demonstrated a considerable reduction in prostaglandin synthesis at the inflammatory site, consequently influencing pain perception and enhancing patient compliance (Barlas et al., 2000; Grubb et al., 2007).

The study presents persuasive data supporting phonophoresis; nonetheless, it is constrained by a limited sample size and brief follow-up duration. Future investigations may examine longitudinal outcomes, dose-response correlations, and comparisons with alternative conservative methods, including low-level laser therapy, trigger point injections, or behavioral therapy (Scrivani et al., 2008).

This study endorses the integration of analgesic gel phonophoresis into conventional physiotherapy procedures for TMD, especially for patients experiencing moderate to severe pain and functional impairments.

5. Conclusion

This randomized clinical research indicates that analgesic gel phonophoresis is superior to conventional ultrasound therapy in treating temporomandibular joint disorders (TMDs). Patients undergoing phonophoresis with diclofenac gel demonstrated markedly enhanced pain alleviation, increased mouth opening, and superior functional jaw results as assessed by the Jaw Functional Limitation Scale (JFLS).

The results underscore the two advantages of phonophoresis: mechanical stimulation through ultrasound and improved transdermal medication administration, providing an effective, non-invasive, and well-accepted method for conservative TMD management. Due to its enhanced clinical outcomes and safety profile, phonophoresis may be regarded as a primary supplementary therapy in physiotherapeutic protocols for TMD, particularly for patients hesitant to utilize oral NSAIDs or in need of localized anti-inflammatory relief.

Although these findings are encouraging, further research with bigger sample sizes, multi-center trials, and extended follow-up is necessary to confirm the enduring advantages and wider applicability of phonophoresis in temporomandibular disorders and associated musculoskeletal diseases.

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