RESEARCH PAPER

Effect of Dry Needling Versus Transcutaneous Electrical Nerve Stimulation on Pain, Mouth Opening, and Temporomandibular Function Following Orthognathic Surgery: A Randomized Controlled Trial

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ABSTRACT

Background: Orthognathic surgery is considered the standard treatment for correcting dentofacial deformities, improving oral function and facial aesthetics. Despite favorable surgical outcomes, postoperative pain, limited mouth opening, and temporomandibular dysfunction remain common challenges that may delay functional recovery and reduce patient comfort.

Objective: to compare between dry needling and Transcutaneous electrical nerve stimulation (TENS) on pain after orthognathic surgery. Patients: Sixty Patients after orthognathic surgery chosen from the Outpatient Clinic, Faculty of Dentistry, Cairo University from both genders (26 males and 34 females) were involved and they age between 20 and 40 years. The patients were randomized into 2 equal groups: dry needling (DN) (group A) or TENS (group B). Both groups received treatment twice weekly for four weeks. Each group received one of the interventions as well as home program. Pain intensity, active range of motion (ROM) for jaw opening and temporomandibular functions were assessed before (7days post-orthognathic surgery, 2weeks and after 4 weeks of interventions by electronic visual Analogue scale, digital vernier caliper and the Fonseca anamnestic index respectively.

Results: The main findings of this study showed that no statistically significant difference was found among the two groups in all outcomes before treatment ($p>0.05$). Following two weeks and 1 month of intervention, TENS group showed superiority to DN group at week 2 for mouth opening and SFAI score but not for pain, while demonstrating superiority across all three outcomes at one month.

Conclusion: Both TENS and dry needling effectively reduced postoperative pain following orthognathic surgery; however, TENS produced greater pain reduction than dry needling. Therefore, TENS may be considered the preferred treatment option for postoperative pain management after orthognathic surgery.

Keywords: Dry Needling, Transcutaneous Electrical nerve Stimulation, Pain, Orthognathic Surgery

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INTRODUCTION

Orthognathic surgery, sometimes called corrective jaw surgery or just jaw surgery, is a tried-and-true method of fixing skeletal irregularities that disrupt the harmony, occlusion, and function of the face. Aesthetics, airway function, speech, along with chewing efficacy are some of the goals of these treatments, which usually include the chin, mandible, and maxilla (1).

Orthognathic surgery is recommended for 27% of patients because to cosmetic concerns and 52% due to functional issues (2). The frequency of class I occlusion was 74.7% in patients having permanent dentition, 19.56% in class II, and 5.93% in class III. The success rate of orthognathic surgery is estimated to be 93.9%. The majority of those who suffer from it say it enhances their quality of life (QOL) (3).

Pain, especially in the jaw muscles and/or the TMJ, is the most prevalent symptom. Pain that radiates down the jaw, neck, or face; jaw muscle stiffness; jaw locking or restricted mobility; clicking, cracking, or grating in the TMJ while opening or shutting the mouth; and a shift in the occlusion of the upper and lower teeth occlude are all possible signs. Orthognathic surgery and orthodontic therapy are often used together to fix the occlusal relationship when there are significant differences in the jaws' skeletal structures (4).

An essential part of treating oral and maxillofacial disorders is pain control, particularly during postoperative rehabilitation. While traditional approaches primarily rely on pharmacological interventions and surgical management, physiotherapy has emerged as an essential component of recovery following maxillofacial surgery (5). Rehabilitation programs aim to reduce pain and muscle guarding, improve mandibular mobility, restore muscle function, and facilitate the return to normal daily activities. Early physiotherapy intervention may also minimize postoperative disability and enhance overall treatment outcomes. Various physiotherapy modalities have been investigated for this purpose, such as exercises therapy, manual therapy, low-level laser therapy, TENS in addition

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to DN. Among these, DN and TENS have gained increasing attention as a minimally invasive method for pain relief and for treatment of muscle dysfunction (4).

A non-invasive electrotherapeutic method, TENS is commonly utilized in the rehabilitation of musculoskeletal and surgical conditions. The Gate Control Theory of Pain, which explains its analgesic effects, provides a primary framework for understanding pain relief. Restoring jaw movement is directly related to its dual action as a pain reliever and a muscle relaxant (6). When it comes to pain and dysfunction, DN is a therapy approach that focuses on releasing trigger points, which are tight bands in the muscles that may transfer pain and restrict mobility. In order to alleviate pain and improve jaw function, it might target the masticatory muscles, which are frequently stiff or spasmodic in individuals with temporomandibular disorder (TMD). This may be useful in lessening the severity and frequency of tooth-related headaches (7).

Although both TENS and DN have demonstrated positive impacts in reducing pain and improving function in various musculoskeletal conditions, direct comparisons between these interventions after orthognathic surgery are scarce. Most published studies have investigated each modality separately or focused on patients with temporomandibular disorders rather than individuals recovering from corrective jaw surgery. Therefore, evidence remains insufficient to determine which physiotherapy intervention provides superior postoperative outcomes in this specific population.

METHODS

Study Design

The purpose of this randomized controlled study was to compare the efficacy of DN vs TENS in reducing postoperative pain, improving temporomandibular function, and increasing mouth opening after orthognathic surgery. The research protocol got approval by Cairo University's Faculty of Physical Therapy Research Ethics Committee (Approval Number P.T.REC/012/004945). Prior to enrolment, written informed permission was obtained from all participants.

Participants

Patients undergoing orthognathic surgery at Cairo University's Outpatient Clinic were included in the study. Individuals between the ages of 20 and 40 who had previously had bilateral sagittal split osteotomy to address malocclusion, had intermaxillary fixation following surgery and were medically stable and able to participate in physiotherapy were considered for inclusion in the study. Patients were excluded if they had: a history of temporomandibular joint surgery, neurological or muscular disorders. temporomandibular joint osteoarthritis, postoperative complications, mandibular ramus or condylar fracture during surgery, use of medications for chronic facial pain unrelated to surgery (8).

Sample Size Calculation

G*Power (Version 3.1.9.2) was used to estimate the sample size. At least 26 subjects were needed for each group, according to previously published data, which showed an effect size of 0.80, statistical power of 85%, as well as a significance level of 0.05. An overall of 60 patients was included in the sample, with 30 recruited for each group to account for any dropouts.

Randomization

After baseline assessment, subjects were randomized into one of two treatment groups utilizing sealed opaque envelopes conducted by an independent researcher. Thirty patients (18 female and 12 male) were assigned to the DN group (Group A), while thirty participants (16 female and 14 male) were assigned to the TENS group (Group B). Allocation concealment was maintained throughout the randomization process.

Procedure:

Outcome measures were assessed by the same examiner before treatment (baseline), after two weeks, and after completion of the four-week intervention program.

Pain intensity

Pain intensity was assessed using the Electronic Visual Analogue Scale (eVAS), a digital version of the conventional VAS. The eVAS involves a 100-mm transverse line displayed on a smartphone screen, anchored by "no pain" (0) and "worst possible pain" (100) (9). Participants, seated comfortably, were asked to point to their pain intensity by moving a slider with one finger on the touchscreen. The application automatically recorded the pain score. Pain severity was categorized as 0 = no pain, 1 to 30 = mild severity, 31 to 60 = moderate severity, and 61 to 100 = severe pain. Assessments were performed at 1, 2, and 4 weeks postoperatively.

Fig. (1)

Secondary Outcomes

Jaw opening was measured using a digital vernier caliper. Participants were seated upright with the head in a neutral position and were asked to open their mouth as much as they could without pain. By holding the calliper vertically, the maximum interincisal distance in millimetres was

measured among the incisal margins of the central incisors of the upper and lower jaws (10). Forced mouth opening was avoided, and the assessment was discontinued if severe pain occurred. Measurements were obtained at 1, 2, and 4 weeks postoperatively.

Fig. (2)

Temporomandibular dysfunction symptoms were assessed using the Short Form of the Fonseca Anamnestic Index (SFAI), a validated five-item self-reported questionnaire for evaluating jaw pain and functional limitations (11). Participants, seated comfortably in an upright position, completed the questionnaire after receiving standardized instructions. Each item was scored using a three-point scale, with 0 representing no, 5 representing sometimes, and 10 representing yes. The total score may be ranging from 0 to 50, while higher scores suggesting more severe symptoms of TMJ dysfunction. At 1,2, and 4 weeks after surgery, evaluations were carried out.

Intervention

An expert physical therapist performed the treatment. For four weeks, patients in both groups had two sessions weekly. On the other four days of the week, patients were asked to adhere to a home exercise program and keep a diary to track their progress.

Group A (DN)

It was performed with the patient in a comfortable position, the neck in a neutral position, and the jaw relaxed. After skin preparation, the therapist palpated the target trigger point while considering relevant anatomical and neurovascular structures. A sterile disposable needle was inserted into the target muscle using the appropriate technique. For the masseter muscle, the muscle was stabilized between the fingers and needled perpendicularly. For the temporalis muscle, needling was performed either perpendicular to the muscle belly or using an inferior approach directed toward the temporal fossa (12). All procedures were done the same expert physical therapist following standardized safety precautions

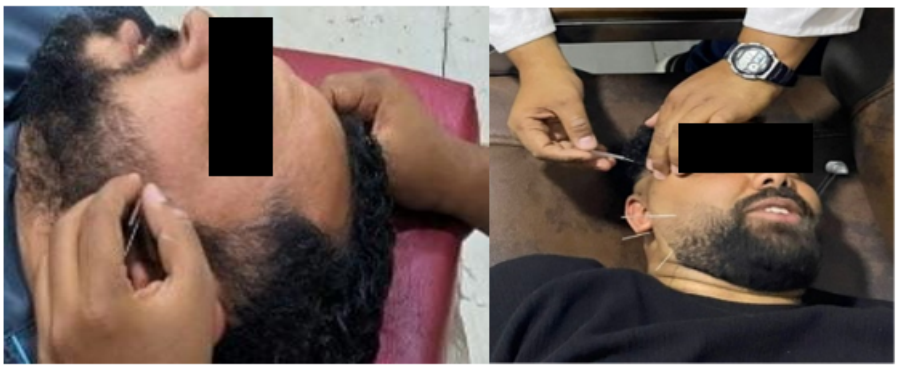

Fig. (3)

Group B (TENS)

It was applied with participants seated comfortably and the head in a neutral position. After explanation of the procedure, self-adhesive electrodes (35–52 mm) underwent bilateral placement on clean, undamaged skin above the superficial masseter muscle (over the gonial angle) as well as the anterior temporalis muscle. The parameters that were adjusted depending on the tolerance of each participant were a pulse width of 20 μs, an intensity ranging from 10 to 30 mA, and a frequency of 120 Hz for the delivery of stimulation (13). Quadratic biphasic symmetrical pulses were applied for 30 minutes per session, twice weekly for 4 weeks.

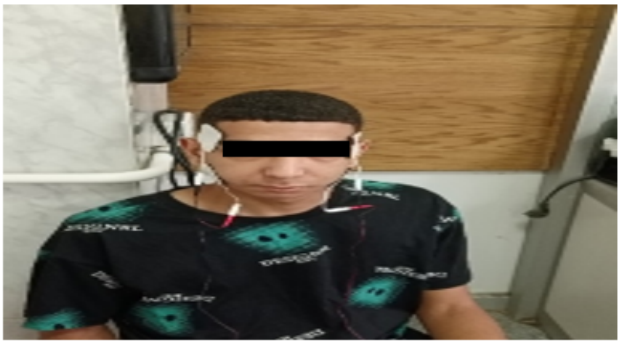

Fig. (4)

Home exercise program: All participants received a conventional home exercise program involving active mandibular ROM exercises, initiated during the first postoperative week. The program included mouth opening, lateral excursion, and protrusion exercises, performed three times daily for 20 minutes to promote early restoration of mandibular mobility (14).

Statistical Analysis

Version 25 of IBM SPSS Statistics was used for the statistical study. Prior to doing inferential analysis, the data was checked for normality.

Categorical data were shown as frequencies and percentages, whereas continuous variables were shown as mean ± standard deviation.

The chi-square test and the un paired-samples t-test were used to compare categorical variables along with continuous variables, respectively, across the groups.

Utilizing dependent-samples t-tests, we examined changes within each group over the course of time. In addition, we used un paired-samples t-tests to examine differences in outcome measures across groups.

All analyses were conducted using a p-value less than 0.05 as the criterion of statistical significance (15).

RESULTS

1- Subject Characteristic

showed the subject characteristics of groups A and B. The statistical analysis showed that no significant differences (P>0.05) among DN group and TENS group in mean values of patients age (P=0.092) and gender distribution (P=0.602).

Effect of treatment on pain, mouth opening and TMJ dysfunction

Comparison among pre- and post-treatment pain within each group

The statistical analysis showed that significant differences were found (P<0.05) in pain within DN group (P=0.0001) and TENS group (P=0.0001) among week 1, week 2, and one-month pre and post and treatment within each group (table 1).

Table (1). Comparison between pre- and post-treatment pain within each group

Pain (Mean ±SD)		
Comparisons among week1, week 2, and one month within each group		
Items	**DN group (n=30)**	TENS GROUP (n=30)
Week 1	47.83 ±3.33	47.87 ±3.52
Week 2	36.07 ±5.34	34.40 ±3.10
One month	16.77 ±1.54	11.73 ±2.49
F-value	96.567	136.273
P-value	0.0001*	0.0001*
Significance	S	S
Comparison between week 1 and week 2 within each group		
Time effect	**DN group (n=30)**	TENS GROUP (n=30)
Week 1	47.83 ±3.33	47.87 ±3.52
Week 2	36.07 ±5.34	34.40 ±3.10
MD (change)	11.76	13.47
Improvement %	24.59%	28.14%
P-value	0.0001*	0.0001*
Significance	S	S
Comparison between week 1 and one month within each group		
Time effect	**DN group (n=30)**	TENS GROUP (n=30)

Week 1	47.83 ±3.33	47.87 ±3.52
One month	16.77 ±1.54	11.73 ±2.49
MD (change)	31.06	36.14
Improvement %	64.94%	75.50%
P-value	0.0001*	0.0001*
Significance	S	S
Comparison between week 2 and one month within each group		
Time effect	**DN group (n=30)**	TENS GROUP (n=30)
Week 2	36.07 ±5.34	34.40 ±3.10
One month	16.77 ±1.54	11.73 ±2.49
MD (change)	19.30	22.67
Improvement %	53.51%	65.90%
P-value	0.0001*	0.0001*
Significance	S	S

SD standard deviation, MD mean difference, p-value level of significance

Comparison of pain between both groups

The statistical analysis showed that no significant difference was detected in pain levels among the DN and TENS groups at week 1 (P=0.970) and week 2 (P=0.146), however a significant difference was observed in pain levels after one month (P=0.0001), as shown in table 2. Considering the effect of the tested groups on pain, this significant decreased in pain at week 2 and one month is favorable of TENS group than DN group.

Table (2). Comparison of pain among both groups

Items	Week 1	Week 2	One month
DN group (n=30)	47.83 ±3.33	36.07 ±5.34	16.77 ±1.54
TENS GROUP (n=30)	47.87 ±3.52	34.40 ±3.10	11.73 ±2.49
MD (change)	0.04	1.67	5.04
t-value	0.038	1.477	9.404
P-value	0.970	0.146	0.0001*
Significance	NS	NS	S

s mean ±standard deviation MD: Mean difference
P-value: probability value S: significant * Significant (P<0.05) NS: non-significant

Comparison between pre- and post-treatment mouth opening within each group

The statistical analysis indicated that significant differences were detected (P<0.05) in mouth opening within DN group (P=0.0001) and TENS group (P=0.0001) among week1, week 2, and one-month pre and post and treatment within each group (Table 3)

Table (3). Comparison between pre- and post-treatment mouth opening within each group

Mouth opening (Mean ±SD)		
Comparisons among week1, week 2, and one month within each group		
Items	**DN group (n=30)**	**TENS group (n=30)**
Week 1	12.17 ±2.52	13.30 ±2.70
Week 2	14.40 ±2.59	17.27 ±2.16
One month	21.50 ±1.83	25.60 ±2.07
F-value	29.997	47.610
P-value	0.0001*	0.0001*
Significance	S	S
Comparison between week 1 and week 2 within each group		
Time effect	**DN group (n=30)**	**TENS group (n=30)**
Week 1	12.17 ±2.52	13.30 ±2.70
Week 2	14.40 ±2.59	17.27 ±2.16
MD (change)	2.23	3.97
Improvement %	18.32%	29.85%

P-value	0.001*	0.0001*
Significance	S	S
Comparison between week 1 and one month within each group		
Time effect	**DN group (n=30)**	**TENS group** (n=30)
Week 1	12.17 ±2.52	13.30 ±2.70
One month	21.50 ±1.83	25.60 ±2.07
MD (change)	8.33	12.30
Improvement %	68.45%	92.48%
P-value	0.0001*	0.0001*
Significance	S	S
Comparison between week 2 and one month within each group		
Time effect	**DN group (n=30)**	**TENS group** (n=30)
Week 2	14.40 ±2.59	17.27 ±2.16
One month	20.50 ±1.83	25.60 ±2.07
MD (change)	6.10	8.33
Improvement %	42.36%	48.23%
P-value	0.0001*	0.0001*
Significance	S	S

Data are expressed as mean ±standard deviation MD: Mean difference P-value: probability value S: significant * Significant (P<0.05)

Comparison of mouth opening among both groups

No significant statistical difference was found (P>0.05) in mouth opening at week 1 (P=0.099) between DN group and TENS group but a significant statistical difference was observed (P<0.05) in mouth opening at week 2 (P=0.0001) and one month (P=0.0001) between DN group and TENS group (table 4)

Considering the effect of the tested groups on mouth opening, this significant increase in mouth opening at week 2 and one month is favorable of TENS group than DN group.

Table (4). Comparison of mouth opening between both groups

Mouth opening (Mean ±SD)			
Items	Week 1	Week 2	One month
DN group (n=30)	12.17 ±2.52	14.40 ±2.59	20.50 ±1.83
TENS GROUP (n=30)	13.30 ±2.70	17.27 ±2.16	25.60 ±2.07
MD (change)	1.13	2.87	5.10
t-value	1.679	4.64	14.033
P-value	0.099	0.0001*	0.0001*
Significance	NS	S	S

Data are expressed as mean ±standard deviation MD: Mean difference
P-value: probability value S: significant * Significant (P<0.05) NS: non-significant

Comparison between pre- and post-treatment TMJ dysfunction within each group

The statistical analysis indicated that significant differences were shown (P<0.05) in SFAI score within DN group (P=0.0001) and TENS group (P=0.0001) among week1, week 2 and one-month pre and post treatment within each group (Table 5).

Table (5). Comparison between pre- and post-treatment SFAI score within each group

SFAI score (Mean ±SD)		
Comparisons among week1, week 2, and one month within each group		
Items	**DN group (n=30)**	**TENS group** (n=30)
Week 1	42.00 ±3.37	44.17 ±3.86
Week 2	37.17 ±3.86	25.33 ±3.92
One month	23.50 ±3.97	15.00 ±4.73
t-value	26.690	42.696
P-value	0.0001*	0.0001*
Significance	S	S
Comparison between week 1 and week 2 within each group		
Time effect	**DN group (n=30)**	**TENS group (n=30)**
Week 1	42.00 ±3.37	44.17 ±3.86

Week 2	37.17 ±3.86	25.33 ±3.92
MD (change)	4.83	18.84
Improvement %	11.50%	42.65%
P-value	0.0001*	0.0001*
Significance	S	S
Comparison between week 1 and one month within each group		
Time effect	**DN group (n=30)**	**TENS group (n=30)**
Week 1	42.00 ±3.37	44.17 ±3.86
One month	23.50 ±3.97	15.00 ±4.73
MD (change)	18.50	29.17
Improvement %	44.05%	66.04%
P-value	0.0001*	0.0001*
Significance	S	S
Comparison between week 2 and one month within each group		
Time effect	**DN group (n=30)**	**TENS group (n=30)**
Week 2	37.17 ±3.86	25.33 ±3.92
One month	23.50 ±3.97	15.00 ±4.73
MD (change)	13.67	10.33
Improvement %	36.78%	40.78%
P-value	0.0001*	0.0001*
Significance	S	S

Data are expressed as mean ±standard deviation MD: Mean difference P-value: probability value S: significant * Significant (P<0.05)

Comparison of TMJ dysfunction among both groups

No significant statistical difference was observed (P>0.05) in SFAI score at week one (P=0.064) and week two (P=0.0001 between DN group and TENS group however, a was significant statistical difference was detected (P<0.05) in SFAI score at week 2 (P=0.0001) between DN group and TENS group (table 6)

Concerning the impact of the tested groups on SFAI score, this significant decreased in SFAI score at one month is favorable of TENS group than DN group.

Table (6). Comparison of SFAI score among groups

SFAI score (Mean ±SD)			
Items	Week 1	Week 2	One month
DN group (n=30)	42.00 ±3.37	37.17 ±3.86	23.50 ±3.97
TENS group (n=30)	44.17 ±3.86	25.33 ±3.92	15.00 ±4.73
MD (change)	2.17	11.84	8.50
t-value	1.983	11.760	7.534
P-value	0.064	0.0001*	0.0001*
Significance	NS	S	S

Data are expressed as mean ±standard deviation MD: Mean difference
P-value: probability value S: significant * Significant (P<0.05) NS: non-significant

DISCUSSION

The current study aimed to test the impact of DN and TENS in alleviating postoperative pain and enhancing functional recovery following orthognathic surgery. The results showed that both treatments produced statistically significant enhancement in pain intensity, mouth opening, and temporomandibular function after four weeks of treatment. However, participants treated with TENS achieved significantly greater improvements across all measured outcomes than those receiving dry needling.

The results of this study were confirmed by Botticchio et al. (16) who highlighted the morphological changes induced by DN, such as reduced muscle and articular disc thickness, alongside improvements in maximum mouth opening. These findings suggest that DN may positively influence both structural and functional parameters, while further investigations are recommended to evaluate the possibility of correlation between morphological changes and functional outcomes.

Our findings came in agreement with Dib-Zakkour et al. (17) who emphasized that DN facilitates enhanced jaw symmetry and trajectory during movement, further supporting its role in improving biomechanical alignment and functional outcomes. a two-center RCT by Duran et al. (18) who reported that dry needling for myogenous TMD produced significant within-group improvements in pain reduction VAS decreased significantly (P<0.05), improved mandibular ROM, and sleep quality over 6 weeks.

In addition, dunning et al. (19) found that DN combined with spinal manipulation yielded superior pain relief and mouth opening compared to interocclusal splint therapy, pharmacological management, in addition to non-thrust

joint mobilization technique at the 3-month follow-up ($p < 0.001$). These findings collectively demonstrate that DN reduces pain and promotes functional recovery in patients with TMD.

In accordance with our results, Nemati et al. (20) from Shahid Beheshti University of Medical Science also found that two months following surgery, patients in the treatment group were given ten TENS treatments; one month later, they repeated the process. Maximum mouth opening (MMO) and pain intensity as assessed by a VAS were the primary objectives of this study. Patients with TMD after orthognathic surgery reported less pain and better MMO after using TENS.

The present study was in agreement with Cacho et al. (21) who reported a stable reduction in pain amid orthognathic surgery patients whom were subjected to weekly TENS applications. Most skeletal class II along with III patients in their study reported low pain intensity during recovery. These patients showed improvement starting at week one and returned to near-baseline values by week four. Both studies confirm that TENS effectively speeds up pain resolution after orthognathic surgery.

Furthermore, Alam et al. (22) demonstrated highly significant within-group MMO increase from preoperative 20.63±1.74 mm to 28.95±1.49 mm at 1 month and 44.71±1.40 mm at 6 months in orthognathic surgery patients receiving TENS ($F=59733.350$, $P<0.001$). Both studies confirm TENS produces robust, statistically significant progressive mouth opening recovery post-orthognathic surgery, supporting its clinical utility for restoring oral function.

On the other hand, García-de la-Banda-García et al. (23) found different results when comparing DN to manual therapy. In their study of jaw joint patients, both treatments worked equally well. Both groups saw their mouth opening increase by similar amounts from the start to the end of treatment. This suggests that two active therapies might produce similar results for muscle pain. reported no significant between-group differences within cervical disability (measured by Neck Disability Index) between DN and manual therapy groups at baseline or any follow-up assessment ($F=0.09$, $p=0.768$, $\eta p^2=0.002$) for TMD patients.

Anjana et al. (24) found that dry needling worked better than TENS for patients with myofascial neck pain. At day 14, the dry needling group had a pain score of 4.12 while the TENS group scored 6.56. By day 28, the dry needling group improved to 1.68 compared to 4.20 for TENS. These differences likely happen because the patients had different types of pain.

Several limitations should be considered. The follow-up period was limited to four weeks; therefore, long-term treatment effects remain unknown, the study didn't involve a passive control or sham treatment group. Without this, we could not separate the natural recovery process or placebo effects from the actual impact of the active treatments, infrequent attendance of some patients during treatment.

Both TENS and DN were effective in alleviating pain following orthognathic surgery. However, the study results demonstrated that (TENS/DN) showed greater improvement in pain reduction. Therefore, (TENS/DN) may be considered an effective treatment option for postoperative pain management in patients having orthognathic surgery. with more improvement seen with TENS than DN in post-orthognathic surgery.

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