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Low Level Laser Therapy versus Therabite Exercises on Pain and Range of Motion Post Temporomandibular Joint Arthrocentesis

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Abstract:Purpose: After arthrocentesis, this study evaluated the therapeutic effects of low-level laser therapy (LLLT) vs therabite exercises on temporomandibular joint (TMJ) pain and range of motion (ROM) to measure the rate of improvement in clinical symptoms in patients with TMJ problems.
Methods: The Visual Analogue Scale (VAS) to measure pain intensity, digital Vernier caliper to measure maximal mouth opening (MMO) and the therabite ROM scale to measure lateral mouth movement (LMM) were used. Sixty subjects of both sexes (25 - 55 years) complaining of TMJ pain and limited ROM after arthrocentesis took involved in the research.Patients have been randomly assigned to three groups, each with an equal number of patients; Group A received LLLT with intensity of 4.3 J/cm^2. It was applied three times a week for four weeks over the affected masseter muscle, along with conventional exercise therapy and medical care. Group B received therabite exercises consisting of four weeks structured exercise program five times/day with the conventional exercises and medical care. Group C received conventional exercises and medical care five times/day for four weeks. Measurements were done before the initial therapy and at the termination of the fourth week of therapy.
Results: The results revealed a significant drop in VAS and an increase in MMO and LMM in the three groups after therapy compared to before therapy ($p < 0.001$). The percent of decrease of VAS of group A, B and C was 63.7, 45.58 and 14.77% respectively. The percent of increase of MMO and LMM of group A was 84.24 and 74.63% respectively and that of group B was 46.93 and 51.2% respectively while that of group C was 13.2 and 31.5% respectively.
Conclusion: Both LLLT and therabite exercises were advantageous and fruitful in decreasing the TMJ pain and significantly improved ROM after arthrocentesis but the LLLT was more effective.

Keywords: Low Level Laser Therapy, Therabite Exercises, Temporomandibular Joint, Arthrocentesis.

INTRODUCTION

The most prevalent reason of non-dental orofacial pain is temporomandibular joint disorder (TMJD). It is a term used to describe disorders involving the TMJ, masticatory muscles, and occlusion resulting in muscle or TMJ pain, restricted movement, muscle tenderness, and intermittent joint sounds[1]. In addition to affecting the patient's esthetic appearance, speech, and

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nutrition, excellent oral opening is required for oral hygiene and dental assessment and treatment[2].

TMD therapy is classified into two groups. The first would be nonsurgical treatment, which comprises therapies such as counseling, physiotherapy, medication, and occlusal splint treatment. The other option is surgical treatment, which includes procedures such as TMJ arthrocentesis and arthroscopy, as well as arthrotomy[3]. Comprehensive physical therapy can significantly relieve pain and improve mouth limitation in patients with chronic TMJ disorders, and long-term efficacy was good[4]. Arthrocentesis is often done as an outpatient procedure using local anesthesia without or with sedation or general anesthesia. Physiotherapy after arthrocentesis has been demonstrated to be useful, particularly in the reduction of pain in TMD patients [5].

The therabite was used for jaw mobilization. The device is constructed with a mandibular mouth piece that moves downwards in an anatomically correct track when the handle is squeezed [6]. LLLT could be utilized in dentistry for a variety of objectives including soft tissue, hard tissue, and pain relief. Despite the fact that literature has proven that using LLLT in health care is useful for more than thirty years, and despite the fact that there have been several studies on this topic in dentistry, opinions differ due to varied methodology and dosage.[7].

The goal of this work would be to assess and compare between the therapeutic effects of (LLLT) and the therabite exercises on temporomandibular joint (TMJ) pain and range of motion (ROM) after arthrocentesis. So, this study may assist in planning an optimal and ideal treatment protocol for such cases.

MATERIALS AND METHODS

Subjects

The current study was done on 60 subjects of both sexes (35 males and 25 females) recruited from Kafrelshiekh University's Outpatient Clinic, Faculty of Physical Therapy, aged 25-55 years complaining of TMJ pain and limited ROM after arthrocentesis. Power test showed that this sample size was needed for the study (95%). Patients were randomly allocated into three groups of equal numbers using block randomization method. Group (A) was consisted of 20 patients who received LLLT plus conventional exercise therapy and medical care. Group (B) included 20 patients who received the therabite exercise plus conventional exercise therapy and medical care. Group (C) included 20 patients who received conventional exercise therapy and medical care only.

Inclusion criteria

- The age was ranged between 25-55 years.
- Patient who had arthrocentesis due to TMJ impairment (oncological surgery).
- Both genders were participated in this study (males and females).

Exclusion criteria

- Patients with poor general health or congenital trismus or teeth abnormalities.
- Associated face or skull lesion or TMJ diseases.
- Internal fixation of mandible or poor general health.
- Recent temporal bone fracture or splint that prevents mouth movement.
- Neurological problems as facial or trigeminal nerve palsy.

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- Less than 12mm mouth opening (cannot use therabite) or cognitive impairment as judged by the clinicians.

Ethical approval:
All applicable national rules and institutional policies have been followed in the human-use research. The ethics committee of Cairo University's faculty of physical therapy, NO.P.T.REC/012/002452, authorized it after it followed the principles of the Declaration of Helsinki.

Materials:
The study measuring materials was divided into two main categories, measuring and therapeutic materials.

Measuring materials:
1- The VAS to measure pain intensity.
2- Digital Vernier caliper to measure MMO.
3- The therabite ROM scale to measure the lateral mouth movement.

Therapeutic materials:
1- Low level laser therapy.
2- Therabite exercises.

Procedures
Explanation about the protocol of assessment was given to every patient.Assessment of the environment was done to be nearly constant throughout the study.All participants were asked to read and sign a consent form before the conduction of study. The detailed evaluative neurological sheet and history were done to every patient.
Patients didn't receive any non-steroidal anti-inflammatory drugs for two weeks before and during treatment procedures. All Patients were informed about the procedure, complications; the materials used and follow up appointments. The procedures of the current study were divided in two main parts: measurement and treatment procedures.

Measurement procedures:
Assessment of pain intensity procedureswas done for all patients in 3 groups:
Joint pain was evaluated during MMO by using the VAS immediately after the arthrocentesis procedure. Before beginning the first session and after finishing the treatment, each patient was requested to mark and start scoring on the line at the point which represented his or her pain intensity on a 10-cm scale (after four weeks). End points 0 for no pain and 10 for the most severe pain [19].

Assessment of mouth ROM procedures:
1. Procedure of therabite range of motion scalewas done for all patients in 3 groups:
After the arthrocentesis procedure, the subject opened slightly (physiological rest position) and moved the mandible as far to the right or left as possible. It has been measured from the maxillary central incisors' labioincisal embrasure to the mandibular incisors' labioincisal embrasure. With the arrow of range of motion scale centered in the maxillary centerals, the patients moved to the

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left by tapping the mandible on the left. The distance was measured then the same procedure was repeated for the right side of the jaw. Normal value is 8 mm[24](Figure 1).

Figure: (1): Measurement of lateral mouth movement using Therabite ROM scale.

2. Procedure of digital Vernier caliperwas done for all patients in 3 groups:

It has been placed on the maxillary central incisor's incisal edge. Immediately after the arthrocentesis procedure, this has been the most vertically orientated and measured vertically to the labioincisal edge of the opposing mandibular incisor**.** The MMO was measured inter-incisally with a millimeter caliper as a mean of both assisted and unassisted mouth opening measures. The aided mouth opening was measured following exerting gentle pressure to reach maximum mouth opening [5] (Figure 2).

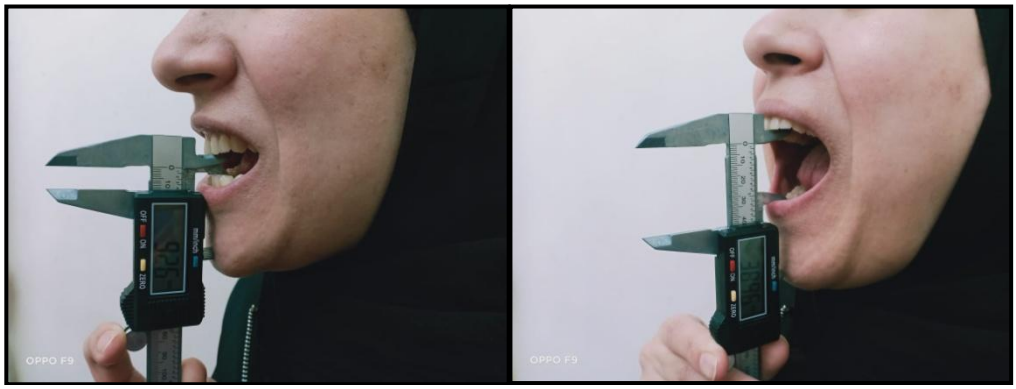

Figure (2): Measurement of MMO using digital Vernier caliper.

Treatment procedures:

Treatment was done immediately after the arthrocentesis procedure.

1. Low level laser therapy procedures were done for patients in group A:

Patient was placed in a comfortable relaxed position. The parameters of the laser device were adjusted to produce intensity of 4.8 J/cm^2. Time was three minutes. Frequency was 5KHZ. Duty cycle 70%. Three times per week for four weeks, laser was applied extra orally

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on the lateral aspect of the lower jaw unilaterally precisely over the affected masseter muscle [20](Figure 3).

Figure (3): Laser application.

2. Therabite exercise procedureswere done for patients in group B:

The exercise program was a four-week structured exercise program with five daily exercises. Warm up actions include opening the jaw ten times and moving the jaws sideways ten times without utilizing the jaw device. Passive stretching, with therabite, 30 seconds, repeated five times. In between sessions, patients were told to unwind. In addition, to avoid pain or injury, the patients were told to progressively increase the volume and intensity of the workouts [6] (Figure 4).

Figure (4): Therabite exercises.

3. Control group conventional exercises:

Conventional treatment, including active and passive range of motion, stretching exercises, and resistive mouth workouts, was administered to the three study groups. Each exercise was done for six seconds and then repeated five times. The program was designed as follows; Slide your lower jaw to the right and to the left. Hold it for two seconds. Repeat five times. Put two fingers on one side of your jaw. Slide your jaw towards your fingers while gently resisting with fingers. Hold it for two seconds. Repeat five times. Push your jaw down while

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gently resisting with fingers. Hold it for two seconds. Repeat five times. Protrude your jaw hold it for two seconds. Repeat five times [5].

Statistical analysis:

Comparison of subject characteristics between groups was conducted using ANOVA for age and Chi- squared test for sex distribution. The Shapiro-Wilk test was used to check that the data had a normal distribution. To test if groups were homogeneous, Levene's homogeneity of variances test has been used. One way ANOVA was performed for comparison of VAS, MMO and LMM among groups. For subsequent multiple comparisons, post-hoc testing employing the Bonferroni correction were performed. In each group, a paired t test was used to compare before and after therapy. For all statistical tests, the significance level was fixed at $p < 0.05$. The statistical package for social studies (SPSS) version 25 for Windows was used to carry out all statistical analysis (IBM SPSS, Chicago, IL, USA).

RESULTS:

***Subject characteristics*:**

The subject characteristics of groups A, B, and C were shown in Table (1). In terms of age and sex distribution, there were no significant differences among groups ($p > 0.05$).

Table 1. Participants' basic characteristics.

	Group A	Group B	Group C	p-value
Age, mean ± (SD), years	35.7 ± 8.76	36.9 ± 9.56	34.1 ± 8.3	0.61
Sex, n (%)				
Females	8 (40%)	10 (50%)	7 (35%)	0.62
Males	12 (60%)	10 (50%)	13 (65%)	

SD, standard deviation; p-value, level of significance

Effect of treatment on VAS, MMO and LMM:

Within group comparison

Within-group comparisons demonstrated a significant decrease in VAS and a rise in MMO and LMM in the three groups after therapy compared to before therapy ($p < 0.001$). The percent of decrease of VAS of group A, B and C was 63.7, 45.58 and 14.77% respectively. The percent of increase of MMO and LMM of group A was 84.24 and 74.63% respectively and that of group B was 46.93 and 51.2% respectively while that of group C was 13.2 and 31.5% respectively (table 2).

Between group comparison

There was no significant difference in any of the parameters among groups pre-treatment ($p > 0.05$). After therapy, group A had a significant decrease in VAS when compared to groups B and C ($p < 0.001$), while group B had a significant decrease in VAS when compared to group C ($p < 0.001$).

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Group A had a significant increase in MMO and LMM compared to groups B and C ($p < 0.01$), and group B had a significant increase in MMO and LMM compared to group C after therapy ($p < 0.05$). (Table 2).

Table 2. Mean VAS, MMO and LMM of groups A, B, and C before and after treatment::

	Group A	Group B	Group C	p- value
	mean ± SD	mean ± SD	mean ± SD	
VAS				
Pre treatment	7.3 ± 0.47	7.35 ± 0.48	7.45 ± 0.51	0.61
Post treatment	2.65 ± 0.48	4 ± 0.56	6.35 ± 0.58	0.001
MD	4.65	3.35	1.1	
% of change	63.7	45.58	14.77	
t-value	27.9	`22.33	8.9	
	p = 0.001	***p = 0.001***	***p = 0.001***	
MMO (mm)				
Pre treatment	31.22 ± 0.57	31.07 ± 0.86	31.45 ± 0.76	0.28
Post treatment	57.52 ± 0.93	45.65 ± 1.02	35.6 ± 1.33	0.001
MD	-26.3	-14.58	-4.15	
% of change	84.24	46.93	13.2	
t-value	-100.16	`-53.56	-13.96	
	p = 0.001	***p = 0.001***	***p = 0.001***	
LMM (mm)				
Pre treatment	3.35 ± 1.02	3.32 ± 0.86	3.27 ± 0.75	0.96
Post treatment	5.85 ± 0.89	5.02 ± 0.73	4.3 ± 0.86	0.001
MD	-2.5	-1.7	-1.03	
% of change	74.63	51.2	31.5	
t-value	-9.94	`-8.95	-4.33	
	p = 0.001	***p = 0.001***	***p = 0.001***	

SD, Standard deviation; p-value, Level of significance

DISCUSSION

The current study evaluated the effectiveness of LLLT compared to therabite exercises on pain, and TMJ ROM after arthrocentesis. The outcomes displayed an extremely significant reduction of the means of the second record of pain scores, and increase in TMJ ROM in all groups but the LLLT group showed more significant effect. The percent of decrease of VAS of group A, B and C was 63.7, 45.58 and 14.77% respectively. The percent of increase of MMO and LMM of group A was 84.24 and 74.63% respectively and that of group B was 46.93 and 51.2% respectively while that of group C was 13.2 and 31.5% respectively.

The results of the current study were in agreement with previous studies [8, 9, 10] that also reported the LLLT as an effective therapy in minimizing the pain symptoms triggered by the TMD. Some mechanisms of laser action are cited as increase on the endogenous opiates liberation, decrease on the permeability of the nerve cell membrane and increase on the ATP production. The reduction in creatine kinase activity, a cytokine engaged in the early phases of muscle damage, as well as C-reactive protein, a sign of systemic inflammation, has also been reported in the literature [11].

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The clinical results showed in VAS figures that pain relief tends to improve after laser application. Although there are some crossings of the lines "before" and "after" in some regions, the line symbolizing the patient after treatment is usually below the one symbolizing the pain before laser application. Although the VAS scale is quite subjective, this method was already validated by the literature. The results obtained by VAS in this study are in agreement with **Shinozaki (2006)**[12], who verified that laser therapy promoted immediate relaxation of the masseter and temporalis muscles with consequential relief in painful symptoms of TMDs.

These results match those of **Kulekcioglu et al. (2003)**[12], who looked into the efficacy of LLLT in the therapy of TMD and compared therapy impacts in myogenic and arthrogenic instances. They discovered that both therapy groups saw a significant decrease in pain and the number of tender points, as well as a significant improvement in maximal mouth opening and lateral jaw motion in the active therapy group relative to the placebo group.

Similarly, **Salmos et al. (2013)**[13] investigated the effect LLLT in reduction of pain intensity and improvement of MMO in 58 patients divided in two groups, 32 with acute TMD (<6 months) and 26 with chronic TMD (>6 months). After LLLT, both groups experienced significant pain intensity decrease and MMO enhancement, leading the researchers to conclude that LLLT could be used as a complementary or alternative physical modality for the treatment of chronic and acute myogenic temporomandibular disorder; even so, patients with acute disease have been more likely to have a better result.

LLLT application, on the other hand, has been shown in a number of studies to be an efficient treatment for TMD patients. Patients have been tracked up to thirty days following the last sessions of laser therapy in the research of **Mazzetto et al. (2010)**[14], **Venezian et al. (2010)**[15], **andCetiner et al. (2006)**[16]. In this time period, they noted that the pain decrease remained statistically significant. Despite these findings, they also stated that the last laser therapy session had the least sensitivity to palpation.

Kulekcioglu et al. (2003)[12]study revealed that both patients had noticeable relief after receiving LLLT therapy, and that this condition was maintained following a one-year follow-up. MMO and lateral movements were not decreased. Moreover, clinically, no pain or tenderness to palpation was noticed. As a result of employing numerous methodologies, non-standardized findings may be achieved. The types, frequencies, and time durations of low-level laser radiation in various patient groups were thought to be responsible for such findings.

The important criteria in exposing the favorable effects of LLLT should be an accurate diagnostic and an adequate application protocol [17]. Acupuncture, TENS, massage, pharmacotherapy, ultrasound, occlusal splints, and psychological therapies have all been employed as alternative approaches in the therapy of TMD [18].

LLLT, on the other hand, is a non-invasive, non-pharmaceutical therapy that is well tolerated. It is a time-saving strategy for both the therapist and the patient as well as having a quick impact which the patient can feel following application. In patients who undergo the active laser dosage, the laser treatment was effective in improving an increase in mandibular motion. We further verified that low-intensity lasers' analgesic impact had a direct influence on mouth opening and a reduction in VAS ratings. These results revealed significant variation between the temporomandibular joint which is healthy and impaired [19].

In the treated group, assessments of painful symptoms on the left and right sides revealed that the healthy and damaged TMJ varied significantly. After optimal mouth opening, LLLT was found to be efficient in lowering painful symptoms. Due to changes in cellular membrane potency,

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vasodilation, edema decrease, enhanced intracellular metabolism, and wound healing speed, LLLT increased tolerance for pain [20].

Because nociceptors occur in the periarticular tissues (discal ligaments, capsular ligaments, and retrodiscal tissues), LLLT has been employed on specific points. Those structures are implicated in temporomandibular joint pain. Our findings confirmed that TMJ pain is strongly related to differences in TMJ pathways as well as the anatomy and physiology of the dental skull. The true analgesic effectiveness of LLLT arises from the fact that TMD symptoms were treated independently using a variety of approaches. Interocclusal splints, pharmacotherapy, physiotherapy, and surgical techniques, as well as lasers, could be extremely beneficial due to an increase of β-endorphin levels, increase of pain discharge threshold, reduce of bradykinin and histamine release, increase of lymphatic flow, decline of edema and algesic substances, increase of blood supply, time decrease of inflammation, and advancement of muscle relaxation [21].

The Therabite has broad mouth pieces following the entire row of teeth and works by pressing the mouthpieces apart along the natural anatomical path of the jaw, thereby decreasing the risk that the teeth would procline. The US Food and Drug Administration has listed the Therabite system. Previous research indicates that Therabite exercise treatment is more effective than conventional exercise treatment at increasing mouth opening [22].

Gibbons and Abulhoul (2007)[23] presented the use of a mouth-opening appliance (therabite) to help in the treatment of bilateral coronoid hyperplasia by overcoming persistent limitation of mouth opening following coronoidectomy. Study presented a 36-years-old white man with restricted mouth opening; the inter-incisal opening of the patient has been limited to 20 mm. His temporalis muscle insertion on his coronoid processes exhibited palpable intraorally thick fibrous bands. At operation, the opening was improved to 30 mm. During the next 4 weeks post-operative, the patient's mouth opening was decreased to 20 mm. He was provided a therabite device to utilize for 5 minutes 3 to 5 times per day. This extended its mouth opening to 38 mm over the course of three months. His improved opening has stayed steady after a year, and there is no evidence of coronoid process regrowth. in contrast, the therabite appliance is simple and easy to use. Finally, they concluded that the study case report demonstrates that employing a therabite mouth opening device with strong patient compliance may improve long-term results.

Cohen et al. (2005)[22] evaluated the usage of the therabite, a mechanical stretching device, for the early post-operative therapy of trismus in select patients with a randomized controlled trial which included eleven patients with mandibular hypomobility and trismus as a sequel of oropharyngeal cancer, were treated using therabite. Using a measuring gauge supplied with the device, the MMO was measured when participants first started using it and with their most recent post-operative visit. All participants were instructed to do six repetitions six times a day while holding their mouth open for six secs each time. The range was initially set at 25 mm and gradually increased as tolerated. Following surgery, the patients were followed for 12 to 48 weeks. Patient self-reporting was used to evaluate compliance. The average MMO at the start, the average MMO at the end, and the average gain were all determined. The average MMO became 30 mm at the first postoperative measurement (range, 24-38 mm). The average MMO became 40 mm in the end (range 30-57 mm). The difference among such two measures was statistically significant ($p<0.05$). In MIO, the average gain became 10 mm (range, 1-21 mm). Average pain rating was mild to none. There were no complications associated with using therabite in either patients who completed or did not complete the research explicitly, and there were no negative impacts on the healing of the mandible, the surgical site, or the reconstruction of a free flap.

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CONCLUSION

Application of LLLT and therabite exercises were significantly effective in decreasing pain and improving TMJ ROM after arthrocentesis but the LLLT was more significant.

Disclosure statement
This study has resulted in no financial gain or financial interest for any of the researchers.

Conflict of interest
The researchers declare that they have no conflicts of interest.

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