

Clinical Treatment with Photobiomodulation Combined with Vacuum Therapy in Temporomandibular Disorders

Vitor Hugo Panhoca¹, PhD, Marcela Sene-Fiorese², PhD, Patrícia Eriko Tamae³, Fernanda Rossi Paolillo⁴, PhD, Vanderlei Salvador Bagnato⁵, PhD

Abstract

Background: Temporomandibular disorder (TMD) may occur in all age groups. Noninvasive and nonpharmacological treatments are desired, mainly, for long-term care. **Objective:** The purpose of the present study was to investigate the synergic effects of photobiomodulation combined with the vacuum therapy on pain, full range of mandibular motion and quality of life in patients with TMD. **Materials and methods:** A clinical trial was performed. Fourteen patients with TMD participated in this study. The device of photobiomodulation and vacuum therapy was used for treatment at 3 regions on face: temporomandibular joint, anterior fibers of the temporal muscle and entire extension of the masseter muscle. The treatment was performed twice a week for 4 weeks, totaling 8 sessions. Measurements of pain intensity and range of mandibular motion during maximum mouth opening were carried out at three moments: T0 = pretreatment, T1 = post-treatment, and T2 = 15 days after termination of the treatment. Oral health-related quality of life measures was performed during T0 and T1. **Results:** The pain intensity was significantly reduced for the right and left side of the masseter and temporal muscles as well as the mouth opening was significantly enhanced after the last session (T1) and 15 days after the last session (T2). In addition, oral health-related quality of life was significantly improved. **Conclusion:** The synergistic treatment of photobiomodulation and vacuum therapy was effective to produce better outcomes in terms of reduced pain, increased mandibular range of motion and improved quality of life in patients with TMD. Moreover, its beneficial effects persisted for at 15 days after the end of treatment.

Keywords: Photobiomodulation; Vacuum Therapy; Temporomandibular Joint Disorders

1. Introduction

Temporomandibular disorder (TMD) is a complex pathology, and its pathogenesis is still not well defined.¹ TMD is a disease of the stomatognathic system and is included in list of musculoskeletal diseases, due to dysfunction of temporomandibular joints (TMJ) and masticatory muscles. In addition, TMD can occasion chronic orofacial pain, characterized as myofascial pain and/or arthralgia.²

This disease is usually related to anatomical abnormalities, joint trauma, joint overload, and psychological factors.³ Several studies have found a correlation between the occurrence and development of TMD with psychological factors, such as anxiety, depression, and stress.^{4,5}

TMD may occur in all ages, in this context, the prevalence of TMD among the population, is 31% for adults/elderly and 11% for children/adolescents with a peak occurring at the age of 20 to 40 years.^{6,7} In addition, an important aspect to be highlighted is that orthodontic patients show a prevalence of TMD varying from 21.1 to 73.3%.⁸

¹ São Carlos Institute of Physics (IFSC), University of São Paulo (USP): Av. Trabalhador São-carlense, 400 – Centro, ZIPCODE: 13560-970, São Carlos, SP, Brazil – Telephone and Fax: +55 16 33739810

² São Carlos Institute of Physics (IFSC), University of São Paulo (USP): Av. Trabalhador São-carlense, 400 – Centro, ZIPCODE: 13560-970, São Carlos, SP, Brazil – Telephone and Fax: +55 16 33739810

³ MSc, Central Paulista University Center (UNICEP), R. Miguel Petroni, 5111 - Lot. Hab. São Carlos 1, ZIPCODE: 13563-470. São Carlos - SP, Brazil. Telephone and Fax: +55 16 3362-2111

⁴ State University of Minas Gerais (UEMG): R. Colorado, 700 - Parque Res. Eldorado, ZIPCODE: 37902-092, Passos, MG, Brazil – Telephone and Fax: +55 35 3701-1919

⁵ São Carlos Institute of Physics (IFSC), University of São Paulo (USP): Av. Trabalhador São-carlense, 400 – Centro, ZIPCODE: 13560-970, São Carlos, SP, Brazil – Telephone and Fax: +55 16 33739810

Managing TMD includes the analgesic, anti-inflammatory and muscle-relaxant drugs or minimally invasive procedures (e.g., corticosteroids, hyaluronic acid, platelet-rich plasma, and botulinum toxin) for acute pain and/or loss of function⁹, but it may be an inappropriate treatment for long-term care. Then, noninvasive and no pharmacological treatments are desired, such as, occlusal splints, therapeutic exercise, massage, acupuncture², photobiomodulation, ultrasound therapeutic¹⁰ and coping therapy.¹¹

The purpose of the present study was to investigate the synergic effects of photobiomodulation combined with the vacuum therapy on pain, full range of mandibular motion and quality of life in patients with TMD.

2. Materials and Methods

The procedure involving human subjects was approved by a research ethics committee of the São Carlos Hospital in São Carlos city, SP, Brazil (CAAE09096219.0.0000.8148 with approval no.3.244.307). The research was registered on the International Clinical Trial Registry Platform (ICTRP - UTN U1111-1266-6024) and *Registro Brasileiro de Ensaios Clínicos* (REBEC - RBR-4g6dc35) platforms. All subjects signed informed consents documents prior to the study. The inclusion criterions were volunteers of both genders with TMD according to the Research Diagnostic Criteria for Temporomandibular Disorders (DC/TMD). Volunteers undergoing any other type of dental or physical treatment as well as using analgesic, anti-inflammatory or muscle relaxant drugs were excluded. Eighteen voluntaries were enrolled in clinical trials, but four were excluded. Fourteen voluntaries participated in this study.

Treatment

The treatment was carried out with the Vacumlaser® device (MMOptics, São Carlos, SP, Brazil). This device includes 3 lasers at wavelengths of 660 nm (red) and 3 lasers at wavelengths 808 nm (infrared). The average power of each laser was 100 mW, which have been applied in non-contact mode. The negative pressure (suction) was applied in pulsed mode (40 pulses per minute) with ranges between -100 and -150 mbar. A suction cup of 40 mm diameter and vegetable oil were used. Photobiomodulation and vacuum therapy were applied at the same time.

The device was performed in the scanning mode at 3 regions on face: temporomandibular joint, anterior fibers of the temporal muscle and entire extension of the masseter muscle. Each region was treated for 120 seconds. The treatment was performed twice a week for 4 weeks, totaling 8 sessions. The laser energy was 72 J per region, 216 J per session and 1728 J per treatment course (**FIGURE 1 and 2**). Measurements of pain intensity and range of mandibular motion during maximum mouth opening were carried out at three moments: T0 = pretreatment, T1 = post-treatment, and T2 = 15 days after termination of the treatment. Oral health-related quality of life measures was performed during T0 and T1.

Pain Measurement

According to DC/TMD^{10,12,13}, visual analogue scale (VAS) was used to assess pain intensity in period in period pre- and post-treatment via manual palpation on the muscles temporal and masseter, and temporomandibular joint. The range for intensity pain was from 0 to 3 (0 for no pain, 1 for mild pain, 2 for moderate pain and 3 for severe pain).

Range of Mandibular Motion

The millimeter-sized ruler was used to measure maximum mouth opening (vertical distance). The ruler was placed between the incisal edge of the maxillary central incisor and the labio-incisal edge of the opposing mandibular incisor.¹⁴

Oral Health-Related Quality of Life Measurement

Oral Health Impact Profile (OHIP-14) questionnaire was performed in period in period pre- and post-treatment. The questionnaire scores were: 0 for never, 1 for rarely, 2 for sometimes, 3 for often, and 4 for always. The total score is inversely related to the quality of life (lower total score indicates better quality of life).^{10,13,15}

2.2 Statistical Analysis

The data were expressed as mean $\pm$ standard deviation (SD). To verify the data normality and the homogeneity of variances, the Shapiro–Wilk and Levene's tests were used. To analyze the effects intervention a two-way analysis of variance (two-way ANOVA) was applied followed by Tukey post hoc test. The significance level was set at 5 % ($p < 0.05$). For the statistical analysis, Statistica for Windows 7 (StatSoft Inc., Tulsa, OK) was used.

3. Results

There was a significant reduction of pain score for the right and left side of the masseter and temporal muscles after the last session (T1) and 15 days after the last session (T2) as well as there was a significant enhance of maximum buccal opening (**TABLE 1**). In addition, there was significant improvement in quality of life, with a lower score indicating a better quality of life (**TABLE 2**).

4. Discussion

The main results of our study were reduced pain, enhanced range of jaw motion and improvement of life quality in patients with TMD treated with combined therapy (photobiomodulation and vacuum therapy). Studies were performed with photobiomodulation therapy¹⁶⁻²⁰ or coping therapy²¹⁻²⁴ for TMD. Nadershah et al.¹⁸ found reduced pain in patients with TMD that received 5 sessions of infrared laser applied every 48 h for 10 days compared with the sham laser group as evaluated by VAS. Another study performed by Del Vecchio et al.¹⁹ also found reduced pain when infrared laser was applied twice a day for seven consecutive days in patients with TMD compared with placebo group. In the study of Aisaitiet al.²⁰, infrared laser was applied once a day for 7 consecutive days in patients with TMD, resulting in reduced pain and improvement of the mechanical sensitivity in patients with TMJ arthralgia while there was greater range of jaw movements in patients with masseter myalgia. Differently, Herpich et al.¹⁷ performed intraoral photobiomodulation using a laser cluster with red and infrared wavelength during 6 sessions twice a week, which resulted in reduced pain e enhanced range of jaw motion in patients with TMD compared with sham laser group.

These benefits are related to modulation of inflammation and pain. Ferrara-Jr et al.¹⁶ investigated the effects of red laser on the pain sensitivity and inflammatory process in rats submitted to an experimental model of TMD for 21 days. These authors found decrease of the mechanical sensitivity of rats and reduced inflammatory response evidenced by lesser inflammatory infiltrate in the masseter muscle as well as by a central inhibition of fractalkine in the trigeminal ganglion.¹⁶

Photobiomodulation is a form of light therapy that utilizes several light sources, such as laser, LED and lamp. However, laser is more advantageous due to special characteristic of light: monochromatic, coherent and collimated. In particular, the coherence favors therapeutic effects due to presence of laser speckles in biological tissue^{26,26} and greater penetration.²⁷ Vacuum therapy is characterized by the application of a cup that generates negative pressure through a vacuum mechanism. Regarding to cupping therapy is an ancient method, characterized by a simple procedure in which negative pressure is applied to the skin through sucking cups.²⁸ This treatment promotes therapeutic effects, including the anti-inflammatory and analgesic action, as well as lymphatic drainage and myofascial release.^{29,30}

Han, Guo and Xia²² founded that the combination of needle acupuncture, medication and cupping therapy significantly reduced craniomandibular index, dysfunction index, palpation index and intensity of pain. In another study, Serritella et al.¹¹ compared different acupuncture methods for TMD treatment, among them body needle acupuncture, electro acupuncture, and needle acupuncture combined with cupping therapy. All methods were effective for reduction of pain and improvement of quality of life. However, these studies focus on the effect of effectiveness of acupuncture.^{11,22}

Sajedi et al.³¹ conducted a comparative study between the laser puncture (808 nm, continuous mode, 0.5 W, 30 J, 4 J/cm², 60 seconds) and cupping therapy carried out in 60 patients with TMD. The therapies were applied on each trigger point on the face during 8 sessions. The authors found that both techniques were equally effective for the treatment of myofascial pain dysfunction syndrome in TMD patients, which showed reduced pain and improved maximum mouth opening.³¹ However, only one study of case report was performed with photobiomodulation and vacuum therapy at the same time for feasibility, safety, and preliminary proof of principles in patients with TMD.³² Moreover, another case report was performed for the treatment of facial nerve palsy. In this study, Panhoca, Nogueira and Bagnato³³ showed the recovery of movements and the return of facial symmetry promoted by synergic application of photobiomodulation and vacuum therapy.

A clinical trial for neurological rehabilitation also was performed with synergic treatment of photobiomodulation and vacuum therapy in patients with Parkinson's disease. In this study, Tamae et al.³⁴ found reduced pain and improved quality of life. Another study, Lopes et al.³⁵ applied the same combined therapy for physical rehabilitation of patients with low back pain, shoulder bursitis and hip dysfunction, resulting in reduction of pain, muscle relaxation and enhanced range of movement. Photobiomodulation¹⁶ and vacuum therapy³⁶ promote effects anti-inflammatory and analgesic. In addition, vacuum therapy is a mechanical stimulus to potentiate laser therapy, leading to synergistic effects.

5. Conclusion

The synergistic treatment of photobiomodulation and vacuum therapy was effective to produce better outcomes in terms of reduced pain, increased mandibular range of motion and improved quality of life in patients with TMD. Moreover, its beneficial effects persisted for at 15 days after the end of treatment.

Acknowledgments

We would like to thank the by the Financier of Studies and Projects (FINEP) – Grant no. 01.13.0430-00, the São Paulo Research Foundation (FAPESP) - grant no. 2013/14001-9 and 2013/07276-1 (CEPOF – CEPID Program), the National Council for Scientific and Technological Development (CNPq) - grant no. 465360/2014-9 (INCT Program), and the Productivity Research Scholarship Program (PQ/UEMG) - grant no. 06/2021 and 10/2022.

Conflict of interest statement No competing financial interests exist.

References

- Hadler-Olsen E, Thon E, Holde GE, et al. Temporomandibular disorders in an adult population in northern Norway: A cross-sectional study. *Clin Exp Dent Res* 2021;7(6): 1144–1153; doi: 10.1002/cre2.463.
- Ferrillo M, Giudice A, Marotta N, et al. Pain Management and Rehabilitation for Central Sensitization in Temporomandibular Disorders: A Comprehensive Review. *Int J Mol Sci* 2022; 23(20):1–20; doi:10.3390/ijms232012164.
- Deregibus A, Ferrillo M, Grazia Piacino M, et al. Are occlusal splints effective in reducing myofascial pain in patients with muscle-related temporomandibular disorders? A randomized-controlled trial. *Turk J Phys Med Rehabil* 2021;67(1):32–40; doi:10.5606/2Ftftd.2021.6615.
- Atsü SS, Güner S, Palulu N, et al. Oral parafunctions, personality traits, anxiety and their association with signs and symptoms of temporomandibular disorders in the adolescents. *Afr Health Sci* 2019;19(1):1801–1810; doi: 10.4314/ahs.v19i1.57.
- Kmeid E, Nacouzi M, Hallit S, et al. Prevalence of temporomandibular joint disorder in the Lebanese population, and its association with depression, anxiety, and stress. *Head Face Med* 2020;16(19):1–11; doi: 10.1186/s13005-020-00234-2.
- Valesan LF, Da-Cas CD, Reus JC, et al. Prevalence of temporomandibular joint disorders: a systematic review and meta-analysis. *Clin Oral Investig* 2021;25(2):441–453; doi:10.1007/s00784-020-03710-w.
- Alresayes S, Al-Aali K, Javed F, Alghamdi O, et al. Assessment of self-rated pain perception and whole salivary cortisol levels among adolescents with and without temporomandibular disorders. *Cranio* 2021;25(1):1–7; doi: 1080/08869634.2021.1899697.
- Lai YC, Yap AU, Türp JC. Prevalence of temporomandibular disorders in patients seeking orthodontic treatment: A systematic review. *J Oral Rehabil* 2020;47(2):270–280; doi: 10.1111/joor.12899.
- Andre A, Kang J, Dym H. Pharmacologic Treatment for Temporomandibular and Temporomandibular Joint Disorders. *Oral Maxillofac Surg Clin North Am* 2022;34(1): 49–59; doi:10.1016/j.coms.2021.08.001.
- Panhoca VH, Bagnato VS, Alves N, et al. Increased Oral Health-Related Quality of Life Postsynergistic Treatment with Ultrasound and Photobiomodulation Therapy in Patients with Temporomandibular Disorders. *Photobiomodul Photomed Laser Surg* 2019;37(11):694–699; doi:10.1089/photob.2019.4697.
- Serritella E, Galluccio G, Impellizzeri A, et al. Comparison of the Effectiveness of Three Different Acupuncture Methods for TMD-Related Pain: A Randomized Clinical Study. *Evid Based Complement Alternat Med* 2021;2021(1286570):1–10; doi:10.1155/2021/1286570.
- Schiffman, E., Ohrbach, R., Truelove, E., Look, J., Anderson, G., Goulet, J. P., ... & Dworkin, S. F. (2014). Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. *Journal of oral & facial pain and headache*, 28(1), 6..
- Panhoca VH, Lopes LAB, Paolillo FR, et al. OHDM Treatment of Temporomandibular Disorder Using Synergistic Laser and Ultrasound Application. *Oral Health Dent Manag* 2018;17(2):1021–1025.
- Khairnar S, Bhate K, Santhosh Kumar SN, et al. Comparative evaluation of low-level laser therapy and ultrasound heat therapy in reducing temporomandibular joint disorder pain. *J Dent Anesth Pain Med* 2019;19(5):289–294; doi:10.17245/jdapm.2019.19.5.289.
- Robinson PG, Gibson B, Khan FA, et al. A comparison of OHIP 14 and OIDP as interviews and questionnaires. *Community Dental Health* 2001;18(3):144–149.
- Ferrara-Jr JI, De Souza ET, Franciosi AC, et al. Photobiomodulation-induced analgesia in experimental temporomandibular disorder involves central inhibition of fractalkine. *Lasers Med Sci* 2019;34(9):1841–1847; doi: 10.1007/s10103-019-02785-6.

- Herpich CM, Leal-Junior ECP, Politti F, et al. Intraoral photobiomodulation diminishes pain and improves functioning in women with temporomandibular disorder: a randomized, sham-controlled, double-blind clinical trial: Intraoral photobiomodulation diminishes pain in women with temporomandibular disorder. *Lasers Med Sci* 2020;35(2):439–445; doi:10.1007/s10103-019-02841-1.
- Nadershah M, Abdel-Alim HM, Bayoumi AM, et al. Photobiomodulation Therapy for Myofascial Pain in Temporomandibular Joint Dysfunction: A Double-Blinded Randomized Clinical Trial. *J Maxillofac Oral Surg* 2020;19(1):93–97; doi:10.1007/s12663-019-01222-z.
- Del Vecchio A, Floravanti M, Boccassini A, et al. Evaluation of the efficacy of a new low-level laser therapy home protocol in the treatment of temporomandibular joint disorder-related pain: A randomized, double-blind, placebo-controlled clinical trial. *Cranio* 2021;39(2):141–150; doi: 10.1080/08869634.2019.1599174.
- Aisaiti A, Zhou Y, Wen Y, et al. Effect of photobiomodulation therapy on painful temporomandibular disorders. *Sci Rep* 2021;11(1):1–12; doi:10.1038/s41598-021-87265-0.
- Deguchi T, Uematsu S, Kawahara Y, et al. Clinical Evaluation of Temporomandibular Joint Disorders (TMD) in Patients Treated with Chin Cup. *The Angle Orthodontist* 1998;68(1):91–94; doi:10.1043/0003-3219(1998)068<0091: CEOTJD>2.3.CO;2.
- Han Y, Guo LH, Xiao J. Acupuncture combined with medicated cupping for temporomandibular disorders. *W J Acup-Moxib* 2015;25(3):31–34; doi:10.1016/S1003-5257(15)30061-1.
- Zurfluh MA, Kloukos D, Patcas R, et al. Effect of chin-cup treatment on the temporomandibular joint: a systematic review. *Eur J Orthod* 2015;37(3):314–324; doi:10.1093/ejo/cju048.
- Kandasamy S, Greene CS. The evolution of temporomandibular disorders: A shift from experience to evidence. *J Oral Pathol Med* 2020;49(1):461–469; doi: 10.1111/jop.13080.
- Hode L. The importance of the coherency. *Photomed Laser Surg* 2005; 23(4):431–434; doi:10.1089/pho.2005.23.431.
- Hode T, Jenkins P, Jordison S, et al. To what extent is coherence lost in tissue? *Proc. SPIE* 7887 2011; 788703(2011):1–10; doi: 10.1117/12.878827.
- Hode T, Duncan D, Kirkpatrick S, et al. The importance of coherence in phototherapy. *Proceedings SPIE* 7165 2009;716507(2009):1–10; doi: 10.1117/12.809563.
- El Sayed SM, Mahmoud HS, Nabo MM. Methods of wet cupping therapy (Al-Hijamah): in light of modern medicine and prophetic medicine. *Altern Integr Med* 2013;2(3):1–16; doi: 10.4172/2327-5162.1000111.
- Rozenfeld E, Kalichman L. New is the well-forgotten old: the use of dry cupping in musculoskeletal medicine. *J Bodyw Mov Ther* 2016;20(1):173–178; doi: 10.1016/j.jbmt.2015.11.009.
- Lopes LAB, Alvarez C, Campos TYTB, et al. Synergistic effects of vacuum therapy and laser therapy on physical rehabilitation. *J Phys Ther Scie* 2019;31(1):598–602; doi: 10.1589/jpts.31.598.
- Sajedi MS, Abbasi F, Asnaashari M, et al. Comparative Efficacy of Low-Level Laser Acupuncture and Cupping for Treatment of Patients with Myofascial Pain Dysfunction Syndrome: A Double-blinded, Randomized Clinical Trial. *Galen Med J* 2022;11(1): 1–13; doi: 10.31661/gmj. v11i.2305.
- Panhoca VH, Tamae PE, Silva MVJ et al. Synergistic effect of low-level laser and vacuum therapy on the temporomandibular disorder: two cases report. *Laser Phys Lett* 2021;18(10):105602; doi: 10.1088/1612-202X/ac20de.
- Panhoca VH; Nogueira MS; Bagnato VS. Treatment of facial nerve palsies with laser and endermotherapy: a report of two cases. *Laser Phys Lett* 2021;18(1):015601; doi: 10.1088/1612-202X/abcbf8.
- Tamae PE et al. Can the associated use of negative pressure and laser therapy be a new and efficient treatment for Parkinson's pain? A comparative study. *J Alzheimer's Dis Parkinsonism* 2020;10(3):1–6.
- Lopes LAB, Alvarez C, Campos TYTB et al. Synergistic effects of vacuum therapy and laser therapy on physical rehabilitation. *J Phys Ther Scie* 2019;31(7):598–602; doi: 10.1589/jpts.31.598.
- Al-Bedah AMN, Elsubai IS, Qureshi NA, et al. The medical perspective of cupping therapy: Effects and mechanisms of action. *J Tradit Complement Med* 2018;9(2):90–97; doi: 10.1016/j.jtcme.2018.03.003.

TABLE 1: Statistical results of the face pain intensity and range of mandibular motion

	Before the first session (T0)		After the last session (T1)		15 days after the last session (T2)	
Pain Score	Right	Left	Right	Left	Right	Left
Masseter Palpation	2.4±0.8	2.2±0.87	0.4±0.66 ^a	0.6±0.66 ^a	0.5±0.67 ^a	0.5±0.67 ^a
Temporal Palpation	1.5±0.87	1.8±1.0	0.5±0.92 ^b	0.4±0.91 ^b	0.3±0.45 ^b	0.6±0.91 ^b
Joint Temporomandibular	1.5±1.0	1.3±1.0	0.5±0.67	0.4±0.66	0.4±0.80	0.5±0.80
Range of Motion (mm)						
Maximum Buccal Opening	32.7±4.56		42.6±5.2 ^c		43.3±6.75 ^c	

^aversus T0 p<0,001 ^bversus T0 p<0,05; ^cversus T0 p<0,01

TABLE 2: Statistical results of the oral health impact profile.

	Before the first session (T0)	After the last session (T1)
Functional limitation	1.5±2.12	0.90±1.59
Physical pain	5.1±1.91	3.1±2.47
Psychological discomfort	5.3±1.94	3.4±2.54
Physical limitation	2.9±2.18	1.2±1.55
Psychological limitation	4.4±1.84	2.5±2.32
Social limitation	1.4±2.19	1.5±1.58
Disability	2.1±1.44	1.2±1.47
Total	22.90±8.92	13.90±10.51 ^a

^aversus T0 p<0,001



FIGURE 1. Clinical application with Vacumlaser® on the muscles temporal = TM and masseter = MM, and temporomandibular joint = TMJ.



FIGURE 2. Clinical procedure with Vacumlaser®.