



Original Article

# Effect of Nd: YAG laser irradiation to the temporomandibular joint on taste threshold



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## KEYWORDS

Nd:YAG laser irradiation;  
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Taste threshold;  
Electric taste meter

**Abstract** *Background/purpose:* The tissue absorption laser has been clinically applied to alleviate pain in various areas. It is used for pain relief from temporomandibular disease (TMD) in dentistry. Although the facial and trigeminal nerves are distributed around the temporomandibular joint, the effects of laser irradiation and absorption on the neural functions have not been directly studied. In this study, the Nd:YAG laser was applied to an area where the facial nerve passes with photonic radiation for the treatment of TMD.

*Materials and methods:* Ten volunteers including seven males and three females were selected as subjects. Nd:YAG laser was irradiated area included several internal and external standard and associated acupuncture points. The chorda tympani nerve, a branch of facial nerve is distributed to the front two thirds of the tongue and is associated with the sense of taste. We evaluated the effect of laser irradiation and absorption on the taste function by means of an electric taste meter.

*Results:* No significant difference was identified in the values between before and after laser irradiation (Wilcoxon signed-rank test).

*Conclusion:* It was confirmed that there was no effect on taste function while applying Nd:YAG laser irradiation around the TMD joint.

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## Introduction

The term temporomandibular joint disorders (TMDs), regards a subgroup of orofacial pain, the symptoms of which include pain or discomfort in the temporomandibular joint, ears, masticatory muscles and neck on one or both sides, as well as joint sounds, limited mandibular movements or mandibular deviation and difficulties chewing.<sup>1,2</sup> Almost 75% of the population presents at least one sign of TMD (movement abnormalities, joint noise, tenderness on palpation, etc.), and 33% one symptom (face pain, joint pain, etc.).<sup>3</sup> The main causes of TMD are; trauma in local tissues, chronic repetitive micro-trauma, non-habitual mandibular movements, and an increase in emotional stress.<sup>4</sup> In the past 30 years, many non-surgical treatments have been explored for the treatment of TMDs, including physical therapy,<sup>5</sup> pharmacotherapy,<sup>6</sup> occlusal splints<sup>7</sup> and low-level laser therapy (LLLT).<sup>8</sup>

The applicability of the LLLT has reported as physical therapy particularly for limited mouth opening and sharp pain relief.<sup>8</sup> Plog<sup>9</sup> carried out pulsed helium neon laser irradiation to an acupuncture point and confirmed an analgesic effect. Maima et al.<sup>10</sup> Arao et al.<sup>11</sup> reported that the laser acupuncture using to the laser irradiation for pain improved the treatment outcome because of its penetration ability. Therefore, tissue absorption typed lasers<sup>12</sup> including Nd:YAG laser<sup>11,13,14</sup> and diode laser<sup>15,16</sup> have been frequently used for a pain relief measure besides helium-neon laser.<sup>9</sup> Reduction of muscular tension and pain in patients with TMD was proven along with analgesic, anti-inflammatory, anti-edematous, and bio stimulatory effects of LLLT.<sup>17,18</sup> LLLT was introduced in randomized controlled trial on musculoskeletal pain in early 1980.<sup>19</sup>

It is effective to apply LLLT using Nd: YAG laser to painful parts around TMJ<sup>13,14</sup> and an acupuncture point.<sup>11,20,21</sup> It was reported that immediate effects, increase of mouth opening width, alleviation of pain, and improved blood flow<sup>22</sup> were obtained by this method.

It has been reported that LLLT to Xiaguan (meridian acupoint: ST7) is applicable for all TMD<sup>20</sup> as well as for muscle pain.<sup>21</sup> Laser irradiation for TMD is performed to alleviate pain around the Xiaguan area<sup>11,20,21</sup> which is an acupuncture point by international standards.<sup>23</sup>

This laser irradiation field includes a broad distribution of the facial<sup>23,24</sup> and trigeminal nerves.<sup>23</sup>

The chorda tympani nerve, a branch of the facial nerve is distributed to two thirds in front of the tongue, and the taste<sup>25</sup> is transmitted. However, effects of laser irradiation on the facial and chorda tympani nerve when it applied to TMD area have never researched. The purpose of this study was to evaluate the effect of low level laser irradiation to the TMJ area on a tasting function<sup>25–27</sup> of the chorda tympani nerve complex.

Laser irradiation to TMJ has been available as one of physical therapies.<sup>5,8</sup> Although no adverse effects of this therapy have reported, they may occur according to the increase of use. Therefore, current research was performed to clarify the effect on the taste disorder, one of possible adverse effect of this therapy procedure.

## Materials and methods

### Participants

Ten volunteers including seven males and three females (mean age  $28.2 \pm 3.65$ ) were selected as subjects. These volunteers have no systemic disease or TMD. The subjects were sufficiently informed the purpose of the experiment, and the consent for all participants was obtained at Tsurumi University Dental Medicine. Experiments were conducted according to the Ethical Provision of the Tsurumi University School of Dental Hospital (Approval Number 821).

### Laser irradiation for acupuncture points

For the laser irradiation area, we selected the Xiaguan (ST7), Ermen (TE21), Tinggong (ST19), and Tinghut (GB2). The procedure of determining respective acupuncture points written in the meridian map<sup>23</sup> was carried out using an acupuncture sensor (Tormenter Iw-zen, Ryodoraku Research Institute, Ltd., Tokyo, Japan). The anatomical acupuncture points were confirmed by the acupuncture point detector that detects point of reduced skin surface impedance.<sup>28</sup> Nd:YAG laser (Denics Laser ND Compact, Incisive LLC., Richmond, CA, USA) was irradiated to the area including these acupuncture points (Fig. 1) using a

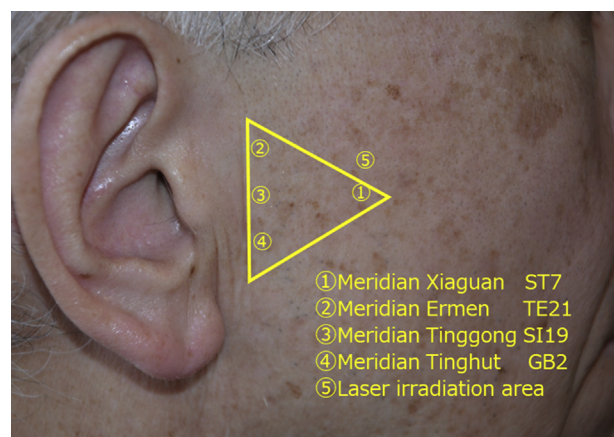
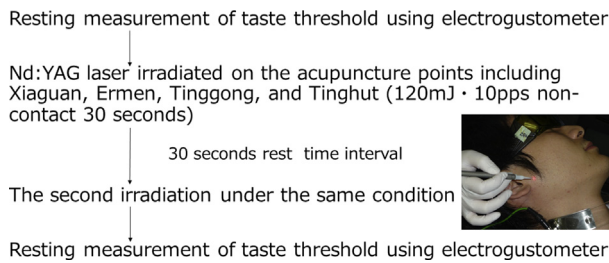


Figure 1 Laser irradiation area and acupuncture points.



**Figure 2** Nd: YAG laser irradiation procedure.

method previously established by Yamaguchi et al.<sup>22</sup> It was performed with a sweeping motion two mm away from the skin surface with energy density of 50J/cm<sup>2</sup> (30 s at 120 mJ and 10 pulses/sec) after 30 s suspension, then irradiated again under the same conditions (Fig. 2).

### Measurement of threshold of the taste

Thresholds of the metallic taste<sup>26,27</sup> before and after laser irradiation were measured using an electric taste meter (electrogustometer, TR-06, RION Co., LTD., Tokyo, Japan). An electrical stimulus through an electrode was applied to the side of the tongue surface 20 mm from the apex, an area innervated by the chorda tympani nerve. The stimulus was applied at increasing strengths (2 dB each), starting at -6dB and increasing up to 34 dB (Fig. 3). When a subject experienced a metallic taste, he/she pressed a button to confirm their response, and then threshold was measured.<sup>26,27</sup> Threshold was measured three times, and the highest value was adopted.<sup>26</sup>

The results of electric taste threshold before and after laser irradiation were statistically evaluated using the Wilcoxon signed-ranks test. A value of  $P < 0.05$  was considered statistically significant.

### Results

The threshold values (mean value and standard deviation) before and after laser irradiation are presented in Table 1. There was no significant difference in the values before and after the irradiation.

**Table 1** Taste threshold before and after laser irradiation.

Before laser irradiation	-2.20±5.21dB
After laser irradiation	-1.80±6.43dB

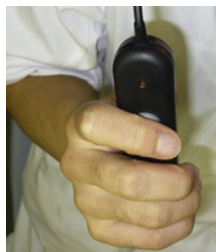
No significant difference was confirmed between before and after laser irradiation with Wilcoxon signed-ranks test ( $p > 0.0$ ). Gender of mean age, standard deviation and subject numbers Male 27.71±3.50(n=7) Female 29.93±4.51(n=3)

### Discussion

We have reported that the blood flow rate in the dental pulp significantly increased during Nd:YAG laser irradiation at the apical area,<sup>22</sup> and that thermal pain perception thresholds<sup>29</sup> were significantly increased immediately following Nd:YAG laser irradiation. Arao et al.<sup>11,20,21</sup> reported that pain relief effect was obtained due to blood flow volume increase after irradiation, the Nd:YAG laser irradiation to Xiaguan for patients with TMD.

This result might have been induced by local circulation improvements by means of low level laser irradiation to lateral pterygoid muscle and a masseter muscle.<sup>11,20,21</sup> This is presumably because the laser irradiation improved the blood flow, and the local stagnant pain-inducing-substances were reduced, resulting in a pain relief effect.<sup>11,20,21</sup>

Low-level laser therapy is a non-invasive, rapid, and safe non pharmaceutical treatment method that may be beneficial for patients with myogenic TMD.<sup>16</sup> It usually targets peripheral area of Xiaguan<sup>11,20,21</sup> (Fig. 1) where the trigemini and facial nerves pass underneath. Especially laser irradiation for Xiaguan<sup>11,20,21</sup> is selected to alleviate pain in masseter and pterygoid muscles that innervated by the mandibular nerve.<sup>11,20,21</sup> The facial nerve underneath the laser irradiated area diverges to the chorda tympani nerve from the upper part of the stylomastoid foramen via the facial neural tube<sup>24</sup> and then merges with the innervation of the tongue nerve<sup>30</sup> (Fig. 4). Although the bottom of the tongue<sup>23</sup> has a branching point of the chorda tympani nerve and tongue nerve located directly underneath, no effect on taste threshold was observed. As there are some anatomical variations in the nervous merging point,<sup>30</sup> a further investigation is necessary in the future. The intensity of tissue absorption Nd:YAG laser to hard tissues



Subjects press the button when they feel a metallic taste



The electrode was applied on the side of the tongue



Electrogustometer

**Figure 3** Measurement of taste threshold using electrogustometer.

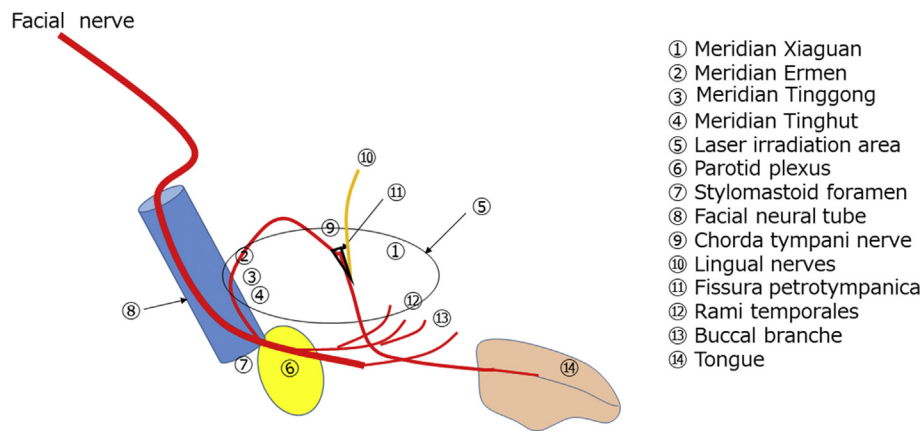


Figure 4 Distribution of nerves around the acupuncture points for TMD.

wanes to 55% due to absorbance into the tissue.<sup>12</sup> As a part of the chorda tympani nerve is covered by the facial neural tube,<sup>24</sup> there is a possibility that tissue absorption typed<sup>13</sup> Nd:YAG laser will hardly affect the tissue.<sup>11,20,21</sup>

A diagnosis of taste disorders is comprised of two main methods: a taste conduction path disorder using an electrogustometer,<sup>26,27</sup> and a receptor-type taste disorder that is suitable for follow up using the filter paper disc method.<sup>31,32</sup> The electrogustometer<sup>26,27</sup> includes a nerve stimulating element, moreover the stimulus can be evaluated quantitatively, therefore it is suitable for evaluating the chorda tympani nerve for taste conduction path disorders, follow-up, and prognosis.<sup>27</sup> For these reasons, it was adopted for the present study. A normal value of taste threshold reported as  $-2.4 \pm -4.4$  dB for left tongue<sup>26</sup> in the chorda tympani nerve region. Also, the normal range threshold of the electric taste meter for each taste control area was reported less than 8 dB in the chorda tympani nerve area, and the values obtained in this study were within this range.

In conclusion, it was suggested that Nd:YAG laser irradiation to TMJ area had no adverse effects on taste threshold. However, the evaluation was performed using only healthy young subjects as the first step, the results might be stabled during the evaluation. Small numbers of subjects and subject generation may also confine the results of the study, therefore further studies using larger sample size, different age ranges, and a controlled gender ratio is promising.

In future, we will continue our laser irradiation therapy around the acupuncture points in order to confirm safety.

## Conflicts of interest

All authors have no conflicts of interest to disclose relates to this study.

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