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Effect of low-level laser therapy (LLLT) on post-operative pain, trismus and quality of life (QOL) of patients undergoing extraction of impacted lower third molars

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Abstract. Low-level Laser Therapy (LLLT) is a physical modality used to support rehabilitation therapy. Often, patients undergoing extraction of impacted lower third molars experience a decline in their quality of life (QOL). This single-blinded randomised controlled trial (RCT) included patients aged between 18 to 30 years who were randomly allocated to an intervention group that received LLLT (n = 21) or a control group that did not (n = 21). Subjects in the intervention group was given a dose 54 J, energy density 18J/cm² at 0, 3rd and 7th day post lower third molar removal. The QOL was assessed in both groups using the Short Form 36 (SF-36) before and after LLLT. A statistically significant reduction in pain was observed on post-operative days 3 and 7 (p < 0.05) between both groups. There is a statistically significant reduction of post-operative trismus at day 3 and 7 (p < 0.05) between both groups. A statistically significant (p < 0.05) improvement in the physical role (RP), bodily pain and general health domains of QOL was seen in both groups. Additionally, a significant improvement (p < 0.05) was observed in the physical component of QOL in both groups. The results of this study showed that LLLT (905 nm 18J/cm² osis, 100 mW power) therapy can decrease post-operative pain and reduce trismus from day 3 in patients that have undergone surgical treatment of impacted lower third molars.

1. Introduction

Low-level laser therapy (LLLT) consists of the application of light that is in the red spectrum or that has a specific energy density (power density) near to infrared (600–1100nm) to pathological tissues, with the aim of inducing tissue regeneration and anti-inflammatory effects and enhancing the secretion of serotonin and endorphins to relieve pain [1]. LLLT is a physical modality used to support medical rehabilitation therapy. Often, it is also used as adjuvant therapy for dentine hypersensitivity, temporomandibular joint disorders, oral mucositis, alveolar nerve injury and post dental surgery [2].
Impaction is the phenomenon by which teeth fail to erupt into the arch of the jaw due to obstruction caused by various factors such as the adjacent teeth, dense bone layers, or thick soft tissues. Its treatment typically involves surgical intervention [3], and the associated symptoms include inflammation of the soft tissues around the teeth, root resorption, alveolar bone and soft tissue diseases, caries in the adjacent teeth, and headaches or jaw pain.

Surgical extraction of the third molar from the bone surrounding its roots is typically known as odontectomy. Usually, these surgeries are associated with a decrease in the patient’s quality of life (QOL) for a period of 4–7 days due to physiological responses such as mild bleeding, swelling, stiffness and pain, which can interfere with daily activities such as eating and drinking [4]. The most severe pain usually occurs within the first 3–5 hours after the disappearance of local anaesthetic effects, while the oedema peaks within 24–48 hours post-surgically, before gradually decreasing and disappearing within 5–7 post-surgically [3]. Trismus begins to disappear on third day with the use of antibiotics for 5 days, and non-steroidal anti-inflammatory drugs are given also for 5 days [3,5,6].

The QOL refers to different aspects of the individual’s life, including their physical health, psychological status, level of independence, social relationships, self-confidence and relationships with the environment. The Short Form 36 (SF-36) is a measuring tool used to assess the QOL in general health [7]. It comprises of 8 key health components, including physical functions (such as physical activity), pain responses, psychosocial influences, emotions and limitation of key tasks (ie physical health problems and their effects on work and daily activities) [7].

Currently, there are a limited number of studies that focus on the rehabilitation of dental and mouth diseases in Indonesia. The current study aimed to examine the effects of LLLT treatment on the quality of life (QOL) of patients who had undergone third molar surgery and exhibited symptoms such as pain and trismus before and after treatment by comparing these measurements with those of a control group that did not receive LLLT.

2. Methods
This single-blinded randomised controlled trial (RCT) was conducted at Cipto Mangunkusumo Hospital, Jakarta, and ethical approval was obtained from the Health Research Ethics Committee of Faculty of Medicine, Universitas Indonesia-Cipto Mangunkusumo Hospital. The study included patients aged 18–30 years who had undergone surgical treatment of impacted lower third molars in the period between December 2013–May 2014 at the Department of Oral and Maxillofacial Surgery, Cipto Mangunkusumo Hospital. The inclusion criteria were as follows: history of surgical treatment of unilaterally impacted third molars; age within 18–30 years; Pell-Gregory impaction grades of II-A & II-B (distoangular, mesioangular, horizontal); duration of operation no more than 1 hour; no history of taking painkillers & antibiotics in the previous 3 days; ability to read. The patients were given 625 mg of amoxicillin-clavulanic acid and 50 mg of potassium diclofenac for the first 5 days after surgery. The patients were randomly allocated into either the LLLT group or the control group (no LLLT), such that each group included 21 individuals. LLLT treatment was administered using Lasermed 2100, GaAs 905nm, a 1cm diameter probe is placed in extraoral area at 3 point ie inserso muscle masseter on mandibular angulus, masseter muscle on ramus mandibula and 1 trajus front finger as high as TMJ.

Statistical analysis included comparison of the two groups using a Chi squared test. The independent variables included the patient’s age, sex and class of impaction, while the dependent variables consisted of pain, trismus and QOL. The non-parametric Mann Whitney tests were used to identify changes in pain (visual analog score / VAS) and trismus, while analysis of the QOL data (SF-36) included initial calculation of RAND, followed by either the Wilcoxon test, paired t-test, or Mann Whitney test, depending on the type of distribution. The level of statistical significance was set at p < 0.05 and all statistical analyses were performed using SPSS for Windows 7.

3. Results
There were 42 patients included in this study, the characteristics are shown in Table 1.
Table 1. Patient demographics

| Variable                | LLLT Group (n=21) | Control Group (n=21) | p value |
|-------------------------|-------------------|----------------------|---------|
| Gender                  |                   |                      |         |
| Male                    | 13 (16.9%)        | 6 (28.6%)            | 0.030   |
| Female                  | 8 (38.1%)         | 15 (71.4%)           |         |
| Age                     |                   |                      | 0.182   |
| Mean (SD) Mean (SD)     | 26.90 (2.91)      | 25.52 (3.64)         |         |
| Range                  | 21 – 30           | 18 – 30              |         |
| Education level         |                   |                      | 0.753   |
| Undergraduate           | 13 (16.9%)        | 12 (57.1%)           |         |
| Highschool              | 8 (38.1%)         | 9 (42.9%)            |         |
| Middle school           | 0 (0%)            | 0 (0%)               |         |
| Occupation              |                   |                      | 0.355   |
| Employee                | 18 (85.7%)        | 15 (17.4%)           |         |
| Homemaker               | 2 (9.5%)          | 2 (9.5%)             |         |
| Others                  | 1 (4.8%)          | 4 (19.1%)            |         |
| Location of Impaction   |                   |                      | 0.212   |
| Right side              | 14 (66.73%)       | 10 (47.6%)           |         |
| Left side               | 7 (33.33%)        | 11 (52.4%)           |         |
| Class of Impaction      |                   |                      | 0.220   |
| IIA Distoangular        | 2 (9.5%)          | 5 (23.8%)            |         |
| IIA Mesoangular         | 10 (47.6%)        | 7 (33.3%)            |         |
| IIA Horizontal          | 3 (14.3%)         | 2 (9.5%)             |         |
| IIB Distoangular        | 1 (4.8%)          | 4 (19.1%)            |         |
| IIB Mesoangular         | 2 (9.5%)          | 3 (14.3%)            |         |
| IIB Horizontal          | 3 (14.3%)         | 0 (0%)               |         |
| Duration of odontectomy |                   |                      | 1.000   |
| >30 minutes             | 12 (57.1%)        | 12 (57.1%)           |         |
| <30 minutes             | 9 (42.9%)         | 9 (42.9%)            |         |
| Chief complaint         |                   |                      | 0.446   |
| Pain                    | 14 (66.73%)       | 10 (47.6%)           |         |
| Swelling                | 2 (9.5%)          | 6 (28.6%)            |         |
| Based on panoramic radiograph | 3 (14.3%) | 3 (14.3%) | |
| Headache                | 2 (9.5%)          | 2 (9.5%)             |         |

3.1. Effect of LLLT on Post-Surgical Pain
The level of pain did not differ significantly (p = 0.801) between the LLLT and control groups on day 0 (Table 2). However, the LLLT group was seen to exhibit a greater decrease in pain between day 0 and day 3 (minimum VAS = 0) compared to the control group (minimum VAS = 2). Moreover, the pain was seen to have subsided completely in the LLLT group by day 7, but not in the control group. The Mann Whitney test showed a significant difference between the two groups on days 3 and 7 (p = 0.000). These findings suggest that LLLT therapy reduced pain successfully, which was assessed using the VAS scores.
Table 2. Effect of LLLT on Post-operative Pain

| Variable | LLLT Group (n = 21) | Control Group (n = 21) | p value |
|----------|---------------------|------------------------|---------|
|          | Median              | Median                 |         |
| VAS Day 0 | 4.8 (3–7.8)         | 4.2 (3–8)              | 0.801   |
| VAS Day 3 | 1 (0–3.8)           | 3 (2–5)                | 0.000   |
| VAS Day 7 | 0 (0–0.2)           | 1.8 (0–4.6)            | 0.000   |

3.2. Effect of LLLT on Post-operative Trismus

No significant differences in the median VAS values of post-surgical trismus were observed between the two groups on day 0 (Table 3). However, trismus was seen to decrease in the LLLT group on day 3, while the control group exhibited an increase in VAS scores on the same day. The median VAS values on day 7 were 4.2 (no trismus present) in the intervention group and 3 (trismus present) in the control group.

Table 3. Effect of LLLT on post-operative trismus

| Variable | LLLT Group (n = 21) | Control Group (n = 21) | p value |
|----------|---------------------|------------------------|---------|
|          | Median              | Median                 |         |
| VAS Day 0 | 3 (1.5–4)           | 3.4 (2.2–4)            | 0.153   |
| VAS Day 3 | 3.5 (2.8–4)         | 2.5 (2–3)              | 0.000   |
| VAS Day 7 | 4.2 (3.5–4.5)       | 3 (2.5–4)              | 0.000   |

The Mann Whitney test showed significant differences in the VAS scores for trismus between the two groups on days 3 and 7 (p = 0.000), while the independent t-test exhibited a significant difference in the mean trismus values between the two groups (p ≤ 0.05). These findings suggest that LLLT therapy successfully reduced and even completely eradicated trismus by day 7.

3.3. Effect of LLLT on the Patient’s Post-operative Quality of Life, Measured Using the 8 Domains of SF-36

No significant differences in physical function (FF) were observed between the two groups, with the pre- and post-operative values being 100.00 for both groups. (Table 4)

Table 4. Effect of LLLT on the patient’s post-operative quality of life, measured using the 8 domains of SF-36

| Variable                  | LLLT Group                  | Control Group                | p value |
|---------------------------|-----------------------------|------------------------------|---------|
|                           | Pre (Mean)                  | Post (Mean)                 | Pre (Mean) | Post (Mean) |         |
| Physical Function (FF)    | 100.00                      | 100.00                       | 1.000    | 100.00 | 100.00 | 1.000 |
| Physical Role (PF)        | 78.57                       | 92.86                        | 0.057    | 76.19  | 83.33  | 0.410 |
| Pain (RN)                 | 57.62                       | 95.90                        | 0.000    | 54.29  | 67.00  | 0.077 |
| General Health (KU)       | 63.81                       | 71.86                        | 0.025    | 62.52  | 63.52  | 0.794 |
| Vitality (V)              | 64.05                       | 71.43                        | 0.047    | 63.33  | 69.52  | 0.051 |
| Social Function domain (FS)| 77.98                      | 79.76                        | 0.710    | 81.55  | 81.55  | 1.000 |
| Emotional Role (PE)       | 80.95                       | 96.83                        | 0.018    | 77.78  | 85.72  | 0.350 |
| Mental Health (KM)        | 66.86                       | 73.90                        | 0.162    | 68.57  | 74.10  | 0.045 |
The post-surgical values of the remaining 7 domains were higher than the pre-surgical values in the LLLT group, although the social function (FS) domain exhibited a smaller increase than the other domains (Table 5). In addition, the pre-surgical scores of the control group were seen to increase post-surgically for all the domains except general health (KU) and social function (FS). The Wilcoxon test comparing pre and post-surgical values showed statistically significant differences for the pain (RN), general health (KU), vitality (V), and emotional role (PE) domains in the LLLT group and the vitality (V) and mental health (KM) domains in the control group.

Table 5. Effect of LLLT on the Patient’s Post-operative Quality of Life, Measured Using the 8 Domains of SF-36

| Variable                      | LLLT Post (Mean) | Control Post (Mean) | p value |
|-------------------------------|------------------|---------------------|---------|
| Physical Function (FF)        | 100.00           | 100.00              | 1.000   |
| Physical Role (PF)            | 92.86            | 83.33               | 0.030   |
| Pain (RN)                     | 95.90            | 67.00               | 0.000   |
| General Health (KU)           | 71.86            | 63.52               | 0.006   |
| Vitality (V)                  | 71.43            | 69.52               | 0.591   |
| Social Function domain (FS)   | 79.76            | 81.55               | 0.948   |
| Emotional Role (PE)           | 96.83            | 85.72               | 0.055   |
| Mental Health (KM)            | 73.90            | 74.10               | 0.575   |

The Mann Whitney test, used to make inter-group comparisons, showed no significant differences in the pre-surgical values of all domains, while the post-surgical values of the physical role (PF), pain (RN) and general health (KU) domains were seen to significantly differ between the groups (p ≤ 0.05).

3.4. Effect of LLLT on the Quality of Life of Patients by SF-36 Components

Both groups exhibited an increase in the pre- and post-surgical values of the physical component (KF) as well as the mental component (KM). Figure 1 shows that the LLLT group exhibited a considerable increase in the KF & KM points compared to the control group. However, the Wilcoxon test comparing pre- and post-surgical values showed a statistically significant difference for KF in the LLLT group only, and no significant differences in KF or KM in the control group. In the pre-therapy KF and KM significance test, there was no significant difference between the two groups, but in post-therapy both groups with independent T-test showed significant difference in KF with value (p ≤ 0.05) and did not differ significantly on inter-group KM (p ≥ 0.05).

Figure 1. Inter-Group Comparison of the Effects of LLLT on the Quality of Life of Patients by SF-36 Components
4. Discussion

4.1. Patient demographics

The majority of the study sample were female, and this difference by gender was statistically significant (p = 0.03). This was in accordance with the results of previous studies by Soeprapto A (2011), who reported that 57.7% of their study sample were women and 42.3% were men, and Hashemipour (2013), who reported a male: female ratio of 1: 1.7 and stated that the difference was statistically significant (p = 0.031). Although some studies suggested that this difference could be attributed to the lower pain threshold in women, others contradicted this. The current study found no significant differences in the prevalence of pain and trismus between men and women [8,9].

No significant differences in age were observed between the LLLT and control groups. The mean age observed in this study was 26.21 ± 3.332 years. Soeprapto (2011) reported that 33.1% of their study sample were aged between 19–24 years, and 29.6% were aged 25–30 years [6,8].

This study only included patients <30 years of age as the prevalence of hardened bone changes increases after 35 years of age. This, in turn, complicates surgical interventions and increases bone separation as well as post-operative pain, swelling and duration of trismus [10].

Approximately 57.1% of the sample in the current study exhibited lower third molar impaction on the right side of the mandible, while 42.9% exhibited it on the left side of the mandible. This was in agreement with Soeprapto who reported that 50.4% of their study sample required dental surgeries for impactions in the right mandible. In addition, other studies have reported that the prevalence of impactions involving the right mandible (50.22%) was higher compared to those involving the left mandible (49.78%), and Feinmann (1995) suggested that this difference could be explained by the fact that the lower third molars were the last teeth to erupt [8-11].

The most frequent class of impaction observed in this study was mesioangular IIA (40.5%), and this was in agreement with Hashemipour (2013) who reported that 38.9% of their sample exhibited class IIA impaction and this difference with the remaining molar impaction classes was statistically significant. Quek (2003) reported a prevalence of 43.3% for class IIA impactions, while 51.4% of the sample in Soeprapto’s (2011) study also exhibited mesioangular impaction. Another study reported that 43% of their sample with position A of 54,55%. The pattern of growth in the lower third molar growth is similar to that of the lower jaw itself, with the dental angulation moving from horizontal to mesioangular in the vertical direction [7-9-11].

No significant differences in the duration of surgery (>30 mins vs <30 mins) were observed, with the majority (approximately 57.1%) of the patients exhibiting durations > 30 minutes in contrast, Bello (2011) reported that the mean duration of operation in their study was 22.63 ± 7.4 minutes (range: 11–35 minutes). In this study the researchers did not describe the actual duration when the operation is done, because during operator only estimates the time spent during the odontectomy. The duration of trauma to the tissues, will increase the expenditure of inflammatory mediators and will illustrate the severity of pain, swelling and trismus. Gracia et al. (1997) stated that there was a correlation between the duration of surgery and the use of 24-hour post-operative analgesia. The variability in the duration of surgery is also said to be influenced by the operators' skills [10].

4.2. Effect of LLLT on Post-operative Pain

The results of this study showed that the LLLT group exhibited a significant decrease in pain and trismus levels on post-operative days 3 and 7 compared to the control group (p ≤ 0.05). No significant differences were observed on day 0 as the VAS measurements were made prior to administration of therapy. Ferrante (2012) reported that treatment using a 980 nm diode lasers at 300 mW and 54J resulted in a decrease in the VAS values of pain, although this difference between the laser treatment and control groups was not statistically significant on days 1 to 3. In agreement with the study conducted by Bello (2011), a significant difference of pain decrease at day 3 and 4 after surgery (p ≤ 0.05). The use of Soft Laser did not provide significant differences between the two groups in the Taube & Clokie study. In
contrast, Neckel’s (2001) study reported significant differences (p ≤ 0.05) in pain reduction between the
intraoral laser (11J/cm² laser diode, 810nm) and control groups. Amarillas (2011) reported a significant
difference in the level of pain between post-operative days 2 and 7 in the LLLT group (810nm, power:
100 mW, dose: 4J/cm²) (p ≤ 0.05). Petersen et al (2012), in their systematic review of 9 studies
comparing the levels of pain between 2 groups, found that only 1 study reported differences in pain
reduction on day 2 between the intervention and control groups. Although clinically reducing pain, but
not statistically significant. Petersen (2012) also stated that a key limitation of their systematic review
was the bias associated with variability in laser wavelengths, power, dosage, and designs used by the
various studies [2,10].

4.3. Effect of LLLT on Post-operative Trismus
Compared to the control group, the intervention group of this study exhibited a greater reduction of
trismus on days 3 and 7, and this difference was statistically significant. However, no such difference
was observed on day 0 as the trismus measurement was carried out prior to administration of treatment.
Ferrante (2012) reported that 980 nm diode lasers used at 300 Mw AND 54J resulted in a significant
difference in trismus reduction on post-operative days 2 and 7 (p ≤ 0.05). In contrast to Amarillas (2011),
no significant difference (p ≥ 0.05) in trismus reduction was observed between days 2 and 7 in the LLLT
group (810nm, power: 100 mW, dose: 4J/cm²). Similarly, Emshoff et al (2008) also reported no
significant difference in reduction of pain and trismus in the temporomandibular joint between the LLLT
(laser 632.8nm, 30 mW, 1,5J/cm², 3x/week) and control groups. The findings of the present study were
in accordance with Todorovic (2006) who reported differences in post-operative pain between the LLLT
and control groups. De Abreu et al (2005) state there was a difference in lowering trismus in the group
using the GaAlAs 780nm Laser [2-5-12].

The severity of pain, swelling and trismus are major indicators of patient discomfort following molar
impaction surgery. However, no objective measurement of swelling in the buccal area was carried out
in the current study. Bello (2011) and Bruce (1980) previously reported that the prevalence of trismus
increased with age, particularly after 35 years [10]. However, no formal correlation test was done in this
study. Post-surgical pain is said to be related to various mechanical, thermal and chemical factors that
are specifically conveyed by the nerve fibres C and Aδ as nociceptors [10,13]. The theory of modalities
suggests that the analgesic effect of LLLT occurs via biostimulation, which stabilises the double lipid
layer and the neural membrane cell [2,14]. A second theory, developed based on in vivo and in vitro
findings, suggests that laser therapy of the temporomandibular area may inhibit cyclooxygenase-2
(COX-2), which results in a decrease in the levels of prostaglandin E2 (PGE2) in soft tissue cultures.
Thus the administration of LLLT itself in its function as a biostimulator can repair cells or tissues that
are disturbed will regenerate again, so the effect of analgesia become very effective [10,13]. The findings
of this study showed that LLLT significantly reduced pain and trismus repair, although these effects
may be affected by the patient’s age and pain threshold levels [1,10,12,13].

A systematic review (2006) found a strong evidence that LLLT as a local anti-inflammatory,
microcirculation and angiogenesis effect, possibly modulated inflammatory markers, and also
increasing growth factors and collateral vessels. Modulation of LLLT allows resolution of the
inflammatory process that occurs in case of acute pain [1,2-14]. The systematic review also reported a
strong correlation (r > 0.8) between pain and trismus, although no such correlation test was carried out
in the current study.

4.4. Effect of LLLT on Post-operative Quality of Life of Patients
The results of this study showed that the QOL of the patients significantly improved upon administration
of LLLT, as the changes in the pain (RN), general health (KU), vitality (V) and emotional role (PE)
domains show. This was in agreement with Tjakkes et al. (2010) who stated that acute
temporomandibular pain was associated with disturbances in the pain (RN), general health (KU) and
vitality (V) domains, but not with the emotional role (PE) domain [7].
Although the control group of the current study showed no improvement in the physical domain of QOL, a significant improvement in the mental health (KM) domain was observed. Tjakkes et al. (2010) reported that the patient’s psychological status could be affected by pain, while another review by Okeson (2005) said that in the acute pain state, nociception pain that appears will affect the patient's physical, then psychosocial factors begin to emerge as compensation for pain effects occur at the end of the acute process [7].

The persistence of pain and trismus prevented improvement of the QOL of the patients in the control group. Tjakkes et al. (2011) stated that there was a significant association between the pain (RN) domain and the duration of pain as perceived by the patient experiencing interference of daily activities [7].

Inter-group comparison showed significant differences in the physical role (PF), pain (RN) and general health (KU) domains between the two groups post-surgically. Chopra (2008) reported that, due to persistence of some of the symptoms and limitation of activities as well the confidence to perform them, the improvement of the QOL of patients would occur slowly in the first week [15]. This, in turn, would affect the physical role (PF) domain by decreasing the willingness to perform activities, and also the general health (KU) domain. While overall improvements in the QOL based on physical components in the LLLT group, but not different in mental components. Matulessy (2010) said that patients with chronic pain and musculoskeletal disorders have a declining QOL, especially on the physical component than the mental component [7].

Petrucci et al. (2011) emphasised the importance of evaluating physical and emotional functions in addition to assessing pain and mobility of the temporomandibular itself [7,12]. The presence of pain and trismus in patients who did not receive LLLT may affect their domain of mental health (KM). Tjakkes et al. stated that chronic pain typically caused disturbances in the physical function (FF), physical role (PF) and social function (FS) domains, while Turner (2001) stated that the patient’s psychological function was solely related to their beliefs and strategies to overcome their physical limitations [7].

The significant differences observed in the physical components suggest that the QOL was significantly improved in patients that received LLLT compared to those that did not. The administration of LLLT can aid recovery and allow the patient to return to his or her daily activities as soon as possible. Unlike the Oral Health Impact Profile 14 (OHIP-14), which can assess impairments in eating and speaking activities, the SF-36 does not specifically assess individual disorders. However, it is commonly used to assess the QOL of patients suffering from both acute and chronic conditions [16].

5. Conclusion

The results of this study showed that LLLT (905 nm 18J/cm2 osis, 100 mW power) therapy can decrease post-operative pain and reduce trismus from day 3 in patients that have undergone surgical treatment of impacted lower third molars. Additionally, the symptoms are seen to disappear by post-operative day 7, and the patient’s QOL exhibits improvement.

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