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COMPARISON OF DIODE LASER VERSUS CONVENTIONAL SCALPEL INCISION IN REMOVAL OF IMPACTED LOWER THIRD MOLAR IN DIABETIC PATIENTS (A SPLIT MOUTH RANDOMIZED CONTROLLED CLINICAL TRIAL)

Hussein B. Zeidan[1]* *BDS,* Nevein S. Mohamed[2] *PhD,* Dina M. Nader[3]*PhD*

ABSTRACT

BACKGROUND: One of the most common minor surgeries in dental practices is the surgical removal of impacted third molars; a procedure that requires optimum physical and radiological assessment to decrease the complications that may arise during the procedure. Certain surgical modalities have been proposed to decrease the invasiveness of the procedure, one is the diode laser therapeutic use.

OBJECTIVES: To clinically compare the wound healing rate and the clinical outcome that occurs following the surgical removal of impacted third molar teeth by the conventional gold standard scalpel versus the diode laser incision in diabetic patients.

MATERIALS AND METHODS: The study was a split-mouth randomized clinical trial. Twenty-three diabetic patients who needed bilateral surgical removal of impacted mandibular third molar were recruited and randomized. One side (study group) had the incision undergone by the diode laser, while the contralateral side (control group) had the conventional scalpel incision to expose the tooth. Pain was recorded by Visual analogue scale (VAS) after one and seven days, edema was measured by three facial lines after one and seven days, trismus was recorded by measuring the inter-incisal opening after seven days and one month and the wound healing was recorded by the Early wound healing scale (EHS) after seven days and one month postoperative.

RESULTS: The clinical outcome showed statistically significant differences in pain, edema, and trismus in the study group, while the control group showed statistically significant differences in wound healing in the early postoperative period, however, a non-significant difference was noted between both groups after one-month follow-up.

CONCLUSION: Diode laser incision was an efficient procedure in decreasing the post-operative pain, trismus and edema following removal of impacted third molars. The only disadvantage was delayed wound healing in the first week.

KEYWORDS: Conventional scalpel, Diode laser, Diabetes, Impaction.

RUNNING TITLE: Surgical extraction using Diode laser in diabetic patients.

1 BDS, 2019, Faculty of Dentistry, Alexandria University, Alexandria, Egypt
2 Professor of Oral and Maxillofacial Surgery, Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University, Alexandria, Egypt
3 Lecturer in Oral and Maxillofacial Surgery, Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University, Alexandria, Egypt

** Corresponding Author:*
E-mail: *hzeidan96@gmail.com*

INTRODUCTION

The third molar teeth impaction is regarded as a frequent condition that may occur owing to the absence of space within the dental arch (1). Patients can be asymptomatic, or experience pain and showing signs of pericoronitis, root resorption of the neighboring tooth, lymphadenopathy, trismus, caries, or having associated cysts or tumors related to the concerned impacted tooth (2). Numerous factors may influence the decision-making of wisdom tooth removal. For instance, the impacted tooth removal may be intended to obtain prophylaxis or asymptomatic or non-pathological cases, even in unjustifiable conditions (3).

The surgical removal of impacted wisdom teeth may be accompanied by post-operative pain, infection, trismus and swelling, alveolar osteitis (dry socket) (4, 5) and nerve damaging (6). For this, surgeons often aim to perform less invasive surgeries in order to decrease the post-operative complications and the overall experience for patients (7).

The conventional surgical protocol has been the used gold standard for removing impacted wisdom teeth. This was achieved via an invasive incision and to raise a soft-tissue mucoperiosteal flap for accessing the wisdom tooth and removing it (8). The optimum flap design shall provide adequate space for the intervention without causing trauma to

the oral tissues or the adjacent teeth. Also, its handling is associated with the surgical outcomes parameters including pain, trismus, and/or bleeding, as well as the periodontal health of the mandibular 2nd molar (9).

Laser therapy has been shown to be one of the effective treatment modalities in the field of dentistry (10). Its application includes soft tissues healing, removal of gingival hyperplasia, operculectomy and/ or uncovering impacted wisdom teeth, photodynamic therapy of cancer cells, and photo-stimulation of herpetic lesion (11). The main advantages of the laser application are the lack of tissue contact and the high temperature during the tissue interaction time, all reduce the chances of wound infection, postoperative pain, bleeding, and tissue scarring during healing (12). The late mentioned advantages are crucial points to consider in patients who are prone to wound infections, and bleeding, for example, diabetic patients.

Globally, Diabetes Mellitus (DM) is regarded as a common health issue that has a substantial impact on morbidity and mortality. Actually it comprises worldwide economic burden (13). DM is a chronic disorder occurs as carbohydrate metabolism caused by failure in response to insulin or insulin deficiency which leads to elevated blood levels of glucose (13). DM is classified into Type 1, Type II and gestational type. Type 1 DM or the juvenile diabetes which the individual doesn't secrete insulin (14). While, Type II DM (the most abundant), is defined as insulin resistant diabetes (15) It is often caused by the insulin secretion deficiency within the pancreatic β-cells or the insulin sensitive cells that are unresponsive to insulin, lastly, the gestational-type DM that may develop during pregnancy (16).

Worldwide, Egypt is ranking 9th in the prevalence of DM in accordance to the International Diabetes Federation (IDF) (17). As reported by Abouzid et al. (2020), Egypt has a prevalence of 15.2%, though there is a high number of undiagnosed individuals that are suspected for diabetes or pre-diabetes (17).

Diabetic patients are usually at greater risk of infection and an impaired healing potential following any surgical operations (18). This is why the least invasive approaches are always appointed for them in view of the inflammatory responses.

Therefore, this split mouth randomized clinical trial was conducted for comparison of the clinical outcomes, and post-operative signs that may occur after usage of the diode laser incision and the clinical outcomes of traditional scalpel in the surgical removal of impacted mandibular wisdom tooth in diabetic patients.

Our tested null hypothesis was that there wouldn't be significant differences in the clinical outcomes of the laser approach when compared to the conventional surgical approach in the surgical removal of mandibular impacted wisdom tooth in diabetic patients.

MATERIALS AND METHODS

This study is a split-mouth randomized controlled clinical trial with a 1:1 allocation ratio. Twenty-three Participants were recruited from the Outpatient Clinic of Alexandria University Teaching Hospital and operated in the Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University. Research had been approved by the ethics committee at Faculty of Dentistry, Alexandria University. Approval number: 0507-10/2022 -16/10/2022.

Materials (Figure 1)

1. EpicTM X Biolase diode laser (Biolase Epic 10, 4 Cromwell Irvine, California, USA).
2. Disposable Biolase laser surgical tips.

Sample size estimation

The sample size was calculated to detect the difference in incidence of postoperative complications of diode laser versus conventional scalpel incision in the surgical removal of impacted third molar. Based on Katariya et al. (19) results, a minimal total hypothesized sample size of 21 eligible diabetic patients of both sex; who complain from impacted mandibular third molars a split-mouth study design is needed to compare the incidence of postoperative complications of diode laser versus conventional scalpel incision in the surgical removal of impacted third molar; taking into consideration 95% confidence level, effect size of 0.683 and 80% power using Chi Square-test.(20,21) After adjustment for a dropout rate of 10%, the sample size was increased to 23 teeth per group (number of groups=2) (Total sample size=46 teeth in 23 patients).

Eligibility criteria

The criteria for including patients were as follow:

Inclusion criteria

- Patients having bilateral class I impacted wisdom teeth in accordance to Pell and Gregory's classification.
- Adult patients from 21-40 years old with no gender predilection.
- Controlled diabetic patients with glycosylated hemoglobin (HbA_{1C}) levels less than 7%.
- Absence of diabetic microvascular difficulties (retinopathy, neuropathy and nephropathy).

Exclusion criteria

- Patients having systemic conditions which could alter the healing potential; examples are uncontrolled Diabetes Mellitus, metabolic bone disorders, autoimmune diseases, or Bisphosphonate therapy (22).
- Associated cyst, or tumor at the area of interest.
- Pre-existing Temporo-mandibular joint problems.
- Smokers consuming > 20 cigarettes/day, or who use > 14 mg/day of nicotine substituting treatment (23).

Pre-operative procedure

- Proper history taking was made for each patient and they were evaluated by the results obtained from lab investigations, for instance, of Glycosylated hemoglobin (HB1AC) that is ranging from 5.7 - 7%.
- Clinical examination to determine the presence or absence of suppuration, discharge or swelling, the gingival biotype, occlusion, and inter-arch space.
- Preoperative radiographic examination: A two-dimensional Panoramic Dental X-ray was taken to determine the classification of the tooth involved.
- All patients received local anesthesia, using (Articaine HCL 4% with vasoconstrictors (1:200.000)).

Operative procedure

1. A standardized 2 lines- flap was done for all patients in both groups by the same surgeon to unify the technique and expose the impacted molar.
2. Group A (study group) patients wore protective diode laser eye goggles. Highly reflective instruments were avoided during laser use as they might reflect the laser beam. Laser incisions were done by means of a diode laser: the excision mode is in contact mode and powered at 2 W (Biolase Epic 10, 4 Cromwell Irvine, California, USA). In continuous mode, the diode laser was emitted and operated in a contact process by a flexible fiber-optic handpiece having initiated tip. The power output at the end of the fiber was adjusted with the power increasing or power decreasing touchpad until measuring from 1.2-to-2W. Then, the diode fiber-optic tip was pointed for the tissues' incision. (Figure 2)
3. Group B (control group) got the conventional full-thickness mucoperiosteal flap reflected by a surgical incision using a Bard-Parker scalpel blade no.15, followed for both by the use of a mucoperiosteal elevator to expose the bone surface. (Figure 3)
4. Bone removal was performed using the guttering technique for both groups to create a point of entry for the straight elevators to elevate the impacted tooth.
5. Tooth sectioning was performed using surgical burs in both groups.
6. Bone shaving was achieved by a bone file and wound irrigation by saline.
7. Wound closure was done using 3-0 silk sutures for both groups.

Early postoperative care

Comprehensive oral hygiene instructions were offered to the patients along with post-operative guidelines as follows:

- Avoid mouthwash for 24 hours after surgery.
- Application of cold fomentation for 24 hours with 2 minutes intervals per hour.
- Soft, high protein, caloric diet, and fluids for 2 weeks postoperatively.

Postoperative medication

- Amoxicillin 875mg + Clavulanic acid 125mg every 12 hours for 7 days (Augmentin: GalaxoSmithKline, UK: https://reference.medscape.com/drug/augmentin-amoxicillin-clavulanate-342474).
- Non-Steroidal Anti-Inflammatory drugs (Cataflam: Diclofenac potassium 50mg: Novartis. Switzerland: https://www.rxlist.com/cataflam-drug.htm) every 8 hrs for 4 days.
- Chymotrypsin +Trypsin 300 E.A.U (Alphintern: Chemotrypsin 300 E.A.U (14microkatals) +Trypsin 300 E.A.U (5microkatals): Amoun Pharmaceutical Co. S.A.E: https://www.amoun.com/leap-portfolio-project/alphintern/) every 8 hours for 5 days.
- Gentle use of a Mouth wash (0.12% chlorhexidine) daily for one week after the first 24 hours.
- Sutures will be removed one-week post-surgery for both groups.

Follow-up phase

Clinical Parameters

In this stage, a thorough clinical follow-up was performed after 24 hrs, 1 week, and 4 weeks, for assessing pain, edema trismus, and the healing process of the wound.

Postoperative pain: Was recorded for each patient after 1,7 days postoperatively through a 10-point Visual Analogue Scale (VAS) from 0 to 10. (0-1= None, 2-4= Mild, 5-7= Moderate, 8-10= Severe) (24).

Postoperative edema: The face edema in patients were evaluated via 3 lines by using 2 instruments holding a black thread for measuring the following three distances (25):

a) The distance from the lateral corner of the eye to the angle of the mandible.
b) The distance from the tragus to the outer corner of the mouth.
c) The distance from the tragus to the pogonion.

These measurements were taken pre-operative and compared for one day and seven days post-operative follow-up.

Postoperative trismus: Was measured by maximum inter-incisal opening MIO, which is ideally set to 35 mms described by Dijkstra et al (26) and Scott et al (27).

The measurements were taken pre-operatively, 7 days and one month after.

Postoperative wound healing: Was measured after 7 days and 1 month by using Early Wound Healing Score system (EHS) described, by Wachtel et al. (28), which aims to estimate the early healing by the primary intention of surgical incisions in periodontal soft tissues. The score was given by determining the clinical signs of re-epithelialization

(CSR), clinical signs of hemostasis (CSH), and clinical signs of inflammation (CSI). A score of (10) is ideal, while a score of (0) denotes suppuration.

- The CSR points are, Score of (0) means visible distance between incision margins, while (3) is given in-case of incision margins in contact, and (6) points when incision margins are merged.
- CSH: 0 points is given when bleeding is at the incision margins; 1 point, in the presence of fibrin at the incision margins; finally, 2 points in the absence of fibrin on the incision margins.
- CSI: 0 points denotes redness involving >50% of the incision length and/or pronounced swelling; 1 point for redness involving <50% of the incision length; 2 points for the absence of redness along the incision length.

Statistical analysis

The statistical analyzing of the obtained data

- Data was computerized by means of IBM SPSS software package (version 25.0.) (Armonk, NY: IBM Corp). Kolmogorov-Smirnov test for normality showed statistical significance in the of most variables' distribution. Hence, non-parametric statistics were employed. Data description included using maximum, median, and minimum. An alpha level was set to 5% with a significant level of 95%. The statistical significance was verified at *p-value* <.05.

Used tests were:

1. The Mann-Whitney U test was used to compare two independently examined, non-normally distributed subgroups.
2. The Wilcoxon Signed Ranks test was used to compare two studied related not-normally distributed subgroups.
3. Friedman's test (an "alternative to the one-way ANOVA with repeated measures") was used to compare the repetitive measures".
4. Post-hoc pair-wise comparisons were carried out as the Friedman test was significant by the Dunn-Sidak test for multiple comparisons.
5. The Bonferroni correction for multiple tests for adjusting the significance of values.

RESULTS

Pain, trismus, edema, and wound healing

On the 1st and 7th day post-operatively, Pain was monitored using the visual analog scale (VAS).

In day one postoperatively, the Diode Laser group, VAS ranged from 2.00-to-5.00 with a median of 3.00, while in the Scalpel group, VAS ranged from 3.00-to-7.00 with a median of 3.00.

VAS showed statistically significant higher records in the Scalpel group in comparison to the Diode Laser group day one postoperatively ($p< 0.001$) (Table 1, Figure 4).

At 7 days postoperatively, the Diode Laser group, VAS ranged from 0.00-to-4.00 with a median of 2.00. While in the Scalpel group, VAS ranged from 0.00-to-5.00 with a median of 3.00.

VAS showed statistically significant higher records in the Scalpel group in comparison to the Diode Laser group 7 days postoperatively (p= 0.029) (Table 1, Figure 4).

Maximum inter-incisal opening was monitored after 7 days and 1month post-operative by a boley gauge caliper.

In seven days postoperative the Diode Laser group, maximum inter-incisal opening MIO ranged from 24.00-to-38.00 mm with a median of 30.00 mm, while in the Scalpel group, maximum inter-incisal opening MIO ranged from 20.00-to-33.00 mm with a median of 27.00 mm.

Maximum inter-incisal opening MIO showed statistically significant higher records in the Diode Laser group in comparison to the Scalpel group Seven days postoperatively (p=.001) (Table 2, Figure 5).

In one month postoperative the Diode Laser group, maximum inter-incisal opening MIO ranged from 30.00 to 46.00 (mm) with a median of 36.00 (mm). While in the Scalpel group, the maximum inter-incisal opening (MIO) ranged from 30.00-to-44.00 mm with a median of 36.00 mm.

The MIO had non-significant differences between the 2 studied groups one month preoperatively (p= 0.965) (Table 2, Figure 5).

In day one post-operatively, the Diode Laser group had the distance from the tragus to the outer corner of the mouth 9.00-to-10.50 cm with a median of 10.00 cm, while in the Scalpel group, it ranged from 9.40-to-11.50 cm with a median of 10.50 cm.

The distance from the tragus to the outer corner of the mouth showed statistically significant higher records the Scalpel group in comparison to the Diode Laser group day one postoperatively (p<.001).

In 7 days postoperatively, the Diode Laser group had the distance from tragus to the outer corner of the mouth to range from 8.50-to-10.50 cm with a median of 9.00 cm meanwhile, in the Scalpel group, it ranged from 8.50-to-10.30 cm with a median of 9.30 cm.

Distance from the tragus to the outer corner of the mouth had non-significant differences between the 2 studied groups on the 7th day preoperatively (p= 0.472).

In day one postoperative, the Diode Laser group, the distance from the tragus to the pogonion (cm) ranged from 12.00-to-14.50 cm with a median of 13.00 cm while, in the Scalpel group, it ranged from 12.50-to-15.00 cm with a median of 13.50 cm.

Distance from the tragus to the pogonion (cm) had no statistically significant differences between the 2 studied groups at day one postoperatively (p= 0.055).

In seven days postoperatively, the Diode Laser group had distance from the tragus to the pogonion (cm) to range from 12.00-to-14.00 cm with a median of 12.70 cm, while In the Scalpel group, it ranged from 12.00-to-14.00 cm with a median of 12.70 cm.

The distance from the tragus to the pogonion (cm) had non-significant difference between the two

studied groups on the seventh day preoperatively (p= 0.859).

In day one postoperatively, the Diode Laser group had the distance from lateral corner of the eye to the angle of the mandible range from 9.40-to-11.00 cm with a median of 10.00 cm. While in the Scalpel group, it ranged from 9.50-to-12.50 cm with a median of 10.50 cm.

Distance from the lateral corner of the eye to the angle of the mandible was statistically significantly higher in the Scalpel group compared to the Diode Laser group one day postoperatively (p= 0.002).

In seven days postoperatively, the Diode Laser group had the distance from lateral corner of the eye to the angle of the mandible to range from 9.00-to-10.50 cm with a median of 9.50 cm. While, within the Scalpel group, the distance from lateral corner of the eye to the angle of the mandible ranged from 9.00-to-10.50 cm with a median of 9.50 cm.

Distance from lateral corner of the eye to the angle of the mandible had non-significant differences between the 2 studied groups on the 7th day preoperatively (p= 0.673).

In Seven days postoperative the Diode Laser group, the EHS ranged from 1.00 to 4.00 with a median of 2.00. While in the Scalpel group, the EHS ranged from 2.00 to 5.00 with a median of 3.00.

The Early Wound Healing Score system was statistically significantly higher within the Scalpel group in comparison to the Diode Laser group 7 days postoperatively (p<.001) (Table 3, Figure 6).

In one month postoperative the Diode Laser group, EHS ranged from 6.00 to 9.00 with a median of 7.00. While in the Scalpel group, EHS ranged from 6.00 to 9.00, with a median of 8.00.

The EHS has non-significant differences between the 2 studied groups one month postoperatively (p= 0.185) (Table 3, Figure 6).

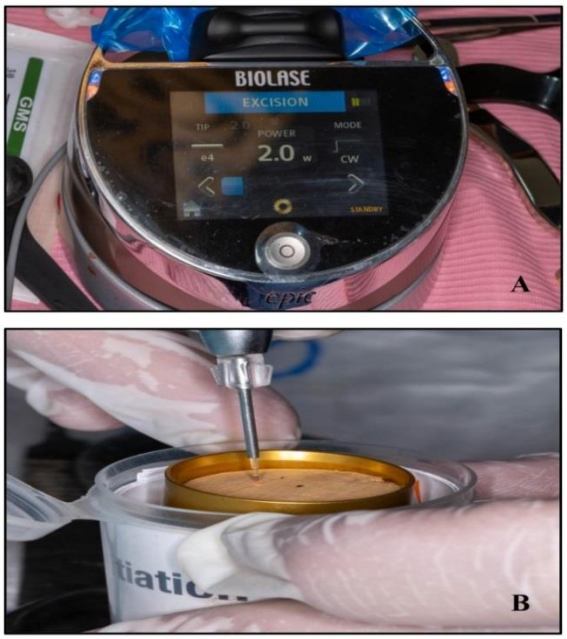

Figure (1): Materials (A) Biolase EpicX diode laser, (B) Biolase disposable laser Tip.

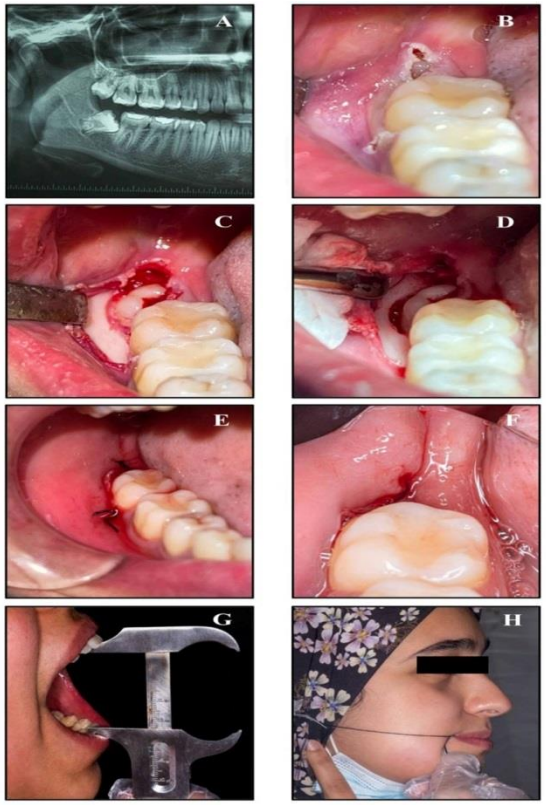

Figure (2): For the Study group A) Pre-operative panorama, B) laser incision, C) reflection of the mucoperiosteal flap, D) Bone guttering, E) suturing of the wound, F) seven days wound healing follow-up, G) seven days Trismus follow-up, H) one day edema follow up.

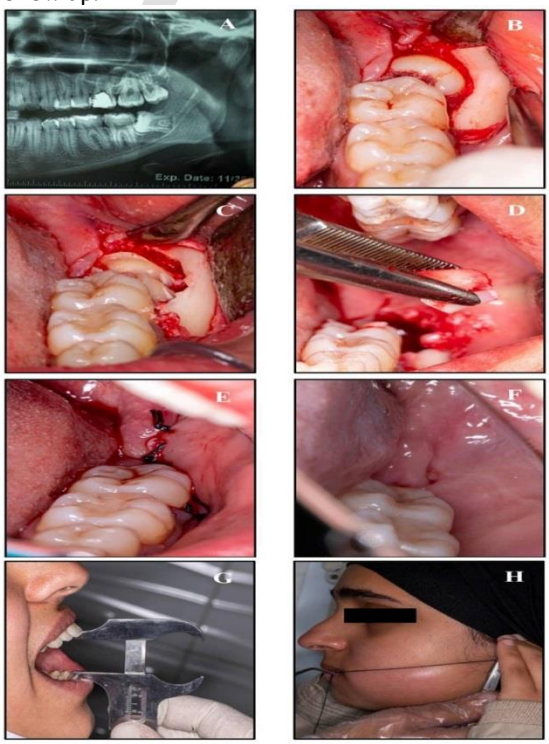

Figure (3): For the control group: A) Pre-operative panorama, B) reflection of the mucoperiosteal flap, C) Bone guttering, D) extraction of the third molar, E) suturing of the wound, F) seven days wound healing

follow-up, G) seven days Trismus follow-up, H) one day edema follow up.

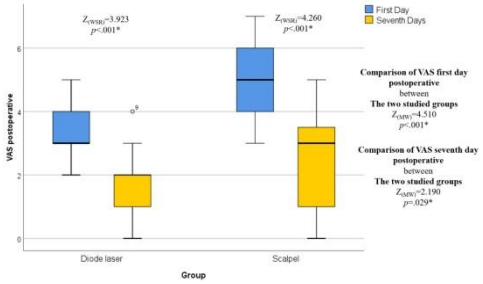

Figure (4): Comparing the difference between the two groups regarding the pain decrease after one and seven days.

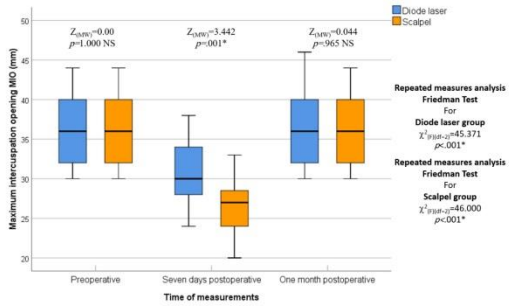

Figure (5): Comparing the difference between the two groups regarding the maximum interincisal opening after seven days and one month.

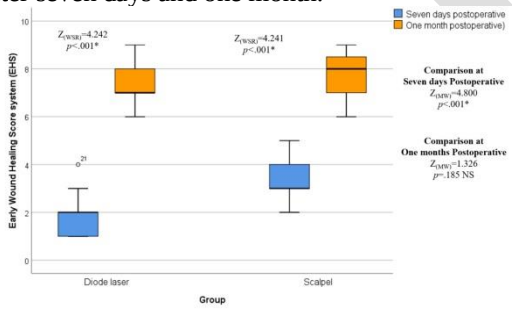

Figure (6): Comparing the difference between the two groups regarding the early wound healing after seven days and one month.

Table (1): Comparison of VAS in the two studied groups one day and seven days postoperatively

VAS postoperative	Groups		Test of significance *p*-value
	Diode laser (n=23)	Scalpel (n=23)	
One day postoperative - Min-Max - Median	2.00-5.00 3.00	3.00-7.00 5.00	$Z_{(MW)}$=4.510 *p*<.001*
Seven days postoperative - Min-Max - Median	0.00-4.00 2.00	0.00-5.00 3.00	$Z_{(MW)}$=2.190 *p*=.029*
Test of significance *p*-value	$Z_{(WSR)}$=3.923 *p*<.001*	$Z_{(WSR)}$=4.260 *p*<.001*	

n: Number of patients
Min-Max: Minimum – Maximum
MW: Mann-Whitney U
WSR: Wilcoxon Signed Ranks Test
* : Statistically significant (*p*<0.05)
NS: Statistically not significant (*p*≥0.05)

Table (2): Comparison of the maximum inter-incisal opening MIO (mm) at different times of measurements in the two studied groups

The maximum inter-incisal opening MIO (mm)	Groups		Test of significance *p*-value
	Diode laser (n=23)	Scalpel (n=23)	
Preoperative - Min-Max - Median	30.00-44.00 36.00	30.00-44.00 36.00	$Z_{(MW)}$=0.00 *p*=1.000 NS
Seven days postoperative - Min-Max - Median	24.00-38.00 30.00	20.00-33.00 27.00	$Z_{(MW)}$=3.442 *p*=.001*
One month postoperative - Min-Max - Median	30.00-46.00 36.00	30.00-44.00 36.00	$Z_{(MW)}$=0.044 *p*=.965 NS
Friedman Test *p*-value	$c^2_{(F)(df=2)}$=45.371 *p*<.001*	$c^2_{(F)(df=2)}$=46.000 *p*<.001*	

n: Number of patients
Min-Max: Minimum – Maximum
MW: Mann-Whitney U
WSR: Wilcoxon Signed Ranks Test
* : Statistically significant (*p*<0.05)

NS: Statistically not significant (*p*≥0.05)

Table (3): Comparison of The Early Wound Healing Score system (EHS) at different times of measurement in the two studied groups

The Early Wound Healing Score System (EHS)	Groups		Test of significance *p*-value
	Diode laser (n=23)	Scalpel (n=23)	
Seven days postoperative - Min-Max - Median	1.00-4.00 2.00	2.00-5.00 3.00	$Z_{(MW)}$=4.800 *p*<.001*
One month postoperative - Min-Max - Median	6.00-9.00 7.00	6.00-9.00 8.00	$Z_{(MW)}$=1.326 *p*=.185 NS
Test of significance *p*-value	$Z_{(WSR)}$=4.242 *p*<.001*	$Z_{(WSR)}$=4.241 *p*<.001*	

n: Number of patients
Min-Max: Minimum – Maximum
MW: Mann-Whitney U
WSR: Wilcoxon Signed Ranks Test
* : Statistically significant (*p*<0.05)
NS: Statistically not significant (*p*≥0.05)

DISCUSSION

The present study was conducted on 23 participants having a controlled diabetic condition (6 males, and 17 females). The ages of the patients ranged from 21 to 28 years, with a mean of 24. Having bilateral impaction of lower third molar teeth designated for

surgical extraction, chosen from admitted patients to the Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Alexandria University.

The current research's methodology takes these factors into consideration since the level of inflammation that arises can determine the post-operative pain and trismus that follows the surgery. Also, it is indicative for tissue trauma that may be caused by the surgical procedure. Individual dependent factors such as pain and edema are correlated with the reaction of the body to the tissue injury and the wound's type. However, different people may experience and perceive pain differently. When later factors are compared in various people, there is a chance of inaccuracy (19).

A split-mouth designed study has been employed in the current investigation and that allowed the subjects to be control. The degree of tissue trauma determines what degree of the inflammatory response will be. However, our current study only considered the impacted mandibular 3rd molar teeth which are bilaterally symmetrical, according to radiography.

The objective of our study was the comparison of the efficiency between two surgical approaches for exposing impacted teeth between the conventional scalpel incision and the diode laser incision. There should be as few intraoperative and postoperative complications as possible while performing the surgical technique.

Owing to their minor size, the fiber-optic delivery, and simplicity of usage for of oral soft tissues' minor surgery, the diode lasers have become popular in the field of dentistry. They come in a variety of wavelengths (810, 940, and 980nm). These lasers' energy specifically targets melanin and hemoglobin in soft tissue (29).

In each group, the following parameters were recorded: Pain, Trismus, Edema, and Wound healing.

The postoperative pain was examined by means of the Visual Analog scale (VAS) on the 1st and 7th day. Patients responses to questions about their level of pain were recorded on a ten-point VAS scoring system.

In the Scalpel group, the VAS was statistically significantly higher in comparison to Diode Laser group in day 1 and day 7 postoperatively.

With regard to pain results, the diode laser group, scores of pain were lower than the scalpel group. These findings were in line with research done by Soliman et al (30) which revealed a significant difference of the pain parameters between both groups: the laser and scalpel. Also, another study conducted by Amaral et al (31) who noticed considerable differences with diode laser surgery in the operational time and the analgesic usage parallel to the conventional scalpel surgery procedures.

Using the soft tissue diode laser had attracted considerable interest, as it triggers primary biostimulation of cell metabolism and microcirculation, together with the photochemical, photoelectrical, and photo energetic accentuation. Thus it has a direct effect on lymph and blood vessels, without any unfavorable effects from radiation (30).

Trismus is defined as difficulty in mouth opening, it is a common postoperative complication following third molar teeth surgery due to inflammation that surrounds the masseter muscle (19).

Trismus was recorded in our study by measuring the Maximum inter-incisal opening (MIO) in both groups by using a Boley gauge caliper.

Maximum inter-incisal opening showed statistically significant higher records in the group of Diode Laser in comparison to the Scalpel group in 7 days postoperatively. Meanwhile non-significant differences were observed after postoperative one month in comparison between both groups.

Our findings were in line with the work of Divya Bharathi et al (32) who observed significant outcomes that demonstrated the effect of the scalpel incision in post-operative mouth opening to the maximal level on 1st and 3rd days postoperatively in comparison with Laser incision.

They also found in their experimental study Twenty-four hours after an injury, that inflammatory response peaks and can extend for up to a week. There are fewer resident cytokines, fewer blood vessels, and fast local fibroblast growth at the wound bed throughout the early stages of both inflammation and curative (33).

In our study, the distance from the tragus to the mouth's outer corner was statistically significantly higher in the Scalpel group in comparison to the Diode Laser group one day postoperatively. While, no statistically significant difference found between the 2 studied groups on postoperative seven days.

Also, the distance from the tragus to the pogonion had non-significant difference between both studied groups one day and seven days postoperative.

The distance from the lateral corner of the eye to the angle of the mandible was statistically significantly higher in the Scalpel group compared to the Diode Laser group one day postoperatively, while had non-significant difference between the two studied groups on seven days postoperatively.

These results were consistent with the work made by Pirnate et al (34) who demonstrated that small lymphatic and blood vessels were sealed due to the formed heat by the diode laser, consequently, The laser had the ability to create 2 to 6 mm deep soft tissue incisions while eliminating both the hemorrhage and edema.

However, according to the conducted reports by Soliman et al (30), and Landucci et al (35), they observed that the procedure's duration, mucoperiosteal flap reflection, and incision are the main causes of edema.

Within each group, wound healing process was recorded by means of an EHS after 7 days and 1 month postoperatively.

In our study, the wound healing was statistically and significantly greater in the Scalpel group in comparison to the Diode Laser group postoperatively within 7 days. While, non-significant difference was found between the two studied groups in one month postoperatively.

This was in line with the work of D'Arcangelo et al (36) who discovered that the scalpel incision's healing was comparable to or even better than that of the laser incision owing to the thermal impairment produced by the laser. Also, this was consistent with the findings of Çayan et al (37) who observed that the healing process following surgery was significantly shorter in the scalpel group.

Our major outcomes can confirm that in comparison to the control group, the laser-assisted surgery led to significantly better alleviated levels of pain, edema, and trismus through the early postoperative period. Meanwhile, the control group showed better wound healing after seven days post-operative and an insignificant difference was observed between both groups after 1 month post-operatively.

CONCLUSION

Despite the present study's limitations, it can be concluded that the diode laser incision can reduce postoperative pain, edema, and trismus. The sole disadvantage was the delaying in the wound healing process within the first week.

CONFLICT OF INTEREST

The authors announce that they have no conflicts of interest.

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