Original Research

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Treatment of ankyloglossia with diode laser (810–980 nm): a clinical study

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Abstract

AIM. The main objective of the research is to demonstrate that diode laser surgery yields better outcomes than traditional scalpel surgery in lingual frenectomy and, thus, is a more beneficial treatment option.

MATERIALS AND METHODS. The short lingual frenum prevents the tongue tip from being pushed out of the lower incisors, hence creating speech and feeding challenges. Ankyloglossia is an inborn and congenital defect, also known as tongue-tie. The participants were divided into two cohorts distinguished by the type of operation method used: one group was operated on with a scalpel, and the other with a 1.5-watt diode laser (810–980 nm). The process of pain, bleeding, edema, and healing in 26 patients of different ages was observed and stratified according to Kotlow's classification (1999). Postoperative day one, postoperative day two, postoperative day three, postoperative day four, and one, two, three, and four weeks after the frenectomy were used as the follow-up evaluations. The patients who went through the laser-assisted frenectomy procedure had significantly lower levels of discomfort compared to their counterparts who underwent the traditional treatment in the first week of the postoperative period and the very first week of the procedure. The group with laser treatment showed statistically significant wound healing results during the first 24 hours. Other benefits of laser-assisted frenectomy included low bleeding volumes, thus the surgical field remained clear; sutures were removed; analgesic use was reduced; and recovery time was shorter.

RESULTS. The results showed that, in a numeric scale (0–100), all the respondents had preferred the use of the laser technique in case they were given another option. Also, the diode laser cohort had a significantly lower mean pain score (1.846 ± 0.6748) than the scalpel group (2.346 ± 0.4852) on day one ($p = 0.006$). This difference increased during the first four weeks. The conventional and laser cohorts improved oral function, but the latter achieved a greater improvement. The week two oral function of the laser group was 1.692 ± 0.4707, and the week four scalpel group was 2.269 ± 0.8744, with end-of-week two scores of 1.808 ± 0.6939. These tests provided corresponding p-values of 0.013 and 0.038, respectively.

CONCLUSIONS. Laser frenectomy is an option to the conventional use of a scalpel, which has better intra- and postoperative results.

Keywords: frenectomy, laser, diode, ankyloglossia

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Лечение анкилоглоссии диодным лазером (810–980 нм): клиническое исследование

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Резюме

ЦЕЛЬ. Основная цель исследования заключается в демонстрации того, что хирургия с использованием диодного лазера обеспечивает лучшие результаты по сравнению с традиционной скальпельной хирургией при проведении френэктомии языка и, следовательно, является более предпочтительным методом лечения.

МАТЕРИАЛЫ И МЕТОДЫ. Короткая уздечка языка препятствует выдвижению кончика языка за нижние резцы, что приводит к нарушениям речи и приема пищи. Анкилоглоссия – врожденный дефект, также известный как «язык, прикрепленный уздечкой». Участники были разделены на две группы в зависимости от метода операции: одна группа была прооперирована скальпелем, другая – диодным лазером мощно-

стью 1,5 Вт (810–980 нм). У 26 пациентах различных возрастов оценивались боль, кровоточивость, отек и процесс заживления, с распределением по классификации Lawrence Kotlow (1999). Наблюдение проводилось на 1-й, 2-й, 3-й и 4-й день после операции, а также через 1, 2, 3 и 4 недели после френэктомии. Пациенты, перенесшие лазерную френэктомию, имели значительно более низкий уровень дискомфорта по сравнению с пациентами традиционной группы в течение первой недели после операции. В группе лазерного лечения наблюдалось статистически значимое улучшение заживления в течение первых 24 часов. Дополнительные преимущества включали минимальную кровопотерю, сохранение чистого операционного поля, отсутствие необходимости наложения швов, снижение потребности в анальгетиках и более короткий период восстановления.
РЕЗУЛЬТАТЫ. Результаты показали, что по числовой шкале (0–100) все участники предпочли бы лазерную методику при наличии выбора. Также в группе диодного лазера наблюдался значительно более низкий средний показатель боли (1,846 ± 0,6748) по сравнению с группой скальпеля (2,346 ± 0,4852) на 1-й день (p = 0,006). Эта разница увеличивалась в течение первых четырех недель. Обе группы показали улучшение функции полости рта, однако в лазерной группе улучшение было более выраженным. Показатели функции полости рта на 2-й неделе в лазерной группе составили 1,692 ± 0,4707, а в скальпельной группе на 4-й неделе – 2,269 ± 0,8744, при показателях конца 2-й недели 1,808 ± 0,6939. Соответствующие значения p составили 0,013 и 0,038.
ВЫВОДЫ. Лазерная френэктомия является альтернативой традиционному использованию скальпеля и обеспечивает более благоприятные интра- и послеоперационные результаты.

Ключевые слова: френэктомия, лазер, диодный лазер, анкилоглоссия

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INTRODUCTION

Ankyloglossia, commonly known as tongue-tie, is a congenital condition where a child is born with a short or thick lingual frenulum, restricting the natural movement of the tongue. The lingual frenulum is a vertical fold of mucous membrane located beneath the tongue, connecting it to the floor of the mouth [1]. Ankyloglossia can cause several complications, including difficulties with infant feeding, speech disorders, and various mechanical and social challenges due to the tongue's limited ability to protrude [2]. To address these issues, lingual frenectomy is often recommended as treatment. For the aim of making decisions about diagnosis and treatment, several classification systems have been proposed in order to take into consideration the fact that the severity of ankyloglossia varies from person to person. The Kotlow classification (1999) [3], displayed in Fig. 1, is one of the most often used classification techniques that categorizes tongue-ties based on the length of time that the tongue is able to move freely without restriction [3; 4].

The most common surgical procedures used to treat ankyloglossia include frenotomy, frenectomy, and frenuloplasty (such as *Z*-plasty). These treatments can be performed with conventional tools such as scissors or a scalpel, as well as with electrocautery or laser techniques. Several types of lasers are available for managing ankyloglossia, but the choice of wavelength should be based on its optical affinity for hemoglobin and water. Among the options, diode lasers are frequently used in tongue frenulum surgeries [5].

The advantages of using a laser include a bloodless surgical field, the absence of post-operative infection or significant pain, and the elimination of the need for sutures. The aim of this study was to determine whether there are differences in patient-related outcomes – such as healing and discomfort – between laser and conventional surgical frenectomies during both the intraoperative and post-operative phases [6].

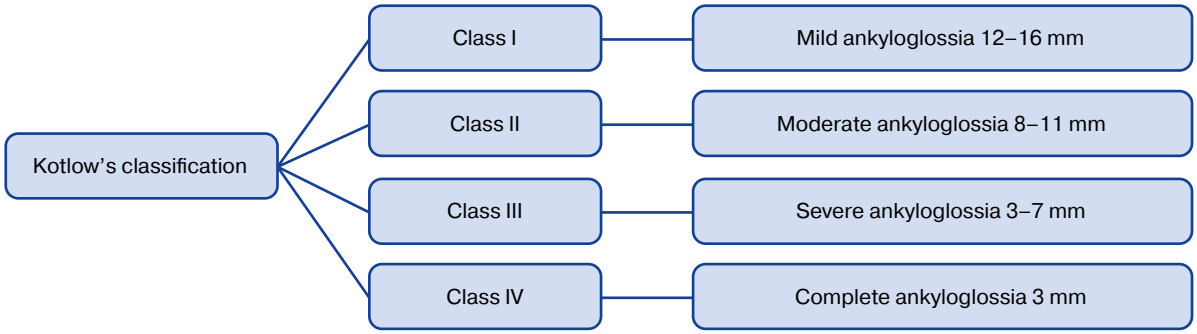

Fig. 1. Kotlow's classification

Рис. 1. Классификация Lawrence Kotlow

The laser-assisted lingual frenectomy is widely considered to have better results when compared to the traditional technique of using a scalpel. The benefit is especially pronounced in pediatric patients, for whom empirical evidence has shown a considerable reduction in postoperative pain, discomfort, and functional impairments, including mastication and articulation problems [7; 8]. The incisions made using laser technology are precise and low-risk, and unlike the conventional scalpels, lingual anatomy is complicated by its location close to the submandibular ductal system, highly vascular floor of the oral cavity, and the hypermobility of the tongue. Therefore, practitioners regularly suture and palpate the ventral tongue after scalpel-based frenectomy, but they report complications including lingual tip numbness, injury to lingual nerve branches or sublingual vessels, and blockage of Wharton ducts [7; 9].

MATERIALS AND METHODS

Study design

In this investigation, the research methodology used was a randomized controlled clinical trial (RCT), conducted in accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines. In the framework of this retrospective study, a cohort of 52 people was studied, including 28 recorded female subjects and 24 recorded male subjects who were diagnosed with ankyloglossia. According to Kotlow's classification method [3; 10], these individuals were classified as either Class III or Class IV. The range of ages represented among the participants was seven to twenty-four years old, with fourteen as the average age.

Frenectomy with laser aid was performed on patients in Group B, while standard surgical frenectomy was conducted on patients in Group A (13 females and 13 males; 12 occurrences of Class III and 14 instances of Class IV). All operations were performed by the same operator, who was working at both the university dental clinics and the specialty dental facilities in the Laser Surgery Unit [11].

The clinical data collected during and after surgery were documented in patient records and later analyzed retrospectively. The selection of the study population was made according to the following inclusion and exclusion criteria.

Inclusion criteria:

– participants had to be between 7 and 24 years of age, in good health, and without any blood-related disorders;

– those with genetic or congenital pathologies were not included;

– subjects requiring medication were excluded;

– participants with viral diseases were excluded;

– finally, parental informed consent was required for all participants before enrollment in the study [12].

Exclusion criteria:

– children with medical conditions, neurosensory impairments, or psychiatric disorders;

– children unable to understand or cooperate with pain assessment methods;

– children presenting with dental emergencies or acute oral issues;

– children with existing pathology at the surgical site [13].

Sample size calculations

The sample size was determined using G-Power analysis, which indicated that a minimum of 26 patients per group was required, with an α error of 0.05 and a statistical power of 80%.

Ethical considerations

This study was initiated following approval from the Research Ethics Committee at Baghdad University, Baghdad. The clinical trial was also registered on ClinicalTrials. Parents or guardians received a detailed explanation of the study and its procedures, and written informed consent was obtained before their children were enrolled in the research.

Allocation

A computer-generated pattern from the software package known as www.random.org was employed to randomly assign participants to one of the two groups while the participants were being evaluated.

Operative protocol for Group A

By successfully separating the lingual nerves in the afflicted area of the tongue, the surgeon was able to block pain transmission using infiltration anesthesia. In addition to reducing swelling at the surgical site, this helped ensure that the treatment was completed under ideal circumstances (Fig. 2). After that, the frenulum was held by two hemostatic forceps, with one of them at the place of its attachment on the tongue, and the other at the floor of the mouth. Due to the proximity of Wharton's ducts to the frenulum attachment, the region is very sensitive; hence, care was taken when using the forceps. The surgeon used a No. 15C blade-equipped scalpel to execute the frenulum incision (Fig. 3). Figure 4 shows the surgeon's placement of three to six interrupted sutures using 4/0 Polysorb wire. Due to the strict adherence to the surgical protocol, there were no postoperative problems. Paracetamol (500 mg) during the first 24 hours, chlorhexidine mouth rinses for 1-week, antibiotic therapy to prevent secondary infections, and a cold, soft diet for the first 2 days were part of the postoperative care for all patients. In most cases, sutures were removed after 10 days. However, in 9 patients, mild bleeding that continued at the 10-day mark necessitated delaying removal to two weeks.

Operative protocol for Group B

The surgeon used infiltration anesthesia in order to prevent pain signals from reaching the brain throughout the recovery process. A careful and cautious drawing forward of the patient's tongue was accomplished with the assistance of surgical gauze. It was determined that placing the frenulum between the middle and index fingers would be the most effective way to prevent tension and deformation. Additionally, the incision line

was precisely designated with a colored tip. For the therapy, a diode laser (Quicklase) with a wavelength of 940 nm, an energy setting of 330 mJ at 50 Hz, and an average power of 1.2 watts was used. The operation was made possible by direct contact with the targeted tissues. Following the activation of the fiber, the operator began cutting the frenulum at its insertion that was closest to the tip of the tongue. Then they moved further out towards the tongue's mouth floor and were parallel to the tongue's longitudinal axis. An inverted "V" shape was suitably made on both the right and left sides of the body in order to construct the incision accurately. This task was accomplished by gently stroking the laser tip while it was in contact mode. In Fig. 6, it is seen that, by gradually releasing tension with this method, the tongue could be lifted into the palate with greater ease. Furthermore, the technique was further improved by deepening the incision toward the midline.

For a smooth, precise procedure, the fiber was reactivated whenever the cutting power diminished, while residues were cleared with gauze moistened in physiological solution. The entire surgery was performed without irrigation.

There was no need to prescribe antibiotics or anti-inflammatory medication [14]. Sutures were also unnecessary, as the laser effectively cauterized the tissue and prevented bleeding. Immediately after the procedure, patients reported noticeable ease in tongue movement and elevation, and an objective improvement in tongue mobility was clearly observed.

Clinical outcomes

The clinical outcomes were evaluated by assessing patient pain, edema, bleeding, satisfaction, the working time required for both the conventional and laser techniques, tongue function, and the necessity for suturing.

Patient pain and satisfaction

A Visual Analogue Scale (VAS) questionnaire was used to compare the two procedures. All patients answered five questions regarding their perceptions and opinions on treatment duration, comfort level, anxiety, nausea, and the possibility of experiencing pain. The VAS scores ranged from 0 to 100 [15; 16].

Patient questionnaire

Patient Name:

Date:

Score:

1. What is your opinion on the treatment time?

a. VAS: 0 (unsatisfactory) – 100 (excellent)

2. How convenient was the procedure for you?

a. VAS: 0 (unsatisfactory) – 100 (excellent)

3. How high was your anxiety level before the procedure?

a. VAS: 0 (low) – 100 (high)

4. Did you experience any discomfort during the procedure?

a. VAS: 0 (no sensation) – 100 (strong sensation)

5. Did you experience any pain during the procedure?

a. VAS: 0 (no pain) – 100 (severe pain)

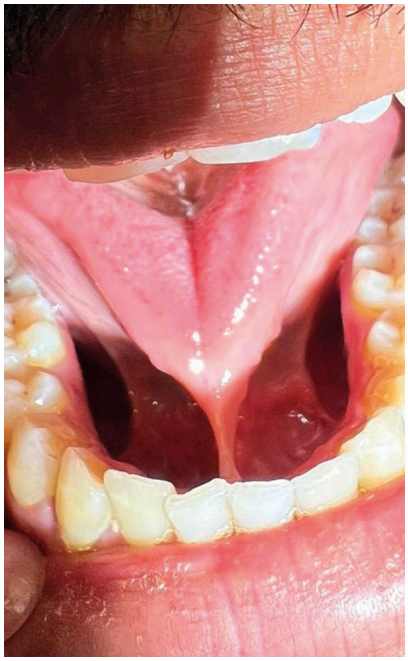

Fig. 2. Lingual view demonstrating limited tongue elevation due to a short and tight lingual frenulum

Рис. 2. Лингвальный вид, демонстрирующий ограниченное поднятие языка вследствие короткой и тугой уздечки языка

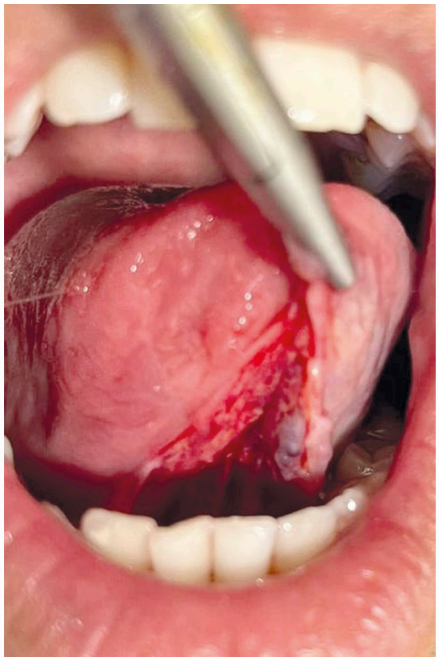

Fig. 3. Post-operative view demonstrates the incision's diamond-shaped pattern

Рис. 3. Послеоперационный вид, демонстрирующий ромбовидную форму разреза

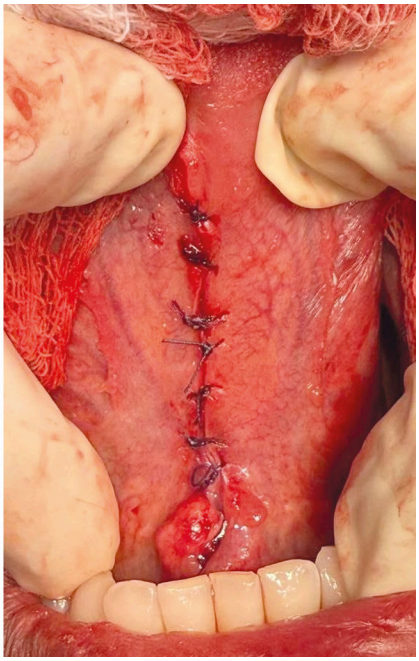

Fig. 4. Post-operative view showing a simple interrupted suture placed at the operative site

Рис. 4. Послеоперационный вид, демонстрирующий наложение простого узлового (прерывистого) шва в области операционного поля

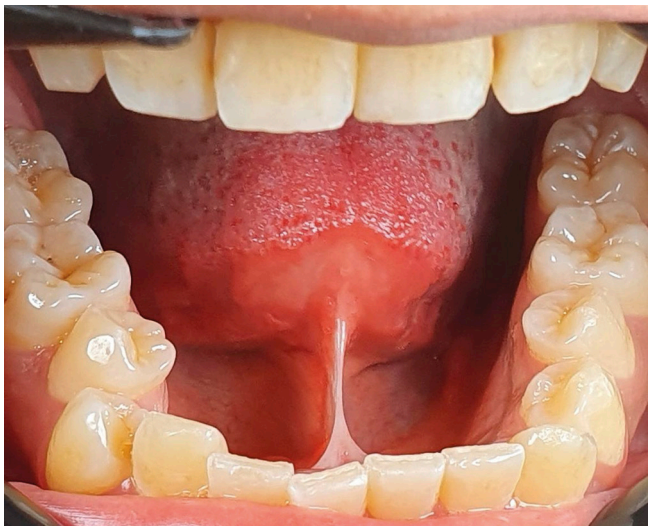

Fig. 5. Demonstrates a short lingual frenum before the operation

Рис. 5. Демонстрация короткой уздечки языка до оперативного вмешательства

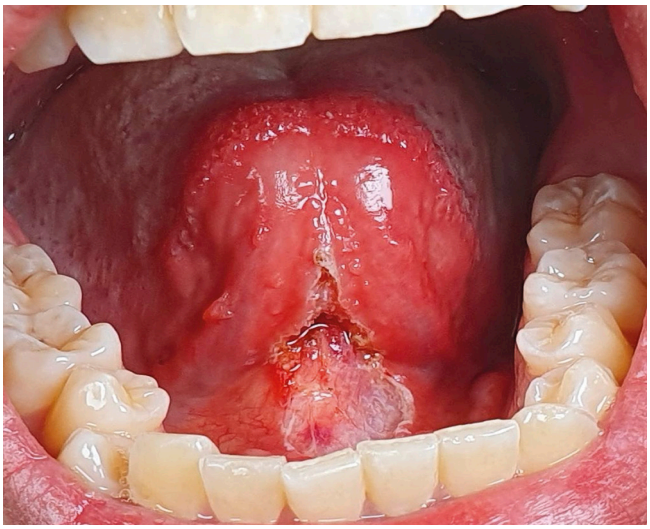

Fig. 6. Shows a diamond-shaped operation site after frenectomy with a diode laser

Рис. 6. Демонстрация ромбовидной операционной области после френэктомии с использованием диодного лазера

Working time

The time required for each procedure was recorded separately in minutes. When necessary, the use of sutures and hemostatic agents was documented as additional events and included as extra working time. All collected data were then subjected to statistical analysis [17].

Edema and bleeding

The selection of a specific therapeutic laser for pediatric oral surgery depends on its photothermal interaction and optical absorption characteristics for water, as well as for tissue chromophores such as hemoglobin, melanin, and collagen [18–21]. For instance, diode lasers have excellent properties for soft tissue cutting, incision, and contouring, as well as for vaporizing deep fibers, achieving coagulation and hemostasis, and decontaminating wounds. When used on vascular lesions rich in hemoglobin, sutures are rarely, if ever, required. The local temperature increase from the diode laser is limited, helping prevent carbonization or necrosis of surrounding tissues and avoiding unnecessary enlargement of the surgical wound [20; 22]. Moreover, it is crucial to carefully select several technical parameters of the laser device – such as power and energy density, operating mode (continuous or pulsed), exposure time, and spot size – to ensure the most effective and least harmful surgical outcome.

The uniform depth of action of the laser beam and the cauterization of nerve terminals both contribute to a reduction in the risk of post-operative discomfort, swelling, infection, and edema. Because bleeding is maintained to a minimum, the surgical region is kept cleaner and less wet, and there is less wound contraction and scarring as a result of this. Due to the fact that they cause less myofibroblast infiltration in wounds, diode lasers are able to minimize the production of scars in comparison to the scalpel method. The risk of bacteremia or the spread of malignant cells is practically zero [23; 24].

Critical clinical trials, involving the utilization of diode laser technology in lingual frenectomy, have shown positive results. An optical fiber handpiece that is flexible makes it possible for their beam delivery system to be set up in a simple and precise manner. The light that is emitted by diode lasers, which are solid-state semiconductor devices consisting of gallium, arsenic, and aluminum, is absorbed by hemoglobin to a significant degree, but water is only able to absorb an inadequate amount of light. This property gives them a strong ability to seal capillaries through protein denaturation and stimulation of clotting factor VII production [2; 24].

Furthermore, diode lasers possess disinfection capabilities, making them particularly suitable for oral soft-tissue surgeries near dental structures where excessive bleeding is not expected. However, prolonged exposure can cause a rapid rise in temperature in the irradiated tissue; therefore, water cooling is essential.

For lingual frenectomy procedures using a diode laser, the recommended parameters are as follows: wavelength of 810–980 nm, fiber diameter of 320–400 μm, power between 1.8 and 3 Watts, and an energy dose of approximately 272 joules, operated in continuous mode [25–27].

Statistical analysis

All statistical analyses were performed with the help of SPSS version 26 software. In order to depict continuous data, we employed the mean, standard deviation, minimum, maximum, and median. For categorical categories, the percentages and frequencies of those variables are shown. A test known as the Kolmogorov-

Smirnov test is used in order to determine whether or not the data distribution is normal. Comparing continuous variables was accomplished via the use of the Mann-Whitney U test, which is appropriate for data that does not adhere to a normal distribution system. Pearson's chi-squared test was used in order to investigate the categorical variables that were under investigation. It was significant when the p-value was lower than 0.05 during the analysis [28; 29].

RESULTS

Assessment of pain score

Pain questionnaires were used as an important parameter in evaluating the course of healing for all patients with ankyloglossia who underwent diode laser and traditional surgery. Pain chart scores were recorded on day 1 and at weeks 1, 2, and 4 after diode laser and traditional surgery (Table 1). There were lower mean pain levels with the diode laser compared with traditional surgery, with a significant difference on day 1 (1.846 ± 0.6748 and 2.346 ± 0.4852 for the diode laser and traditional surgical groups, respectively; $p = 0.006$). In week 1 and week 2, there was a gradual reduction in the mean pain score with a significant difference (1.192 ± 0.6939 and 1.962 ± 0.8709 in week 1 and 0.231 ± 0.4297 and 1.154 ± 0.4641 in week 2 for the diode laser and traditional surgical groups, respectively, with p-values of 0.003 and < 0.001 for weeks 1 and 2, respectively). At week 4, the patients were finishing with no pain in both the diode laser and traditional surgery.

Table 1. Mean pain level comparison between the diode laser and traditional surgery (clinical study of ankyloglossia ($n = 52$) / mean ± SD)

Таблица 1. Сравнение среднего уровня боли между диодным лазером и традиционным хирургическим методом (клиническое исследование анкилоглоссии ($n = 52$) / среднее значение ± стандартное отклонение)

Post-operative pain	Diode laser group ($n = 26$)	Surgical group ($n = 26$)	p-value*
Day 1	1.846 ± 0.6748	2.346 ± 0.4852	0.006
Week 1	1.192 ± 0.6939	1.962 ± 0.8709	0.003
Week 2	0.231 ± 0.4297	1.154 ± 0.4641	< 0.001
Week 4	0	0	–

* Mann-Whitney U test

Distribution of the operation site bleeding score

Diode laser operations were characterized by less bleeding than traditional surgery. So, on day 1, there was a minimum bleeding score in the diode laser (0.192 ± 0.4019) that had decreased to no bleeding in week 1, week 2, and week 4. Compared with traditional surgery, day 1 had a bleeding score of 2.115 ± 0.9089, which decreased to 1.654 ± 0.6895 in week 1, but in weeks 2 and 4, there was no bleeding from the operative site. There was a highly significant difference between diode laser and traditional surgery on day 1 and week 1 ($p < 0.001$ for both), as shown in Table 2.

Table 2. Bleeding score in patients with ankyloglossia (clinical study of ankyloglossia ($n = 52$) / mean ± SD)

Таблица 2. Оценка кровоточивости у пациентов с анкилоглоссией (клиническое исследование анкилоглоссии ($n = 52$) / среднее значение ± стандартное отклонение)

Post-operative bleeding	Diode laser group ($n = 26$)	Surgical group ($n = 26$)	p-value*
Day 1	0.192 ± 0.4019	2.115 ± 0.9089	< 0.001
Week 1	0	1.654 ± 0.6895	< 0.001
Week 2	0	0	–
Week 4	0	0	–

* Mann-Whitney U test

Evaluation of oral edema score

Post-operative edema is a normal pathophysiological event in tissues after an operation and promotes healing. The response to tissue injury was lower with the laser diode than with traditional surgery. On day 1, the edema score was lower with the diode laser (1.077 ± 0.6884) than with traditional surgery (1.731 ± 0.4523), with a highly significant difference ($p < 0.001$). In week 1, the edema score decreased to 0.769 ± 0.9081 and 1.423 ± 0.7575 in the diode laser and traditional surgery groups, respectively, with a significant difference ($p = 0.009$). On the other hand, at weeks 2 and 4 after the operations, there was no edema in the diode-laser or surgical operations.

Table 3. Mean of distinguishing oral edema in patients with ankyloglossia operations (clinical study of ankyloglossia ($n = 52$) / mean ± SD)

Таблица 3. Средние показатели выраженности отека полости рта у пациентов после операций по поводу анкилоглоссии (клиническое исследование анкилоглоссии ($n = 52$) / среднее значение ± стандартное отклонение)

Post-operative edema	Diode laser group ($n = 26$)	Surgical group ($n = 26$)	p-value*
Day 1	1.077 ± 0.6884	1.731 ± 0.4523	< 0.001
Week 1	0.769 ± 0.9081	1.423 ± 0.7575	0.009
Week 2	0	0	–
Week 4	0	0	–

* Mann-Whitney U test

Level of oral function score

Post-operative oral function can be affected by the initial period after the operation, which requires oral hygiene instructions and the performance of recommended exercises to retain normal oral movement. As clarified in Table 4, the oral function level in diode laser operations had a lower edema score in comparison to traditional surgery at day 1 and week 1 with a significant difference (0.615 ± 0.4961 and 0.115 ± 0.3258 level on day 1 and 0.962 ± 0.72 and 0.538 ± 0.7606 in week 1

in diode laser and surgery, respectively, with $p < 0.001$ and 0.031 on day 1 and week 1, respectively). At week 2 and week 4, the oral function level was increasing in both the diode laser and traditional surgery, with a significant difference (1.692 ± 0.4707 and 1.346 ± 0.4852 in week 2 and 2.269 ± 0.8744 and 1.808 ± 0.6939 in week 4 in the diode laser and surgical groups, respectively, with *p*-values of 0.013 and 0.038 in week 2 and week 4, respectively).

Table 4. Average of characteristic oral function criteria in patients with ankyloglossia (clinical study of ankyloglossia ($n = 52$) / mean ± SD)

Таблица 4. Средние показатели функциональных критериев полости рта у пациентов с анкилоглоссией (клиническое исследование анкилоглоссии ($n = 52$) / среднее значение ± стандартное отклонение)

Post-operative function	Diode laser group ($n = 26$)	Surgical group ($n = 26$)	*p*-value*
Day 1	0.615 ± 0.4961	0.115 ± 0.3258	< 0.001
Week 1	0.962 ± 0.72	0.538 ± 0.7606	0.031
Week 2	1.692 ± 0.4707	1.346 ± 0.4852	0.013
Week 4	2.269 ± 0.8744	1.808 ± 0.6939	0.038

* Mann-Whitney U test

Grade of patient's satisfaction score

However, the abovementioned parameters (pain, bleeding, edema, and oral function) might play a role or have some effect on patients' satisfaction at day 1 (Table 5); the mean satisfaction score showed 0.3462 ± 0.0706 for diode laser in comparison to 0.1481 ± 0.0499 in traditional surgery with a highly significant level ($p < 0.001$). At week 1, satisfaction increased to 0.5077 ± 0.1016 for the diode laser compared with traditional surgery at 0.3327 ± 0.137, with a significant difference ($p = 0.001$). As a final point in diode laser operation, there was increased satisfaction at week 2 and week 4 (0.7923 ± 0.044 and 0.898 ± 0.0299, respectively), with significant differences ($p < 0.001$ and 0.001, respectively).

Table 5. Average of satisfaction score (clinical study of ankyloglossia ($n = 52$) / mean ± SD)

Таблица 5. Средний показатель уровня удовлетворенности (клиническое исследование анкилоглоссии ($n = 52$) / среднее значение ± стандартное отклонение)

Post-operative satisfaction	Diode laser group ($n = 26$)	Surgical group ($n = 26$)	*p*-value*
Day 1	0.3462 ± 0.0706	0.1481 ± 0.0499	< 0.001
Week 1	0.5077 ± 0.1016	0.3327 ± 0.137	0.001
Week 2	0.7923 ± 0.044	0.6 ± 0.1174	< 0.001
Week 4	0.898 ± 0.0299	0.8077 ± 0.0902	0.001

* Mann-Whitney U test

DISCUSSION

Specific clinical criteria are used to diagnose ankyloglossia. When asked to open their mouth, the patient is unable to touch the palate with the tip of the tongue. The tongue may appear mechanically bifid or display a central groove when protruded. Additionally, there may be little to no space beneath the tongue. When the patient attempts to extend the tongue fully, it cannot go beyond the vermilion border of the lips, often causing the tongue's central portion to bend downward.

Although treatment is most effective when performed at an early age, early intervention is also important to prevent future complications, such as speech difficulties, lingual inclination of the lower diastemas, incisors, dental rotation, and anterior open bite. These medications may also be administered to adult patients who present with ankyloglossia and problems associated to dysphonia [18; 30–35].

While traditional surgical methods can lead to several complications – regardless of the patient's condition – such as prolonged healing times, excessive bleeding, keloid formation, significant discomfort, and more, results indicate that diode laser surgery offers several advantages over conventional techniques.

These advantages are based on the working principles of laser technology that, unlike traditional methods of surgery, focuses on the contact with tissue. The laser at approximately 60°C causes denaturation and coagulation of the tissue instead of simply removing the structural constituents of the frenulum, such as collagen and elastin fibers [36].

On the other hand, a scalpel can be used to divide fibrous structures by removing the edges and thus, the tension is reduced without removing either constituent. The resultant inflammatory reaction is a repair process in the body [37]. Nevertheless, the denaturation effect caused by the laser significantly changes the fibrous tissue, breaking the covalent bonds, including those between lysine residues and between amino acids that compose protein structures, reducing physiological tension, destroying particular fibers, and weakening intramolecular hydrogen bonds between collagen triple helices. As a result, coagulation occurs due to decreased inter-residue spacing [38].

Fibroblastic repair is hampered in coagulated areas, resulting in delayed wound healing. Laser frenectomy ablates more tissue and affects a larger area than traditional surgery. To re-establish the fascicles to the right length, there is a need to resorb coagulated fibers, lay down new fibers, and have the two ends gradually re-establish tension to extend inflammation and tissue repair. The laser also causes collagen wrinkling because of heat, which enlarges the inter-fibrous spaces and leads to coagulation and structural damage of the fibers. A deeper incision than that made with a scalpel accelerates tissue healing.

Altogether, these effects reduce post-operative inflammation, swelling, and pain. The laser also shortens the procedure time, eliminates the risk of superinfection, removes the need for antibiotics, minimizes wound contraction, and prevents residual scarring.

These advantages are achieved by operating the laser in the pulsed mode, thereby protecting other anatomical structures from the tissue-warming effects. Finally, laser-assisted frenectomy may significantly decrease the bleeding in the course of the operation and avoid the use of sutures, since it is not necessary to use a traditional scalpel. Children are more likely to tolerate the operation since it is faster and produces less discomfort. Patients do not link therapy with a traumatic surgical experience, which makes it simpler to repeat the treatment if required.

Several new studies have discovered the same thing, lending credence to the concept that laser-assisted frenectomy is better than the old-fashioned surgical procedures. The decreased need for sutures was highlighted in particular by Nammour [39]. Additional advantages of diode laser frenectomy over conventional surgery were highlighted by Brignardello-Petersen [40], Viet et al. [41], and others. These include reduced anesthetic infiltration, shorter operation times, and less patient discomfort [42–48].

The operating principle of diode lasers is photothermal interaction, in which incident light energy is absorbed by the tissue and converted to thermal energy. Cuts, vaporization, or coagulation are among the outcomes of this process. More absorption of near-infrared wavelengths emitted by these lasers (810–980 nm) is shown by melanin and hemoglobin. The advantages of diode lasers as mentioned, such as the enhanced hemostasis, enhanced sterilization, and targeted tissue ablation, make them a better substitute or complement to the traditional surgical procedures.

Tongue exercises should be included as a supplemental treatment for the comprehensive care of ankyloglossia in pediatric patients, either on the day of or the day following surgery. The child's speech capacity will improve as a result of these activities, which help the tongue adjust to its altered position and mobility. The exercises should be done three to five times a day for 30 days, according to Tsaousoglou et al. [49].

STUDY LIMITATIONS

The fundamental limitation of the research is its reliance on a retrospective design, which introduces the possibility of bias. For instance, it was not possible to take into account factors such as ethnicity, socioeconomic status, and the capacity to allocate gender equitably between the two groups. This approach stood in contrast to a prospective study, which would have allowed for controlling for factors of this kind. Furthermore, because it could only use regularly acquired data, the number of factors that could be considered was also limited.

On the other hand, a prospective study would allow evaluation of more specific factors, such as changes in tongue mobility and the ability to chew, speak, and swallow. In addition, the small sample size does not provide a sufficiently substantial dataset to support the findings on a broader scale, which is another limitation. It would be necessary to conduct a more extensive study with a larger number of patients to determine whether these results are consistent when other factors are taken into account. In addition, patients tend to choose numbers at the extremes of the Numerical Rating Scale (NRS), which may result in either underestimation or overestimation of their discomfort. This might potentially introduce bias into the computation of post-operative pain when using this scale. For the purpose of obtaining a more objective evaluation, it would have been ideal to use the Visual Analog Scale (VAS), which provides a more precise measure of subjective pain.

CONCLUSION

These results indicate that laser frenectomy can be considered as a possible alternative to traditional surgical practice, provided that the limitations of the current study are observed. Patients who are unable to withstand lengthier procedures or who are very sensitive to pain are the ones who are most likely to experience this. These encouraging findings highlight the need for doing more research with a bigger sample size in order to provide evidence that these findings are valid on a more widespread basis.

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AUTHOR'S CONTRIBUTION

All the authors made equal contributions to the publication preparation in terms of the idea and design of the article; data collection; critical revision of the article in terms of significant intellectual content and final approval of the version of the article for publication.

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