

THE USE OF ND:YAG LASER IN ORAL SOFT-TISSUE SURGERY (CASE REPORTS)

УПОТРЕБАТА НА ND:YAG ЛАСЕРОТ ВО ОРАЛНА МЕКОТКИВНА ХИРУРГИЈА (ПРИКАЗ НА СЛУЧАИ)

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Abstract

Goal: To define the advantages and disadvantages of using the Nd:YAG laser in oral soft-tissue pathology (gingival enlargement, high frenulum attachment, operculotomy) treatment. **Materials and methods:** Case report of several different cases, where pain perceived by the patient, need of anesthesia, bleeding, duration of procedure, requirement of sutures, the occurrence of inflammation, scars formation were followed. For the procedures, Nd: YAG laser (1064 nm) was used with manufacturer's instructions for proper interventions. The aforementioned parameters were assessed with a numeric rating scale (NRS), with values of 0-5. **Results:** In the patients presented in this study, low levels of anxiety before intervention, reduced use of local anesthesia and significant hemostatic effect were detected. Also, the results showed minimum contraction of tissue without scarring, therefore application of sutures was not necessary. Reduction in post-operative pain was observed, with no inflammation. **Conclusion:** Lasers are effective and useful when it comes to soft-tissue surgery. They show clinical use with satisfying results if manufacturer's guidelines are strictly followed, and interventions are performed by experts and trained professionals. **Key words:** Nd: YAG; laser; soft-tissue surgery; gingivectomy; frenectomy; operculotomy.

Апстракт

Цел: Да се согледаат предностите и недостатоците при употребата на Nd:Yag ласерот во третманот на мекоткивната орална патологија (гингивални зголемувања, висок припој на френулум, оперкулектомија). **Материјал и метод:** Приказ на различни клинички случаи, во поглед на перцепирана болка од страна на пациентот, потреба од анестезија, крварење при интервенција, времетраење на процедурата, потреба од сутури, појава на инфламација, формирање на лузни. За процедурите е користен Nd:YAG ласер (1064 nm) по упатствата на производителот за соодветните интервенции. Горенаведените параметри беа оценети со нумеричка скала за оценување (NRS), со вредности од 0-5. **Резултати:** Кај пациентите во оваа студија е забележно намалено ниво на страв пред интервенција, намалена употреба на локална анестезија и значително хемостатско дејство. Добивме минимална контракција на ткивото. Процедурите беа изведени без потреба од апликација на сутури. Кај пациентите нема постоперативни цикатрикси. Забележана е редукција во постоперативна болка, и не е забележана инфламација на ткивото во постоперативниот период. **Заклучок:** Употребата на ласерот има корисно и ефективно место во мекоткивната хирургија. Дава клинички задоволителни резултати доколку се почитуваат параметрите за употреба на произведувачот и доколку интервенциите се изведени од стручен и обучен кадар. **Клучни зборови:** Nd:YAG, ласер, мекоткивна хирургија, гингивектомија, френулектомија, оперкулектомија.

Introduction

Nd:YAG (Neodymium: yttrium-aluminum-garnet) The physical principles of the Nd: YAG laser are based upon Einstein's in the early 1900s. The first device was invented by Theodore Maiman in 1960. Only six years later, working prototypes of gas, liquid, solid, and semi-

conductor lasers had been constructed by several groups of investigators, spurred on by Maiman's achievement.

By the end of that decade, hundreds of materials had been found capable of laser action. The first prototype was made in 1961 by Snitzer E.

In 1990, the FDA is approving the Nd:YAG laser for usage in oral soft tissue surgery, thus making the laser an

optional approach in surgical treatments involving oral soft tissues. One of the first to successfully use the Nd:YAG Laser was White J.M.¹ doing soft tissue surgeries without using anesthesia and with minimal bleeding compared to conventional scalpel.

The Nd:YAG laser wavelength, which is produced for the specific active element, is characteristic and measured at 1064nm and the frequency measured in units of hertz (Hz) is the number of occurrences of a repeating event per unit of time.

The wavelength of the light is the primary determinant to the degree upon which the light will be absorbed in the target zone².

When the laser reaches biological tissue, the light can be reflected, scattered, absorbed, or transmitted to the surrounding tissues³. Nd:YAG laser penetrates up to 2-5 mm in depth, has high level potency of deep penetration compared to other lasers, with that said, the tissues/ structures under the surface are exposed to the laser energy. In the field of dentistry, Nd:YAG lasers work mostly in pulsed mode. Incision, excision, and removal of tissue is a result of photo ablative reaction defined by vaporization and superheating of the tissue fluids. The resulting hemostasis and protein denaturation form natural wound dressing and work towards lower infections, with no need for sutures and no scarring⁴.

The work tip of the Nd:YAG laser offers flexible fiber delivery system with varying dimensions. For most applicable treatments, contact of the working fiber tip with the tissue is essential.

The use of Nd:YAG laser in soft tissue surgery

In the moment when the laser light is absorbed in the tissue, it is momentarily transformed into heat. The primary effect is photo – thermal, which results in structural changes: protein denaturation, vaporization – ablation of tissue, hemostasis, sterilization, carbonization.

The photo – thermal effect that is achieved by the laser lights tissue penetration and thermogenesis is useful, as it produces relatively thick layer of coagulation (0.3 – 0.8mm), which, in turn, guarantees hemostasis. This is beneficial as a therapy option, as it excludes post – operative infection, reduces post – operative inflammation, and provides a clear surgical field and better visualization during the intervention. This therapeutic modality is applicable in a wide range of indications: frenectomy, gingivectomy, gingivoplasty, de-epithelialization, periodontal flap, excision of granulated tissue, implant exposure, lesion ablation, incisional or excisional biopsy of benign or malignant lesions, coagulation of the donor side for the free gingival graft, crown – lengthening etc.

There is very few information available concerning tissue contraction and absent or low scarring that is strongly correlated with laser wavelength, and sensitive to the energy density or fluency (energy per unit area), as fluency is the most important parameter for laser therapy⁵.

Delay in wound healing was registered by Romanos et Al.⁶, but only in cases when 3W power and 20Hz pulsating tempo was used. Wound healing was similar or equal when comparing Nd:YAG laser and scalpel technique, with the following parameters used: 1.75 W and 20 Hz pulsating tempo. In relation to manufacturer's guidelines, in order to eliminate the need for using local anesthetic on the target place, initially the treatment should begin with the flexible fiber tip in non –contact position, 1W power and 10 pps (pulsating per second), for a period of 1-1.5 min. Following this, the power should be raised to 1.5 W for another period of 1-1.5 min, before starting the treatment. The soft tissue removal begins with 1.75 W power and 20 pps, while in contact mode. The value of 3 W and 30 pps should not be exceeded for this type of interventions.

A research presenting evidence that 90% of the patients were unable to go through the whole procedure without the administration of local anesthesia was published in 1999. Only 10 % of the patients included in this research didn't ask for additional anesthesia application⁷. Regarding these results, the use of local anesthesia became a routine for all patients, given that the laser pre-treatment didn't secure the adequate analgesic effects.

The lasers are positively accepted by the patients as one of the available treatment options. Researches involving adults as well as pediatric patients, which required additional parental consent for undergoing laser surgery, showed that all the age groups involved had lower pre-operative stress level, compared to the scalpel technique. The treatment was accepted and chosen more frequently among other therapy approaches.

Goal

To define the advantages and disadvantages of using the Nd:YAG laser in oral soft-tissue pathology (gingival enlargement, high frenulum attachment, operculectomy) treatment.

Materials and methods

During our research, we had the opportunity to work with Nd:YAG (Fotona XP series) laser and present some of our clinical cases, as well as our findings. All the soft-tissue related surgeries, that we are going to present in this paper, were performed in our University Dental

Clinical Centre St. Pantelejmon, Department of Oral Health and Periodontology. All the surgeries were performed by the same surgeon, and the level of pain, fear and other aforementioned parameters were assessed with a numeric rating scale (NRS), with values from 0 to 5, with 0 being the lowest value, and 5 being the highest⁸. The numerical values in our scale were 0 - no pain; 1 - mild pain; 2 - moderate pain (discomforting); 3 - severe pain; 4 - very severe pain (horrible); 5 – the worst pain (excruciating). The graphically presented values of pain in the tables 1-4, present the initial level, before additional anesthesia was administered. Six of our patient are the subject of discussion in this paper, all at the age between 8 and 68 years. We measured and recorded our findings for the related topics of interest: stress, pain, bleeding, tissue contraction/scarring, post-operative pain, post-operative inflammation.

Results

Clinical Case No.1 (Operculectomy)

Male Patient aged 25, presented with pain and difficulties when eating caused by pericoronitis (operculis) on the lower right third molar. After discussing the patient's medical history, initial exam was performed. The patient was offered several options for treatment, whereas the approach with Nd:YAG laser was chosen. The settings used for this intervention were in the incision mode, power set at 3W and 20Hz frequency. Initial time was set for 60 sec with 20pps. The intervention started with application of topical anesthetic and incision in contact mode. (Picture 1, 2, 3-1, 3-2;)



Picture 1: Showing initial situation

The patient was experiencing mild levels of stress and mild to moderate pain. In order to complete the intervention, mandibular nerve block anesthesia was administered. Bleeding was completely absent, due to



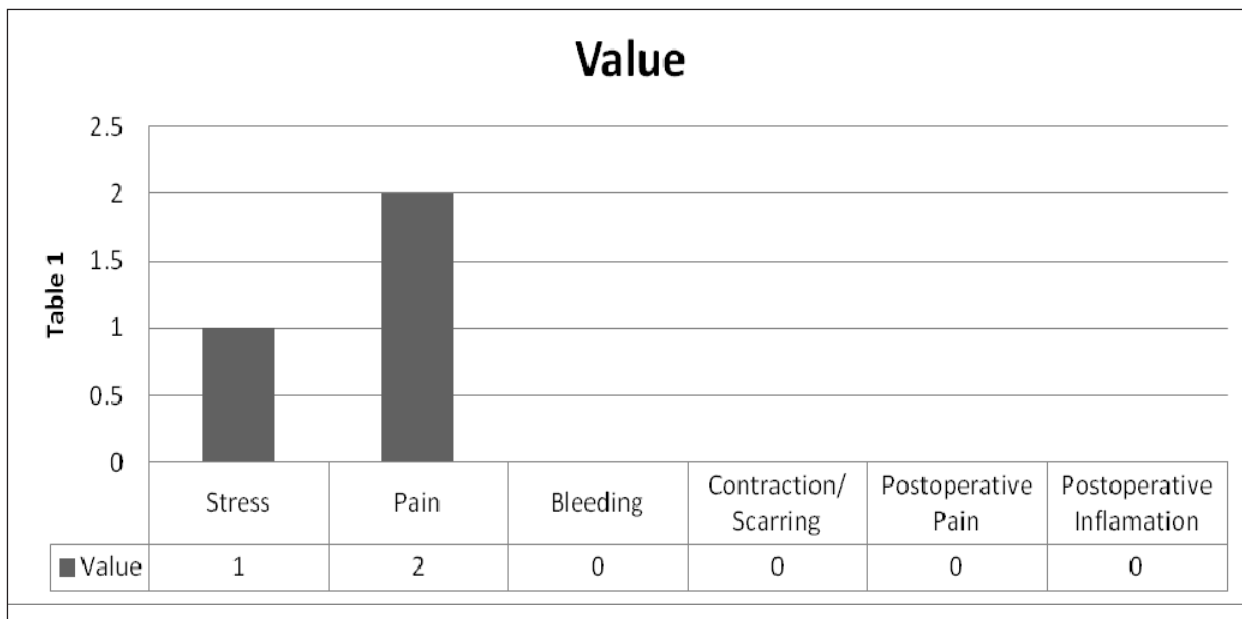
Picture 2: Incision site immediately after surgery



Picture 3. S-1/2: One week later, incision site fully recovered

coagulation, which provided a clean surgical field and better visualization. Sutures were not necessary due to the acquired hemostasis. The post-operative period was without any signs of pain or inflammation as well as no tissue contraction or scarring. (Table 1)

Table 1: Numeric rating scale (0-5) presenting results in Case N° 1 (Operculectomy)



Clinical Case No.2 (Gingivoplasty)

Female patient, aged 15, underwent laser surgical removal of enlarged papillae. Medical history, initial

intraoral and extraoral exam were performed at first visit. For the required procedure the settings were set at gingivoplasty mode, at 20Hz and 2W power. Pulsating



Picture 4: Showing Initial Status



Picture 6: 4 days after intervention

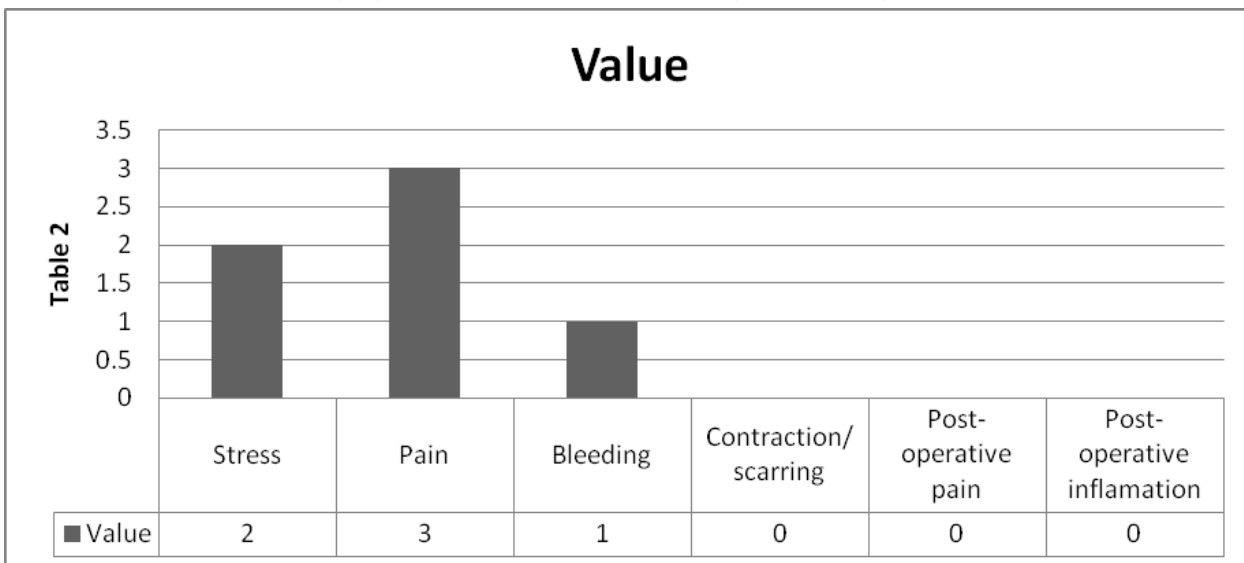


Picture 5: Status immediately after surgery



Picture 7: 7 days after intervention

Table 2: Numeric rating scale (0-5) presenting results in Case N° 2 (Gingivoplasty)



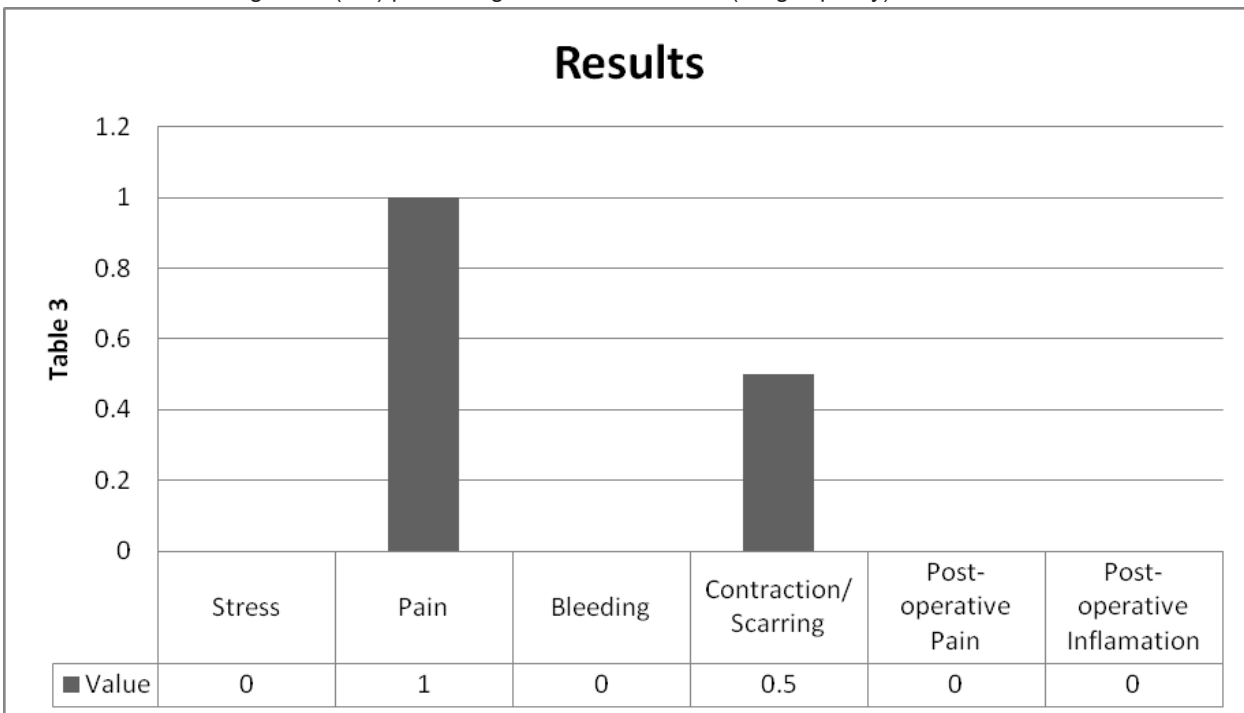
was set at 20 pps, for 60 seconds. Presenting the following results (Picture 4, 5, 6, 7). The patient was experiencing mild stress and moderate level of pain. The procedure was finished only with topical anesthesia. There was some mild bleeding that contributed to exacerbated visualization of the surgical field. Sutures were not necessary and zinc oxide eugenol based surgical packing

was used. The post-operative period was without any signs of pain or inflammation as well as no tissue contraction or scarring. (Table 2)

Clinical Case No.3 (Frenectomy)

Female patient, aged 9, after initial exam and diagnosis underwent laser surgery for frenulum removal.

Table 3: Numeric rating scale (0-5) presenting results in Case N° 2 (Gingivoplasty)



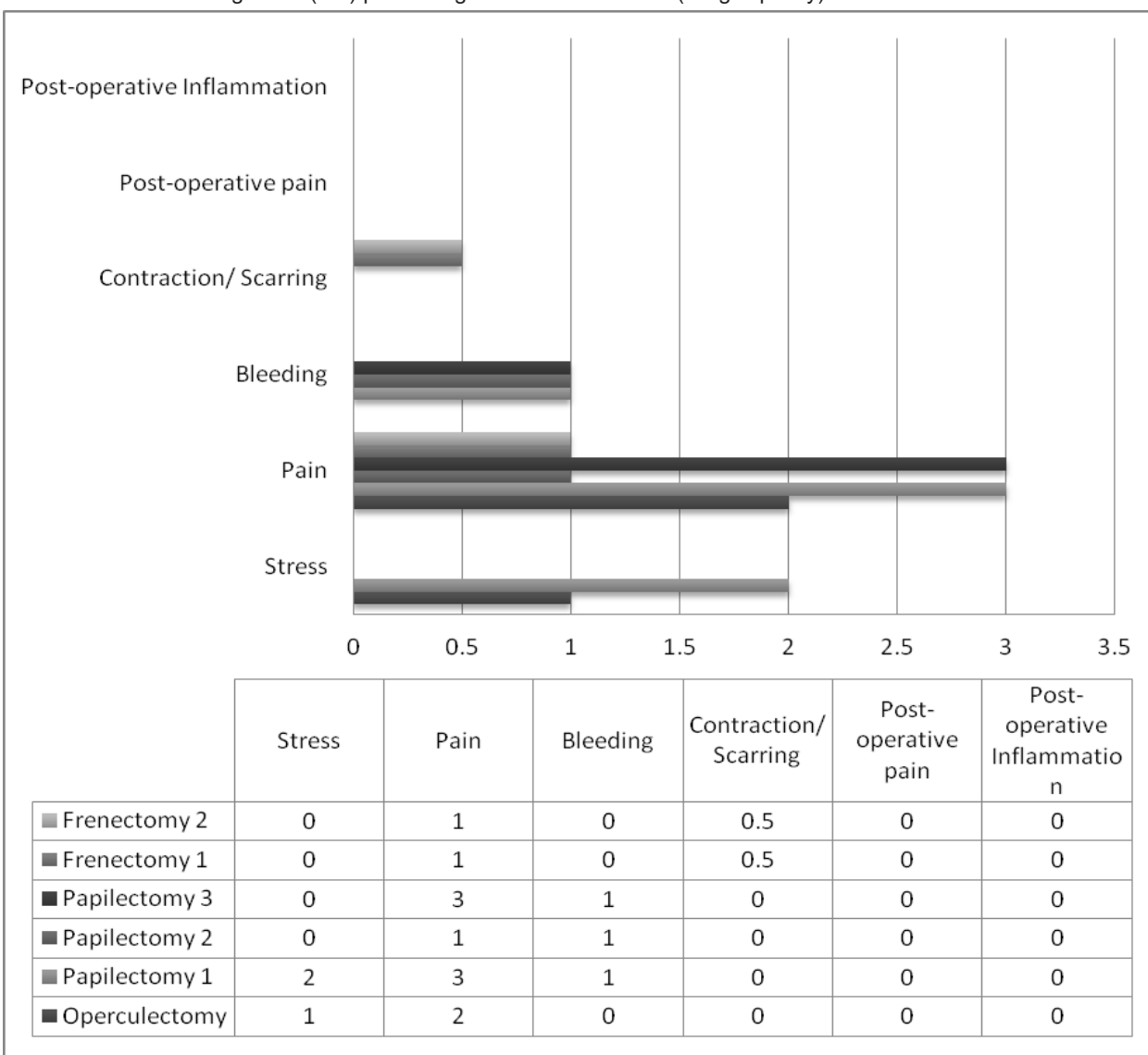


Picture 8: Showing Initial Status



Picture 9: Status immediately after surgery

Table 4: Numeric rating scale (0-5) presenting results in Case N° 2 (Gingivoplasty)





Picture 10: Status 7 days after the surgery

Prior to the intervention, the necessary parental consent was obtained. Initially, the procedure started with application of topical anesthesia, the level of pain indicated that additional plexus block anesthesia was required. After administration of the anesthesia, the procedure was completed successfully. The settings used for this procedure were: 3W power, frequency of 20Hz and 20pps for an extended time of 60 sec at each turn (Picture 8, 9, 10). Sutures were not necessary and no surgical packing was used. There was moderate contraction that contributed to some scarring. The post-operative period was without any signs of pain or inflammation. (Table 3)

Aside from above mentioned, clinically described cases, the remaining 3 cases that were included in our review were another two cases of papillectomy and one frenectomy case. The following table is a graphic chart showing accumulated findings of all these cases, which, combined together, will contribute to the discussion regarding the advantages and disadvantages of using the Nd:YAG laser in soft-tissue surgery. (Table 4)

Discussion

Based on the considered scientific literature as well as the clinical results received from the patients in the study, the Nd:YAG laser has certain advantages that make it superior to the conventional scalpel technique in the field of soft tissue surgery. The removal of pigmented oral soft tissues, protein coagulation resulting in hemostasis and natural wound dressing, which brings out the preventive nature against bacterial opportunistic infection as well as bactericidal effect of the laser, that contributes to that prevention as well. This specific feature is something that is achievable only by this approach.

Another useful feature of this kind of procedure is the eliminated need for sutures. A study by M. Calisir and B. Ege⁹ shows similar results, stating that after the

operation, 77.5% of the patients (n=31) preferred laser frenectomy, while 22.5% (n=9) stated that conventional surgery was more preferable. The reasons for preferring the Nd:YAG laser method were mainly lack of sutures (31.4%) and less pain (29.4%). In addition, no bleeding during the operation was among the primary reasons of preference compared to the other methods. Also, the interventions take significantly less time, and without the part of suturing, patients are more comfortable, not having to take additional care of the stitches and without the financial cost for another visit to remove them.

The procedures are well accepted by all patients, young and adults. In a study by Yadav R.K¹⁰, laser-group patients recorded significantly lower VAS score and used less analgesics than the scalpel group, indicating that laser-group patients experienced less pain during the procedure and post-operative time.

All the above-mentioned cases proved the beneficial outcome of the Nd:YAG laser regarding reduction of post-operative pain and inflammation as well as minimum or absent tissue contraction, with little or no scarring compared to the scalpel technique. In a study by Akpınar A.¹¹, similar results were presented stating that according to the female VAS scores of pain, chewing and speaking were statistically higher in the conventional group than those of the laser group on the operation day and first and third postoperative days. Male pain scores were statistically higher in the conventional group than those in the laser group on operation day. Male scores for discomfort while speaking were significantly higher in the conventional group than those in the laser group on the operation day and first postoperative day. In the conventional group, VAS scores for all parameters were significantly higher than laser group VAS scores on the operation day and first and third postoperative days.

As presented in a study by Romanos G.E¹², according to their findings, no clinically detected scar tissue formation could be established after the surgical incisions with the low-energy laser. With energy parameters of 1.75 W and 20 pulses per sec, the Nd:YAG laser presented a normal (not delayed) wound healing, compared to the control sites with the usual scalpel. This may have great advantages in the field of plastic and reconstructive surgery. Nd:YAG laser irradiation (wavelength of 1064 nm, 0.3 W, 10 pps, 30 mJ, 10.34J/cm², irradiation time 60s) may contribute to regeneration of bone tissues due to enhanced osteoblast cell migration, as reported by Tsuka Y et al.¹³.

On the other hand, some of our findings prove that the Nd: YAG laser analgesia is not effective with children, as they all experienced up to moderate levels of pain and, as mentioned before, the use of plexus block anesthesia was necessary in order to complete the procedure. Similar findings were reported by Mehmet M. Taskan et al.¹⁴, as

they described, in 2 hour/8 hours/ 1, 2, 3, 4, and 5 days, Er:YAG laser and conventional surgery groups caused lower pain levels compared to the Nd:YAG laser ($p < 0.05$). The disinfectant effects are a certain advantage, findings by Kadlecová M. et al.¹⁵ stated that the Nd:YAG laser's (1.06 μm , 1,32 μm , and 1.44 μm) disinfection effect is visible for all the three radiation wavelengths.

Some of the disadvantages of this laser, which we proved to be more difficult, are to remove some of the fibrous tissue, when certain procedures were made. The lasers are expensive and their servicing is additional cost that has to be considered as it affects the patient's cost of the surgical procedure.

Conclusion

The use of Nd:YAG laser was proven useful and effective in soft tissue surgery. It shows clinically satisfactory results, as long as manufacturer's guidelines are followed and properly trained medical personnel perform the interventions.

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Declaration of Interest

We hereby state that no financial or material support was received for the performed work. No affiliation or organization will be affected by the material in the manuscript. We state that there is no conflict of interest.

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