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Tonsillotomy by a Fractional Carbon Dioxide Laser: A New Technique in the Treatment of Chronic Tonsillitis

Heloisa Juliana Zabeu Rossi Costa*, Renata Cantisani Di Francesco, Suzana Maria Giancoli, Fernando Mathias Pereira de Miranda, Ricardo Ferreira Bento

Department of Otorhinolaryngology, University of Sao Paulo Medical School, Sao Paulo, Brazil

***Correspondence to**
Heloisa Juliana Zabeu Rossi Costa,
Email: heloisacosta90@gmail.com

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Abstract

Introduction: Chronic tonsillitis has a global prevalence, ranging from 5% to 12%. Its clinical manifestations, like recurrent acute tonsillitis, tonsils hypertrophy, caseum and halitosis, can lead adult patients to be submitted to palatine tonsillectomy, surgery that has morbidity and the potential risk of complications, including severe bleeding. This article proposes a new therapy for chronic tonsillitis in adult patients using a fractional carbon dioxide (CO2) laser, which is a fast, minimally invasive procedure capable of removing the need for the traditional tonsillectomy in many patients. The present research aimed to verify the efficacy of tonsillotomy by fractional ablation using the CO2 laser by comparing the number of bacterial infections, tonsils hypertrophy, halitosis and caseum; it is also aimed at analyzing the benefits, risks and complications of the technique.

Methods: In this clinical prospective study, 20 patients were subjected to one session of tonsillotomy by fractional ablation and were followed up for a year. The control group was formed by the same patients in the pre-procedure period (one year) without treatment. Statistical analysis: The Wilcoxon paired test, Friedman tests, and multiple non-parametric comparisons were utilized to analyze the data (significance level of 5%).

Results: No complications occurred, and the procedure was fast (30 seconds), safe and tolerated well without general anesthesia. After 1 year, there was a total remission of recurrent acute tonsillitis in 95% of the patients, and after 6 months there was a statistically significant improvement in halitosis and caseum, and tonsils size reduction ($P<0.05$). The level of satisfaction average was 10 after 3 months and 8 after one year.

Conclusion: Tonsillotomy by fractional ablation using the CO2 laser is a safe, efficient procedure for chronic tonsillitis in adults, and it can be incorporated into daily clinical practice.

Keywords: Fractional carbon dioxide laser; CO2 laser; Tonsillotomy; Chronic tonsillitis; Recurrent tonsillitis; Caseum; Halitosis; Tonsils hypertrophy; Tonsil; Treatment

Introduction

Chronic tonsillitis (tonsils chronic inflammation process) is a common disease with a global prevalence estimated to be between 5% and 12%. Its clinical manifestations, such as caseum, halitosis, recurrent acute tonsillitis (acute bacterial infections that require antibiotic treatment) and tonsils hypertrophy, may lead adult patients to be submitted for a palatine tonsillectomy, which is surgery with morbidity and potential risk of complications, including severe bleeding.[1-3]

Several types of laser equipment and different procedures have been tried to substitute the traditional cold scalpel surgery. Some techniques employed are laser tonsillectomy (extracapsular tonsil resection),[4-7] carbon dioxide (CO2) laser-assisted tonsillotomy[8-10] (partial tonsil removal) and laser cryptolysis (elimination of the inflamed crypts).[11,12] These methods intend to get a partial or total ablation of the tonsil, using such a device as the CO2 laser in vaporization or continuous cut mode. However, none of them completely reached the three target points: elimination of the recurrent or chronic tonsillitis symptoms, absence of complications, and minimal morbidity.

Some papers have demonstrated good results using fractional CO2 laser therapy in the management of benign oral and genital lesions, with a minimum complication rate,[13-19] but no previous studies have focused on the use of the CO2 laser, in its fractional mode, to treat chronic tonsil diseases.

The present article proposes a new therapeutic method for cases of chronic and recurrent tonsillitis, through a non-surgical fractional ablation of the palatine

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tonsils, using the CO2 laser: a simple, fast and safe laser technique, which requires neither hospitalization nor general anaesthesia.

This study aimed to verify the efficacy of tonsillotomy by fractional ablation with the CO2 laser to treat chronic tonsillitis, comparing standardized clinical parameters (number of bacterial infections, tonsils hypertrophy, halitosis and caseum) and biochemical/microbiological parameters (salivary pH measured/oropharynx culture) pre- and post-intervention (one-year follow-up). the benefits, risks, morbidity and complications of the technique (recovery period parameters).

Materials and Methods

This clinical prospective study was conducted in compliance with the Ethics Committee on Human Being Research, following approval by the Ethics Commission for Research Project Analysis (CAPPesq) of the Clinical Board of the Clinical Hospital of University of Sao Paulo (CAAE 601796.0.0000.0068, Parecer 1.858.333).

In this study, 20 patients from the Pharyngology outpatient department of the Clinical Hospital of University of Sao Paulo, with symptoms of chronic tonsillitis without any preventive treatment (just taking antibiotic and anti-inflammatory drugs for the infections) during one year, were subjected to one session of tonsillotomy by fractional ablation with a CO2 laser and evaluated until one year after the procedure.

They were selected from among 264 patients from the Pharyngology outpatient department of the Clinical Hospital of University of Sao Paulo, according to the inclusion and exclusion criteria listed below. Such patients, after signing the Informed Consent Form of the Research Ethics Committee of the University of Sao Paulo School of Medicine, were submitted to the tested procedure.

Adult patients (from 21 to 50 years of age), of both genders, with a history of recurrent acute bacterial tonsillitis (more than three in a year) and/or tonsil hypertrophy (grade II to IV tonsils) and/or caseum accumulation/halitosis, were included in the study. Only patients presenting with Mallampati I or II classification[20] were included.

Patients with a short neck, increased nauseous reflex and large tongue were included during the study (removed from the exclusion criteria) once these factors were not an obstacle to performing the procedure (there was no significant difficulty increase for laser visualization and application). Patients suffering from morbid obesity, hypertension and diabetes mellitus were also included once there were no contraindications to the procedure, and it represents a less invasive and morbid option compared to the conventional tonsillectomy. In addition, patients with laryngopharyngeal reflux were also included due to the high incidence of this condition associated with chronic tonsillitis.

Patients who presented a previous peritonsillar abscess, suspected malignity, intense emotional lability, dental infections, infection of the airways on the day of the procedure, hypersensitivity to the protocol substances, coagulation disorders (including the use of anticoagulants), immunodeficiency, and pregnancy and those who were out of the age range for inclusion were excluded from the study.

The procedures were conducted in the outpatient operating room of the Department of Otorhinolaryngology of the Clinical Hospital of University of Sao Paulo. The intervention room followed the safety standard for emergency procedures and against thermal lesion risk.

The equipment and material required for the intervention included a chair, smoke evacuator, frontal focus, CO2 laser SmartXide 2 C80, Deka brand, protective glasses, 10% lidocaine spray, and disposable materials. The procedure was conducted with topic anesthesia (lidocaine spray). The patients did not receive any other pre- or peri-intervention medicine.

The laser device was borrowed from Deka Laser Company to the Department of Otorhinolaryngology of the University of Sao Paulo (without any cost) to conduct the research.

Following the procedure, the patients remained under observation for 30 minutes, and following this period they were discharged from the hospital, with a prescription for dipyrone, if necessary, written recommendations and care to be taken.

The CO2 laser SmartXide DOT HiScan V2LR, Deka brand, with 40-W power, dwell time 1200 milliseconds, DOTs pitch 400 μm and SmartStack 4. Density 19.6%, fluency 37.88 J/cm^2, energy pulse 242.4 mJ, scan normal mode, emission DP, size 40%, relation 6/10, laser guide 20%, manual mode. Measures against accidental thermal lesions were taken. The medical team and the patient wore protective glasses during the entire procedure. A disposable mouth opener (children's polycarbonate crystal Expansor Expandex Jon® brand) was used and protection with gauze was provided in the patients' perioral region and anterior teeth. The patients remained in the seated position during the procedure. The topical anesthesia was conducted with 10% Lidocaine spray, 5 minutes after which the patient had a gargle with 0.9% saline solution. Then, the laser was triggered up to 1.2 mm depth and 0.1 to 0.3 mm diameter in the palatine tonsils, covering a scan area corresponding to the exposed surface of the tonsil.

The procedure lasted approximately 30 seconds, and after the mouth opener was removed, the patients had a gargle with a cold 0.9% saline solution.

In order to evaluate the clinical efficacy of the tested procedure, a protocol was previously elaborated to complete the following information: procedure time,

amount of bleeding during the procedure, presence of bleeding post-intervention or not, degree of pain post-intervention, degree of edema post-intervention (+ to 3+), difficulty swallowing (Y or N), use of analgesics (Y or N), recovery time, diet (absent, liquid, pasty, solid), intra- and post-intervention complications, size of the tonsils pre- and post-procedure, presence of caseum and halitosis pre- and post-procedure, and amount of tonsillitis before and after the procedure (12 months before the procedure until 12 months after).

The evaluation of pain was conducted according to the visual analogue scale from 0 to 10.

The patients had salivary pH measured and oropharynx culture pre-intervention evaluation and at timepoints after the intervention.

Palatine tonsils size was classified according to the criteria described by Brodsky.[21,22]

The patients were followed for one year following the procedures, being evaluated before the intervention and after 3 days, 1 week, 1 month, 3 months, 6 months and 1 year.

Throughout the study, the patients filled in a questionnaire in order for the present researchers to measure the degree of satisfaction with the procedure.

Statistical Analysis

The sample calculation was based on previous, similar studies, and the ethical issues related to the study on human beings were observed.

The post-treatment qualitative characteristics of the patients were described by using absolute and relative frequencies, and the post-treatment qualitative characteristics were described by using summary measures (mean, standard deviation, median, minimum and maximum).[23]

The original characteristics evaluated before and after the treatment were described by using absolute and relative frequencies at every evaluation timepoint, and the quantitative characteristics were described by using summary measures at every evaluation timepoint, being the timepoints compared by using Wilcoxon paired tests for the measures evaluated in only two timepoints and Friedman tests for the measures evaluated in more than two timepoints, followed by multiple non-parametric comparisons for longitudinal data in order to verify between each timepoint the differences occurred.[24]

Software IBM-SPSS for Windows version 20.0 was used to perform the analysis, and software Microsoft Excel 2003 was used to tabulate the data. The tests were conducted with a significance level of 5%.

Results

This interventional study was considered minimally invasive because 1. No parenteral anesthesia was required to perform it; 2. Its duration was from 5 to 7 minutes; 3. There were no complications requiring ventilatory or drug support, tissue repair or hemostasis containment; 4. It did not harm the patients' physical integrity (Figure 1).

The laser session was conducted in an outpatient scenario, not requiring hospitalization. After the approach, the patients remained under observation for thirty minutes and were subsequently released.

The total procedure time for treating both tonsils was less than thirty seconds (2 or 3 laser shots in each tonsil). The results refer to the total number of patients submitted to the procedure (n = 20).

Recovery Period Parameters

General health recovery post-intervention was immediate since there were no major injuries, complications or complaints. There were no bleeding events during and after the procedure up to the one-year follow-up.

It was an almost painless procedure. Above 50% of the patients presented mild odynophagia only on the first day after the session, and the others reported minimal pain until the third day (Table 1). Two patients (10%) had to take analgesics after the intervention (one pill each).

The rapid improvement of odynophagia enabled the premature reestablishment of a solid diet. Fifty percent of the patients had returned to the solid diet on the first day, and 100% after three days (Table 1). Two patients presented slight dysphagia up to the second day.

Small edema was observed in tonsils after the intervention; it had full regression after three days in half of the patients, and after one week in the remaining patients.

Clinical Efficacy Parameters

The main clinical parameters analyzed were the number of acute tonsils infections from 12 months before the procedure until 12 months after the procedure, the presence or absence of caseum and/or halitosis, and the size of the tonsils pre- and post-procedure (Table 2).

The number of acute tonsils infections drastically decreased after the procedure, sustaining this remission all over the follow-up period in 95% of the patients. The

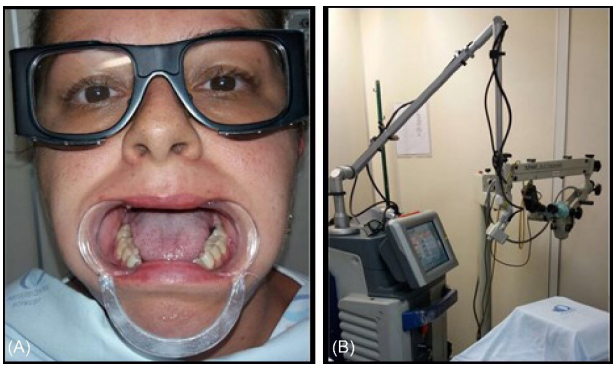

Figure 1. (A) patient in the seated position with the protective glasses and mouth opener. (B) equipment used in the procedure

Table 1. Description of the Characteristics Evaluated in the Post-procedure Period

Variable	Description
Candidate to surgery, n (%)	
No	11 (55)
Yes	9 (45)
Candidate to 2nd laser session, n (%)	
No	12 (60)
Yes	8 (40)
Reflux, n (%)	
No	9 (45)
Yes	11 (55)
Analgesics, n (%)	
No	18 (90)
Yes	2 (10)
Postoperative dysphagia, n (%)	
No	18 (90)
Yes	2 (10)
Maximum degree of pain	
Mean ± SD	1.1 ± 1.3
Median (min.; max.)	1 (0; 4)
Days with pain	
Mean ± SD	1.1 ± 1.3
Median (min.; max.)	1 (0; 4)
Postoperative solid diet (days)	
Mean ± SD	1.3 ± 0.63
Median (min.; max.)	1 (1; 3)

For results based on all patients n = 20 (100%). Degree of pain based on pain scale 0-10; days with pain (mean, median); days for solid diet restoration (mean, median).

frequency of these acute events decreased from pre 1 year and pre 6 months to the post timepoints ($P < 0.05$) and no longer increased during one-year follow-up (Table 3).

By analyzing the halitosis and caseum parameters, it was verified statistically significant symptoms remission until six months after the laser session. However, these parameters progressively worsened from the 3rd month to the 12th month in most patients.

The degree of halitosis and caseum decreased from pre to 3 and 6 months ($P < 0.05$), but it returned to baseline after one year ($P = 0.055$), with a statistically significant increase from 3 months to one year ($P = 0.005$; Table 3).

Nevertheless, these symptoms became milder; in the pre-intervention, 13 patients suffered from caseum grade 3 (most severe) and 9 patients from halitosis grade 3, and at the end of the study (after one year) one patient had caseum grade 3 and three patients had halitosis grade 3.

The maximum size of the tonsils statistically decreased from pre to 3 and 6 months ($P < 0.05$).

Figure 2 shows macroscopic changes in the palatine tonsils related to the CO2 laser session; it was observed a slight size reduction of the tonsil, which became with smoother surface and shallower crypts.

The median of the patients' satisfaction grades was 10 after 3 months and 8 after one year.

Despite complete remission of the acute infections in 95% of the individuals, most patients mixed symptoms. Therefore, 55% of the patients remained candidates for surgery due to halitosis, caseum or tonsils hypertrophy.

Biochemical and Microbiological Parameters

Table 2 shows that the culture and the salivary pH did not present statistically significant changes from the pre-treatment to post-treatment periods ($P > 0.05$).

Oropharynx culture was positive in one patient before the intervention (*Staphylococcus aureus*) and became negative in all patients 30 days post-intervention.

Discussion

Chronic tonsillitis is a prolonged and general inflammation of the tonsils (not only of their crypts) due to a metabolic change caused by intrinsic and extrinsic factors. This condition changes the pH and the local microbiome, transforming the colonizing bacteria into being potentially pathogenic, which may result in the formation of biofilms, production of inflammatory cytokines, inhibition of bactericidal enzymes and inactivation of the local immune system.[25-29]

It has been observed in previous studies[30-32] that patients who have been subjected to laser therapy to treat chronic tonsillitis have improved quickly and permanently. The laser therapy, according to these articles, reestablished the cytological balance and immunoregulation of the tonsils; there was the normalization of CD4/CD8 ratio, an increase in T CD4 helper lymphocytes and in salivary and serum IgA.

The technique presented in this article intends to promote biofilm disaggregation (by rearranging the colonizing agents) and retraction of the tissue while preserving the majority of the surface epithelium. These factors enable the restorage of local immune functions in the tonsil histological unit.

In adults, the most common indication of the need for a tonsillectomy is recurrent infectious tonsils disease (57% to 78.85% [2]), followed by tonsillar hypertrophy in 27% and suspected neoplasia in 16% of the patients.[3]

Traditional tonsillectomy conducted with a cold scalpel (gold standard method) has a mortality rate ranging from 1:14 000 to 1:25 000, in addition to significant peri- and post-operative complications (15 to 20%).[33,34] The most relevant post-operative complications are hemorrhage (5 to 11%),[35,36] intense odynophagia (5%), dehydration (4%), vomiting (3%) and fever (1%), extending the hospitalization time, costs, risks and rehabilitation period.[37-40] According to the Brazilian Health Ministry data of 2017, the tonsillectomy annual demand in public

Table 2. Description of the Characteristics Evaluated Over the Evaluation Timepoints and Comparative Test Results (n = 20)

Variable	Timepoint					*P* Value
Caseum, n (%)	**Before**	**After 3 Months**	**After 6 Months**	**After 1 Year**		< 0.001
0	2 (10)	15 (75)	10 (50)	4 (26.7)		
1	1 (5)	5 (25)	7 (35)	5 (33.3)		
2	4 (20)	0 (0)	3 (15)	5 (33.3)		
3	13 (65)	0 (0)	0 (0)	1 (6.7)		
Size, n (%)	**Before**	**After 3 Months**	**After 6 Months**			0.002
1	8 (40)	11 (55)	11 (55)			
2	6 (30)	7 (35)	8 (40)			
3	5 (25)	2 (10)	1 (5)			
4	1 (5)	0 (0)	0 (0)			
Halitosis, n (%)	**Before**	**After 3 Months**	**After 6 Months**	**After 1 Year**		< 0.001
0	4 (20)	13 (65)	7 (35)	6 (40)		
1	3 (15)	5 (25)	7 (35)	3 (20)		
2	4 (20)	1 (5)	3 (15)	3 (20)		
3	9 (45)	1 (5)	3 (15)	3 (20)		
Edema, n (%)	**After 3 Days**	**After 7 Days**				0.002*
0	10 (50)	18 (90)				
1	8 (40)	2 (10)				
2	2 (10)	0 (0)				
Culture, n (%)	**Before**	**After**				0.317*
Negative	19 (95)	20 (100)				
Positive	1 (5)	0 (0)				
Tonsillitis	**Before 1 Year**	**Before 6 Months**	**After 3 Months**	**After 6 Months**	**After 1 Year**	< 0.001
Mean ± SD	7.2 ± 7.1	3.7 ± 3.9	0.1 ± 0.3	0.3 ± 0.8	0.9 ± 2.5	
Median (min.; max.)	6.5 (0; 30)	3.5 (0; 15)	0 (0; 1)	0 (0; 3)	0 (0; 10)	
Pain	**Day 1**	**Day 2**	**Day 3**			< 0.001
Mean ± SD	1.1 ± 1.3	0.6 ± 1.2	0.3 ± 0.8			
Median (min.; max.)	1 (0; 4)	0 (0; 4)	0 (0; 3)			
Salivary pH	**Before**	**After**				0.259**
Mean ± SD	6.3 ± 0.4	6.4 ± 0.5				
Median (min.; max.)	6 (5.5; 7)	6.5 (5.5; 7)				
Patient grade	**After 3 Months**	**After 6 Months**	**After 1 Year**			0.011
Mean ± SD	8.6 ± 2.5	7.5 ± 2.8	7.4 ± 2.9			
Median (min.; max.)	10 (0; 10)	8 (0; 10)	8 (0; 10)			

Friedman's test; * Paired Wilcoxon test; ** Paired student *t* test.

hospitals is around 20 000 surgeries with an average waiting time of 408 days.

Historically, the first laser technique related to tonsils was the laser tonsillectomy (with the resection of the entire tonsil) using ablative lasers. It emerged as an alternative method to conventional tonsillectomy, in an attempt to decrease intra- and post-surgery bleeding. However, this technique caused prolonged postoperative pain and recovery time since the laser damaged the musculature due to a total extracapsular resection of the tonsil.[4-6] It was described, for example, that the potassium titanyl phosphate (KTP) laser tonsillectomy caused more pain and bleeding in the late postoperative period[4-7] when compared to conventional dissection with a cold scalpel.[8]

Other laser techniques have been developed to minimize or eliminate the recurrence of acute tonsils infections and other chronic tonsillitis symptoms.

The CO2 laser-assisted tonsillotomy,[8,9] more conservative yet still aggressive, continuously vaporizes the tonsil by layers, reaching 70% of tonsil ablation (75% success rate).[10] This method promotes total ablation of the tonsil surface, which leads to a more extensive bleeding area and impairs the morphofunctional full recovery of the organ. Despite the good results in controlling the chronic disease, the operation time and recovery period are much longer than the technique described in this present study.

Laser cryptolysis is intended to eliminate inflamed and enlarged tonsil crypts and their related inconveniences. But even after a 4-session treatment, it has often suffered therapeutic failure.[8,11,12] The reason for the failure may be the extremely conservative method, being restricted to some small areas of the tonsil surface (few enlarged crypts).

The present method achieved a 95% remission of acute recurrent infections, compared with 75% in the studies by Remacle et al. (2003)[9] and other authors.[41] Reichel et al[42] showed a rare recurrence of tonsillitis after the CO2 laser tonsillotomy (although applying a different technique), in accordance with our paper.

Table 3. Result of the Multiple Comparisons of the Characteristics Which Presented Differences Over the Evaluated Timepoints

Variable	Comparison	Z Value	*P* Value
Caseum	Before vs after 3 months	5.64	<0.001
	Before vs after 6 months	4.46	<0.001
	Before vs after 1 year	2.27	0.023
	After 3 months vs after 6 months	-1.18	0.239
	After 3 months vs after 1 year	-3.37	<0.001
	After 6 months vs after 1 year	-2.19	0.028
Size	Before vs after 3 months	2.01	0.044
	Before vs after 6 months	2.37	0.018
	after 3 months vs after 6 months	0.36	0.721
Halitosis	Before vs after 3 months	4.74	<0.001
	Before vs after 6 months	3.20	0.001
	Before vs after 1 year	1.92	0.055
	After 3 months vs after 6 months	-1.53	0.125
	After 3 months vs after 1 year	-2.82	0.005
	After 6 months vs after 1 year	-1.29	0.198
Tonsillitis	Before 1 year vs before 6 months	2.30	0.021
	Before 1 year vs after 3 months	6,37	<0.001
	Before 1 year vs after 6 months	6.10	<0.001
	Before 1 year vs after 1 year	5.10	<0.001
	Before 6 months vs after 3 months	4.06	<0.001
	Before 6 months vs after 6 months	3.79	<0.001
	Before 6 months vs after 1 year	2.80	0.005
	After 3 months vs after 6 months	-0.27	0.786
	After 3 months vs after 1 year	-1.26	0.206
	After 6 months vs after 1 year	-0.99	0.320
Pain	Day 1 vs day 2	3.13	0.002
	Day 1 vs day 3	4.25	<0.001
	Day 2 vs day 3	1.12	0.264
Patient grade	After 3 months vs after 6 months	1.94	0.053
	After 3 months vs after 1 year	3.13	0.002
	After 6 months vs after 1 year	1.20	0.232

Multiple non-parametric comparisons for longitudinal analyses.

After six months, a statistically significant improvement of halitosis and caseum in the studied patients was observed, compared to the same pre-procedure period. In this paper, following one session, a change in the macroscopic tonsil appearance to a smoother surface with shallower crypts was noted. This anatomical modification hinders the caseum accumulation and consequent halitosis. In cases of caseum recurrence, another session after 3 to 6 months would possibly control this clinical manifestation.

There was a significant reduction of the tonsils observed up to 6 months after the procedure ($P<0.05$). Six patients (30%) had tonsils size grade III-IV pre-intervention, and after 6 months only one patient (5%) had tonsils size grade III-IV. This patient had tonsils retraction from grade IV to III.

This work has demonstrated effectiveness in controlling manifestations related to chronic tonsillitis, according to previous papers,[25-31,43] referring to the idea of a biochemical, physiological and microbiological rebalancing. Ph measures pre- and post-intervention did not show a statistical difference; however, one positive culture became negative after the intervention.

The fractional CO2 laser technique revealed numerous advantages to the patient and surgeon: it takes around 30 seconds to perform, causes minimum tissue injury with almost no pain, edema or inflammatory reaction, and has no risk of postoperative bleeding, infection or scar contracture. It can be conducted in an outpatient scenario with local anaesthesia[32,43] and can be performed on hypertensive, diabetic and morbidly obese patients without increasing the relative risk. It has proven to be the fastest one, with less intra- and post-procedure morbidity and similar or greater efficacy than other aforementioned.[5,7-11]

The CO2 laser provides energy with a wavelength of 10.6 nm. It is applied without contact, and lesions to the adjacent tissue have been proven to be minimal.[44,45] It presented advantages compared to the KTP laser in the mucous membranes, with less postoperative bleeding and less postoperative pain. The CO2 laser also caused less postoperative pain than Nd:YAG. In addition, its

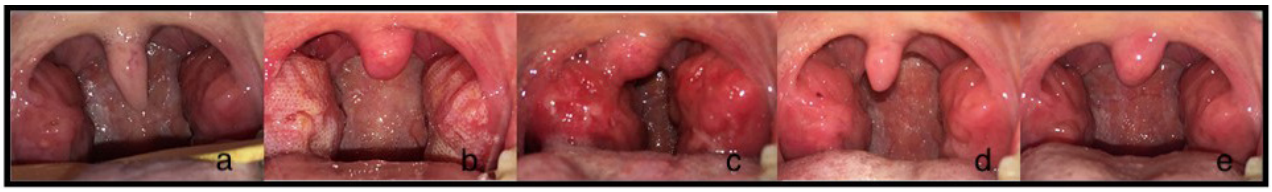

Figure 2. Macroscopic Changes in the Palatine Tonsils Related to the Procedure; a) before, b) immediately after, c) after 1 week, d) after 1 month, e) after 6 months

pulsatile mode allows less adjacent thermal lesion than other lasers such as diode-laser.[46-49]

The pulsatile mode of the laser and the possibility to perform the procedure with the patient being awake (without intubation) eliminate the risk of fire in the upper airways, which is the most feared complication of using the laser in the airways.[50]

The fractional mode aims simultaneously at many points of a delimited area, which allows full control over the surface being treated. The stacking mode standardizes the depth of application with minimum damage to the adjacent tissue.

The patients' satisfaction average was 10 after three months and 8 after one year. Despite the high degree of satisfaction and the significant improvement observed, most patients had a mixture of symptoms and expected a complete cure for the disease. Therefore, 55% of the patients remained candidates for surgery due to halitosis, caseum or tonsils hypertrophy.

It should be emphasized that the indication of fractionated CO2 laser tonsillotomy must be focused on the recurrent tonsillitis complaint. Halitosis and caseum may fit as relative indications, and the patient must be warned about the possibility of partial improvement and the need for another session after six months.

Since this is an original procedure, there is no literature data to compare our results.

The verified pieces of evidence observed in this project encouraged us to incorporate this procedure into the daily clinical practice due to its safety and efficacy.

Conclusion

Fractional laser ablation practically eliminated tonsil acute bacterial infections during a year of follow-up and significantly decreased tonsil size, halitosis and caseum for six months. No complications or risks were observed using this technique.

Tonsillotomy through fractional laser ablation is a safe and efficient procedure for acute bacterial recurrent tonsillitis and chronic tonsillitis in adults, and it should be incorporated into daily clinical practice.

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Conflict of Interests

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

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References

1. Watkins DA, Johnson CO, Colquhoun SM, Karthikeyan G, Beaton A, Bukhman G, et al. Global, regional, and national burden of rheumatic heart disease, 1990-2015. N Engl J Med. 2017;377(8):713-22. doi: 10.1056/NEJMoa1603693.
2. Seshamani M, Vogtmann E, Gatwood J, Gibson TB, Scanlon D. Prevalence of complications from adult tonsillectomy and impact on health care expenditures. Otolaryngol Head Neck Surg. 2014;150(4):574-81. doi: 10.1177/0194599813519972.
3. Galindo Torres BP, De Miguel García F, Whyte Orozco J. Tonsillectomy in adults: analysis of indications and complications. Auris Nasus Larynx. 2018;45(3):517-21. doi: 10.1016/j.anl.2017.08.012.
4. Oas RE Jr, Bartels JP. KTP-532 laser tonsillectomy: a comparison with standard technique. Laryngoscope. 1990;100(4):385-8. doi: 10.1288/00005537-199004000-00010.
5. Auf I, Osborne JE, Sparkes C, Khalil H. Is the KTP laser effective in tonsillectomy? Clin Otolaryngol Allied Sci. 1997;22(2):145-6. doi: 10.1046/j.1365-2273.1997.d01-305.x.
6. Saito T, Honda N, Saito H. Advantage and disadvantage of KTP-532 laser tonsillectomy compared with conventional method. Auris Nasus Larynx. 1999;26(4):447-52. doi: 10.1016/s0385-8146(99)00025-5.
7. Kothari P, Patel S, Brown P, Obara L, O'Malley S. A prospective double-blind randomized controlled trial comparing the suitability of KTP laser tonsillectomy with conventional dissection tonsillectomy for day case surgery. Clin Otolaryngol Allied Sci. 2002;27(5):369-73. doi: 10.1046/j.1365-2273.2002.00596.x.
8. Krespi YP, Ling EH. Laser-assisted serial tonsillectomy. J Otolaryngol. 1994;23(5):325-7.
9. Remacle M, Keghian J, Lawson G, Jamart J. Carbon-dioxide laser-assisted tonsil ablation for adults with chronic tonsillitis: a 6-month follow-up study. Eur Arch Otorhinolaryngol. 2003;260(8):456-9. doi: 10.1007/s00405-003-0600-4.
10. Andrews PJ, Latif A. Outpatient laser tonsillar ablation under local anaesthetic. Eur Arch Otorhinolaryngol. 2004;261(10):551-4. doi: 10.1007/s00405-003-0718-4.
11. Coelho SR, Patrocínio LG, Patrocínio JA, Oliveira JAA. Estudo da histologia das tonsilas palatinas após aplicação da criptólise a laser de CO2. Int Arch Otorhinolaryngol. 2004;8:1-5.
12. Krespi YP, Kizhner V. Laser tonsil cryptolysis: in-office 500 cases review. Am J Otolaryngol. 2013;34(5):420-4. doi: 10.1016/j.amjoto.2013.03.006.
13. White JM, Chaudhry SI, Kudler JJ, Sekandari N, Schoelch ML, Silverman S Jr. Nd:YAG and CO2 laser therapy of oral mucosal lesions. J Clin Laser Med Surg. 1998;16(6):299-304. doi: 10.1089/clm.1998.16.299.
14. Bornstein MM, Suter VG, Stauffer E, Buser D. [The CO2 laser in stomatology. Part 2]. Schweiz Monatsschr Zahnmed. 2003;113(7):766-85. [French, German].
15. Mogedas-Vegara A, Hueto-Madrid JA, Chimenos-Küstner E, Bescós-Atín C. Oral leukoplakia treatment with the carbon dioxide laser: a systematic review of the literature. J Craniomaxillofac Surg. 2016;44(4):331-6. doi: 10.1016/j.jcms.2016.01.026.
16. Huang Z, Wang Y, Liang Q, Zhang L, Zhang D, Chen W. The application of a carbon dioxide laser in the treatment of superficial oral mucosal lesions. J Craniofac Surg. 2015;26(3):e277-9. doi: 10.1097/scs.0000000000001285.
17. Lee A, Lim A, Fischer G. Fractional carbon dioxide laser in recalcitrant vulval lichen sclerosus. Australas J Dermatol. 2016;57(1):39-43. doi: 10.1111/ajd.12305.
18. Frega A, Verrone A, Schimberni M, Manzara F, Ralli E, Catalano A, et al. Feasibility of office CO2 laser surgery in patients affected by benign pathologies and congenital malformations of female lower genital tract. Eur Rev Med Pharmacol Sci. 2015;19(14):2528-36.
19. Torezan LA, Careta MF, Osorio N. Intra-oral lymphangioma successfully treated using fractional carbon dioxide laser.

Dermatol Surg. 2013;39(5):816-7. doi: 10.1111/dsu.12157.
20. Mallampati SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiberger D, et al. A clinical sign to predict difficult tracheal intubation: a prospective study. Can Anaesth Soc J. 1985;32(4):429-34. doi: 10.1007/bf03011357.
21. Brodsky L. Modern assessment of tonsils and adenoids. Pediatr Clin North Am. 1989;36(6):1551-69. doi: 10.1016/s0031-3955(16)36806-7.
22. Kumar DS, Valenzuela D, Kozak FK, Ludemann JP, Moxham JP, Lea J, et al. The reliability of clinical tonsil size grading in children. JAMA Otolaryngol Head Neck Surg. 2014;140(11):1034-7. doi: 10.1001/jamaoto.2014.2338.
23. Kirkwood BR, Sterne JA. Essential Medical Statistics. 4th ed. Wiley-Blackwell; 2006. p. 502.
24. Neter J, Wasserman W, Kutner M. Applied Linear Statistical Models. 4th ed. Chicago: WCB/McGraw-Hill; 1996.
25. Diaz RR, Picciafuoco S, Paraje MG, Villegas NA, Miranda JA, Albesa I, et al. Relevance of biofilms in pediatric tonsillar disease. Eur J Clin Microbiol Infect Dis. 2011;30(12):1503-9. doi: 10.1007/s10096-011-1249-3.
26. Kosikowska P, Pikula M, Langa P, Trzonkowski P, Obuchowski M, Lesner A. Synthesis and evaluation of biological activity of antimicrobial--pro-proliferative peptide conjugates. PLoS One. 2015;10(10):e0140377. doi: 10.1371/journal.pone.0140377.
27. Kosikowska U, Korona-Głowniak I, Niedzielski A, Malm A. Nasopharyngeal and adenoid colonization by *Haemophilus influenzae* and *Haemophilus parainfluenzae* in children undergoing adenoidectomy and the ability of bacterial isolates to biofilm production. Medicine (Baltimore). 2015;94(18):e799. doi: 10.1097/md.0000000000000799.
28. Skevaki CL, Tsialta P, Trochoutsou AI, Logotheti I, Makrinioti H, Taka S, et al. Associations between viral and bacterial potential pathogens in the nasopharynx of children with and without respiratory symptoms. Pediatr Infect Dis J. 2015;34(12):1296-301. doi: 10.1097/inf.0000000000000872.
29. Cross B, Faustoferri RC, Quivey RG Jr. What are we learning and what can we learn from the human oral microbiome project? Curr Oral Health Rep. 2016;3(1):56-63. doi: 10.1007/s40496-016-0080-4.
30. Petrek M, Hubácek J, Ordeltová M. Immunomodulatory effects of laser therapy in the treatment of chronic tonsillitis. Acta Univ Palacki Olomuc Fac Med. 1991;129:119-26.
31. Zbyshko Ia B. [A comparative analysis of tonsillectomy and ablation of the palatine tonsils with CO2 laser]. Vestn Otorinolaringol. 2007(4):15-7. [Russian].
32. Zbyshko YB. [Efficacy of CO2 laser in the treatment of patients with chronic tonsillitis]. Vestn Otorinolaringol. 2007(5):57-9. [Russian].
33. Brown PM. How safe is paediatric tonsillectomy? Int J Pediatr Otorhinolaryngol. 2006;70(4):575-7. doi: 10.1016/j.ijporl.2005.12.006.
34. Marques I, Paço J, Rodrigues L. Amigdalectomia: que técnica selecionar na hora de operar? Cadernos Otorrinolaringologia-Clínica, investigação, inovação- Laringologia. 2016; 1-12.
35. Wiikmann V, Prado FA, Caniello M, Di Francesco RC, Miziara ID. Post-operatory complications in adenotonsillectomy. Rev Bras Otorrinolaringol. 2004;70(4):464-8. doi: 10.1590/s0034-72992004000400005.
36. Vieira FM, Diniz FL, Figueiredo CR, Weckx LL. Hemorrhage in adenoidectomy and/or tonsillectomy: 359 cases study. Rev Bras Otorrinolaringol. 2003;69(3):338-41. doi: 10.1590/s0034-72992003000300007.
37. Windfuhr JP, Savva K, Dahm JD, Werner JA. Tonsillotomy: facts and fiction. Eur Arch Otorhinolaryngol. 2015;272(4):949-69. doi: 10.1007/s00405-014-3010-x.
38. Rivas Lacarte M. [Tonsillectomy as a major outpatient procedure. Prospective 8-year study: indications and complications. Comparison with inpatients]. Acta Otorrinolaringol Esp. 2000;51(3):221-7. [Spanish].
39. Castellano P, Gámiz MJ, Bracero F, Santiago F, Soldado L, Solanellas J, et al. ["Usual" morbidity of pediatric tonsillectomy: a study of 126 cases]. Acta Otorrinolaringol Esp. 2001;52(5):390-5. doi: 10.1016/s0001-6519(01)78225-8. [Spanish].
40. Hoddeson EK, Gourin CG. Adult tonsillectomy: current indications and outcomes. Otolaryngol Head Neck Surg. 2009;140(1):19-22. doi: 10.1016/j.otohns.2008.09.023.
41. Havel M, Sroka R, Englert E, Stelter K, Leunig A, Betz CS. Intraindividual comparison of 1,470 nm diode laser versus carbon dioxide laser for tonsillotomy: a prospective, randomized, double blind, controlled feasibility trial. Lasers Surg Med. 2012;44(7):558-63. doi: 10.1002/lsm.22053.
42. Reichel O, Mayr D, Winterhoff J, de la Chaux R, Hagedorn H, Berghaus A. Tonsillotomy or tonsillectomy?--a prospective study comparing histological and immunological findings in recurrent tonsillitis and tonsillar hyperplasia. Eur Arch Otorhinolaryngol. 2007;264(3):277-84. doi: 10.1007/s00405-006-0162-3.
43. Gáspár L. The use of high-power lasers in oral surgery. J Clin Laser Med Surg. 1994;12(5):281-5.
44. Ishii J, Fujita K, Komori T. Laser surgery as a treatment for oral leukoplakia. Oral Oncol. 2003;39(8):759-69. doi: 10.1016/s1368-8375(03)00043-5.
45. Basu MK, Frame JW, Rhys Evans PH. Wound healing following partial glossectomy using the CO2 laser, diathermy and scalpel: a histological study in rats. J Laryngol Otol. 1988;102(4):322-7. doi: 10.1017/s0022215100104852.
46. Carew JF, Ward RF, LaBruna A, Torzilli PA, Schley WS. Effects of scalpel, electrocautery, and CO2 and KTP lasers on wound healing in rat tongues. Laryngoscope. 1998;108(3):373-80. doi: 10.1097/00005537-199803000-00012.
47. Ishii J, Fujita K, Chen M, Komori T. Clinical assessment of KTP laser surgery for tongue lesions. Comparison with CO 2 laser surgery. J Jpn Soc Laser Dent. 2001;12:10-5.
48. Fischer M, Horn IS, Quante M, Merkenschlager A, Schnoor J, Kaisers UX, et al. Respiratory complications after diode-laser-assisted tonsillotomy. Eur Arch Otorhinolaryngol. 2014;271(8):2317-24. doi: 10.1007/s00405-014-2956-z.
49. Brugmans MJ, Kemper J, Gijsbers GH, van der Meulen FW, van Gemert MJ. Temperature response of biological materials to pulsed non-ablative CO2 laser irradiation. Lasers Surg Med. 1991;11(6):587-94. doi: 10.1002/lsm.1900110614.
50. Paiva Filho O, Braz JR. Laser surgery and anesthesia. Rev Bras Anestesiol. 2004;54(1):99-107. doi: 10.1590/s0034-70942004000100014.