

CO₂ Laser Cryptolysis by Coagulation for the Treatment of Halitosis

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ABSTRACT

Objective: The aim of this study was to evaluate the impact of CO₂ laser cryptolysis by coagulation (LCC) treatment in the volatile sulphur compounds (VSC) halitometry in patients with chronic caseous tonsillitis (CCT). **Background Data:** Caseum retention and halitosis characterize CCT. Failure of clinical treatment indicated tonsillectomy. Recently, a conservative new treatment, CO₂ LCC, has been introduced. It is painless and opens the crypt ostium, thus avoiding caseum retention. Halitometry is an objective new method for halitosis diagnosis. It measures VSC in parts per billion (ppb) in breathed air. **Methods:** Thirty-eight patients with CCT and complaints of halitosis were selected, underwent physical examination and halitometry measurements, and then received four sessions of LCC. The laser technique consisted of 6-W applications, in scanned and unfocused mode, around crypts, following the shape of their openings (fluence 54.5 joules/cm²) and, afterwards, over the entire tonsillar surface (fluence 18 joules/cm²). Halitometries were done before each LCC session. **Results:** LCC was well tolerated by all patients, and all patients showed improvement in halitosis after LCC treatment. Eight patients (21%) had abnormal halitometry (>150 ppb) before treatment, but after LCC sessions their halitometry values became normal. These patients had caseum at examination. VSC measurement was reduced by 30.1%, and caseum retention was significantly decreased in this group. **Conclusion:** Abnormal halitometry in this population is related to the presence of caseum. LCC is safe, well tolerated, and improves complaints of halitosis in patients with CCT. Improvement was related to a decrease in caseum retention. Patients with abnormal halitometry had VSC halitometry improvement of approximately 30%.

INTRODUCTION

THERE ARE MANY CAUSES of halitosis, but most of them are related to the oral cavity (90%); others are related to otolaryngology and respiratory diseases (8%). Gastrointestinal diseases, liver/renal impairment, and other metabolic syndromes are minor causes (2%).^{1–5}

Halitosis is primarily related to the decomposition of organic material by anaerobic proteolytic bacteria, consequently increasing the production of odorivectors such as volatile sulphur compounds (VSC) exhaled during breathing.

Hydrogen sulfide, methylmercaptans, and dimethylsulfide are the VSC most responsible for breath malodor and they are easily perceived by human sense of smell.^{6–8} There are other

odorivectors (such as cadaverine, putrescine, and scatol) that are much less offensive to the human sense of smell than VSC.^{8,9}

Recently, methods and instruments have been developed to identify and quantify substances present in the breathed air.^{8,10} The Halimeter® is a device with an electrochemical voltammeter sensor that generates a signal when exposed to VSC sulphur compounds. It has a digital display that records the quantity of VSC in parts per billion (ppb) present in the expired air. Results below 150 ppb are considered normal.¹¹ The Halimeter® is one of the most common devices used that allows a correct diagnosis, follow-up, and reassessment of halitosis.^{8,10}

Palatine tonsils contain crypts (Fig. 1), which are twisted tubular invaginations extending from the tonsillar surface and

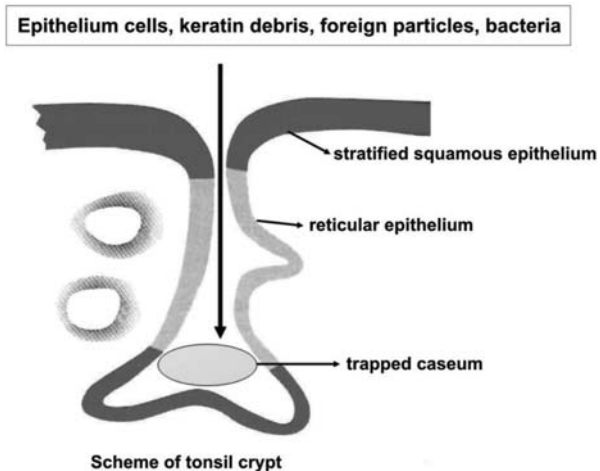


FIG. 1. Scheme of palatine tonsil crypt.

penetrating deeply through the parenchyma.^{12,13} These crypts, depending on the depth, may retain exfoliated epithelium cells, keratin debris, and foreign particles, causing the accumulation of secretion and caseum formation. Therefore, palatine tonsils are the most suitable sites for the activity of anaerobic bacteria in the upper airway system.^{13,14}

Chronic caseous tonsillitis (CCT) is a common disease at ear, nose, and throat (ENT) clinics, and complaints of halitosis among patients with CCT are prevalent (about 77%).¹⁵ This complaint can be very disabling for the patient. Caseum formation and its retention inside the tonsil crypts characterize CCT. Caseum retention also may cause inflammation, leading to hyperemia and hypertrophy of the tonsils (Fig. 2). Other CCT-related symptoms are throat irritation and sensation of foreign bodies. CCT affects both men and women at any age, in all kinds of tonsils, without any relation to their size, and can occur on one or both sides.^{12,15} Clinically, tonsil caseum is strongly related to halitosis complaint.^{13,15} However, an objective measure of halitosis (VSC halitometry) in patients with CCT has not been described previously in the literature.

The initial approach for CCT includes the use of topical anti-septics, anti-inflammatories, and oral antibiotics. When this clin-

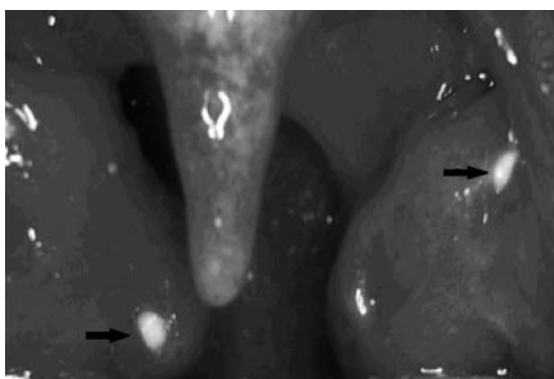


FIG. 2. Tonsil with caseum (arrows) causing hyperemia and hypertrophy in the palatine tonsils.

ical treatment does not bring relief, surgical excision of the tonsils is indicated.^{13,15,16}

Recently, a less invasive therapy has been proposed for CCT treatment in order to preserve the tonsils due to their importance in local immunological process.^{15,17} This therapy is CO₂ laser cryptolysis by coagulation (LCC). LCC is tolerated quite well by patients and is virtually painless. The treatment takes four to six sessions on average, with an interval of 4 weeks between laser sessions. The coagulation is obtained with moderate CO₂ laser power density, reaching temperatures in the tonsillary tissue of 50–100°C. Consequently, there is dehydration, whitening, and contraction of the tissue due to protein and collagen denaturation.^{15,18} With this technique, which is more conservative than conventional ones using the CO₂ laser, the laser/tissue interaction occurs only superficially in the epithelial layer, widening the tonsillar ostium, reducing crypt depth, and decreasing caseum retention.^{15,19}

Recent studies have shown that patients with CCT treated by CO₂ LCC reported a considerable clinical improvement of halitosis.^{15,19} However, a systematic and objective study using the VSC halitometry in these patients has not yet been described. The study of halitosis in these patients is justified since it is a very common symptom among these patients, and CO₂ LCC is a relatively new technique.

The aim of this study is to evaluate the impact of CO₂ LCC on the VSC halitometry profile of patients with CCT and complaints of halitosis.

METHODS

Study design

Thirty-eight adult patients of both genders, with CCT diagnosis and halitosis complaint, were selected at the Medicine Laser Unit of the University Hospital Center. These patients were evaluated by a multiprofessional team that included a senior otolaryngologist, a specialist in internal medicine, and a senior dentist.

Selection criteria

All patients were assessed at the ENT outpatient clinic at the State University of Campinas (UNICAMP). They underwent anamnesis and complete clinical/oral examinations, and answered questions related to food habits, oral hygiene, medical history, and use of medications. After failure with conventional clinical treatment for CCT, they were selected for CO₂ LCC.

The exclusion criteria were patients with prosthesis or restorations not well adapted, presence of periodontal diseases, tooth decay, exposed tooth pulps, presence of infection of the soft tissue of the oral cavity, presence of systemic diseases (such as gastrointestinal, pulmonary, hepatic, endocrine, autoimmune, or other metabolic disorders), and pregnancy. Smokers, heavy alcoholic drinkers (more than 30 g of alcohol/day), drug users, those taking any kind of regular medication, and those with xerostomia were also excluded. Except for the CCT, all patients had a normal medical history. These criteria were established to exclude other causes of halitosis.



FIG. 3. Halitometry technique.

The patients underwent four CO₂ LCC sessions with an interval of 4 weeks between the sessions. At each session, all patients were reassessed concerning symptom improvement.

The VSC halitometry test was performed immediately before each laser session. The halitometry values were recorded for statistical analysis.

Halitometry technique

Preparation. All patients received instructions before the halitometry to abstain from oral mouthwash or toothpaste, from chewing gum, and from spicy or seasoned food at least three h before halitometry, and to not fast for a period of more than four h.

All patients agreed to participate in the study in accordance with the University Ethical Research Committee and signed an informed consent agreement.

Technique. Halitometry was always performed in the same time period, at the beginning of the afternoon, on Monday, at the Multidisciplinary Group of Laser Medicine at State University of Campinas Hospital. The VSC halitometry technique (Fig. 3) followed the instruction manual for the Halimeter® (Halimeter RH-17 Series, Interscan Corp., Chatsworth, CA).

Device. The Halimeter® device measures VSC in ppb, and before each measurement it is set to 0 ppb according to manufacturer's instructions. The technique consisted of having the patient keeping his/her mouth closed for 3 min prior to testing, trimming the Halimeter® to zero, inserting a sterile straw probe 2 inches into a slightly opened mouth (the straw must not touch the lips, teeth, or internal surface of the mouth, nor could the patient blow through or inhale from the straw) and holding one's breath for the few seconds of testing, until a peak value is obtained which will occur in 8–10 sec on average. The display reading was allowed to return to ± 10 ppb before the next measurement was taken. This procedure was repeated three times, and the results were recorded.

Laser cryptolysis technique

The CO₂ laser used in this study was Sharplan 40C with nominal power of 40 W (CO₂ Surgical Lasers System, Shar-

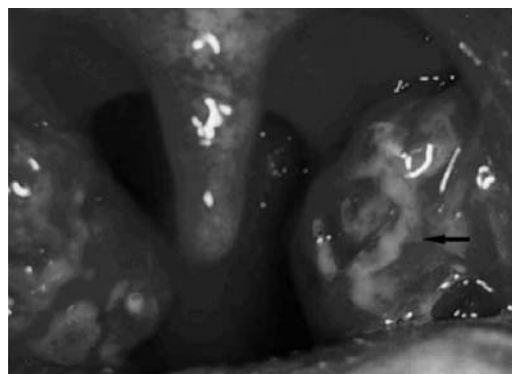


FIG. 4. Laser around the crypt (arrow). The laser fluence applied around the crypt was approximately 54.5 joules/cm².

plan Lasers, Inc., Israel) attached to an articulated arm, hand-piece, and a scanner accessory (*Swiftlase*). A smoke aspirator with biological filter, frontal light beam to illuminate the oropharynx, and protection glasses for the patient and medical team were also used. The coagulation technique with CO₂ laser,¹⁵ consisted of applications of 6 W of continuous wave (CW) laser power, in scanned and unfocused mode, over a mean area of 2.2 mm², initially only around the crypts and following the shape of their openings (Fig. 4). The laser fluence applied around the crypt was about 54.5 joules/cm². At a subsequent time, the laser beam was swept over the entire tonsillar surface with a fluence of about 18 joules/cm² (Fig. 5). It is important that the handpiece not touch the tonsils and be lined up with the labial commissura. This procedure was repeated every 4 weeks, 4 sessions in total for each patient.

To calculate the laser fluence applied around the crypt, the sweeping speed was estimated to be 5 mm/sec, the laser beam diameter 2.2 mm, and a laser power of 6 W, resulting in a energy density, or fluence, of 54.5 joules/cm². The laser was swept over the tonsillar surface at an estimated speed of 15 mm/sec, resulting in a fluence of about 18 joules/cm².

The patients were advised not to eat spices, seasonings, or acidic food, and to avoid hard or crisp food during the 2 first days after the procedure.

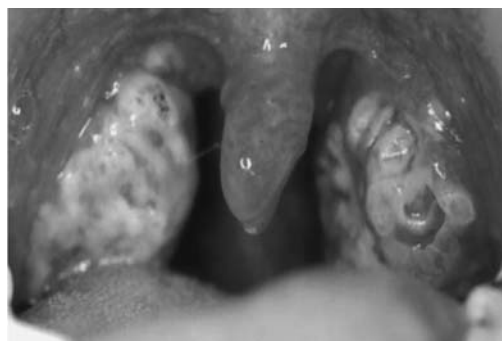


FIG. 5. Laser over the tonsil with a fluence of approximately 18 joules/cm².

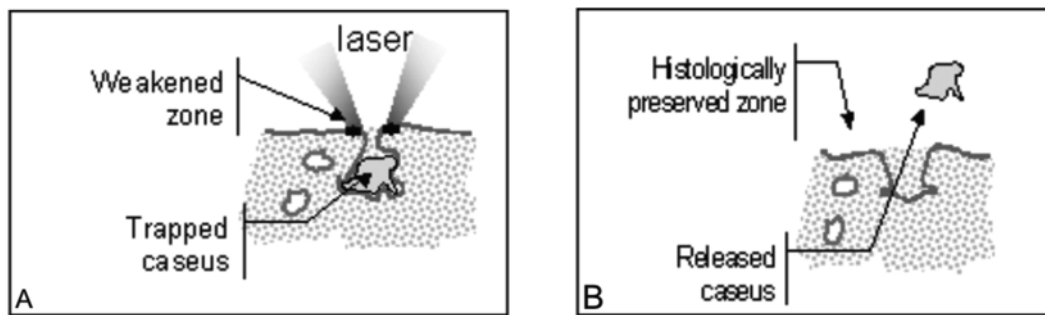


FIG. 6. Schematic representation of CO₂ laser cryptolysis by coagulation (LCC) procedure. (A) Low-energy density is applied around the crypt, causing an immediate weakening zone hit by the laser beam. (B) CO₂ laser caused the widening of the opening ostium and shallowing of the crypt, resulting in elimination of debris and of other residues, thus avoiding caseum retention.

Data treatment

An electronic data sheet was created using Microsoft Windows Excel® software with name, registration number, age, gender, the three halitometry values (in ppb of VSC), and the mean of the three measurements (in ppb of VSC).

Statistical analysis

The mean of the three halitometry values of each patient obtained before each laser session was used for the statistical analysis. Non-parametric tests were used because the population was considered to have a distribution different from normal.

The different halitometry measures were compared within the same group and between the two groups. The Friedman test was used for the intra-group comparison to analyze the halitometry profile in a population throughout treatment.

Comparisons between the groups were made using the Mann-Whitney test. Percentual variation (PV) between the second, third, and fourth laser sessions, in relation to initial halitometry, was calculated in both groups.

The PV formula was as follows:

$$PV = 100 \times (\text{halitometry}_i - \text{halitometry}_1) / (\text{halitometry}_1)$$

where $i = 2, 3, \text{ or } 4$, indicating the halitometry value of the second, third, and fourth laser sessions, and $\text{halitometry}_1 = \text{initial}$

halitometry value. Rejection level (p) was fixed at a value of ≤ 0.05 .

RESULTS

The studied population was composed of 38 patients (13 male, 25 female), with a mean age of 26 years old (SD = 9.59).

The action of CO₂ LCC was superficial, causing only epithelial coagulation, with no significant tissue slough after each laser application. This enabled a weakening of the tension forces in the crypt borders, causing them to open. This effect resulted in the reduction and even disappearance of caseum retention.

Figure 6 illustrates the laser action in the crypts. Figure 7 shows widening of the crypt ostium induced by laser action, preserving the immunological function of tonsil. Figure 8 demonstrates that the laser was effective in widening the tonsil crypts entrance.

Two groups were created:

- Group A: Patients with normal halitometry values, including those who had halitometry values below 150 ppb
- Group B: Patients with abnormal halitometry, including those who had halitometry values above 150 ppb

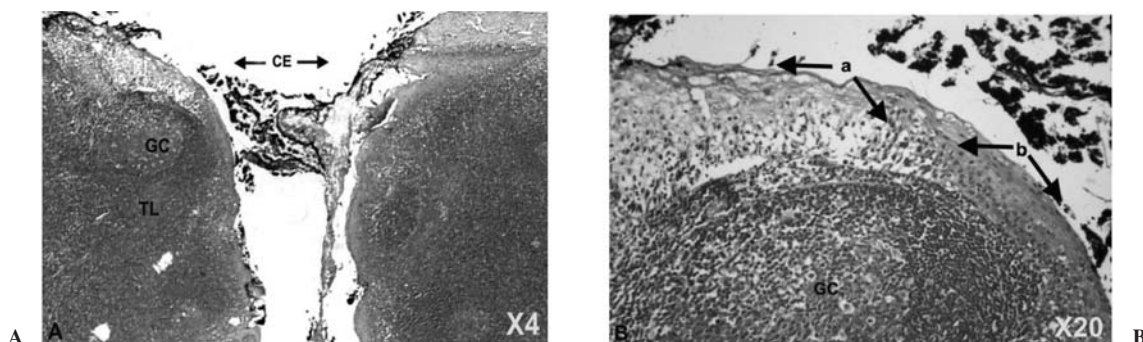


FIG. 7. (A) Histological section of one of the crypts showing the laser action. CE, crypt entrance; GC, germinal center; LT, lymphoid tissue. Original magnification, $\times 4$; H&E stain. (B) Detail of areas of damaged epithelium (a) and normal epithelium (b) pointed by arrows. Original magnification, $\times 20$; H&E stain. (From Passos et al.,¹⁹ with permission.)

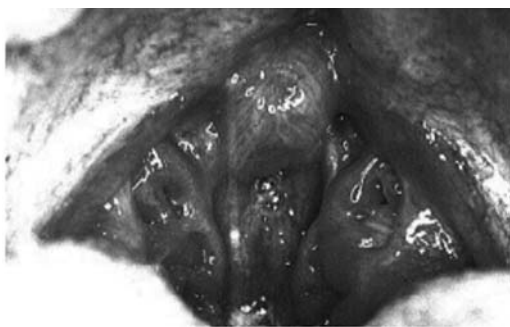


FIG. 8. Aspect of the tonsil with the crypts opened after CO₂ laser cryptolysis by coagulation (LCC) treatment. (From Passos et al.,¹⁵ with permission.)

Table 1 represents the distribution of the two studied groups in relation to sex and age.

Halitometry mean values recorded throughout CO₂ LCC treatment are represented in Table 2.

Table 3 shows that caseum was present in all patients in group B (abnormal halitometry) and in only 10% of patients in group A (normal halitometry) before treatment. Table 4 demonstrates that, at the end of treatment, caseum disappeared in all patients of group B. This improvement reflects significant amelioration of VSC halitometry in this group, as one can see in Table 5.

Comparative statistics

Intra-group comparison. Group A (normal halitometry), the Friedman test (Table 6) demonstrated that there was no statistical difference ($p = 0.398$) among the different halitometry measures taken before each laser session. In Group B (abnormal halitometry), the Friedman test (Table 6) demonstrated that there was statistical difference ($p = 0.016$) among the halitometry measures taken at each laser session.

Intergroup comparison. The PV of the second, third, and fourth halitometry values in relation to the first were calculated. The PV of Groups A and B were compared using the Mann-Whitney test. The difference between the PV of Group A and Group B in the fourth halitometry was statistically significant (Table 6).

The mean of the PV of halitometry values in relation to initial halitometry was also calculated for Groups A and B. The results demonstrated that there was a decrease of 30.1% in the fourth halitometry value when compared to the first in Group B (Table 7).

TABLE 1. DISTRIBUTION OF THE POPULATION IN GROUPS ACCORDING TO SEX AND AGE

Patients	Male	Female	Mean age	
			(years)	SD
Group A, normal halitometry ($n = 30$)	11 (37%)	19 (63%)	26.6	10
Group B, abnormal halitometry ($n = 8$)	2 (25%)	6 (75%)	21.2	5.8
Total ($n = 38$)	13 (34%)	25 (66%)	—	—

TABLE 2. HALITOMETRY MEANS IN GROUPS A AND B IN THE CO₂ LCC SESSIONS

Halitometry (in ppb)	1 st	2 nd	3 rd	4 th
Group A				
Mean	55.2	52.9	60.2	58.3
SD	25.7	24.8	25.7	23.3
Group B				
Mean	249	273	229	121
SD	182	113.8	145	75

LCC, laser cryptolysis by coagulation; SD, standard deviation.

TABLE 3. CASEUM PRESENCE IN BOTH GROUPS BEFORE CO₂ LASER TREATMENT

Caseum presence at first examination	Group A	Group B	Total
Yes	3 (10%)	8 (100%)	11
No	27 (90%)	0	27
Total	30	8	38

TABLE 4. CASEUM PRESENCE IN BOTH GROUPS AFTER CO₂ LASER TREATMENT

Caseum presence at last examination	Group A	Group B	Total
Yes	1 (3.3%)	0	1
No	29 (96.7%)	8 (100%)	37
Total	30	8	38

TABLE 5. FRIEDMAN TEST

n	Chi-square	p	Statistical significance
Group A = 30	2.959	0.398	No
Group B = 8	10.367	0.016	Yes ^a

^aThe test demonstrated that the measures of the last halitometry were, on average, less than the first and second ones.

TABLE 6. COMPARISON OF PERCENTUAL VARIATION OF GROUPS A AND B (MANN-WHITNEY)

	$PV-1_A \times PV-1_B$	$PV-2_A \times PV-2_B$	$PV-3_A \times PV-3_B$
p	0.914	0.210	0.11

PV-1, percentual variation between the second and the first halitometry value; PV-2, percentual variation between the third and the first halitometry value; PV-3, percentual variation between the fourth and the first halitometry value.

TABLE 7. HALITOMETRY PERCENTUAL VARIATION MEAN OF GROUPS A AND B

	PV-1 mean, %	PV-2 mean, %	PV-3 mean, %
Group A (n = 30)	11.3	31.3	25.4
Group B (n = 8)	170.6	130.1	-30.1

VP-1, percentual variation between the second and the first halitometry value; VP-2, percentual variation between the third and the first halitometry value; VP-3, percentual variation between the fourth and the first halitometry value.

DISCUSSION

CCT is a disease that affects both genders, without predominance.^{12,15} CCT can affect individuals at any age; however, teenagers and young adults with CCT seem to be more affected by halitosis. Our studied population was composed predominantly of young adults (average age, 26.3).

In this study, 38 patients with CCT were selected from a university hospital, with a wide age range and complaint of halitosis. These patients were assessed by specialists and were indicated for CO₂ LCC due to failure of traditional clinical treatment and trying to avoid surgical tonsillectomy in order to preserve the immunological function of the palatine tonsils.

Halitosis in CCT patients can affect men and women equally. However, the descriptive statistic of our population demonstrated that there was a predominance of young women with halitosis. From the studied population, only eight (21%) patients with CCT had abnormal halitometry. All of these patients had caseum at examination. The other 30 patients (79%) had normal halitometry, and only 10% of these patients had caseum at examination.

At first glance, these results seem paradoxical, since all patients included in this study had halitosis complaints. However, firstly, although caseum characterizes CCT, it may not be present at the exact moment of evaluation. Secondly, it is known that devices developed to detect odorivectors may not detect halitosis in all patients, because some odorivectors are not detectable by this method. There are odorivectors other than VSC that produce halitosis (such as cadaverine, putrescine, and scatol).^{9,10} Those vectors are not detectable by the Halimeter®, which can detect only sulphur-related odorivectors, and as yet, there are no other devices to detect other odorivectors.

In Group A (normal halitometry), statistical tests demonstrated that there was no difference in the halitometry values throughout the laser treatment. This means that patients with normal halitometry (below 150 ppb) before treatment continued with normal values after laser treatment. It is important to note that, in Group A, there were no side effects related to LCC, and patients experienced improvement of symptoms with regard to halitosis, sore throat, sensation of foreign bodies, and caseum formation. According to Group A patients, their quality of life improved after undergoing CO₂ LCC. The

presence of tonsillary caseum represents an increased risk to abnormal halitometry and can be considered a predictor factor for abnormal halitometry in patients with CCT (unpublished data). In Group A, tonsillary caseum was present in only 10% of the patients throughout the treatment, which means that, despite complaints of halitosis, in the absence of caseum the halitometry test was normal. This would explain why most of patients of this study did not have abnormal halitometry. Caseum was not always present in Group A. Sometimes it was present in the depth of the crypt, not visible, in a very small size, or not enough to produce VSC capable of triggering the Halimeter up to 150 ppb (a value established by the Halimeter instruction manual) but reaching values close to 150 ppb. Therefore, when there is the absence of caseum, halitometry is most likely to be normal. Sometimes, caseum is not visible upon original evaluation, but after expressing the tonsils it comes up. Sometimes the movement of swallowing presses the tonsils, and the patient ends up swallowing the caseum. So, even though caseum is not present at the time of the examination, the patient's complaint needs to be taken into account.

In Group B (abnormal halitometry), statistical tests demonstrated that there was a decrease in halitometry values with laser treatment, culminating with the normalization of VSC halitometry values in all patients at the end of treatment. These patients also experienced an improvement in their halitosis, and caseum formation practically ceased. It is important to emphasize that all patients of this group had caseum at all halitometry tests, confirming that the presence of caseum is an increased risk for abnormal halitometry.

It is known that CO₂ LCC causes epithelium cells to exfoliate. One may argue that this debris could be substrate for bacterial proliferation, causing halitosis. Nevertheless, our study did not confirm this hypothesis, maybe because CO₂ LCC was used to open the crypts, thus avoiding the retention of cells debris.

When treating the tonsils with a low-energy CO₂ laser, using unfocused scanned mode, a coagulative situation is guaranteed, with no volatilization of tissue. So, the tissue volume is preserved immediately after the laser action, having only a superficial thermal effect of little penetration, but sufficient to cause contraction along the epithelial surface, with consequent mechanical opening of the treated crypts.¹⁹⁻²¹ Superficial coagulation and contraction is similar to that observed in resurfacing treatments.^{22,23} Mechanical opening of the crypts creates less risk of retention of debris and consequently decreases caseum formation. This explains the normalization of the VSC halitometry values in patients of Group B.

The number of patients in Group B was small, and perhaps if there had been more patients in this group, a more significant statistical difference might have been revealed.

The selected patients were few because the exclusion criteria were wide and strict. Moreover, as laser treatment required numerous sessions, there were some patients who discontinued it. Patients who abandoned the treatment before the fourth laser session were, of course, excluded. Our 3-year follow-up demonstrated a decrease in tonsillitis recurrence, and there were no side effects (such as abscess formation) or other complications.

CONCLUSION

In a selected group of patients with CCT and halitosis complaint, a new conservative method of CO₂ LCC was performed in order to avoid tonsillectomy. This treatment was well tolerated, and no side effects were noted. All patients experienced an improvement of halitosis and other CCT-related symptoms. In the group of patients presenting an abnormal halitometry profile, this improvement was approximately 30.1%. All patients presented normal halitometry after four sessions of CO₂ LCC.

Finally, an increase of self-esteem was noticed in both groups, with improvement in their appearance. Patients also claimed improvement in their personal relationships with partners, parents, and friends. Overall, quality of life improved for patients with CCT and halitosis complaint after undergoing CO₂ LCC treatment. The objective measures of halitometry allowed patients to monitor their own improvement in halitosis throughout the CO₂ LCC treatment, which increased their self-confidence.

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