Transoral Carbon Dioxide Microsurgery of the Larynx as a Day-Case Outpatient Procedure: An Observational, Retrospective, Single-Center Study

Carlos M. Chiesa-Estomba, MD, MS, FEBEORL-HNS, Jon A. Sistiaga Suarez, MD, FEBEORL-HNS, Elisabeth Ninchritz-Becerra, MD, Maria Soriano-Reixach, MD, Jose A. González-García, MD, Ekhiné Larruscain, PhD, and Xabier Altuna, MD, PhD, FEBEORL-HNS

Abstract

Introduction: Despite good results of transoral laser CO₂ microsurgery (CO₂TOLMS) of the larynx, a lack of data related to the safety of this technique as a day-case procedure across the literature is evident. Materials and Methods: An observational, retrospective, non-randomized study. Results: One hundred four (62.6%) patients met the inclusion criteria, 96 (92.3%) patients were male, and 8 (7.7%) patients were female. The mean age of the study group was 66 ± 11 years (min: 34/max: 90). All the patients underwent CO₂TOLMS were treated as an outpatient procedure. The glottis was the most common location affecting 97 (93.3%) patients, regarding the need of readmission, just 4 (3.8%) patients needed to be readmitted after surgery due to dyspnea secondary to laryngeal edema in 2 cases by laryngeal bleeding, and cervical emphysema in one case, respectively. Being just necessary to reintubate 1 patient (<1%) to control the bleeding. We didn’t find any statistical correlation between variables and the need for readmission of reintubation. Conclusion: According to our results, CO₂TOLMS of the larynx can be safely performed as an outpatient procedure. To establish a proper protocol and to perform a careful preoperative assessment are essential to increase our success rate and to prevent any potential complication.

Keywords
laser, outpatient, surgery, readmission

Introduction

Transoral laser CO₂ microsurgery (CO₂TOLMS) of the larynx is a well-established surgical technique that has gained followers around the world during the last 4 decades, becoming the gold standard for almost all premalignant lesion (Dysplasia, leucoplakia, etc) and malignant early-stage cancer (Tis-T2). It also represents a safe and useful technique, associated with excellent locoregional control, overall survival, and disease-free survival, comparing with other methods.1-6

Despite the extended use of this technique and the feasibility as a day-case procedure, there is a lack of studies analyzing the risk and the rate of readmission when it is used in such a way. In spite of this, the present study aims to describe the safety of CO₂TOLMS as an outpatient procedure in a group of patients treated for malignant and premalignant lesions of the larynx in a tertiary university hospital.

Material and Methods

After the approval of the ethics committee of our institution, a retrospective analysis of data prospectively collected from 104 patients diagnosed with a larynx lesion and treated with CO₂TOLMS between July 2016 and July 2018 was performed. Those patients with definitive malignant histology were staged...
Table 1. General Patient Selection Criteria for Day-Case Procedures at Donostia University Hospital.

- Chronic illnesses like DM, HTA, controlled.
- No history of prolonged bleeding.
- No previous history of complications following general anesthesia.
- ASA-III or less.
- Procedure cannot last more than 3 hours.
- Postoperative pain must be easily controlled.
- Availability of personal transport to hospital in less than 45 minutes.
- Home access to telephone.
- Adult companion in attendance for first 24 hours after surgery.

Abbreviations: ASA, American Society of Anesthesiology grade; DM, Diabetes mellitus; HTA; arterial hypertension.

according to the criteria of the Union Internationale Contre le Cancer and the American Joint Committee on Cancer.

Demographic data, medical background, tumor stage in case of malignancy, diagnostic tests information, final histology, definitive size of the tumor reported by the pathologist, type of surgery, surgical complications, the need to visit the emergency room, and the need to be readmitted to the hospital were collected in the head and neck database of our department by the main author. Visits at the emergency room or need of readmission associated with exacerbation of chronic diseases that were not possible to associate to the use of this technique were excluded.

To consider a patient as a candidate for an outpatient CO₂ TOLMS of the larynx, a careful examination was performed in the clinic, taking into account comorbidities, familiar support, tumor or lesion characteristics, laryngeal structures affected and anatomical conformation of the mouth and neck of the patient. Those criteria followed in our department to elect candidates for an outpatient procedure were described in Table 1. General anesthesia with orotracheal intubation with special tubes for laser surgery (Laser-Shield II; Medtronics, and Mallinckrodt; Coxidien) was used. During the procedure, the O₂ level was reduced, and the cuffed tube was protected in its proximal portion with cotton sponges moistened with saline. To expose the larynx, we use a Weerd laryngoscope or Klein-sasser laryngoscope (B, C, or D) according to the type of lesions. The resection was performed using a Smartxide 2 Laser CO₂ device (Deka), with a power setting of 2 to 6 W, used in superpulsed mode and continuous setting, varying size and shape of the spot according to the moment of the surgery using the micromanipulator. The type of resection was classified according to the European Laryngological Society (ELSOC) proposal for glottic7,8 and supraglottic endoscopic resections.9 Technique report was done according to the consensus nomenclature of ELSOC.10 In the case of small tumors (T1a, T1b), whenever possible, en-bloc resection was attempted, and after resection, the piece was pinned and oriented in a corkboard.

Laser vestibullectomy was performed when a ventricular fold hid the lateral or anterior portion of a tumor. And surgeons tried to achieve a margin of healthy tissue of 1 to 3 mm, attempting to preserve function without affecting the oncological radically of the procedure when it was necessary.

In all cases, 1 mg/kg of intravenous methylprednisolone was administrated at the onset of intubation, and all patients remained for 2 hours in the postanesthetic recovery room. Patients then remained in the hospital at least 6 hours. During this period, they received a standardized postoperative treatment that included analgesics together with a further dose of 0.5 to 1 mg/kg of methylprednisolone 5 to 7 hours after extubation. The discharge was usually after review by an ENT registrar or a training nurse. All patients were required to eat, urinate, walk, and to be pain-free before discharge.

Statistical analysis was performed using SPSS for Windows, version 21.0 (SPSS, Inc). Quantitative variables in the study were expressed as mean ± SD. The potential associations between epidemiological or clinical variables and outpatient CO₂TOLMS of the larynx outcome were assessed through cross-tab generation between 2 variables (binary or categorical variables) and χ² test. Students t test was used for unpaired data. A P value <.05 was considered significant.

Results

One hundred thirteen patients met the inclusion criteria, from those 104 (92%) were included in the final analysis, while 9 (8%) patients were excluded because of the need to remained hospitalized at least for 24 hours for different reasons (Table 2). Ninety-six (92.3%) patients were male, and 8 (7.7%) patients were female. The mean age of the study group was 66 ± 11 years (min: 34/ max: 90). Twenty (19.2%) of these were diabetic, 59 (56.7%) were hypertensive, 67 (64.4%) were smokers, and 44 (42.3%) consumed alcoholic beverages. All the patients underwent CO₂TOLMS were treated as an outpatient procedure. The glottis was the most common location affecting 97 (93.3%) patients. The rest of the demographic variables are described in Table 3.

Regarding the need for readmission, just 4 (3.8%) patients required to be readmitted after surgery. The cause for readmission was dyspnea secondary to laryngeal edema in 2 cases, laryngeal bleeding and cervical emphysema in 1 case, respectively. Being just necessary to reintubate one patient (1%) to control the bleeding. We didn’t find any statistical correlation between variables and the need for readmission or reintubation.

Data about the type of cordectomy is presented in Table 2: in glottic tumors type I was the most common

Table 2. Cause to Remain Hospitalized After CO₂TOLMS.

| Cause                                           | N    |
|-------------------------------------------------|------|
| Extended dissection (including thyroid cartilage perichondrium dissection) | 7    |
| Prolonged surgery (> 3 hours)                   | 1    |
| High risk of bleeding (Pedicle clamped)         | 1    |
| Total                                           | 9    |

Abbreviation: CO₂TOLMS, tranoral CO₂ microsurgery.
type, performed in 40 patients, while for supraglottic tumors, the type IIIa was the most common one, performed in 3 patients. However, 19 (14.8%) resection couldn’t be classified. There was no correlation between the type of cordectomy and the need for readmission or reintubation ($P = .269$; Table 4).

The rate of perioperative complications was 10.6% (11/104), and in 7 patients, this corresponds to a minor complication and in 4 cases a major complication ($P = .492$). The type of complications is described in Table 5.

### Table 3. Demographic Data of Patients Included.

| Variables          | N   | %   | $P = NR$ |
|--------------------|-----|-----|----------|
| Sex                |     |     |          |
| Male               | 96  | 92.3% | .278    |
| Female             | 8   | 7.7%  |          |
| Mean Age           | 66 ± 11 years | .319 |
| (min: 34/max: 90)  |     |     |          |
| ASA                |     |     | .245    |
| 1                  | 6   | 5.8%  |          |
| 2                  | 69  | 67%   |          |
| 3                  | 28  | 27.2% |          |
| 4                  | 0   | 0%    |          |
| Comorbidities      |     |     |          |
| DM                 | 20  | 19.2% | .940    |
| HTA                | 59  | 56.7% | .417    |
| COPD               | 25  | 24%   | .243    |
| Cardiopathy        | 29  | 27.9% | .896    |
| Smoker             | 67  | 64.4% | .317    |
| Ex-smoker          | 28  | 26.9% | .164    |
| Alcohol            | 44  | 42.3% | .294    |
| Mean hospital stay |     |     | .113    |
| Histology          |     |     |          |
| SCC                | 49  | 47.1% |          |
| Keratosis          | 25  | 24%   |          |
| Leukoplakia        | 7   | 6.7%  |          |
| Granuloma formation| 6   | 5.7%  |          |
| Low-grade dysplasia| 1   | 0.9%  |          |
| Moderate-grade dysplasia| 1 | 0.9%  |          |
| High-grade dysplasia| 4  | 3.8%  |          |
| Papilloma          | 2   | 1.9%  |          |
| Adenoid cystic carcinoma| 1 | 0.9%  |          |
| Verrucous carcinoma| 2   | 1.9%  |          |
| Angioma            | 1   | 0.9%  |          |
| Need of readmission| 4   | 3.8%  | NA       |
| Cause for readmission| 4 | 3.8%  | NA       |
| Dyspnea            | 2   | 1.9%  |          |
| Bleeding           | 1   | 1%    |          |
| Cervical emphysema | 1   | 1%    |          |
| Anatomical location|     |     |          |
| Supraglottic       | 4   | 3.9%  |          |
| Glottis            | 97  | 93.3% |          |
| Subglottic         | 3   | 2.9%  |          |
| Lesion size        | 1.1 ± 0.7 cm | .690 |
| (min: 0.4/max: 2.1) |     |     |          |
| Total              | 104 | 100% |          |

Abbreviations: NR, need for readmission; DM, diabetes mellitus; HTA, arterial hypertension; SCC, Squamous Cell Carcinoma; COPD, chronic obstructive pulmonary disease; NA, not apply.

### Table 4. Type of Cordectomy.

| Type of cordectomy | Tx | Tis | pT1a | pT1b | pT2 | Total | $P = NR$ |
|--------------------|----|-----|------|------|-----|-------|----------|
| GLS type I         | 25 | 6   | 7    | 1    | 1   | 40    | .269     |
| GLS type II        | 3  | 0   | 9    | 0    | 0   | 12    |          |
| GLS type III       | 0  | 1   | 9    | 1    | 2   | 13    |          |
| GLG type IV        | 0  | 0   | 3    | 0    | 1   | 4     |          |
| GLS type Va        | 1  | 0   | 3    | 3    | 2   | 9     |          |
| GLS type Vb        | 0  | 0   | 0    | 0    | 2   | 2     |          |
| GLS type Vc        | 0  | 0   | 0    | 1    | 2   | 3     |          |
| GLS type Vs        | 0  | 0   | 0    | 0    | 2   | 2     |          |
| GLS type VI        | 0  | 0   | 1    | 0    | 0   | 1     |          |
| SGL type I         | 2  | 0   | 0    | 1    | 0   | 3     |          |
| SGL type IIIa      | 0  | 0   | 0    | 1    | 0   | 1     |          |
| Other type of resection| 0 | 0   | 0    | 0    | 14  |       |          |

Abbreviations: NR, need for readmission; GLS, Glottic laryngeal surgery; SGi, supraglottic laryngeal surgery.

### Table 5. Perioperative Minor and Major Complications in CO2TOLMS. Including Intraoperative and Postoperative Complications.

| Type of complications | N | %   | $P$ |
|-----------------------|---|-----|-----|
| Minor                 |   |     | .492|
| – Oral cavity bleeding secondary to intubation. | 2 | 1.9 |
| – Tooth damage during intubation or laryngoscopy | 2 | 1.9 |
| – Inferior lip lesion | 1 | 0.9 |
| – Pharyngeal wall bleeding during laryngoscope | 1 | 0.9 |
| – Cuff damage during laser Co2 excision (first balloon) | 1 | 0.9 |
| Total                 | 70| 6.7 |
| Major                |   |     |     |
| – Severe dyspnea after extubating | 2 | 1.9 |
| – Cervical Emphysema  | 1 | 0.9 |
| – Laryngeal bleeding  | 1 | 0.9 |
| Total                 | 4 | 3.8 |

Abbreviation: CO2TOLMS, transoral laser CO2 microsurgery.

### Discussion

During the study period, 104 (62.6%) of cases that were treated by CO2TOLMS were scheduled for an outpatient procedure, according to clinical and epidemiological criteria. From these, just 4 cases (3.8%) needed to be readmitted, without significant consequences for the patient in any case. Also, we were not able to find any statistical correlation between comorbidities, histology, size of the lesion or type of comorbidities, and the need of readmission. Results that might be related to the small number of patients who required to be readmitted, a fact that support selection criteria established in our department.

As other authors highlighted before, Co2TOLMS represents a highly efficient technique to treat malignant or premalignant lesion of the larynx that allows patients to come back to their normal life quickly. Moreover, in comparison with other techniques, like the classical open laryngeal approach for early-stage tumor, or with organ preservation techniques like radiotherapy, Co2TOLMS represents a cost-effective method...
due to the decrease in the need for hospital admission, sick leave, transportation expenses, and functional sequelae. The safety of outpatient direct laryngoscopy has been challenged in the literature owing to the fear of postoperative airway compromise. However, according to our results and the previous data published, defining rigorous inclusion criteria and following some recommendations described previous reports like the use of postoperative steroids and postoperative surveillance at least 2 hours after surgery in the recovery room, these risks related to the airway manipulation can be significantly reduced. In the previous publication by Altuna et al, any of those 73 patients underwent CO2TOLMS for early-stage laryngeal cancer required to be readmitted. Armstrong et al reported an incidence of 0.5% of reintubation after 589 direct laryngoscopies and Whinyet et al reported no major complications after 325 rigid endoscopies of the upper aerodigestive tract with less than 1% of readmission rate. Results similar to those reported in this up to date series from our department were 3.8% of the patients needed to be readmitted, and just 1% required to be reintubated.

To prevent high-risk complications, a good clinical and physical examination is essential. Perioperative complications related to CO2TOLMS are extensively described and need to be considered. These can be divided into medical or surgical complication. In the first group, we can include the risk of bradycardia or severe respiratory insufficiency. And related to specific surgical complications, the risk of postsurgical bleeding besides the coagulation capacity of the laser and the risk of airway ignition represents the most feared for surgeons, while cervical emphysema due to penetration of the cricothyroid membrane the most significant for patients, followed by tooth damage and mucosal bleeding due to a laceration of the oral cavity mucosa, the lateral pharyngeal wall mucosa, or the lip during suspension laryngoscopy.

A worldwide need for cost-effectiveness has led many health systems toward inventing new ways and improving techniques and skills in order to achieve better and safer outpatient/daycase health care delivery. Fifteen years ago, our department published an initial experience about the use of CO2TOLMS of the larynx as an outpatient procedure for larynx cancer patients. Due to the previous success, our protocol is still widely used in our department. We need to highlight some limitations in our study that can be the small sample size, the retrospective analysis of our data, the absence of economic analysis, and the lack of control group.

**Conclusion**

According to our results, CO2TOLMS of the larynx can be safely performed as an outpatient procedure. To establish a proper protocol and to perform a careful preoperative assessment are essential to increase our success rate and to prevent any potential complication.

**Declaration of Conflicting Interests**

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**ORCID iD**

Carlos M. Chiesa-Estomba https://orcid.org/0000-0001-9454-9464

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