

# Use of Carbon Dioxide Laser in Otorhinolaryngology: Experience with 640 Patients Over 10 Years

## Otorinolarenolojide Karbon Dioksit Lazer Kullanımı: 10 Yılda 640 Hastadan Elde Edilen Tecrübe

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### ABSTRACT

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**Background and Objective:** To share the single institute's experience in carbon dioxide (CO<sub>2</sub>) laser surgery in otorhinolaryngology.  
**Study Design/Materials and Methods:** Retrospective analysis of all operations performed with CO<sub>2</sub> laser between March 1996 and March 2006. Site(s) of laser use and indication(s) for operations were evaluated. All operations were performed using Compact 30 C™ by Lumenis laser system.  
**Results:** Between March 1996 and March 2006, 686 operations were done with CO<sub>2</sub> laser at 640 patients. Laser was used mostly ( 88.2%) for benign pathologies and most frequently for laser assisted uvulopalatoplasty operation. However, most frequent region that laser used was larynx.  
**Conclusion:** This paper presents the technology and application of CO<sub>2</sub> laser beam in ENT and provides a summary of the current status of this field.

#### Keywords

*Laser surgery, otorhinolaryngologic diseases*

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### ÖZET

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**Amaç:** Kliniğimizde karbondioksit lazerin kullanımında olduğu son on yıllık dönemde elde ettiğimiz sonuçların incelenmesi.  
**Yöntem ve Gereçler:** Mart 1996-Mart 2006 tarihleri arasında CO<sub>2</sub> lazer kullanılarak gerçekleştirilen tüm operasyonlar retrospektif olarak incelendi. Lazer kullanım alanları ve operasyon endikasyonları değerlendirildi. Tüm operasyonlar Lumenis firması tarafından üretilen Compact 30 C ile gerçekleştirildi.  
**Bulgular:** Mart 1996 ile Mart 2006 arasında CO<sub>2</sub> lazer ile 640 hastaya toplam 686 operasyon uygulandı. Lazer en sık (%88.2) benign patolojiler için kullanılırken en sık endikasyon lazer asiste uvuloplastiydi. Fakat lazerin en sık kullanıldığı alan larenksti.  
**Tartışma:** CO<sub>2</sub> lazer KBB alanında geniş kullanım alanı olan bir teknolojidir. Bu çalışma CO<sub>2</sub> lazerin KBB alanındaki şu andaki kullanım şekillerini özetlemektedir.

#### Anahtar Sözcükler

*Otorinolarenolojik cerrahi, lazer cerrahisi*

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## INTRODUCTION

**L**ASER is an acronym for Light Amplification by the Stimulated Emission of Radiation. Einstein postulated the theoretical foundation of laser action in 1917. In 1960, Maiman built the first laser that produced electromagnetic radiation at a wavelength of 0.69  $\mu\text{m}$  in the visible range of the spectrum with using synthetic ruby crystals. Two important advances pioneered laser use in otolaryngology: development of carbon dioxide ( $\text{CO}_2$ ) laser in 1965 and "articulated arm" system to deliver  $\text{CO}_2$  laser beam in 1968. He combined his works with Jako and used the  $\text{CO}_2$  laser with articulated arm in laryngeal surgery.<sup>1,2</sup> This is followed by various advancements in  $\text{CO}_2$  laser technology. Lasers opened new horizons in otorhinolaryngology since they improved and varied surgical techniques.

$\text{CO}_2$  laser can be used as a precise cutting tool for most of otolaryngology procedures because collateral thermal damage produced by laser on adjacent tissues is minimal.<sup>3</sup>

Several studies noted impaired wound healing with the  $\text{CO}_2$  laser incision when compared with the scalpel incision. Whereas, other studies on the healing properties of laser wound concluded that laser incisions have equivalent or better healing results than surgical knife wounds.<sup>4</sup>

With these characteristics,  $\text{CO}_2$  laser found a broad usage in otolaryngology. Operation time and hospital stay is shortened in many operations.<sup>5-9</sup> In this study,

single institute's experience in  $\text{CO}_2$  laser surgery in otorhinolaryngology practice is shared.

## MATERIALS AND METHODS

In this study, all operations performed with laser at Ankara University Faculty of Medicine Otorhinolaryngology, Head and Neck Surgery Department between March 1996 and March 2006 were reviewed retrospectively. By reviewing operation notes and patient files, we evaluated the site(s) of laser use, indication for operation and major complications occurred due to use of laser.

All operations were performed using Compact 30 C<sup>TM</sup> by Lumenis (former Sharplan), (Yokneam, Israel) laser system. For microscopic  $\text{CO}_2$  laser surgery Microslad<sup>TM</sup> laser microspot micromanipulator with 300 micron spot size at 400 mm working distance was used. For other operations Sharplan handpieces with smoke evacuation channels were used.

## RESULTS

Between March 1996 and March 2006, 644 patients were operated (690 operations) with laser at our department. Four patients that had hemangiomas at oral cavity were operated with Neodymium: Yttrium-Aluminum-Garnet Laser (Nd:YAG Laser). Remaining 686 operations were done with  $\text{CO}_2$  laser. Diagnosis of patients and operations performed with  $\text{CO}_2$  laser are presented in Table 1.

**Table 1.** Preoperative diagnosis of patients and operations performed using  $\text{CO}_2$  laser.

DIAGNOSIS	OPERATION	NUMBER OF PATIENTS
<b>OROPHARYNX</b>		
Snoring and obstructive sleep apnea	Laser assisted uvulopalatoplasty	190
Benign lesions of oral cavity	Excision	22
Malign lesions of oral cavity	Excision	18
Chronic tonsillitis, hypertrophic tonsils	Tonsillectomy/Tonsillotomy	5
<b>NASAL CAVITY</b>		
Inferior turbinate hypertrophy	Reduction of inferior turbinate	81
Nasal synechia	Synechiolysis	1
Osler Weber Rendu Syndrome	Carbonisation of telangiectatic vessels	1
<b>LARYNX</b>		
Benign laryngeal lesions	Phonosurgery	88
Malign laryngeal lesions	Cordectomy/Excision	62
Vocal cord paralysis	Posterior transverse laser cordotomy	85
Laryngeal papillomatosis	Vaporisation	31
Granulation tissue formation	Excision	23
Laryngeal web	Web excision	16
Subglottic stenosis	Endoscopic excision of stenotic tissues	2
<b>EAR</b>		
Otitis media with effusion	Myringotomy	14
Ear canal stenosis	Excision of stenotic tissues	1

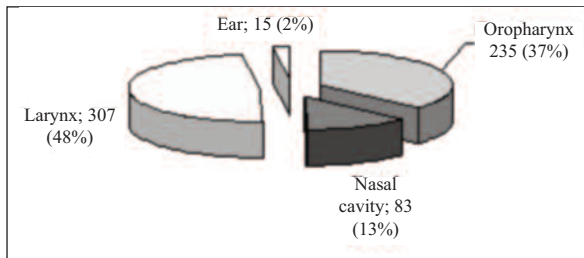


Figure 1. Distribution of operations using laser according to sites.

Distribution of laser surgeries according to sites is shown in Figure 1. CO<sub>2</sub> laser was most frequently used for laser assisted uvulopalatoplasty (LAUP) for 190 times. However, most frequent region that laser used was larynx. Patients that were re-operated using laser were mostly had laryngeal papillomatosis or vocal fold paralysis. Few patients were re-operated for recurrent laryngeal carcinoma and granulation tissue formation.

When operation numbers in proportion to the years were analyzed, we found that CO<sub>2</sub> laser was used regularly and almost in the same frequency every year for LAUP, posterior transverse laser cordotomy (PTLC) and vaporization of laryngeal papillomas.

Eighty-five percent of all CO<sub>2</sub> laser inferior turbinate reduction operations (69 of 81 cases) were performed between the years 1996-2000. CO<sub>2</sub> laser was last used in March 2003 for this indication.

Laser was used mostly (88.2%) for benign pathologies. Among benign pathologies most common indication was snoring and obstructive sleep apnea (190 patients). Laser was frequently used for excision of malignancies located in oral cavity and larynx. We used laser 81 times for malignancies, 18 patients placed in oral cavity and 62 patients in larynx. One patient was re-operated due to tumoral infiltration in surgical margins. In 1996, when we first started to use CO<sub>2</sub> laser, only 3 larynx malignancies were operated using laser, in time we started to operate nearly every all early glottic and some supraglottic cancers with endoscopic laser transoral excision.

## DISCUSSION

The laser is a precise but potentially dangerous surgical instrument that must be used with caution. Although laser surgery has distinct advantages in the management of certain benign and malignant diseases, these advantages must be weighed against the risks of

complications. Because of these risks, the surgeon must first determine if laser provides an advantage over conventional surgical techniques in particular indication. When using laser, care must be taken to avoid injury of patient, physician and operating room personnel.<sup>10-12</sup> In our department, educational courses about laser safety and usage are arranged to train operating nurses and personnel. In our experience, no complications due to safety violations have occurred during laser surgery up to date.

Since Strong and Jako first described CO<sub>2</sub> laser use in larynx and trachea surgery, microlaryngoscopic surgery is one of the most common aspects that CO<sub>2</sub> laser is found to be practical and successful.<sup>13,14</sup> In most of the pathologies, laser should be a supporting device instead of replacing cold micro dissection.

CO<sub>2</sub> laser is used for microlaryngoscopic surgery commonly and successfully since we started to use laser in our clinic. Out of 686 operations that laser was used, 353 (51%) were for laryngeal pathologies. The only major complication of these operations was endotracheal tube ignition of two cases that were not resulted in severe airway damage. Ignitions did not turn out into flame in our cases because the ignitions turned off with the colored saline inside the cuff. We would like to emphasize that during microlaryngeal surgery, beside general safety considerations, the most important issue is protection of the endotracheal tube and cuff. When we first started to use CO<sub>2</sub> laser in 1996, almost all information about safe laser use were compiled and because we obey the strict rules during operation, there was no serious complication except these two cases.

Bilateral posterior transverse laser cordotomy (PTLC) with CO<sub>2</sub> laser is a safe, effective and non-invasive procedure in the treatment of bilateral abductor vocal fold paralysis (BAVFP).<sup>15</sup> Since it eliminates the need for tracheotomy, it is a widely accepted treatment alternative.<sup>15,16</sup> In an attempt to evaluate long term acoustic, aerodynamic and functional results of the primary bilateral PTLC technique, we compared preoperative and postoperative symptom scales, spirometric measures and acoustical analysis results of 22 BAVFP patients. Successful results were obtained at first trial in 68.2 % of patients (15/22) following PTLC. Six patients needed revision procedures due to granulation tissue formation. The overall success rate was 90.9 per cent (20/22). Aspiration was not encountered. Success obtained in the laryngeal airway is long-lasting. Since PTLC

is minimally invasive and can be applied in emergency cases if required, the requirement for tracheotomy in patients with BAVFP could be reduced. Postoperative changes in voice quality do occur but appear to improve over time as the membranous part of the vocal folds is not affected. Our data confirms the safety and efficiency of primary bilateral PTLC in the treatment of BAVFP.<sup>16</sup>

Main surgical treatment alternatives for early glottic and supraglottic tumors are open surgery or micro-laryngeal surgery using laser. Different surgeons declare different stages and sizes of tumor that can be resected endoscopically. Surgeons like Steiner and Olsen propose that even advanced tumors could be resected endoscopically, but there are studies advocating laryngectomy in treatment of advanced T1 and T2 tumors.<sup>17,18</sup> We usually excise Tis, T1a, T1b, T2 glottic tumors and chosen T1 and T2 supraglottic tumors using CO<sub>2</sub> laser. Laser use in laryngeal tumors is a good alternative to open surgical procedures, since it decreases morbidity and shortens hospital stay.<sup>19</sup> The oncologic results of transoral laser surgery seem to be comparable to those of classic open surgical methods if clean surgical margins can be reached.<sup>20</sup>

We had 31 patients with laryngeal papillomatosis that underwent laser excision 46 times in total (five patients twice, three patients three times, one patient four times). Papillomas are excised using the CO<sub>2</sub> laser in the continuous superpulse mode at 2-3 watts. Lesions in trachea excised with bronchoscopy under microscope.

LAUP was first described by Kamami in 1990 and success rates up to 85% were achieved in treatment of snoring.<sup>21</sup> It is also effective for treatment of mild obstructive sleep apnea (OSA) caused by elongated uvula or soft palate loosening. In a study carried out in our clinic, 40 patients with snoring, mild and moderate OSA are treated with LAUP and pre- and postoperative snoring, midday drowsiness and apnea scores were evaluated prospectively. We found a significant decrease in these parameters in all groups and LAUP decreased snoring in 94.28 % of snoring patients without apnea.<sup>22</sup> This procedure is commonly used as an office based procedure until 2004 in our department (95% of cases). Despite its efficacy, postoperative prolonged pain requiring narcotic analgesics and difficulty in swallowing are the main drawbacks of LAUP. These problems not only decrease the patient satisfaction, but also reduce patient compliance for staged surgery. Temperature controlled

radiofrequency ablation (RFA) has been reported to be as effective as LAUP with no severe side effects and in particular pain. It is reported that only over-the-counter analgesics are required in less than half of patients after RFA, suggesting that patients may quickly return to vocational and recreational activities.<sup>23</sup> In our series, it is seen that soft palate surgery with temperature controlled RFA has mostly taken over the LAUP procedure after 2004.

Cases with nasal obstruction and congestion after long term intranasal steroid application could undergo laser photocoagulation.<sup>24</sup> In a study carried out in our department, 19 patients with inferior turbinate hypertrophy underwent inferior turbinate reduction, 17 of patients (90%) had improved symptomatically.<sup>25</sup> We performed laser turbinoplasty in 81 patients however we have mostly abandoned this technique after 2003 due to excessive crusting in nasal cavity. We recently choose to use thermocoupled radiofrequency device for this purpose, which is also an easy to perform outpatient procedure, offering a cost-effective and timesaving method for the reduction of hyperplastic turbinates.

Oral cavity and oropharynx surgery is one of the most commonly used fields of CO<sub>2</sub> laser.<sup>26</sup> Laser is preferable to cold surgery, electrocautery and cryosurgery in chosen cases because of less pain, less edema and potentiality of repeated surgery.

Benign lesions of oral cavity are either excised or vaporized under local or general anesthesia. Preferred surgical technique is excision because it allows pathologic investigation and margin assessment. Vaporization shall only be done after exact diagnosis. Since wound is covered with a layer of denaturated proteins, there is no need to suture or close up the wound. Granulation tissue formation is enough for regeneration..

In our clinic, we operated 18 patients with carcinoma in situ and early invasive squamous cell carcinoma (T1) of tongue, buccal mucosa and soft and hard palate. Only one patient with tongue carcinoma had recurrence after 1 year of follow-up, and he underwent laser excision again.

Laser is used in ear surgery, especially in stapes surgery and for myringotomy broadly. Studies showed that laser myringotomy is a good alternative to conventional surgery in early stage otitis media with effusion cases which do not require long term ventilation of middle ear.<sup>27</sup> In laser myringotomy, perforation closes later than knife because there is less inflammation. There are

centers where laser myringotomy is routinely done as an office based procedure with otoscope mounted CO<sub>2</sub> laser systems, however we do not have such a system and laser myringotomy is not in our daily practice. Recent studies showed that laser-assisted myringotomy in children with recurrent otitis media and chronic otitis media with effusion was associated with a high incidence of recurrence or persistence of disease and with perforation of the tympanic membrane.<sup>28</sup>

Laser is an expensive tool which has constant development in technology. We do not consider that latest technology is essential for most surgical interventions, for instance Microslad™ laryngeal surgery has adequate accuracy to us, though there is a new generation microspot micromanuplator available in the market. Likewise, robotic surgery makes operations easier, but if you are experienced enough, it is not essential too.

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## CONCLUSION

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Carbon dioxide laser is a very handy surgical instrument but it may be very dangerous if not used properly. Although distinct advantages are associated with the use of laser surgery in the management of certain benign and malignant diseases of the upper aerodigestive tract, these advantages must be weighed against the risks of complications. Because of these risks, the surgeon must first determine if the laser offers an advantage over conventional surgical techniques. We do not believe the latest and most expensive technology have to be bought; most of the operations in otolaryngology could be held by a relatively old laser system.

In this review, we also would like to point out that if certain safety precautions are taken during surgery, laser is safe and has a great extent of usage in otorhinolaryngologic surgery.

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