

# Peri- and post-operative complications after carbon dioxide laser surgery of the larynx

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## ABSTRACT

**الأهداف:** تحليل الأعراض المصاحبة لجراحة الليزر عبر تنجويث الفم (TLS) لأورام الحنجرة - المعهد المركزي وإعطاء الإشارة للمخاطر المحتملة.

**الطريقة:** أجريت دراسة استيعادية للأعراض قبل وبعد العملية في 500 مريض خضعوا TLS وتم تحليل بياناتهم خلال الفترة من نوفمبر 2001 حتى يوليو 2008 قسم جراحة الرأس والأنف والحنجرة والعنق - مستشفى محافظة أنهوي - جامعة أنهوي الطبية - هفوي - الصين.

**النتائج:** كان المعدل الإجمالي للمضاعفات 10.2%. سجلت المضاعفات الأساسية نسبة تتراوح 0.8%، شاملة اشتعال لدى مريض واحد، ونزيف بعد العملية لدى مريض، و ضيق التنفس لدى مريض، وحوار أمامي لدى مريض واحد. أما المضاعفات الجانبية فقد وجدت 47 من 500 مريض (9.4%) شاملة 30 مريض تنظير الحنجرة التعليقي المرتبط بالمضاعفات. تمت ملاحظة حدوث الأعراض بصفة عالية في المرضى المصابين بسرطان الحنجرة أعلى من المصابين بأفات حميدة أو محتملة الإصابة بالسرطان  $p=0.00$ .

**خاتمة:** أن الأعراض المصاحبة لما قبل وبعد جراحة الليزر لأورام الحنجرة الحميدة TLS نادرة الحدوث ولكنها منتشرة بسرطان الحنجرة. يجب على كل جراح يقوم بعمليات الليزر أن يكون له هدف واضح للسيطرة على تلك الأعراض ومبادئ منع هذه الأعراض من الظهور.

**Objectives:** To analyze the complications of transoral laser surgery (TLS) for larynx tumors in a single center institution, and to highlight its possible risks.

**Methods:** This is a retrospective study of the peri- and post-operative complications of 500 patients who underwent TLS from November 2001 to July 2008 in the Department of Otolaryngology, Head and Neck Surgery, Anhui Provincial Hospital, Anhui Medical University, Hefei, China.

**Results:** The total rate of complications was 10.2%. The major complications accounted for 0.8%,

including one ignition, one post-operative bleeding, one dyspnea, and one laryngeal web; and the minor ones were found in 47 of 500 patients (9.4%), including 30 patients with suspension laryngoscopy related complications. A higher incidence of complications was observed in patients with larynx carcinoma than those with benign/precancerous lesions ( $p=0.00$ ).

**Conclusion:** Peri- and post-operative complications after TLS for benign larynx tumors are relatively rare events, but are relatively frequent for larynx cancers. Every surgeon who performs laser surgery should have a clear concept of management for these complications, and strategies to avoid these complications should be performed.

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**T**ransoral laser surgery (TLS), or microlaryngoscopic laser surgery was initially proposed for the treatment of patients with limited glottic carcinomas, papillomas, and precancerous lesions.<sup>1-4</sup> The main advantage of laser surgery presented as organ preservation by sparing tissues not invaded by the tumor as much as possible. Previous reports have shown that laser microsurgery causes minimal morbidity and good functional results, and has a low complication alternative to open surgical procedures.<sup>1,4,5</sup> Several studies have discussed the peri- and post-operative complication rates after laser surgery, most of which concerned Western populations.

Although TLS for laryngeal tumors has been applied in Western countries for more than 30 years,<sup>6</sup> it has been no more than 20 years since it was first introduced in China,<sup>7</sup> and little attention was paid to discuss the peri- and post-operative complications concerned with this technique in the Chinese population. The aim of the present study was to assess and describe the type, and clinical significance of peri- and post-operative complications of laryngeal tumors treated with laser surgery in a tertiary referral center in China.

**Methods.** A retrospective study of 500 patients was carried out. All patients with larynx tumors treated with TLS from November 2001 to June 2008 in the Department of Otolaryngology, Head and Neck Surgery, Anhui Provincial Hospital, Anhui Medical University were included. The patients' age ranged from 2-76 years. The clinical features of the enrolled 500 patients are listed in Table 1. The end of the follow-up period was defined as May 2009, and the mean follow-up time was 33.6 months (from 11-89 months). The study obtained ethical approval from the Anhui Provincial Hospital, Anhui Medical University Ethics and Medical Research Committee. Three hundred and ninety-six patients with local benign/precancerous lesions (polyps, cyst, keratosis, and leukoplakia) had undergone mucosal ablation with carbon dioxide (CO<sub>2</sub>) laser (using non-continuous/continuous pulse mode, and 1-2 watts (W) power. The papillomas were ablated with continuous CO<sub>2</sub> laser at 5 W power in 74 patients. Cordectomies (type II-V) were performed in 104 patients with early glottal carcinoma (T1a-2N0M0) using continuous mode, and 5-10 W power. The techniques used for laser with a greater extent of resection were in accordance with the classification proposed by the European Laryngological Society in 2000.<sup>8</sup> Operations were carried out under general anesthesia using CO<sub>2</sub> laser. The patients were examined 1, 2, 3, 6, 12, and 24 months post-operatively. The retrospective clinical study presented here investigated the peri- and post-operative complications of laser surgery for laryngeal tumors. Complications were assessed according to Preuss et al.<sup>5</sup> Briefly, complications were recorded as intra-operative ones during the procedure, post-operative ones during the post-operative hospital stay, and late complications, which occurred after the inpatient period. Follow-up data were collected at periodic visits to our outpatient's department.

The frequencies of the complications between cancers and benign/precancerous lesions groups were compared by the Chi-square test. The SPSS version 11.0 package was used for the statistical analysis of the data. Two-sided *p*-values of less than 0.05 were interpreted as statistically significant.

**Results.** The complications after the laser surgical procedures are listed in Tables 2 & 3. The total rate of complications was 10.2%. According to the definition of complications suggested by Vilaseca-Gonzalez et al,<sup>9</sup> the rate of major complications was 0.8% (4/500), and the minor ones was 9.4% (47/500). The group of patients with carcinomas had a higher rate of complications in comparison with the group with the benign/precancerous lesions (26.9% versus 5.8%, *p*=0.00). Complications related to suspension laryngoscopy are listed in Table 4. Intraoperative bleeding with blood loss of approximately 150 ml occurred in 2 patients with cancer, and was stopped by CO<sub>2</sub> laser. Post-operative bleeding occurred in one cancer patient, and was stopped by microlaryngoscopic hemostasis. Tracheotomy and blood transfusion were unnecessary for those patients. One patient with laryngeal cancer staged as T2 had airway fire during the surgical procedure. After a fire was ignited inside the polyvinyl chloride (PVC) endotracheal tube, the distorted tube was removed immediately, and subsequently replaced with a new one. Dyspnea occurred when the patient was in the recovery room, and after conservative treatment for 10 days, the patient was discharged. However, one month later, the dyspnea occurred again, and examination with fiber laryngoscopy showed tracheal stenosis, and a stent was placed into the narrow trachea. The patient's condition remained stable at the last follow-up, 28 months later. A 65-year-old patient with right vocal cord cancer staged as T2 had immediate post-operative dyspnea that needed tracheotomy in the recovery room, and definitive decannulation was performed 2 weeks later. No prophylactic tracheotomy was performed in other patients. Minor mucosal lesions were found in 2.4% of all patients, and all healed spontaneously within a few days. Dental injuries occurred in 1.6% of all patients. No temporary nerve lesions were observed. Arrhythmias were observed in 10 patients, which were all sinus bradycardia, and only one patient had bradycardia before operation. When bradycardias appeared, the laryngoscope was removed immediately from suspension to relieve pressure on the larynx, then the 10 patients hyperventilated with oxygen and 6 bradycardias disappeared spontaneously. After the use of intravenous atropine (0.5-1.0 mg), the other 4 also disappeared. All the operations were performed successfully. In addition, granulomas were present in 9.6% of type II-IV cordectomies in patients with cancer 1-2 months post-operatively. All granulomas resolved spontaneously, 3 months post-operatively. An anterior commissure web was seen in 5 patients (including 3 cancers, and 2 papillomas), and one required treatment as it affected his voice and breathing. Transoral CO<sub>2</sub> laser webotomy was performed 3 months after the first surgery.

**Table 1** - Clinical characteristic of the patients (N=500).

Characteristic	n	(%)
<i>Gender</i>		
Male	405	(81.0)
Female	95	(19.0)
<i>Benign/precancerous lesions</i>		
Papilloma	74	(14.8)
Keratoses	98	(19.6)
Amyloidosis	15	(3.0)
Polyp	176	(35.2)
Cyst	17	(3.4)
Reinke's edema	16	(3.2)
<i>Cancer</i>		
T1	82	(16.4)
T2	22	(4.4)

**Table 2** - Peri- and post-operative complications (N=500).

Complications	n	(%)
<i>Intra-operative</i>		
Significant bleeding	2	(0.4)
Dental injury	8	(1.6)
Mucosal injuries	12	(2.4)
Arrhythmia (sinus bradycardia)	10	(2.0)
Ignition	1	(0.2)
<i>Post-operative</i>		
Bleeding	1	(0.2)
Dyspnea	1	(0.2)
<i>Late complications</i>		
Anterior commissure web	5	(1.0)
Granuloma	11	(2.2)
<b>Total</b>	<b>51</b>	<b>(10.2)</b>

**Table 3** - Peri- and post-operative complications of early laryngeal carcinoma (N=104).

Complications	n	(%)
Bleeding	3	(2.9)
Dental injury	3	(2.9)
Mucosal injuries	4	(3.8)
Arrhythmia (sinus bradycardia)	4	(3.8)
Ignition	1	(1.0)
Anterior commissure web	3	(2.9)
Granuloma	10	(9.6)
<b>Total</b>	<b>28</b>	<b>(26.9)</b>

**Table 4** - Complications related to suspension laryngoscopy (N=500).

Complications	n	(%)
Dental injury	8	(1.6)
Mucosal injuries	12	(2.4)
Arrhythmia (sinus bradycardia)	10	(2.0)
<b>Total</b>	<b>30</b>	<b>(6.0)</b>

accompanied by peri- and post-operative complications. We can however, say that the frequency of peri- and postoperative complications after laser surgery for tumors of the larynx was relatively low in absolute numbers.

According to the definition of Vilaseca-Gonzalez et al,<sup>9</sup> we divided the complications into major and minor ones. Minor complications were defined as those that resolved spontaneously, or with conventional outpatient treatment without any consequence, and major complications were those that required intensive medical treatment, blood transfusion, surgery, or intensive care unit (ICU) admission. Major complications either resolved completely, or resulted in sequelae. In our study, the major complications were observed in 4 patients with cancer (including one post-operative bleeding, one post-operative asphyxia, one intra-operative airway ignition, and one laryngeal web). The group of patients with carcinomas had a higher number of complications in comparison with the group with benign/precancerous lesions. This showed that the rate of complications might be related to the surgical scale and operation time. Preuss et al<sup>5</sup> reported 5 significant intra-operative bleeding, and 8 post-operative bleeding in 275 laryngeal cancer patients treated with TLS. Vilaseca-Gonzalez et al<sup>9</sup> showed that postoperative bleeding was the most frequent complication among 275 patients treated with TLS of the larynx and hypopharynx carcinomas, 22 patients experienced some type of post-operative hemorrhage (8%), and in 6 it was self-limiting (2.18%), in 16 patients (5.8%) the bleeding was considered life threatening, and endoscopic coagulation under general anesthesia was required in 15; one patient needed additional embolization to stop the bleeding, the remaining patient died. In our study, no significant intra-operative bleeding was seen in those patients with benign/precancerous lesions (0/396), and in those patients with cancers, we observed 2 significant intra-operative bleeds, and one post-operative bleed. The 3 patients with bleeding all had malignant tumors. The removed tissues of the malignant disease were much larger than those who had benign/precancerous lesions, which might be the cause of the cancer patients having a higher incidence of bleeding than those with benign/precancerous lesions. These data indicates that every medical center carrying out laser surgery should establish a clear concept on how to deal with this problem. Particularly, when large tumors are resected, the risk of vascular complications, caused for instance by endoscopic identification, and maybe injury to the internal carotid artery, has to be taken into account.<sup>12</sup> The precision intrinsic hemostatic properties and dissection of the laser have led to its wide use in airway

**Discussion.** Since 1981, a number of articles have been published on the complications associated with laser surgery of the larynx.<sup>10,11</sup> Our study shows that laser surgery of tumors of the larynx was regularly

surgery, especially in microscopic laryngeal surgery. However, the intense heat generated by the high energy density of the surgical laser can convert combustible tubes into veritable torches, cause disastrous effect, and result in severe injury to the patient. This was of particular importance when high energy was used in the continuous mode, or when the endotracheal tube was repeatedly hit by the laser at the same spot. We encountered airway fire in one patient when we adjusted the location of the intubation tube, and the saline gauze covered capsule shifted.

Sesterhenn et al's study<sup>13</sup> showed that in laryngeal laser surgery, 59/86 departments regularly use special laser tubes in daily routine (74.5%). In around 20,000 laser surgical procedures, 15 incidents of endotracheal tube fire have been reported. In 6 of the reported 15 patients, a tube fire occurred although special laser tubes had been utilized. It was vitally important, therefore, that both surgeon and anesthesiologist should understand, and anticipate the major risk factors for this potential tragedy, as well as the immediate management for this fatal complication, even when using special laser tubes other safety measures should be taken.

Suspension laryngoscopy was routinely used in diagnostic and operative laryngology. We found no major complications related to the suspension laryngoscopy. In contrast, we found mucosal lesions in 2.4% of our patients, and these lesions healed spontaneously without further treatment, and severe sequelae of endoscopy. All lip lesions were located on the lower lip, and these lesions often occurred during the insertion of the laryngoscope, when the tongue could be trapped between the frontal or lateral teeth and the laryngoscope, and incurred lesions. We found an overall dental injury rate of 1.6%. All dental injuries occurred in the upper jaw. The knowledge of the mechanisms that lead to mucosal and dental injuries would help one to avoid them, and might be helpful in mastering the endoscopic technique of TSL. There were no temporary lingual and hypoglossal nerve injuries.

Suspension laryngoscopy could also affect heart function. Strong et al<sup>14</sup> suggest that cardiac infarction, myocardial ischemia, and arrhythmias might occur during, or after microsurgery of the larynx; they were most likely to be precipitated by pressure stimulation of the deep receptors of the larynx during suspension of the laryngoscope. Wenig et al<sup>15</sup> studied the cardiac complications of suspension laryngoscopy, his result showed among 100 patients, 26 patients had significant elevations, 4 of these patients developed intra-operative arrhythmias; arterial blood gas, and cardiac enzymes were within normal limits. In our study, 10 patients with arrhythmia (sinus bradycardia) were observed,

but no major complications occurred. The results in this current study support the belief that suspension laryngoscopy could effect cardiac rhythm and blood pressure, but the incidence of intra-operative and post-operative cardiac complications was low.

Granuloma often appears 1.5-2 months after surgery, and almost all could resolve spontaneously 3 months later. We consider it was just a compensatory reaction to the surgery after most of the vocal fold was excised, so a conservative 'wait and see' policy was recommended during the first 2-3 months post-operatively, to allow for possible spontaneous recovery. An anterior commissure web was observed in 4.8% (5/104) of laryngeal cancer patients who underwent type II-IV cordectomies. Surgeons must take care to avoid anterior commissure injury during cordectomies, and encourage patients to speak early, instead of voice rest after surgery.

In conclusion, it could be said that the rate of complications related to laser surgery is low, but sometimes a surgeon has to deal with complications of different types such as ignition, bleeding, or asphyxiation. These situations forces the laser surgeon to make himself familiar with the different types of complications connected with this therapeutic mode to make its application a safe option. In this study, we did not discuss the complications related to a special disease one by one; some more detailed research work will be carried out on this in the future.

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## References

- Schrijvers ML, van Riel EL, Langendijk JA, Dikkers FG, Schuurung E, van der Wal JE, et al. Higher laryngeal preservation rate after CO2 laser surgery compared with radiotherapy in T1a glottic laryngeal carcinoma. *Head Neck* 2009; 31: 759-764.
- Hartl DM, de Monès E, Hans S, Janot F, Brasnu D. Treatment of early-stage glottic cancer by transoral laser resection. *Ann Otol Rhinol Laryngol* 2007; 116: 832-836.
- Preuss SF, Klussmann JP, Jungehulsing M, Eckel HE, Guntinas-Lichius O, Damm M. Long-term results of surgical treatment for recurrent respiratory papillomatosis. *Acta Otolaryngol* 2007; 127: 1196-1201.
- Xu W, Han D, Hou L, Zhang L, Yu Z, Huang Z. Voice function following CO2 laser microsurgery for precancerous and early-stage glottic carcinoma. *Acta Otolaryngol* 2007; 127: 637-641.
- Preuss SF, Cramer K, Klussmann JP, Eckel HE, Guntinas-Lichius O. Transoral laser surgery for laryngeal cancer: outcome, complications and prognostic factors in 275 patients. *Eur J Surg Oncol* 2009; 35: 235-240.
- Strong MS. Laser excision of carcinoma of the larynx. *Laryngoscope* 1975; 85: 1286-1289.
- Huang Z, Han D, Yu Z, Ni X, Ge X. [Evaluate the curative effect of CO2 laser in treatment of glottic carcinoma] *Zhonghua Er Bi Yan Hou Ke Za Zhi* 2002; 37: 219-222. Chinese.

8. Remacle M, Eckel HE, Antonelli A, Brasnu D, Chevalier D, Friedrich G, et al. Endoscopic cordectomy. A proposal for a classification by the Working Committee, European Laryngological Society. *Eur Arch Otorhinolaryngol* 2000; 257: 227-231.
9. Vilaseca-González I, Bernal-Sprekelsen M, Blanch-Alejandro JL, Moragas-Lluis M. Complications in transoral CO2 laser surgery for carcinoma of the larynx and hypopharynx. *Head Neck* 2003; 25: 382-388.
10. Meyers A. Complications of CO2 laser surgery of the larynx. *Ann Otol Rhinol Laryngol* 1981; 90: 132-134.
11. Fried MP. Complications of CO2 laser surgery of the larynx. *Laryngoscope* 1983; 93: 275-278.
12. Ellies M, Steiner W. Peri- and postoperative complications after laser surgery of tumors of the upper aerodigestive tract. *Am J Otolaryngol* 2007; 28: 168-172.
13. Sesterhenn AM, Dünne AA, Braulke D, Lippert BM, Folz BJ, Werner JA. Value of endotracheal tube safety in laryngeal laser surgery. *Lasers Surg Med* 2003; 32: 384-390.
14. Strong MS, Vaughan CW, Mahler DL, Jaffe DR, Sullivan RC. Cardiac complications of microsurgery of the larynx: etiology, incidence and prevention. *Laryngoscope* 1974; 84: 908-920.
15. Wenig BL, Raphael N, Stern JR, Shikowitz MJ, Abramson AL. Cardiac complications of suspension laryngoscopy. Fact or fiction? *Arch Otolaryngol Head Neck Surg* 1986; 112: 860-862.

#### Related topics

Bahannan AA, Zábrodsky M, Cerny L, Chovanec M, Lohynska R. Quality of life following endoscopic resection or radio-therapy for early glottic cancer. *Saudi Med J* 2007; 28: 598-602.

Abou Zeid HA, Arab SA, Al-Ghamdi AM, Al-Qurain AA, Mokhazy KM. Airway management of a rare huge-size supraglottic mass. *Saudi Med J* 2006; 27: 711-713.

Hamza AH, Nasr MM, Deghady AA. The use of mitomycin-C for respiratory papillomas: clinical, histologic and biochemical correlation. *Saudi Med J* 2005; 26: 1737-1745.

Al-Fattah HA, Hamza AH, Gaafar AH, Tantawy AA. Partial laser arytenoidectomy in the management of bilateral vocal fold immobility. A modification based on functional anatomical study of the cricoarytenoid joint. *Saudi Med J* 2005; 26: 1539-1545.