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## 半导体激光切除犬垂直半喉的极限范围

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**[摘要]** **目的:**观察半导体激光烧灼犬垂直半喉的极限范围,为探讨临床喉癌激光部分垂直半喉切除术的切除范围提供参考。**方法:**12只实验犬按半导体激光垂直半喉切除范围的不同随机分为3组(A、B、C, n=4),A组:向前切除前联合至甲状软骨内膜,向外切除右侧声带;B组:向前切除前联合至甲状软骨内膜及部分前联合软骨,向外切除右侧室带、声带、甲杓肌及部分环杓侧肌,向下切除至甲状软骨下缘,向后切除部分杓状软骨;C组:向前切除前联合及前联合处部分甲状软骨,向外切除右侧室带、声带、甲杓肌、环杓侧肌及声门旁间隙达甲状软骨板,向下切除部分环甲膜至环状软骨上缘,向后完全切除右侧杓状软骨。术后即刻、1周和4周分别观察各组犬创面恢复情况、犬吠声嘶情况及术后并发症发生情况等,评价术后疗效。**结果:**术后1周喉镜下见:A、B组手术创面即有新生黏膜覆盖;C组创面新生黏膜覆盖不全,局部有感染迹象。A、B组无明显术后并发症,C组并发进食呛咳。4周后喉镜下见:各组创面黏膜表面光滑,前联合处粘连形成喉蹼并有新的前联合。A组术侧见新声带形成,声门关闭仅见小缝隙;B组新声带较健侧窄、薄,声门关闭不全;C组原声带处仅见黏膜微微隆起,声门严重关闭不全。A组无明显声嘶,B组中度,C组声嘶较重,进食呛咳消失。C组术侧甲状软骨板较对侧变薄。**结论:**半导体激光烧灼实验犬垂直半喉极限切除时,可将甲状软骨板内侧软组织全部切除,包括杓状软骨和前联合处部分甲状软骨,术后可以得到满意的修复而无明显并发症。

**[关键词]** 垂直半喉切除术;激光;声带;甲状软骨内膜;杓状软骨

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### Resection range of dog hemi-vertical larynx by semiconductor laser

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**[ABSTRACT]** **Objective:** To observe the resection range of dog hemi-vertical larynx by semiconductor laser. **Methods:** Twelve dogs were randomly divided into three groups (A, B and C, n=4). Group A: the hemi-vertical larynx was cauterized forward from the anterior commissure to thyroid cartilage internal membrane, outwards including the right vocal cords. Group B: the hemi-vertical larynx was cauterized forward from anterior commissure to thyroid cartilage internal membrane and partial cartilage of anterior commissure, outwards including the right ventricular fold, vocal cord, thyroarytenoid muscle and partial lateral cricoarytenoid muscle, downwards including the lower edge of thyroid cartilage, and backwards including the partial arytenoid cartilage. Group C: the hemi-vertical larynx was cauterized forward including the anterior commissure and partial thyroid cartilage of anterior commissure, outwards including the right ventricular fold, vocal cord, thyroarytenoid muscle, lateral cricoarytenoid muscle and paraglottic space to thyroid cartilage, downwards including the partial cricothyroid membrane to the upside of cricoid cartilage, and backwards including total right arytenoid cartilage. The recovery of the laryngeal wounds, hoarseness, and complications were observed and evaluated by using digital camera and electrolaryngoscope immediately, 1 week and 4 weeks after operation. The treatment outcome of the resection was evaluated. **Results:** The laser surgery was completed

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successfully in all the animals. Laryngoscope showed that the neonatal membrane covered the wound in group A and B one week later, without obvious complications. The neonatal membrane covered part of the wound in group C, accompanied by inflammatory reaction and cough when eating. Four weeks later the new membrane over the wound surface were smooth in all the three groups; adhesion appeared in the anterior commissure and new anterior commissure was formed. A new vocal cord was formed in group A; only a small gap was seen when the glottis was closed. In Group B, the new vocal cord was narrower and thinner; granulation growth was seen in local areas; and the glottis was closed incompletely. In Group C, mucosa was slightly raised over the original location of the vocal cord. Closure of the glottis was poor. Group A had no hoarseness, Group B had moderate, and Group C had severe hoarseness, but without cough when eating. Also in Group C the lamina of thyroid cartilage of the operative side was thinner than that of the contralateral side. **Conclusion:** When cauterizing dog partial hemi-vertical larynx using semiconductor laser, we can resect all the soft-tissue internal the thyroid cartilage, including the arytenoid and partial thyroid cartilage in the anterior commissure. The repair is satisfactory after operation, without obvious complications.

**[KEY WORDS]** hemi-vertical laryngectomy; laser; vocal cords; thyroid cartilage internal membrane; arytenoid cartilage

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激光手术用于治疗早期喉癌是近年来耳鼻咽喉-头颈外科手术治疗的重要进展,与传统手术相比具有明显的优势<sup>[1]</sup>。Altuna等<sup>[2]</sup>认为其甚至可在部分门诊喉癌患者中进行而无需住院。但目前激光手术治疗喉癌的确切适应证仍不清楚,手术中喉部切除的极限范围也不明确。部分学者认为,激光手术适合于较早期声门癌(Tis、T1及T2)的治疗<sup>[3-4]</sup>;但黄志刚等<sup>[5]</sup>认为只要支撑喉镜下病变暴露满意,晚期声门癌(如T3)也可以进行激光手术,但切除范围不很明确。因此,本研究采用自行研制的激光光纤把持器,以半导体激光烧灼犬垂直半喉不同范围,观察术后创面恢复情况,为进一步探讨临床喉癌激光部分垂直半喉切除术的切除范围提供参考。

## 1 材料和方法

1.1 主要仪器及设备 英国产 Diomed-25 半导体激光器,国产支撑喉镜,日本产 Olympus P-240 型电子喉镜,日本产 Casio 数码照相机,喉显微外科手术器械,与纤维喉镜配套的日本产 Sony 电视监视器系统。

1.2 动物来源及分组 12 只实验犬购自第二军医大学动物实验中心,雌雄不限,体质量 10~17 kg,随机分为 3 组(A、B、C,  $n=4$ ),分别编号为 1、2、3、4,模拟支撑喉镜下垂直半喉半导体激光手术的全过程。

### 1.3 犬垂直半喉半导体激光切除术

1.3.1 术前麻醉及处理 术前 8 h 禁食,以 3% 戊巴比妥钠按 30 mg/kg 腹腔注射进行麻醉,并以适量上述药品腹腔注射维持麻醉。术中、术后用吸引器吸除口腔及气管内分泌物,清醒后送返动物室。全身麻醉后,用前联合喉镜暴露犬喉部,采用自行研制的激光光纤把持器(专利号:ZL 04 2 0020225.5),以半导体激光光纤插入把持器内,由于把持器前端由可弯曲金属材料制成,因此激光光纤有较大的烧灼范围(图 1)。

激光输出功率 10 W,采用连续输出方式。

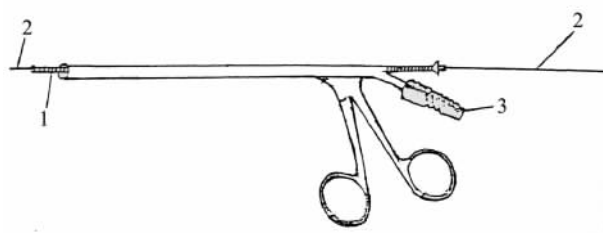


图 1 自制激光光纤把持器

Fig 1 Self-made laser fiberoptic holder

IP Number: ZL 04 2 0020225.5; 1: Bendable part of the holder; 2: Laser optic fiber; 3: Suction joint

1.3.2 手术烧灼范围的选择 手术烧灼范围参考国外喉激光手术切除范围和深度 5 型标准<sup>[3]</sup>及国内黄志刚等<sup>[5]</sup>的术式,进一步扩大切除范围,以探讨可能的手术切除极限。具体手术切除范围, A 组:向前切除前联合至甲状软骨内膜,向外切除右侧声带; B 组:向前切除前联合至甲状软骨内膜及部分前联合软骨,向外切除右侧室带、声带、甲杓肌及部分环杓侧肌,向下切除至甲状软骨下缘,向后切除部分杓状软骨; C 组:向前切除前联合及前联合处部分甲状软骨,向外切除右侧室带、声带、甲杓肌、环杓侧肌及声门旁间隙达甲状软骨板,向下切除部分环甲膜至环状软骨上缘,向后完全切除右侧杓状软骨。

1.4 术后随访观察 术后即刻、1 周和 4 周分别用数码相机或电子喉镜拍照观察各组动物喉部创面情况,并记录犬吠声嘶状况、体质量变化及有无术后并发症等。

1.5 统计学处理 采用 Two-way ANOVA 方法进行数据分析,  $P < 0.05$  为差异有统计学意义。

## 2 结果

2.1 一般情况 所有激光手术均一次顺利完成。

各组4号犬术后即刻无痛处死,以数码相机拍照,标本观察手术切除范围与术前设计一致。3组犬体重变化见表1。从表1中数据可见,由于手术的原因,实验犬术后早期(1周内)进食受到一定影响,体质量较术前明显减轻。随着时间延长,创面修复,手术后期(4周),实验犬进食逐渐恢复,A、B两组犬术后体质量较术前无明显差异,C组仍有明显差异( $P < 0.05$ ),提示该组恢复需要更长时间。

**表 1 各组犬术后体质量的变化**  
**Tab 1 Body weight changes of dogs**  
**in each group after operation**

( $n=3, \bar{x} \pm s, m_B/kg$ )

Group	Pre-operation	Post-operation <i>t</i> /week	
		1	4
A	15.83±0.71	14.03±0.76*	15.34±0.95
B	16.00±1.00	14.83±1.04	15.15±0.73
C	15.73±0.76	13.07±0.69*	13.29±1.01*

\*  $P < 0.05$  vs pre-operation

2.2 各组术后创面变化 术后即刻喉镜下所见:A组创面有激光烧灼后的黄褐色焦痂(图2A);B组创面有激光烧灼后的黄褐色和黑色焦痂(图2B);C组创面有激光烧灼后的黑色和黄褐色焦痂(图2C)。术后1周喉镜下所见:A、B组手术创面即有新生黏膜覆盖,术区水肿,炎性反应;C组创面新生黏膜覆盖不全,术区水肿,可见肉芽生长,局部见渗出较多,呈糜烂样,有感染迹象。声嘶及并发症:A、B组轻中度犬吠声嘶,无明显术后并发症;C组仅闻呼吸声,并发进食呛咳。

2.3 各组术后4周创面变化 术后4周后喉镜下所见:A、B、C3组创面黏膜表面光滑,前联合处粘连形成喉蹼并有新的前联合。A组术侧见新声带形成,声带长度较术前缩短,声门关闭仅见小缝隙(图3A)。B组新声带较健侧窄、薄,局部见肉芽样组织,声门关闭不全(图3B)。C组原声带处仅见黏膜微微隆起,声门严重关闭不全(图3C)。声嘶及并发症:A组无明显声嘶,B组中度,C组声嘶较重,进食呛咳消失。标本所见:C组术侧甲状软骨板较对侧变薄。



图 2 术后即刻创面观察结果

Fig 2 Wound surface immediately after laser burning

A: In group A, yellow-brown eschars were seen on the wound surface after laser burning. The right vocal cord was removed completely. B: In group B, yellow-brown and black eschars were seen on the wound surface after laser burning. C: In group C, black and yellow-brown eschars were seen on the wound surface after laser burning



图 3 术后4周创面观察结果

Fig 3 Wound surface 4 weeks after laser burning

A: In group A, mucosa over the wound surface was smooth; a new vocal cord formed on the right side, though it was thinner than the contralateral healthy one and the position was a bit lower; only a small gap was seen when the glottis was closed. B: In group B, mucosa over the wound surface was smooth; the external residual tissue of the right vocal cord formed a new cord-like structure at the place a bit lower to the contralateral cord, though it was narrower and thinner than the healthy one; granulation growth was seen in local areas; and the glottis was closed incompletely. C: In group C, dark red newborn mucosa was seen over the wound surface, where there was no sign of exudation and infection. Mucosa was slightly raised over the original location of the vocal cord. Closure of the glottis was poor. The lamina of thyroid cartilage of the operative side was thinner than that of the contralateral one

### 3 讨论

本研究使用的自行研制简易激光光纤把持器,其光纤导管前端可以适当弯曲,增加了激光手术中的视野,为手术提供了较大方便。Damm等<sup>[6]</sup>对支撑喉镜下垂直半喉部分切除激光手术的切除范围进行了探讨,认为:激光手术垂直半喉切除适合于T1、T2期喉癌患者,并应密切随访,防止局部复发;T3期患者是否合适应根据手术能切除的范围而定。Motta等<sup>[7]</sup>认为声门癌如果没有侵犯到软骨,都可以进行激光手术,其喉结构保留率优于开放式手术。Davis等<sup>[8]</sup>为了观察喉内结构对CO<sub>2</sub>激光声带切除术的限制作用,对9例人尸体喉标本进行激光声带切除术,发现向外受到甲状软骨的限制,向下受到环状软骨的限制,而后界无明显限制性结构。近年来,国内黄志刚等<sup>[9]</sup>对支撑喉镜下应用CO<sub>2</sub>激光对喉部分切除范围也进行了相关研究,认为激光手术适合于T2、T3期喉癌病变<sup>[5,10]</sup>。

本研究应用Diomed-25半导体激光烧灼犬垂直半喉不同范围后,观察其创面术后即刻、1周和4周后恢复情况,并记录犬吠声嘶状况、体质量变化及术后并发症出现情况等,为进一步探讨临床喉癌垂直半喉激光切除范围提供参考。结果表明,Diomed-25半导体激光用光纤传输系统传导,与支撑喉镜及可弯曲的激光光纤把持器配合使用,可以达到更大的手术范围。结果表明,向前前联合处可以切除至甲状软骨内膜,并且可切除前联合处甲状软骨;向外可切除室带、声带、甲杓肌、环杓侧肌及声门旁间隙达甲状软骨板内侧;向后切除杓状软骨;向下可切除至环甲韧带和环状软骨上缘。总之,采用半导体激光技术切除垂直半喉可以达到手术预期的切除范围,与经典喉垂直部分切除范围相比,其保留了甲状软骨板,而且避免了气管切开等创伤。

本研究手术术后各组标本观察,可见创面已修复,A、B两组喉内结构基本变化不大,A组声门闭合仅有细小缝隙;B组存在声门关闭不全;C组于原声带处仅见黏膜微微隆起,声门严重关闭不全,术侧甲状软骨板较对侧变薄。犬吠声嘶状况随着切除范围增大而逐渐加重,C组仅闻呼吸声。A、B两组术前、术后体质量无明显变化,C组术后早期减轻较其

他两组明显,但4周后可基本恢复术前水平。除C组术后早期偶见进食呛咳外,其他各组均未见明显并发症发生。3种切除范围的犬喉部手术效果均较理想,实验犬垂直半喉不同范围切除后,其创面恢复情况有差异,但最终创面均可获得良好愈合。

综上所述,半导体激光烧灼实验犬垂直半喉极限切除时,可将甲状软骨板内侧软组织全部切除,包括杓状软骨和前联合处部分甲状软骨,术后可以得到满意的修复而无明显并发症。支撑喉镜下暴露的范围与临床手术过程基本相似,可基本反映临床手术过程,对临床喉癌激光垂直半喉切除术有一定的参考价值。需要指出的是,动物实验与临床手术还是存在差异的,与人相比,实验犬的开口度较大,头可过度后仰,舌根部组织较薄,支撑喉镜完整暴露喉部较容易,且结构上犬室带、声带较薄。

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