A Histopathological Comparison of Two Techniques for Soft Palate Resection in Normal Dogs

Eighteen dogs were used to compare histopathological findings following excision of the soft palate using either a bipolar sealing device or a carbon dioxide laser. Histopathological comparisons were done at 48 and 96 hours after soft palate resection. Mean depths of tissue injury at 96 hours were 3.5 and 3.33 mm for bipolar sealing device and carbon dioxide laser, respectively. Control of hemorrhage was excellent in all dogs, and none of the dogs developed signs of respiratory compromise after soft palate resection. Using the bipolar sealing device for soft palate resection was significantly faster than using the carbon dioxide laser, although both techniques were fast. J Am Anim Hosp Assoc 2007;43:39-44.

Introduction

Elongated soft palate is the most common upper airway anomaly diagnosed and surgically treated in brachycephalic dogs. Breeds commonly affected include the English bulldog, pug, and Boston terrier. The elongated soft palate may also be accompanied by other primary anatomical abnormalities, including stenotic nares and hypoplastic trachea. Such conditions increase negative airway pressure that may produce secondary abnormalities such as everted laryngeal saccules and laryngeal collapse. Together, these abnormalities may result in inspiratory dyspnea and unusually high airway resistance, with secondary respiratory distress, soft-tissue edema, upper airway obstruction, and death. Some of these abnormalities require surgical procedures to relieve the obstructive signs.

Surgical resection is the preferred procedure to treat elongated soft palates in brachycephalic dogs. Traditional resection is performed by sharply excising a portion of the soft palate and apposing the oral and nasal mucosa with sutures. Monopolar electrocautery has also been used to perform the resection. One report demonstrated that the carbon dioxide (CO₂) laser is an acceptable tool that may be utilized for soft palate resection. A second report documented similar clinical outcomes between the CO₂ laser and the traditional method, and significantly shorter surgical times with the CO₂ laser. In this study, the authors have utilized a bipolar sealing device (BSD), which is an electrosurgical bipolar vessel sealer, for soft palate resections. This is the first report of using a BSD for soft palate resections. The instrument provides firm compression and adjusts the bipolar current depending on the impedance to current flow through the compressed tissue. The BSD utilizes pressure and electrical current to cauterize soft tissues and permanently seals the collagen and elastin in vessel walls up to 7 mm in diameter.

This preliminary study was conducted in normal dogs before doing the procedure in clinical patients, as the authors wanted to compare the histopathological findings to be sure the BSD was safe to use during soft palate resection, and to identify any clinical complications following...
removal of a portion of the soft palate using either the BSD or CO₂ laser.

Materials and Methods

The Institutional Animal Care and Use Committee approved this study. Subjects included six female, adult mongrel dogs (weight range 15.8 to 23.2 kg, mean 18.33 kg) for the 48-hour samples and 12 male, adult beagles (weight range 9 to 12 kg, mean 10.16 kg) for the 96-hour samples. All dogs were research dogs and were to be euthanized following unrelated studies. All dogs were randomly assigned to either the BSD or CO₂ laser group, with three females and six males in each group. All dogs were premedicated using acepromazine (0.05 mg/kg intramuscularly [IM]) and buprenorphine (0.01 mg/kg IM), followed by induction with thiopental (12 mg/kg intravenously [IV]). The dogs were intubated and maintained under isoflurane in oxygen.

For the BSD procedure, the dogs (n=9) were placed in dorsal recumbency, and the maxilla and mandible were taped open to facilitate access to the soft palate. An Allis tissue forceps was placed on the caudal tip of the soft palate. The BSD was applied to the lateral edge of the soft palate at the level of the middle third of the tonsils [Figure 1] and directed cranially and medially to the level of the rostral third of the tonsil [Figure 2]. The BSD was set to the lowest energy setting and activated until 1 to 2 mm of blanched tissue could be seen on either side of the forceps. The BSD was removed, and the palate was transected using Metzenbaum scissors, leaving 1 mm of blanched tissue at the site of resection [Figure 3]. The BSD was then applied to the opposite side, starting at the same level and directed centrally to meet the end of the initial resection. The palate resection was completed by cutting through the blanched tissue. Depending upon the size of the dog, a third or fourth application of the BSD was required to treat the entire width of the palate.

The dogs (n=9) in the CO₂ laser group were placed in sternal recumbency. Excision of the palate using the CO₂ laser started laterally from the caudal aspect of the tonsillar crypt and coursed cranially and medially to a level opposite half the length of the tonsillar crypt [Figure 4]. The excision was then directed caudally toward the contralateral aspect of the tonsillar crypt. The procedure was performed using a 0.8-mm tip at a setting of 10 watts in noncontact, supr pulse mode. The resulting power density was 2000 watts/cm². The endotracheal tube in each of these dogs was wrapped with reflective tape and saline-soaked gauze sponges to prevent potential damage and combustion from the CO₂ laser. Wet gauze was also inserted behind the soft palate to prevent inadvertent damage to adjacent tissues.

The length of time for each procedure was recorded. The start time was defined as the time either the BSD or CO₂ laser was activated, and the end time was defined as the moment when the soft palate was completely freed of any attachments.
The dogs were recovered, extubated, and monitored hourly for a total of 6 hours for clinical signs associated with the respiratory tract, such as coughing, stridor, snoring, gagging, cyanosis, altered respiratory rate, and abnormal mucous membrane color. One hour after extubation, each dog was given buprenorphine (0.01 mg/kg IM) and carprofen (2.2 mg/kg subcutaneously [SC]) for pain control.

The dogs were euthanized at either 48 hours (BSD [n=3], CO₂ [n=3]) or 96 hours (BSD [n=6], CO₂ [n=6]) after the procedure. The remaining portion of the soft palate was removed, sutured to cardboard, and fixed in 10% buffered formalin. Full-thickness sections (4-mm wide) were made perpendicular to the edge of the excision at the midline of the palate. The sections were embedded in paraffin, sectioned at 3 µm, and stained with hematoxylin and eosin. The slides were randomized and evaluated by a single pathologist (Howerth). A histopathological description was generated for the samples (n=1) from each palate. In addition, each palate was subjectively graded from 0 to 3 for five changes—namely, inflammation, fibroplasia, edema, hemorrhage, and necrosis. The grades were assigned as 0=no change, 1=mild changes, 2=moderate changes, and 3=severe changes for each category. Maximum depth of change was also recorded for each sample, and data for each were expressed as mean ± standard deviation (SD).

A normality test was performed prior to application of an unpaired t-test for each histological category from the 96-hour samples and for comparison of the surgical durations. If the data were nonparametric, a rank sum test was performed. A value of P<0.05 was considered significant.

**Results**

The time for surgical resection of the soft palate using the BSD technique (mean 67.5±14.1 seconds, range 45 to 90 seconds) was significantly less (P<0.001) than with the CO₂ laser (mean 174.5±76.5 seconds, range 90 to 313 seconds). During the 6 hours of postoperative monitoring, capillary refill times, mucous membrane color, and respiratory rate were normal for all 18 dogs. No snoring, gagging, or stertor was observed in any of the dogs. Two of the BSD dogs coughed at the time of extubation, but no coughing was observed during the remainder of the recovery period.

At 48 hours after surgery, palates excised by both techniques had similar histopathological changes, which could be subdivided by depth. In the superficial layers, neutrophils, fibrin, and thrombosed vessels were seen. In the deeper tissues was an area of edema, neutrophilic infiltration, hemorrhage, myofiber degeneration, and necrosis (Table 1; Figures 5A-5D). Mean depths of maximum tissue injury at 48 hours were 4.7±1.2 mm for the BSD and 5.3±1.5 mm for the CO₂ laser.

At 96 hours after surgery, palates resected by both methods also had similar histopathological changes. Changes could be divided into three distinct depths or layers. The superficial layer was composed of fibropurulent exudate.

![Figure 4](image1)

**Figure 4**—Illustration of a dog in ventral recumbency, which was the position used for the CO₂ laser technique. The CO₂ laser is used to resect the excess palate. Saline-soaked gauze protects the adjacent tissue, and reflective tape protects the endotracheal tube from the laser energy.

![Figures 5A-5D](image2)

**Figures 5A-5D**—Photomicrographs of soft palate samples taken 48 hours postresection with a CO₂ laser (A, B) or a bipolar sealing device (C, D). All sections are stained with hematoxylin and eosin. (A) Note the thick, superficial layer of neutrophils and fibrin (S) and the deeper necrosis and edema of the underlying muscle and soft tissues (N) that extend beyond the field of view (bar=2 mm). (B) High-magnification image of the area outlined by the box in Figure 5A, depicting the junction between the superficial exudate and underlying necrosis, with infiltrating neutrophils (P) and myofiber degeneration (arrow) (bar=200 µm). (C) Note the thick, superficial layer of neutrophils and fibrin (S), as well as necrosis and hemorrhage of the underlying muscle (N) that extends beyond the field of view (bar=2 mm). (D) High-magnification image of the area outlined by the box in Figure 5C, illustrating the junction between the superficial exudate and underlying necrosis and showing infiltrating neutrophils (P), fibrin (F), thrombosed vessel (T), and myofiber degeneration (arrow) (bar=200 µm).
The middle layer had necrosis, edema, fibrin, mild to moderate hemorrhage, mild neutrophilic infiltration, and thrombosed vessels. The deepest layer had a mild infiltration of neutrophils and early fibroplasia [Figures 6A-6D]. None of the grading results of the histopathological comparisons between the operated groups were significantly different [Table 2]. Mean depths of maximum tissue injury at 96 hours were 3.5±1.23 mm and 3.33±1.03 mm for BSD and CO2 laser, respectively.

**Discussion**

Use of the BSD or CO2 laser for resection of elongated soft palates offered rapid operating times, produced minimal hemorrhage, and created limited collateral tissue injury. The collateral damage was comparable for the BSD and CO2 laser in this study. Use of the BSD does not require the safety precautions necessary for the use of the CO2 laser. In accordance with the Federal Laser Product Performance Standard, these requirements include use of a laser-safe room with appropriate signage, closed windows and doors, minimal personnel traffic, and the wearing of laser-safe glasses by everyone in the room. When using a laser in the animal’s airway, special precautions must also be taken to protect the endotracheal tube. Although it is an electrocautery device, the BSD differs from a typical handheld electrocautery device, in that a BSD provides compression of the tissues, and continuous adjustments are made to the amount of energy that is delivered to the tissue, resulting in a precise and controlled delivery of energy.

Use of either the CO2 laser or the BSD requires operator training and experience with the instrumentation. The CO2 laser requires the user to have knowledge of appropriate power settings and the rate at which the tip is advanced across the tissue. In the study reported here, a power setting of 10 watts delivered by a 0.8-mm tip (equalling a power density of 2000 watts/cm²) was used. This technique differed from the previous reports, because the super-pulse mode was utilized instead of the continuous-wave mode.

**Table 1**

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<th>Method of Resection</th>
<th>Case No.</th>
<th>Inflammation</th>
<th>Fibroplasia</th>
<th>Edema</th>
<th>Hemorrhage</th>
<th>Necrosis</th>
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*0=no change; 1=mild changes; 2=moderate changes; 3=severe changes

**Figures 6A-6D**—Photomicrographs of soft palate samples taken 96 hours postresection with a CO2 laser (A, B) or a bipolar sealing device (C, D). All sections are stained with hematoxylin and eosin. (A) Note the superficial layer of neutrophils (S) and necrosis of the underlying muscle and soft tissues (N) that is demarcated by a rim of inflammation and early fibroplasia (arrows) (bar=2 mm). (B) High-magnification image of the area outlined by the box in Figure 6A, showing fibroplasia (F) that demarcates the deep edge of the necrotic tissue; M=muscle fiber (bar=200 µm). (C) Note the superficial layer of neutrophils (S) and necrosis of the underlying muscle (N) that is demarcated by a rim of inflammation and fibroplasia (arrows) (bar=2 mm). (D) High-magnification image of the area outlined by the box in Figure 6C, showing fibroplasia (F) that demarcates the deep margin of the necrotic tissue; M=remnant degenerative myofiber (bar=200 µm).
The super-pulse mode of the CO$_2$ laser releases very high, peak-power pulses in short durations to achieve efficient tissue transection and decreased thermal transfer to adjacent tissues.$^{15}$ The depth of tissue damage was not reported in two previous papers describing CO$_2$ laser resection of the soft palate in dogs, but a recent paper described collateral damage as a mean of 0.34±0.191 mm following skin biopsy using the CO$_2$ laser.$^{14,15,19}$ Based on previous data, the average depth of injury with the CO$_2$ laser (5.3±1.5 mm at 48 hours) was unexpected.$^{18,19}$ This greater depth of injury may be explained by many different factors, such as the variability in power density that was obtained by varying the focal distance, the angle of incidence to the tissue, the time the laser beam was applied to the tissue, the failure to remove char that subsequently served as a heat sink, and the water content of the tissue being incised.$^{18}$ Each of these variables may have contributed to increased collateral damage, and each was harder to control in the oral cavity than when being applied to the skin where the tissue is easily visualized and stabilized. It is uncertain whether this extent of collateral damage is typical when the soft palate is resected using a CO$_2$ laser.

Successful palate resection using the BSD required a subjective assessment of the appropriate duration of application, which appeared to be approximately 1 to 2 seconds. The time of application for this procedure varied from case to case. It was also necessary for the operator to learn the appropriate amount of ischemic tissue to remove following BSD application.

The primary goal of this study was to compare the histopathological changes associated with the use of either the BSD or the CO$_2$ laser for resection of the soft palate. In order to achieve this goal, the authors chose to use normal dogs, which minimized the potential for confounding variables found in brachycephalic dogs. Such variables might have included redundant oral and pharyngeal tissue, reduced tracheal lumen diameter (that might impact clinical recovery), and the inability to harvest histopathological samples at appropriate time points. None of the dogs in this study had respiratory difficulties after surgery, which indicated that swelling after both of the techniques was

<table>
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* 0=no change; 1=mild changes; 2=moderate changes; 3=severe changes
clinically insignificant. The failure to detect differences in histopathological findings between techniques and the smooth recoveries of these normal dogs support further study of the BSD technique in brachycephalic dogs. Although this model does not allow for sequential assessment of the histopathological changes within the soft palate, it does provide ample information on histopathological changes at defined time points. In this study, no attempt was made to define pain following the procedure, but all animals in the study received postoperative analgesia. Respiratory scores to assess successful resolution of airway obstruction following palate resection would not have been helpful in this study, as none of the dogs had elongated soft palates or clinical disease prior to surgery. Respiratory scores to assess difficulty in breathing following surgery may have been useful in evaluating complications, but no respiratory difficulty occurred in any of the dogs after surgery.

The times required for soft palate resection using the CO2 laser in this study were similar to times reported by Davidson et al. (mean 309 seconds, range 210 to 450 seconds).\(^\text{15}\) Based on the similarity of the results using the BSD and the CO2 laser in this study, the authors did not attempt to compare the BSD technique to the traditional cut-and-suture technique. The anatomical landmarks and patient positions used for the soft palate resections were different between the BSD and the CO2 laser techniques. This difference in positioning arose because two different surgeons performed the different techniques. It was felt that each surgeon should perform the resection in the position used routinely by each, so that the time/duration of the procedures would not be affected by the positioning.

It is important to note that the anatomical landmarks and patient positioning used for the BSD resection of the soft palate varied from those currently recommended for soft palate resection.\(^\text{1,20}\) It was not the intent of this study to evaluate or advocate a change in the standard landmarks or positioning used for soft palate resection. In general, all animals should have a complete oral examination in a normal head position, with the tongue relaxed, to determine the extent of the palate that requires resection. The caudal to midtonsillar crypt region should be used as a landmark for soft palate resection.\(^\text{1,20}\)

**Conclusion**

A bipolar sealing device and a CO2 laser were used for soft palate resection in 18 normal dogs. Comparable histopathological changes occurred with both techniques. Both methods provided a rapid, effective means of resection. Based on the results of this study, future studies are warranted on the use of the bipolar sealing device for soft palate resection in clinically affected brachycephalic dogs.

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\(\text{\textsuperscript{a}}\) LX-20SP Novapulse Laser System; Luxar Corporation, Bothell, WA 98011-8009
\(\text{\textsuperscript{b}}\) Ligasure; Valleylab, Tyco Healthcare Group LP, Boulder, CO 80301-3299

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**References**