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The use of lasers for treatment of upper respiratory tract disorders

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Lasers, delivery systems, and instrumentation

Surgical lasers emit an intense focused beam of light that differs from incandescent light in that it is monochromatic (single wavelength), coherent (wavelengths in phase in time and space), and collimated (minimal beam divergence). These characteristics of laser light provide the surgeon with an instrument that can incise, coagulate, or vaporize tissue. Although the carbon dioxide laser was first used in veterinary surgery in 1972, the use of lasers for treatment of upper respiratory tract disorders in horses required development of a wavelength and delivery system that could be passed through the biopsy channel of an endoscope. Although flexible hollow waveguides were developed in 1986 to enable transendoscopic use of the carbon dioxide laser, these devices are still not commercially available. The neodymium:yttrium aluminum garnet (Nd:YAG) laser was the first commercially available laser used for transendoscopic surgery in the horse (Fig. 1) [1]. More recently, the gallium aluminum arsinate diode (GaAlAs) diode laser was introduced into the equine surgical market for transendoscopic surgery of the upper airway (Fig. 2) [2]. Both the Nd:YAG and diode lasers employ quartz or silica fiberoptic delivery systems to deliver laser energy to tissue.

Other equipment required for the use of lasers in the upper respiratory tract of horses includes a laser-compatible endoscope with a biopsy channel greater than 2 mm in diameter, grasping forceps, and polyethylene tubing. A videoendoscopic display offers the equine surgeon a significant advantage over conventional endoscopy by providing improved visibility with magnification of the larynx and pharynx, reduced risk of optical injury to the surgeon, and reduced fatigue, which may develop while peering into the objective of the endoscope. Laser compatibility of videoendoscopic systems

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Fig. 1. The neodymium:yttrium aluminum garnet (Nd:YAG) laser was the first laser to be coupled with a fiberoptic delivery system for transendoscopic use in the upper respiratory tract of horses. (*From* Orsini JA. Chronicle of laser usage in equine surgery. Clin Tech Equine Pract 2002;1:3–8; with permission.)

requires incorporation of a filter in the endoscope that filters out the wavelength emitted by the laser. Otherwise, activation of the laser causes an optical flare that obscures the visibility of the surgeon or causes complete ‘‘whiteout’’ of the video monitor.

Long (600 mm) bronchoesophagoscopic universal grasping forceps (Richard Wolf, Inc., Vernon Hills, IL) are passed up the opposite nostril from that containing the endoscope and are used to provide tissue traction for contact dissection of tissues in the larynx and pharynx (Fig. 3). These forceps must be bent to an angle that provides appropriate access to target tissues within the larynx or pharynx.

Fig. 2. The gallium aluminum arsinate diode laser has largely replaced the neodymium:yttrium aluminum garnet laser for transendoscopic applications in equine upper respiratory tract surgery because of its compact size, increased reliability, and decreased cost. (*From* Orsini JA. Chronicle of laser usage in equine surgery. Clin Tech Equine Pract 2002;1:3–8; with permission.)

Polyethylene tubing serves two important functions. Before surgery, the tubing is passed through the biopsy channel of the endoscope to irrigate the surgical site with local anesthetic and vasoconstrictor solutions. The contact fibers used with Nd:YAG and diode lasers have sharp tips that may lacerate the walls of the biopsy channel when passed down the endoscope. This results in loss of the watertight integrity of the biopsy channel. Preplacement of the polyethylene tubing into the biopsy channel of the endoscope and then passage of the laser fiber through the lumen of the tubing help to avoid inadvertent damage caused by the endoscope.

Fig. 3. Bronchoesophagoscopic grasping forceps are used to place target tissues under tension for transendoscopic dissection within the upper respiratory tract.

Laser safety

Although the use of lasers for minimally invasive surgery of the horse has proven to be a safe application of laser technology, significant potential safety issues must be addressed to protect both the patient and operative personnel. Ocular injury to the patient and surgeon is avoided by activation of the laser only when the tip of the fiber is located within the body cavity, and the surgical image is viewed on a television monitor. If the surgeon views the operative field directly through the objective of the endoscope, a protective filter must be attached to the eyepiece of the endoscope or the surgeon must wear protective eyewear that is specific to the wavelength of the laser being used for the procedure. Transendoscopic surgery with lasers should be performed in a room with locks on the doors to eliminate accidental exposure to unprotected personnel. Warning signs should also be posted on the outside of the doors to prevent inadvertent exposure. The tip of laser-compatible endoscopes usually contains a ceramic element to protect the tip of the endoscope from heat generated by the laser beam. It is advisable to keep the tip of the laser fiber at least 1 cm beyond the tip of the endoscope when performing surgery to reduce the amount of heat applied to the surface of the endoscope and to minimize the accumulation of debris on the surface of the lens or video chip.

A smoke plume is generated when vaporizing significant amounts of tissue in the upper respiratory tract of horses, using a high-energy and noncontact surgical technique. The plume contains organic materials, such as xylene and toluene, that are noxious and toxic to some degree and may obscure the visual field of the surgeon. In the standing conscious horse, some of the plume is simply inhaled and exhaled by the patient. Excessive laser plume may be evacuated by a smoke evacuator.

Laser safety training is available for veterinarians and veterinary technicians. Certification courses for equine practitioners that include appropriate laser safety procedures are provided by the American College of Veterinary Surgeons (4401 East West Highway, Suite 205, Bethesda, MD 20814–4523, USA; accessed at: www.acvs.org) and the American Society for Laser Medicine and Surgery (2404 Stewart Square, Wausau, WI 54401, USA; accessed at: www.aslms.org).

Principles and techniques of transendoscopic laser surgery

All the commonly used lasers in equine practice exert a thermal effect on tissue. The heat of the laser beam or of a contact fiber is used to incise, coagulate, or vaporize tissue in the upper airway. When laser energy is applied to tissue, it is absorbed, scattered, reflected, and transmitted to varying degrees depending on the wavelength of the laser used and the thermal properties of the target tissue. When tissue is heated to approximately 60°C, protein is coagulated. Vaporization occurs when tissue is heated to a temperature of 100°C. If a precise incision is desired (eg, relief of epiglottal entrapment), conical tip fiber delivery systems (400–600 μm in diameter) should be employed in direct contact with tissue. These fibers concentrate the effect of the laser in a small contact area, achieving high-power density. Larger fibers (800–1000 μm in diameter) are used to deliver large amounts of energy with a proportionately larger spot size to vaporize and ablate tissue (eg, ablation of pharyngeal masses).

The wavelengths of the Nd:YAG and diode lasers generally provide good hemostasis when used to incise mucosal tissues of the upper respiratory tract in both contact and noncontact modes. Contact mode dissection is accomplished with the fiber tip directly in contact with tissue and using 10 to 15 W of power. Higher energy levels (40–100 W) can be used for noncontact coagulation and ablation of tissue in the upper respiratory tract of horses using the Nd:YAG laser and gas-cooled fiberoptic delivery systems. Noncontact ablation of tissue with high energy levels creates deep penetration of energy into tissue (up to 0.5 mm) to coagulate blood vessels and causes a profound degree of delayed thermal necrosis. This property of the Nd:YAG laser makes it the instrument of choice for elimination of the richly vascular tissue comprising progressive ethmoid hematomas. Although the newer diode lasers are capable of generating up to 50 W of energy, the bare fiberoptic delivery systems used with these lasers do not effectively transmit the high energy levels to tissue in the noncontact mode. Without gas cooling of the fiber, the high energy levels accumulate at the tip of the fiber, melting the fiber tip and igniting the fiber cladding.

Patient preparation

In general, transendoscopic surgery with lasers is best accomplished with the horse restrained in stocks. In our practice, chemical restraint is accomplished by initial administration of a combination of xylazine (0.44 mg/kg intravenously and detomidine (0.01 mg/kg intravenously). Local anesthesia is achieved by irrigation with mepivacaine hydrochloride and bleeding is controlled by preoperative irrigation of the mucosal surface with phenylephrine hydrochloride (Neo-Synephrine) solution. The head is positioned by an assistant, and a twitch is applied to limit movement of the patient. Subsequent doses of xylazine and detomidine may be administered as necessary to provide adequate sedation and analgesia during the procedure.

Postoperative treatment

Most of the following procedures are performed with sedation in the standing horse on an outpatient basis. Postoperative medication protocols are designed to minimize swelling of the pharyngeal or laryngeal tissues and to prevent infection of the surgical site. Postoperative treatment should be prescribed at the discretion of the surgeon on an individual case basis considering both the degree of surgical trauma and varying requirements for restricted activity related to the specific procedure. In most cases, horses are treated both systemically and locally with antimicrobial and anti-inflammatory medications, and exercise is restricted for 7 to 14 days. In all cases, food is restricted (or the horse is muzzled) for at least 2 hours after surgery, and horses operated on as outpatients are not allowed access to hay nets during the ride home from the hospital. These precautions help to prevent inadvertent aspiration or choke, which may result from compromised swallowing as a result of sedation or local anesthesia of the larynx and pharynx. Horses treated with vocal cordectomy/laryngoplasty are rested for 30 days after surgery. A follow-up endoscopic examination is generally performed 7 to 14 days after surgery, and the postoperative medication and exercise regimen may be adjusted according to the results of that examination.

Routinely, sulfamethoxazole/trimethoprim sulfa (26.6 g of sulfamethoxazole per kilogram administered orally twice daily) is administered for 3 days after surgery, and phenylbutazone (4.4 mg/kg administered orally once daily) is administered for 7 days. Prednisolone is administered orally once daily in tapering doses, beginning with 0.9 mg/kg for 7 days, followed by 0.45 mg/kg for 7 days, and then 0.45/mg/kg every other day for three additional treatments. Ten milliliters of a pharyngeal spray (1 L of nitrofurazone 0.2% solution [Furacin], 1 L of glycerine, 250 mL of dimethyl sulfoxide [DMSO], and 2 g of prednisolone) is administered twice daily for 7 to 10 days after surgery. Horses treated with soft palate cautery for intermittent dorsal displacement of the soft palate occasionally race within 10 days of surgery, and those horses are not treated with systemic antimicrobial medication.

Surgical procedures

Epiglottal entrapment

Correction of epiglottal entrapment by midsagittal division of the aryepiglottic fold was one of the first applications of lasers for upper respiratory tract surgery in the horse. This may be accomplished by using either the noncontact or contact technique [3,4]. After irrigation of the entrapping membrane with mepivacaine, the tip of the laser fiber (400 or 600 μm) is placed on the caudal margin of the entrapping tissue on the midline and dragged in a rostral direction to the tip of the epiglottis while a light downward pressure is applied to the fiber tip as the laser is activated using 10 to 12 W of power. This incision is repeated to cause a progressive division of the entrapping membrane until the entrapment is corrected (Fig. 4). The elastic properties of the aryepiglottic fold cause the entrapping membranes to retract beneath the epiglottis when the procedure is complete. The horse should be encouraged to swallow repeatedly by saline irrigation of the larynx to ensure that adequate division of the entrapping membrane has been accomplished. Should partial re-entrapment occur, the incision is

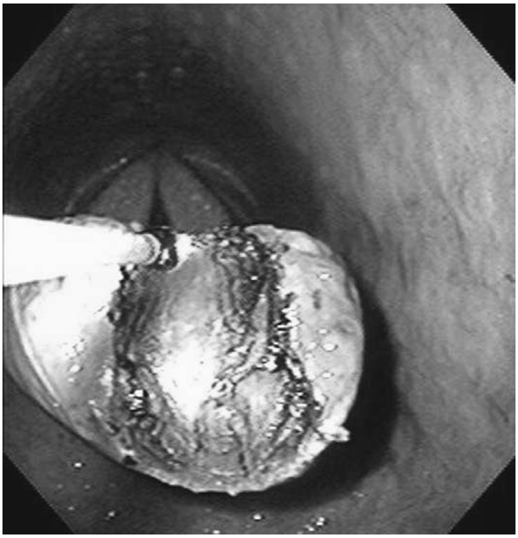

Fig. 4. Correction of epiglottal entrapment is accomplished by progressive midsagittal division of the entrapping membranes.

deepened until the epiglottis remains free when the horse swallows. Care must be taken to prevent inadvertent trauma to the mucosa or cartilage of the tip of the epiglottis. In some cases, it is helpful to use the bronchoesophagoscopic forceps to grasp the margin of the entrapping membrane from beneath the epiglottis, placing it under tension to facilitate dissection with the laser fiber. In chronic cases of epiglottal entrapment, the entrapping membrane is thickened or ulcerated with varying degrees of fibrous tissue present in the fold. When these membranes are divided, they may not completely retract beneath the epiglottis. Postoperative medical therapy generally reduces the size of these membranes to some degree. If follow-up endoscopic examination indicates that these tissue tags interfere with normal swallowing or breathing, they may be removed by placing them under tension with the grasping forceps and excising them with the laser using contact dissection.

The rate of recurrence of epiglottal entrapment is reported to be 5%. The presence of ulceration of the entrapping membrane is an indication of the chronicity of the disorder and may also require a more aggressive and prolonged postoperative medical treatment program to reduce the chronic inflammation of sepsis that can be associated with chronic erosion of the mucosal surface of the epiglottis.

Vocal cordectomy and laryngeal sacculectomy

In 1936, Professor W.L. Williams and Sir Frederick Hobday described the use of ventriculectomy to treat laryngeal hemiplegia in the horse. [5] Ablation of the laryngeal saccule may be accomplished by noncontact laser irradiation of the lining of the saccule using the Nd:YAG laser. Coagulation of the mucosal surface causes scar tissue to form within the saccule, stabilizing the adjacent vocal fold [6]. The saccule may also be everted with grasping forceps and excised using the contact technique. Laryngeal sacculectomy by the use of any of these techniques is believed to limit the axial displacement of the arytenoid cartilage during maximal inspiration. Subjectively, horses treated with laryngeal sacculectomy produce less noise after surgery. Unfortunately, controlled treadmill studies measuring airflow and impedance have not confirmed the effectiveness of this procedure in performance horses [7]. Flaccidity of the vocal cord itself causes respiratory stridor in performance horses. This noise may be eliminated by excision of the affected vocal fold using the Nd:YAG or diode laser and the transendoscopic contact technique. In the case of draft and pleasure horses, excision of the vocal fold usually eliminates the abnormal noise associated with laryngeal hemiplegia. Vocal cordectomy may also be used in conjunction with laryngoplasty to help restore the upper airway to a more functional state in racehorses.

The author currently uses a transendoscopic contact dissection technique developed by Ducharme et al [8] to perform vocal cordectomy in standing horses. With the horse restrained in stocks, the affected vocal fold is irrigated with mepivacaine and Neo-Synephrine. The laser fiber is then placed on the axial and distal border of the vocal fold, and the laser is activated with 10 to 12 W of power as the fiber is dragged across the mucosal surface in a rostral and abaxial direction. This cut is repeated through the mucosal surface and into the muscularis layer beneath. Progressive division of the base of the vocal fold creates a horizontal flap of tissue as the incised fold retracts. The bronchoesophagoscopic grasping forceps are placed through the opposite nostril and used to grasp the incised border of the vocal fold. The handle of the forceps is rotated in a clockwise direction to place the vocal fold under tension (Fig. 5). The laser fiber is then placed on the most proximal insertion of the fold adjacent to the insertion of the fold on the vocal process of the arytenoid cartilage, and the fiber is dragged ventrally in an arc that extends into the opening of the laryngeal saccule to complete the incision.

Horses with a grade 3 laryngeal hemiplegia retain a variable degree of motion of the affected cartilage and are more likely to fail after laryngoplasty. For this reason, some clinicians believe that racehorses with a partial paralysis are best treated by partial arytenoidectomy.

Dorsal displacement of the soft palate

Dorsal displacement of the soft palate is a common cause of exercise intolerance in the performance horse. Numerous surgical procedures are used to treat this condition with mixed results. In our practice, we currently recommend removal of a 6-cm section of the sternothyroideus muscle beneath the larynx (Llewellen procedure) in conjunction with cautery of the

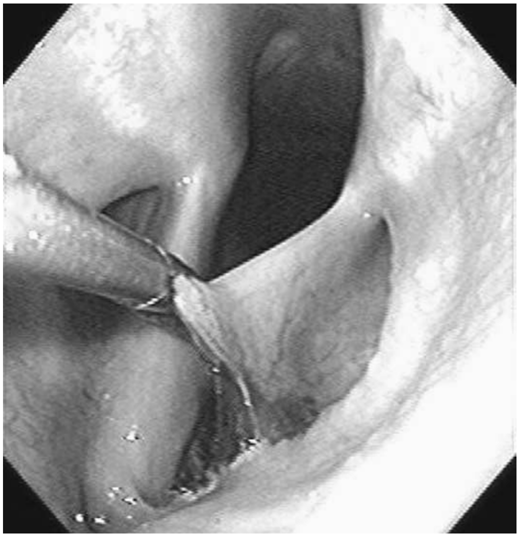

Fig. 5. Transendoscopic vocal cordectomy is performed in the standing horse to eliminate the need for a ventral laryngotomy incision.

rostral curvature of the opening in the soft palate. With the horse sedated and restrained in stocks, the soft palate is irrigated with 10 mL of mepivacaine through polyethylene tubing placed through the biopsy channel of the endoscope. The laser fiber is then placed through the polyethylene tubing, and the fiber tip is placed in contact with the mucosal surface of the soft palate immediately adjacent to the base of the epiglottis. The laser is activated for 1 to 2 seconds at 15 W of power to cause localized mucosal ablation at the point of contact and immediate shrinkage of the surrounding tissue. Repeated applications of the laser are made at 2- to 4-mm intervals and extend rostrally just past the tip of the epiglottis (Fig. 6). A total of approximately 1000 J of energy is applied to the palate mucosa [9].

Postoperative treatment includes systemic and local antimicrobial and anti-inflammatory medications as described earlier. Horses are withheld from training for 7 days. If a follow-up endoscopic examination indicates acceptable healing at that time, the patient is returned to normal daily training. During the healing process, fibrous scar tissue develops at the treatment sites. We speculate that this leads to a stiffening of the palate and an improved fit with the base of the epiglottis. In a progressive study of 52 horses, 50 of 52 (92%) were able to successfully race after treatment with reduction or elimination of respiratory noise during exercise [9].

Arytenoid chondritis

Arytenoid chondritis is a progressive disease of the arytenoid cartilage that originates as a primary infection of the cartilage [10]. One form of

Fig. 6. Cautery of the soft palate creates thermoplastic changes in the mucosal surface of the soft palate that appear to reduce the tendency for intermittent dorsal displacement.

chondritis is the development of granulomas on the axial surface of the arytenoid cartilage. These localized granulomas may be excised using the Nd: YAG or diode laser with the contact or noncontact transendoscopic technique (Fig. 7). Alternatively, a minimally invasive approach may be made through the cricothyroid space with direct endoscopic control to ablate granulomas of the cartilage surface. This approach provides improved access to the core of the septic lesion, improving the chances of resolving the infection [11]. The prognosis for racing after granuloma removal is dependent on complete elimination of the infection and the degree of dysplasia of the parent portion of cartilage. If there is good mobility of the affected arytenoid cartilage with maximum abduction obtained by nasal occlusion or treadmill evaluation, the prognosis is good for a return to racing with granuloma ablation or excision.

Horses with advanced disease of the arytenoid cartilage cannot adequately abduct the affected arytenoid cartilage on inspiration. The enlargement of the corniculate process and the body of the arytenoid cartilage causes significant obstruction of the lumen of the larynx, decreasing airflow and increasing impedance. Advanced cases of unilateral arytenoid chondritis should be treated with a partial arytenoidectomy. Removal of the corniculate process and the body of the arytenoid cartilage provides significant improvement of the affected airway. Although some horses may develop a chronic cough after partial arytenoidectomy, it is the experience of the author that the prevalence of this complication is less than that previously reported in the literature. Horses presenting with a bilateral arytenoid chondritis may be treated by performing a partial arytenoidectomy on the

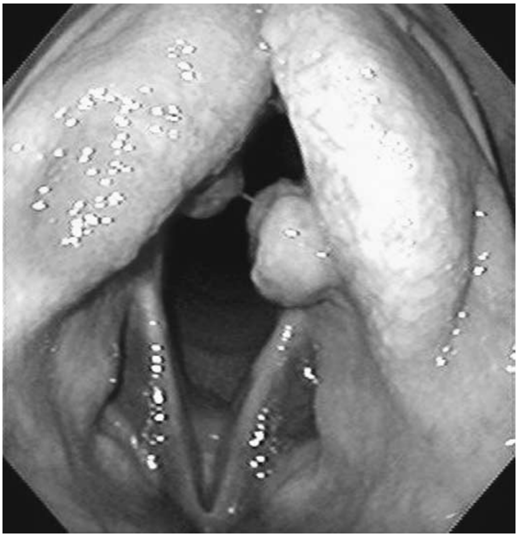

Fig. 7. Localized granulomas of the arytenoid cartilage may be removed by contact or noncontact transendoscopic laser photoablation.

most severely affected side, but the prognosis for racing these horses is poor. Surgery is a salvage procedure for these horses. The removal of both arytenoid cartilages is contraindicated because of the bilateral obliteration of the lateral food channels, making aspiration of food and water into the trachea a relative certainty.

Pharyngeal lymphoid hyperplasia and pharyngeal masses

Pharyngeal lymphoid hyperplasia is a common disorder of the upper respiratory tract of 2-year-old racehorses. Most mild cases respond well to reduced training levels and medical treatment. Chronic pharyngeal lymphoid hyperplasia that is unresponsive to medical treatment may be effectively treated by cautery of the dorsal roof of the pharynx (Fig. 8). This may be accomplished by either contact or noncontact ablation of the enlarged lymphatic nodules. If the Nd:YAG laser is used, these nodules may be treated with either the contact or noncontact technique. If the diode laser is used, the contact technique is most effective. For contact ablation of the follicles, a 600- to 800-μm fiber is used with 10 to 15 W of power. For noncontact treatment with the Nd:YAG laser, 60 W is used with a gas-cooled fiber held 1 to 2 mm distant from the tissue surface as the laser is activated. The visual end point is blanching and coagulation of the lymphatic nodule. When the contact technique is used, a small area of char is found immediately beneath the contact surface of the fiber with a surrounding halo of coagulated tissue. Healing of the mucosal surface is usually complete within 21 days of surgery.

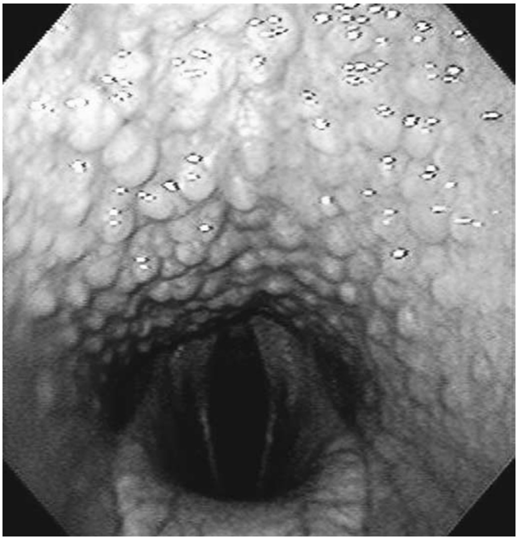

Fig. 8. Refractory cases of pharyngeal lymphoid hyperplasia respond well to cautery of the pharyngeal nodules with the contact laser technique.

Occasionally, large pharyngeal masses are found in the upper portions of the pharynx of performance horses, causing some degree of upper respiratory tract obstruction. These masses may be coagulated and ablated with noncontact Nd:YAG laser treatment, or they may be excised with either the Nd:YAG or diode laser using the contact dissection technique. For contact dissection, the grasping forceps may be used to place the lesion under tension while the fiber tip is passed transversely across the base of the mass to separate the mass from the wall of the pharynx. The transendoscopic use of lasers to remove these lesions eliminates the need for general anesthesia and a ventral laryngotomy approach.

Subepiglottic cyst

Although subepiglottic cysts are usually diagnosed in young Thoroughbred and Standardbred racehorses and are likely a congenital condition, they are occasionally found in older horses with no previous history of upper respiratory tract problems [12]. Subepiglottic cysts cause upper airway obstruction by distorting the normal articulation between the larynx and the pharynx and may also lead to swallowing disorders. In extreme cases, these cysts may cause aspiration pneumonia.

Subepiglottic cysts may be ablated by noncontact irradiation with the Nd:YAG laser (60–100 W and a gas-cooled noncontact fiber) or by contact excision using either the Nd:YAG or diode laser (12–15 W and a 600-μm fiber). In the standing horse, bronchoesophagoscopic grasping forceps may be passed up the opposite nostril from the endoscope to grasp the mucosal surface of the cyst and place it under tension. The laser is then used to make a fusiform incision in the mucosal surface around the jaws of the forceps. The incision is progressively extended submucosally around the greater curvature of the cyst with increasing rostral traction of the cyst until it is freed from the surrounding mucosa. The resulting defect is allowed to heal by second intention. If the horse swallows during the surgery or the cyst otherwise slips from the grasping forceps and falls beneath the soft palate, it may be regrasped with the forceps in most cases. If this is not possible, the surgery must be completed through an oral transendoscopic approach.

For the oral approach, the author prefers to position the horse under general anesthesia in lateral recumbency using a guaifenesin, ketamine, and xylazine (GKX) anesthetic protocol. A mouth speculum is used to provide access to the caudal pharynx, and the endoscope is passed over the tongue to visualize the cyst. The grasping forceps are passed alongside the endoscope to place traction on the mucosa of the cyst, and the dissection is performed as described for the nasal approach (Fig. 9) [10]. An advantage of this technique is that the oral approach provides improved visibility and reliable access to the cyst. The disadvantage is the increased cost and risk associated with general anesthesia.

After surgery, the patient is treated with systemic and local antimicrobial and anti-inflammatory medications as described earlier. In uncomplicated cases, exercise is restricted for approximately 2 weeks before returning to normal daily activity. The prognosis for complete recovery is good.

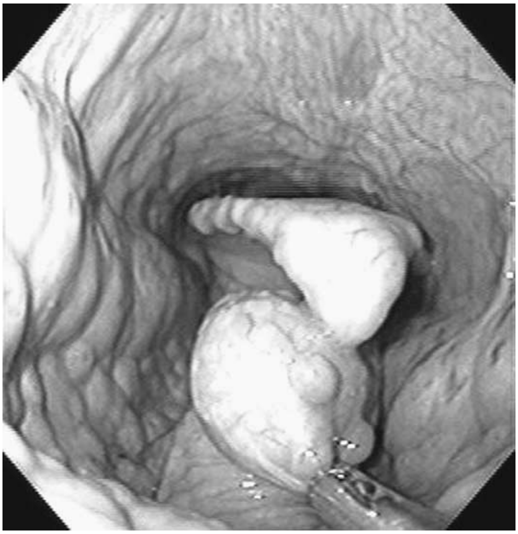

Fig. 9. Subepiglottic cyst removal is best accomplished by transendoscopic oral dissection.

Subepiglottic granuloma

Subepiglottic granulomas are a currently unreported disease of the upper airway of horses that may be confused with subepiglottic cysts. The cause of these granulomas is unknown, but it is likely that they originate as an acute ulceration of the aryepiglottic fold beneath the epiglottis. If this breach in the mucosa of the aryepiglottic fold or the base of the epiglottis becomes infected, one tissue response to this irritation is the formation of granulation tissue. Clinical signs include exercise intolerance, coughing, and dysphagia in some cases. Acute cases may respond to antimicrobial and anti-inflammatory medical therapy in conjunction with rest. In chronic cases, large granulomas may develop that distort the normal articulation between the larynx and the opening in the soft palate (Fig. 10). Large granulomas require excision either orally or through a ventral laryngotomy incision. These granulomas are firmly incorporated into the base of the epiglottis and are difficult to excise. Laser photoablation of the surface of the granuloma may be accomplished using the diode laser, a 1000-μm fiber, and 15 to 20 W of power with the contact technique. Aftercare is the same as that described earlier with follow-up endoscopic examination used to monitor healing. Horses are withheld from training until the inflammation beneath the epiglottis is completely resolved.

Progressive ethmoid hematoma

Progressive ethmoid hematoma is a benign lesion found in older horses that is characterized by varying degrees of epistaxis, usually from one

Fig. 10. Subepiglottic granuloma formation may cause intermittent dorsal displacement of the soft palate by distorting the normal anatomy of the base of the epiglottis.

nostril. Histologically, progressive ethmoid hematomas are composed of respiratory epithelium and fibrous tissue. The surrounding stroma contains blood, fibrous tissue, macrophages, giant cells, and deposits of calcium and hemosiderin [13]. Although most cases of progressive ethmoid hematoma are unilateral, 15% to 20% of horses presenting with this tumor have bilateral involvement [13]. Radiographic examination employing the standard lateral and dorsoventral views is the most common diagnostic technique used to determine the extent and nature of hematoma involvement. Oblique views of the sinus cavities may also be helpful to identify obscure lesions. Scintigraphic examination may be helpful to differentiate a progressive ethmoid hematoma from a sinus cyst or carcinoma, and when available, optimum preoperative planning should include the use of computed tomography to define the sites and detect small bilateral lesions that would otherwise go undetected [13].

Isolated hematomas that originate in the ethmoid region are easily identified by endoscopic examination and respond well to injection with formalin or photoablation using the Nd:YAG laser at 100 W and the noncontact technique (Fig. 11). Masses that originate in the sinus cavities (most often the maxillary or sphenopalatine sinus) and extend into the ethmoid region or nasal passage are best treated with radical excision through a frontomaxillary flap approach, followed by transendoscopic laser ablation using the Nd:YAG laser and noncontact laser irradiation of any residual masses (Fig. 12). The flap procedure may be performed with local anesthesia in the standing horse if the patient is compliant, but most horses

Fig. 11. A localized progressive ethmoid hematoma that originates from the ethmoid region can be effectively eliminated by formalin injection or laser ablation.

Fig. 12. Transendoscopic nasal view of the maxillary sinus cavity after excision of a large progressive ethmoid hematoma. The medial wall of the sinus has been obliterated, creating a large common opening between the maxillary sinus, the ventral conchal sinus, and the ethmoid turbinate region. (Courtesy of David J. Murphy, BVSc, MS, Clarksburg, NJ.)

are operated on under general anesthesia. Aggressive debridement of the lining of the affected sinus and the ethmoid region during the flap procedure usually creates a large opening into the nasal passage that greatly facilitates transendoscopic treatment of recurrent lesions after surgery. With thorough diagnostic evaluation and aggressive treatment as described previously, a 70% success rate has been reported [13].

Guttural pouch tympanites

Tympanites of the guttural pouch occur in foals shortly after birth and up to 1 year of age [14]. Although the cause is unknown, the clinical signs include gross swelling of the guttural pouches, which may lead to dyspnea, dysphagia, and, rarely, aspiration pneumonia (Fig. 13). Unilateral involvement is the most common form of tympanites, but gross distention of the affected guttural pouch may cause a degree of enlargement that makes the condition appear to be bilateral.

Definitive treatment of unilateral cases of guttural pouch tympanites involves fenestration of the median septum of the pouches using either the Nd:YAG or diode laser and either the contact or noncontact technique. The foal is most expediently operated on by placing the patient in lateral recumbency under general anesthesia. The laser fiber is placed in the biopsy channel of the endoscope, which is placed in the uppermost nostril to visualize the pharynx. A Chamber's mare catheter is placed through the

Fig. 13. Guttural pouch tympanites cause marked distention of the parotid region of affected foals.

dependent nasal passage, and using the endoscope for guidance, the catheter is inserted into the dependent guttural pouch. The endoscope containing the laser fiber is then inserted into the opening of the uppermost guttural pouch, and the tip of the Chamber's mare catheter is used to tent the median septum while the fiber is extended from the endoscope and placed in contact with the septum mucosa and the laser is activated. A hole with a 3-cm diameter is created in the septum by placing the fiber tip at the margin of the original opening and enlarging the incision by progressive dissection (Fig. 14). Relief of the distention of the guttural pouch is immediate.

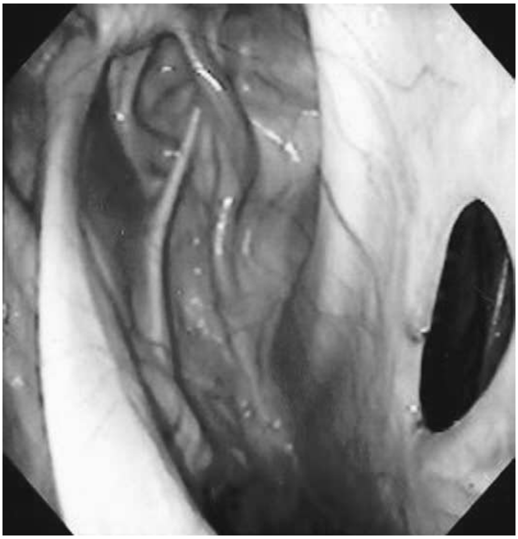

Fig. 14. Fenestration of the median septum of the guttural pouch with contact laser technique corrects unilateral guttural pouch tympanites. (Courtesy of Eric P. Tulleners, DVM, Kennett Square, PA.)

In the case of bilateral tympanites, an opening must be made in the pharynx dorsal to the natural opening in the guttural pouch in addition to fenestration of the median septum. The surgical technique begins with fenestration of the septum of the pouch as described previously. Subsequent to this procedure, the endoscope is withdrawn from the dorsal pouch to visualize the opening of the dependent guttural pouch. The Chamber's mare catheter is withdrawn from the depth of the dependent pouch and positioned just caudal to the flap covering the entrance to the dependent guttural pouch and rotated so that the ball of the catheter tip tents up the pharyngeal mucosa approximately 2 cm dorsal to the opening in the guttural pouch. The laser fiber is then placed in contact with the pharyngeal mucosa above the catheter tip, and a fenestration is made in the pharyngeal mucosa (Fig. 15). A Foley catheter is then placed through this fenestration, and the distal portion of the catheter is sutured in the false nostril to keep the catheter in place for 7 to 10 days, preventing healing of the fenestration.

Complications of transendoscopic surgery with lasers

Complications directly attributed to use of lasers are rare. Edema of the operated tissues may occur after surgery using a thermal instrument, including lasers. This edema may be minimized by the efficient use of energy during the procedure and by the administration of both corticosteroid and

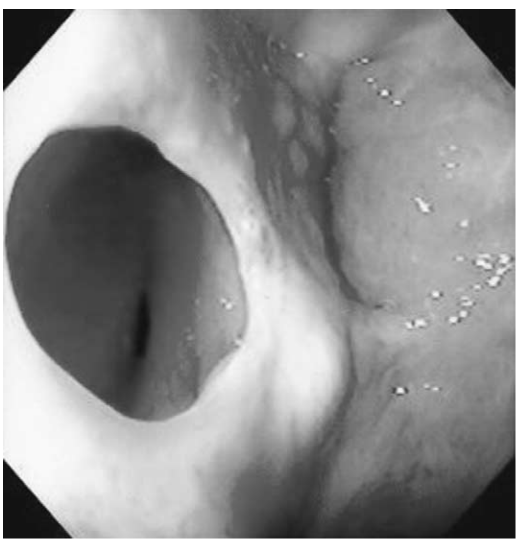

Fig. 15. Fenestration of the pharyngeal wall dorsal to the normal opening of the guttural pouch is performed in conjunction with fenestration of the median septum as a treatment for bilateral guttural pouch tympanites. (Courtesy of Eric P. Tulleners, DVM, Kennett Square, PA.)

nonsteroidal anti-inflammatory medications after surgery. Inadvertent treatment of adjacent tissues is a potential complication that is avoided by careful application of laser energy to only the target tissues and by the use of an appropriate laser safety protocol.

Summary

Lasers have become important tools for the equine surgeon in the treatment of upper respiratory tract disease in the horse. Multiple wavelengths and delivery systems are available. Indications for the use of lasers in the upper respiratory tract primarily include minimally invasive procedures not possible with conventional surgical instrumentation. New applications for the use of lasers to treat upper respiratory disease are likely to evolve with the development and introduction of new wavelengths and delivery systems.

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