Review

Laser surgical treatment options for diseases of the upper respiratory tract in horses – An overview

Laserchirurgische Therapiemöglichkeiten bei Erkrankungen der oberen Atemwege des Pferdes – Ein Überblick

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Abstract

Diseases of the upper respiratory tract in horses can be life-threatening, or more frequently, limit the ability of the equine athlete to perform. Traditional surgical approaches are often invasive and are limited due to anatomic considerations. This article summarizes minimal invasive surgical techniques and in particular, laser surgical techniques useful for treatment of common diseases of the upper respiratory tract in horses.

Keywords: minimally invasive surgery; nasal passage; paranasal sinus; guttural pouch; pharynx; larynx.

Zusammenfassung

Erkrankungen der oberen Atemwege des Pferdes können lebensbedrohlich sein oder in den meisten Fällen die Belastbarkeit des Pferdeathleten einschränken. Konventionelle chirurgische Methoden sind häufig sehr invasiv und darüber hinaus wegen der schwierigen anatomischen Situation beschränkt einsetzbar. In diesem Artikel werden minimal-invasive chirurgische Techniken, insbesondere laserchirurgische Techniken, beschrieben, die zur Behandlung häufiger Erkrankungen der oberen Atemwege des Pferdes eingesetzt werden können.

Schlüsselwörter: Minimal-invasive Therapie; Nasenhöhle; Nasennebenhöhle; Luftsack; Pharynx; Larynx.

1. Introduction

Treatment of upper respiratory tract diseases in the horse can be challenging due to the anatomical situation and the close relationship to a number of sensitive structures. Transendoscopic surgical techniques can reduce the risks of

surgery of the upper respiratory tract, but not all diseases can be treated using such an approach because of limited endoscopic access. For transendoscopic applications, laser types which can be used with flexible fibres such as Nd:YAG lasers (e.g., Medilas Fibertom 8100, Dornier MedTech Laser GmbH, Germany: 1064 nm, 100 W) or diode lasers (e.g., Medilas D Fibertom, Dornier MedTech Laser GmbH, Germany: 940 nm, 60 W; MLT premiumXL 30W, Medizinische Laser Technologie GmbH, Ingelheim, Germany: 810 nm, 30 W) can be employed. In contrast to CO₂ lasers these laser types possess stronger tissue coagulating than tissue cutting qualities. In addition to sapphire tips, the bare fibre can be used in contact and non-contact mode. The effects of the laser light are dependent on the device presets, the application mode (contact, non-contact), and the optical properties of the tissue treated (pigment and water content, absorption, reflection).

In calm horses transendoscopic laser surgery can be performed on the standing, tranquilized animal. For tranquilization, detomidine or romifidine can be used with or without the addition of an analgesic agent (butorphanol or levomethadone), and a local anaesthetic drug (e.g., lidocaine) can be added. For some diseases an endoscopic approach is not possible on the standing horse (e.g., intermittent dorsal displacement of the soft palate), and for these horses, general anaesthesia is indicated.

The purpose of this paper is to provide an overview of laser surgical therapeutic applications for treatment of diseases of the upper respiratory tract in horses. The use of modern surgical lasers has expanded therapeutic options in this field, especially in combination with minimally invasive endoscopic procedures. In each case, careful evaluation should be performed to determine if the use of a surgical laser would provide an advantage over conventional surgical approaches or other minimally invasive surgical techniques (i.e., high-frequency electrosurgery).

2. Diseases of the nasal passage, the paranasal sinuses and the ethmoid

2.1. Amyloidosis

Amyloidosis is a disease predominantly of the mucous membranes of the upper respiratory tract in horses. Incorporation

of amyloid results in narrowing of the nasal passage and a strong tendency for haemorrhaging after mechanical irritation of the grossly changed mucosa. For treatment the altered mucosa can be resected [1] or can be coagulated with a medical laser (Figure 1) [2].

2.2. Tumours of the nasal passages and progressive ethmoidal hematomas

Tumours of the nasal passages (e.g., fibromas, myxomas) and progressive ethmoidal hematomas can cause narrowing or obliteration of the nasal airways. Small masses and tumours that are accessible via endoscope can be removed transendoscopically using high-frequency electrosurgery [3] or laser surgery [4, 5]. Transendoscopic injection of 10% formalin has been described for the treatment of progressive ethmoidal hematomas [6]. Larger masses and masses involving the paranasal sinuses can often only be removed through a sinus-flap approach. Alternatively, some masses involving the paranasal sinuses may be treated transendoscopically through a small trephine opening into the paranasal sinuses using laser surgery [4] or injection techniques [7].

3. Diseases of the guttural pouches

3.1. Guttural pouch tympany

Guttural pouch tympany is a disease predominantly found in foals. An anatomical malformation of the medial lamina of the affected guttural pouch opening results in a valvular stenosis, and subsequent tympany of the affected guttural pouch. Removal of the excess air via transdermal centesis does not result in a permanent cure. Successful treatment can be achieved by fenestration of the median septum of the guttural pouch or by partial resection of the malformed medial lamina [5, 8]. Both procedures can be performed with a low level of risk through an endoscope and preferably with a laser (600 µm bare fibre, contact, 10–15 W, cw mode) [9–11]. In cases with unilateral guttural pouch tympany, fenestration of the median septum is sufficient. However, the differentiation between one- and two-sided guttural pouch tympany can be difficult, and therefore the combination of median septum fenestration and resection of the medial lamina has

been recommended. For fenestration of the median septum the endoscope is passed into the lesser affected guttural pouch because the median septum will be bulging into this pouch. The fenestration should be as large as possible and located in the centre of the bulging septum, approximately in the middle of the septum height (Figure 2A). Dissection should be performed in a caudal to rostral direction to minimize the risk of damage to larger vessels. Smaller vessels will be sealed through laser coagulation. Resection of the medial lamina should be performed on the more severely affected side. A curved incision is made through the medial lamina with the endoscope placed in the guttural pouch opening (Figure 2B). While the endoscope is slowly pulled back, a second dorsal to ventral directed cut is performed. Even after successful treatment some symptoms of guttural pouch tympany (nasal discharge, stridor) may only be resolved after a few weeks due to the overstretched tissues of the guttural pouch. The fenestration of the median septum may spontaneously close within 4–6 weeks. In a study involving 50 foals with guttural pouch tympany, treatment as described above resulted in complete resolution in 42 foals (84%). In the remaining eight foals recurrence of guttural pouch tympany was noted but could be resolved by a second operation (transendoscopic fenestration of the median septum and/or resection of the medial lamina) in all cases [12]. If surgical treatment is delayed until the animal is fully grown, prognosis for resolution is worse, presumably due to the affected tissues being overstretched for a long period of time.

3.2. Guttural pouch mycosis

The predominant clinical sign of guttural pouch mycosis is bloody nasal discharge and in some cases massive and fatal nasal haemorrhaging. Endoscopically a fungal granuloma can be seen in the area of large arteries in the guttural pouch resulting in damage to the arterial wall. Local and systemic treatment of the granulomas that are usually caused by *Aspergillus spp.*, with antimycotic drugs (amphotericin B, nystatin, itraconazole) are associated with severe risks, depending on the degree of arterial wall damage. Another treatment option is laser coagulation of the fungal granuloma (600 µm bare fibre, non-contact, 10–30 W, cw-mode, 5–10 s/impulses) and can be successful (Figure 3) but is not a very safe treatment modality [13, 14].

Figure 1 Nasal amyloidosis in horses. (A) Nasal mucosa bleeding, and (B) thermal coagulation of mucosal surface.

Figure 2 Guttural pouch tympany in a foal. (A) Fenestration of the median wall, endoscope 90° turned, and (B) partial resection of medial lamina, endoscope turned 180°.

3.3. Guttural pouch empyema

Typical symptoms for a guttural pouch empyema are unilateral swelling of the guttural pouch which can be visualised and palpated in the parotid region, and unilateral mucopurulent nasal discharge which may become worse when the horse's head is lowered. Due to the swelling of the guttural pouch, some difficulty in swallowing, regurgitation and stridor noises may occur. In case of chronic guttural pouch empyema, chondroids may be formed out of inspissated pus. The daily, transendoscopic lavage of the guttural pouch has first priority in the therapy of acute and chronic empyema of the guttural pouch. If possible, a removal of chondroids should be performed transendoscopically. Creating a fistula between the pharynx and the auditory tube using a Nd:YAG laser has been described for the treatment of chronic guttural pouch empyema [15]. In a case of complete occlusion of the left auditory tube pharyngeal orifice also a laser surgical

fenestration is possible to remove guttural pouch chondroids (Figure 4) [16].

4. Diseases of the oro- and naso-pharynx

4.1. Follicular hyperplasia of the pharyngeal mucosa

Follicular hyperplasia of the pharyngeal mucosa can be found in more than 90% of young horses and is usually resolved without treatment by the age of 5 years. Treatment attempts with laser application therefore do not appear to be indicated. Individual larger mucosal follicles may be removed with a laser or with high-frequency electrosurgery [17].

4.2. Dorsal displacement of the soft palate

In horses with dorsal displacement of the soft palate, the soft palate is displaced dorsal to the epiglottis. Established

Figure 3 Guttural pouch mycosis. (A) Lasercoagulation of mycotic granuloma, and (B) perforation of median wall after successful laser surgery.

Figure 4 Empyema and chondroids in a sealed guttural pouch after laser-fenestration of the median wall.

treatment modalities such as tie forward surgery [18], staphyl-ectomy and partial myectomy [19] resulted in success rates of approximately 60–80%. Staphylectomy can be performed under general anaesthesia using a laryngotomy approach, but also in the standing horse transendoscopically using laser or high-frequency electrosurgery. Laser coagulation of the caudal edge of the soft palate resulted in similar success rates [2, 20, 21]. This procedure is performed under brief (approx. 15 min) general anaesthesia. Orotracheal intubation results in permanent dorsal displacement of the soft palate and permits transnasal endoscopic access to the caudal edge of the soft palate. A bare fibre is used to coagulate a 5 mm wide and 40–50 mm long section of the caudal edge of the soft palate (non-contact: 30 impulses, 4 s, 30–40 W or contact: 30 impulses, 4 s, 10–15 W; Figure 5). Horses can begin training 2 weeks after the surgery. If the symptoms recur, repetition of the same procedure can be successful [22].

Figure 5 Laser coagulation of the caudal border of soft palate in a horse with dorsal displacement of the soft palate.

5. Diseases of the larynx

5.1. Epiglottic entrapment

In epiglottic entrapment, the plica aryepiglottica wraps around the epiglottis, thereby interfering with the movement of the epiglottis. Surgical treatment involves axial transection or resection of the entrapping tissue. Possible approaches are a laryngotomy incision, pharyngotomy incision or transoral. Transnasal division of the entrapping tissue with a sharp bistoury, especially in the standing horse, is not recommended because of the risk of inadvertent damage to the soft palate. In the standing, sedated horse transnasal division of the entrapping tissue can be performed under endoscopic control using a surgical laser [23, 24] or high-frequency electrosurgery [24, 25].

5.2. Subepiglottic cysts

Subepiglottic cysts can cause loud in- and expiratory noises and can interfere with swallowing. Laser surgical excision is possible, and complete removal of the entire cystic lining is important [26]. High-frequency electrosurgery can also be used to remove the cyst and may be easier to perform than laser surgery [5, 27].

5.3. Laryngeal hemiplegia

Two different approaches can be used for the treatment of laryngeal hemiplegia. The rima glottis can be enlarged through ventriculectomy or ventriculocordec-tomy or the arytenoid cartilage can be fixed in an open position using a laryngoplastic. If both procedures are combined, success rates have been described of 30–50% in race horses and 80% in riding horses. Ventriculectomy and ventriculocordec-tomy can be performed in the standing, sedated horse using a transendoscopic laser surgical approach (Figure 6) [2, 28, 29]. This procedure requires a well-trained team, because one surgeon inverts the ventricle with a long forceps, while the other surgeon uses a transendoscopically inserted laser fibre to resect the ventricle (600 µm bare fibre, contact, 10–15 W, cw mode). Intraoperative haemorrhage is not uncommon during this procedure and interferes with visualisation. Transection of the ventricle therefore should be performed in a ventral to proximal direction. The transen-doscopic approach avoids the open laryngotomy approach needed for ventriculectomy by the traditional open surgical technique.

5.4. Stenosis of the larynx

Stenosis of the larynx near the rima glottis results in severe laryngeal stridor and exercise intolerance and can occur as a complication of laryngeal surgery. Granulation tissue or tumours protruding into the laryngeal lumen can be resected transendoscopically using a laser surgical or a high-frequency electrosurgical approach and without the need for a laryngo-tomy [2, 5, 28].

Figure 6 Recurrent laryngeal neuropathy. (A) Laser surgical ventriculectomy after laryngoplasty, and (B) 12 days follow-up endoscopy.

6. Conclusions

Minimally invasive surgery greatly improves the treatment options for diseases of the upper respiratory tract in horses. Established conventional surgical methods cannot be replaced but frequently can be amended or facilitated. Both laser surgery and high-frequency electrosurgery reduce the tendency of intraoperative haemorrhaging, allowing an endoscopic view of the surgical site. The effects of high-frequency electrosurgery are dependent on the electrical properties of the treated tissues. In contrast, for laser surgery, it is the optical properties of the tissue that are important and explains the differences in tissue penetration and coagulation. For clinical cases the most suitable method for each patient and each patient owner needs to be selected. The reduced surgical trauma and shortened recovery time justify the relatively high costs associated with the purchase of the necessary equipment.

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