

## Trans-endoscopic ventriculocordectomy in horses using monopolar electrocautery

### Ventriculocordectomia trans-endoscópica em equinos, com uso de eletrocautério monopolar

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#### Abstract

Laryngeal hemiplegia is one of the most common upper airway affections in horses. Laryngoplasty is indicated in high-performance animals, and when the only complaint is noisy breathing, ventriculotomy and cordectomy can be performed. This study aimed to establish a minimally invasive surgical approach to ventriculocordectomy in horses, through a videoendoscopic procedure. The technique was developed in two stages, the first one was a cadaveric study and the second one was *in vivo*, both using two flexible endoscopes. A bilateral ventriculocordectomy was performed in two cadavers, totaling the removal of four vocal cords. In the second stage, a left unilateral ventriculocordectomy was performed in three animals with laryngeal hemiplegia. The vocal cords were pulled by one of the endoscopes with 3.2mm grasping forceps, while the second equipment was used for the resection of vocal cords with a flexible electrode adapted for monopolar electrosurgery (electrocautery). The average time for removal of the vocal cords was 23±5 minutes. In the postoperative care, moderate inflammation around the surgical wound was observed, with complete healing in 21 days in one horse and 28 days in the other two. One animal presented exuberant granulation tissue on the surgical site. Other complications due to the tested technique were not noticed; therefore, it could be a less invasive option for ventriculocordectomy in horses. The developed technique proved to be effective for ventriculocordectomy execution in horses. The main advantages of this approach were reduced surgical time, shorter healing average time, no need for daily dressings and return to normal activities in a shorter period when compared to other surgical approaches. The limitation of the technique consists of the need for two endoscopes for its accomplishment. Further studies, with more animals, are needed to improve the technique.

**Key words:** Horses. Laryngeal hemiplegia. Minimally invasive surgery.

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## Resumo

Hemiplegia de laringe representa uma das afecções mais frequentes em vias aéreas anteriores de cavalos. Em animais de alto desempenho esportivo a laringoplastia é indicada, e nos casos em que a única queixa é o ruído respiratório recomenda-se realizar a ventriculectomia e a cordectomia. O presente trabalho teve como objetivo estabelecer uma abordagem cirúrgica minimamente invasiva, através de videocirurgia, para realização da ventriculocordectomia em cavalos. A técnica cirúrgica foi desenvolvida em duas etapas, sendo a primeira cadavérica e a segunda *in vivo*, ambas utilizando videoendoscópios flexíveis. A primeira consistiu na realização de ventriculocordectomia bilateral em dois cadáveres, para padronização da técnica, totalizando quatro cordas vocais removidas. Na segunda, procedeu-se a ventriculocordectomia unilateral esquerda em três animais naturalmente afetados pela hemiplegia de laringe. As cordas vocais foram tracionadas utilizando uma pinça de preensão de 3,2mm, através do canal de trabalho de endoscópio flexível, e com o segundo equipamento similar, realizou-se a ressecção da corda vocal com eletrodo flexível monopolar adaptado para eletrocirurgia (eletrocautério), também através do canal de trabalho. O tempo médio dos procedimentos foi de 23±5 minutos. No período pós-operatório observou-se moderada inflamação ao redor da incisão, sendo o tempo de cicatrização total de 21 dias em um cavalo e 28 dias nos outros dois. Um dos animais apresentou tecido de granulação exuberante no local de excisão da corda vocal, que foi tratado com infiltração de corticosteroide. Não foram observadas outras intercorrências inerentes à técnica proposta, sendo esta uma opção pouco invasiva, que dispensa a realização da laringotomia. A técnica desenvolvida no presente trabalho mostrou-se promissora para realização da ventriculocordectomia em cavalos. As principais vantagens desta abordagem foram: tempo trans cirúrgico reduzido, tempo médio de cicatrização menor, eliminação da necessidade de curativos diários e retorno dos animais às atividades normais em um período inferior, quando comparado às outras abordagens cirúrgicas. A limitação da técnica consiste na necessidade de dois endoscópios para sua realização. Mais estudos, com um número maior de animais, são necessários para aprimorar a técnica.

**Palavras-chave:** Cavalos. Cirurgia minimamente invasiva. Hemiplegia de laringe.

Laryngeal hemiplegia is one of the most frequent affections of the anterior respiratory tract of horses (THOMASSIAN, 2005), and is almost always limited to the left side (DYCE, 2004). This condition occurs due to injury of the recurrent laryngeal nerve, which may cause neurogenic atrophy of the intrinsic muscles of the larynx, resulting in a deficiency in arytenoid cartilage abduction during inspiration, increased resistance to airflow and noise during exercise (REED et al., 2004; SAVAGE, 2001). The presumptive diagnosis is based on clinical history and findings of the physical examination, and the definitive diagnosis is made by endoscopic examination (AUER; STICK, 2012). The treatment is surgical, the technique of choice is laryngoplasty, with or without ventriculocordectomy, but with a high rate of postoperative complications (RADCLIFFE et al., 2006). Despite controversies, ventriculocordectomy has been shown to be effective

in reducing respiratory noise. This procedure without cordectomy improves performance in horses with laryngeal hemiplegia; however, it has been suggested that the combination of cordectomy and ventriculectomy is necessary to return to normal function (TAYLOR et al., 2006).

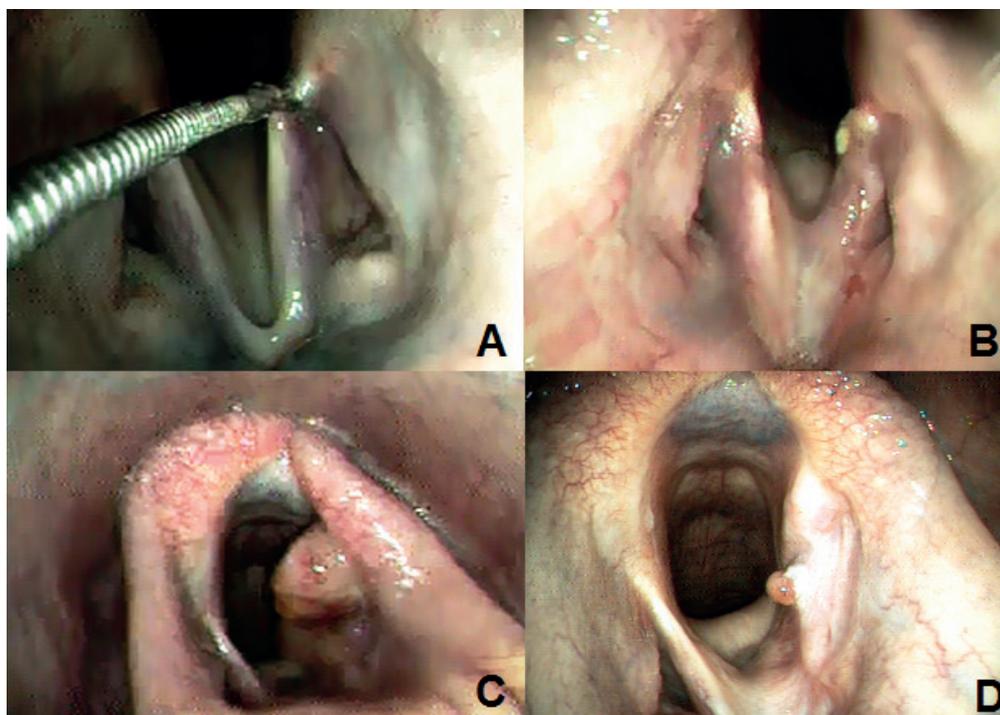
Conventional surgical access for ventriculocordectomy is performed by laryngotomy and healing occurs by second intention. The animal needs confinement until healing and returns to normal activities after eight weeks of surgery (TURNER; MCILWRAITH, 2002). Ventriculectomy can be performed by minimally invasive surgery via laser endoscopy (DUCHARME et al., 2002); however, this technique has not been described with the use of electrocautery. The objective of the present study was to adapt the technique in horses using the monopolar electrode.

The research was approved by the Ethics Committee on the Use of Animals of the Agrarian Sciences Sector of the Federal University of Paraná (protocol nº56/2011). The study was developed in two stages. The first was performed for surgical technique development, where two equine cadavers were used, in which bilateral ventriculocordectomy was performed by videoendoscopic route, with four vocal cords removed. In the second stage, three non-breed animals were used, one female and two males, with a mean age of  $11 \pm 3$  years. The three animals were used for walking and the only complaint from the owners was respiratory noise during exercise. After endoscopic evaluation, grade 3 left laryngeal hemiplegia was diagnosed in all animals.

The established technique for ventriculocordectomy consisted of the introduction of a flexible videocolonoscope (Storz GMBH &

CO®, 170 centimeters long and 10 millimeters in diameter) through the right nostril, finding the larynx entrance to identify the vocal cords. The left vocal cord was grasped and drawn with the aid of an endoscopic grasping forceps (Figure 1A), inserted through the working channel of the first videoendoscopic equipment. The second flexible colonoscope (Storz GMBH & CO®, 170 cm long and 10 mm in diameter) was introduced by the contralateral nostril closer to the affected vocal cord, to guide a flexible monopolar electrode adapted for electrosurgery (Figure 2). With this electrode, cauterization of the ventricle and removal of the vocal cord along its insertion were performed. The endoscopic forceps maintained light traction on the vocal cord throughout the procedure. After removal of the left vocal cord and left ventricle, the same procedure was used for the removal of these structures on the right side only in the cadavers.

**Figure 1.** A - Traction of the left vocal cord by endoscopic grasping forceps; B - Aspect of surgical wound 21 days after ventriculocordectomy; C - Exuberant granulation tissue developed at the site of excision of the left vocal cord; D - Small cyst observed at 28 days, two weeks after intralesional application of 6mg triamcinolone acetate in exuberant granulation tissue (previously shown in figure C).



**Figure 2.** Flexible monopolar electrode adapted for electrosurgery.

The animals of the second stage were submitted to general anesthesia and placed in dorsal recumbency position before the surgical procedure. Induction and anesthetic maintenance were performed exclusively by injectable drugs administered intravenously. The administered drugs were xylazine ( $0.5\text{mg kg}^{-1}$ ) as pre-anesthetic medication, glyceryl guaiaccol ether ( $75\text{mg kg}^{-1}$ ), ketamine ( $2.2\text{mg kg}^{-1}$ ) and midazolam ( $0.1\text{mg kg}^{-1}$ ) for induction and propofol in continuous infusion for maintenance (rate  $0.4\text{mg kg}^{-1}\text{ h}^{-1}$ ). The oxygen supply was performed by nasal catheter, and no tracheotube was inserted, allowing free access to the vocal cord.

In the postoperative period, the patients received an antibiotic containing penicillin benzathine at a dose of  $30,000\text{IU kg}^{-1}$ , intramuscularly, with three applications over a 48-hour interval, and flunixin-meglumine at a dose of  $1.0\text{mg kg}^{-1}$  intravenously for three consecutive days. Physical examination (heart rate, respiratory rate, mucosal staining, capillary filling time, rectal temperature and intestinal motility) of the three animals was performed daily until medical release. Endoscopic examinations

occurred weekly to assess the surgical wound for the presence of inflammation and/or infection and to monitor healing.

After the surgical technique was established, patients in the second stage had their vocal chords and left ventricles removed in an average time of  $23 \pm 5$  minutes. The anesthetic recovery was fast and uneventful. The clinical follow-up of the animals in the postoperative period showed parameters within those expected for this species. During the endoscopic evaluation of surgical wounds, moderate inflammation was observed around the incisions in all horses with absence of signs of infection. Complete healing occurred after 21 days in one horse (Figure 1B) and 28 days in the other two. One of the animals presented a development of exuberant granulation tissue, as seen in Figure 1C. To reduce this tissue, intralesional application of  $6\text{mg}$  of triamcinolone acetate was performed by videoendoscopy, 14 days after surgery. For this procedure, a sclerotherapy needle was used. After 28 days of surgery, it was observed that the granulation tissue had reduced to a small cyst, as

seen in Figure 1D.

In all animals submitted to the procedure, it was possible to completely remove the affected vocal cords and their respective ventricles, with good local healing. Removal of vocal cords allowed the increase of glottic rhyme, reducing resistance to airflow, and eliminating breathing noises during exercise. The animals were able to return to their activities, without restrictions, after healing of the surgical wound. At six months postoperatively, the three owners reported a noise reduction in the patients and stated that they were satisfied with the result of the surgery.

When selecting surgical options to treat laryngeal hemiplegia, surgeons should consider the ability of to improve upper airway function and/or reduce respiratory noise, minimizing the likelihood and severity of complications. Therefore, the surgical procedures should be chosen according to the horse's activity and the owner's complaint (BROWN et al., 2005).

Exposure horses with respiratory noise to exercise can be penalized during competition (ROBINSON et al., 2006); furthermore, some owners complain only of noise, regardless of the performance of the animal. In these cases, ventriculocordectomy, as an isolated technique, may be indicated. In addition, the technique may be complementary to others in high performance horses. Taylor et al. (2006) suggest that ventriculocordectomy in hemiplegic horses is necessary for the return of animals to normal function, thus supporting the combination of this technique with others used in the correction of laryngeal hemiplegia. In the animals used in the present study, the only complaint was respiratory noise during exercise. Since none of the patients sought an improvement in athletic performance, the isolated ventriculocordectomy was the surgical technique of choice, as it aims to reduce noise and leads to few postoperative complications.

Attempts were initially made to remove vocal cords from the first cadaver using only one portal (a

nostril), through a flexible colonoscope with a flexible monopolar electrode adapted for electrosurgery which was placed. Single access was not viable for the proposed purpose, since manipulation and resection of the vocal cord was not possible. In order to solve this issue, two colonoscopes were used, one for traction of the vocal cord and another for its resection. Unlike that reported by Brown et al. (2005), who underwent laser cordectomy with the sedated animals standing, the surgeries of this experiment were performed with the animals under general anesthesia. This method of anesthesia was chosen because it was a pilot study, in which the average time to perform the surgical technique was not yet established and it was not possible to predict the trans-operative complications. In the technique described by Ducharme et al. (2002), for performing laser cordectomy, only one endoscope was used, which was alternated between the nostrils to complete. The researchers also used flexible bronchoesophagoscopic forceps, manually bent over an arc of approximately 30° to hold the vocal cord before the laser incision. The technique developed in this study was the first to use two endoscopes for ventriculocordectomy. With the use of this second equipment it was not necessary to alternate the nostrils during the procedure, reducing the surgical time. In addition, the endoscopic grasping forceps was introduced through the working channel, eliminating the need to bend it manually and facilitating tissue manipulation.

Although this is a pilot study to develop a new surgical approach, the time spent performing the procedures was considered satisfactory. The smoke produced during cauterization of the vocal cord and ventricle with the monopolar electrode made it difficult to visualize the structures at some times; however, the smoke was dissipated without major complications and was facilitated by the animal's breathing. The use of laser also promotes cauterization of the structures, with consequent smoke production; therefore, the laser, in addition to representing higher costs, does not present

advantages in relation to the monopolar electrode. However, the present technique presents the need for two endoscopes as a limitation.

The clinical evaluation in the postoperative period did not show signs of inflammation that hinder breathing or signs of infection, demonstrating that antibiotic and anti-inflammatory therapy was adequate for the proposed purpose. The proposed videoendoscopy-assisted ventriculocordectomy technique proved to be effective for the complete removal of the affected vocal cord and its respective ventricle, with total healing occurring on average from three to four weeks. It did not require dressings, unlike the traditional technique, via laryngotomy, where healing occurs by second intention, requiring daily dressings and confinement of the animal for two to three weeks (TURNER; MCILWRAITH, 2002).

In this study, the healing was evaluated macroscopically by endoscopic visualization, and surgical wounds were considered healed since there was no more solution of continuity in the mucosa. Hawkins and Andrews-Jones (2001) had histologically verified that complete healing after laser ventriculocordectomy occurs only after 42 to 47 days. Since the cicatrization was not evaluated by a histological assay in this study, it is not possible to establish a strict comparison with such data; however, macroscopically, the healing time was apparently lower than that quoted in the literature.

Reed et al. (2004) mentioned several complications resulting from laryngoplasty, among them dysphagia and cough. None of the animals in this experiment presented such problems, probably because the ventriculocordectomy was performed by the less invasive access used. However, tissue-like growths of exuberant granulation was observed in one of the horses. For the treatment of such complications the intralesional administration of steroidal anti-inflammatory deposition was performed, which was sufficient to reduce granulation.

Robinson et al. (2006) evaluated anterior airway pressure in horses with experimentally induced laryngeal hemiplegia before and after unilateral laser ventriculocordectomy and noted that baseline values were resumed after surgery. These researchers believe that with the use of a laser, the damage to the adjacent tissues is greater, resulting in more scarring when compared to the scalpel; this can better stabilize the affected arytenoid. It is believed that the characteristics of the electrocautery incision and its cicatrization are similar to those of the laser, assuming that the airflow in the horses' airways improved after the ventriculocordectomy. This hypothesis justifies the elimination of respiratory sounds in operated horses.

The technique developed to aid with the treatment of laryngeal hemiplegia in horses through videoendoscopic ventriculocordectomy with electrocautery was shown to be promising. The main advantages of this approach were: reduced transoperative time, shorter mean healing time, elimination of need for daily dressings, and return to normal activities in a shorter period when compared to other surgical approaches. The limitation consists of the need for two endoscopes for its accomplishment. More studies, with a larger number of animals, are necessary to improve the technique and to prove its efficacy.

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