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Nd:YAG Laser–Assisted Modified Forssell's Procedure for Treatment of Cribbing (Crib-Biting) in Horses

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Objective—To report an neodymium:yttrium-aluminum garnet (Nd:YAG) laser-assisted modified Forssell's surgical technique and outcome for treatment of cribbing (crib-biting) in horses.
Study Design—Retrospective clinical study.
Animals—Ten adult horses with stereotypic cribbing behavior.
Methods—Data were obtained from medical records and telephone conversations with owners, trainers, and veterinarians. Surgical technique involved an approximately 34-cm ventral median skin incision starting rostral to the larynx and extending caudally. A 10-cm section of the ventral branch of the spinal accessory nerve was removed, using an Nd:YAG laser at 25 W and continuous pulse with a contact, sculpted-fiber tip. After neurectomy, approximately 34-cm sections of the paired omohyoideus and sternothyrohyoideus muscles were removed starting 2 cm rostral to the ventral aspect of the larynx, at the basihyoid bone, using the Nd:YAG laser.
Results—Median horse age was 7 years (range, 1 to 11 years). Median surgical time was 90 minutes (range, 75 to 130 minutes). Long-term outcome (range, 7 to 72 months) was available for all horses. None of the horses had cribbing behavior after surgery, and all returned to their previous use. Four horses had complications (two of which were unrelated to the surgical site), but all recovered fully.
Conclusion—The successful outcome we obtained is better than reported previously using a modified Forssell's technique.
Clinical Relevance—Surgical treatment for cribbing by Nd: YAG laser-assisted myectomy and neurectomy resulted in an excellent prognosis for resolution of the stereotypical behavior with minimal complications.

SEVERAL TYPES OF ABNORMAL behavior, including stereotypes, have been reported in domestic and captive wild horses.[1,2] A stereotype is defined as a repeated, relatively invariant sequence of movements that has no obvious function.[3] Cribbing (crib-biting) is an acquired stereotypic oral behavior in which a horse grasps a horizontal solid object with its upper incisors, contracts its ventral neck muscles and arches its neck, retracts the larynx, and pulls backward.[4] The muscles used during cribbing include the sternomandibularis, sternothyrohyoideus, and omohyoideus muscles.[5] The sternothyroideus muscles insert on the thyroid lamina. The sternohyoideus and omohyoideus continue rostrally and insert on the basihyoid and its lingual process.[6]

The etiology of cribbing is unknown[7]; however, commonly cited causes are boredom or frustration.[4,8,9] Different types and amounts of exercise[10] and differences in endogenous opioid and serotonergic systems[11] (with higher basal sympathetic activity[12] and higher beta-endorphin levels of beta-endorphin[13]) have been reported as contributing factors. Endoscopic

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and radiographic examination during episodes of cribbing have shown that air does not pass into the proximal esophagus by deglutition, but rather because of a negative pressure gradient created between the esophagus and pharynx. Thus, the term "wind-sucking" is a misnomer.[8] Sequelae to cribbing include poor performance, weight loss, abnormal wear of the incisor teeth, and flatulent colic.[4]

Conservative treatment methods for cribbing include the use of cribbing straps,[14] providing the horse with a companion animal such as a goat or a pony,[7] moving the horse to pasture or increasing the frequency of turn-out,[4,15] applying noxious agents to the surfaces used for crib-biting,[16] and electric shock aversion therapy.[17] Creation of permanent buccal fistulae has been used to prevent cribbing;[18] however, buccostomy has disadvantages including undesirable cosmesis and other complications associated with a buccal fistula.[18] Acupuncture has also been used to eliminate cribbing.[19] Despite the many reported methods, some are undesirable, results are unreliable, and successful correction of cribbing is quite variable.[4,7]

Various surgical procedures have been described to treat cribbing in horses. In 1872, Gerlach performed an omohyoid myotomy with variable results.[20] Forssell, in 1926,[20] performed a procedure that involved segmental myectomy of the sternomandibularis, omohyoideus, and sternothyrohyoideus muscles[18,20]; however, it resulted in considerable disfigurement of the neck because of the loss of a large part of the sternomandibularis muscle.[21] To improve the cosmetic appearance of the neck, a modification of Forssell's technique that did not involve myectomy of the sternomandibularis muscle was developed.[22] This modified technique involved a bilateral neurectomy of the ventral branches of the spinal accessory nerves,[23,24] which provide motor function to the sternomandibularis muscles.[5] Bilateral section of these nerves without myectomy yielded inferior results compared with a combination of neurectomy and myectomy of the omohyoideus and sternothyrohyoideus.[25-27] This latter modification of Forssell's technique provided superior cosmetic appearance compared with Forssell's original procedure and is currently the treatment of choice for cribbing.[23,28] However, based on their experience with poor outcome after use of the modified Forssell's procedure, Schofield and Mulville concluded that this procedure should no longer be recommended for the treatment of oral stereotypes in horses.[29]

Previous reported success rates for the modified Forssell's technique range from 50% to 93%.[24,30] Recurrence of cribbing behavior may be related to seroma or hematoma formation that could result in development of tendon-like fibrous tissue between the cut muscle ends.[31] Thus, minimizing seroma or hematoma formation postoperatively may improve outcome after a modified Forssell's technique. The wavelength of the neodymium:yttrium aluminum garnet (Nd:YAG) laser makes it ideal for coagulation of vascular tissues because of the relatively good absorption of the laser beam by hemoglobin.[32] A reduction in the amount of muscle remaining ventral to the larynx may further minimize the development of the tendon-like fibrous tissue that is believed to facilitate retraction of the larynx and reoccurrence. To our knowledge, there are no reports of a modified Forssell's technique that describe muscle transection rostral to the ventral aspect of the larynx.

To minimize postoperative recurrence of cribbing, we developed a modified Forssell's technique with more rostral transection of the sternothyrohyoideus and omohyoideus muscles performed with an Nd:YAG laser to reduce seroma or hematoma formation. Nd:YAG laser neurectomy of the ventral branches of the spinal accessory nerve was also incorporated into the procedure. Thus, the purpose of the study reported here was to describe our experience with another modification of Forssell's technique and to report outcome in 10 horses.

MATERIALS AND METHODS

Criteria for Case Selection

The medical records of horses admitted for surgical treatment of cribbing between November 1994 and February 2000 were reviewed.

Retrieved Data

Signalment (age, breed, gender) and historical data (duration of the stereotype, current or intended use), confinement (stabling or pasture), amount of exercise, and current feeding program were retrieved from the medical records. Preoperative variables retrieved included results of physical examination, complete blood count, serum fibrinogen concentration, serum biochemical profile, and antimicrobial and nonsteroidal anti-inflammatory (NSAID) administration. Postoperative variables of interest were complications (including incisional drainage or infection, abscess, or seroma formation), the number of days a drain was maintained, antibiotic and NSAID administration, and days of hospitalization.

Surgical Technique

Horses were anesthetized and positioned in dorsal recumbency with the neck in full extension. The ventral aspect of the neck and throat from the midcervical to intermandibular region were clipped and prepared for aseptic surgery. A ventral median skin incision extended caudally for approximately 34 cm starting 2 cm rostral to the ventral aspect of the larynx, at the basihyoid bone (Fig 1). The skin edges were retracted laterally to expose the paired omohyoideus, sternothyrohyoideus, and sternomandibularis muscles. Skin and subcutaneous hemostasis was achieved by electrocautery. A dissection plane was established along the medial aspect of each sternomandibularis muscle, approximately 7 cm caudal to the musculotendinous junction. Each muscle was then rolled laterally to identify the arterial supply to the cranial portion. The ventral branch of the spinal accessory nerve is located deep to the artery and emerges from within the fascia. A segment of the nerve was carefully freed from the fascia along the muscle. Identification of the ventral branch of the spinal accessory nerve was confirmed by contraction of the sternomandibularis muscle and flexion of the atlanto-occipital joint when the nerve was grasped with hemostat forceps. The nerve was isolated, and a 10-cm section was removed by use of an Nd:YAG laser (Sharplan model 2100 Nd:YAG Laser; Tel-Aviv, Israel) with a contact sculpted-tip fiber at 25 W in a continuous pulse mode.

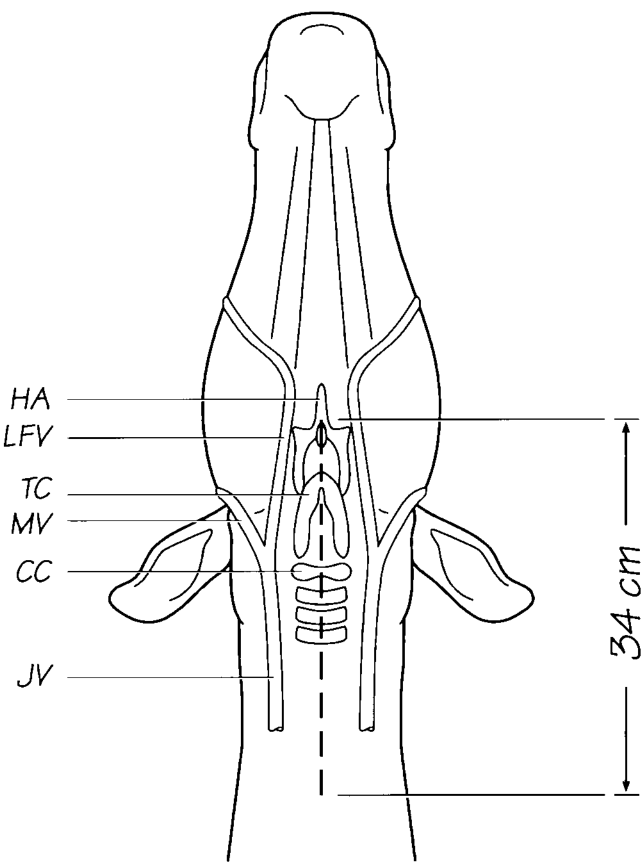

Fig 1. Ventral median incision for approach to perform a modified Forssell's to alleviate cribbing. The skin incision is made starting at the basihyoid bone and extended caudally. HA, basihyoid bone; LFV, linguofacial vein; TC, thyroid cartilage; MV, maxillary vein; CC, cricoid cartilage; JV, jugular vein.

After neurectomy, approximately 34-cm sections of the paired omohyoideus and sternothyrohyoideus muscles were removed. Blunt dissection with scissors was used to isolate the paired muscle bellies from the trachea, ventral aspect of the larynx, and underlying fascia. Then the Nd:YAG laser with the same tip and power setting was used to transect the muscles (Fig 2). These power settings provided rapid and efficient excision of muscle with a thermal effect that achieved hemostasis and lymphostasis. The sternohyoideus and omohyoideus muscles were transected approximately 2 cm rostral to the most cranial aspect of the ventral surface of the larynx, at the basihyoid bone. The sternothyroideus muscles were transected at their insertion onto the thyroid cartilage laminae. Caudal transection of the omohyoideus muscle was performed in an oblique fashion deep to the jugular vein. The sternothyrohyoideus muscles were sectioned transversely at the distal limits of the skin incision.

A 1-inch-diameter Penrose drain (Davol Inc, Cranston, RI) was positioned longitudinally in the subcutaneous space and exteriorized through separate 3-cm stab incisions rostral and caudal to the ends of the surgical incision. The horse's head was placed in slight flexion, and the subcutaneous tissues were closed in a simple continuous pattern with 2-polydioxanone. Stainless steel staples were used to appose the skin. A stent bandage was sutured over the wound for protection during recovery from anesthesia. After the drain was removed, horses were discharged from the hospital with instructions to confine to a box stall with daily hand walking for 10 days. The stab incisions were to be cleaned with a mild disinfectant solution daily until healed.

Outcome

Short-term (hospital discharge) and long-term (no less than 6 months after surgery) outcome were recorded. Recurrence of cribbing, complications that developed after hospital discharge, owner's satisfaction with cosmetic appearance, respiratory noise during exercise, and postoperative return to function were obtained by telephone conver-

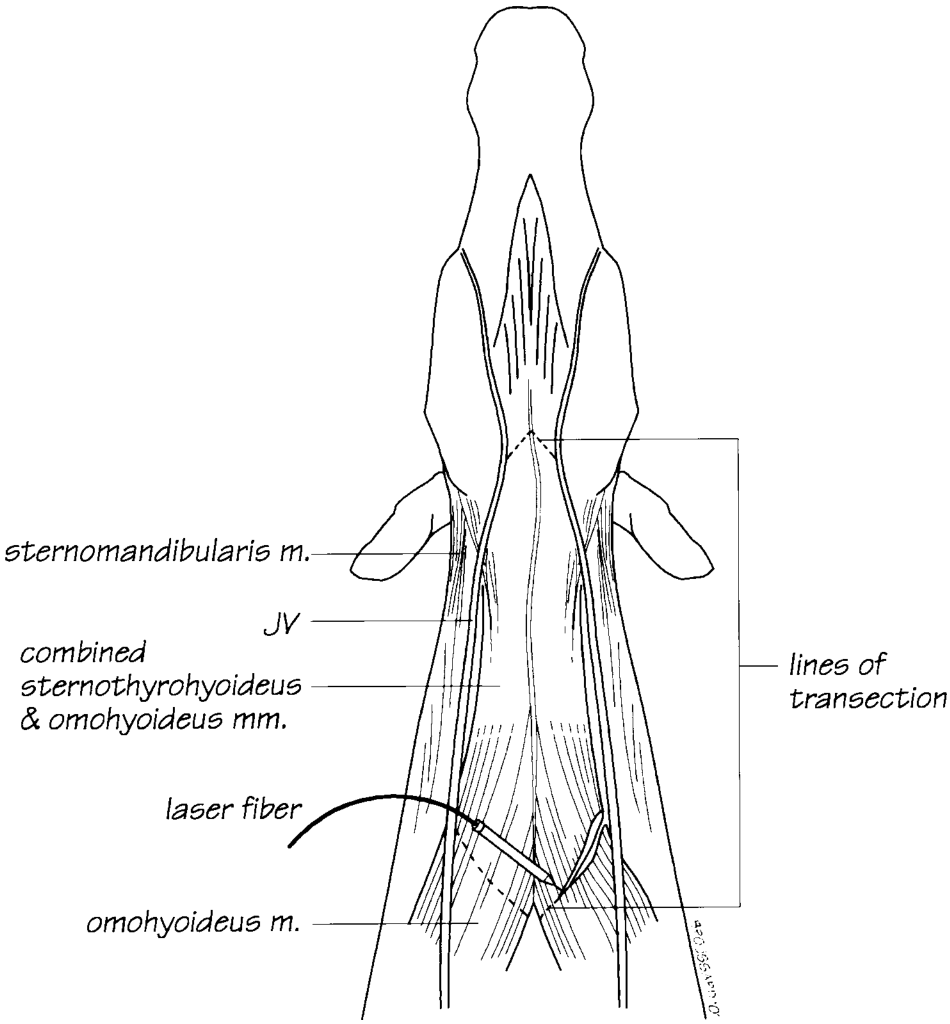

Fig 2. An Nd:YAG laser with a contact sculpted-tip fiber is used to transect the combined sternothyrohyoideus and omohyoideus muscles to alleviate cribbing (cribbiting). JV, jugular vein.

sation with owners, trainers, and referring veterinarians by use of a standardized questionnaire.

RESULTS

There was one stallion, four geldings, and five females; median age was 7 years (range, 1 to 11 years). Two breeds were represented: Quarter Horses (n = 7) and Thoroughbreds (n = 3). Although the exact duration of the stereotype was difficult to determine, eight horses were classified as chronic cribbers (>2 years), and two horses were classified as acute cribbers (1.5 months, 4 months). The actual or intended use for the Quarter Horses was cutting and for the Thoroughbreds was racing. All horses were box stall confined between exercise use. The feeding program for all horses included oats or concentrated pelleted feed, or both, and grass hay.

Except for two yearlings that had excessive wear of the incisor teeth, physical examination results were unremarkable. No clinicopathologic abnormalities were identified. Preoperatively, horses were administered either potassium penicillin G (22,000 U/kg, intravenously [IV], every 6 hours) and gentamicin (6.6 mg/kg, IV, once daily), ceftiofur sodium (4.4 mg/kg, IV, every 12 hours), or trimethoprim-sulfamethoxazole (15 to 30 mg/kg, orally, every 12 hours). The antimicrobial drug(s) administered preoperatively were continued for a median of 10 days (range, 5 to 10 days) after surgery. Phenylbutazone (2.2 mg/kg, orally, once or twice daily) was administered to all horses, preoperatively and for 5 days after surgery.

Median surgical time was 90 minutes (range, 75 to 130 minutes). Flexion of the atlanto-occipital joint as a neural reflex occurred when the spinal accessory nerve was grasped in all horses. The median length of muscle resected was 34 cm (range, 30 to 34 cm), and the median length of nerve resected was 10 cm (range 7 to 15 cm). Hemorrhage from the transected muscles was minimal in all horses. A Penrose drain was maintained in all horses for a median duration of 5 days, (range, 4 to 6 days). Median duration of hospitalization was 5 days (range, 3 to 10 days).

Postoperative complications occurred in four horses. One horse developed phlebitis of the jugular vein (at 5 days), diarrhea and abdominal discomfort (at 7 days), and an incisional infection (at 10 days) after surgery. The cause of the diarrhea was undetermined but was suspected to be associated with antimicrobial administration. This horse recovered uneventfully. One horse had an incisional abscess, 1 month after surgery, that was drained and healed by second intention. Two weeks after surgery, another horse developed moderate inflammation at the surgery site. This responded to local application of hot-packs.

Long-term outcome (median duration, 28 months; range, 7 months to 6 years) was available for all horses. Immediately after surgery, but as a single episode, two horses applied their incisor teeth to an object but did not grasp the surface, flex the neck, or make associated gulping noises. After hospital discharge, there was no recurrence of cribbing behavior. Owners and trainers were satisfied with the cosmetic appearance of the surgical site, and all horses returned to, or exceeded, their presurgical level and intended use of activity.

DISCUSSION

With this modification of the Forssell's technique, we were successful in preventing cribbing in 10 horses. This outcome may have been a result of transection of the sternothyrohyoideus and omohyoideus muscles rostral to the ventral aspect of the larynx, at the basihyoid bone, use of an Nd:YAG laser to perform the neurectomy and control hemorrhage during muscle transection, or a combination of these techniques.

Our follow-up period after surgery ranged from 7 to 72 months. Our success with these 10 horses was higher than the success rate reported previously by the following authors: Schofield and Mulville (1998), 50%[29]; Fjeldborg (1993), 60%[31]; Hakansson et al (1992), 50%[30]; Turner et al (1984), 57%[28]; Greet (1982), 78%[23]; Fricker and Hugelshofer (1981), 80%[33]; and Huskamp et al (1983), 93%[24]; using a modified Forssell's technique. Reported success with Forssell's technique were Hakansson et al (1992) with 92%,[30] Hermans (1973) with 73%,[34] and Forssell (1926) with 80%.[20] The poor outcome achieved by Schofield and Mulville led them to conclude that a modified Forssell's procedure could no longer be recommended for the treatment of oral stereotypes in horses.[29] We believe the difference in successful outcome between some of the reported studies and our experience was partly related to the more rostral transection of the muscles than previously reported[35] and use of an Nd:YAG laser to perform the myectomy.

The recurrence of cribbing after surgery may occur because of alternative innervation or reinnervation of the sternomandibularis muscle, fibrous reunion of transected muscle ends, or adaptation by other structures.[24,29] The eleventh cranial nerve (spinal accessory) is classified as a motor nerve.[5] The ventral branch of this nerve enters the dorsal aspect of the sternomandibularis muscle at the junction of the muscle belly and its tendon of insertion.[5] The use of an Nd-YAG laser for resection of as much of this nerve as possible may reduce the likelihood of reinnervation. After segmental resection of these muscles, a tendon-like fibrous tissue may develop in place of the extirpated muscles, thereby making it possible for the horse to engage in cribbing behavior again.[31] More rostral transection of the sternothyrohyoideus and omohyoideus muscles, as we describe, may decrease the likelihood of a fibrous union forming between the transected muscle ends. Minimizing seroma or hematoma formation postoperatively may decrease fibrous tissue formation and improve outcome. The omohyoideus muscles should be meticulously freed from the larynx, linguofacial vein, and thyroid gland before application of the Nd-YAG laser to avoid inadvertent secondary thermal effects to these structures. We believe that the use of an Nd:YAG laser to transect these muscles may reduce seroma or hematoma formation because of the coagulative effects of the laser thermal energy.[32]

We considered use of a Penrose drain to be necessary with our technique.[28] Despite meticulous control of hemorrhage, postoperative seroma formation is possible because of the dead space that is created by muscle resection. Serum drainage occurred in all horses but was not excessive. Horses were administered systemic antibiotics for at least 1 day after drain removal, and the drain was the principal reason horses were administered postoperative antibiotics. Those horses that did not develop complications after surgery were able to return to their intended use within 14 days after surgery. Importantly, none of the horses had any alterations in performance that resulted from the surgical procedure.

In conclusion, although the number of horses reported here was limited, our success was better than previously reported. In our opinion, transection of the sternohyoideus and omohyoideus muscles rostral to the larynx at the basihyoid is critical to improved success because this may reduce the likelihood of a fibrous union forming between the transected muscle ends. The use of an Nd:YAG laser to perform the myectomy is also an effective method of reducing the hemorrhage associated with muscle transection.

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