

# Ventriculocordectomy as the Sole Treatment for Recurrent Laryngeal Neuropathy: Long-Term Results from Ninety-Two Horses

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**Objective**—To evaluate the effect ventriculocordectomy (VC) for treatment of recurrent laryngeal neuropathy (RLN) on exercise performance and owner satisfaction in a mixed-breed population of horses.

**Study Design**—Retrospective study.

**Animals**—Adult horses (n = 92) with a history of abnormal respiratory noise and RLN.

**Methods**—Retrospective analysis of horse that had unilateral VC (and contralateral ventriculectomy in 63 horses) for treatment of idiopathic RLN. Owners/trainers completed a questionnaire about complications and outcome at least 1 year after surgery. Performance index was determined using race records for previously raced Thoroughbreds to evaluate outcome.

**Results**—Clinical signs included abnormal exercise-induced respiratory noises (noises; 52%), poor performance (11%), and noises and poor performance (37%). The median preoperative resting endoscopic grade of laryngeal function was Havemeyer grade III.1 (mild asymmetry). No discharge from the laryngotomy 1 week postoperatively occurred in 62% horses, 22% coughed after surgery, 66% made no noises, 9% continued to make noises at the canter, 21% made noise at the gallop, and 4% of owners were unsure whether noises were present. Ninety-three percent of horses returned to full work after surgery. Overall, 86% of owners considered the surgery worthwhile, 3% did not consider it worthwhile, and 11% were unsure. Surgery had a significantly beneficial effect on the racing performance index in Thoroughbreds ( $P = .004$ ).

**Conclusions**—VC is a useful alternative to laryngoplasty for selected cases of RLN and is associated with a positive effect on exercise performance, a low postoperative complication rate, and a high rate of owner satisfaction

**Clinical Relevance**—Unilateral VC should be considered as a sole treatment in horses with low grades of RLN.

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## INTRODUCTION

RECURRENT LARYNGEAL NEUROPATHY (RLN) causes clinical disease in 2.6–8.3% of adult horses.<sup>1–3</sup> Clinical signs include abnormal respiratory noises (noises) with or without poor exercise performance.<sup>4–6</sup> We are unaware of reports of the outcome after unilateral ventriculocordectomy (VC) in horses with

RLN. It is generally accepted that laryngoplasty is required to return airway mechanics to baseline values when laryngeal hemiplegia (equivalent to Grade IV laryngeal function)<sup>7</sup> is experimentally induced by left laryngeal neurectomy.<sup>8–10</sup> VC has been shown to be more effective than laryngoplasty at reducing noises in horses with experimentally induced laryngeal hemiplegia.<sup>10</sup> Ventriculectomy without vocal cordectomy improved

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performance in draft horses with naturally occurring RLN<sup>11</sup>; however, this has been disputed and it has been suggested that laryngoplasty combined with VC is necessary to return affected draft horses to normal function.<sup>12</sup>

Vocal cord collapse has been identified in 22% of horses during high-speed treadmill videoendoscopy and occurred as a sole abnormality in 5%.<sup>13</sup> Many surgeons consider laryngoplasty the treatment of choice for RLN but some authors advocate a combination of laryngoplasty and vocal corpectomy because vocal cord collapse has been diagnosed during high-speed treadmill videoendoscopy in horses previously treated with laryngoplasty alone.<sup>14</sup>

Vocal corpectomy is thought to increase the ventral diameter of the rima glottidis and reduce airflow turbulence and thus noises during exercise in horses with RLN.<sup>5,15</sup> In addition to noise reduction, the other goal of surgery is to improve airflow mechanics and thus exercise tolerance.<sup>16</sup> To our knowledge, no study has subjectively or objectively evaluated the use of VC alone to treat RLN in clinically affected horses. Thus, our purpose was to determine the effect of VC as the sole treatment for RLN, on the performance of selected horses and to determine the degree of owner satisfaction after VC.

## MATERIALS AND METHODS

Medical records of 92 horses that had unilateral or bilateral ventriculectomy and left vocal corpectomy for treatment of idiopathic RLN, between January 1985 and January 2005, were selected for retrospective analysis. Retrieved data were presenting complaint, endoscopic grade of laryngeal function at rest,<sup>7</sup> and postoperative complications. Horses were excluded from study if any additional upper airway surgery was performed.

### *Anesthesia*

Food, but not water, was withheld for 12 hours before anesthesia. Procaine penicillin, streptomycin, and flunixin meglumine (1.1 mg/kg intravenously [IV]) were administered preoperatively. Horses were premedicated with romifidine (100 µg/kg IV) and morphine sulfate (120 µg/kg IV). Anesthesia was induced with ketamine hydrochloride (2.2 mg/kg IV) and diazepam (0.05 mg/kg IV). Total IV anesthesia was maintained with a combination of 15% guaifenesin, 750 mg xylazine, and 1.5 g ketamine to effect. Alternatively, anesthesia was maintained with halothane vaporized in oxygen and the endotracheal tube was temporarily removed to allow the surgical procedure to be completed with administration of ketamine (1.1 mg/kg IV) and diazepam (0.0025 mg/kg IV) as needed. Horses were positioned in dorsal recumbency, with the head and neck extended.

### *VC*

A ventral median laryngotomy<sup>17</sup> was used for access to perform VC. After sharp excision of the everted laryngeal

ventricle and vocal fold, the cricothyroid membrane was sutured closed with 0 polyglactin 910 in a simple interrupted pattern. The subcutaneous tissues and skin were partially closed with simple interrupted 0 polyglactin 910 sutures.

### *Follow-Up*

Endoscopy was performed at 1 and 6 days, and 6 weeks after surgery. A postal questionnaire was sent to all owners/trainers after the horses had been back in work for at least 1 year after surgery. If there was no response within 2 months, information was obtained by telephone questionnaire of the owner. Evaluation of racing performance in Thoroughbred horses that had raced >3 times preoperatively was objectively assessed by reviewing racing performance records before and after surgery. Data were obtained from RacingPost.com. The last 3 races before surgery and the first 3 races after surgery were used to calculate a performance index, as described by Woodie et al.<sup>18</sup>

### *Statistical Analysis*

A Wilcoxon's signed rank test was used to determine whether the pre- and postsurgery performance index was significantly affected by surgery. A significance level of  $P < .05$  was used.

## RESULTS

### *Horses*

There were 92 horses: 67 Thoroughbreds, 22 Thoroughbred crosses, 5 Warmbloods, 1 Irish Draught, 1 Clydesdale, and 3 Cobs. Their use included 64 National Hunt racehorses, 1 flat racehorse, 12 hunters, 3 eventers, 3 showjumpers, and 15 with miscellaneous work loads. The median age was 6 years (range, 3–15 years), and the median height was 16.2 hands (range, 12.0–18.2 hands). Admitting signs were abnormal respiratory noises at exercise detected by the owner/trainer (53%), poor exercise performance (11%), noises and poor performance (33%), and noises detected at a prepurchase veterinary examination (3%).

### *Endoscopic Grading of RLN*

The median preoperative RLN endoscopic grade was Havemeyer grade III.1 (range II.1–IV); 91 horses had left-sided RLN and 1 had right-sided RLN. Twenty-three horses had treadmill endoscopy (Table 1). Twenty-nine percent of horses had endoscopic evidence of lower airway disease.

### *VC*

Bilateral ventriculectomy and unilateral vocal corpectomy was performed in 29 horses and 63 horses had unilateral VC.

Table 1. Grade of Laryngeal Function Observed During Resting and Treadmill Endoscopy

Horse No.	Breed	Clinical Signs	Grade <sup>1</sup>	VCC
1	WB	ARN	II.1.B	Yes
2	TB	ARN + PP	II.1.B	Yes
3	TB	PP	II.2.A	Yes
4	TB	ARN + PP	II.2.A	Yes
5	TB	ARN + PP	II.2.A	Yes
6	TB	ARN + PP	II.2.B	No
7	WB x	ARN	II.2.B	Yes
8	TB	ARN + PP	II.2.A	Yes
9	WB	ARN	II.1.A	Yes
10	TB	ARN	II.2.A	Yes
11	TB	ARN	III.1.A	Yes
12	TB	ARN	III.1.A	Yes
13	TB	ARN + PP	III.1.A	Yes
14	TB	ARN + PP	III.1.A	Yes
15	WB	ARN	III.1.B	Yes
16	TB	ARN + PP	III.1.B	Yes
17	TB	ARN + EIPH	III.1.A	Yes
18	TB	ARN + PP	III.1.A	Yes
19	TB	ARN + PP	III.1.B	Yes
20	TB	ARN + PP	III.1.B	Yes
21	TB	ARN	III.2.B	Yes
22	TB	ARN + PP	III.2.B	Yes
23	WB x	ARN	III.2.B	Yes

TB, Thoroughbred; WB, Warmblood; ARN, abnormal respiratory noise; PP, poor performance; EIPH, exercise-induced pulmonary hemorrhage; VCC, vocal cord collapse.

### Complications of Surgery

Sixty-two percent of horses had no discharge from the laryngotomy when the horse was discharged from the hospital at 1 week postoperatively, whereas in 20% horses, the discharge resolved by 2 weeks postoperatively, and in 3% horses, laryngotomy discharge persisted for >4 weeks. Twenty-two percent of horses coughed after surgery; 6% coughed when eating and 16% coughed at times not associated with eating (Fig 1). When back in full work, 66% of horses made no noises, 9% continued to make some noises at the canter, 21% made noises at the gallop, and 4% of owners were unsure whether noises were present (Fig 2). Twenty-five of 30 horses that continued to make some noises at exercise returned to full work regardless.

### Postoperative Performance

Ninety-three percent of horses returned to full work after surgery, 6% were able to perform at a reduced level, and 1 horse (1%) was retired. Fifty-nine percent of owners/trainers reported that the horse's performance had increased compared with preoperative performance, 16% reported no change, and the remaining owners were unsure whether any change had occurred (Fig 3). Overall,

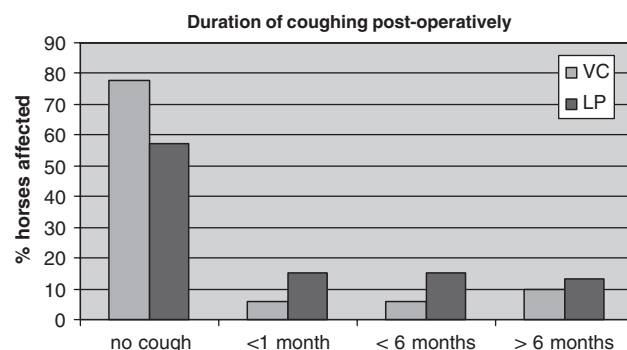


Fig 1. Bar chart showing percentage of horses affected with cough postoperatively after ventriculocordectomy (VC) and after laryngoplasty with ventriculocordectomy (LP; data from Dixon et al<sup>6</sup>).

86% of owners considered the surgery worthwhile, 3% did not consider it worthwhile, and 11% were unsure of its value (Fig 4).

Sixteen of the racehorses fulfilled inclusion criteria for calculation of a racing performance index. Surgery had a significant effect on performance index ( $P = .004$ ). The preoperative performance index (median = 1; range, 0–4) was significantly lower than the postoperative performance index (median 2.5; range, 0–4.5).

## DISCUSSION

Our results provide clinical evidence that VC can be recommended as a sole treatment in selected (lower grade) cases of RLN using both subjective criteria (reduction or elimination of abnormal respiratory noise, owner's perception of surgical success) and objective (analysis of performance index) methods.

Overall, 89% of horses in our study had abnormal respiratory noises associated with exercise. Most (56%)

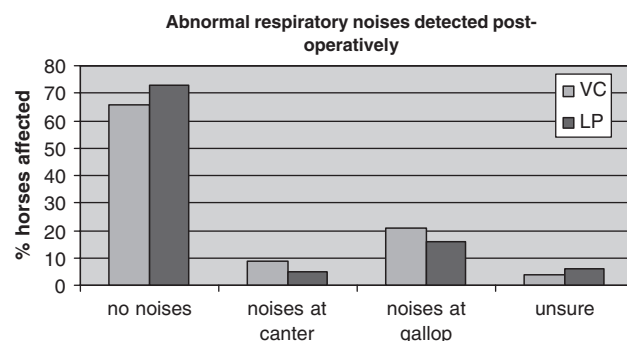
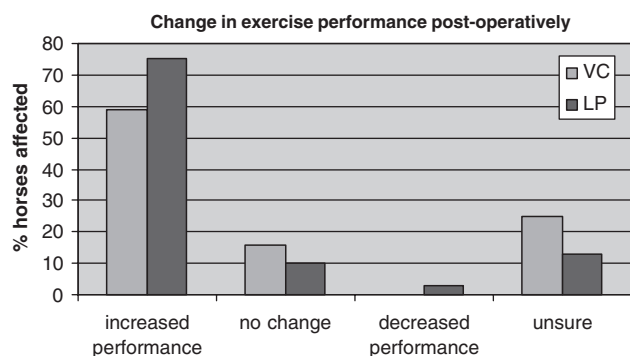


Fig 2. Bar chart showing percentage of horses making abnormal respiratory noises postoperatively after ventriculocordectomy (VC) and laryngoplasty with ventriculocordectomy (LP; data from Dixon et al<sup>6</sup>).



**Fig 3.** Bar chart showing percentage of horses that the owner/trainers considered had increased, decreased, or no change in exercise performance postoperatively after ventriculocordectomy (VC) and laryngoplasty with ventriculocordectomy (LP; data from Dixon et al<sup>6</sup>).

horses had no history of reduced exercise performance, usually because they were removed from training because of noises, before performance could be fully assessed. Forty-four percent of horses had a history of reduced performance at exercise (with or without noises). These results are similar to those previously documented for clinical RLN.<sup>6,11</sup> Vocal cord collapse has been reported to occur without marked arytenoid cartilage collapse in horses with grades I–III laryngeal function<sup>13,19,20</sup>; however, the effect that vocal cord collapse without marked arytenoid cartilage collapse has on airway function is yet to be determined.<sup>21</sup>

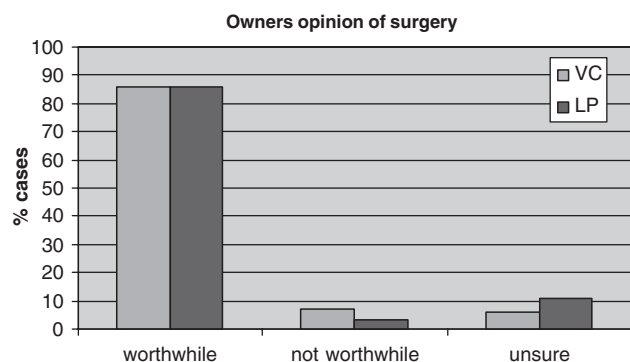
It has been suggested that most noises in horses with RLN arise from vibration of the vocal cord.<sup>19,22</sup> Recent studies have shown that VC significantly reduces abnormal respiratory noises in horses with experimentally induced laryngeal hemiplegia (equivalent to grade IV Havemeyer laryngeal function)<sup>15,23</sup> and this technique has been recommended if reduction of respiratory noise is the primary objective of surgery. Kidd and Slone<sup>22</sup> also

suggested that inclusion of a vocal cordectomy along with laryngoplasty was important to eliminate noises in clinical cases. VC has been shown to improve upper airway function in horses with experimentally induced laryngeal hemiplegia, but not to baseline levels.<sup>21</sup> Sound analysis after laser vocal cordectomy in 6 experimental horses showed that the procedure did not effectively improve upper airway noise<sup>24</sup>; however, a more recent study concluded that laser VC reversed upper airway obstruction and reduced upper airway noise in 6 hemiplegic horses.<sup>23</sup> Therefore, for horses with low-grade RLN, where vocal cord collapse is likely to make a major contribution toward the most common presenting sign, i.e. noises,<sup>15,19</sup> VC could be expected to reduce markedly the presence of this clinical sign.

VC may also enhance exercise performance to some degree if the vocal cord is causing airflow obstruction of the ventral rima glottidis.<sup>5</sup> Because VC was associated with fewer complications and less cost than laryngoplasty, it could be considered as the treatment of choice for lower grade RLN.

When compared with laryngoplasty in a similar population of horses,<sup>24</sup> VC had a lower rate of postoperative complications. Unsurprisingly, healing of the laryngotomy wound was similar to that in horses that had LP and VC,<sup>24</sup> with most horses having no discharge from the surgical site 2 weeks postoperatively. However, in horses that had LP and VC, an additional 19% had wound complications (seromas, suture abscesses, etc.) associated with laryngoplasty incisions.<sup>24</sup> Although 22% of horses coughed after VC, this is considerably less than the 43% of horses that coughed after laryngoplasty. This is unsurprising because after VC, the affected arytenoid cartilage should be able to adduct and protect the airway during deglutition. Additionally, in most horses that did cough after VC, coughing was not associated with eating and could be attributable to pre-existing or recently acquired lower airway disease (present in 29% of horses on admission), rather than to dysphagia because of surgical interference. However, VC entails removal of the vocal fold, and coughing postoperatively may be a result of a mild degree of aspiration of food through the small space created by excision of this structure as well as to transient decreased mobility of the ipsilateral arytenoids.

A slightly higher percentage of horses were reported to make abnormal respiratory noises after VC (34%) as compared with LP combined with VC (27%)<sup>24</sup> even though the group that had VC alone had a lower median grade of RLN than those undergoing VC combined with laryngoplasty. Similarly, slightly fewer horses were subjectively considered to have increased exercise performance after VC as compared with horses that had laryngoplasty<sup>24</sup> but the overall rate of owner satisfaction was very similar for the 2 procedures.



**Fig 4.** Bar chart showing the owner/trainer's overall opinion of surgery after ventriculocordectomy (VC) and laryngoplasty with ventriculocordectomy (LP; data from Dixon et al<sup>24</sup>).

Dixon et al<sup>3</sup> found evidence of progression in 15% of horses with RLN, and for this reason we would advise against performing VC alone in a performance horse with low-grade RLN that has clinical or historic evidence of progression, as further progression may result in laryngoplasty being required at a later date.

Our results shows that VC is a useful alternative to laryngoplasty for selected cases of RLN (lower grades of RLN in performance horses or with more severe grades of RLN in non-performance horses) and is associated with a low postoperative complication rate, an increase in performance index, and a high rate of owner satisfaction.

### REFERENCES

1. Lane JG, Ellis DR, Greet TRC: Observations on the examination of Thoroughbred yearlings for idiopathic laryngeal hemiplegia. *Equine Vet J* 19:531–536, 1987
2. Anderson BH, Kannegeiter NJ, Goulden BE: Endoscopic observations on laryngeal symmetry and movements in young racing horses. *NZ Vet J* 45:188–192, 1997
3. Dixon PM, McGorum BC, Railton DI, et al: Clinical and endoscopic evidence of progression in 52 cases of equine recurrent laryngeal neuropathy (RLN). *Equine Vet J* 34:29–34, 2002
4. Christley RM, Hodgson DR, Evans DL, et al: Cardio respiratory responses to exercise in horses with different grade of idiopathic laryngeal hemiplegia. *Equine Vet J* 29:6–10, 1997
5. Ducharme NG, Goodrich L, Woodie B: Vocal cordectomy as an aid in the management of horses with laryngeal hemiparesis/hemiplegia. *Clin Tech Equine Pract* 1:17–21, 2002
6. Dixon PM, McGorum BC, Railton, et al: Laryngeal paralysis: a study of 375 cases in a mixed-breed population. *Equine Vet J* 33:452–458, 2001
7. Robinson NE (Chairperson) Workshop summary, in Dixon P, Robinson NE, Wade JF (eds) Havemyer Foundation Monograph Series No.11. Proceedings of a workshop on equine recurrent laryngeal neuropathy, September 2003. Newmarket, UK, R & W Publications Ltd., 2003, pp. 96–97
8. Shappel KK, Derksen FJ, Stick JA, et al: Effects of ventriculectomy, prosthetic laryngoplasty, and exercise on upper airway function in horses with induced left laryngeal hemiplegia. *Am J Vet Res* 49:1760–1765, 1988
9. Tetens J, Derksen FJ, Stick JA, et al: Efficacy of prosthetic laryngoplasty with and without bilateral ventriculocordectomy as treatments for laryngeal hemiplegia in horses. *Am J Vet Res* 57:1668–1673, 1996
10. Brown JA, Derksen FJ, Stick JA, et al: Effect of laryngoplasty on respiratory noise reduction in horses with laryngeal hemiplegia. *Equine Vet J* 36:420–425, 2004
11. Bohanon TC, Beard WL, Robertson JT: Laryngeal hemiplegia in draft horses: a review of 27 cases. *Vet Surg* 19:456–459, 1990
12. Kraus BM, Parente EJ, Tulleners: Laryngoplasty with ventriculectomy or ventriculocordectomy in 104 draft horses (1992–2000). *Vet Surg* 32:530–538, 2003
13. Tan RHH, Dowling BA, Dart AJ: High-speed treadmill videoendoscopic examination of the upper respiratory tract in the horse: the results of 291 clinical cases. *Vet J* 170:243–248, 2005
14. Davenport-Goodall CLM, Parente EJ: Disorders of the larynx. *Vet Clin North Am Equine Pract* 19:169–187, 2003
15. Brown JA, Derksen FJ, Stick JA, et al: Ventriculocordectomy reduces respiratory noise in horses with laryngeal hemiplegia. *Equine Vet J* 35:570–774, 2003
16. Derksen FJ: Upper airway sound analysis: Implications for diagnosis and surgical treatment, in Proceedings 3rd World Equine Airway Symposium, Cornell University, Ithaca, NY, July 2005. 2005, pp 94–96
17. Stick JA: Larynx, in Auer J, Stick J (eds): *Equine Surgery*. St Louis, MO, Saunders Elsevier, 2006, pp 566–590
18. Woodie JB, Ducharme NG, Kanter P, et al: Surgical advancement of the larynx (laryngeal tie forward) as a treatment for dorsal displacement of the soft palate in horses: a prospective study 2001–2004. *Equine Vet J* 37:418–424, 2005
19. Hammer EJ, Tulleners EP, Parente EJ, et al: Videoendoscopic assessment of dynamic laryngeal function during exercise in horses with grade III left laryngeal hemiparesis at rest: 26 cases (1992–1995). *J Am Vet Med Assoc* 212:399–403, 1998
20. Lane JG: Differences between resting and treadmill endoscopic findings in regard to RLN, in Dixon P, Robinson NE, Wade JF (eds) Havemyer Foundation Monograph Series No.11. Proceedings of a workshop on equine recurrent laryngeal neuropathy, September 2003. Newmarket, UK, R & W Publications Ltd., 2003, pp. 47–48
21. Ducharme NG: Upper airway: Clinical perspectives, in Proceedings World Equine Airway Symposium, Cornell University, Ithaca, NY, July 2005. 2005, pp 68–73
22. Kidd JA, Slone DE: Treatment of laryngeal hemiplegia in horses by prosthetic laryngoplasty, ventriculectomy and vocal cordectomy. *Vet Rec* 150:481–484, 2002
23. Robinson P, Derksen FJ, Stick JA, et al: Treatment of laryngeal hemiplegia using laser assisted ventriculocordectomy, in Proceedings World Equine Airway Symposium, Cornell University, Ithaca, NY, July 2005. 2005, 131pp.
24. Dixon PM, McGorum BC, Railton DI: Long-term survey of laryngoplasty and ventriculocordectomy in an older, mixed-breed population of 200 horses. Part 1: maintenance of surgical arytenoid abduction and complications of surgery. *Equine Vet J* 35:389–96, 2003