Treatment of laryngeal hemiplegia in horses by prosthetic laryngoplasty, ventriculectomy and vocal cordectomy

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The medical records of 80 horses treated for left laryngeal hemiplegia by prosthetic laryngoplasty, ventriculectomy and vocal cordectomy were examined, first to compare the subjective and objective success rates for groups of horses of different ages and used for different purposes, and secondly, to compare the efficacy of including vocal cordectomy in the surgical protocol with published success rates for laryngoplasty and ventriculectomy alone. Subjectively, 70 per cent of the horses were said to have had a successful surgical outcome. The success rate for thoroughbred racehorses (66 per cent) was lower than for other breeds (90 per cent) on the basis of a subjective assessment by owners and trainers. Thoroughbreds two years old or younger had a success rate of 69 per cent, but older thoroughbreds had a success rate of 61 per cent. Of the 17 horses for which an objective performance index could be calculated, 10 (59 per cent) had an improved performance postoperatively. There was a nearly significant association between the objective and subjective assessments (P=0·078). Six of 69 horses (8·7 per cent) continued to make a respiratory noise after surgery. The subjective assessment of success did not appear to correlate with the objective measure of success used in this study and age had no apparent association with a successful surgical outcome. Inclusion of a vocal cordectomy in the surgical protocol may be more important in the eradication of postoperative respiratory noise than in improving clinical success rates.

PROSTHETIC laryngoplasty is the most commonly used procedure for the surgical treatment of laryngeal hemiplegia in horses and it is usually combined with a ventriculectomy (Speirs and others 1992). Several authors have reported clinical success rates after surgery (Marks and others 1970, Baker 1983, Speirs 1987, Ducharme and Hackett 1991), but they have not considered whether an objective or a subjective assessment is the best measure of a successful clinical outcome.

Ventriculectomy is considered to decrease the noise associated with the condition (Speirs and others 1992) but the effect of a vocal cordectomy on the incidence of respiratory noise has not been reported, and there is only one other reference to vocal cordectomies in relation to the treatment of laryngeal hemiplegia (Tetens and others 1996). That study concluded that the addition of ventriculocordectomy to prosthetic laryngoplasty did not improve the upper airway function of affected horses, but neither the clinical success rates nor the postoperative reduction in respiratory noise after ventriculocordectomy have been reported.

The aims of this study were first, to compare the subjective and objective success rates for 80 horses with laryngeal hemiplegia treated by laryngoplasty, ventriculectomy and vocal cordectomy, grouped according to age and use, and secondly to assess the contribution of a vocal cordectomy to the clinical success rate and the incidence of postoperative respiratory noise.

MATERIALS AND METHODS

The records of 80 horses undergoing prosthetic laryngoplasty, ventriculectomy and vocal cordectomy for left laryngeal hemiplegia between March 1993 and December 1997, were reviewed. Before March 1993, a vocal cordectomy was not included in the surgical protocol. The criteria for surgery included respiratory noise, exercise intolerance, and laryngeal hemiplegia diagnosed by endoscopy. The horse's breed, age and sex were recorded, and complications occurring before the horse was discharged from the hospital, and the postoperative grade of arytenoid cartilage retraction, were also recorded.

All the procedures were performed by the same surgeon, who used a method similar to that described by Marks and others (1970) with the following modifications. The prosthetic laryngoplasty was performed with the horse in right lateral recumbency, using number 5 braided polyester (Ethibond; Ethicon) placed as two separate sutures as the prosthesis. The skin incision was closed with surgical staples (AutoSuture; US Surgical). The ventriculectomy and cordectomy were performed with the horse in dorsal recumbency after it had been moved to the recovery area but while it was still under general anesthesia. A laryngotomy was performed and both laryngeal saccules were everted with a burr and excised. The vocal folds were then removed by grasping each cord centrally with Allis tissue forceps and removing the entire fold with curved Mayo scissors. The transected edge of the vocal cord was then cauterised for haemostasis by electrocautery. The laryngotomy incision was allowed to heal by second intention.

The horses received 22,000 iu/kg bodyweight of potassium penicillin (V-Cillin; Lilly) intravenously immediately before surgery and every eight hours after surgery for 48 hours. Each horse also received a single oral dose of 2 g of phenylbutazone (Butazolidin; Coopers) and 1500 iu tetanus toxoid intramuscularly immediately after surgery. The laryngotomy was cleaned daily for approximately three weeks after the surgery, and the horses were discharged from the hospital three to five days postoperatively. It was recommended that the horses should resume training between 45 and 60 days after surgery.

The horses were examined endoscopically on the day they were discharged, and the postoperative degree of arytenoid abduction was recorded on a five-point scale: grade 1 was given if the arytenoid cartilage crossed the vertical midline; grade 2 if the arytenoid cartilage was in the normal resting position; grade 3 if the arytenoid cartilage was abducted past the resting position but was not touching the pharyngeal wall; grade 4 if the abducted arytenoid cartilage contacted but did not depress the pharyngeal wall; and grade 5 if the abducted cartilage depressed the pharyngeal wall.

Subjective assessment of success

The postoperative progress of the horses was assessed subjectively for between three months and five years after surgery (median 34 months) by telephoning the owner or trainer of all 80 horses, and follow-up information was obtained for 69 horses from owners or trainers who had contact with the

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horse during and after the convalescent period. The owners or trainers were asked about the intended use of the horse, the performance it had reached before surgery, the period after surgery before it resumed training, its performance after surgery, including respiratory noise and exercise intolerance, any complications which occurred, and whether they considered the surgery to have been successful on the basis of the performance of the horse before and after surgery.

Objective assessment of success

For the objective assessment, race records were obtained for 51 of the 80 horses from the Bloodstock Research Information Service. A performance index (PI) for each horse was calculated as described by Hawkins and others (1997) and Hammer and others (1998) as the sum of the performance points obtained for the three to five races immediately postoperatively, divided by the sum of the performance points obtained for the three to five races immediately preoperatively. The performance points for each race were calculated as the horse's finish place multiplied by a scalar. A first place was assigned five points, a second place four points, a third place three points, a fourth place two points, and a fifth place or lower was assigned one point. The scalars were derived from the race rating assigned to each race by Bloodstock Research and took into account the past performance of the horses in the race, the class of race, and the value of the purse. Race ratings ranged from 80 to 130: a race rating of 120 or more was assigned a scalar of 1·0; a race rating of less than 120 but at least 110 was assigned a scalar of 0·8; a race rating of less than 110 but at least100 was assigned a scalar of 0·6; and a race rating of less than 100 was assigned a scalar of 0·4.

The performance of horses with a PI more than 1 was considered to have improved after surgery, whereas the performance of horses with a PI between 0 and 1 was considered to have deteriorated. Horses which could not race or train owing to respiratory impairment before surgery but which did race after surgery were considered to have improved, as were horses which had raced less than three times before surgery owing to respiratory impairment but raced successfully after surgery. Horses which raced before surgery but could not race after surgery were considered to have deteriorated. Not all the information from questionnaires or race records was available for all of the 80 horses.

Statistical methods

Any association between the objective and subjective assessments of whether the horses had improved or deteriorated was tested for by using Fisher's exact test. Background variables (age and sex) of racehorses were evaluated with respect to both the subjective and objective assessments as potential confounding variables by using Fisher's exact test. The horses were categorised as two years of age or less, and more than two years of age. The association between the degree of postoperative arytenoid abduction and the objective outcome was similarly evaluated.

RESULTS

The sex and breed distribution of the 80 horses included in the study are listed in Table 1. Their ages at surgery ranged from one to 19 years with a mean of 3·4 years. Of the 71 thoroughbreds, 67 (94 per cent) were intended for use as racehorses. The other 13 horses included show draft horses, a polo pony, a barrel racer, three hunter/jumpers, a pony, a dressage horse and an eventer.

Upper respiratory noise was noted during exercise in 31 horses (45 per cent) preoperatively and exercise intolerance in 17 (25 per cent). On routine endoscopy, two were found to have laryngeal hemiplegia.

TABLE 1: Sex and breed distribution of the 80 horses included in the study

	Number (%) of horses
Sex	
Male	42 (53)
Gelding	25 (31)
Female	14 (18)
Breed	
Thoroughbred	71 (89)
Quaterhorse	2 (2·5)
Clydesdale	2 (2·5)
Paint	2 (2·5)
Warmblood	3 (4)

TABLE 2: Postoperative degree of arytenoid cartilage abduction in the 75 horses for which information was available

Grade of abduction	Number of horses
1	0
2	0
3	13
4	62
5	0

Complications experienced while the horses were in hospital included mild postoperative haemorrhage in six horses, a nasal discharge in two horses, pyrexia in two horses, swelling at the laryngoplasty site in one horse and coughing in one horse. A cough, pyrexia and a nasal discharge were all observed in one horse. Transverse laryngeal webbing was not observed in any of the horses after they had had a bilateral vocal cordectomy.

Postoperative arytenoid abduction was recorded in 75 horses. The grade of abduction is shown in Table 2 and the subjective assessment of the success of surgery by grade of abduction is shown in Table 3. A Fisher's exact test showed that there was no significant association between the subjective assessment of success and the grade of postoperative abduction (P=0·218).

Subjective assessment of surgical success

Of the 69 horses for which follow-up information was available, 48 (70 per cent) were considered subjectively by their owners or trainers to have had a successful surgical outcome, and 14 (20 per cent) were considered not to have had a successful surgical outcome; seven cases could not be classified as either successful or unsuccessful by their owners.

Fifty-five of the 69 owners (80 per cent) reported no complications during the convalescent period. Complications reported after the horses had left the hospital included coughing during eating in two horses and a purulent discharge from the laryngoplasty site in two horses. One other horse was shipped 1500 miles 30 days after the surgery and subsequently died of pneumonia, but the owner was uncertain whether the pneumonia was related to the surgery. No other case of lower respiratory tract disease was reported during the convalescent period. In five of the horses, the surgical prosthesis failed to maintain the abduction achieved during surgery and two of them underwent further surgery. Both had a second pros-

TABLE 3: Subject assessment of outcome for the horses with grade 3 or 4 postoperative abduction of the arytenoid cartilage

Grade of postoperative abduction	Number (%) of horses with Successful outcome	Unsuccesful outcome	Unknown outcome
3 (n=13)	6 (46)	4 (31)	3(23)
4 (n=62)	37 (60)	9 (14·5)	16 (26)

thetic laryngoplasty which was unsuccessful in one case but was followed by a successful arytenoidectomy.

Forty-four of 60 horses (73 per cent) for which information was available were given the recommended length of convalescence before they resumed training; two were given less time, and 14 (23 per cent) were given more time. Of the 44 horses given the recommended amount of time off, the surgery was considered subjectively by their owners/trainers to have been successful in 34 (77 per cent), unsuccessful in six and the results for four horses were not known. Of the 14 horses given more than the recommended time off, the surgery was considered to be successful in 10 (71 per cent) and unsuccessful in four. Of the two horses given less time off, one was considered to have had a successful outcome; the result for the other horse was unknown. A Fisher's exact test showed that there was no significant association between the subjective assessment of success and the length of convalescence before the horses resumed exercise.

Of the 69 horses for which follow-up information was available, 31 (45 per cent) had had a history of respiratory noise before surgery and, of these, six were reported to be still making a noise postoperatively. However, four of the six owners of these horses considered the surgery to have been successful.

Racehorses

Of the 67 racehorses, nine were lost to follow-up. Of the remaining 58, 38 (66 per cent) were said to have had a successful surgical outcome, 13 (22 per cent) were said to have had an unsuccessful surgical outcome, and seven could not be classified as either successful or unsuccessful by their owners or trainers.

The 67 racehorses were then divided into two age groups: 41 were two years old or younger, and the remaining 26 were classified as 'older horses'. Of the 41 younger horses, six were lost to follow-up. Of the remaining 35, 24 (69 per cent) were said to have had a successful outcome, seven (20 per cent) were said to have had an unsuccessful outcome, and four (11 per cent) could not be classified as either successful or unsuccessful. Of the seven horses with an unsuccessful outcome, the surgery had failed to improve respiratory function in three, one had continued drainage from the surgery site, one was diagnosed with equine protozoal myeloencephalitis (EPM), one had an unrelated upper respiratory tract infection and its coughing caused the prosthesis to fail, and one was considered unsuccessful for unknown reasons.

Of the 26 older horses, three were lost to follow-up. Of the remaining 23, 14 (61 per cent) were said to have had a successful outcome, six (26 per cent) were said to have had an unsuccessful outcome, and three (13 per cent) could not be classed as either successful or unsuccessful. A Fisher's exact test showed that there was no significant association between the age classifications and the subjective assessments of success or failure. A similar analysis showed that there was no association between the sex of the horses and the subjective assessments.

Other breeds

Of the 13 horses of other breeds, three were lost to follow-up. Of the remaining 10, nine were said to have had a successful outcome and did not make respiratory noises while exercising. The unsuccessful case was a jumper which showed no improvement in respiratory function and continued to make a noise while training.

Objective assessment of surgical success

Race records were available for 50 of the 67 racehorses; the other 17 had not raced before surgery and did not race after surgery. Of these 17, nine were still in training, three were lost to follow-up, one was sold as a hunter prospect, one was retired owing to unrelated musculoskeletal problems, one was diagnosed with EPM, one was given away after becoming tentative about training, and one was limited by a perceived lack of talent. Of the 14 unraced horses for which follow-up information was available, 11 were considered to have had a successful surgical outcome, two were considered unsuccessful, and one could not be classified by the owner; the nine unraced horses which were still in training were considered to have had a successful surgical outcome.

Fifty horses had raced before and/or after surgery, 17 of them more than three times before and after surgery and could therefore have a PI calculated. Ten (59 per cent) had a PI of more than 1 (mean 2·34, range 1·18 to 4·89), indicating that their performance had improved after surgery, and the remainder had a PI of less than 1 (mean 0·49, range 0·32 to 0·72) indicating that their performance had deteriorated. Of the 10 horses whose performance improved, six were considered subjectively to be successful by their owner or trainer, two were lost to follow-up, and two could not be classified as either successful or unsuccessful. None was considered to have had an unsuccessful surgery. Of the seven horses whose performance deteriorated, four were considered by their owner or trainer to have had a successful surgical outcome, two were considered to have had an unsuccessful outcome, and one could not be classified as either successful or unsuccessful.

Twenty-six horses did not race before surgery but raced after surgery; the performance of 14 of them was said to have improved after surgery, indicating a successful subjective surgical outcome. Six were said to have been unsuccessful, two could not be classed as either successful or unsuccessful, and four were lost to follow-up.

Three horses raced before surgery but did not race after surgery, and all three were considered to have had unsuccessful outcomes.

Four horses raced less than three times both before and after surgery and could not have a PI calculated. Three of them were considered to have had a successful surgical outcome and one was lost to follow-up.

Fisher's exact tests showed that the association between the objective outcome and age (P=0·085) approached statistical significance, but that there was no association between the objective outcome and sex (P=0·0167).

DISCUSSION

There is some controversy over the role played by the vocal cords in laryngeal hemiplegia during exercise and the value of removing them surgically. Speirs and others (1992) suggested that resecting the vocal cords conferred no benefit, although they stated that the dynamic collapse of the affected cartilage and its associated soft tissue structures at high speeds causes an increased inspiratory pressure, increased time of inspiration and a decrease in maximal airflow. Hammer and others (1998) demonstrated that affected horses exercising at higher speeds (14 m/second) suffer axial collapse of the arytenoid and vocal folds and they postulated that it is the vibration of the vocal folds which causes the characteristic noise associated with laryngeal hemiplegia. Shappell and others (1988) and Williams and others (1990) also recorded the axial collapse of the vocal cords during exercise. However, Tetens and others (1996) demonstrated that in standardbred horses the dynamics of upper airway airflow are not improved by the addition of ventriculocordectomy to prosthetic laryngoplasty; however, they used a maximal treadmill speed of 13 m/second which is lower than the maximal speed at which a thoroughbred performs.

Of the 69 horses for which follow-up information was

available, six (8·7 per cent) were reported to be making a respiratory noise postoperatively, although the owners of four of them considered the surgery to have been successful. Hawkins and others (1997) reported that 59 of 168 horses (35 per cent) treated with a laryngoplasty either with or without a ventriculectomy but without a vocal cordectomy continued to make a noise postoperatively. Russell and Slone (1994) reported that 26 of 55 horses (47 per cent) treated with a laryngoplasty and a ventriculectomy continued to make a respiratory noise postoperatively. These data suggest that the inclusion of a vocal cordectomy may be more important in terms of eliminating respiratory noise than in substantially altering functional success rates, especially when compared to the number of horses making a noise after surgery from this practice at a time when cordectomies were not yet being performed.

A postoperative grade of 4 for arytenoid abduction had a 60 per cent success rate subjectively whereas a postoperative grade of 3 had a 46 per cent success rate, the difference not being statistically significant. However, 82 per cent of the cases had a postoperative abduction grade of 4, making it difficult to evaluate the association between the postoperative degree of abduction and the subjective success rates. The lack of grades 1, 2 and 5 was probably due to the fact that all the horses were operated on by the same surgeon.

The overall subjective success rate of 70 per cent achieved in this study was similar to the rate achieved by Hawkins and others (1997) and slightly higher than the 60 per cent success rate achieved by Russell and Slone (1994). Success rates for prosthetic laryngoplasty and ventriculectomy vary widely and have been reported to range from 58 to 95 per cent (Marks and others 1970, Baker 1983, Speirs 1987, Ducharme and Hackett 1991) depending on the criteria used to gauge success and the types of horses examined. There have been few studies of large numbers of clinical cases to determine success rates and few in which all the horses have been treated by the same surgeon. In this study, a slightly lower success rate was achieved in racehorses aged three years or more (61 per cent) than in younger racehorses (69 per cent), rates which are comparable with the 70 per cent and 65 per cent reported by Hawkins and others (1997). However, they do not agree with the results of Russell and Slone (1994) who reported a 70 per cent success rate for the younger thoroughbreds but only a 25 per cent success rate for the older group.

The objective success rates for thoroughbred racehorses, based on a PI calculated from race records, were slightly lower with a success rate of 59 per cent. Only one previous study has used this rigorous comparison of horses which have had at least three races before and after laryngeal surgery to assess its effect. Because of these restrictive criteria, it was possible to evaluate only 17 horses. Other studies have reported improvements in performance ranging from 38 to 85 per cent after laryngoplasty (Spiers 1980, Goulden and Anderson 1982, Spiers and others 1983, Russell and Slone 1994) but the criteria for the assessment of the improvements were much less stringent.

Only 60 per cent of the horses for which follow-up information was available and whose performance improved on the basis of a calculated PI were considered subjectively to have had a successful surgical outcome, which suggests that there may be little correlation between the subjective and objective assessments of a surgical outcome. Conversely, of the seven horses whose performance had deteriorated on the basis of a calculated PI, four were considered subjectively to have had a successful surgical outcome. A Fisher's exact test showed that there was no significant association between the subjective and objective assessments of the surgical outcome ($P=0·078$) confirming that owner satisfaction is not necessarily linked to functional outcome.

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