Sternothyroideus Myotomy for the Treatment of Dorsal Displacement of the Soft Palate

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An in-stall technique of sternothyroideus myotomy and soft palate resection is given for correction of the dorsal displacement of the soft palate. Authors' addresses: Abernant Veterinary Services, Box 808 Stayner, Ontario L0M 1S0, Canada (Llewellyn) and 434 Hickory St., Hinsdale, IL 60526 (Petrowitz).

1. Introduction

The medical records of 41 racing Standardbreds, diagnosed as having dorsal displacement of the soft palate (DDSP), that underwent sternothyroideus myotomy and soft palate resection were reviewed. All horses had endoscopy of their upper respiratory tract, but not necessarily by Dr. Llewellyn.[a] The history had to confirm the diagnosis of DDSP.

Surgery in each patient was performed by Dr. Llewellyn, using the same surgical protocol in each instance.[b] Postsurgical racing results were obtained for each of the patients to analyze improvement in on-track performance from the USTA. The race times for each horse were analyzed and adjusted for the track upon which the fastest presurgical and postsurgical results were obtained, using the experimental track ratings, also provided by the USTA. All horses, which were randomly selected for this review, raced at least once after the surgery had been performed. Overall, 29 (70%) of the horses in this study showed some degree of performance improvement after the surgery, whereas six (15%) and six (15%) horses either returned or failed to return to their previous level of performance, respectively, following the surgery.

Dorsal displacement of the soft palate is a normal phenomenon that occurs during normal deglutition. Dorsal displacement of the soft palate during exercise is usually an intermittent problem in horses. This displacement of the soft palate occurs when the palatolaryngeal seal is suddenly broken and the free edge of the soft palate lies within the rima glottis of the larynx.[1] Elevation of the soft palate above the epiglottis and into the airway as a result of DDSP redirects expiratory gases dorsal and ventral to the soft palate, resulting in airflow through the oral cavity and nasal passages of the exercising horse. The caudal border of the soft palate vibrates violently in the laryngeal opening when expiratory airflow velocity increases during exercise, resulting in the loud expiratory noise associated with DDSP.[3] This obstruction to free airflow contributes significantly to the total resistance to airflow in the upper airway, which normally comprises 40% of the total resistance to airflow in the resting horse.

Because the horse is an obligate nasal respirator, as a result of the tight seal formed between the soft palate and larynx, the soft-tissue obstruction to free airflow through the nasopharynx and the larynx results in dyspnea. A condition of relative tissue

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hypoxia soon develops as a result of the decreased inspiratory and expiratory capabilities of the horse, which are the result of a higher carbon dioxide level and a lower oxygen level at the pulmonary alveoli. Numerous disease processes within the pharynx, larynx, and lower airways can change the stability of the relationship between the palatopharyngeal arch and larynx.[3]

Normal horses that race despite painful disorders, such as mild lameness, sore feet, and so on, may displace their soft palate as a result of the painful stimulus. During strenuous exercise, there may be a caudal retraction of the larynx and dislocation of the larynx from the palatopharyngeal arch. Conditions such as hypoplastic epiglottis, cranial displacement of the palatopharyngeal arch, lymphoid hyperplasia of the pharynx, subepiglottic cysts, and entrapment of the epiglottis may lead to instability of the palatopharyngeal arch and larynx, resulting in DDSP.

The most common factor initiating DDSP is the large increase in negative pressures during the inspiratory phase of the respiratory cycle.[5] This can result in ventral and medial collapse of the pharynx and DDSP if this phenomenon is not counteracted by the action of the palatopharyngeus, pterygopharyngeus, and tensor veli when these pharyngeal muscles become exhausted.

DDSP can also occur during expiration.[5] In comparison with inspiratory displacement, the stationary position of the caudal free edge of the soft palate on the larynx progressively becomes more lax. As ventilation becomes maximal, a portion of the expiratory airflow redirects ventral to the soft palate, causing elevation of the soft palate above the epiglottis.

If a swallow is initiated during exercise, with ventilation being maximal and pharyngeal muscles being fatigued, the tendency to displace the soft palate dorsally is greatly increased. Predisposition to this dysfunction is associated with epiglottic hypoplasia.[5]

A diagnosis of DDSP is often one by exclusion of other processes that cause similar clinical signs. Because of the intermittent nature of the disorder, the veterinarian must often rely on information provided by the trainer, rider, or driver to presumptively diagnose the condition. A postrace endoscopic examination of the upper respiratory system of a horse suspected of DDSP is often unrewarding because when the horse finishes the race and slows to a stop, it often has enough time to swallow, which replaces the soft palate into its normal anatomical location.

In some horses, DDSP can be induced simply by occluding both nostrils while viewing the larynx and soft palate with an endoscope or simply from irritation caused by the endoscope. This sometimes makes a definitive diagnosis of the disorder with only an endoscopic examination difficult.

Although the actual displacement of the soft palate may not be seen, submucosal hemorrhage may be noted in the free edge of the soft palate and dorsal pharynx as a result of traumatic injury from air turbulence in the nasopharyngeal and laryngeal regions. In such cases, there may be a ring of inflammation in the mucosa along the dorsal border of the nasopharynx, just cranial to the rima glottis.

2. Materials and Methods

A. Case Selection

The patients used in this review were selected by using the random-number technique from a total population pool of 405 Standardbreds (1993–1994) upon which Dr. Llewellyn performed this procedure. The total population pool was much greater, but the patients for this study were limited to the horses that could be positively identified on the medical records by their names registered through the USTA.

B. Surgical Technique

The following surgical protocol,[4] developed by Dr. Llewellyn, is used for the average 450-kg Standardbred. The horse is placed against the wall of the box stall and is given xylazine 600–750 mg IV as a preanesthetic medication. The horse is then observed for the development of slight rear limb weakness and ataxia, which is usually ~3 min. At this time, ketamine 1100 mg IV is administered as an induction agent for general anesthesia. One person is assigned to hold the head, another the shoulder region, and a third the hindquarters. The horse is balanced, rather than pressed, against the wall to prevent struggling and excitation. It is maintained in a standing position for as long as possible; the majority of horses settle down quietly.

Some horses may show extrapyramidal signs, primarily muscle quivering and shaking, for ~1 min postinduction. This shaking will subside with the placement of a hand or towel over the eye. The horse is placed in dorsal recumbency, either in the middle or up against the wall of the stall. The horse is held in this position either by two persons, one on each side, or by one individual sitting astride the horse's chest. Instruments required for this procedure are minimal: a 7-in. (~18 cm) Metzenbaum scissors (straight or curved), Gelpi retractors, a 7-in. Rochester or equivalent straight forceps, a scalpel, and a pen light or similar light source.

The surgical site is prepared. Starting at the level of the cricoid cartilage of the larynx and extending cranially, a 5-cm incision is made through the skin, underlying subcutaneous tissue, and muscle in one even stroke. Blunt dissection with the index finger is used to elevate the sternothyroideus muscles at their laryngeal insertion on the thyroid cartilage laminae. The sternothyroideus muscles vary in shape, size, and mode of insertion from horse to horse; not all have an aponeurosis at their laryngeal insertion. Some horses will have adhesions in the area around the proximal sternothyroideus, and

undermining the muscle in these cases can be a little difficult compared with normal cases. Careful dissection with an index finger will isolate the muscle. Elevation of the muscle out of the incision is difficult in some horses; to facilitate this, raise the nose of the horse, and that will reduce tension in the muscle and allow transection of the aponeurosis. Next, Gelpi retractors are placed through the skin incision to hold the muscles apart to visualize the larynx adequately. A laryngotomy is then performed by placing the back edge of the scalpel blade against the cricoid cartilage. An initial stab incision is made into the laryngeal lumen and the incision is then extended cranially. Placement of the scalpel in this manner avoids incising the cricoid cartilage. The Gelpi retractors are now replaced to hold the laryngotomy open.

As one kneels on the right side of the horse, the middle finger of the right hand is inserted into the larynx and used to press ventrally (up) on the epiglottis. At the same time, the horse's head is lifted. This action will result in displacement of the epiglottis and the soft palate will then become visible, using the light source. The middle of the caudal free edge of the soft palate is grasped with the forceps. Approximately 9 mm of the free edge of the soft palate is grasped, and with the use of the Metzenbaum scissors, a cut is made around the tips of the forceps. This results in a small notch in the middle of the caudal free edge of the soft palate. The Gelpi retractors are removed and the horse is rolled back into lateral recumbency and left in the stall to recover.

Postoperative care consists of cleaning the wound thoroughly with a dry gauze pad three to four times daily. The more vigorously the wound is cleansed, the faster it will heal. Postoperative swelling is minimal. If the wound should become infected, the horse should be placed on appropriate antibiotic therapy. Dr. Llewellyn feels that wound infection develops from poor wound care postoperatively. The horse should be jogged daily and when the incision is healed, usually within 10–14 days, the horse can be trained.

C. Complications

1. Hemmorrhage

Hemorrhage is not common but can be seen in two situations. The first of these is jugular thrombosis, when aberrant vessels develop in the surgical area as a result of the thrombosis. If the bleeding vessel can be found, ligation should be performed. The exact source of the bleeding can be difficult to find because of retraction of the vessels within the muscles. The hemorrhage can be stopped by placing large mattress sutures in the muscles. In the second of these, the insertion of the sternothyroideus muscle occasionally has a blood vessel associated with it. Generally the vessel does not bleed when cut, but if it does ligating the stump of the sternothyroideus stops it.

2. Palatine Exuberant Granulation Tissue

The area of the staphylectomy will become thickened and exhibit exuberant tissue. The horse may or may not have persistent DDSP but will almost always make a respiratory noise.

Treatment of this condition is to resect the exuberant granulation tissue and free any perilaryngeal adhesions. The horse is put on an antibiotic and phenylbutazone for 4 days and Naquazone[c] for 2 days. No exercise is allowed for 7 days.

3. Postoperative Swelling

Because of inadequate debridement of the incision, and maintaining drainage, swelling occasionally develops. If swelling develops the horse should receive antibiotics and nonsteroidal anti-inflammatories, and ventral drainage should be achieved by digital debridement of the area. Exercise should continue. The person in charge of cleaning the wound must be instructed as to how to do so and impressed upon as to the importance of the result.

4. Poor Performance

Almost all the horses stop making the gurgling noise, but some continue to have poor performance. These horses probably have some other performance-limiting problem that may have led to DDSP, e.g., pain.

5. Redevelopment of DDSP

Infrequently, DDSP reoccurs in some horses after a rest for treatment of some other ailment. The condition can usually be alleviated by performing the surgery as before, but now the object is to free any adhesions that have developed in the laryngeal area. The adhesions are broken by careful blunt dissection with the fingers. The horse is put back to work the next day, the incision is cleaned as before, and a nonsteroidal anti-inflammatory drug is administered for 4 days.

3. Results

Through the use of the medical records provided by Dr. Llewellyn and the charted race times provided by the USTA, the performance level of each individual was analyzed preoperatively and postoperatively. All horses randomly selected from the medical records of Abernant Veterinary Services for this study were positively identified through the records of the USTA.

Statistical analysis: The paired *t* test was used to compare the previous performance level in the form of the fastest achieved race time and postsurgical performance level in the form of fastest achieved race time within the same racing season. The sex, age, and gait of the horses used in this study were not considered as factors because the horses were selected by using the random-number selection sys-

tem and only their individual performance levels preoperatively and postoperatively were compared. The experimental track ratings formulated by the USTA were used to standardize the fastest times achieved on different tracks in the United States and Canada. A value of $p < 0.05$ was considered significant.

All the horses used in this study were either making abnormal respiratory sounds or were felt to be performing at a level below that which was expected of them. No other physical abnormalities could be found in these individuals. The diagnosis of DDSP in these horses was either made by a referring veterinarian, trainer, or driver.

The ages of the Standardbreds used in this study ranged 2–11 years of age, with the average age being just over 3 years of age (median = 2 years of age). Of the 41 horses used in this study, there were 12 (29%) females, 23 (56%) colts or stallions, and six (15%) geldings. There were 30 (73%) pacers and 11 (27%) trotters.

Of the 41 horses used in this study, 35 horses achieved either the same or a faster race time. Six horses failed to achieve their previous performance level. Of the 35 horses that achieved the same or faster race time postsurgically, 29 of these showed improvement in their race time. This improvement varied from 0.2 s to as much as 7 s. Of the 29 horses that showed some degree of improvement in race time following surgery, the mean improvement in race time was 2.248 s, with a median improvement time of 0.2 s.

4. Discussion

DDSP is an event that occurs during normal deglutition. This displacement, along with caudal retraction of the larynx and epiglottic closing of the rima glottis, allows food to pass from the oral cavity into the esophagus.

The identification of DDSP endoscopically in a resting horse does not necessarily indicate a clinical abnormality, nor does the absence of the same rule out the possibility of DDSP during strenuous exercise. Many horses with DDSP are asymptomatic at rest or during moderate exercise. However, during heavy exercise, the soft palate–epiglottic seal is broken, and the soft palate is pulled dorsally into the pharyngeal lumen as the result of negative pressure created during inspiration.

A definitive diagnosis of this disorder can be made by endoscopy of an exercising horse on a treadmill; however, even this is unreliable because it does not reproduce the excitement, head position, and rein action of an actual race. Unless the horse is presented to a referral center that has this capability, the diagnosis of this disorder is made by historical events and clinical signs.

The findings of this study show dramatic improvement in on-track performance in those Standardbreds that were displacing their soft palates dorsally following sternothyroideus myotomy at the laryngeal aponeurosis and soft palate resection. The mean improvement in race time for the 29 horses that demonstrated faster postsurgical performance was 2.248 s, whereas the mean improvement in race time for the entire population pool in this study was 1.488 s.

Those horses in this study that showed no improvement in postsurgical race times were probably not displacing their soft palates dorsally at maximal exercise. Dr. Llewellyn said that some of the horses upon which he performs this procedure were quitting at the end of the mile or were performing at an unacceptable level prior to surgery. No lameness nor other medical abnormalities could be diagnosed in these individuals to explain their poor level of performance, so the surgery was performed despite endoscopic findings, as a diagnostic rule out.

This procedure is relatively simple, quick, and effective, and it can be performed with minimal equipment in the horses's own environment. The horse loses very little training time, which can be a very important factor in a racing schedule. The few complications have been discussed and can be rectified fairly easily.

Some commonly encountered positive benefits other than performance are loss of anxiety, and weight gain. In terms of loss of anxiety, horses with DDSP are frequently nervous, especially on race day. This is probably a learned behavior, because they know that their respiration is going to be compromised. Following surgery, horses of this type are usually more placid and content. In terms of weight gain, a loss of weight is probably a result of the anxiety associated with DDSP. When this is removed following surgery, affected horses improve in condition.

Although Standardbreds were selected for this study, the procedure has been employed with equal success in Thoroughbreds and racing Arabian horses. Other breeds such as Hackney ponies and draught horses that have DDSP also benefit from the surgical therapy.

Sternothyroid myotomy alone has been used successfully in horses that have a normal pharyngeal anatomy. This is very beneficial if the horse has an imminent important race.

A percentage of horses that have an entrapped epiglottis will later develop DDSP. In an attempt to prevent this occurrence, we routinely perform a sternothyroid myotomy at the same time as correcting the epiglottic entrapment.

The procedure has been performed on approximately 5000 horses of various breeds. As a way to acquire statistically significant results, the performance of racing Standardbreds was chosen. This compared the times for 1 mile on a fairly standard surface versus Thoroughbreds that race varying distances on different surfaces.

There are numerous treatments for correction of DDSP other than the one upon which this study was based. Conservative measures, such as the applica-

tion of a tongue tie, may prevent the displacement of the soft palate dorsally in some cases.[1] In most cases, surgical intervention is needed to prevent recurrence of the disorder. Staphylectomy, excision of portions of the caudal free border of the soft palate by means of a midline ventral laryngotomy, has been advocated.[5] This may not reduce the ability of the horse to dislocate the larynx at times of maximal airflow, but excising the portion of the soft palate that interferes with airflow at the glottis prevents airway obstruction. However, if too much of the caudal free border of the soft palate is excised, the condition may actually be exacerbated. Sternothyroideus myectomy has also been advocated.[2] The sternothyroideus muscles are transected at the level of the eighth to tenth tracheal rings. A CO_2 or Nd:YAG laser can also be used to transect the muscles. A convalescent period of 14 days before normal training can resume following surgery is recommended.

Complications associated with this procedure include excessive hemorrhage from the transected muscle bellies, suture dehiscence, and infection as a result of retrograde wicking of bacteria up the Penrose drain, which must be placed to control seroma formation. Death was reported in a horse that had severe hemorrhage from the muscle stumps, which caused tracheal compression and asphyxiation.[2]

5. Conclusions

Sternothyroideus myotomy at the laryngeal aponeurosis has been used for horses that do not displace their soft palates dorsally; in these cases surgery has been used as a performance-enhancing procedure. The feeling is that by transecting the sternothyroideus muscles at their laryngeal aponeuroses, the larynx is projected cranially into the nasopharynx.

The surgery is routinely performed on young racehorses in some training establishments: the reason given for this is that dorsal displacement of the soft palate is so common and may develop prior to important races. By performing surgery early in the horses's training, one may avoid DDSP. We do not agree with performing surgery without some clinical indication. This action allows for a more direct route of airflow into the larynx. This procedure may also increase the luminal diameter of the rima glottis by allowing the epiglottis to seat more flatly on the soft palate, thus decreasing the resistance to airflow and increasing airflow through the area that contributes 30–40% of the total airway resistance in a horse at rest. This lower resistance and increased airflow helps prevent the adverse effects upon athletic performance caused by anaerobic metabolism.

Beneficial results from the myotomy have been seen in horses with arytenoid asynchrony or laryngeal paresis. We believe that because of the insertion of the sternothyroideus muscles on the distal thyroid cartilage laminae, contraction of the muscle tends to dilate the posterior part of the larynx and as a result constrict the anterior part. This would make the work of the cricoarytenoid dorsalis muscle harder, i.e., abducting the vocal cords. By transection of the insertion of the sternothyroideus, the cricoarytenoid dorsalis may work more efficiently.

References and Footnotes

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[a]Because all horses were referrals, it cannot be determined what percentage showed endoscopic signs of DDSP.

[b]Surgeries are not performed merely at the trainer's request.

[c]Naquazone, diuretic anti-inflammatory, Schering-Plough, 3535 Trans Canada Hwy., Pointe Claire, H9R 1B4 PQ, Canada.