

## Palatal sclerotherapy for the treatment of intermittent dorsal displacement of the soft palate in 51 standardbred racehorses

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**Abstract** – This retrospective study evaluated the efficacy and side effects of palatal sclerotherapy in standardbred racehorses suspected to have intermittent dorsal displacement of the soft palate (IDDSP). Fifty-one horses were treated with multiple endoscopically guided injections of 3% sodium tetradecyl sulfate in the soft palate. Two groups were identified: those that had respiratory noises during exercise ( $n = 27$ ) and those that did not ( $n = 24$ ). Treatment was well-tolerated. Furthermore, horses significantly reduced their racing times for the last 400 m compared with their times before treatment and even when their times were compared to the mean times for horses in the same race. In conclusion, palatal sclerotherapy appears to be a suitable alternative therapeutic option for horses suspected to have IDDSP.

**Résumé** – **Thérapie sclérosante palatale pour le traitement du déplacement dorsal intermittent du palais mou chez 51 chevaux de course Standardbred.** Cette étude rétrospective a évalué l'efficacité et les effets secondaires de la thérapie sclérosante palatale chez les chevaux de course Standardbred soupçonnés d'avoir un déplacement dorsal intermittent du palais mou (IDDSP). Cinquante et un chevaux ont été traités avec des injections multiples guidées par endoscopie de 3 % de tétradécyl sulfate sodique dans le palais mou. Deux groupes ont été identifiés : ceux qui avaient des bruits respiratoires durant l'exercice ( $n = 27$ ) et ceux qui n'en avaient pas ( $n = 24$ ). Le traitement a été bien toléré. De plus, les chevaux ont significativement réduit leur temps de course pour les derniers 400 mètres comparativement à leurs temps avant le traitement et même à leur temps comparativement aux temps moyens des chevaux de la même course. En conclusion, la thérapie sclérosante palatale semble être une méthode de remplacement appropriée pour les chevaux soupçonnés d'avoir IDDSP.

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### Introduction

In horses, intermittent dorsal displacement of the soft palate (IDDSP) is the most common cause of exercise intolerance (1–4). The IDDSP obstructs the upper airways, mostly during the expiratory phase (5–6) and is usually associated with clinical signs of poor performances and respiratory noises during exercise (7–8). Approximately 10% to 20% of horses diagnosed on the treadmill for DDSP did not make a noise and were referred to as silent displacers (3–7). We were interested in verifying the response to the treatment of this specific group. The pathophysiology of IDDSP seems to be complex and some

authors have suggested that flaccidity of the soft palate due to neuromuscular disorders could play a role in its displacement during exercise (9–11). Based on these observations, one of the goals of treatment could be to increase the rigidity of the soft palate (12–14). Several therapies have been reported, including thermal palatoplasty with laser (15–17) and cautery (18–20).

In humans, soft palate flaccidity is related to the snoring syndrome and contributes to obstructive sleep apnea. A recent treatment for these conditions consists of a soft palate stiffening procedure called “injection snoreplasty” or “palatal sclerotherapy.” This technique involves injecting a sclerosing agent

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(sodium tetradecyl sulfate) in the submucosal layer of the soft palate to induce fibrosis. It has been effective in stiffening the soft palate in a canine model (21) and showed promising results in human patients affected by snoring and sleep apnea (22–23). A similar approach, injecting poly-L-lactic acid into the soft palate, has been described in horses (24). Recently, an experimental study performed on horses but using lower dosages of sodium tetradecyl sulfate failed to detect long-term fibrosis in the soft palate (25).

A recent preliminary study involving young standardbred horses showing typical clinical signs of IDDSP demonstrated that palatal sclerotherapy was a safe, repeatable, inexpensive, and efficient procedure in the treatment of intermittent dorsal displacement of the soft palate (26). This retrospective study was designed to: 1) evaluate the efficacy of injecting a sclerotic agent into the soft palate of mature standardbred racehorses showing typical clinical signs of IDDSP with or without respiratory noises during exercise, 2) record the type and frequency of complications associated with palatal sclerotherapy in mature standardbred racehorses.

## Materials and methods

All experimental procedures were performed in accordance with the guidelines of the Canadian Council for Animal Care and were approved by the Animal Care Committee of the Faculty of Veterinary Medicine of the University of Montreal.

### Case selection

Horses included in this study were standardbred racehorses (2 to 10 years old, mean:  $4.6 \pm 2.3$  y) presented to the Veterinary Teaching Hospital of the University of Montreal between January 2003 and September 2004 with a history of sudden unexplained exercise intolerance during the last 400 m of their last 2 races related or not related to abnormal upper respiratory sounds. Definitive inclusion of cases in the study further depended on clinical examination, endoscopy performed immediately after the race and/or at rest, and exclusion of other known common causes (including significant lameness) of exercise intolerance. Horses were separated into 2 groups based on whether or not abnormal respiratory noises (sudden loud gurgling or snoring sounds) were heard during exercise and if these noises were associated with a sudden speed reduction in the last 400 m of the race. Horses were grouped as Group A, in which noises were heard ( $n = 27$ ) or Group B, in which noises were not heard ( $n = 24$ ).

A physical examination of each horse including a lameness examination, bronchoalveolar lavage, and post-exercise CK-AST (creatin kinase-aspartate aminotransferase) measurement was done. Examinations also included a resting upper airway video-endoscopy (GIF type 100-1 meter; 9.8 mm in diameter, Olympus, Tokyo, Japan) with a 30 s nasal obstruction test when a positive endoscopic diagnosis of DDSP was made for horses in which the caudal portion of the soft palate dorsal was displaced over the epiglottis. The soft palate was subjectively evaluated to determine flaccidity. Lymphoid hyperplasia (pharyngitis) was diagnosed when there was a pronounced hyperplasia of the lymphonodular follicles within the pharyngeal mucosa

**Table 1.** Description of different grades of pharyngeal lymphoid hyperplasia in horses as described by Raker and Boles (27)

Grades	Description
I	There are few small white lymphoid follicles scattered over the dorsal pharyngeal wall. These appear to be inactive and shrunken. This appearance of the pharyngeal mucosa was considered normal for the young horses.
II	Many small white lymphoid follicles lying close together on the dorsal and lateral pharyngeal walls, not unlike the appearance of coarse sandpaper. Laterally they extend to or slightly below the pharyngeal openings to the guttural pouch.
III	Presence of pink and white lymphoid follicles which lie very close together, covering the entire dorsal and lateral pharyngeal walls. They extend below the openings to the guttural pouches and often involve the dorsal surface of the soft palate.
IV	The follicles appear large and edematous and cover an extensive area as in grade III. They may extend into the guttural pouches and are frequent accompanied by numerous polyps arising from the mucosa of the pharyngeal diverticulum or the dorsal and lateral pharyngeal walls.

and single or multiple lymphonodular masses may be within, or protruding from, the pharyngeal mucosa. The pharyngitis was graded from 1 (slight and localized) to 4 (severe and diffuse) in accordance with Raker's classification (27) (Table 1).

A diagnosis of recurrent laryngeal neuropathy (RLN) was confirmed by identification of failure of the arytenoid cartilage to abduct normally during forced inspiration. The RLN was graded from I to IV, with IV being the most severe. Horses that had synchronous, complete abduction and adduction of the laryngeal cartilages were designated grade I. Grade II RLN was characterized by asynchronous movements of the arytenoids during any phase of respiration. Grade III horses had asynchronous movement of the arytenoids at rest and full abduction was not inducible. Grade IV horses had marked asymmetry of the arytenoids with no movement of one of the arytenoids during any phase of respiration (28). Tracheal secretion scores were defined as following: 0 (none), 1 (little), 2 (moderate), 3 (marked), 4 (large) and 5 (extreme) (29).

### Bronchoalveolar lavage (BAL)

Bronchoalveolar lavages were done using standard laboratory procedures (30). Horses were sedated with xylazine (Rompun; Bayer Corporation, Etobicoke, Ontario), 0.4 to 0.5 mg/kg bodyweight (BW), IV, followed 10 min later by butorphanol (Torbugesic; Fort Dodge Animal Health, Fort Dodge, Iowa, USA), 20 to 30  $\mu$ g/kg BW, IV. A fiber-optic flexible endoscope (250 cm long, 10.5 mm diameter; SIF-0140; Olympus, Tokyo, Japan) was passed through the nasal passage until it was wedged in the distal right bronchus. Two 250-mL boluses of sterile isotonic saline solution (NaCl 0.9%; Baxter Corporation, Mississauga, Ontario) at 37°C were instilled and aspirated. Total nucleated cell counts were determined using a hemocytometer. Differential counts were obtained from 400 cells, under oil-immersion microscopy; epithelial cells were excluded from the differential cell count.

## The sclerotherapy procedure

The procedure was as described in a previous study (26). A semi-rigid plastic tube (#076X038-pc; Putnam Plastics Corporation, Dayville, Connecticut, USA), to the distal end of which the metal part of a 20-gauge needle had been snugly fitted and glued in place (Cyanoacrylate adhesive; Permabond, Somerset, New Jersey, USA), was passed through the instrument channel of a 10-mm videoendoscope (GIF type 100-1 meter; Olympus). The channel lining was protected from puncture by a Teflon sleeve (Teflon sheath-HX-20L-1, model maj-251; Olympus) inserted into the instrument channel so that 1 cm protruded from the end of the endoscope. The channel was also protected by covering the end of the needle with a 1-cm long accessory piece of the tube during passage through the channel. When the tube was completely inserted in the channel, the accessory piece covering the needle was removed and the tube was retracted so that the needle would be located within the protective sleeve at about 1 cm from the end of the videoendoscope.

Injection of the soft palate with the sclerosing agent was performed with the horses restrained in stocks by a nose-twitch and sedated with xylazine (Rompun; Bayer, Etobicoke, Ontario), 0.5 mg/kg BW, IV, and butorphanol (Torbugesic; Fort Dodge Animal Health), 0.025 mg/kg BW, IV.

The videoendoscope was inserted into the nostril and advanced into the nasopharynx. The nasal and pharyngeal mucous membranes were then anesthetized with a solution of 30 mL of saline solution and 10 mL of lidocaine (Lurocaine, 20 mg/mL; Vétoquinol N-A, Lavaltrie, Quebec) delivered through the accessory channel of the videoendoscope. Before injection, and to facilitate visualization of the distal border of the soft palate, dorsal displacement of the free distal margin of the soft palate was obtained with a blunt-end hook inserted through the contralateral nostril. The injections were aimed at the submucosal level of the distal 2/3 of the soft palate and each horse received 8 to 10 injections of 1 mL of 3% sodium tetradecyl sulfate (Tromboject; Omega Laboratory, Montreal, Québec) depending on its body weight (1 injection/50 kg BW). Phenylbutazone (generic), 4.4 mg/kg BW, IV, was administered at the end of the procedure; subsequently, the horses received phenylbutazone (2.2 mg/kg BW, PO, q12h) for 2 d. The horses were discharged immediately after treatment with specific instructions to be stall rested or hand walked for 5 d and to do slow jogging exercise for the 15 subsequent days. A post-sclerotherapy endoscopy was performed to evaluate the upper respiratory airway in cases with complications (cough, dyspnea) after treatment.

After this period of 15 d, upper respiratory endoscopy was performed in all horses; if the soft palate still seemed more flaccid than normal on visual evaluation the procedure was repeated.

## Post-treatment performance evaluations

Objective evaluations of performances were assessed by reviewing the racing records obtained from the official Quebec racing authorities and by comparing the times of the horse recorded during the last 1/4 mile (400 m) for each horse in the last 2 races (mean times). Evaluations were done 1) before and after treatment, and 2) between the treated horse and the rest

of the horses in the same races (mean times) before and after treatment.

## Statistical analysis

A repeated-measures linear model was used to compare average race times during the last 1/4 mile (400 m) for each horse in the last 2 races before treatment and the first 2 races after treatment. In addition, the differences in race times between each horse and the race field (delta) were calculated for the same races. A repeated-measures linear model was used to compare averaged delta during the last 1/4 miles (400 m) before and after treatment. The following factors were included in the 2 models: group (with and without noises), the interaction between time and group, chronicity of the problem, the occurrence of pharyngitis, exercise-induced pulmonary hemorrhage (EIPH), airways inflammatory disease (AID), RLN, tracheal secretion, exercise-induced myopathy and the presence of IDDSP during endoscopy. A value of  $P < 0.05$  was considered statistically significant.

## Results

### Clinical findings

Fifty-one horses (13 males, 17 geldings, and 21 females) met the inclusion criteria. One horse was excluded because of lameness. Results of physical examination of 43 of the 51 horses were unremarkable, 5 horses showed minor thrombophlebitis, 2 horses had tracheal wheezes, and 1 showed a scar from a previous tracheal trauma.

### Endoscopic and procedure findings

According to Raker's classification (27) and based on endoscopic findings, horses had grade 1 ( $n = 2$ ), grade 2 ( $n = 15$ ), grade 3 ( $n = 16$ ) and grade 4 ( $n = 4$ ) lymphoid hyperplasia (pharyngitis); aryepiglottic folds vibration ( $n = 3$ ); partial pharyngeal roof collapse ( $n = 1$ ); grade 1 ( $n = 46$ ) and grade 2 ( $n = 3$ ) RLN; grade 0 ( $n = 49$ ) and grade 1 tracheal secretion ( $n = 8$ ); and in 1 case a fibrous callus involving a fracture of 3 tracheal rings which induced a minimal reduction of the tracheal diameter ( $< 10\%$ ). Thirteen of the 51 horses showed IDDSP based on the nasal occlusion performed on endoscopic examination and 3 horses had ulceration of the free margin of the soft palate (including 2 horses with both IDDSP and ulceration and 1 with only soft palate ulceration). Except for the DDSP, none of the abnormalities were considered sufficient to logically explain the sudden and important race exercise intolerance in all horses and the sudden and violent appearance of the "snoring-like" respiratory noises which always occurred concomitantly with the appearance of intolerance in the specific noise category. Cytology on BAL fluid performed on 48 horses revealed signs of pulmonary hemorrhage in 35 horses and cytological evidence of small inflammatory airway (neutrophils  $> 5\%$  and/or mast cells  $> 2\%$ ) in 18 horses. Thirteen horses had abnormal post-exercise elevations of AST [ $> 384$  U/L; reference interval (RI): 409 to 3080 U/L;  $n = 10$ ] and/or CK ( $> 444$  U/L; RI: 518 to 2090 U/L;  $n = 7$ ) on plasma samples, suggesting a subclinical exercise-induced myopathy.

Following the injection procedure only 8 horses developed minor side effects of which only 4 were detected endoscopically

**Table 2.** Correlation between the presence of lymphoid hyperplasia, airway inflammatory disease (AID), exercise-induced pulmonary haemorrhage (EIPH), and exercise induced myopathy, with racing time, last 1/4 race time (L 1/4 RT) and the difference between last 1/4 race times versus field time (D 1/4 RC versus FT) in horses suspected of IDDSP before and after palatal sclerotherapy. Racing times were available for 48/51 horses

	Race time	L 1/4 RT	D 1/4 RC versus FT
Lymphoid pharyngeal hyperplasia	$P = 0.98$	$P = 0.93$	$P = 0.84$
Inflammatory airway disease	$P = 0.40$	$P = 0.78$	$P = 0.38$
Exercise-induced pulmonary hemorrhage	$P = 0.76$	$P = 0.96$	$P = 0.72$
Exercise-induced myopathy	$P = 0.99$	$P = 0.71$	$P = 0.89$

(significant soft palate inflammation). One horse had temporary mucosal bleeding (1 to 2 h) just after the procedure, 2 horses had occasional coughing for 1 wk related to the palate inflammation after injection. The cough was mostly associated with eating. One of the horses that coughed had a moderate fever (2 d duration) of unknown origin which resolved without treatment. Another horse developed pleuropneumonia 2 wk after treatment but no relationship to the procedure could be found.

### Post-treatment performance evaluations

Objective evaluations of individual racing performances were available for all horses from 7 to 13 mo after treatment (Tables 2 and 3). The linear model of repeated measures indicated a significant beneficial effect ( $P = 0.02$ ) of the treatment on the racing times of the last 1/4 mile (400 m) of the treated horses compared with their individual pre-treatment times [improvement of 31/48 horses (65%)], and compared with the mean time of the rest of the horses in the field ( $P = 0.03$ ) [improvement of 28/48 horses (58%)], and this effect was the same for both groups (with and without noises) (Table 3). Interestingly, the times of racing ( $P = 0.009$ ) and the last quarter miles (400 m) ( $P = 0.03$ ) were significantly higher for horses with pulmonary hemorrhage compared to horses without.

### Discussion

This retrospective study evaluated the efficacy and the side effects of palatal sclerotherapy as a treatment of IDDSP in standardbred racehorses showing exercise intolerance with or without abnormal respiratory noises. The most significant finding of this study is the greatly reduced times to run the last 400 m of races compared with times before treatment [31/48 horses (65%)], even when times were compared with the mean times of other horses in the field, which helps to partially dampen the effect of different racing conditions on the results. This 65% improvement of horses with suspected IDDSP is in the range of other previous treatments proposed to control IDDSP in racehorses: 58% to 70% for sternothyrohyoideus myectomy (31,32), 60% for staphylectomy (33), 53% for epiglottic augmentation (34), 63% to 92% for laser thermoplasty (15,35), 60% to 78% for various composite surgeries (36,37), and more recently, 80% to 82% for laryngeal tie-forward (38). Based on these results, palatal sclerotherapy with 3% sodium tetradecyl sulfate represents a non-invasive, repeatable, safe alternative procedure for

**Table 3.** Raw data of the race times (seconds), the last 1/4 race time, and the difference between last 1/4 race time and field time in horses without noise (Group A) and with noise (Group B) for the periods pre- and post-palatal sclerotherapy

	Mean $\pm$ SE (Time in s)
Race time	
Group A pre-treatment	121.03 $\pm$ 0.8
Group A post-treatment	121.19 $\pm$ 0.8
Group B pre-treatment	121.72 $\pm$ 0.7
Group B post-treatment	121.50 $\pm$ 0.7
Last 1/4 race time	
Group A pre-treatment	31.2 $\pm$ 0.4 <sup>a</sup>
Group A post-treatment	30.4 $\pm$ 0.4 <sup>a</sup>
Group B pre-treatment	31.2 $\pm$ 0.4 <sup>a</sup>
Group B post-treatment	30.3 $\pm$ 0.4 <sup>a</sup>
Difference between last 1/4 race time versus field time	
Group A pre-treatment	-1.31 $\pm$ 0.3 <sup>b</sup>
Group A post-treatment	-0.82 $\pm$ 0.3 <sup>b</sup>
Group B pre-treatment	-1.11 $\pm$ 0.22 <sup>b</sup>
Group B post-treatment	-0.56 $\pm$ 0.22 <sup>b</sup>

<sup>a</sup> Significant difference of the last 1/4 race time before and after palatal sclerotherapy with  $P < 0.05$ .

<sup>b</sup> Significant difference of the difference between last 1/4 race time and field time before and after palatal sclerotherapy with  $P < 0.05$ .

the treatment of IDDSP in standardbred horses; it requires no sophisticated equipment and is easy to perform.

The efficacy of this procedure was probably due to the sclerosing effect of the drug, which, should, as in humans (23), increase the rigidity of the soft palate and thus help to prevent its displacement during exercise. Contrary to previous findings in small animals and humans, an experimental study using normal soft palates of horses failed to detect any fibrosis or stiffening after sclerotherapy (25). However the dosage used in the Munoz study (25) was lower than the dose used herein. It would seem logical that the tissue reaction is dose-dependent. It is also possible that abnormal tissues might react differently than normal tissues. Both factors (lower dose and normal tissues in the context of Munoz study) could explain the different data from the 2 studies. Additionally, the lack of a definitive diagnosis of IDDSP in horses might have had an effect on our results.

Studies, including this one, assessing the success of treatment of horses with IDDSP have been plagued by at least 2 factors: 1) in the absence of a precise and reliable method of diagnosis there is doubt concerning the selection of cases; and, 2) there is related doubt surrounding the assessment of resolution of IDDSP. Most clinicians agree, however, that IDDSP is the most probable pathology, if not the only one, that occurs on an important clinical scale and is related to sudden and violent respiratory noises that occur concomitantly with the appearance of important exercise intolerance in the last 400 m of a race.

The gold standard for establishing an IDDSP diagnosis is the observation of a soft palate positioned dorsally to the epiglottic cartilage for multiple breaths, that is for  $> 8$  s (5) during high-speed treadmill video-endoscopy or with dynamic overground endoscopy. Therefore, the power of our study would have been stronger with treadmill endoscopic examination. However, this was not acceptable to most owners for financial reasons and

the guarded prognosis of these horses as future race animals. In this study, a treadmill evaluation could possibly have identified horses with other causes of dynamic obstruction or displacement. The selection of our cases was performed with referring veterinarians to ensure that the clinical signs of the exercise intolerance were suggestive of IDDSP. Barakzai et al (39) reported that the presence of spontaneous DDSP during resting endoscopic examination as an inclusion criterion for investigating efficacy of treatments for DDSP is likely to result in a low proportion of horses with false positive diagnoses. However, Lane et al (40) reported that a palatal malfunction misdiagnosis rate of ~35% would be suspected in thoroughbred racehorses and should be considered in the case selection process.

The second point is the related doubt surrounding the assessment of resolution of IDDSP. In our study, for the objective evaluation of performance improvement, we used the following measurements: 1) the difference in racing times between the last 1/4 mile (400 m) of the 2 races before and the 2 races after the treatment, and 2) the time difference between the last 1/4 mile of each treated horses and the rest of the horse field for the 2 races before and after treatment. This objective evaluation considered 2 important factors during a race: the comparison of the horse with itself and with other horses during the same race. We feel that this objective evaluation obtained in the last 400 m corresponds to the usual clinical picture of IDDSP in standardbred racing horses in which horses are known to complete the last part of their races with great difficulty. However, we cannot exclude that other positive factors (such as rest) had an effect on the 2 racings after treatment.

The results obtained in this study are as good as those obtained with most previously reported medical or surgical treatments attempted on mature racehorses. However, without the use of endoscopy, it is impossible to prove that IDDSP had truly resolved in any case. The assumption that the pathophysiology of IDDSP seems to be multifactorial probably accounts for some of the variation in success rates reported in the literature and in our study.

Interestingly, groups of horses (with and without abnormal respiratory noises) responded almost identically to treatment. Silent displacers have been reported in several papers (7,39,40). The results herein seem to support this fact in a racing environment and that a silent form of IDDSP is a real entity in racehorses.

In conclusion, sclerotherapy of the soft palate in suspicious cases of IDDSP in standardbred horses is an interesting medical option which requires only a short recovery time. This treatment could be considered as a first line therapeutic approach in IDDSP in a racehorse. Compared with other techniques, palatal sclerotherapy does not require general anesthesia and sophisticated equipment, is relatively easy to perform, is not costly, and does not cause significant side effects. Furthermore, the treatment can be easily repeated if clinical results are not satisfactory or permanent.

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