Unilateral and bilateral compression of the epiglottis during poll flexion in harness racehorses

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Abstract

Background: Horses exercised "onto the bit" with periods of induced poll flexion can demonstrate a unique array of upper respiratory tract (URT) disorders. Objectives: To describe a previously unreported exercise-induced disorder of the epiglottis associated with poll flexion in harness racehorses. Study design: Retrospective observational study. Methods: Medical records of all harness racehorses that presented for exercising URT endoscopy between 2005 and 2022 were reviewed. These horses were exercised on a high-speed treadmill using a previously standardised protocol with alternating one-minute phases of free head carriage (no rein tension on the bit) and poll flexion (driven onto the bit with long reins) until they could no longer maintain the trotting gait. Results: Seven Standardbreds and 11 Norwegian-Swedish Coldblooded trotters were diagnosed with unilateral or bilateral compression of the epiglottis during exercise in poll flexion. These horses demonstrated progression of this disorder during the phases of induced poll flexion and showed no signs of epiglottic compression during phases exercised with free head carriage. Main limitations: Retrospective nature of study and limited sample size due to low prevalence. Conclusions: Exercise-induced compression of the base of the epiglottis is an URT disorder only evident videoendoscopically when horses are driven onto the bit leading to poll flexion. It is most often seen in association with dynamic laryngeal collapse but can also be witnessed as a solitary disorder. Videoendoscopically, it appears that the compression is initiated by the rostral advancement of the larynx and hyoid apparatus within a progressively narrowing intermandibular space during poll flexion. Visually this leads to local inward compression of the lateral nasopharyngeal walls and base of the epiglottis. Further studies are ongoing to confirm this hypothesis and to objectively quantify the degree of URT obstruction caused by this conformational narrowing of the epiglottis during poll flexion.

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RUNNING TITLE: Epiglottic compression in harness racehorses

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Correspondence: Hanna Vermedal. Email:*hannaver@hotmail.com.* Keywords: horse, upper airway, respiratory, epiglottis, harness racehorse.

Clinical relevance:

- This manuscript describes a novel exercise-induced upper respiratory tract (URT) disorder occurring during periods of induced poll flexion in harness racehorses; unilateral and bilateral compression of the epiglottis during poll flexion. Horses affected by this disorder presented with signs of abnormal respiratory noise and/or poor performance.

- This manuscript describes a novel exercise-induced URT disorder involving the epiglottis, not previously described in any horse breed or disciplines.
- The pathophysiology likely involves inward compression of the epiglottis from the hyoid apparatus, in the area of thyrohyoid bone and thyroid cartilage articulation, as the larynx and hyoid apparatus advances rostrally during poll flexion.
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SUMMARY

Background: Horses exercised "onto the bit" with periods of induced poll flexion can demonstrate a unique array of upper respiratory tract (URT) disorders.

Objectives: To describe a previously unreported exercise-induced disorder of the epiglottis associated with poll flexion in harness racehorses.

Study design: Retrospective observational study.

Methods: Medical records of all harness racehorses that presented for exercising URT endoscopy between 2005 and 2022 were reviewed. These horses were exercised on a high-speed treadmill using a previously standardised protocol with alternating one-minute phases of free head carriage (no rein tension on the bit) and poll flexion (driven onto the bit with long reins) until they could no longer maintain the trotting gait.

Results: Seven Standardbreds and 11 Norwegian-Swedish Coldblooded trotters were diagnosed with unilateral or bilateral compression of the epiglottis during exercise in poll flexion. These horses demonstrated progression of this disorder during the phases of induced poll flexion and showed no signs of epiglottic compression during phases exercised with free head carriage.

Main limitations: Retrospective nature of study and limited sample size due to low prevalence.

Conclusions: Exercise-induced compression of the base of the epiglottis is an URT disorder only evident videoendoscopically when horses are driven onto the bit leading to poll flexion. It is most often seen in association with dynamic laryngeal collapse but can also be witnessed as a solitary disorder. Videoendoscopically, it appears that the compression is initiated by the rostral advancement of the larynx and hyoid apparatus within a progressively narrowing intermandibular space during poll flexion. Visually this leads to local inward compression of the lateral nasopharyngeal walls and base of the epiglottis. Further studies are ongoing to confirm this hypothesis and to objectively quantify the degree of URT obstruction caused by this conformational narrowing of the epiglottis during poll flexion.

INTRODUCTION

Exercise-induced upper respiratory tract (URT) disorders are a common cause of poor performance and abnormal respiratory noise at exercise in sport horses and racehorses (Morris & Seeherman 1991; Kannegieter & Dore 1995; Lane et al. 2006; Davidson et al. 2011; Strand et al. 2012). The literature suggests a breed, gait and sporting discipline difference in the prevalence (Kannegieter & Dore 1995; Tan et al. 2005; Strand et al. 2012) and predisposition (Strand et al. 2012) to different forms of URT disorders. Certain disorders appear to have a phenotypic (conformational) cause, especially in horses where poll flexion is induced, such as in harness racehorses (Fjordbakk et al. 2008; Strand et al. 2012; Velie et al. 2020). Harness racehorses, along with draft horses, dressage horses and gaited horses can also demonstrate a unique array of exercise-induced URT disorders only during poll flexion compared to horses not examined or exercised in this manner (Hanche-Olsen et al. 2010; Allen et al. 2011; McCarrel & Woodie 2015; Hackett & Leise 2018; Joó et al. 2021).

Exercise-related laryngeal disorders associated with poll flexion are often induced by changes in the relative positioning of the larynx and hyoid apparatus within the intermandibular space (McCluskie et al. 2008; Fjordbakk et al. 2013) and exacerbated by the increased negative inspiratory pressures caused by narrowing of the pharyngeal/laryngeal lumen width during poll flexion (Petsche et al. 1995; Strand et al. 2009), as predicted by the Bernoulli Principle and Venturi Effect. Upper respiratory tract disorders evident during poll flexion can be primary in nature (Strand et al. 2004) or secondary to the increased regional airway pressure gradients occurring with other URT disorders (Strand & Skjerve 2012) and/or surgical interventions that alter laryngeal and/or hyoid conformation (Vermedal & Strand 2020).

Currently reported exercise-induced disorders of the epiglottis include intermittent epiglottic entrapment (Morris & Seeherman 1991; Kannegieter & Dore 1995; Tan et al. 2005), epiglottic retroversion (Tan et al. 2005) and flaccid epiglottis (Strand et al. 2012; Strand & Skjerve 2012). These are less commonly reported than other exercise-induced disorders of the larynx and/or pharynx. There is sparse literature regarding exercise-induced epiglottic disorders in the horse in general and compression of the base of the epiglottis during poll flexion has not, to the authors knowledge, been reported as an exercise-induced URT disorder. Similar manifestations have been mentioned in the literature, namely dynamically flaccid epiglottis or dorsomedial deviation of the margins of the epiglottis, however in these cases the epiglottic disorder occurred concurrent with or subsequent to other URT disorders such as dynamic laryngeal collapse (DLC) associated with poll flexion and/or medial deviation of the aryepiglottic folds (MDAF) (Fjordbakk et al. 2008; Strand & Skjerve 2012; McCarrel & Woodie 2015; Joó et al. 2021).

The aim of this study was to report a clinically specific URT disorder involving the epiglottis, seen videoendoscopically only during periods of exercise with induced poll flexion, in harness racehorses.

MATERIAL AND METHODS

Population

Medical records and high-speed treadmill endoscopy (HSTE) recordings of harness racehorses that presented with abnormal respiratory noise and/or poor performance which underwent HSTE using a standardised protocol at the Norwegian University of Life Sciences between 2005 and 2022 were reviewed. Horses were included in the study if they had videoendoscopic evidence of epiglottic compression during phases of poll flexion, prior to appearance of any other URT abnormalities (if present). Epiglottic compression was defined as inward compression of the base of the epiglottis resulting in a local U-shaped conformation which often partially or fully (visually) obscured the vocal fold(s). Data reviewed for these cases included breed, sex, age, presenting complaint and HSTE findings. Horses were excluded from the study if they were visually lame at the time of examination, diagnosed with DLC associated with poll flexion at the time of examination, if they had been diagnosed with DLC previously or if they had undergone any form of URT surgery prior to the HSTE examination.

High-speed treadmill endoscopy protocol

Horses were exercised using a previously standardised HSTE protocol (Fjordbakk et al. 2008; Strand et al. 2012) and driven on the treadmill by an experienced driver with full racing tack including bit, bridle, harness, conventional overcheck and long reins. Horses were equipped with a heart rate monitor and following a warm-up period of approximately 2500 m, the horses were exercised in 1-minute phases, alternating between free head carriage (phases 1, 3, 5) and poll flexion (phases 2, 4 ± 6). During phases with poll flexion, horses were driven "onto the bit" by applying even tension on the long reins as if they were being driven on a racetrack. During "free head carriage", tension on the reins and bit were released. Standardbreds (STBs) were trotted at 9 m/s and Norwegian-Swedish Coldblooded Trotters (NSCTs) at 8.5 m/s, all on a 1.5-degree treadmill incline. Exercising racehorses typically achieve a heart rate over 200 bpm during phase 1 and reach exhaustion at the trotting gait by phases 5 or 6. Videoendoscopic evaluation of the larynx was carried out through the length of the exercise protocol, with the endoscope being passed through the right ventral meatus to the level of the caudal nasopharynx in all cases. Videoendoscopic recordings were evaluated in real time and slow motion retrospectively for horses included in the study. Exercise-induced compression of the base of the epiglottis was identified as unilateral or bilateral if present. Other concurrent URT abnormalities that developed subsequent to compression of the base of the epiglottis were recorded if present.

Cadaver sample

A cadaver sample of a larynx with the hyoid apparatus attached was obtained from a harness racehorse euthanised for reasons unrelated to the URT. This larynx was carefully examined to physically explain the structures which were potentially involved with causing the local compression of the base of the epiglottis.

RESULTS

Population

Population summary is presented in Table 1. On average 60 harness racehorses present each year at the Norwegian University of Life Sciences for HSTE using our standardised protocol. This represents approximately 1080 horses during the study period between 2005 and 2022. Of these, eighteen harness racehorses were diagnosed with compression of the base of the epiglottis during periods of poll flexion and met the inclusion criteria, giving an estimated prevalence rate of 1.7%. Of these eighteen horses, 11 were NSCTs and 7 were STBs. There were 50% (9/18) mares, 39% (7/18) stallions and 11% (2/18) geldings. The horses as a group presented at a mean $\pm$ SD age of 4.7 $\pm$ 2.0 years. The STBs presented at 4.0 $\pm$ 0.8 years (range 3-5 years) and the NSCTs at 5.1 $\pm$ 2.4 years (range 3-10 years). The presenting complaint was poor performance alone in 44.4% (8/18), abnormal respiratory noise alone in 33.3% (6/18) and both abnormal respiratory noise and poor performance in 11.1% (2/18). One horse (5.6%) presented due to physical collapse during a race and one horse (5.6%) presented for a routine fitness test. Three horses had abnormal respiratory noise mostly evident when driven on the bit (horse nr. 6, 9 and 15).

High-speed treadmill endoscopy findings

All horses developed exercised-induced compression of the base of the epiglottis from the first phase of induced poll flexion (phase 2), often with exacerbation during subsequent phases of poll flexion. Compression was bilateral in 13/18 horses (72.2%) (Figure 1 and 2) and unilateral in 5/18 horses (27.8%), with equal distribution between left and right sides (Figure 3 and 4). Bilateral compression was seen in 10 of 11 NSCTs (90.9%) and in 3 of 7 STBs (42.9%), whilst unilateral compression was seen in 4 of 7 STBs and in 1 of 11 NSCTs. All horses demonstrated a unilateral or bilateral inward bulging of the nasopharyngeal wall adjacent to the compressed side of the epiglottis (green arrows in figures) during periods of exercise in poll flexion.

One horse (horse nr. 1) also developed moderate ventromedial luxation of the apices of the corniculate processes during the first phase of poll flexion after development of epiglottic compression, which persisted during phases without poll flexion. Two horses developed intermittent dorsal displacement of the soft palate (iDDSP) (horse nr. 8 and 11) at the end of the examination protocol (phase 6 and 5, respectively) when the horses were completely fatigued and could not maintain the trotting gait and position on the treadmill. This was several minutes after developing compression of the base of the epiglottis. Two additional horses developed palatal instability (horse nr. 7 and 9) and MDAF (horse nr. 12 and 13) respectively, also several minutes after the onset of epiglottic compression (phases 4-6).

Cadaver sample

An equine larynx/hyoid specimen from a harness racehorse was acquired to explain the cause of this unusual disorder (Figure 5). When manual pressure was applied on the thyrohyoid bone (only) approximately 1 cm distal to the articulation between the thyrohyoid bone and thyroid cartilage (thyrohyoid articulation) a similar compression of the base of the epiglottis (Figure 5 bottom right) as witnessed videoendoscopically was created. This compression visually obscures the vocal folds as the base of the epiglottis narrows and forms a U-shape.

DISCUSSION

This manuscript describes a novel exercise-related (dynamic) disorder of the epiglottis induced during periods of poll flexion in harness racehorses. Compression of the base of the epiglottis appeared visually during the first phase of induced poll flexion (phase 2) in all 18 horses. In all cases, whether unilateral or bilateral, it appeared videoendoscopically as if there was extraluminal compression of the base of the epiglottis from the lateral nasopharyngeal wall (green arrows in figures) locally on the affected side(s), potentially caused by a change in position of the larynx/hyoid apparatus within the intermandibular space during poll flexion. In most cases the compression of the epiglottis was of a magnitude that it visually obscured the abducted vocal fold(s) on the affected side(s). In certain cases, the lateral margins of the epiglottis displayed progressive inward deviation with prolonged duration of exercise, potentially due to greater inspiratory luminal pressures in the region of the larynx.

Poll flexion during exercise, defined as a decreased angle between the mandible and ventral neck, affects upper airway function in horses competing in multiple athletic disciplines (Petsche et al. 1995; Strand et al. 2009; Davidson et al. 2011). Harness racehorses perform in a position of "high" poll flexion, due to the overcheck which prevents lowering of the head and neck and aids steering the horse tactically in races. These horses are gathered onto the bit with long reins and are restrained from premature exhaustion or galloping. Poll flexion during maximal exercise in clinically normal Standardbreds causes an increase in inspiratory impedance and greater negative inspiratory pressures (7-8 cm H_2O difference), relative to when these horses are exercised in free head carriage (head and neck extended), creating a mild inspiratory obstruction (Petsche et al. 1995). Similar findings (6 cm H_2O difference) have been documented in clinically normal elite Norwegian-Swedish coldblooded trotters during maximal exercise in poll flexion relative to maximal exercise with free head carriage (Strand et al. 2009). This physiologic event is explained by the Bernoulli principle and Venturi effect, occurring as a consequence of narrowing of the URT during poll flexion (Cehak et al. 2010). Narrowing of a region of the URT will lead to increased velocity of air through the constricted region and therefore lower intraluminal pressures according to Poiseuille's Law (fluid dynamics notation). If a form of URT obstruction is present, local narrowing (collapse) of the region can become self-perpetuating with progressive lowering of inspiratory pressures over time and worsening of the obstruction. This has been demonstrated to occur in harness racehorses diagnosed with DLC (Strand et al. 2009).

Poll flexion can also induce or exacerbate both simple and complex forms of exercise-induced URT disorders reported in harness racehorses (Strand et al. 2004; Fjordbakk et al. 2008; Strand et al. 2012). Exacerbation of already existing URT disorders during poll flexion may be due to the increase in airway turbulence, impedance and intraluminal pressures occurring during poll flexion, while the pathophysiology behind induction of new URT disorders solely evident during poll flexion is likely more complex.

In addition to altering airway dynamics, poll flexion also causes anatomical conformational changes of the laryngohyoid apparatus which can be readily measured from lateral radiographs of the region (McCluskie et al. 2008; Fjordbakk et al. 2013). The larynx moves rostrally in relation to the hyoid apparatus during poll flexion; McCluskie et al. (McCluskie et al. 2008) demonstrated a rostral advancement of the ossified portion of the thyroid cartilage in relation to the thyrohyoid bone. Achieving this local conformation change is the basis of the "laryngeal tie-forward" procedure for treating iDDSP (Woodie et al. 2005).

Fjordbakk et al. (2013) demonstrated that horses affected by DLC showed a statistically significantly greater rostral advancement of the larynx in relation to the thyrohyoid bone during poll flexion compared to unaffected control horses. This rostral advancement within the intermandibular space resulted in external compression of the larynx as shown by the authors in form of a reduced laryngeal lumen width in affected horses measured ultrasonographically (Fjordbakk et al. 2013). Though DLC to this date has been diagnosed in a number of different breeds and disciplines, the aforementioned study and more recent research into genetics illustrate that URT disorders occurring solely during poll flexion often result from a combination of phenotypic predisposition along with the consequences of a rostral laryngohyoid displacement (Fjordbakk et al. 2013; Velie et al. 2020).

Epiglottic compression appears soon after inducing poll flexion by gathering the reins and driving the horse onto the bit, similar to how DLC visually appears. The authors have seen compression of the epiglottis manifesting most commonly as part of a DLC diagnosis, and epiglottic compression may be a variation of a complex array of exercise-induced laryngeal disorders seen only during phases of poll flexion. The occurrence of the disorder primarily, without concurrent DLC, has however not been described before.

Dynamic laryngeal collapse is a form of bilateral arytenoid cartilage and vocal fold collapse occurring during exercise in poll flexion in predisposed horses, not associated with recurrent laryngeal neuropathy (Fjordbakk et al. 2015; Ducharme 2016). It is most commonly diagnosed in NSCTs but is also reported to be common in the Colombian Criollo Paso breed (Joó et al. 2021) and other gaited horses that exercise in "high" poll flexion (Hanche-Olsen et al. 2010; Allen et al. 2011; McCarrel & Woodie 2015; Hackett & Leise 2018). In DLC, a phenotypic predisposition combined with rostral laryngohyoid advancement in the intermandibular space occurring during poll flexion leads to inward displacement of the arytenoid cartilages with secondary collapse of the vocal folds (Strand et al. 2004; Fjordbakk et al. 2008). The phenotypic, or conformational traits include: a rostrally positioned larynx relative to the vertical ramus of the mandible, a high head and neck position during exercise, a narrow intermandibular space and an energetic attitude when driven "onto the bit" (Strand et al. 2004; Velie et al. 2020). A rostrally positioned larynx, relative to the vertical ramus of the mandible, is a trait of many draft and pony breeds of horses (Hawe et al. 2001). In the cases presented here, the rostral laryngohyoid advancement caused by periods of poll flexion leads to compression of the base of the epiglottis while the arytenoid cartilage's ability to abduct is unaffected. As opposed to horses diagnosed with DLC, horses showing epiglottic compression likely have more compression of a rostroventrally positioned articulation between the thyrohyoid bone and thyroid cartilage which is not interfering with the ability of the cricoarytenoideus dorsalis muscles to abduct the arytenoid cartilages, as seemingly occurs with DLC (Figure 5) (Strand et al. 2004; Fjordbakk et al. 2008).

The majority of horses in this study presented for investigation of poor performance and/or abnormal respiratory noise (Table 1), however one horse (nr. 3) presented after physical collapse during a pari-mutuel race. This horse had visually the most severe degree of URT obstruction of all 18 horses in this review during HSTE with both compression of the base of the epiglottis and dorsomedial deviation of the epiglottic margins. This highlights the importance of examining harness racehorses during exercise using bit, bridle, long reins and overcheck to induce different head and neck angles similar to what these horses experience under competition if one is to fully understand the clinical condition. This can be accomplished using high-speed treadmill videoendoscopy, as described here, or utilising a vigorous exercise protocol on the racetrack with overground endoscopy.

Unilateral compression of the base of the epiglottis was seen in 57.1% of STBs and in 9.1% of NSCTs, whilst bilateral compression was seen in 42.9% of STBs and in 90.9% of NSCTs. This uneven breed distribution may be related to the low sample size, or to a potential anatomical conformational difference of the hyoid apparatus and/or thyrohyoid articulation between these two genetically distinct breeds. Another plausible cause of unilateral compression of the base of the epiglottis is uneven head carriage while being driven, but this variable was not investigated in this study. However, the experienced drivers of the horses in this study always attempted to drive them evenly onto the bit during the examination. Additionally, any horses showing signs of lameness during the examination, a common cause of uneven head carriage in harness racehorses, were excluded from the study. The position of the endoscope should also not affect the unilateral appearance of the disorder as the endoscope was passed via the right ventral meatus in all cases, and there was an even distribution between left and right unilateral epiglottic compression. Finally, the compression of the epiglottis occurred only during phases of poll flexion and was never evident in phase 1 (free head carriage) prior to first induction of poll flexion.

CONCLUSIONS

Horses affected by epiglottic compression in the current manuscript presented primarily with signs of abnormal respiratory noise and/or poor performance, as well as one horse presenting after physically collapsing in a race. The pathophysiology of this disorder likely involves inward compression of the epiglottis from the hyoid apparatus, in the area of thyrohyoid bone and thyroid cartilage articulation, as the larynx and hyoid apparatus advances rostrally through a progressively narrowing intermandibular space during poll flexion. This is supported by the inward movement of the lateral nasopharyngeal walls seen visually during poll flexion in all cases, combined with current knowledge of how the laryngohyoid apparatus changes in position during poll flexion. The present treatment recommendation is to limit the degree of poll flexion by use of tack modifications in affected horses. Further studies are necessary to confirm the proposed pathogenesis of this URT disorder and objectively define how this disorder impacts upper airway dynamics in exercising horses.

AUTHOR CONTRIBUTIONS

H. Vermedal, AE. Klemsdal, GM. Roen, Z. Fretheim-Kelly and E. Strand contributed with collection of data and data analysis. H. Vermedal, JM. O'Leary and E. Strand contributed with manuscript preparation. All authors revised and approved the submitted manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to this report.

ETHICS STATEMENT

All animal materials used in the current study were received from client owned animals and used with owner consent.

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FIGURE LEGENDS

Figure 1: Endoscopy image of horse nr. 3, a 3-year-old Norwegian-Swedish Coldblooded Trotter (stallion) during phase 1 (A/left) with free head carriage and during phase 4 (B/right) with induced poll flexion demonstrating compression of the base of the epiglottis (yellow arrows) along with inward deviation of the left nasopharyngeal wall (green arrow).

Figure 2: Horse nr. 18, a 5-year-old Standardbred (mare) demonstrating bilateral compression of the base of the epiglottis (yellow arrows) during phase 2; the first phase of induced poll flexion (A). The epiglottic compression is accompanied by simultaneous inward deviation of the nasopharyngeal walls (green arrow). Once relieving rein tension and reducing the angle of poll flexion, epiglottic conformation returns to normal as seen in phase 3 (B). Note the transtracheal pressure sensor passed through a polyethylene catheter for simultaneously measuring tracheal pressures.

Figure 3: Horse nr. 15, a 3-year-old Standardbred (stallion) with a normally appearing epiglottis during phase 1 (A) and unilateral compression of the left side of the base of the epiglottis (yellow arrow) with inward deviation of the left nasopharyngeal wall (green arrow) (B) during poll flexion in phase 2. Note the

transtracheal pressure sensor passed through a polyethylene catheter for simultaneously measuring tracheal pressures.

Figure 4: Horse nr 4, a 4-year-old Standardbred (mare) in phase 1 (A) with a normal conformation of the epiglottis, and during poll flexion in phase 2 (B) with left sided compression of the base of the epiglottis (yellow arrow) and inward deviation of the left nasopharyngeal wall (green arrow).

Figure 5: An equine larynx/hyoid specimen illustrating the thyrohyoid articulations (red arrows top picture and bottom left) and how manual pressure applied ca. 1 cm distal to the thyrohyoid articulation causes compression of the base of the epiglottis (bottom right). Note how the vocal folds are visually obscured during epiglottic compression (bottom right).

TABLES

Table 1: Summary of signalment, presenting complaint and unilateral or bilateral nature of epiglottic compression for the 18 harness racehorses included in this study:

Nr.	Breed	Age	Sex	Presenting complaint	Unilateral/bilateral
1	STB	3	Stallion	Abnormal respiratory noise	Bilateral
2	NSCT	3	Stallion	Poor performance	Bilateral
3	NSCT	3	Stallion	Collapse in race	Bilateral
4	STB	4	Mare	Routine fitness test	Unilateral (left)
5	NSCT	3	Mare	Abnormal respiratory noise	Bilateral
6	NSCT	6	Stallion	Abnormal respiratory noise	Bilateral
7	NSCT	8	Mare	Poor performance	Unilateral (right)
8	NSCT	7	Mare	Poor performance	Bilateral
9	NSCT	3	Mare	Abnormal respiratory noise	Bilateral
10	STB	5	Mare	Abnormal respiratory noise	Bilateral
11	NSCT	3	Stallion	Abnormal respiratory noise	Bilateral
12	NSCT	5	Gelding	Poor performance	Bilateral
13	NSCT	10	Stallion	Poor performance	Bilateral
14	STB	4	Mare	Abnormal respiratory noise and poor performance	Unilateral (right)
15	STB	3	Stallion	Abnormal respiratory noise and poor performance	Unilateral (left)
16	NSCT	5	Gelding	Poor performance	Bilateral
17	STB	4	Mare	Poor performance	Unilateral (left)
18	STB	5	Mare	Poor performance	Bilateral

NSCT = Norwegian-Swedish Coldblooded Trotter, STB = Standardbred.