

Adaptation and acceptability testing of the Expector® vibration vest in horses

Adaptação e teste de aceitabilidade do colete de vibração Expector® em equinos

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ABSTRACT

The project is based on a test of a thoracic vibration vest prototype, adapted to equines by the Expector® vest's company, on healthy animals. Ten (10) equines were used in the project, male or female, adults, healthy, belonging to FMVZ-USP or private owners. Each animal went through two phases: A and B. Phase A consisted of the placement of the vest without turning on the vibrators, evaluating the animal's acceptability, facility, adaptation to the animal's body, and discomfort due to the vest's use. Phase B included the placement of the vest and turning on the vibrators, evaluating the animal's acceptability, reaction to the vibrators, and, if present, to which velocity/type of vibration, and the presence of adverse effects. Both phases were done three times on separate days. The behavioral parameters: "placement facility" and "adaptation to the animal's body" were observed. In phase B, the response to the vibration was classified from 0 to 5. The answer was evaluated on low and high intensities for the four vibration types. The heart rate (HR) and respiratory rate (RR) were also evaluated at the beginning and end of each repetition. The animals' HR was kept on normal, except for one animal on one day of the test. Concerning the RR, most animals presented moments of tachypnea. On the experiment's first day, 100% of grade Great to "facility of placement" and "adaptation to the animal's body" was obtained, but on days 2 and 3 this value dropped to 90% due to alterations in one animal's responses. Regarding vibration's responses, 77.3% were evaluated as no discomfort (grade 0), 17.1% little discomfort (grade 1), 3.3% medium discomfort (grade 2), 0.4% great discomfort (grade 3), 0.21% extreme discomfort (grade 4), and 1.6% non-acceptance of the vest (grade 5). Some possible changes on the prototype were also verified to be suggested to the manufacturer, such as the change of the buckle and the use of wireless control. Vest use appears promising for equine respiratory physiotherapy, considering the acceptability was good, and its efficiency on the expectoration of diseased animals must be tested.

Keywords: Equine. Thoracic. Respiratory. Behavior. Expectoration.

RESUMO

O projeto consistiu no teste de um protótipo de colete de vibração torácica, adaptado aos equinos pela empresa do colete Expector®, em animais saudáveis. Foram utilizados 10 equinos, machos ou fêmeas, adultos, saudáveis, pertencentes à FMVZ-USP e a proprietários particulares. Cada animal passou por duas fases: A e B. A Fase A consistiu na colocação do colete sem ligar os vibradores, avaliando-se a aceitabilidade do animal; facilidade; adaptação ao corpo do animal e incômodo do mesmo à sua presença. Já a Fase B contava com a colocação do colete e funcionamento dos vibradores, avaliando-se a aceitabilidade do animal; reação aos vibradores e, se presente, a qual velocidade/tipo de vibração; presença de reações ou efeitos adversos. As duas fases foram realizadas em triplicata em dias separados. Foram observados os parâmetros comportamentais "facilidade de colocação" e "adaptação ao corpo do animal". Na fase B, a resposta à vibração foi classificada de 0 a 5. A resposta foi avaliada nas intensidades baixa e alta para os quatro diferentes tipos de vibração. Foram avaliadas também as frequências cardíaca (FC) e respiratória (FR) no início e final de cada repetição. A FC dos animais se manteve dentro do intervalo de normalidade, com exceção de um animal em um dia de avaliação. Em relação à FR, a maioria apresentou momentos de taquipneia. No primeiro dia de experimento obteve-se 100% de avaliação Ótima para "facilidade de colocação" e "adaptação ao corpo do animal", mas nos dias 2 e 3 esse valor caiu para 90% devido à alteração na resposta de um animal. Em relação à resposta à vibração, 77,3% das respostas foram avaliadas como nenhum

incômodo (nota 0), 17,1% pouco incômodo (nota 1), 3,3% médio incômodo (nota 2), 0,4% muito incômodo (nota 3), 0,21% incômodo extremo (nota 4) e 1,6% não aceitação do colete (nota 5). Foram também verificadas algumas possíveis mudanças no protótipo a serem sugeridas ao fabricante, como mudança do tipo de fivela e uso de controle sem fio. A utilização do colete parece ser muito promissora para a fisioterapia respiratória em equinos, visto que a aceitabilidade foi muito boa, devendo-se agora realizar a avaliação de sua eficácia na expectoração de animais enfermos.

Palavras-chave: Equino. Torácico. Respiratório. Comportamento. Expectorção.

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Introduction

Respiratory diseases affect horses of all ages, being responsible for great economic losses, such as the death of the animals, and reduced performance of sport animals (Mazan, 2018; Widmer et al., 2009).

Among respiratory disorders, those that affect the lung, especially infectious and inflammatory ones, usually generate large amounts of mucus and secretions. These, when in large quantities or when elimination is difficult by the animal, besides contributing to the worsening of the clinical condition (cough, dyspnea, difficulty in gas exchange, etc.), can serve as a substrate for secondary bacterial contamination (Dixon & Pirie, 2003). In cases where the management itself causes difficulty in mucociliary transport (as in the case of “shipping fever”), a bacterial infection is also facilitated (Maeda & Oikawa, 2019).

Mucus transport is influenced by temperature, humidity, ventilation pattern, bronchial perfusion, epithelial changes, ATP concentration in the airway surface fluid, mucus properties, position, forced expiration and coughing techniques, and oscillatory techniques (Pieterse & Hanekom, 2018).

In human medicine, the elimination of airway secretions is of great importance in the treatment of respiratory diseases or diseases that predispose to their appearance, such as cystic fibrosis (Hoo et al., 2015). Although there are still controversies about the best techniques for each situation

(Strickland, 2015), the action of eliminating secretions assumes even greater importance in hospitalized and/or bedridden people, who have difficulty in eliminating secretions (Wang et al., 2018).

In humans, depending on the case, the elimination of secretions can be attempted with the use of medications (mucolytics) or physiotherapy techniques. These techniques can be active and performed by the person (postural drainage, forced expiration techniques, positive expiratory pressure with or without oscillation, etc.) or passive, with external manipulation (manual thoracic percussions and vibrocompression), percussive non-invasive ventilation, and, more recently, with the use of chest vibration devices (Hoo et al., 2015; Reychler et al., 2018; Strickland, 2015).

In a pilot study in human patients with cystic fibrosis, the use of physical therapy (positive expiratory pressure with mask and autogenous drainage) before cardiopulmonary tests improved the ventilatory dynamics during the exercises (Vendrusculo et al., 2019).

Manual vibrocompression aims to increase mucociliary transport from the pulmonary periphery to the larger diameter airways (Frownfelter & Dean, 2012), but there is a practical difficulty in maintaining the vibrations at the ideal frequency for this modality, which is below the ideal frequency for the transport of mucus (25 to 35 Hz).

In horses, many diseases would benefit from better respiratory physiotherapy techniques, as the accumulation of secretions is an important part of the physiopathogenesis, but it is usually only treated with mucolytic and anti-inflammatory medications (Mazan, 2018; Reuss & Giguère, 2015).

In veterinary medicine, especially in horses, respiratory physiotherapy is still underdeveloped, being mostly restricted to tapping on the animals' thorax, especially in foals, to decrease the secretion adherence to the small airways (Coons et al., 1990; Thomassian & Mikail, 2009), facilitating its expectoration.

There is a single study on horses, with RAO (recurrent airway obstruction), using a sound wave device, without good results. The device used in this experiment produces sound waves from the animal's nostril and propagates to the bronchial tree (Goncarovs et al., 2010).

The development of external vibration devices for humans in the form of vests, for direct action on the chest, is already a reality, although still not widespread. A Brazilian vest has been developed (Expector®) and is already in research and use in human medicine (Angheben et al., 2016). But there had been no adaptation for veterinary medicine. Given this need, the human model was adapted by the company to the equine's dimensions, requiring a test to verify its acceptability and safety for healthy adult equines before carrying out effectiveness tests on sick animals.

The objective of this research was to verify the acceptability and safety of the Expector® vest adapted for healthy adult horses.

Materials and Methods

The project is based on a test of a thoracic vibration vest prototype on healthy adult equines to verify its acceptability and safety. For this purpose, a vest was adapted to the size and anatomy of the horses, in which two medium-sized adult horses (350 to 450 kg/770 to 990 lbs) were used to determine the size of the adapted prototype and the position of the fixation points and the vibrators. The prototype (Figure 1) was made by the Expector® vest company and is designed to cover the entire lung projection area of the horse.

For the acceptability and safety phase, ten (10) equines were used, male or female, adults, healthy, belonging to FMVZ-USP or private owners. Each animal went through two phases:

- Phase A – placement of the vest without turning on the vibrators, evaluating the animal's acceptability, facility, adaptation to the animal's body, and discomfort due to the vest's use;
- Phase B – placement of the vest and turning on the vibrators, evaluating the animal's acceptability, reaction

to the vibrators, and, if present, to which velocity/type of vibration, and the presence of adverse effects.

The two phases were performed three times in separate periods, to assess whether recognition of the process facilitates or exacerbates the animal's response. The behavioral parameters: "placement facility" and "adaptation to the animal's body", which were classified as E (excellent), VG (very good), G (good), F (fair), and P (poor) were observed. The discomfort of the animals to the vest (phase A), which was evaluated immediately after the vest was placed and again after 5 minutes, and the animals' response to vibration, were classified from 0 to 4 (0 being no discomfort, 1 little discomfort, 2 intermediate discomfort, 3 moderate discomfort, and 4 extreme discomfort). For calculation purposes, grade 5 was considered non-acceptance of the vest. The response was evaluated on low and high intensities for the four vibration types. The heart rate (HR) and respiratory rate (RR) were also evaluated at the beginning and end of each repetition.

The project animals were used for daily handling, with eight of them used for hippotherapy and two not used for riding.

The information (breed, sex, age, and behavior) of the 10 animals used in the project is shown in Table 1.

The variation of heart and respiratory rates in the evaluated times were statistically compared by the Tukey test, considering $p < 0.05$ for statistical difference. The GraphPad Instat software, version 3.01 was used.

Results and Discussion

During the use of the prototype in the experiment, suggestions were made for some changes, such as changing the type of buckle that attaches the vest to the animal's chest. The model used is easy to adjust, just demanding pulling



Figure 1 – Prototype of the Expector® vest placed on one of the horses used in the project.

Table 1 – Relation of breed, sex, age, and behavior of the 10 animals used in the experiment

Animal	breed	Sex	age (years old)	BEHAVIOR
1	Mixed breed	Female	17	calm; use in hippotherapy
2	Andalusian	Male	17	calm; use in hippotherapy
3	Andalusian	Male	17	calm; use in hippotherapy
4	Arabian	Male	17	calm; use in hippotherapy
5	Criollo	Male	8	calm; use in hippotherapy
6	Criollo	Female	8	calm; use in hippotherapy
7	Andalusian	Male	8	calm; use in hippotherapy
8	Brazilian Sport Horse	Male	18	calm; use in hippotherapy
9	Arabian	Male	7	calm; not used for riding
10	Arabian	Male	7	calm; not used for riding

the excess tape. But the strap is exceptionally large and ended up with a large portion that sometimes touched the floor, in addition to not being quickly removable. The ideal would be to change it to a model that is easy to place and adjust, with a quick-release mechanism for emergencies, such as quick-release buckles or straps with Velcro closure.

The wired control for changing the intensity and type of vibration works very well (Figure 2) but, if possible, it could be replaced with wireless control. This would help avoid accidents if the animal does not accept the procedure or becomes alarmed during its performance. In addition, when switched on, the control could start at the low intensity, not the current high level, which often scares the animal due to strong vibration and noise. Thanks to the indicator light it is possible to know what type of vibration the vest is on, but there is no indicator of the intensity of vibration, which would also be good to know during the procedure.

After the three days of the experiment for each animal, it was possible to verify the changes in the heart (HR) and respiratory (RR) rates of the horses, as well as their behavior. The graphs in Figures 3 and 4 show the changes in HR and RR, respectively. Table 2 shows the means and statistical evaluation of these parameters.

Based on the evaluation of the graphs and table, it is possible to notice that the heart rate of the animals showed no statistical difference and remained within the normal range for horses (28 to 44 bpm), except for animal 5, which on the second day of the experiment was startled by an external stimulus, presented intense tachycardia, and did not allow the completion of the phase B protocol. Concerning the respiratory rate, no statistical difference was observed either. Only one animal (Animal 4) presented values within the normality range for horses (8 to 18 bpm) during the three days of the experiment, with the other animals presenting moments of tachypnea. The increased values of heart and respiratory rates obtained demonstrate that even if the animals accept the placement and functioning of the vest, they are expected to show a certain

Table 2 – Means and statistical evaluation of heart and respiratory rates at the evaluated times

Time	Heart rate	Respiratory rate
Basal	33.6	14.6
Day 1 initial	33.0	16.6
Day 1 end	33.8	17.0
Day 2 initial	29.2	19.0
Day 2 end	37.8	16.6
Day 3 initial	29.0	19.0
Day 3 end	29.7	20.2
p	0.3914	0.7686



Figure 2 – Control used on the prototype.

reaction to it, as occurs with various types of manipulation in equines. We found that animals already accustomed to more intense handling and saddle placement were more receptive to putting on the vest, with less discomfort compared to animals unaccustomed to such handling.

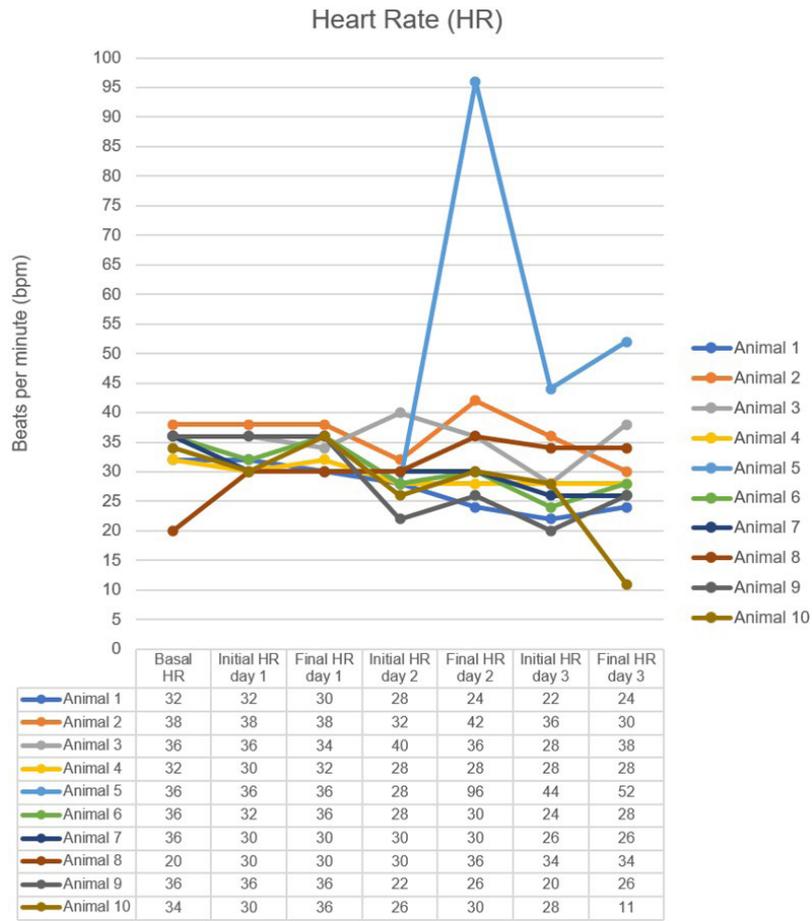


Figure 3 – Animals’ basal heart rate values, as well as initial and final HR on each day of the experiment.

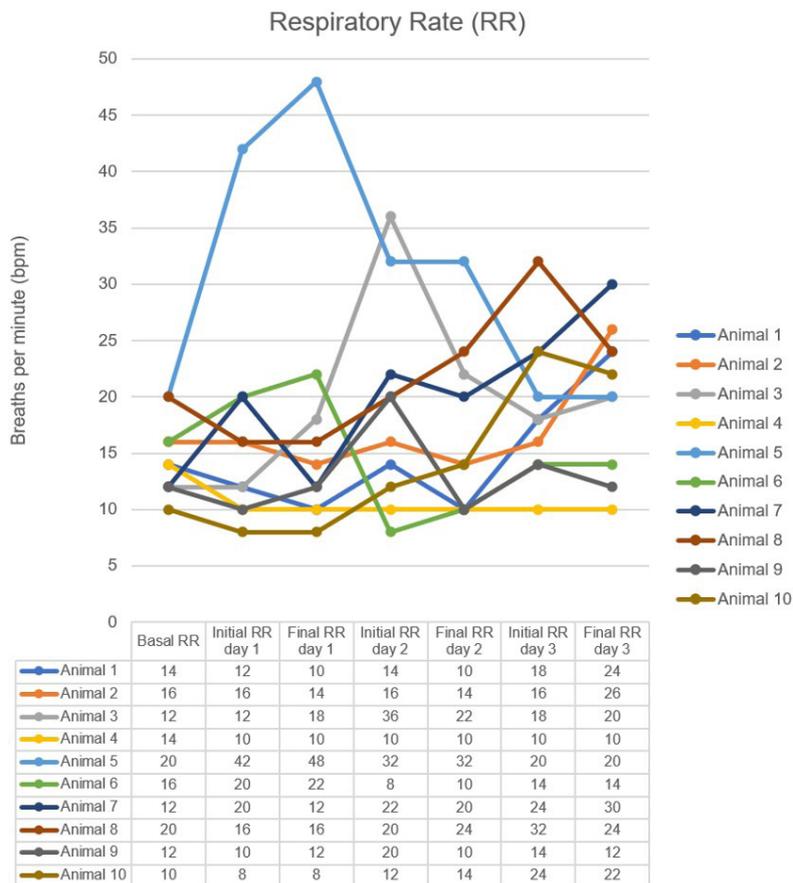


Figure 4 – Animals’ basal respiratory rate values, as well as initial and final RR on each day of the experiment.

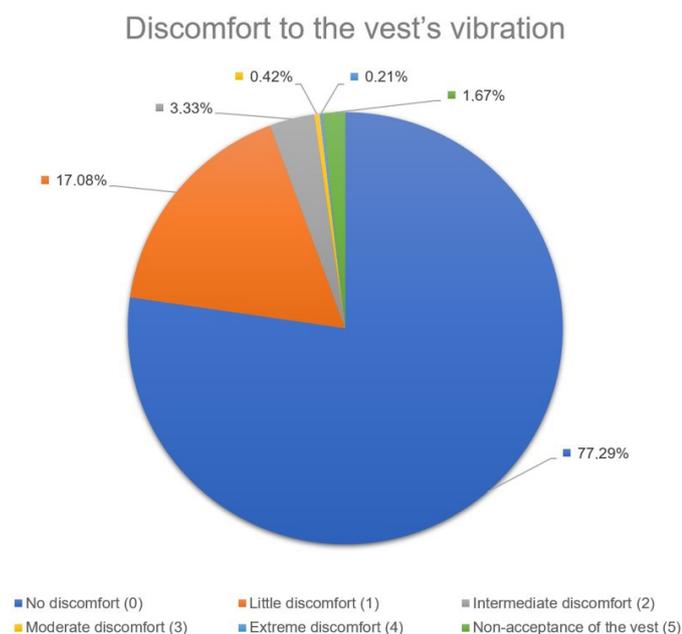


Figure 5 – Distribution of the different grades attributed to the discomfort of the animals to the vest.

In addition to the physiological parameters mentioned above, the behavioral parameters “ease of placement” and “adaptation to the animal’s body” were also observed. Regarding these two parameters, only one animal (Animal 5) did not receive an Excellent (E) assessment during the 3 days. Thus, on the first day of the experiment, we obtained 100% of Excellent (E) grades for both parameters, but on days 2 and 3 this value dropped to 90% due to the change in Animal 5’s response. It is important to note that for the classification of animal discomfort, it is necessary to pay attention to indicators other than HR and RR values, such as repetitive head movements (discomfort), wide-opened eyes (fear), ears turned backward (irritation), dilated nostrils (warning), ears forward and erect (attentive animal), and excessive tail wagging (irritation or discomfort).

In phase B, the animals’ response to vibration was evaluated at low and high intensities for the four vibration types of the device and is represented in Figure 5. In most cases (77.29% of the evaluations), no discomfort was observed on the part of the animals, followed by little discomfort (17.08%). To a lesser extent, there was intermediate discomfort (3.33%), non-acceptance of the vest (1.67%), moderate discomfort (0.42%), and in a lesser amount, extreme discomfort (0.21%).

Regarding the discomfort to each vibration type, the animals showed more discomfort immediately after the vest was

connected (mode 1), and gradually became more comfortable with the vibration. Out of a total of 108 perceived discomforts (regardless of the degree assessed), 40 were identified in Mode 1 of vibration, corresponding to 37% of the disturbances, with the others distributed evenly among the other 3 vibration types.

In addition to the classification of the level of discomfort, the presence of secretion or cough was also verified each time the intensity or type of vibration was changed. Of a total of 480 vibration times evaluated, nasal secretions were verified only during 9 of them, and no cough was verified at any time.

Given the findings, it appears that the vest is safe, easy to use, with good acceptance by the animals, and with variation in the discomfort response following the horses’ characteristics, as well as for any other procedure done in this species.

Conclusion

Despite the small changes that are necessary for the making of the vest, its use seems to be very promising for respiratory physiotherapy in horses, since it has proved to be safe and easy to adapt and use. A second project evaluating its efficacy in sick animals is necessary. For that, animals with respiratory conditions should be used to check the expectoration resulting from the protocol with the use of the vest.

Conflict of Interest

None of the authors of this paper has a financial or personal relationship with other people or organizations that could inappropriately influence or bias the content of the paper.

Ethics Statement

This research project was approved by the Ethic Committee on Animal Use of the Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, under the number CEUA FMVZ-USP n. 4891280519.

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