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Renal Resistive Index of Adult Healthy Dogs Submitted to Short-Term Whole-Body Vibration Exercise

Livia Freire, Sheila Canevese Rahal, Ivan Felismino Charas Dos Santos, Carlos Roberto Teixeira, Leticia Rocha Inamassu and Maria Jaqueline Mamprim
Department of Veterinary Surgery and Anesthesiology, School of Veterinary Medicine and Animal Science, University Estadual Paulista (UNESP), Botucatu, São Paulo, 18618-970, Brazil

Corresponding Author: Ivan Felismino Charas dos Santos, Department of Veterinary Surgery and Anesthesiology, School of Veterinary Medicine and Animal Science, University Estadual Paulista (UNESP), Botucatu, São Paulo, 18618-970, Brazil Tel: +551438802022

ABSTRACT

Exercises involving whole-body vibration are useful for stimulation and physical rehabilitation. However, it is necessary to verify its effects not only on musculoskeletal tissues but also on internal organs. This study aimed to investigate the influence of the whole-body vibration platform on the renal resistive index in healthy dogs. Ten clinically healthy dogs of different breeds, 6 males and 4 females, aged from 1.7-3.5 years (mean 2.1±0.6 SD) and weighing from 20.5-41 kg (mean 32.1±7.1 SD), were used. The dogs were submitted to one session on a whole-body vibration platform (Thera Plate) at 30 Hz frequency for 5 min, followed by 50 Hz for 5 min and finishing with 30 Hz for 5 min. The renal artery resistive index of the left kidney was measured before and immediately after the whole-body vibration platform session, using a spectral doppler ultrasound (Triplex doppler imaging). The mean resistive index values before and immediately after the session were 0.65 (±0.04 SD) and 0.63 (±0.05 SD), respectively. In conclusion, the resistive index is not altered by a single whole-body vibration session using the TheraPlate platform.

Key words: Vibration plate, canine, blood urea nitrogen, serum total protein, complete blood count, doppler ultrasound

INTRODUCTION

Vibrating platforms promote Whole-Body Vibration (WBV) most frequently by reciprocating vertical displacements or by oscillating up and down (Cardinale and Wakeling, 2005). Exercises involving the WBV are useful for stimulation and physical rehabilitation in humans and animals (Prisby *et al*., 2008; Carstanjen *et al*., 2013; Osawa *et al*., 2013; Theraplate, 2015). In horses, the WBV has been used especially for treatment of tendon diseases (Theraplate, 2015). On the other hand, in small animals such as dogs and cats the use of the vibrating platforms remains incipient.

Most of the vibrating platforms allow frequencies from 15-60 Hz (Hz = number of repetitions of the oscillatory cycle per second), amplitudes (displacement on the basis of vibration) from less than 1-11 mm (Cardinale and Wakeling, 2005; Dolny and Reyes, 2008) and acceleration up to 15 g (gravitational acceleration, 1g = 9.8 ms^{-2}) and stimulus duration from 30 sec (Cormie *et al*., 2006) to 16 min (Giorgos and Elias, 2007). However, there is lack of information on optimal parameters (frequency, amplitude, acceleration and duration) of exposure to vibrating platforms, as well as on the type of vibratory signal (Cormie *et al*., 2006; Prisby *et al*., 2008; Cochrane, 2011).

Modifications in amplitude or frequency will define the alterations in acceleration transferred to the body (Cochrane, 2011). Incorrect combinations of vibration parameters can lead to deleterious effects on health, including cardiovascular and neurological symptoms and neurological disorders (Dolny and Reyes, 2008; Prisby *et al*., 2008).

Doppler ultrasonography is a noninvasive technique that can be used to evaluate the renal vascular bed and renal blood flow (Szatmari *et al*., 2001; Seiler, 2013). This technique allows the study of anatomy and hemodynamics of the blood flow, which is useful in the early identification of kidney disorders (Novellas *et al*., 2007; Yoo *et al*., 2008; Nyland *et al*., 2015). In order to validate the clinical use of the vibrating platform, it is necessary to verify its effects not only on musculoskeletal tissues but also on internal organs. To the best of the authors' knowledge, there are no studies on the effects of the WBV platform on kidneys in healthy dogs. Therefore, the aim of this study was to investigate the acute effects of the WBV platform on the renal Resistive Index (RI) in healthy dogs. The hypothesis was that the established protocol is not able to induce kidney lesions.

MATERIALS AND METHODS

The study was approved by the Ethics Committee of the School of Veterinary Medicine and Animal Science-University Estadual Paulista (UNESP) (n°. 042/2014-CEUA). The respective owners gave written consent for each dog's participation in this study.

Ten intact clinically healthy dogs, 6 males and 4 females, aged from 1.7-3.5 years (mean 2.1±0.6 SD) and weighing from 20.5-41 kg (mean 32.1±7.1 SD) were used. The dog breeds were Pit Bull (n = 5), Labrador retriever (n = 3), Rottweiler (n=1) and one crossbreed. The dogs were judged to be healthy by complete physical and orthopedic examinations. Exclusion criteria included use of medications or supplements, or previous surgical treatment. Complete blood count (CBC), urinalysis and serum biochemical analyses (blood urea nitrogen-BUN, creatinine-CR, alanine aminotransferase-ALT, serum total protein-STP, albumin-ALB) were performed before the WBV platform session. All exams were performed after 12 h of fasting. Blood samples (5 mL) were collected from the jugular vein. Immediately after the WBV platform session, CBC and serum biochemistry were analyzed again.

The WBV was performed on a vibrating platform with length 210 cm, width 9 cm and height 28 cm and frequency range from 0-100 Hz (TheraPlate Revolution®, Texas, USA). The dogs were allowed to rest for approximately 1 h before the session. Each dog was placed at the center of the vibrating platform standing on all four feet. A single session at frequency of 30 Hz for 5 min, followed by 50 Hz for 5 min and finishing with 30 Hz for 5 min was performed. The velocity and amplitude varied from 12-40 ms^{-2} and 1.7-2.5 mm, respectively.

Ultrasound exams were performed before and immediately after the WBV platform session by an experienced operator. To perform triplex Doppler ultrasonography (Esaote®, Esaote Healthcare, São Paulo, Brazil), the hair on the abdomen was clipped and acoustic gel was applied to the skin. To scan the left kidney, the dogs were positioned in right lateral recumbency without any chemical restraint. Multi-frequency convex transducer (1-8 MHz) was used, depending on the dog's body mass and renal depth. Color doppler was employed to visualize the renal vascular tree and subsequent pulsed doppler data from the renal artery was acquired. The smallest scale that showed the flow without aliasing was chosen. The mean RI was established by the averaging of four doppler waveforms. Resistive index measurements were performed by the same examiner before and immediately after the vibrating platform session. The RI was calculated automatically by the ultrasound machine software after manual delimitation of peak-systolic velocity and end-diastolic velocity (Rivers *et al.,* 1997a), as follows: RI = (Peak systolic velocity)-(End diastolic velocity)/(Peak systolic velocity).

The values were expressed as Mean±standard deviation, median and the minimum and maximum range. The paired t test was used to detect differences of RI values between moments (before and immediately after each session). The Proc T-test program (SAS Institute 2011) was used to perform analysis of variance. Differences were considered significant at $p<0.05$.

RESULTS

The vibrating platform test at the frequency of 30 Hz was well accepted by all the dogs. However, some degree of discomfort was observed when the frequency was increased from 30-50 Hz. According to the owners, the dogs slept the majority of the day after the WBV platform session. No significant differences were observed between the RI values obtained before and immediately after the vibrating-platform session ($p>0.05$) (Fig. 1 and Table 1).

The values of CBC, urinalysis and serum biochemical performed before the WBV platform session were within the reference range. Red Blood Cell count (RBC), hematocrit (HT), hemoglobin (HB) and Platelet Count (PLT) decreased after the vibrating-platform session but remained within the reference range. Other hematological parameters showed variations but within the reference range. The blood urea nitrogen, CR and ALT were augmented in 40% (4/10) and diminished in 60% (6/10) of the dogs but these alterations were within the reference range. Urinalysis could not done after the WBV platform sessions, because most of the dogs had urinated before the exam.

DISCUSSION

The exposure time and vibration frequency used in the present study were based on descriptions provided by the manufacturer for rehabilitation therapy in human patients (Theraplate, 2015), since protocols for dogs have not yet been described. Medium-sized dogs were used in the study and the results may not be useful for small- or large-sized dogs. There is hypothesis that the amplitude of the vibrating platform may be influenced by different body masses (Cochrane, 2011).

Table 1: Mean±SD median, minimum and maximum range of the RI before M1 and after M2 vibrating-platform session in 10 adult healthy dogs

Evaluation moments	Mean±SD	Median	Minimum	Maximum
M1	0.65±0.04	0.65	0.59	0.71
M2	0.63±0.05	0.63	0.56	0.70

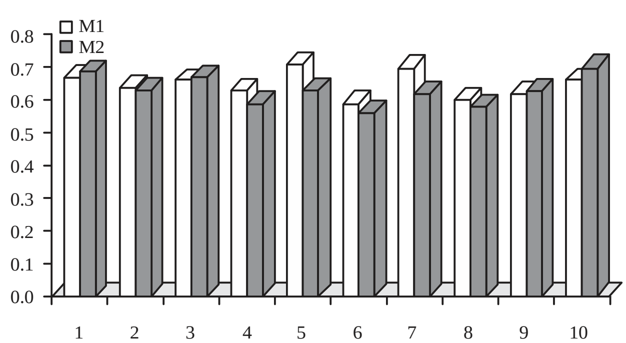

Fig. 1: Values of RI before M1 and after M2 vibrating-platform session in 10 adult healthy dogs

In a study that evaluated acute effects of WBV in horses, the animals were standing on four separate platforms (Carstanjen *et al*., 2013). The dogs in the present study were maintained standing with all four feet on the vibrating platform. In human patients, it is indicated to maintain the knees flexed to limit transmission of vibrations to the head, when the subject stands on the vibrating platform (Cardinale and Wakeling, 2005). The importance of the body position in animals requires further investigations.

The number of sessions-single session, short-term multiple sessions, long-term multiple sessions is dependent on the application and results expected from the WBV (Cochrane, 2011; Carstanjen *et al*., 2013). Several meta-analysis studies had been done in human patients to prove the benefits of the WBV but in several instances the lack of information or differences in methodologies hampered the establishment of a protocol pattern (Cardinale and Wakeling, 2005; Cochrane, 2011; Lau *et al*., 2011; Osawa *et al*., 2013). In addition, despite the possible benefits of WBV platform exposure, other implications and adverse effects prior its use must be determined (Cardinale and Wakeling, 2005; Prisby *et al*., 2008; Lau *et al*., 2011; Carstanjen *et al*., 2013). Therefore, in the present study only one session was employed to evaluate the acute response to WBV in an internal organ.

Total peripheral resistance to the blood flow may increase during body vibration (Mester *et al*., 2006; Games *et al*., 2015). Therefore, the doppler-based RI was used to evaluate the kidney in the present study. The RI is an indirect measurement of the vascular resistance originating from doppler spectral waveforms, which may be influenced by cardiac output, blood pressure and vascular blood flow impedance (Rivers *et al*., 1997b; Novellas *et al*., 2007; Nyland *et al*., 2015). Values of 0.70 (Morrow *et al*., 1996), 0.72 (Novellas *et al*., 2007) and 0.73 (Rivers *et al*., 1997a) for upper limit (mean+2 standard deviation) of the intrarenal RI have been suggested as normal in dogs. The upper limit values obtained in the present study were 0.71 and 0.70, respectively, before and after the WBV session.

Thus, there was no statistical difference in the studied parameters before and after the WBV, suggesting that the protocol did not induce a deleterious effect on the kidney. However, it is important to consider that the dogs had been found clinically healthy by physical and laboratory examinations. One case report of a human athlete with asymptomatic nephrolithiasis found morbidity after a single WBV session (Monteleone *et al*., 2007). In addition, episodes of gross hematuria were observed in a runner after WBV (Franchignoni *et al*., 2013).

In the present study, the values of CBC and serum biochemical parameters (BUN, CR, ALT, STP and ALB) were maintained within the reference range after a WBV session. Furthermore, no significant differences were detected in clinical parameters, hematology, fibrinogen, lactate, IGF-I, gamma-glutamil transferase (GGT), CR, myeloperoxidase activity or bone marker values in seven horses after acute exposure to WBV (10 min at a frequency of 15-21 Hz), despite the observation of decreases in cortisol and creatine-kinase (Carstanjen *et al*., 2013). On the other hand, blood variables and six minerals evaluated in Alaskan huskie dogs before a test run (9 km) and at 10, 20 and 30 min afterwards and during the training, showed significant changes in packed cell volume, RBC, creatine kinase and CR after bouts of exercise (Querengaesser *et al*., 1994). Changes in some physiological parameters and serum enzymes may be an indication of the severity of the exercise (Ready and Morgan, 1984; Querengaesser *et al*., 1994). In addition, CR is an indirect measurement of the glomerular filtration rate and may be indicative of kidney lesion (Chew *et al*., 2011). An increase of the CR level after an exercise bout has been associated with decreasing renal excretion and increasing release of the muscles (Querengaesser *et al*., 1994). Since the CR was within the reference range, the protocol used in the present study could not be considered an exhaustive exercise.

CONCLUSION

In conclusion, based on the parameters used, the RI is not altered by a single WBV session using the TheraPlate platform.

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