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Effect of two months whole body vibration on hoof growth rate in the horse: A pilot study

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ABSTRACT

Hoof problems are commonly seen in veterinary practice and manipulation of hoof growth rate can be practical and beneficial for that matter. The purpose of this research was to evaluate the effect of whole body vibration (WBV) on hoof growth rate of front feet in the horse. The study was an experimental, single subject, repeated measure design, with all horses serving as control and treatment. Ten horses were subject to WBV, 30 min, twice daily, five days a week, for 60 days in addition to their regular exercise routine. Hoof growth was measured from the reference hairline down to a horizontal groove in both front feet at 30-day (monthly) intervals starting 30 days before the start of treatment (WBV) up until 60 days post cessation of the treatment (WBV). The data analysis was carried out, by applying several paired *t*-tests to the mean 30-day hoof growth before, during, and after treatment (WBV). A significant mean increase in hoof growth was seen after 30 days WBV ($p < 0.001$) as well as after 60 days WBV ($p = 0.001$) with the increase occurring mainly during the first 30 days of WBV. No prolonged effect on hoof growth rate was seen after cessation of WBV. These results indicate that whole body vibration can be used as a non-invasive, safe and non labor-intensive therapeutic modality to accelerate hoof growth in the horse.

1. Introduction

The digit and more specific the hoof is one of the most important structures related to soundness in the horse. This is likely due to the ability of the hoof to attenuate impact vibrations transmitted at ground contact (Dyhre-Poulsen et al., 1994; Willemen et al., 1999). Hoof growth, quality and function as such become important factors as they often affect the usefulness of the horse. Manipulation of hoof growth can also have practical implications for farriers and veterinarians in terms of growing out lesions, producing sufficient horn to properly trim and balance the foot or nailing in to (Curtis, 2006).

Hoof growth is influenced by several factors. These include but are not limited to season (Frackowiak and Komosa, 2006; Lewis et al., 2014), age (Reilly et al., 1998; Curtis et al., 2014), gender (Frackowiak and Komosa, 2006), breed (Curtis, 2006), metabolic rate (Huntington and Pollitt, 2005), trimming and shoeing (Glade and Salzman, 1985) and nutrition (Butler and Hintz, 1977; Reilly et al., 1998). Average hoof growth for these reasons has a wide range but for a mature horse is around 0.19–0.28 mm/day or 5.7–8.4 mm/month (Glade and Salzman, 1985; Lockard and Reinertson, 1986; Pollitt, 1990). Most research has focused on the effects of nutrition on hoof growth and quality, with adequate caloric intake (Butler and Hintz, 1977) and biotin supplementation (Reilly et al., 1998) being important factors for proper hoof growth, just to mention a few. As most horses receive already a well balanced diet with adequate levels of nutrients to support proper hoof growth and quality, other means to further increase hoof growth would be helpful for those hoofs affected by factors beyond our control such as season, age, gender and breed. Whole body vibration (WBV) is a therapeutic modality in which low frequency vibration is delivered to the entire body. Whole body vibration claims to increase hoof growth in the horse but to the best of the authors' knowledge, no studies have been published so far to support those claims. Whole body vibration has proven to be safe for use in the horse and capable of inducing thermographic changes in the distal limbs and muscles (Tingbo M, unpublished data, 2005). Human research indicates that WBV is capable of increasing skin blood flow (Lohman et al., 2007) and studies in mice show that WBV is capable of improving angiogenesis (Weinheimer-Haus et al., 2014) and wound healing (Weinheimer-Haus et al., 2014).

Based on these data, WBV may have a potential benefit on the hoof. The aim of this study was to explore the effect of WBV on hoof growth rate. We hypothesized that adding WBV, five days a week, to a horse regular exercise regime will cause an increase in dorsal hoof wall

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growth compared to control over a 60-day (two month) period. Additionally the author was interested to see if the effect of WBV on hoof growth rate was sustained post cessation of WBV.

2. Materials and methods

2.1. Study design

The study was an experimental, single subject, repeated measure design. All horses served as control and treatment group. All participants were subjected to the treatment (i.e., WBV) and measurements taken at defined times to assess the effect of treatment.

2.2. Horses

Through convenience sampling, ten mature horses (age 10.7 ± 4.3 years) were selected from an accessible population of 1651 horses owned by clients of "masked for review". Inclusion criteria were as follows: mature horse (≥5 years old), shod in regular steel shoes in all four feet, lameness not exceeding a lameness score of 4/5 on an AAEP scale (Stashak, 2002) and otherwise in good health, and signed informed client consent form before the start of the study. All horses were required to be housed in a stall (4 × 4 m) with daily turn out in a small paddock (8 × 16 m) and exercised six days a week. All horses in each group were trimmed and shod by the same farrier. Exercise consisted of a 30 to 45-minute under saddle training session tailored to their discipline and intended performance level except for two horses, which were laid up (Table 1). All horses were fed an oat/alfalfa (75/25) hay mix with a vitamin-mineral supplement and an additional pelleted feed (concentrate) depending on the needs (workload, body condition, metabolism) of each horse. None of the horses had access to fresh grass. As such, a specific type and duration of exercise, as well as diet, was not a prerequisite, but for participation in the study, farrier, rider, exercise regime and diet were required to remain the same from three months prior to the start of WBV and throughout the duration of the study for that individual horse.

Study subjects (Table 1) were involved in athletic activities (5 dressage horses [group A] and 5 eventer horses [group B]). Group A consisted of five Warmbloods, all gelding. Group B consisted of one Warmblood, two Irish sport horses and two Thoroughbreds of which four geldings and one mare. Horses in Group A were assessed from early October 2011 through early March 2012 (fall and winter). Horses in Group B were assessed from the end of April 2012 through end of September 2012 (spring and summer). Table 2 depicts the climate conditions and photoperiod during the two study periods.

Table 1
Characteristics of horses included in the study.

Horse id	Breed	Age (years)	Gender	Discipline	Exercise/ performance level	AAEP lameness score (0–5) (day 0)
A1	WB	9	G	Dressage	Third	3
A2	WB	15	G	Dressage	Second	1
A3	WB	19	G	Dressage	Second	2
A4	WB	8	G	Dressage	Laid up	3
B1	TB	8	M	Eventing	Training	1
B2	ISH	5	G	Eventing	Training	3
B3	ISH	10	G	Eventing	Training	1
B4	TB	8	G	Eventing	Training	1
B5	WB	10	G	Eventing	Laid up	4

WB – Warmblood, TB – Thoroughbred, ISH – Irish sport horse, G – Gelding, M – Mare. Second, Third, Training – performance/competition level for each discipline as defined by the United States Equestrian Federation. Laid up – stall rest with 15 min of hand walking.

2.3. Whole body vibration and exercise

All horses underwent WBV five days a week (Tuesday, Wednesday, Thursday, Saturday, Sunday), twice daily (morning and afternoon) for 30 min at a frequency of 40 Hz, amplitude of 0.8 mm and an acceleration of 4.9 m/s^2 (0.5 g) for a total of 60 days using a mobile linear (vertical) type vibration platform (Vitafloor VM0; Vitafloor USA Inc., Aromas, CA), producing an indirect vertical sinusoidal vibration applied to all four feet. This was added to their normal exercise routine as mentioned previously. As a safety measurement, all horses were lightly sedated with 0.006 to 0.01 mg/kg detomidine; Zoetis, Florham Park, NJ (Dormosedan) intravenously the first time they were introduced to the WBV platform. No sedation was needed after the introduction session. A hay net was provided while the horses were on the vibration platform to keep them occupied.

2.4. Hoof growth measurement of the dorsal hoof wall

A small horizontal groove was made in the dorsal hoof wall on midline with a hoof rasp, 2 cm below the distal hairline at the coronary band (reference hairline), of the left front and right front foot 30 days before the start of WBV in group A and B. Hoof growth was measured by the author ("Peninsula equine medical center, Menlo Park, California") in millimeters (mm) with a measurement tape from the reference hairline down to the groove at 30-day (monthly) intervals up until 60 days post cessation of WBV. Measurements were repeated 3 times for left front and right front hoof respectively. Measurements of both left front and right front hoof of each horse were pooled, with mean (average) 30-day hoof growth of both front hoofs shown in Table 3. Two horses were lost for post treatment follow-up. One horse (B1) moved out of the area and one horse (B3) was sold.

2.5. Statistical analysis

The data analysis was carried out, by applying several paired *t*-tests to the data of Table 2. All calculations were performed using IBM SPSS version 22.0; IBM, Armonk, NY. All tests are performed two-tailed which means that the mentioned *p*-values are two-sided probabilities. Also, as some measurements are missing, the number of samples (N) differs from test to test. Confidence intervals for the estimation of mean differences are calculated at the 95% level.

3. Results

3.1. Effect on hoof growth rate during treatment (WBV)

A first paired *t*-test was performed in order to compare the average 30-day hoof growth (mm) for the first 30 days of WBV (mean = 8.65; SD = 1.383) with the average 30-day hoof growth (mm) before the start of treatment (mean = 6.53; SD = 1.080). In that case all data from the 10 horses are available. The *t*-test shows a strongly significant mean increase in hoof growth after 30 days of WBV ($t = 7.82$; $df = 9$; two-tailed $p < 0.001$). Hence it is very unlikely that the mean increase of hoof growth is accidentally. With almost certainty the increase is due to the applied treatment (WBV). The 95% confidence interval for the increase of mean hoof growth is 1.5 to 2.7 mm/30 days (month) (Fig. 1).

From a similar analysis with respect to the second 30 days of WBV, however, it follows that there is still an increase in hoof growth (mean = 7.3; SD = 1.053; N = 9), but the difference with respect to the period before the treatment started is no longer significant ($t = 1.66$; $df = 8$; two-tailed $p = 0.1$). The 95% confidence interval for the mean hoof growth this time does not exclude the possibility of no increase or even a slight decrease (−0.3 to 1.8 mm/30 days (month)). So it is not proven that continuation of WBV after the first 30 days is still effective (Fig. 1). Moreover, the decrease of the mean hoof growth during the second 30 days of WBV with respect to the first 30 days of WBV is close