

# VIBRATION PLATFORM OSCILLATION CHARACTERISTICS USING HIGH SPEED 3-D MOTION CAPTURE

Jaimie Branscomb, Gerald Smith, and Eadric Bressel  
Biomechanics Laboratory, Utah State University, Logan, UT, USA  
email: jaimie.b@aggiemail.usu.edu

## INTRODUCTION

Review papers dealing with whole body vibration (WBV) training contain numerous inconsistent outcomes [1, 2, 3]. While some of these inconsistencies may be due to procedural differences, a less obvious source of variability may be inherent in some of the vibration instrumentation used in the studies. Few WBV studies provide detailed information concerning the vibration characteristics of the instrumentation beyond what may be provided by manufacturers. Accelerometry measured characteristics are typically reported but often these are one-dimensional, vertically oriented data with little information concerning horizontal plane vibration and its potential effect on subject responses to vibration treatment.

Three-dimensional motion analysis instrumentation has only recently increased speed and resolution capabilities to where high frequency vibration can be reliably detected. This project made use of such instrumentation to compare vibration platform motion characteristics with the specifications listed by manufacturers.

## METHODS

Two commercial vibration platforms were used in this study testing 3-D motion characteristics through a range of frequencies and loading conditions. Initial testing was performed in an unloaded condition while comparison loaded data were obtained as a subset of another study concerning vibration attenuation with adult subjects. Manufacturer specifications are also reported for each device.

The FreeMotion iTonic vibration platform allows user control of frequency and amplitude with nominal settings of 25 Hz, 30 Hz and M on a frequency dial and amplitudes of High and Low on a second dial. The Pneu-Vibe Pro vibration platform from PneuMex Inc. allows user control of frequency and amplitude through a control box with continuous settings of frequency between 10 and 60 Hz and a switch changing amplitude between high and low.

Three conditions were tested for the machines: nominal frequencies of 25 Hz, 30 Hz and M or 55 Hz for iTonic and Pneu-Vibe respectively. Low amplitude was used in each case.

A Vicon MX system with seven T-20 cameras sampling at 500 Hz tracked the three-dimensional trajectories of low mass retro-reflective markers placed on corners of the vibration plates using double-sided tape. 3-D position data from each reflective marker were computed and subsequently analyzed cycle-by-cycle using Microsoft Excel. Twenty cycles of vibration data were extracted for each condition. Mean peak-to-peak amplitude in each direction was determined as the average across the 20 cycles.

## RESULTS AND DISCUSSION

Typical vibration characteristics for both machines are illustrated in Figures 1 – 3. In the unloaded condition, iTonic vibrations were systematically higher in frequency than nominal: about 28 and 33 Hz for the 25 and 30 Hz settings. M frequency corresponded with about 42 Hz. For the Pneu-Vibe machine vibration frequencies were more complex with vertical motion occurring at twice the frequency of horizontal oscillation (Figure 1A) for the nominal 25 Hz setting. At other frequency settings, Pneu-Vibe was systematically low (24 Hz and 53 Hz for the nominal 30 and 55 Hz settings). Under loaded conditions, Pneu-Vibe was more consistent with systematically low frequencies (19, 25 and 53 Hz for the 25, 30 and 55 Hz settings). When loaded, iTonic exhibited similar frequency to unloaded.

Motion characteristics of the platforms were complex with both vertical and horizontal movements. Peak-to-peak amplitude was relatively consistent for the iTonic machine across frequency but changed dramatically for the Pneu-Vibe. This was especially strong for the 55 Hz condition (Figure 2) where vertical amplitude was about 5 mm. Similar large amplitude oscillation was observed for the device under loaded conditions.

## CONCLUSIONS

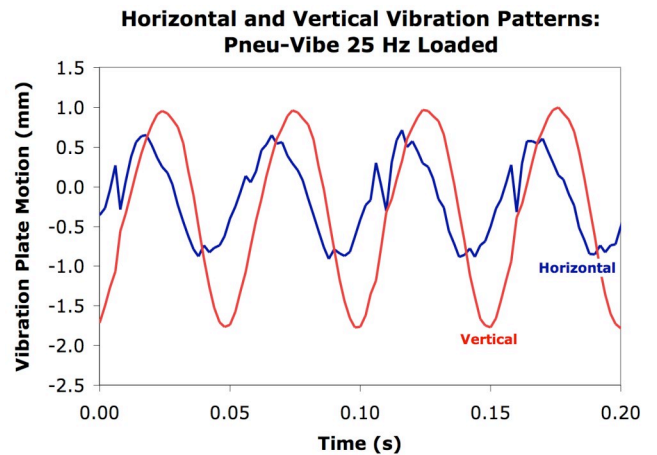
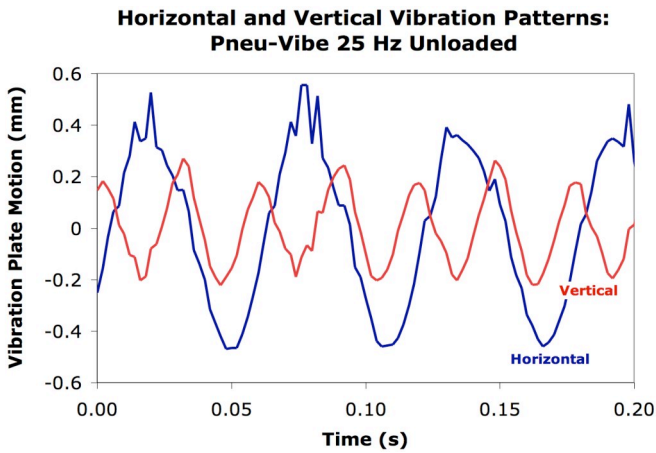
Both Pneu-Vibe and iTonic vibration platforms differed in frequency by more than 10% from nominal settings of 25 and 30 Hz. The iTonic machine was systematically higher than nominal in frequency but was very consistent in this characteristic with changes due to loading. While repeatable, Pneu-Vibe had a complex movement pattern with horizontal and vertical frequencies different in the unloaded condition.

Peak-to-peak amplitude of the Pneu-Vibe machine changed with frequency and reached as much as

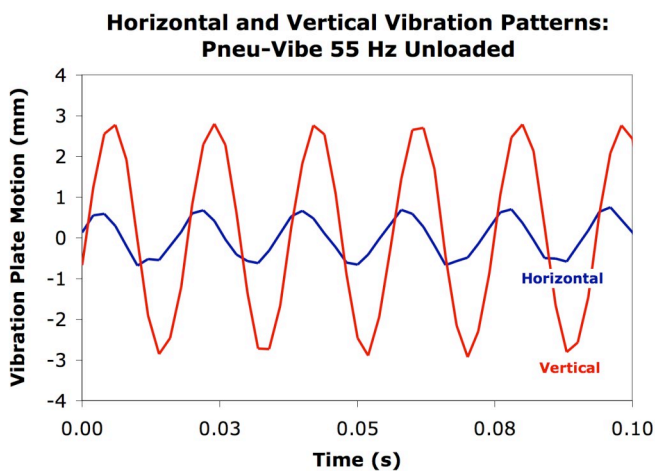
5 mm. In contrast, amplitude of vibration for iTonic was relatively consistent across frequencies. For controlled vibration dosage in therapy or training, such differences may be important considerations.

## REFERENCES

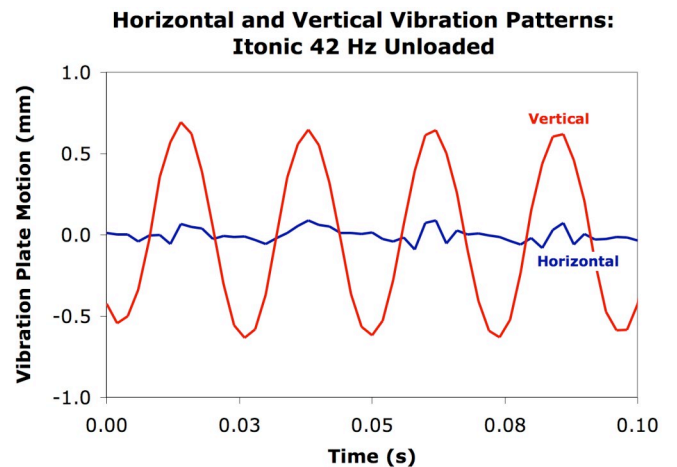
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**Figures 1A and 1B:** Movement patterns for the Pneu-Vibe machine at a nominal frequency of 25 Hz in unloaded (left) and loaded (right) conditions. Note that unloaded, the vertical frequency was double the horizontal frequency (about 34 and 17 Hz) but once loaded to body weight the horizontal and vertical vibrations were of the same frequency but somewhat out of phase. In addition, peak-to-peak amplitudes changed with loading condition.



**Figure 2.** Movement patterns for the Pneu-Vibe machine near its maximum frequency. Despite the same amplitude setting as used with lower frequencies (Figure 1), vertical motion was considerably greater.



**Figure 3.** Movement patterns for the iTonic machine at its maximum frequency of about 42 Hz. At this frequency little horizontal motion was evident in the unloaded condition shown in the graph or when loaded to body weight.