A PILOT STUDY OF THE TRANSMISSIBILITY OF THE RAT TAIL COMPARED TO THAT OF THE HUMAN FINGER

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Introduction

Continual occupational exposure to vibrating hand tools can damage the neural, vascular and other soft tissues of the fingers. Rat tail models have been developed to investigate the biological responses of the tissues to vibration.[1-2] However, the biodynamic response of the tail relative to that of the human fingers has not been characterized. The objective of this pilot study was to compare the transmissibilities of rat tails measured via a scanning laser vibrometer to those of human fingers gripping a handle.

Methods

In Part I of this experiment, four male Sprague Dawley rats (6 weeks old) were exposed to discrete 5g-rms sinusoids of 32, 63, 125, 160, 250, and 500 Hz. The rats were restrained in Broome-style restrainers with their tails constrained without compression to an exposure platform via elastic straps as shown in Figure 1. The platform was attached to a vertically vibrating shaker. The vibration was measured for the array of points shown in Figure 1 using a scanning laser vibrometer (Polytec) and the transmissibility calculated for each point on the tail relative to the reference points on the platform.

In Part II, three male human subjects were exposed at the frequencies specified in Part I - with the addition of 1000 Hz - at a magnitude at the ANSI <0.5-hr limit up to 63 Hz, after which the acceleration was held constant at 5g-rms. The subjects gripped an instrumented handle at 20 N as shown in Figure 2. The transmissibility was calculated relative to the reference points on the handle.

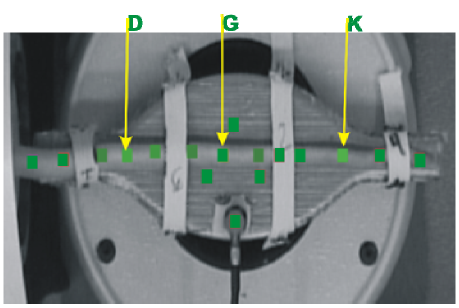

Fig. 1. Index points for tail. D is closest to the rat body.

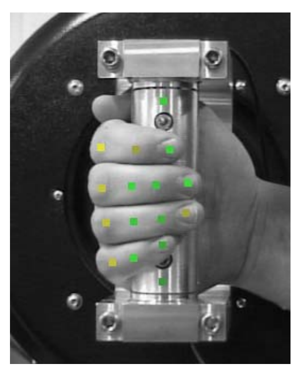

Fig. 2. Experimental set-up for Part II.

Results

Figure 3 shows the transmissibility calculated at the nails of the index, middle and ring fingers of the human subjects. Figure 4 shows a comparison of the transmissibilities of the three most active points on the rat tail with the mean response of all of the tips of the human fingers.

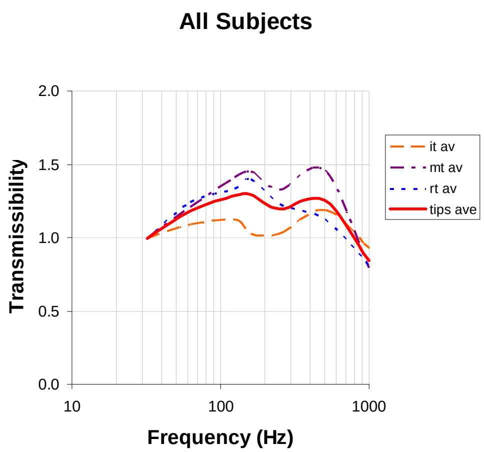

Fig. 3. Transmissibility at middle (mt), and index (it) finger nails.

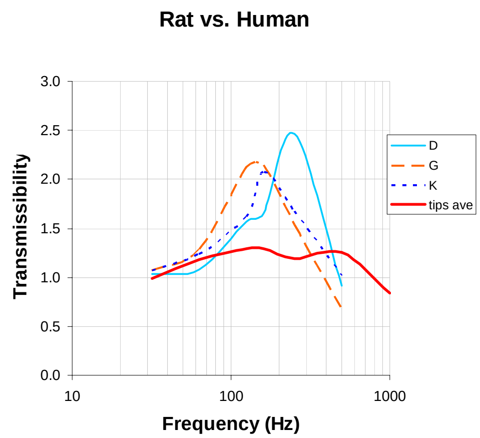

Fig. 4. Comparison of frequency ring (rt) responses of the tail model and the average for the finger nails.

Discussion

As shown in Figure 3, the finger nails tend to show similar frequency responses with comparable first resonances around 125-160 Hz and a second peak at 500 Hz, albeit with varying levels of amplification. The fingers are larger with more mass and damping, while the tail is also stiffer. The rat has considerably higher amplification at all of the most active points. Therefore the rat tail may offer an accelerated model for the investigation of the physiological response to vibration while having similar resonant frequencies to the finger tip.

References

1. Curry et al. (2002). Vibration injury damages arterial endothelial cells. *Muscle & Nerve* 25, 527-34.
2. Krajnak et al. (In press). Acute vibration increases α_{2C}-andregenic smooth muscle constriction and alters thermosensitivity of cutaneous arteries. *J. Appl. Physiol.*