

EFFECTS OF VIBRATION ON VASCULAR PERMEABILITY IN RATS

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ABSTRACT

Evidence suggests that damage due to vibration exposure may be related to alterations in capillary permeability. The aim of this study was to investigate the effect of vibration exposure on vascular permeability. Rats were exposed to whole-body vibration at 125 Hz and 50 m/s² rms for 4 hours/day for 5 days. Vascular permeability in the gastrocnemius muscle and the liver was evaluated via Evans blue dye uptake. Results indicate that the uptake in the liver was 110% higher in vibrated animals compared to controls while that in the gastrocnemius was 38% higher, indicating that vibration exposure at the parameters studied leads to increases in vascular permeability.

INTRODUCTION

Hand-arm vibration syndrome (HAVS) is a disorder that affects workers using vibrating hand tools such as chainsaws, pneumatic hammers, and grinders. Mechanisms by which vibration causes damage remain unknown. HAVS involves pathologies of the nervous, vascular, and musculoskeletal systems [1]. It has been shown that workers with HAVS exhibit signs of chronic inflammation [2, 3]. An important component of inflammation is an increase in vascular permeability leading to the leakage of plasma proteins and fluid from the intravascular to the extravascular space. Increases in permeability can be measured by labeling albumin with either ¹³¹I or Evans blue dye. Previous animal studies have shown a correlation between vibration exposure and increased vascular permeability [4, 5].

MATERIALS AND METHODS

Eight male Sprague-Dawley rats (220-290 g) were used in this study. Use of these animals was approved by the Western New England College Institutional Animal Care and Use Committee. Four rats each were assigned to the vibrated and control (non-vibrated) groups. During the experiments, the rats were housed in enclosures made of polycarbonate with an aluminum base plate. Vibration of the rats in the vertical direction was provided by an electromagnetic shaker and associated equipment, described in detail elsewhere [6]. The enclosures were mounted to the shaker and the vibration experienced by the rats was monitored via an accelerometer attached to the aluminum base plate. Rats were exposed to whole-body vibration at 125 Hz and 50 m/s² rms for 4 hours/day for 5 days. Control animals were housed in an identical enclosure as the vibrated animals, but not attached to the shaker. Both the vibrated and control animals were exposed to 80 dB of noise from the blower used to cool the shaker. Vascular permeability was measured as described previously [7]. Following exposure on the 5th day, the rats were injected with Evans blue dye (20 mg/kg) via the caudal vein. After 20 minutes, the animals were euthanized and the gastrocnemius muscle and liver removed to investigate the effects of vibration close to and away from the vibration source,

respectively. Half of each tissue was dried at 60°C for 24 hours. The other half was placed in formamide (4 mL/g) for 24 hours to extract the dye. Concentration of the dye was measured spectroscopically at 620 nm and normalized to the equivalent dry weight of the tissue. Data were analyzed using a t-test with a significance level of $p < 0.05$.

RESULTS AND DISCUSSION

The mean and standard error of Evans blue dye uptake for the vibrated and control animals are shown in Figure 1. The differences in Evans blue dye uptake in the control and vibrated animals is statistically significant for both the gastrocnemius muscle and liver.

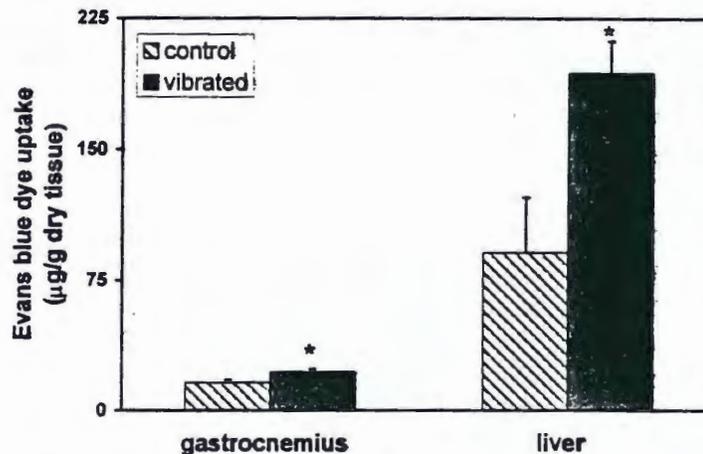


Figure 1: Evans blue dye uptake in tissue (*significant at $p < 0.05$)

These results are consistent with previous studies relating increases in vascular permeability to vibration exposure. Rats exposed to whole-body vibration of 50 Hz at 0.5 mm displacement (49 m/s^2) for 3 hours/day experienced an increase in vascular permeability between the 60th and 90th day of exposure as measured by ^{131}I -albumin [4]. Exposure of rat hind limbs to vibration at 82 Hz at a peak-to-peak amplitude of 0.21 mm (56 m/s^2) for 4 hours/day for 5 days resulted in epineurial edema as visualized by Evans blue dye fluorescence [5]. Our results also show an increase in vascular permeability due to vibration exposure in tissues close to and away from the vibration source. This increase may be an important component in the injury mechanisms of HAVS.

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