CHACTERISTICS OF VIBRATION INJURIES IN PERIPHERAL NERVES

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Introduction

This experimental study was done to determine pathological feature of vibration injury to the peripheral nerves in the hind limbs of rats exposed to 7 days of vibration.

Materials and Methods

Animals: Twenty four male Sprague-Dawley rats weighing 350-400 grams were randomly divided into two groups: sham control group and vibrated group. To document vibration-induced changes in the experimental model, the sciatic nerve was used because it contains both motor and sensory fibers and is relatively superficial in the posterior thigh.

Customized Vibrating Platform: The hind limbs of the rats in the vibrated group were exposed to vibration in a custom-built vibrating apparatus consisting of two platforms: a smaller vibrating platform on which the hind limbs of the rat are secured, and a larger platform on which the remainder of the body rests. The vibration parameters (frequency 43.5 Hz, amplitude 1.5mm, acceleration 4.75G, velocity 6cm/sec., and displacement of 3.0mm) of this model were measured.

Methods: Rats were anesthetized with 35mg/kg of intraperitoneal Nembutal (phenobarbital) and their hind limbs fixed to the vibrating platform by Velcro loops. Both hind limbs rest on the vibrating platform while the remainder of the body rests on the larger platform. The rats were vibrated 4 hours a day, for 7 days, with close monitoring of the vibration parameters. The 4-hour duration of hazardous vibration was based on recommendations from the British Standards Institution. The sciatic nerve of rats not exposed to vibration, but similarly anesthetized and secured to the vibrating platform, acted as controls. At the end of seven days of exposure to vibration, nerves from both the vibrated rats and the control rats were harvested after perfusion of the lower half of the body using glutaraldehyde as described below.

Neural Fixation: The aorta was cannulated, and the inferior vena cava was nicked and the animal was initially perfused with 0.9% buffered sodium chloride. This was followed by perfusion of a filtered mixture of 3% glutaraldehyde and 3% paraformaldehyde fixation solution, The tissue was subjected to post fixation by routine. The neural tissue was then submitted for light and electron microscopy.

Results

While light microscopy showed minimal histological differences between vibrated (n=12) and control nerves (n=12), the changes revealed by electron microscopy were dramatic. These included thickening of the epineurium, as well as thickening of the myelin sheath as compared with normal nerve. Also, the axon plasma was detached from the myelin sheaths, and many vacuoles were seen between the myelin laminae(Fig.1); These changes were found in all vibrated animals, and in the whole segment of each vibrated nerve. Myelin balls, consisting of

destroyed myelin rolled into wool-like threads, were located inside the myelin layers (Fig. 2); Axonal damage was seen in both myelinated and nonmyelinated axons (Fig. 3). In addition, nonmyelinated axons were edematous. An interesting finding was the circumferential disruption of several myelin layers, leaving a large circular space around the impacted myelin with central axonal constriction, this characteristic finding, giving the appearance of a finger ring, was found in every vibrated nerve (Fig. 4). Many microtubes and microfilaments were ruptured or had disappeared (Fig. 2-4).

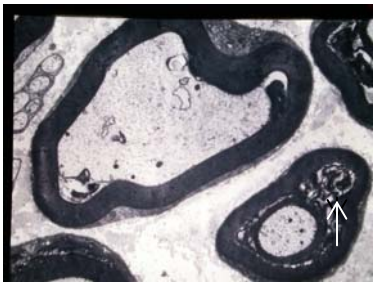
Fig. 1 

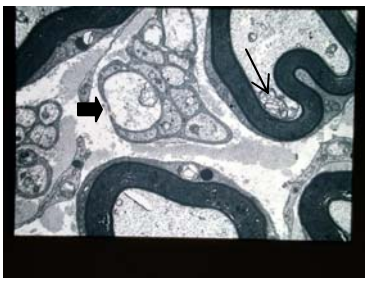
Fig. 3 

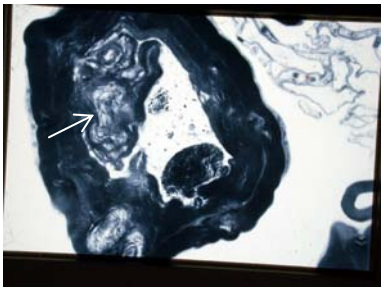
Fig. 2 

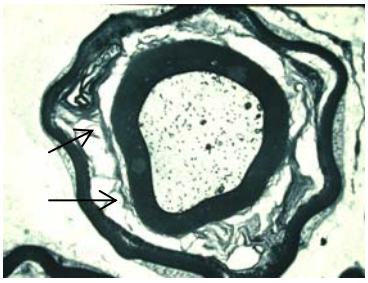
Fig. 4 

Fig. 1. Arrow indicates a big vacuole in myelin laminae; **Fig 2.** Arrow indicated a huge myelin ball, wool-like thread consisting of destroyed myelin; **Fig. 3** Axonal plasmadamage was seen in both myelinated (arrow) and nonmyelinated axons (arrow head); **Fig. 4.** Arrows showed a large circular space between the myelin layers.

Discussion

The vibrated nerves show definite pathologic changes in the form of axonal damage and myelin fragmentation[1-4]. We therefore conclude: Myelin disruption, myelin balls, myelin "finger ring" changes, and axonal de-attachment are identifiable characteristics of the neuropathological changes due to vibration injury. Further research to identify the hazardous components of vibration (amplitude, frequency, etc.) is in progress in our laboratory.

References

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