TESTING OCCUPATIONAL WHOLE-BODY VIBRATION EXPOSURES ON THE SPINE IN A LAB SETTING

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INTRODUCTION

Lower back injuries are a significant occupational concern in terms of both cost and lost work time [1]. Whole-body vibrations (WBV), such as those experienced by drivers, have been shown to be a risk factor in the development of lower back injuries by way of epidemiological evidence [2]. However, despite these associations, the development and progression of WBV-induced occupational lower back injuries are still not well understood from an etiological and biomechanical perspective.

This study translated real-world, occupational WBV exposures to a controlled laboratory setting while comparing two different road vibration signatures: a continuous, low-amplitude vibration and an impulsive, high-amplitude vibration.

METHODS

Occupational WBV accelerations were collected at the floor of a bus as it traversed two different road types – a smoother freeway segment (freeway) and a rougher older freeway segment laden with expansion joints every 50m (expansion joints). These road signatures were then played into a six-degree-of-freedom hydraulic shaker platform and sternum measured accelerations were collected from 12 subjects. Then, based on the 12 subjects, the average amplitude and frequency of the spinal displacement for both road types was derived and calculated.

Six cadaveric lumbar spine functional spinal units (FSUs) were prepared by removing posterior bony anatomy and musculature to create a disc-body-disc model. The specimens were then potted in polymethylmethacrylate and exposed for 2.4 hours to one of the two vibration-derived displacement signatures (amplitude and frequency) using a servohydraulic testing machine. A bi-colored staining technique using safranin red and alcian blue stains was used to distinguish pre-existing damage to the specimens from damage incurred during the specimen cycling.

RESULTS AND DISCUSSION

Analysis of the freeway vibration exposure resulted in an amplitude of 0.34 mm at a frequency of 2.5 Hz. Analysis of the expansion joint exposure resulted in an amplitude of 1.6 mm at a frequency of 2.5 Hz with a 0.5 Hz duty cycle. A second peak at 0.8 mm and 2.5 Hz was added to mimic the decaying nature of the expansion joint impulses.

As illustrated in Figure 1, all specimens exposed to the expansion joint signature showed signs of damage developed during cycling (either endplate fractures, damage to the annulus fibrosis, or both). Conversely, no specimens exposed to the freeway signature showed any signs of deterioration/damage developed during cycling. Complete subject results are shown in Table 1.

![Figure 1: Photographic results from cadaveric testing](image)

CONCLUSIONS

A more impulsive vibration exposure seems more likely to result in damage to the intervertebral discs and/or vertebrae than a less impulsive exposure. However, further testing and more specimens are needed to develop more definitive conclusions.

REFERENCES

1. Marras, W. Ergonomics 43 (7):880-902

<table>
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<tr>
<th>Specimen #</th>
<th>Age of Donor</th>
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<th>Exposure</th>
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<th>Endplate Fracture</th>
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<td>L4-L5</td>
<td>Freeway</td>
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<td>-</td>
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