

EVALUATION OF NEWLY DESIGNED CUSHION FOR ELECTRIC POWER WHEELCHAIR DRIVING

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INTRODUCTION

Whole-body vibration can result in low-back pain, disc degeneration and other harmful effects to the body [1]. Researchers are investigating optimal solutions for reducing vibration and seat pressure exposure of electric power wheelchair users [2, 3, 4]. The purpose of this study was to investigate the effectiveness of the newly designed water-filled cushion (NDWF), based on vibration amplitude transmissibility from the wheelchair seat to the head, and pressure mapping while driving an electric-powered wheelchair, as compared to other typical wheelchair cushions (Air-filled (AF), Viscoelastic fluid (VF), Water-filled (WF)).

METHODS

A triaxial accelerometer (ARJ-A-T ±10g) was mounted on a seat frame to measure the vibration on the seat frame. Another accelerometer was mounted on a Bite-Bar that was held between the teeth of subjects in order to measure the whole-body vibration experienced by subjects. Signals from the accelerometers were amplified and sampled at 200Hz via a battery-powered acquisition system, and pressure distribution mapping was recorded simultaneously. The subjects sat on the different cushions placed on a sensor seat (BIG-MAT) in order to measure two values: the peak pressure and the contact area. Subjects drove the electric-powered wheelchair (JW1-22B) over four different surfaces: pavers, asphalt, brick and gravel, while sitting on four different cushions: AF, VF, WF, and NDWF. The electric-powered wheelchair was driven at one meter per second over these four surfaces. Ten subjects participated in this experiment. Their average age, weight and height were 22.2 ± 1.03 years old, 62.2 ± 9.39 kg, and 171.7 ± 8.32 cm tall respectively. Each driving trial was repeated three times, resulting in each subject driving the wheelchair for 36 trials (3 surfaces x 4 cushions x 3 times). From the collected signals, the Vibration Dose Value (VDV) was calculated for each direction (XYZ) respectively, then determined the resultant vibration dose value (VDV_{total}). The Vibration Dose Value Ratio (VDVR) which represented the effective amplitude transmissibility of a cushion was also calculated. From the peak pressure and contact area data, the decreasing rate of the peak pressure (DP) and the increasing rate of the contact area (IC) were calculated based on those normative data when cushions were not used. To evaluate the effect of different cushion designs on a user's whole-body vibration, the variables VDVR, DP and IC were compared for significant differences between cushions using a mixed-model ANOVA, with an alpha of p=0.05.

RESULTS AND DISCUSSION

The average and standard deviation of VDVR on each surface, peak pressure (DP) and increasing rate of the contact area (IC) are shown in Fig. 1, 2 respectively. Results showed that the

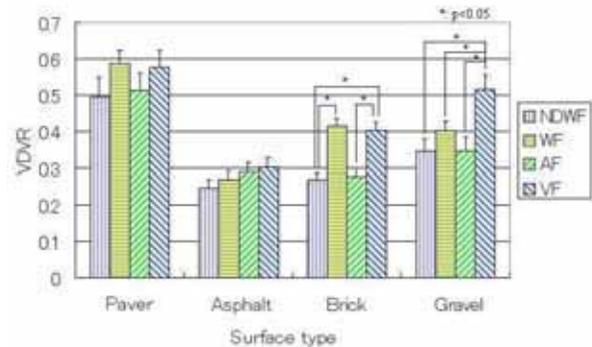


Fig.1 The VDVR on each surface

VDVR on the paver and asphalt surfaces did not have significant differences between cushions. The VDVR of the NDWF and AF cushion showed significantly less than WF, VF cushion on the brick and gravel surfaces (p<0.05). VF cushion showed a significant highest VDVR value compared to other three cushions. (P<0.05)

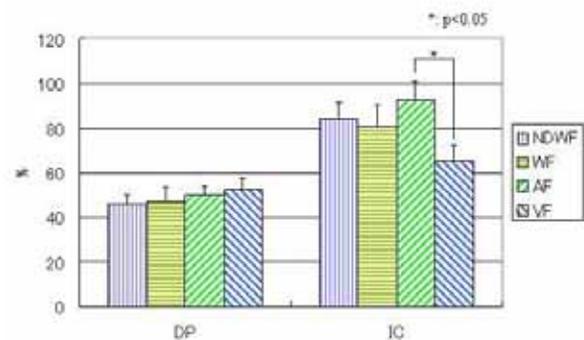


Fig.2 The DP and IC on paver surface

The DP and IC of the NDWF, WF and AF cushion were almost identical while driving wheelchair on the paver surface (Figure 2). From present results, whole-body vibration of NDWF cushion users was significantly reduced and did not change the pressure distribution compared to other three cushions. Based on present limited data, the NDWF cushion was comparable to commercial cushions and might be able to provide a comfortable ride and had a comparable effect in the prevention of pressure sores for power wheelchair users.

REFERENCES

1. Seidel et. al., *Int Arch Occup Environ Health* 58, 1-26, 1986
2. Dobson et al, *Proceedings of RESNA'2004*, Atlanta, GA, 2003.
3. Cooper RA, et al. *J Spinal Cord Medicine*, 27, 468-475, 2004
4. Kubo J, et al. *Proceedings of 21th ISS*, 117, 118.