SHORT-TIME ISCHEMIA REDUCES PLANTAR FOOT SENSITIVITY

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INTRODUCTION

Prolonged ischemia induced by vascular diseases (e.g. diabetes mellitus with peripheral neurophaty and chronical lower limb ischemia) leads to a loss of sensitivity at the plantar foot region. This loss is caused by the degeneration of the cutaneous mechanoreceptors (e.g Vater-Pacini and Meißner corpuscles) located in the dermis and cosequently impairs motor performance [1]. While there is a great number of studies examining the degenerative effects of permanently reduced blood flow on different foot tissues, only little knowledge exists about the effects of a short-time blood flow reduction on plantar foot sensitivity. Furthermore, there is a lack of information about the consequences of ischemia on plantar foot sensitivity of healthy subjects, since sensory testing in this research area is usually carried out in patients. Investigating healthy subjects may provide first insight into initial adaptations caused by reduced blood flow in plantar foot sensitivity. Therefore, the goal of the present study was to investigate the effects of short-time ischemia on plantar foot vibration sensitivity of healthy subjects.

METHODS

20 female (24.1±2.1years; 170.0±7.6cm; 63.7±9.9kg) and 19 male (23.9±1.9years; 182.8±10.6cm; 75.0±10.2kg) subjects participated in the study. Vibration thresholds were measured with a vibration exciter (200Hz) at three anatomical locations of the right plantar foot: heel, 1st. metetarsal head (MET I) and hallux. Thresholds were measured in three blood flow conditions in the following order: baseline (0mmHg), venous occlusion (50mmHg) and total occlusion (150mmHg). Blood flow occlusion was generated by a pneumatic tourniquet placed around the upper leg, about 10cm above the popliteus cavity. Each blood flow condition was held for 4min prior to threshold measurements. No reperfusion time was allowed between the conditions. During measurements, blood flow perfusion (Perfusion Units, PU) at the foot skin was controlled by a laser Doppler probe, placed on the medial foot area, around the Navicular bone.
Thresholds were collected with subjects seated. Vibration amplitude was raised from zero until the amplitude that subjects could perceive (vibration perception threshold). Five repetitive trials were performed for each location and blood flow condition. Measurement locations were randomized within and between subjects. For data analysis the lowest CoV of at least three trials was used to select the most homogeneous measurements. Means and standard deviations were calculated from these trials. The mean thresholds of the different blood flow conditions were compared with a repeated measures ANOVA ($p<0.05$).

RESULTS AND DISCUSSION

A reduction of blood flow at the foot skin was found for women (begin: 9.1PU; end: 8.1PU) and for men (begin: 6.7PU; end: 6.0PU). Blood flow reduction caused a significant increase in vibration thresholds at all anatomical locations for the women (Fig. 1), whereas for the men significant increases were found at the hallux and MET I (Fig. 2). All significant increases in thresholds were found when comparing baseline measurements to measurements performed during complete blood flow occlusion (150mmHg). Although results at the heel area were not significant for the men, the present data indicates that a short-time complete blood flow occlusion results in a reduction of plantar foot vibration sensitivity.
Previous investigations [2] have shown that a 15-25min complete blood flow occlusion blocks the activity of muscular group I afferents. The present results show that already a much shorter complete blood flow occlusion may affect the afferent transmission of vibratory stimuli perceived by Vater-Pacini corpuscles. Moreover, since the Vater-Pacini corpuscles receive vascular blood supply from the skin capillaries, the reduced cutaneous blood flow at the foot may also directly affect their function [3].

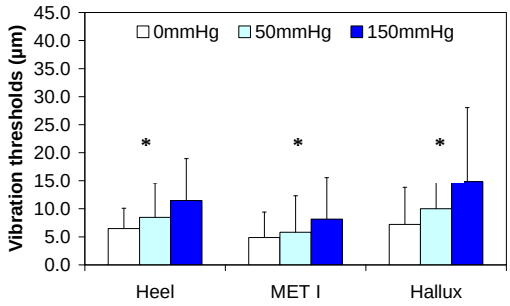

Figure 1: Vibration thresholds: women (*=$p<0.05$).

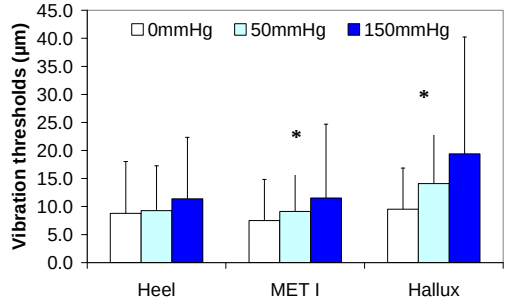

Figure 2: Vibration thresholds: men (*=$p<0.05$).

CONCLUSIONS

The results of this study show that a short-time blood flow occlusion at the foot area significantly reduces plantar foot vibration sensitivity of healthy subjects. Further research is needed to investigate the potential effects of this reduced sensitivity on motor performance, e.g. balance control.

ACKNOWLEDGEMENTS

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REFERENCES

1. Priplata AA et al., *Ann Neurol.* **59**:4-12, 2006.
2. Grey MJ et al., *J. Physiol.* **534**:925-933, 2001.
3. Mizobuchi K et al., *Clin Neurophysiol.* **113**:310-315, 2002.