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Skin Hardness of the Foot Sole and Weight Bearing Reduce the Perceptual Representation of the Sole Mechanosensitivity Altering Posture Control

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Editorial

The cutaneous mechanoreceptors of the foot sole detect the changes in the application of mechanical loads on the plantar surface during gait and standing, and contribute to controlling the standing balance and postural reflexes in healthy subjects [1]. Electrophysiological human studies reported the presence of both slow (Merkel and Ruffini corpuscles) and fast (Meissner and Pacinian corpuscles) adapting mechanoreceptors [2]. The Merkel and Meissner corpuscles are located at the dermal-epidermal junction, whereas the Ruffini and Pacinian corpuscles are only present in the deeper dermal layers. The vibration frequency can selectively activate either the Merkel disks and Ruffini corpuscles (25 Hz) or the Meissner and Pacinian corpuscles (150 Hz). These cutaneous afferents project on the somatosensory cortex leading to a perceptual representation. The perceptual thresholds for the foot sole mechanosensitivity were expected to correlate with the hardness of the skin and also to the counterforce exerted on the foot sole when bearing heavy loads.

In a recent study [3], we examined the vibration sensitivity of three plantar location of different hardness, the fifth metatarsal head having often the highest one. The mean Shore values were for the 1st -2nd, and 5th metatarsal heads, and the heel were 30 +/- 4, 60 +/- 3 and 50 +/- 2. The Stevens power function ($\Psi=k^{*}\Phi^{n}$) allowed to obtain regression equations between the estimate (Ψ) of the vibratory stimuli and their physical magnitude (Φ).We found that the vibration threshold was significantly higher at the level of the 5th metatarsal head and the heel for both the 25 Hz and 150 Hz frequencies. After skin abrasion, the vibration sensitivity was significantly higher at both vibration frequencies. Thus, skin hardness affects the foot sole mechanosensitivity and could alter the control of posture during standing and walking.

Heavy backpacks are used by firefighters and soldiers. Majumdar et al. [4] showed that soldier load carriage affects the kinematics of gait. Also carrying a military backpack increased the postural sway during standing [5]. Unpublished observations by our team revealed that weight bearing when standing upright or walking reduced the vibration sensitivity of the heel and metatarsal heads and increased the surface and lateral deviation of the center of pressure measured by posturography. Thus, skin hardness and bearing of heavy loads affect the foot sole's sensitivity and posture control. This strongly suggests first, that foot care by podiatrist is relevant to improve posture control and second, that the efficient completion of tasks by soldiers which is of operational relevance could be affected by bearing heavy loads.

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