Can high frequency electrical stimulation of the skin (HFS) induce a long-lasting secondary hyperalgesia at the dorsum of the foot?

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Background and aims

High Frequency Stimulation (HFS) applied onto the human skin produces an increase in sensitivity to mechanical pin-prick stimuli in the surrounding non-stimulated skin. This phenomenon is thought to be related to the secondary hyperalgesia caused by a lesion, and to be a consequence of central sensitization. Most previous studies have explored HFS-induced secondary hyperalgesia at the upper limb [1; 3]. The aim of this study was to characterize the change in mechanical pinprick sensitivity induced by HFS delivered to another body part, the distal end of the lower limb as it has never been explored so far.

Methods

32 healthy volunteers (15 women and 17 men aged between 20 and 30; mean 23,7) were included in this between subject experiment. Half of the participants were randomly assigned to receive HFS on the volar forearm (10 cm distal from the cubital fossa, dermatomes C6-C7-T1) [2; 4]. The other half received HFS on the lateral side of the foot (dermatomes L5-S1) [2]. The stimulation consisted of 5 trains. The electrode consisted of 10 blunt tungsten pins with a diameter of 0.25 mm protruding 0.65 mm from the base (MRC Systems GmbH, Heidelberg and University of Heidelberg, Germany). The time interval between each train onset was 10 s. The intensity of stimulation corresponded to 20 times the detection threshold to a single pulse (forearm: 0.12 +/-0.06 mA [mean +/- SD], foot : 0.30 +/-0.10 mA). Pinprick sensitivity was assessed before HFS and 30 min, 60 min, 90 min, 120 min, 180 min and 240 min after HFS by asking participants to rate the intensity of a 128 mN pinprick stimulus (0.25 mm probe) applied perpendicular to the conditioned skin. The area of increased pinprick sensitivity was assessed along eight radial axes at each time point.

Results

Both HFS applied to the volar forearm and HFS applied to the lateral foot dorsum induced a significant increase in pinprick sensitivity, which was present both up to 240 min at the forearm and the foot. The increase in sensitivity was greater at the forearm compared to the foot dorsum ($p < .05$). The area of increased sensitivity was also greater at the forearm as compared to the foot ($p = 0{,}003$).

Fig. 1

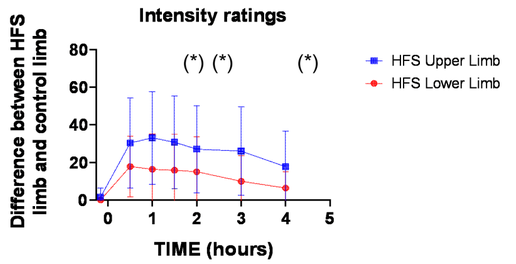

Fig. 2

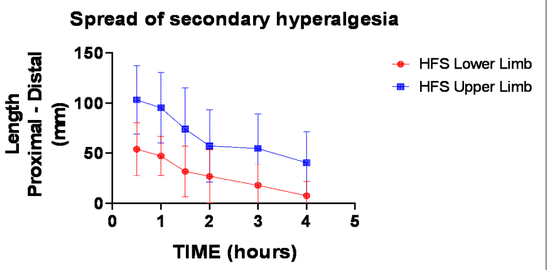

Fig. 1: Time course of the difference between ratings given when applying pinprick on the sensitized limb and the control one. Sensitivity after HFS was significantly different between higher and lower limbs (2-way ANOVA; $p < 0{,}05$) but only significantly different after multiple t-test for these time points (*).

Fig. 2: Time course of the area of increased pinprick sensitivity after HFS. Area of increased sensitivity was significantly different between higher and lower limbs (2-way ANOVA; $p = 0{,}003$) and significantly different after multiple t-test for each time-point ($p<0{,}02$ at least for each).

Conclusion

HFS induces secondary hyperalgesia at the dorsum of the foot. However, the change in pinprick sensitivity induced by HFS at the foot is not as strong as the change in pinprick sensitivity induced by HFS at the volar forearm. This could be due to differences at peripheral or central level, including differences in epidermal nerve fiber density, differences in skin thickness, differences in the daily exposures to stimuli, and/or differences in the central processing of nociceptive input originating from the upper and lower limbs.

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The authors have no conflict of interest to declare

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