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Multiregion thermal sensitivity mapping of the hand☆

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Summary Previous neurophysiological studies of discrete hand regions have suggested the dorsum to be more sensitive to temperature changes than the palmar surface, but no multiple-region investigation of the corresponding dorsal and palmar regions has been performed. This study aimed to investigate whether the dorsum of the hand is more sensitive to temperature changes than the palm across multiple regions. In 15 healthy human volunteers, cold and warmth detection thresholds were measured in 10 defined areas of the hand using a thermode of 2.56 cm^2. The testing algorithm employed was the Method of Limits with a baseline temperature of 32 °C and a rate of change of 1°/s. In five subjects, cold-pain and heat-pain thresholds were also measured. All dorsal regions were significantly more sensitive to cold than equivalent palmar areas. Differences in warmth thresholds were not uniform but, overall, dorsal sensitivity was significantly higher. This study finds that the dorsal aspect of the hand was more sensitive to temperature changes than the palm, with higher sensitivity to painful thermal stimuli.

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Introduction

Thermal sensation is important not only for maintaining stable body temperature but also for facilitating discrimination between materials and protecting our skin from damage, and the human hand is particularly sensitive to temperature variation.[1]

Clinical teaching suggests that the back of the hand can be employed to assess for temperature differences during clinical examination.[2,3] In addition, a small number of neurophysiological studies have reported differences in thermal sensitivity between palmar glabrous and dorsal hairy skin.[4–7] Based on this background, we hypothesized that specific dorsal regions were more sensitive to temperature changes than corresponding palmar areas. Using relatively large thermodes, those studies only tested limited regions of the hand and gave just an overview rather than precise information about possible regional variations to temperature sensitivity. To our knowledge, there is no detailed comparison of a higher number of accurately defined palmar and equivalent dorsal areas regarding thermal sensitivity. As such, the aim of our study was to determine thermal thresholds in 10 defined regions of the hand in healthy subjects.

Methods

After receiving the local institutional review board's approval, we recruited healthy volunteers. Fifteen subjects (seven female) participated. Prior to any measurements, we obtained informed consent. All subjects were treated in accordance to the Declaration of Helsinki. Exclusion criteria were neurological disorders, systemic metabolic disease, injury of the upper extremities or spine, skin temperature below 27 °C and medication causing peripheral neuropathy. Even though several studies found no correlation of skin temperature and thermal thresholds,[8] we defined this limit because a skin temperature of ≥27 °C would have no[9] or negligible[6] impact.

Prior to threshold testing, we measured skin temperature with an infrared thermometer. For measuring thermal thresholds, we used a reliable computer-controlled device, which was able to apply cold or heat onto the skin via a thermode (Thermal Sensory Analyzer TSAII 2001, Medoc Ltd., Ramat Yishai, Israel). The thermode's area was 2.56 cm^2 (1.6 × 1.6 cm). Our testing algorithm was the Method of Limits with a baseline temperature of 32.0 °C and a rate of change of 1 °C/s in either direction.

Regions of interest were considered to be more sensitive to heat when participants felt changes in increasing

Table 1 Cold detection thresholds.

	Palmar	Dorsal	*P* value
Thenar/radial dorsum	29.2 ± 0.9 °C	30.3 ± 0.5 °C	0.002
Hypothenar/ ulnar dorsum	29.3 ± 0.8 °C	30.6 ± 0.3 °C	0.001
Dig II proximal	29.8 ± 0.8 °C	30.7 ± 0.3 °C	0.017
Dig II distal	28.5 ± 1.1 °C	N/A Nail	
Dig V proximal	29.3 ± 0.7 °C	30.7 ± 0.3 °C	0.001
Dig V distal	27.1 ± 2.2 °C	N/A Nail	

Cold detection thresholds for palmar and corresponding dorsal areas: In the first line, for instance, "palmar" indicates the threshold for the thenar and "dorsal" the one for the radial dorsum. The *p* value demonstrates a significant difference between those two regions.

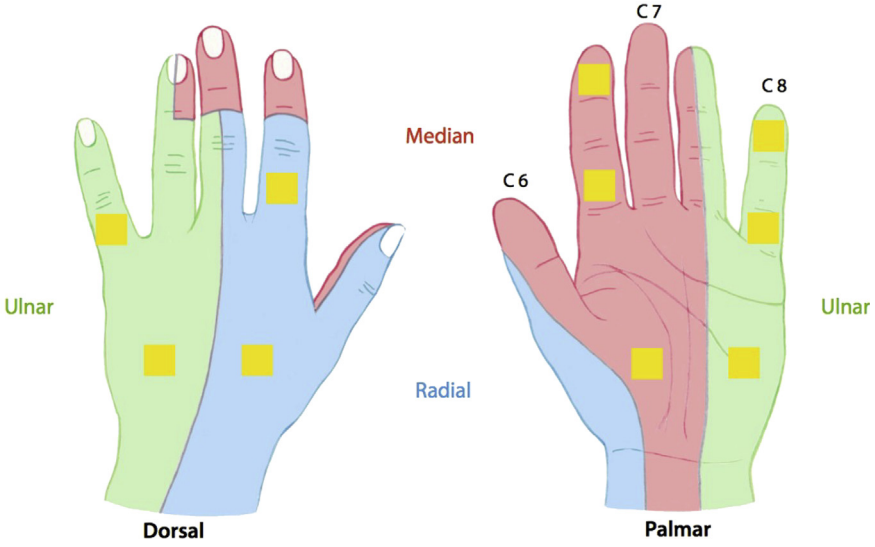

Figure 1 **Areas tested for thermal sensitivity.** *Left*: On the dorsal side, we tested four areas: two within the area supplied by the Ulnar nerve (from proximal: Ulnar dorsal and Dig V dorsal) and two within the area supplied by the Radial nerve (from proximal: Radial dorsal and Dig II dorsal). As the fingernails prevented accurate measurements at the distal part of the dorsal fingers, we could not determine thresholds for those regions. Dig II = Index finger, Dig V = little finger. *Right*: On the palmar aspect, we tested six defined areas: three within the area supplied by the Ulnar nerve (from proximal: Hypothenar, Dig V proximal and Dig V distal) and three within the area supplied by the Median nerve (from proximal: Thenar, Dig II proximal and Dig II distal).