PROSPECTIVE STUDY ON TACTILE SENSITIVITY IN THE HANDS OF A BRAZILIAN POPULATION USING THE PRESSURE-SPECIFIED SENSORY DEVICE

Francisco Tustumi[1], Hugo Alberto Nakamoto[2], Paulo Tuma Junior[2], Dimas André Milcheski[1], Marcus Castro Ferreira[3]

ABSTRACT

Objective: To evaluate the pressure perception thresholds on the pulp of two fingers (index and little fingers), among a Brazilian population with no nerve injury or neuropathy. Methods: We used the Pressure-Specified Sensory Device (a computerized device) to derive static and dynamic normal pressure perception thresholds and two-point discrimination distances. Results: We tested finger sensitivity on 30 volunteers. Significance analyses were performed using the Student t test. The mean values (g/mm^2) for static one and two-point pressure thresholds (s1PD, s2PD) and dynamic one and two-point discrimination (m1PD, m2PD) in the dominant index finger were: s1PD = 0.4, m1PD = 0.4, s2PD = 0.48, m2PD = 0.51. Conclusion: There was no significant difference in sensitivity between the dominant and nondominant hands.

Keywords – Touch Perception; Median Neuropathy; Ulnar Neuropathies

INTRODUCTION

Although there are well-established methods for assessing motor recovery after hand injuries, there are no equivalent methods for examining the recovery of sensitivity, even though hand sensitivity tests may provide estimates of physical condition and even of hand functional ability(1).

Most of the methods that attempt to assess hand sensitivity are unsatisfactory, particularly because they do not quantify sensitivity accurately and are incapable of determining the performance of sensory afferent neurons in isolation(2-6). Use of Semmes-Weinstein monofilaments, one of the methods for evaluating sensitivity that have been established in the literature(7-9), has the inconvenient feature of only assessing static points, with non-continuous values, and this method is incapable of making an assessment to discriminate between two points.

Dellon et al(7) introduced the PSSD (Pressure-Specified Sensory Device), a computer-assisted device with the capacity to measure skin pressure sensitivity. This instrument has advantages in relation to other sensitivity tests, since it is capable of quantitatively assessing the functioning of skin pressure receptors: both slow-adaptation receptors (evaluated by means of static point tests) and fast-adaptation receptors (evaluated by means of dynamic point tests). The device can be used repeatedly and frequently and does not require invasive procedures(1).

Within this context, some researchers have tried to investigate factors that might influence the hand sensitivity results in populations that are said to be normal. Age, sex, occupation, ethnicity and dominance are some of the factors that have been investigated. However, most of the studies aiming towards assessing mechanical sensitivity have involved use

1 – Undergraduate Medical Student at the School of Medicine, University of São Paulo (FMUSP), São Paulo, SP, Brazil.
2 – MSc in Plastic Surgery from FMUSP. Attending Physician in the Hand and Microsurgery Group, Institute of Orthopedics and Traumatology, Hospital das Clínicas, FMUSP, São Paulo, SP, Brazil.
3 – Titular Professor of FMUSP; Academic Head of the Discipline of Plastic Surgery and Head of the Division of Plastic Surgery, Hospital das Clínicas, FMUSP, São Paulo, SP, Brazil.

Work performed in the Division of Plastic Surgery, Hospital das Clínicas, FMUSP, São Paulo, SP.

Correspondence: Rua Alves Guimarães 733, ap. 22, 05410-001 São Paulo, SP, Brazil. E-mail: franciscotustumi@gmail.com.

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of the tests described by Semmes et al[6] or vibration tests[8-11]. There have not been any studies using PSSD to determine the influences of factors like sex, age, dominance and occupation on the hand sensitivity of the normal population of Brazil.

The aim of the present study was to assess the influences of sex, occupation, age and dominance on the pressure perception thresholds of the digital pulp of the index and little fingers, using the PSSD, among a Brazilian population without nerve injuries or neuropathy, with the aim of establishing these values in a Brazilian population, in order to validate the method in our setting and have normative data for use in subsequent studies on patients with pathological conditions of the hand.

PATIENTS

This project was approved by the Ethics Committee for Research Project Appraisal (CAPPesq), under number 1088/07.

In this study, volunteers with a history of diabetes, peripheral neuropathy, nerve injury, presence of calluses on the fingers or any skin abnormality that might interfere with the test were excluded. Individuals who were incapable of understanding the sequence of procedures necessary for the examination were also excluded.

The hands of 30 volunteers of ages ranging from 19 to 78 years (mean of 45) were evaluated. In total, 28 nondominant hands and 30 dominant hands were evaluated in this study. Among the volunteers, 13 were under 45 years of age.

METHODS

The present study followed methodology similar to what was described by Dellon et al[7]. We used the PSSD (Pressure-Specified Sensory Device, Sensory Management Services, Lutherville, MD, USA) on the digital pulp of the index and little fingers (Figure 1). Tests were performed at one static point (s1PD), two static points (s2PD), one dynamic point (m1PD) and two dynamic points (m2PD). In the case of static points, the tips of the device were brought slowly towards the finger that was to be examined, thus progressively increasing the pressure on the finger. In the case of dynamic points, the tips of the device were moved along the digital pulp while applying progressively greater pressure. In the two-point tests (s2PD and m2PD), both tips of the device were applied to the digital pulp. In the one-point tests (s1PD and m1PD), only one tip of the PSSD came into contact with the finger. The pressures exerted on the finger surface were transduced by the PSSD and measured in g/mm^2. In this study, the distance between the tips of the devise was set at 4 mm. The digital pulp was evaluated on both the dominant and the nondominant hand.

Figure 1 – Pressure-Specified Sensory Device.

Comparisons were made between the pressure sensitivity thresholds (the minimum values at which the volunteer reported feeling the touch of the device, in g/mm^2), by means of the paired Student's t test, correlating the following: paired samples; little and index fingers; dominant and nondominant hands; young and older volunteers; volunteers in predominantly manual occupations and occupations that required little use of the hands; and between our study and the data from the study by Dellon et al[7]. To establish parallels with their study, the role of age in relation to sensitivity was evaluated by comparing individuals under and over the age of 45 years.

RESULTS

On the index finger, the means for the pressure thresholds in each test were: s1PD = 0.39g/mm^2; m1PD = 0.39 g/mm^2; s2PD = 0.45 g/mm^2; and m2PD = 0.5g/mm^2. On the little finger, they were: s1PD = 0.41g/mm^2; m1PD = 0.42 g/mm^2; s2PD = 0.52g/mm^2; and m2PD = 0.52 g/mm^2 (Tables 1 and 2).

In occupations that were said to be predominantly

Table 1 – Index finger. Fifty-eight fingers were analyzed. Values are given in g/mm². Confidence interval (CI). Single-point static test (s1PD). Two-point static test (s2PD). Single-point dynamic test (m1PD). Two-point dynamic test (m2PD).

Variable	Mean (g/mm²)	Standard deviation (g/mm²)	Standard error of the mean (g/mm²)	95% CI
s1PD	0.3919	0.1912	0.0251	(0.3402; 0.4436)
m1PD	0.3855	0.1903	0.025	(0.3420; 0.4290)
s2PD	0.4509	0.2276	0.0299	(0.3968; 0.5049)
m2PD	0.4969	0.2058	0.027	(0.4371; 0.5567)

Table 2 – Little finger. Fifty-eight fingers were analyzed. Values are given in g/mm². Confidence interval (CI). Single-point static test (s1PD). Two-point static test (s2PD). Single-point dynamic test (m1PD). Two-point dynamic test (m2PD).

Variable	Mean (g/mm²)	Standard deviation (g/mm²)	Standard error of the mean (g/mm²)	95% CI
s1PD	0.4122	0.1968	0.0258	(0.3620; 0.4625)
m1PD	0.4226	0.1654	0.0217	(0.3725; 0.4726)
s2PD	0.5167	0.2055	0.027	(0.4569; 0.5766)
m2PD	0.5178	0.2273	0.0298	(0.4636; 0.5719)

manual, there was a greater threshold for m1PD on the dominant index finger than there was in other occupations ($p < 0.05$).

In investigating discrimination between two points, it was shown with a high significance level that m1PD had a pressure threshold that was lower than that of m2PD on the nondominant little finger ($p < 0.001$); and that s1PD had a pressure threshold that was lower than that of s2PD on the nondominant index finger ($p < 0.008$). Moreover, the value for m1PD was lower than for m2PD on the nondominant index finger and dominant little finger ($p < 0.05$).

No difference could be demonstrated between the sensitivity of the index and little fingers; between the volunteers under 45 and over 45 years of age; between dominant and nondominant hands; or between static and dynamic points.

The results from the present study had higher sensitivity thresholds than those obtained by Dellon et al[7].

DISCUSSION

The sensitivity thresholds of the present study were higher than those obtained by Dellon et al[7] in their study on an American population, which is compatible with the fact that tactile sensitivity varies between different populations, as demonstrated in examinations using Semmes-Weinstein monofilaments[8,9]. It has to be borne in mind that Dellon et al[7] used a distance of 3 mm between the points of the device in the two-point tests. On the other hand, in our study, we preferred to set the distance at 4 mm, given that a large population would be rejected if shorter distances were used. The American Society of Hand Surgery[12] considers discrimination between two static points to be normal up to 6 mm. By using a distance of 4 mm, none of the volunteers were excluded from the test for this reason.

Possibly because of this variation between populations, some measurements in our study did not satisfactorily obey a Gaussian distribution. Thus, sensitivity measurements using the PSSD alone are not diagnostic for sensory loss. What can be done is to compare an injured hand with the contralateral hand and thus determine the percentage sensory loss, given that all the sensitivity thresholds evaluated in the present study were equivalent, comparing dominant and nondominant hands. In addition, the thresholds before and after the operation can be compared in order to assess the progression of reinnervation, as done in carpal tunnel decompression surgery or after nerve repair.

In our study, there was no significant difference between the index and little fingers, and there was no difference between the dominant and nondominant hands (thus agreeing with Jain et al[8], who used the test described by Semmes et al[6], and with Louis et al[13], who used the PSSD). This result is compatible with the lack of significant difference in skin thickness or sensory nerve receptor density between the dominant and nondominant hands, between the index and little fingers, between men and women, or between different age groups[10]. On the other hand, in the population studied by Gelli and Pool[14], the little finger had a smaller discrimination two-point distance than what was shown by the index finger. Using the PSSD, Dellon et al[7] did not find any differences in sensitivity between these two fingers in any of the measurements (m1PD, m2PD, s1PD and s2PD). These data lead us to take the view that the importance of thickening of the epidermis depends on the population studied.

The studies by Lindsell and Griffin[11] and Shahbazian et al[15] showed that skin sensitivity to vibration changes slightly according to the type of professional occupation. In the population of our study, pressure sensitivity was only affected by occupational differences in m1PD on the index finger of the dominant hand.

Comparing age differences, Cauna and Ross[16] and Ridley[17] noted that older individuals have higher vibration thresholds, and this could be explained by the age-related decrease in the number of Meissner corpuscles, which are the main nerve receptors involved in sensing vibrations on the skin. However, in our study on pressure sensitivity, we did not find any changes related to aging. This result is compatible with the fact that Merkel cells (which have a large influence on pressure sensitivity) do not alter with age[7].

Identifying one or two stimuli probably depends on skin innervation and also on the innervation of the encephalic cortex. Taking the view that discrimination would primarily take place in the cortex and that the same stimulus would be necessary to activate peripheral mechanical receptors, it might be expected that single-point tests would have results similar to those of two-point tests[7]. However, Mountcastle and Powell[18] suggested that two-point discrimination could result from inhibitory impulses from the peripheral stimulus. In this case, single-point tests would differ from two-point tests. In our study, we found significant differences between one and two-point tests, thus indicating that two-point discrimination depends more on peripheral participation than on cortical participation.

CONCLUSION

It is clear that the PSSD may be a very useful tool for examining hand sensitivity after nerve injury or under conditions of neuropathy, although it is necessary to assess other factors that might influence the results. Furthermore, it has to be borne in mind that not all individuals are eligible for the test, considering that some of the volunteers in the present study were incapable of comprehending the test procedure.

Because of the importance of touch in the functional capability of the hand, sensitivity tests need to have a role in diagnostic investigation and treatment follow-up. Since the PSSD has advantages in relation to traditional methods (continuous measurement and the possibility of testing both fast-adaptation and slow-adaptation fibers), it seems to be a good alternative for use as a standard sensitivity test, both for establishing recovery scores and for comparing results between different treatment methods from an academic point of view. In this regard, validation of normal values in the Brazilian population makes it possible to individualize sensory rehabilitation protocols in order to seek better functional recovery for patients.

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