

PERCEPTIONS AND ELECTRIC SENOIDAL CURRENT STIMULATION

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ABSTRACT - Objective: To analyze the relationship between perceptions and electrical senoidal current stimulation (ESCS). **Method:** The study population comprise 100 healthy volunteers. ESCS of 5 Hz and 2 kHz were applied to the left index finger at one and 1.5 sensory threshold. Following each stimulus train a list of eight words (four related to thin fiber sensations and four related to thick fiber sensations) was presented to the subjects who were asked to choose the three words closer to the experienced sensation. Each chosen word was given a score 1; final results were obtained by the sum of the scores for the words related to thin and thick fiber systems for each situation. **Results:** For 5 Hz ESCS at one and 1.5 sensory threshold thin fibers had significantly higher scores than thick fibers; for 2 kHz ESCS, thick fibers had significantly higher scores. **Conclusion:** These results show that there is a relation between different sensations and ESCS of different frequencies.

KEY WORDS: peripheral nerve, electric stimulation, senoidal currents, sensations, perceptions.

Percepções e estimulações elétricas por correntes senoidais

RESUMO - Objetivo: Estudar a relação entre as sensações evocadas por estimulação elétrica por corrente senoidal (ESCS). **Método:** 100 voluntários normais foram estudados. ESCS a 5 Hz e 2 kHz foram aplicadas no dedo indicador esquerdo com uma e 1,5 vezes o limiar sensorial. Listas de oito palavras (4 relacionadas a fibras grossas, 4 a fibras finas) foram apresentadas após cada estimulação e foi solicitado que o sujeito escolhesse as 3 palavras que mais se aproximassem das sensações experimentadas. As palavras escolhidas foi dado o escore 1. Os resultados finais para análise foram obtidos da soma dos escores para as palavras relacionadas aos diferentes sistemas de fibras. **Resultados:** Para ESCS a 5 Hz sensações relacionadas a fibras finas foram significativamente mais escolhidas, já para estimulações a 2 kHz sensações relacionadas a fibras grossas foram significativamente mais escolhidas. **Conclusão:** Estes resultados mostram um relação entre diferentes percepções e diferentes frequências de correntes elétricas senoidais.

PALAVRAS-CHAVE: nervo periférico, estimulação elétrica, correntes senoidais, sensações, percepções.

During the 80's a device for the determination of perception threshold to electric currents of senoidal shape in different frequencies became commercially available¹. An important aspect of the equipment was the ability to maintain the currents constant in face of the known variations of skin impedance^{1,2}. It was also hypothesized that perceptions to currents at 5 Hz would be related to activation of amyelinic fibers, at 250 Hz and 2000 Hz to thin and thick myelinated fibers respectively.

No questions seemed to be raised concerning the ability of the device in maintaining the delivery of

constant currents to the tissues, in face of impedance variations; however, the same cannot be said about the relationship between the different nerve fibers and the stimulation frequencies.

In a project directed to evaluate this last premise, we collected data that, in a preliminary analysis, offered useful information on clarifying this aspect.

METHOD

The project was developed at the Federal University of São Paulo (UNIFESP) Neurology Department, Clinical Neurophysiology laboratory, in collaboration with the City of São

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Paulo University - School of Physiotherapy. The project was approved by the UNIFESP ethic's committee.

All volunteers signed an informed consent. The data analyzed in this report refers to the first 100 subjects studied (29 males and 71 females, ages ranging from 18 to 60 years old).

In pilot experiments we selected words that were closely related to the sensations evoked in neurological examinations of the superficial sensibility using needles, forks, tweezers, cotton and ice cubes to the skin of the second digit.

Among these words we selected "picada, pontada, agulhada, queimação, aperto, pressão, movimento e vibração" (prick, pang, twinge, burn, squeeze, pressure, movement and vibration - free translation from Portuguese) as words linked to sensations mediated by activation of thin and thick nerve fibers. Lists with these eight words, appearing in random order, were elaborated.

In a sound attenuated and temperature controlled room (approx. 24°C), the volunteers seated in a comfortable armchair with the left hand resting on the chair's arm. The distal phalanx of the second finger was cleaned with an alcohol embedded gauze and then wiped with another dry gauze; stimulation gold electrodes were applied to medial and lateral surfaces of the phalanx with a thin amount of conductive gel.

Thresholds for currents at 5 Hz and 2000 Hz were then determined by the limits method followed by double forced choice, in protocols of 3s on and 2s off for the 5 Hz stimulus and 2s on and 2s off for the 2000Hz stimulus. The Neurometer® CPT (USA) was used.

Following these procedures the protocol of data collection started, which consisted, initially, of presenting a

burst of 5 Hz stimulation with 10s duration at threshold intensity and then asking the subject to choose 3 words from the presented list that were closer to the sensation felt during the stimulation. If the subject could not find appropriate words in the list, he was asked to choose randomly; then the same procedure was repeated, but the bursts were changed to 5 Hz at 1.5 times sensory threshold, to 2000 Hz at sensory threshold and finally to 2000 Hz at 1.5 times sensory threshold, in this order.

The obtained data were analyzed in the following way: the chosen words were given a score 1 and the others a score 0; the thin fiber score was defined as the mean of the scores of the prick, pang, twinge and burn words and the thick fiber score was defined similarly for the squeeze, pressure, movement and vibration words. The thick and thin fiber scores for the different stimulations were then compared through a Wilcoxon sign ranked test, with significance level set at 5%.

RESULTS

During the presentation of the different stimulus, subjects did not refer special difficulties to choose the words, except for the 5 Hz stimulation at sensory threshold stimulation where some of the volunteers were asked to choose the words randomly since they affirmed that they could not feel the stimulus.

Tables 1 and 2 show scores for thin and thick fibers.

The thin fiber scores obtained after threshold stimulation at 5 Hz and 2000 Hz showed a significant difference (5 Hz > 2000 Hz, $p=0,0186$, Fig 1), the same

Table 1. Summary statistics for thin fiber scores with different stimulations.

	5 Hz		2000 Hz	
x ST	1	1.5	1	1.5
mean	1.25	1.58	0.98	0.95
sd	1.00	0.96	0.97	0.86
median	1	2	1	1
range	0 - 3	0 - 3	0 - 3	0 - 3

x ST, times sensory threshold; sd, standard deviation.

Table 2. Summary statistics for thick fiber scores with different stimulations.

	5 Hz		2 kHz	
x ST	1	1.5	1	1.5
mean	1.75	1.41	2.02	2.05
sd	1.00	0.95	0.97	0.86
median	2	1	2	2
range	0 - 3	0 - 3	0 - 3	0 - 3

x ST, times sensory threshold; sd, standard deviation.

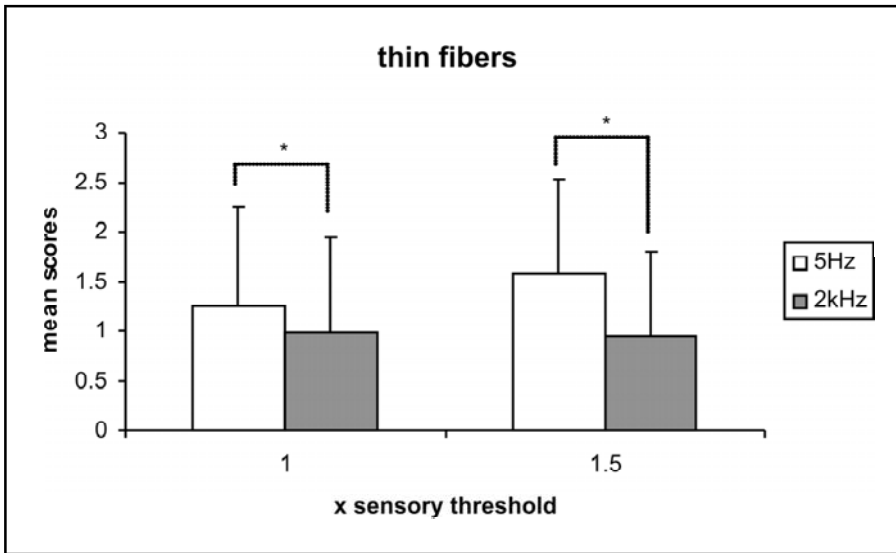


Fig 1. Mean and standard deviation of thin fiber scores for different frequencies of stimulation at sensory threshold (*5 Hz > 2 kHz, $p=0.0186$) and at 1.5 sensory threshold (*5 Hz > 2 kHz, $p<0.0001$).

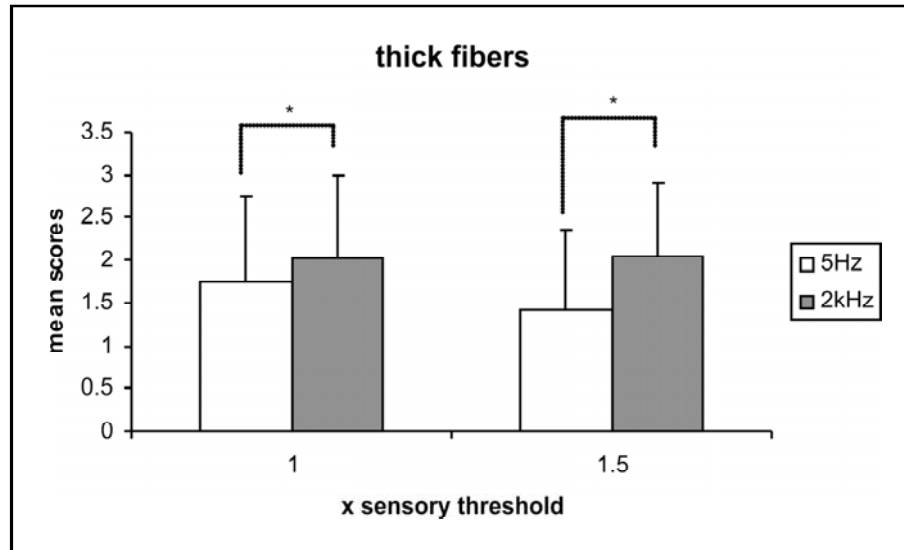


Fig 2. Mean and standard deviation of thick fiber scores for different frequencies of stimulation at sensory threshold. (*5 Hz < 2 kHz, $p=0.0186$) and at 1.5 sensory threshold. (*5 Hz < 2 kHz, $p<0.0001$).

occurring for the 1.5 sensory threshold stimulation, with the difference being even higher (5 Hz > 2000 Hz, $p<0.0001$, Fig 2).

For the thick fiber scores, significant differences were also detected but in reverse order (5 Hz < 2 kHz, $p=0.0186$) for sensory threshold stimulation (Fig 2), and for 1.5 sensory threshold (5 Hz < 2000 Hz, $p=0.0001$).

DISCUSSION

Our data clearly show that the sensations experienced by the subjects tested were described by different words depending on the stimulus applied. With 5 Hz currents, the sensations were those that we hypothesized to correlate with thin fibers, while at 2000 Hz the chosen words related with the thick

fiber system. These findings are in line with clinical studies which disclosed an association between the different currents and clinical tests of the different fiber systems as well with works relating sensations, electric senoidal stimulation and the effect of anesthetics in healthy volunteers²⁻⁶.

Other investigation, however, did not find correlation of the perception thresholds for low frequencies (250 Hz and specially 5 Hz) and clinical signs of involvement of the thin fiber system⁷. In this last case we believe that other factors should be taken into account, i.e. it is possible that when the threshold for this system is increased the amount of current needed for threshold determination could be determined by other fiber systems, a hypothesis that is under current investigation.

Unfortunately our findings are secondary to indirect evidence and the relationship of the chosen sensation and the peripheral fiber system involved can not be considered as definite, although very suggestive; it should be reminded that an important aspect of the sensory systems is the modal - or its so called labeled line - code character⁸. Our findings do not allow the inference that there is exclusive involvement of thin or thick fibers during the electrical stimulation.

In the present study we were able to show that it was possible to detect the association of different sensations with electric senoidal stimulation at different frequencies. These findings are in line with suggestions of this relationship based on free description of some experimental subjects reported "en passant" previously^{2,6,9}. It is worth mentioning that with some improvements this approach may lead to a measurement instrument that may allow quantification of these perceptions in similar contexts.

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