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Thermal and mechanical sensory and pain testing in healthy students

Tsagareli M. G.[1, 2], Gurtskaia G. P.[2], Mjavanadze D. S.[1], Sanadiradze G. S.[1], Kvachadze I. D.[1]

[1]Department of Physiology, Tbilisi State Medical University, Tbilisi, Georgia
[2]Laboratory of Pain and Analgesia, Beritashvili Center for Experimental Biomedicine, Tbilisi, Georgia

Summary. *Several lines of clinical and experimental investigations of a wide variety of painful conditions have suggested ethnic and gender differences in pain perception. In this study we report some findings of cold and heat sensations, thermal pain thresholds, mechanical pressure thresholds and pressure pain thresholds in healthy student volunteers. We did not find any statistical significant differences in thermal assessment. However, we revealed gender differences on the mechanical pressure sensation threshold and the mechanical pressure pain threshold. Our study confirmed significant variability across trials and individuals, which appeared greater at lower heat and mechanical pressure intensities. Additional studies and collecting more data are needed to determine ethnic and gender differences between groups.*

Key words: *gender, thermal assessment, mechanical pressure assessment, experimental pain.*

Introduction

Studies of pain mechanisms in normal, pain-free individuals provide a degree of experimental control not found in studies of clinical pain and open a window to the experience of pain that is not available in controlled studies with laboratory animals. These studies approach this goal by improving tools of pain measurement and increasing understanding of the physiological and psychological mechanisms that mediate and modulate perceived pain. Heat or cold is one of the most commonly used methods of evoking experimental pain sensations. For example, heat pain is commonly applied by contact and many modern thermodes can be used to apply contact heat. Mechanical pressure is the second classic method in which pain sensations are evoked by deformation of the skin via von Frey hairs and needles, by the application of gross pressure, by pinching, and others [10]. Pressure algometry is also a reliable technique for the assessment mechanical pain sensitivity in humans [2].

Numerous clinical and experimental studies, investigating a wide variety of painful conditions, have suggested ethnic and gender differences in pain perception [3, 4, 8, 14, 15]. At the same time, the experience of pain is characterized by immense inter-individual and group variability with one likely contributing factor being ethnicity. Synergistically, pain and ethnicity are multidimensional, malleable and shaped by culture. Although there is no consensus regarding the underlying mechanisms, ethnic group differences inevitably reflect a holistic influence of biological, social, cultural, and psychological factors; the bio-psycho-socio-cultural model of pain. To elucidate these mystifying, yet integrated mechanisms, researchers have undertaken both clinical and experimental pain studies to document the pain experience [3, 5, 6, 16].

Gender differences in pain have also been a topic of increased interest in recent years. Epidemiologic and clinical findings clearly demonstrate that women are at increased risk for chronic pain and some evidence suggests that women may experience more severe clinical pain [8]. Studies of experimentally induced pain have produced a very consistent pattern of results, with women exhibiting greater pain sensitivity, enhanced pain facilitation and reduced pain inhibition compared with men, though the magnitude of these sex differences varies across studies [9]. In addition, some evidence suggests gender differences in responses to pharmacological and non-pharmacological pain treatments, though the findings differ depending on the specific treatment and perhaps on characteristics of the pain [18].

We have recently started experimental sensory and pain investigations of thermal and mechanical assessments in healthy subjects. Here we report data of cold and heat sensations, thermal pain thresholds, and also mechanical pressure thresholds and pressure pain thresholds in healthy student volunteers. We found gender differences in the mechanical sensation and the pressure pain threshold but not in the thermal assessment. Preliminary data of this study has appeared as a short report in the local journal [13].

Subjects and methods

Participants

The experimental protocol was approved by the local Ethics Committee of Tbilisi State Medical University and study was conducted in accordance with the Declaration of Helsinki II. Written informed consent was obtained from all participants. Thirty-four undergraduate student volunteers (21 male and 13 female) with age 21.68 ± 2.045 (mean ± standard deviation) from Tbilisi State Medical University participated in the study. Students were recruited through classroom announcements and they were from India (11), Iraq (11) and Turkey (12). Exclusion criteria were: any acute or chronic pain condition, intake of any pain medication for less that 24 h before the investigation, pregnancy and breast feeding. Investigations took place in a quiet room, with the subject seated in an armchair, in two sessions (for the thermal and mechanical assessments separately) lasting approximately 1.5 hours. The height and weight of all subjects were taken before testing and the body mass index (BMI) was calculated.

Thermal tests

Contact thermal stimuli were delivered using a computer-controlled Medoc Pathway combined ATS/CHEPS system (Medoc Ltd, Ramat Yishai, Israel) which is a peltier element-based stimulator. Temperature levels were monitored by a contactor-contained thermistor and were returned to a preset baseline temperature (32 °C) by active cooling at a rate of 10 °C/second. The 30-mm^2 contact probe was applied to the left volar forearm and affixed in place with Velcro straps. Warmth and cold thresholds, heat and cold pain thresholds were assessed using an ascending or descending method of limits. From a baseline of 32 °C, contactor temperature increased or decreased at a rate of 0.5 °C/second until the subject responded by pressing a button. The cutoff temperature (to avoid tissue damage) for all trials was 55°C for heat stimuli and 0°C for cold stimuli. Interstimulus intervals between trials of 10 seconds were maintained between successive stimuli to avoid either sensitization or habituation of cutaneous receptors. The thermal stimuli were delivered in the following order: 4 trials of cold threshold (CTh) and 4 trials of warm threshold (WTh), and 3 trials of cold pain threshold (CPTh) and 3 trials of heat pain threshold (HPTh). These values of all trial for CTh, WTh, CPTh and HPTh were averaged, respectively. The position of the thermode was altered slightly between trials to avoid some effects of sensitization or habituation.

Mechanical tests

Mechanical pressure threshold and pain tolerance were obtained using computerized pressure algometer (AlgoMed, Medoc Ltd, Ramat Yishai, Israel) in Kilo Pascal (KPa). Pressure was applied to the left volar forearm. The threshold was determined when subjects first perceived the mechanical pressure stimulus (the pressure stimulus threshold, PSTh) and they responded by pressing a button. In the second session, the threshold to painful stimuli delivered when subjects no longer could sense the pain (the painful pressure threshold, PPTh) and they responded by pressure a button. Mechanical pressure threshold and pain threshold tests were repeated four times and the averaged means were recorded. An inter-stimulus interval between trials was of 5 seconds. Similar to thermal testing, the position of the pressure stimulation was altered slightly between trials to avoid some effects of sensitization or habituation.

Data analysis

Data were tested for normal distribution. The mean values for each of the responses for detection thermal and mechanical pressure sensation thresholds, thermal and mechanical pain thresholds were calculated. An analysis of variance (ANOVA) with post-hock Tukey *t*-test was used to analyze within and between subjects groups effects of temperature and pressure. Data are presented as means ± standard deviations. Differences between means were acknowledged as statistically significant if $p < 0.05$. All analyses were conducted using InStat 3.05 (GraphPad Software, USA).

Results

Cold and warm detection thresholds and cold and heat pain thresholds data are presented in the Fig. 1

There are significant differences between the cold sensation threshold and the cold pain threshold (light and dark blue columns, t = 17.637, P < 0.001) and between the warm sensation threshold and the heat pain threshold (orange and red columns, t = 11.547, P < 0.001) that is correct for these indices (Fig. 1*A*). At the same time we did not find gender differences, neither for the thermal sensation threshold nor for the thermal pain threshold (Fig. 1*B*).

Mechanical pressure thresholds and pressure pain thresholds data are presented in the Fig. 2*A*.

There is a statistical difference between the pressure threshold and pressure pain threshold groups. The two-tailed test shows significant value, t = 6.196, P < 0.001, df = 66, n = 34. Here we found gender difference values either for the pressure stimulus threshold (t = 4.612, P < 0.01) or for the painful pressure threshold (t = 6.502, P < 0.001) (Fig. 2*B*).

Discussion

Our study confirmed significant variability across trials and individuals, which appeared greater at lower heat and mechanical pressure intensities. These data did not allow us

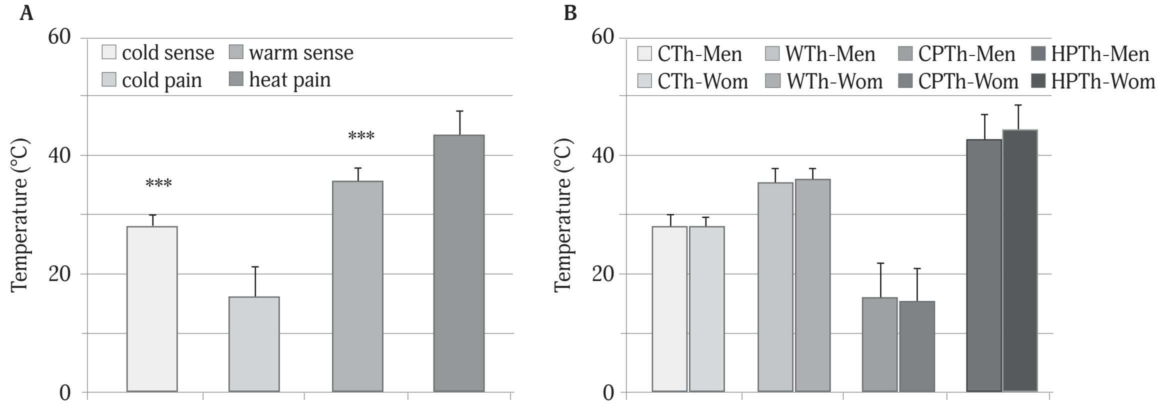

Fig. 1. The thresholds of thermal (cold and warm) sensations and of cold and heat pain in healthy volunteer students (A), the number of participants (n = 34). The gender differences are not revealed in these experiments (B). The number of participants, male (n = 21), female (n = 13). Abbreviations: CTh – cold threshold; CPTh – cold pain threshold; HPTh – heat pain threshold; WTh – warm threshold

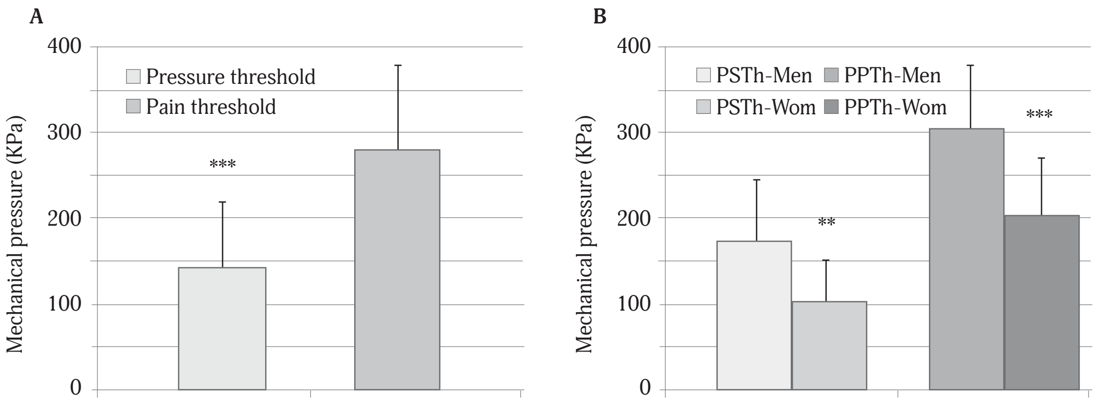

Fig. 2. The mechanical pressure thresholds and pressure pain thresholds (A), and gender differences between men and women groups (B). Note the significant gender differences for PSTh ($P < 0.01$) and PPTh ($P < 0.001$) groups, respectively. Abbreviations: PPTh – painful pressure threshold; PSTh – pressure stimulus threshold

to reveal the gender differences between male and female groups in assessment of thermal stimuli. However, we clearly showed gender differences in assessment both the mechanical pressure threshold and the pressure pain threshold.

Of the different types of experimental pain, pressure pain in particular seems to be sensitive to sex differences. In some meta-analysis of gender differences in pain report, pressure pain had one of the highest effect sizes [1, 17].

Further complicating research on sex differences in pain is the nature of pain report, which combines both a sensory response to a noxious stimuli and a response bias, the willingness to report that response. Thus there is difficulty in ascertaining the extent to which these differences are primarily due to physiological (sensory) or subjective effects. This distinction is important because the treatments may vary if the sex differences are caused by sensory (i.e., pain pathways), as opposed to non-sensory variables (i.e., subjective ratings influenced by social expectancies) [12].

Studies have shown that women generally report both a greater number of painful symptoms and greater severity of pain in the clinical setting [3, 9]. It is widely believed that social factors contribute to the lower pain reports by men, and even contribute to the lower likelihood of men seeking medical attention [8]. When examined via experimental pain procedures, social factors, such as the sex of the experimenter, are known to affect the results, with men reporting less pain to female experimenters compared to male experimenters [4, 5, 15, 16]. Other non-sensory factors that have been shown to affect individual differences in pain report are the presence of anxiety [11] and pain catastrophizing (the belief that pain will be unbearable or extremely awful) [7]. Since these factors have been shown to be more prevalent in women, they could all have an impact upon sex differences in pain report [12].

In summary, while we have shown gender differences in mechanical pressure assessment, additional studies and a collection of more data are needed to determine gender differences between male and female groups in assessment temperature intensities in healthy human subjects.

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Тестирование температурной и механической чувствительности и боли у здоровых студентов

Цагарели М. Г.[1,2], Гурцкая Г. П.[2], Мжаванадзе Д. Ш.[1], Санадирадзе Г. С.[1], Квачадзе И. Д.[1]

[1]Тбилисский государственный медицинский университет, г. Тбилиси, Грузия;
[2]Научный центр экспериментальной биомедицины им. И. С. Бериташвили, г. Тбилиси, Грузия

Резюме. *Ряд исследований указывают на этническое и гендерное различие при восприятии боли. В данной работе представлены результаты исследования порогов термо- (холодовых и тепловых) механических ощущений, а также порогов температурной и механической боли у здоровых студентов-добровольцев. Статистически значимые различия по гендеру в оценке температуры и термальной боли не обнаружены. Установлены гендерные различия показателей механического порога ощущения и порога механического болевого давления. Данные подтвердают значительную вариабельность между исследуемыми и физическими лицами, что в наибольшей степени проявляется при низкой температуре и низких значениях интенсивности механического давления. Необходимы дальнейшие исследования для выявления этнических и гендерных различий между группами.*

Ключевые слова: *гендер, температурная чувствительность, оценка механического давления, экспериментальная боль.*

Тестування температурної і механічної чутливості і болю у здорових студентів

Цагарелі М. Г.[1,2], Гурцкая Г. П.[2], Мжаванадзе Д. Ш.[1], Санадірадзе Г. С.[1], Квачадзе І. Д.[1]

[1]Тбіліський державний медичний університет, м. Тбілісі, Грузія
[2]Науковий центр експериментальної біомедицини ім. І. С. Берідашвілі, м. Тбілісі, Грузія

Резюме. *Ряд досліджень вказують на етнічну та гендерну відмінність при сприйнятті болю. У даній роботі представлено результати дослідження порогів термо- (холодових і теплових) механічних відчуттів, а також порогів температурного і механічного болю у здорових студентів-добровольців. Статистично значущих гендерних відмінностей в оцінці температури і термального болю не виявлено. Встановлено гендерні відмінності показників механічного порогу відчуття і порогу механічного больового тиску. Дані підтверджують значну варіабельність між пробами і фізичними особами, що найбільшою мірою проявляється при низькій температурі та низьких значеннях інтенсивності механічного тиску. Необхідні подальші дослідження для виявлення етнічних і гендерних відмінностей між групами.*

Ключові слова: *гендер, температурна чутливість, оцінка механічного тиску, експериментальний біль.*