

Influence of gender on cold-induced pain

Influência do gênero na dor induzida pelo frio

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ABSTRACT

BACKGROUND AND OBJECTIVES: Ice as treatment modality is indiscriminately used without considering possible differences between males and females in terms of threshold and tolerance to cold-induced pain during cryotherapy. Pain referred by patients during cryotherapy may be a defense mechanism against possible tissue injury caused by severe vasoconstriction. This study aimed at observing the difference in threshold, tolerance and perception of cold-induced pain between individuals of both genders.

METHODS: Participated in the study 117 young volunteers of both genders, who were submitted to cold-induced pain protocol simulating a situation of immersion cryotherapy.

RESULTS: The study has shown significant differences between genders in pain threshold and tolerance. Pain perception was not significantly different between groups.

CONCLUSION: Males had higher threshold and tolerance to cold-induced pain as compared to females. According to results, one may infer that differences in responses between genders should be respected, since indiscriminate standardization of cryotherapy application time might result in tissue injury.

Keywords: Adverse effects, Cryotherapy, Gender, Pain measurement, Pain threshold.

RESUMO

JUSTIFICATIVA E OBJETIVOS: O uso do gelo como forma de tratamento é utilizado indiscriminadamente sem considerar as prováveis diferenças, entre os pacientes do gênero masculino e feminino, no limiar e na tolerância à dor induzida pelo frio durante a aplicação da crioterapia. A dor referida pelo paciente durante a aplicação da crioterapia pode atuar como um mecanismo de defesa frente a uma possível agressão tecidual ocasionada por uma vasoconstrição acentuada. O objetivo deste estudo foi veri-

ficar a diferença no limiar, tolerância e percepção da dor induzida pelo frio entre indivíduos de ambos os gêneros.

MÉTODOS: Participaram do estudo 117 voluntários jovens, de ambos os gêneros, que foram submetidos a um protocolo de indução de dor pelo frio simulando uma situação de crioterapia por imersão.

RESULTADOS: A análise dos grupos estudados revelou diferenças significativas entre os gêneros para o limiar e a tolerância a dor. A percepção da dor não apresentou diferença significativa entre os gêneros.

CONCLUSÃO: Indivíduos do gênero masculino apresentaram maior limiar e tolerância à dor, induzida pelo frio, do que os do gênero feminino. De acordo com os resultados, pode-se inferir que as diferenças nas repostas encontradas entre os gêneros devem ser respeitadas, já que uma padronização indiscriminada no tempo de aplicação da crioterapia pode acarretar em lesões teciduais.

Descritores: Crioterapia, Efeitos adversos, Gênero, Limiar da dor, Mensuração da dor.

INTRODUCTION

Cryotherapy is a widely used physiotherapeutic resource for initial acute locomotor system injuries. There are evidences that it induces analgesia and promotes structural and functional recovery of injured tissues¹. This lowering temperature method gradually decreases sensory nervous impulses transmission by decreasing nervous fibers conduction velocity, increasing pain threshold. During cryotherapy, there are physiological responses such as decreased cell metabolism, edema and spasm, among other responses which depend on injury site and the way it is used¹⁻⁴.

Cold has been useful to rehabilitate and prevent sports injuries. Among its usage methods, there are ice packs, immersion in cold liquid medium or cold massage²⁻⁵. One should notice that when inadequately used without the understanding of neurophysiologic, muscular and vascular phenomena, cryotherapy may bring undesirable consequences, directly interfering with the quality of the treatment^{3,4}. Application time is another mostly neglected factor, being necessary an adequate time to obtain the desirable effects; however, this fact is not observed in the clinical practice, often with an insufficient or too long time. This might lead to the worsening of initial presentation².

Cryotherapy is indiscriminately used without considering differences in pain between males and females⁶⁻¹⁰. Pain referred by patients during cryotherapy may act as a defense mecha-

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nism against possible tissue injury caused by marked vasoconstriction¹¹. This is very relevant to encourage other studies in this area and, as a consequence, better understanding of professionals about the use of ice.

So, this study aimed at checking the difference in cold-induced pain threshold, tolerance and perception between individuals of both genders.

METHODS

Participated in the study 130 healthy young adults of both genders, from the students' population of the Universidade Federal do Piauí (UFPI), aged between 18 and 25 years. Participants were randomly divided in two groups, separated according to gender.

Sample was of convenience and young and healthy individuals agreeing with the study protocol and qualified and willing to participate were included. Selected individuals were informed about the experimental procedure (verbally and in writing) being explained risks and contraindications of all procedures. All participants have signed the Free and Informed Consent Term (FICT).

Exclusion criteria were individuals with peripheral vascular disorders, hypertension and hypotension, peripheral neuropathies or changes in sensitivity, recent trauma and dysmenorrhea.

Individuals who supported more than four minutes with the non-dominant hand immersed in cold water were also excluded, because this shows specific conditions of tolerance to cold which would make the sample heterogeneous and would impair the analysis between groups.

Visual analog scale (VAS) and a digital Kenko stopwatch model KK-2080-Chine, hydrogel, micropore, water heater, two mercury thermometers INCOTERM L-212/04, two containers (one plastic and one metallic), ice cubes and filtered water were used.

Experiments were carried out in the Physiotherapy Laboratory, UFPI, Ministro Reis Velloso campus, city of Parnaíba, PI. Used protocol was a modification of a model already used in other studies. The experiment was divided in three stages. Throughout the procedure, individuals have remained comfortably sitting, with the non-dominant arm supported along the body and, when asked, would immerse the hand of this limb in one of two containers located close to the body.

Stage 1: standardization of skin temperature – before nociceptive induction, non-dominant hand was immersed in a container with warm water (37°C) for five minutes to eliminate any variability in initial skin surface temperature.

Stage 2: pain induction – non-dominant upper limb extremity was then immersed (until the first crease of the wrist) in a metal container with water and ice maintained at 0°C by a manual feedback system. It should be stressed that hand was in direct contact only with the cooled water which was separated from the ice to prevent real pain sensation distortion.

Stage 3: determination of analyzed variables: individuals have remained with the non-dominant hand immersed in

water and when the first sign of pain was reported, this was recorded as their pain threshold; after this, they remained until the state of maximum pain perception recorded as tolerance to pain; at this moment, individuals would immediately remove the hand and VAS was applied to quantify pain perception.

Statistical analysis

Unpaired Student *t* test was used to identify differences between experimental groups in each analyzed variable. Significance level was 0.05. All data were analyzed with the program Graph Pad Prism (version five) for Windows.

The study was approved by the Research Ethics Committee, UFPI, process 0381.0.045.000-10.

RESULTS

Participated in the study 130 individuals, however 13 were excluded for going beyond the maximum limit of remaining with the non-dominant limb immersed during the application of the pain protocol. So, 117 individuals have finished the study, being 55 males and 62 females. Anthropometric data of participants are shown in table 1.

Table 1. Anthropometric data

Gender	Age (years)	Weight (kg)	Height (m)	BMI (kg/m ²)
Male	21.4±1.9	70.1±12.9	1.70±0.1	23.4±3.8
Female	21.2±1.8	56.6±9.8	1.60±0.1	21.9±3.7

BMI = body mass index.

The analysis of studied groups has shown significant differences between genders for pain threshold and tolerance. Males have taken longer to perceive pain sensation (threshold $p < 0.05$) and have supported pain induction for a longer period as compared to females (tolerance $p < 0.05$). Pain perception was not significantly different between genders (Table 2).

Table 2. Analysis of cold-induced pain

	Male	Female	p value
Pain threshold (seconds)	25.7±1.6	17.2±1.2	<0.0001*
Pain tolerance (seconds)	76.2±5.9	50.9±3.6	0.0003*
Pain perception (VAS)	7.8±0.1	8.1±0.1	0.152

VAS = visual analog scale; *Statistically significant difference.

DISCUSSION

Different studies have investigated differences in pain between genders using experimental protocols with a large variety of noxious stimuli^{8,9}. These authors have shown that females are more sensitive to pain as compared to males, be it mechanical, ischemic or cold-induced. Our study has shown significant differences between genders for pain threshold and tolerance, which is in line with other authors^{10,12,13}. Factors contributing for these differences between genders with

regard to pain include physiological, socio-cultural and psychological variables¹⁰⁻¹⁵.

Males are more motivated to support and repress pain expressions due to socio-cultural and psychological influences of the male sexual role, while the female sexual role encourages pain expression and produces lower motivation to support pain^{9,15}. In the attempt to minimize this influence, before procedures all participants were oriented not to follow this trend and were informed about the importance of accurately reporting their sensation.

Data were collected by the same evaluators for all individuals aiming at obtaining homogeneous evaluations. Even with sexual differences in pain neurophysiology, there were no significant differences in pain perception. This variable corresponds to pain intensity experienced by each component of the sample population. VAS was used as evaluation method, which is a widely used evaluation tool in the scientific and clinic universe^{16,17}.

Females participating in the study were not asked about their menstrual cycle and this is a limitation of this study for not considering pain modulation under endocrine influence¹⁸. Stening et al.¹⁸ have investigated the hormonal influence on pain sensation in different menstrual cycle phases of healthy females by means of a cold-induced pain protocol, evaluating pain threshold, tolerance and intensity. Results have shown that pain sensation is increased during the luteal phase and that high serum progesterone and estradiol concentrations correspond to lower values for pain intensity. Cryotherapy by immersion used in this study has identified differences in sensitivity and tolerance to cold between males and females. This observation is relevant, since prescription of cryotherapy application time is indiscriminately used without considering possible differences between males and females in cold-induced pain threshold and tolerance. There are different studies in the literature involving different therapeutic modalities such as the use of ice and establishing the same application time for individuals of both genders⁶⁻⁸.

Sudden temperature decrease stimulates peripheral nervous system action by means of free skin nervous terminations, to regulate temperature by sending afferent signals to central nervous system. When there is considerable temperature decrease, receptors are activated inducing reflex vasoconstriction^{1,19}. Nervous fibers which might be stimulated by cryotherapy are myelinated A delta, related to pain sensation, and non-myelinated C, responsible for nociceptive stimuli perception²⁰. Controlled temperature between 0°C and 2°C was able to induce pain in all participants of the study.

Although with few possibilities, inadequate use of ice as therapy for some individuals may lead to nervous structures injury resulting in incapacities to the individual submitted to the therapy. Although uncommon, Bassett et al.¹¹ have presented six cases of peripheral nerve injury induced by cryotherapy in athletes with treatment duration varying from 15 to 60 minutes. They recommend limited cryotherapeutic intervention, of approximately 20 minutes, in areas

where anatomically there are peripheral nerves more superficial to skin, especially when there is compression with the use of cold or in patients more sensitive to marked changes in skin temperature.

Pain during exposure to cold may be related to injury to blood vessels or to peripheral nervous structures responsible for thermoregulation²¹. Peripheral nerves injury leads to the release of cell mediators acting on nervous fibers and changing the number and location of ion channels. These changes tend to help the inflow of action potential-generating ions and, as a consequence, to decrease nociceptors depolarization threshold. This enables stimuli, which do not activate nociceptors, to reach pain threshold²². Skin thermal regulation depends on blood vessels density. Klein-Weigel et al.²³ have observed that individuals intolerant to cold have significant decrease in vessels, impairing nervous structures irrigation and leading to cold intolerance symptoms.

The relevance of considering cold application time is related to loss of tissue sensitivity, resulting from progressive decrease in nervous impulse transmission velocity and increase in neuronal excitability threshold. These circumstances decrease tissue defense strategies by inefficiency of sensory responses increasing the risk for skin injuries^{24,25}. Gregório et al.²⁶ have investigated this subject and have shown that there are significant changes in tactile sensitivity regardless of intervention time. However, the longer the time of using cold, the more expressive is this neuronal afferent inefficiency. As from these considerations, results of this study do not allow the establishment of treatment duration based on gender, but highlight the individuality of the intervention and raise questions on higher female sensitivity to cold-induced injuries.

Based on our results, it is suggested that females, for having lower pain threshold and tolerance values, are less resistant to peripheral nerves injury induced by cryotherapy and may present, in addition to other factors, different characteristics with regard to nociceptive stimuli activation or peripheral blood vessels density. This sensory and vascular change tends to impair skin temperature regulation, to worsen vasoconstriction effects and, as a consequence, to pose further risks to tissue aggression during prolonged cryotherapy time. Further studies are needed to confirm whether females are more prone to this type of injury and whether cold-induced pain threshold and tolerance characterizes individuals at higher risk of suffering tissue injury during a prolonged time of therapy with ice.

CONCLUSION

Males have higher cold-induced pain threshold and tolerance as compared to females. According to our study results, one may infer that differences in responses between genders should be respected, since the indiscriminate standardization of cryotherapy application time could lead to tissue injuries.

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