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RESEARCH ARTICLE

Response of respiratory system to noxious stimuli and correlation between respiratory parameters and pain sensitivity parameters

Samir J Mendpara, Bhakti P Gadhavi

Department of Physiology, Shantabaa Medical College, Amreli, Gujarat, India

Correspondence to: Bhakti P Gadhavi, E-mail: bhakti.gadhavi85@gmail.com

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ABSTRACT

Background: Pain is multidimensional feeling that varies among individual patients. Pain is the main reason for visiting hospital. Pain is necessary for healthy survival of animal. People with lose of pain sensitivity have reduced life expectancy. **Aims and Objectives:** The objective of our study is to find any correlation between two respiratory parameters and three pain parameters among medical students. Second is to determine gender difference between pain sensitivity parameters and respiratory system response to experimental pain. **Materials and Methods:** In this study, a total of 100 medical students (male 57 and female 43) were participated. The cold pressor test was used to give pain as noxious stimuli. Respiratory parameters (respiratory rate and vital capacity) and pain sensitivity parameters (pain rating using visual analog scale, pain tolerance, and pain threshold) were measured. **Results:** Respiratory reactivity in response to experimental pain applied by cold pressor test in both sexes was not found significant in this study. Second, we found no remarkable correlation between respiratory system and pain sensitivity in both sexes. **Conclusion:** Respiratory system stimulates in response to pain because of both sympathetic and parasympathetic neural activity. There is no correlation between respiratory and pain sensitivity.

KEY WORDS: Physiology of Pain; Cold Pressor Test; Response to Noxious Stimuli

INTRODUCTION

Pain word was used in English in 1297. It arises from Latin word poena which means punishment or penalty.[1] In 1931, French doctor Albert Schweitzer said, "Pain is more terrible lord of mankind than even death itself."

Main symptom of 50% patients visiting emergency department is pain. In the USA alone, 100 million people suffer from pain in 1 year.

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Pain is body's protective mechanism; it warns us that we should visit doctor. Without sensation of pain, healthy survival of animal is not possible. Body has reflex to protect the affected part from noxious stimulus. Insensitivity to pain reduces life expectancy. On the other hand, pain steals our physical and mental well-being and reduces our productivity.

Pain is now universal disorder. It affects not only the patient but also family and health-care providers to support his physical and emotional condition and that is the reason why pain is a topic of widespread scientific interest. Many scientists have studied pain and contributed wide range of literature.

Pain is part of many diseases. If doctor knows its origin, severity, progress, quality, aggravating factors, and relieving factors, it will help to diagnose the disease accurately.

There are different pain receptors in our body and they respond differently so there are a lots of variation in response to pain stimulus. Lots of study have done to investigate differences in experimental pain perception using different noxious stimuli.[2] In this study, we tried to evaluate variation in response of respiratory system to experimental pain using cold pressor test.[1] We also tried to evaluate any relation between respiratory system and pain sensitivity.

MATERIALS AND METHODS

We have obtained approval from the Sumandeep Vidyapeeth Institutional Ethics Committee for this study. We have selected 100 volunteer students of Smt. B. K. Shah (SBKS) Medical College as participant for this study. Out of 100, 57 were male students and 43 were female students. This study was organized in physiology laboratory of SBKS Medical College. We asked each volunteer to write informed consent as per ethical committee policy. Before procedure, each participant was asked for recent and past history. They were examined for any pathological conditions. Person with respiratory disease or taking analgesic for relieving pain was excluded from this study.

Procedure of this study was interventional with cold pressor test. Cold pressor test is simple, inexpensive, non-invasive, and reliable test to measure autonomic status of person.[3]

Data were collected before and immediately after cold pressor test. Participant was asked to relax. Participant s were instructed about procedure and painful nature of the test, but at the same time, they were also reassured that it would not be harmful.

After rest for around 15 min, resting respiratory rate was measured and recorded as rate per minute. Vital capacity was measured in ml. For that, student spirometer was used. For vital capacity, participants were explained to do maximal expiration after maximal inspiration. Participants were asked to exhale forcefully to the maximum into the mouthpiece connected to rubber tube of student's spirometer after taking a deep inspiration.

To perform cold pressor test, ice cold water with 5°C temperature was taken in laboratory water bath. Laboratory thermometer was placed in water bath to record temperature of water. We added cold water to the container to maintain cold temperature, if it was required.[4]

Participant was instructed to keep his/her dominant hand into laboratory water bath filled with ice water. They were told to keep palm down, up to 5 cm above wrist level. When participant put hand in water, two stopwatches were started. Participant was asked to decide severity of pain during procedure. They were instructed to rate pain on scale of 0–10 (visual analog scale). They were explained that 0 means no pain at all and 10 means worst unbearable pain.[5] When participant felt pain 1st time, one stopwatch was stopped. This gave pain threshold (stating of feeling pain). When participant could not bear pain anymore and removed his/her hand, the second stopwatch was stopped. This gave pain tolerance. Immediately, after this procedure, we measured respiratory rate per minute and vital capacity in ml.

Statistical Analysis

We collected data in excel file. We have used student *t*-test and correlation coefficient (zero order) for statistical analysis of data.

RESULTS

Table 1 shows response of respiratory system to experimental pain in male ($n = 57$) and female participants ($n = 43$). Table 1 shows that in this study, respiratory parameters such as respiratory rate and vital capacity were found to be highly significantly increased in both sexes. Table 2 shows that in this study, we have found no significant variation in respiratory reactivity in response to pain exerted by cold pressor test in both sexes. Second, we have found pain threshold to be highly significantly more in male compared to female ($t = 3.452$, $P = 0.0007$), pain tolerance to be highly significantly more in male compared to female ($t = 8.380$, $P < 0.0001$) while pain rating to be highly significantly more in female compared to male ($t = 5.397$, $P < 0.0001$) as shown in Table 2. We have found no any significant correlation between respiratory parameters and pain sensitivity parameters in both sexes as shown in Table 3.

DISCUSSION

In this study, respiratory parameters such as respiratory rate and vital capacity were found to be significantly increased

Table 1: Response to experimental pain in male and female participants

Gender	Parameters	Before CPT	After CPT	*t* value	*P* value
Male	Respiratory rate (per minute)	13±1.56	14.15±1.37	7.00	*P*<0.0001**
	Vital capacity (ml)	3734±339.7	3866±300.24	7.27	*P*<0.0001**
Female	Respiratory rate (per minute)	12.82±1.17	14.08±1.69	6.94	*P*<0.0001**
	Vital capacity (ml)	3145.54±416.78	3257.43±384.28	6.53	*P*<0.0001**

Values are shown in mean±standard deviation, Statistical test: paired *t*-test; *P<0.05 significant, **P<0.01 highly significant

Table 2: Sex-related variation in baseline parameters and in response to experimental pain (*n*=100, male 57 and female 43)

Parameters	Male (*n*=57)	Female (*n*=43)	*t* value	*P* value
Respiratory rate reactivity	1.15±1.64	1.22±1.76	0.291	0.771
Vital capacity reactivity	132±181.4	111±169.9	0.844	0.399
Pain threshold (sec)	22.57±6.81	19.21±6.95	3.452	0.0007**
Pain tolerance (sec)	77.68±18.62	57.92±14.47	8.380	*P*<0.0001**
Pain rating VAS (0–10)	5.45±1.18	6.34±1.16	5.397	*P*<0.0001**

Values are shown in mean±standard deviation, Statistical test: unpaired *t*-test; **P*≤0.05 significant, ***P*<0.01 highly significant, VAS: Visual analog scale

Table 3: Correlation between respiratory parameters and pain sensitivity parameters

Gender	Parameters	Pain threshold	Pain tolerance	Pain rating
Male	Respiratory rate	*r*=−0.0114, *P*=0.9102	*r*=0.0721, *P*=0.4757	*r*=−0.1270, *P*=0.2081
	Vital capacity	*r*=−0.0778, *P*=0.4413	*r*=−0.0974, *P*=0.3348	*r*=−0.0538, *P*=0.5944
Female	Respiratory rate	*r*=0.168, *P*=0.0948	*r*=0.062, *P*=0.5381	*r*=0.021, *P*=0.8380
	Vital capacity	*r*=0.108, *P*=0.2827	*r*=−0.006, *P*=0.9538	*r*=−0.075, *P*=0.4607

Correlation coefficient, Values are shown as *r* value and *P* value. **P*≤0.05 significant, ***P*<0.01 highly significant

after cold pressor test in both sexes. Significant variation was found in pain sensitivity parameters between both sexes. The present study also shows that men have higher pain thresholds and pain tolerances while pain ratings are low compared to women. No significant variation was found in respiratory reactivity between both sexes. When correlation was measured between respiratory parameters and pain sensitivity parameters, no any significant correlation was found in both sexes.

Filligrim and Maixner have studied sex differences in response to noxious stimuli, they found that female had more sensitivity to noxious stimuli in their study.[6] Berkley found in his study that masculine sex role plays an important part in male participant when we are studying about pain tolerance and expressions of pain.[7] Lewis *et al*. found that stimulatory effect on respiratory system during cold pressor test was mainly because of sympathoadrenal discharge which increased circulating catecholamine levels.[8]

Study of pain sensitivity parameters, sex-related variation, and their correlation with respiratory parameters may be clinically helpful in better understanding of some of the pathological conditions, and more efficient analgesic medicine could be developed that is the strength of this study. We have not taken into consideration some of the factors which might affect sex-related difference in pain response. These factors are menstrual cycle phases, gender role, and body mass index. This is limitation part of the study.

CONCLUSION

In this study, we concluded that when extreme cold produced pain during the procedure, respiratory system was stimulated and both rate and depth of respiration increased due to increased circulating catecholamine levels. We also tried to see correlation between respiratory and pain sensitivity, but no significant correlation was found.

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