Original Article

DOI: 10.7860/JCDR/2012/4800.2647

The Role of Mental Distraction on the Pain Response in Healthy Young Indian Adults

Physiology Section

MANOJ KUMAR, JAYBALLABH KUMAR, INDU SAXENA

ABSTRACT

Background and Objectives: The pain sensitivity of a person depends on the type of pain, his/her genetics, racial and cultural factors. Its dependence on the gender is debatable. The significance of the psychological or the behavioural intervention in pain management is gaining importance, along with a reduction in the doses of the analgesics. We wished to investigate **(a)** whether Indian subjects showed a pain response which was similar to that which was reported for American subjects, **(b)** whether sex-related differences in the pain response were present in the Indian population, and **(c)** which method of mental distraction (from a choice of the presence of a male/female attendant, preferred music, and solving simple arithmetic problems) was best suited for the Indian subjects.

Methods: The cold pressor task was performed on a group of 80 subjects (38 females who were in the proliferative or the secretory phase of the menstrual cycle) under the conditions which have been mentioned above, as well as in the absence of mental distractants.

Results: The female subjects endured pain for a longer duration while they listened to the music of their choice; the male subjects endured pain longer while they were in conversation with the female attendants.

Interpretation and Conclusions: A comparison with the reported data showed the Indian males to be more pain-sensitive than the American males. Sex related differences in the pain sensitivity were absent in the Northern Indian subjects. Preferred music was the most effective mental distractant for females, while a conversation with the female attendants was the most effective distractant for the male subjects.

Key Words: Cold pressor task, Mental distraction, Pain response, Pain sensitivity

INTRODUCTION

Pain, the most common symptom that brings a patient to a physician, is an indication of disease and tissue damage. The magnitude of the pain response to a stimulus varies from person to person, depending on the biology of the noxious event and on psychological, and social factors. A suggestion of relief can have a significant analgesic effect [1-3], while the pain expectation acts as a potent modulator in both humans as well as in animals [4,5]. Gender differences in the pain perception have been observed, with women exhibiting lower pain tolerance than men [6-8]. Kumar et al.,[9] have shown variations in the pain perception in menstruating females across the different phases of the menstrual cycle. Pain sensitivity has also been related to the resting blood pressure of the individual, with the hypotensive subjects showing a greater pain sensitivity [10]. However, Pondevigue et al.,[11] have shown that the relationship between sex, blood pressure, and the pain intensity which was felt by the subjects were stimulus dependent. Genetic [12], racial [13], cultural [14] and socioeconomic factors [15] have also been shown to affect the pain response.

Besides using analgesics, physicians are investigating the role of psychological or behavioural interventions in pain management. Behavioural techniques that prepare the patients for invasive procedures require a prior practice that may not always be possible. An acute elicitation of the relaxation response [16] and the use of distraction techniques [17-19] have been demonstrated to be effective in the sense that patients are able to tolerate more pain with reduced amounts of analgesics, or even without analgesics. The effect of mental distraction on the pain response has also been investigated by subjecting volunteers to experimental pain [20-22].

In this study, the experimental pain was produced by the cold pressor task. CPT has been successfully used to produce experimental pain in both adults [23] and in children [24]. Mental distraction was produced by (a) conversations with male/female attendants on non-procedural topics (b) listening to the music of choice and (c) mentally solving elementary mathematical problems which were taken from the 2nd standard mathematics book.

MATERIALS AND METHODS

This experimental study was carried out on young, healthy, adult volunteers and it was conducted over a period of eighteen months. The study protocol was approved by the institutional ethics committee at the SRMS-Institute of Medical Sciences, Bareilly and at Teerthanker Mahaveer Medical College and Research Centre, Moradabad (Uttar Pradesh, India), where the study was performed. A written, informed consent was obtained from all the volunteers before the beginning of the study.

The subjects who reported a history of bone injury in the non-dominant hand and those who took analgesics were excluded from the study. Women have been reported to show increased pain sensitivity during ovulation [9,23]. This study was therefore conducted on female subjects who reported regular menstrual

cycles of 28-30 days, who were in the proliferative or the secretory phase of the menstrual cycle. Only the subjects with sedentary habits were selected, who had not undergone any kind of sports training. A total of 80 students (38 females) of the age group of 17-27 years participated in the study.

The Method of Performing the Cold Pressor Task: The method of performing the Cold Pressor Task (CPT) was explained to each participant before the beginning of the experiment. The subject was asked to sit in a comfortable position in a quiet room which was maintained at 24-26°C. She/he was asked to immerse the non-dominant hand, palm down, up to 5cm above the wrist, into a circulating water-bath with a pump and a thermometer (which was designed locally). The temperature of the water-bath was maintained at 0-1°C by using crushed ice. The time of the immersion, the pain threshold (the time duration after which the subject reported a feeling of pain), and pain tolerance (the time duration for which the subject endured the pain) were recorded in seconds by using a stop-watch. A visual analog scale [24] was used to obtain the pain rating from each subject, immediately after the test. The blood pressure of each subject was recorded before and immediately after performing the CPT.

The Conditions for the Cold Pressor Task: Five separate episodes of CPT were performed on each volunteer under the following conditions:

1. Control (absence of mental distraction): The experimenter avoided eye contact with the subject. Silence was maintained throughout the experiment, except for the subject stating "Pain", to indicate the pain threshold, and the experimenter asking the subject to rate her/his pain on a Visual Analog Scale (VAS) at the end of the experiment. The experimenter noted the time of withdrawal of the hand from the water-bath to determine the pain tolerance, without the subject saying anything.

2. The performance of CPT in the presence of a male attendant who was involved in conversation with the subject. The conversation was not related to the experiment or the pain.

3. The performance of CPT in the presence of a female attendant. The other conditions remained the same as in 2 .

4. The performance of CPT while the subject listened to music of her/his choice at the desired volume level through headphones.

5. The performance of CPT while the subject mentally solved simple arithmetic problems (multiplication and division) which were taken from a second standard mathematics textbook. The problems were displayed before the subject and she/he had to speak out the answers one by one, which were marked by a technician.

The systolic and the diastolic blood pressure and the heart rate were recorded before and immediately after performing each episode of CPT. For convenience, only the increases in the pulse (dPulse), the Systolic Blood Pressure (dSBP), and the Diastolic Blood Pressure (dDBP) which were obtained upon performing the CPT, have been presented. The pain threshold, pain tolerance, and the pain rating were obtained for each episode with each subject.

Although habituation to the pain does not easily occur, an interval of at least 2 weeks was allowed between 2 episodes of CPT with the same subject as 'wash-out' time, so that the volunteer did not become habituated to the pain which was experienced during the procedure.

Since the t-test has been reported to be a reliable data analysis method in VAS measurements [25], it was used to analyze the variations which were obtained in the different episodes of CPT. The data which were obtained in each mental distraction condition were independently compared with the data which were obtained under the control conditions. A P-value of <0.05 was considered to be significant.

RESULTS

The base line parameters which were obtained for the female and the male volunteers have been shown in [Table/Fig-1]. [Table/Fig-2] compares the pain response of the female and the male subjects which were obtained on performing the cold pressor task under the control conditions (episode I); i.e., without distraction. The mean increases in the blood pressure on performing the CPT were greater in males than in females, but only the dDBP values were significantly different between the two groups. Although the mean values of the dPulse, pain threshold, pain tolerance and the pain rating were higher in case of the female subjects, the differences were not statistically significant.

[Table/Fig-3] compares the pain responses of the female subjects which were obtained under different experimental conditions. The results of the experimental episodes II (while in conversation with male attendants), III (while in conversation with female attendants), IV (while listening to preferred music), and V (while mentally solving simple mathematical problems) were independently compared with the data which were obtained in episode I (experiments which were conducted under the control conditions). The dPulse values did not change significantly in the different episodes. The dSBP values were significantly lower than the control in the episodes II, III, and IV, while the dDBP values were significantly lower in the episodes, III and IV, and they were higher in episode V. The pain threshold showed a significant increase in the episodes II, III, IV, and V, with the maximum increase in episode IV. A statistically significant increase in the pain tolerance occurred in the episodes II, III, and IV. The decreased pain tolerance which was observed in episode V was not significant. The pain rating decreased significantly in episode III.

The pain responses of the male subjects which were obtained under different experimental conditions have been compared in [Table/Fig-4]. The different experimental episodes were the same as those in [Table/Fig-3]. The dPulse values were significantly lower in episode III, and significantly higher in episode V. The dSBP values were significantly lower than the control in the episodes III and IV, while the dDBP values were significantly lower in the episodes II, III, and IV. The pain threshold and the pain tolerance increased signifi-

Parameters	Female Subjects	Male Subjects
Age (years)	19.8 ± 1.8	21.43 ± 2.22
Body weight (kg)	58.4 ± 11.0	68.87 ± 12.95
BMI (kg/m2)	24.8 ± 4.3	23.11 ± 4.51
Resting pulse (/ min)	88.2 ± 11.4	87.3 ± 7.9
Resting SBP (mmHg)	101.8 ± 13.2	103.4 ± 12.2
Resting DBP (mmHg)	72.4 ± 9.6	76.4 ± 12.58

[Table/Fig-1]: Baseline values of different parameters of female and male subjects

Parameters	Female Subjects	Male Subjects
dPulse (/min)	7.4 ± 6.4	4.5 ± 3.8
dSBP (mmHg)	10.2 ± 7.0	11.9 ± 5.7
dDBP (mmHg)	5.8 ± 3.2	8.7 ± 5.5
Pain Threshold (seconds)	23.4 ± 21.6	15.8 ± 11.0
Pain Tolerance (seconds)	42.1 ± 78.8	36.4 ± 25.9
Pain Rating (VAS)	5.8 ± 1.5	5.4 ± 1.4

[Table/Fig-2]: Data obtained under control conditions (without mental distraction) in female and male subjects

Episodes	Female Subjects				
	I	II	III	IV	V
dPulse (/min)	7.4 ± 6.4	4.2 ± 2.4	2.1 ± 1.9	3.7 ± 2.0	9.2 ± 2.4
dSBP (mmHg)	10.2 ± 7.0	5.0 ± 4.7	2.2 ± 2.2	3.6 ± 3.5	10.5 ± 6.3
dDBP (mmHg)	5.8 ± 3.2	5.4 ± 4.1	2.6 ± 2.5	2.8 ± 3.0	7.9 ± 3.1
Pain Threshold (seconds)	23.4 ± 21.6	35.3 ± 25.6	44.5 ± 35.0	52.7 ± 54.3	33.9 ± 19.7
Pain Tolerance (seconds)	42.1 ± 78.8	74.4 ± 98.2	89.2 ± 97.1	103.1± 150.5	33.8 ± 85.1
Pain Rating	5.8 ± 1.5	6.0 ± 1.5	4.8 ± 2.0	5.3 ± 1.8	5.9 ± 1.5

[Table/Fig-3]: Pain response data obtained in different conditions in female subjects

Episodes	Male Subjects				
	I	II	III	IV	V
dPulse (/min)	4.5 ± 3.8	3.6 ± 2.6	1.9 ± 2.3	4.5 ± 2.6	13.4 ± 5.2
dSBP (mmHg)	11.9 ± 5.7	9.3 ± 5.0	3.5 ± 3.6	7.5 ± 5.3	14.4 ± 5.6
dDBP (mmHg)	8.7 ± 5.5	5.9 ± 3.3	2.7 ± 2.6	5.8 ± 6.2	8.5 ± 4.4
Pain Threshold (seconds)	15.8 ± 11.0	27.2 ± 17.9	47.8 ± 27.5	35.8 ± 25.3	25.5 ± 14.1
Pain Tolerance (seconds)	36.4 ± 25.9	66.6 ± 58.0	160.7 ± 155.5	111.4± 136.4	25.9 ± 21.3
Pain Rating	5.4 ± 1.4	5.4 ± 1.1	4.8 ± 1.8	4.6 ± 1.4	6.9 ± 1.1

[Table/Fig-4]: Pain response data obtained in different conditions in male subjects

Parameter	Sex	Mean ± SD*	Mean ± SD**
dPulse (/min)	Female	14.1 ± 8.01	7.4 ± 6.4
	Male	19.2 ± 9.5	4.5 ± 3.8
dSBP (mmHg)	Female	7.9 ± 7.6	10.2 ± 7.0
	Male	5.7 ± 7.7	11.9 ± 5.7
Pain Threshold (second)	Female	14.3 ± 8.5	23.4 ± 21.7
	Male	20.8 ± 12.4	15.8 ± 11.0
Pain Tolerance (second)	Female	33.5 ± 15.4	42.1 ± 78.8
	Male	107.0±103.8	36.4 ± 25.9
Pain Sensitivity	Female	Higher	No significant difference
	Male	Lower	

[Table/Fig-5]: Comparison of data reported by Myers et al28 and by us (Episode I) (*: Data reported by Myers et al28; age of subjects 18-30 years; **: Data obtained by us under control conditions (Episode I); age of subjects 17-27 years)

cantly in the episodes II, III, and IV, with the maximum increase being observed in episode III. The pain rating decreased significantly in episode IV and it increased significantly in episode V.

DISCUSSION

The first aim of our study was to examine whether the pain response which was obtained from the subjects of Indian origin was the same as that which was reported by various studies which were carried out on the subjects of western origin. Our second aim was to investigate whether sex differences in the pain response existed in the Indian population.

Myers et al., [26] had conducted CPT under conditions which were similar to ours in episode I of our study, on subjects of western origin (Caucasian: 78.8%, Asian-American: 9.6%, Latino-Hispanic: 7.7% and others: 3.8%) [Table/Fig-5]. Summarizes their findings and compares them with our observations of episode 1 (CPT carried out under control conditions). We have not compared our data with any study other than that of Myers et al., [26], as the conditions of the experiment, the type of the experimental pain which was produced, or the age of the subjects did not match with those of the other studies. It appears from [Table/Fig-5] that Northern-Indian males were more sensitive to the cold pressor pain than American males. However, Nayak et al., [14] have reported just the opposite, and we believe that it was possible, since their studies were carried out in Southern India, presumably on subjects of Southern Indian origin. India is a big country with vast cultural differences. It is quite possible that the pain sensitivity of the people varies from region to region due to the genetic, social or the cultural differences. Another difference which was apparent from [Table/Fig-5] was that while American females were more sensitive to pain than American males, there were no sex-related differences in the pain response in the Indian population [Table/Fig-3 & 4]. Again, Nayak et al., [14] have reported the opposite. The pain threshold and tolerance vary across the menstrual cycle [9], with the maximum pain sensitivity being exhibited during the period of ovulation. In our study, we selected regularly menstruating young female subjects. The CPT episodes were conducted during the first ten or the last ten days of the menstrual cycle to avoid the ovulation period. No such precautions were taken by Nayak et al., [14] or Myers et al., [26]. Another probable explanation of our results is the preference for the male child in Northern India (as was evident from the sex ratios in the different states). It is possible that the relatively greater hardships which are faced by the girl children in our male dominated society decrease their pain tolerance over a period of years. An interesting observation supports our hypothesis. In our study, the

female subjects who were their parents' only child (n=17), were more pain sensitive than the males, thus implying that when an Indian girl child is raised without a sexual bias, her pain sensitivity is greater than that of an average Indian male, just as in the case of American women. A much larger study needs to be carried out on the female subjects, with or without siblings, to confirm our hypothesis. Our third aim was to determine as to which method of mental distraction was most suited for the Indian population. The lowest values of the cardiovascular reactivity (dPulse, dSBP, and dDBP; [Table/Fig-3 & 4] were observed in episode III in both female and male subjects. The low values of dPulse, dSBP, and dDBP indicated that the subject was better able to tolerate the pain. The maximum pain threshold and pain tolerance were observed in episode IV (with preferred music) in female subjects [Table/Fig-3]. The greater increases in the pulse and the blood pressure in episode IV (as compared to episode III) were due to the tolerance of pain for a longer duration. Mitchell and MacDonald [27] showed that females reported less pain intensity (pain rating) than males in the preferred music conditions. In our study, there was no significant difference in the pain ratings which were provided by either the male or the female subjects (as compared to the respective values which were obtained under the control conditions). Since the past two decades, audio analgesia has become quite a popular distractant, and we also recommend a low volume music of popular choice to be played in the waiting rooms of hospitals.

The male subjects showed the maximum pain threshold and tolerance in episode III, when the CPT was carried out in the presence of a female attendant, with the conversation being on non-procedural topics. In our study, the female attendant was 10 years older than the eldest male subject. It would be interesting to carry out the experiment in the presence of female attendants of different ages. A more mature person may produce a 'motherly' effect, while a younger person may appear to be more interesting.

The pain response to the cold pressor task was considered in this experiment. It is possible that different pain stimuli may produce different effects.

On the basis of our results, we conclude that:

1. The Northern Indian males were more sensitive to the pain which was produced by the cold pressor task as compared to the American males.

2. The male and female subjects showed no significant differences in the pain sensitivity.

3. The most effective distractant in case of the female subjects was preferred music, while for the male subjects, it was a conversation on non-procedural topics with a female attendant.

ACKNOWLEDGEMENTS

We express our gratitude to the students of MBBS who were enrolled at SRMS-IMS, Bareilly and TMMC and RC, Moradabad, for readily volunteering to be the subjects in this study.

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AUTHOR(S):

1. Dr. Manoj Kumar
2. Dr. Jayballabh Kumar
3. Dr. Indu Saxena

PARTICULARS OF CONTRIBUTORS:

1. Professor, Department of Physiology, TMMC & RC, Moradabad, (U.P.), India.
2. Assistant Professor, Department of Physiology, TMMC & RC, Moradabad, (U.P.), India.
3. Assistant Professor, Department of Biochemistry, AIIMS, Jodhpur, Rajasthan, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Manoj Kumar,
Professor, Department of Physiology,
Department of Physiology, TMMC&RC, TMU,
Pakbara, NH-24, Moradabad-244001 (U.P.), India.
Phone: 09415011315
E-mail: Premmanoj2001@yahoo.co.in

FINANCIAL OR OTHER COMPETING INTERESTS:

None.

Date of Submission: **Jul 07, 2012**
Date of Peer Review: **Jul 28, 2012**
Date of Acceptance: **Aug 24, 2012**
Date of Online Ahead of Print: **Sep 08, 2012**
Date of Publishing: **Dec 15, 2012**