Assessment of resting cardiorespiratory parameters in the chronic pain patients

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Abstract

Objective: Present study was conducted to understand the effects of chronic pain on resting cardiorespiratory parameters of the patients having chronic pain of severity >3 on visual analogue score (VAS).

Materials and Methods: 50 male cases and 28 female cases were selected from the pain clinic. 58 male and 28 female age-sex matched controls were also selected in the study. The electrocardiogram (ECG), systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR) and respiratory frequency (RF) were recorded in cases and controls.

Results: Mean SBP/DBP of male cases is lesser than the male controls ($P > 0.05$). Mean SBP/DBP of female cases is more than the female controls ($p < 0.05$). Mean SBP/DBP of male cases is lesser than female cases ($P > 0.05$) and the Mean SBP/DBP of male controls is greater than female controls ($P > 0.05$). The HR of male cases and female cases is significantly greater than the male and female controls respectively ($p < 0.05$). The HR of male cases versus female cases and male controls versus female controls is not different ($P > 0.05$). There is no difference in the RF changes in all the groups.

Conclusions: Observations reveal that the sympathetic tone has not changed much in the male cases but it is increased in the female cases indicating the loss of sympathetic tone in male cases in comparison to the female cases. However, the parasympathetic tone seems to be decreased in both male and female cases.

Key words: Chronic Pain, Blood Pressure, Heart Rate, Respiratory Frequency, Sympathetic and Parasympathetic tone.

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Introduction

Autonomic nervous system balances the functions of the internal organs, like heart rate, intestinal motility, urination, sexual activity and many other functions. The human body faces various challenges from external and internal environment and responds for its existence. Many ongoing researches have shown correlation between chronic pain and blood pressure alteration[1], thereby involving both sympathetic and parasympathetic systems. The various works done on autonomic functions in chronic pain, still fails to prove that which part dominates, whether sympathetic or parasympathetic. It has been observed by some other worker that a large number of people are suffering from musculoskeletal disorder, joint pain, pain in the superior extremity and fibromyalgia[2,3]. Chronic pain is reported by 19% of the adult European population[4] affecting more females than males.

Sympathetic hyperactivation has been shown in fibromyalgia (FM)[5], migraine[6] chronic neck and shoulder pain elsewhere[7]. Sympathetic nervous system may be involved in the pathogenesis of chronic pain syndromes. It has been observed that the pain is spatially correlated with signs of autonomic dysfunction, with the fact that blocking the efferent sympathetic supply to the affected region relieves the pain[8]. The sympathetically maintained pain concept has strong and ample foundations in the animal model. In contrast, the clinical information regarding the involvement of autonomic nervous system in the chronic pain patient is inadequate.

Gender differences regarding the cardiovascular autonomic responses are also known[9,10,11,12]. These differences in autonomic nervous system may be because of the differences in the development which may be due to the effects of male or female sex hormones.

Though studies on the effect of chronic pain on autonomic functions have been carried out by some workers elsewhere[13,14] and also on the gender difference[15,16,17,18,19] but the same study has not been conducted yet in the population of Eastern Uttar Pradesh, India, so far the best of our knowledge. This study was planned to evaluate the resting cardiorespiratory functions in the chronic pain patients and its correlation with the age-sex matched controls. Further, the resting cardiorespiratory functions of the male cases versus female cases and normal males versus normal females were also compared to understand the correlation between the two genders.

Materials and Methods

The present study was conducted in the Department of Physiology, Institute of Medical Sciences, Banaras Hindu University, U.P., India after getting approval from

Institute Ethical committee. 50 male cases and 28 female cases were selected from the Pain Clinic, SSL Hospital, IMS, BHU, Varanasi, based on the exclusion and inclusion criteria. 58 male and 28 female age sex matched healthy persons were also selected in the study and defined as control. All those patients suffering with chronic pain of musculoskeletal origin were selected with no history of diseases like Diabetes Mellitus, Hypertension, Hyper/ Hypothyroidsm, Uremia etc or the use of any medication like Diuretics, Calcium channel blocker, Neuroleptics, Antiepileptic, Antidepressant, α and β blockers. In the females, the period of performance of the tests was chosen within one week of last menstrual period (LMP). All the observations were grouped into four main categories: 1) Male cases 2) Female cases 3) Male Controls 4) Female controls. All the parameters of male cases were compared with male controls, female cases with female controls, male cases with female cases and male controls with female controls. The disease distribution pattern of male and female cases is given in the Fig. 1.

The patients were asked to stop caffeine, tea and alcohol intake and smoking at least 12 hours prior to the recording. They were also told to avoid strenuous activities such as running and jumping which can alter the cardiorespiratory functions, two hours before the recordings. Patients were also instructed to take light meal which contains minimum fat and maximum carbohydrate and also to take 6-8 hours of deep sleep in the previous night. All tests were performed in late morning, after a light breakfast. The temperature of the laboratory was maintained at 25 ± 2^0C, with minimum light and noise. The patients were briefed about the various procedures. The height and weight were measured and Body mass index (BMI) was calculated. The patients were allowed to lie down on the bed and were given 10-15 minutes of rest. With digital blood pressure apparatus (Omron Health Care co. limited, Japan), the blood pressure (BP) was measured and baseline parameters like electrocardiography (ECG) and respiration were recorded by POLYRITE-D (RMS, Chandigarh, India). Further heart rate (HR) and respiratory frequency (RF) were calculated from E.C.G. and respiratory recordings respectively. The respiratory recordings were performed by using stethograph over the chest at the level of nipple.

Data is presented in the form of mean and SEM. Statistical Analysis is done by using Graph Pad Prism version-6. Unpaired Student's T-Test is performed wherever required. P value less than 0.05 was considered as significant.

Results

Patients suffering with chronic pain of chronicity >6 months and severity of >3 VAS were assessed and the cardiorespiratory parameters were recorded. Age and BMI was also recorded in the cases as well as in the controls.

The mean age of male cases is 38 ± 2.22 yrs versus male controls of 35 ± 2.22 yrs, when compared it was not different ($P > 0.05$). The mean age of female cases is 40.5 ± 2.00 yrs versus mean age of female control of 39.6 ± 1.19 yrs ($P > 0.05$). The male cases of 38 ± 2.22 yrs of mean age is compared with female cases of mean age of 40.5 ± 2.00 yrs ($P > 0.05$). The mean age of male controls is 35 ± 2.22 yrs versus female controls of mean age of 39.6 ± 1.19 yrs ($P > 0.05$; Fig. 1).

The mean BMI of male cases is 23.5 ± 0.85 kg/m^2 versus male controls of 25.5 ± 0.82 kg/m^2 ($P > 0.05$). The mean BMI of female cases is 26.5 ± 1.39 kg/m^2 versus female controls of 23.0 ± 0.74 kg/m^2 when compared it was different ($P < 0.05$). The mean BMI of male cases is 23.5 ± 0.85 kg/m^2 and female cases is 26.5 ± 1.39 kg/m^2 ($P > 0.05$). The mean BMI of male controls is 25.5 ± 0.82 kg/m^2 versus female controls which is 23.0 ± 0.74 kg/m^2 ($P > 0.05$; Fig. 1).

The mean SBP of male cases is 122.6 ± 1.76 mm Hg versus male controls of 127.1±3.24 mm Hg ($P > 0.05$). Mean SBP of female cases is 136.0 ± 5.2 mm Hg and mean SBP of female controls is 118.8 ± 3.2 mm Hg ($P < 0.05$). Mean SBP of male cases is 122. 6 ± 1.76 mm Hg and female cases is 136.0 ± 5.2 mm Hg ($P < 0.05$). Mean SBP of male controls is 127.1 ± 3.24 mm Hg versus female controls of 118.8 ± 5.2 mm Hg ($P > 0.05$; Fig. 3).

The mean DBP of male cases is 79.6 ± 1.97 mm Hg versus male controls of 77.4 ± 2.21 mm Hg ($P > 0.05$). The mean DBP of female cases is 83.3 ± 2.05 mm Hg versus female controls of 76.2 ± 2.22 ($P < 0.05$). The mean DBP of male cases is 79.6 ± 1.97 mm Hg versus female cases of 83.3 ± 2.05 mm Hg ($P > 0.05$). The mean DBP of male controls is 77.4 ± 2.21 mm Hg versus female controls of 76.2 ± 2.22 ($P > 0.05$; Fig. 3).

The mean HR of male cases is 79.9 ± 2.85 bpm versus male controls of 68.2 ± 1.79bpm ($P < 0.05$). Mean HR of female cases is 88.6 ± 3.55 bpm and mean HR of female controls is 69.3±1.60 bpm ($P < 0.05$). Mean HR of male cases is 79.9 ± 2.85 bpm and female cases is 88.6 ± 3.55 bpm ($P > 0.05$). Mean HR of male controls is 68.2 ± 1.79 bpm versus female controls of 69.3±1.60 bpm ($P > 0.05$; Fig. 4).

The mean respiratory frequency (RF) of male cases is 14.6±0.30 per min versus male controls of 14.8±0.20 per min ($P > 0.05$). The mean RF of female cases is 14.0±0.30 per min versus female controls of 14.2±0.45 per min ($P > 0.05$). The mean RF of male cases is 14.6±0.30 per min and female cases is 14.0±0.30 per min ($P > 0.05$). The mean RF of male controls is 14.8±0.20 per min and female controls is 14.2±0.45 per min ($P > 0.05$; Fig. 5).

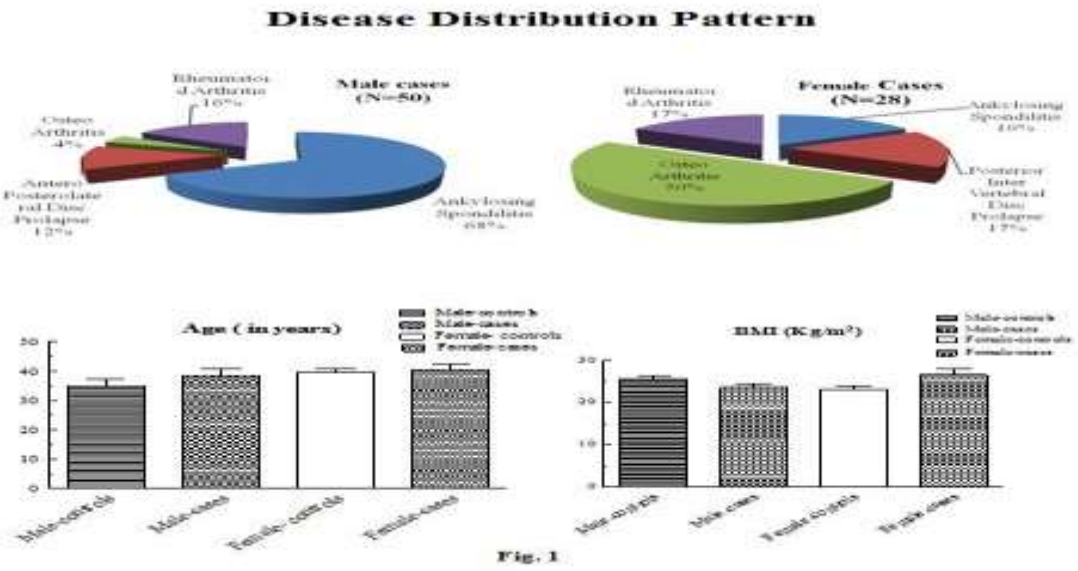

Fig. 1: Disease distribution pattern in the cases and the histograms are showing the correlation between different groups of the Age and BMI

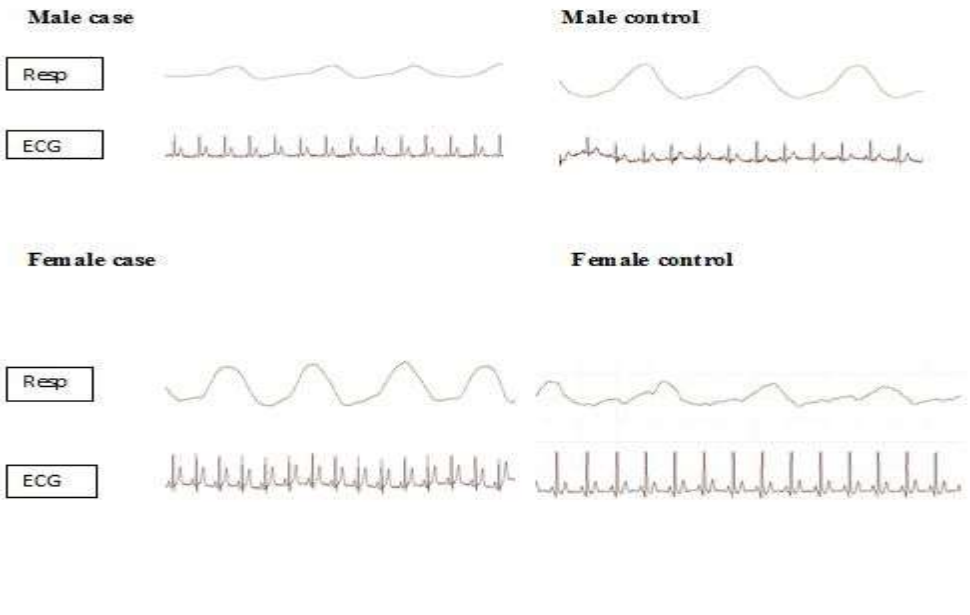

Fig. 2: Recordings of baseline parameters (respiration and ECG) in the resting condition (speed = 15mm/s, S = 500 µv for resp and 50 µv for ECG)

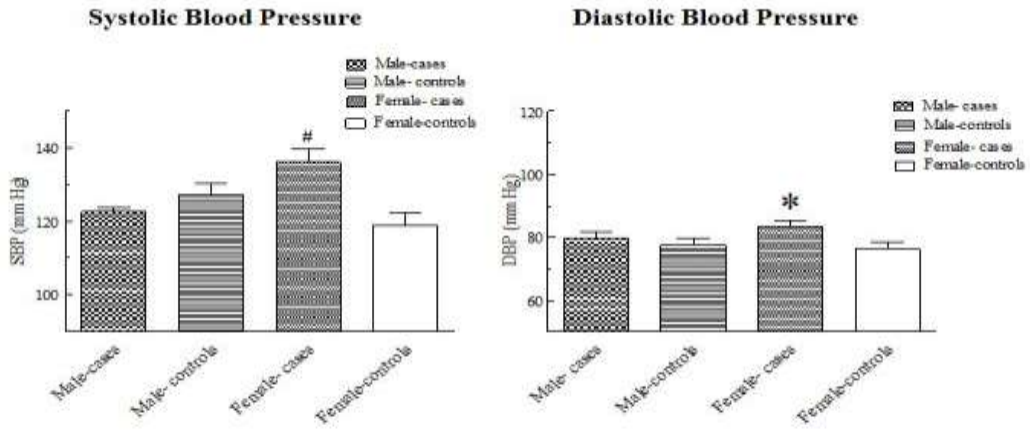

Fig. 3

Fig. 3: Systolic blood pressure (SBP) and diastolic blood pressure (DBP) of male cases, female cases, male controls and female controls are shown. The data represents the mean ± SEM value of SBP & DBP. An asterisk "*" shows P < 0.05 as compared to female controls and '#' shows P < 0.05 as compared to female controls (unpaired t-test)

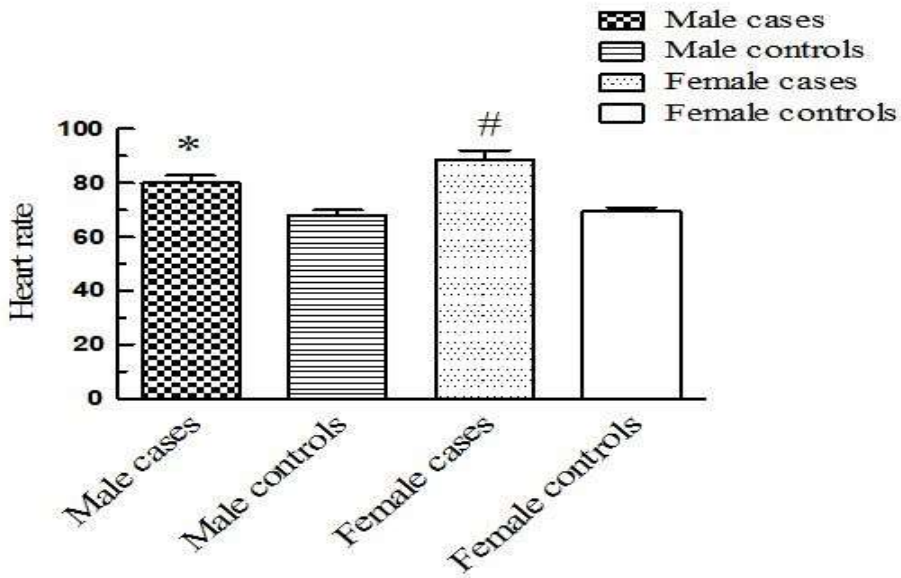

Fig. 4

Fig. 4: Mean ± SEM value of heart rate (HR) of male cases, female cases, male controls and female controls are shown. An asterisk "*" shows P < 0.05 as compared to male controls. A hash "#" shows p < 0.05 as compared to female controls (unpaired t-test)

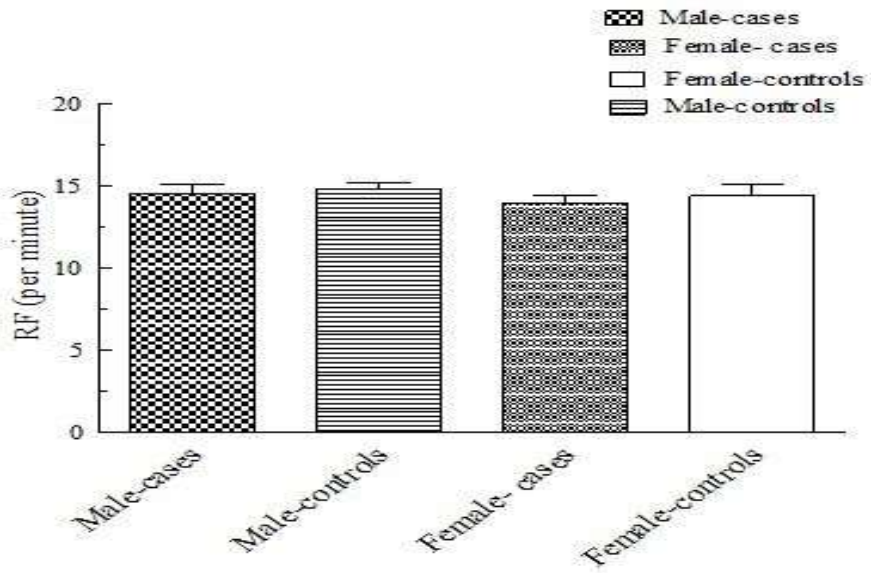

Fig. 5

Fig. 5: Mean ± SEM value of respiratory frequency (RF) of male cases, female cases, male controls and female controls in the resting condition

Discussion

When body is exposed to the noxious stimuli from internal or external environment, information regarding the degree of damage is transmitted through the peripheral nervous system to the central and autonomic nervous systems. This type of information processing is known as nociception[20]. It is mediated by specialized receptors known as nociceptors that are attached to thin myelinated Aδ and unmyelinated C fibers, which terminate in the dorsal horn of the spinal cord. The ability to adapt the changing environmental conditions is mainly contributed by autonomic nervous system. The sympathetic and parasympathetic systems work together to maintain harmony of the human physiological system but this state is disrupted by the painful stimuli. The adjustability to both acute and chronic pain is an important contributor to the quality of life. The cardiovascular system is under the control of autonomic nervous system which has resulted to various studies showing relationship between autonomic dysfunction and chronic pain[13,21,14].

This study was conducted to test the assumption that the chronic pain can alter the cardiorespiratory parameters, in which the patients suffering with chronic pain were selected for the observation of the cardiorespiratory changes. Our finding suggest that there is no difference in the mean age of any group with their respective controls, indicating that the comparisons made were age matched for all the four groups. The mean BMI of female cases was more as compared to the female control group. The reasons for this may be the sedentary life style of the female cases in comparisons to the female controls which belongs to the active class. Our results also reveal that there is no difference in the male cases versus male controls, male cases versus female cases and male controls versus female controls, suggesting that the BMI of these groups are not significantly different than each other.

In the resting state, mean SBP of male cases was found not different than their controls but the mean SBP of female cases was found to be different than the female controls. The probable reason for these differential responses may be due to the differences in the autonomic tone in both the sexes[18,19,22]. The mean SBP of male cases was found significantly lower than the female cases. Gender differences in the autonomic nervous system during the development may be because of male and female sex hormones[22]. In the studies elsewhere, it has been suggested that males have a sympathetic dominance than females[15,16,17,18,19] and the observations in our study is consistent with this finding as the SBP in the male controls is more than the SBP in female controls. But the SBP of the male cases is lesser than the SBP of female cases which may be because of the subnormal sympathetic function due to the exposure of chronic pain.

The male and female cases were compared with their respective controls for changes in the DBP. It was observed that the resting mean DBP of female cases are significantly higher than the female controls, showing shifting of sympathovagal balance in the sympathetic side in females suffering with chronic pain. The DBP was found not different in the rest of the comparable groups.

The resting HR of male and female cases is significantly higher than their respective controls. The probable reasons for the tachycardia in the cases may be the shifting of the vagosympathetic balance in the vagal side. In the studies elsewhere, it was found that women have more vagal or parasympathetic predominance[23]. Our findings do not support this assumption as there is no bradycardia in the female control group as compared to the male control group. This part cannot be explained on the basis of the present findings as a limitation of our study. There is no significant difference in the HR changes in the male cases versus female cases indicating less effect of gender differences. The resting RF changes in the cases were not different than the controls indicating the respiratory adjustment during the chronicity. In acute pain, tachypnoea is normally observed along with the increase in blood pressure. In chronic pain, it seems that the respiratory adjustment is over and that may be the reason for the non-difference in the mean RF of cases and controls.

Observations reveal that the sympathetic tone has not changed much in the male cases but it is increased in the female cases indicating the loss of sympathetic tone in males in comparison to the female cases. However, the parasympathetic tone seems to be decreased in both male and female cases.

Conflict of Interest: None

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