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The Involvement of ANS in Neck Shoulder Pain and Low Back Pain

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Abstract

A large number of people suffer from musculoskeletal disorders (MSDs), including regional pain in the neck-shoulder region and lower back, or more widespread pain, e.g., fibromyalgia [1]. Chronic MSDs are characterized by a localized, regional or widespread sensation of pain affecting muscles, joints, tendons or ligaments, accompanied by symptoms such as fatigue, tenderness at palpation and muscle stiffness. An autonomic imbalance may also reflect altered regulation of the entire stress response system and may have detrimental consequences in terms of pathological conditions as mentioned above [6].

In particular, this study paid attention to the involvement of the ANS in the initiation and maintenance of chronic muscle pain.

We had incorporated patients to study the Autonomic function imbalance in the Neck Shoulder Pain and Low Back Pain patients. We intended to include 15 patients in both the test groups and 15 normal subjects (Age and Sex matched) for comparative analysis. A detailed clinical history was taken from all the patients and subjects to exclude the presence of diabetes mellitus, hypertension, alcohol dependence and other diseases that can affect autonomic functions. Both the limbs of ANS were studied using standard battery of autonomic function tests:

• Deep Breathing Test • Lying to Standing Test • Valsalva Maneuver • Hand Grip Test • Cold Pressor Test

The results were recorded and carefully evaluated. It was found that Sympathetic over activity in low back pain patients can be the cause of this autonomic imbalance or it may be a predictor of prognostic evaluation in such patients.

We conclude that sympathetic overactivity plays a major role in the patients suffering from low back pain whereas the role of parasympathetic reactivity from the presence study is not clear.

The best way to arrive at investigative & prognostic evaluation of patients suffering from low back pain would be CPT and HGT as a standard marker of sympathetic reactivity.

Keywords: Musculoskeletal Disorders; Fibromyalgia; Palpation; Tendons; Ligaments.

Introduction

A large number of people suffer from musculoskeletal disorders (MSDs), including regional pain in the neck-shoulder region and lower back, or more widespread pain, e.g., fibromyalgia [1]. Chronic MSDs are characterized by a localized, regional or widespread sensation of pain affecting muscles, joints, tendons or ligaments, accompanied by symptoms such as fatigue, tenderness at palpation and muscle stiffness. Diagnoses are often based on self-reported symptoms, as adequate objective markers are difficult to obtain at an individual level [2].

The etiology of MSDs is multifactorial, involving the interactions of physiological, psychological, behavioral and external mechanical factors. Physical (e.g., mechanical) or psychological stressors can

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facilitate chronic pain by their effects on physiological stress systems [3].

At the central level there is a strong connection between autonomic activation and nociception [4]. The ANS does not function independently, but rather constitutes an important part of a multi-stress system involving sophisticated co-activation and interaction between different homeostatic processes, and the immune and endocrine systems, including the Hypothalamic-Pituitary-Adrenal Axis and the Sympatho-Adrenomedullary axis [5]. In this sense, an autonomic imbalance may also reflect altered regulation of the entire stress response system & may have detrimental consequences in terms of pathological conditions [6]. *In particular, this study paid attention to the involvement of the ANS in the initiation and maintenance of chronic muscle pain.*

A predominance of sympathetic activity, either due reduced parasympathetic tone or excessive sympathetic activation, reduces the dynamic flexibility of the ANS and results in poor adaptation to altered internal or external demands. Taken together, it is possible that chronic muscle pain could be maintained and intensified due to pain-induced alterations in ANS regulation, particularly through the sympathetic branch of the ANS. The other objective of this study was to explore this realm.

Furthering our understanding of core mechanisms could improve prevention, diagnostics and treatment of chronic MSDs. Both the limbs of the autonomic nervous system are important in maintaining and regulating visceral functions directly and other body systems indirectly.

We had hypothesized that since nociceptive pathways are also affected by autonomic control, the study was planned to evaluate the cardiovascular autonomic responses in patients suffering from low back pain and neck shoulder pain.

Objectives

1. Involvement of the ANS in the initiation and maintenance of chronic muscle pain in MSDs like Neck-Shoulder Pain & Low Back Pain.
2. To verify the dominant role of Sympathetic branch of ANS in sustenance and intensification of pain.

Methodology

We had incorporated patients to study the Autonomic function imbalance in the Neck Shoulder Pain and Low Back Pain patients.

We intended to include 15 patients in both the test groups and 15 normal subjects (Age and Sex matched) for comparative analysis.

Procedure of Recording Parameters

Clinical history

A detailed clinical history will be taken from all the patients and subjects to exclude the presence of diabetes mellitus, hypertension, alcohol dependence and other diseases that can affect autonomic functions. The vital signs of subjects, such as pulse and blood pressure will be checked. Subjects will be asked about the presence of any autonomic symptoms, like excessive sweating, loose motions, constipation, impotence, syncopal attacks and palpitation.

Prior instructions will be given before recording the physiological parameters. They will be:

- No use of medicine(s) 24 hrs before recording.
- No consumption of tea, coffee or any other caffeinated beverage at least two hours before the testing.

Pre-testing procedure

The subjects will be given proper instructions about the tests and recording procedure before starting the actual tests. The subjects will be made comfortable. Temperature of the laboratory will be comfortable (22 ± 1^{o}C) and the laboratory will be kept free of noise from any kind as far as possible. EKG electrodes will be applied for standard limb leads. The jack pins of electrodes will be connected to the connection board that will be connecting to amplifier.

Table 1: Amplifier setting for autonomic function tests

Signal	Sensitivity	½ Amplitude high frequency cut	Time constant	50 Hz filter
EKG	0.5mV/cm	35 Hz	0.1 sec	off

Lying to standing test (LST)

The subjects will be asked to stand up from supine position in 2 to 3 seconds. They will stand steady for 2 minutes. The EKG and respiration will be recorded continuously. Blood pressure measurement will be done serially at 0.5^{th}, 1^{st} and 2^{nd} minutes of standing. Then the patients will be asked to sit down comfortable. Rest of the tests will be performed in sitting position.

Deep breathing test (DBT)

The subjects will be given continuous signal in the form of raising the hand continuously up and then bringing the hand continuously down corresponding to inhalation and exhalation to their full capacity without breaking the breath during exhalation or inhalation. The frequency of the cycle will be 6 breaths per minutes for 1 minute. Phases of respiration will be marked manually on the chart paper. The average of 6 shortest inspiratory and 6 longest expiratory R-R intervals from EKG will be taken into account for the calculation of E:I ratio and heart rate difference between inspiration and expiration. The E:I ratio will be calculated by dividing the average of maximum expiratory R-R intervals by the average of minimum inspiratory R-R intervals.

Valsalva maneuver (VM)

In this test the subjects will be asked to raise the intra-thoracic pressure to 40mm of Hg through a mouthpiece connected to a mercury monometer and maintain at this level for 15 seconds. The subjects will be instructed prior to testing not to take deep breaths before and after VM. After 15 seconds as the mouthpiece will be removed the subjects will be instructed to sit quietly. The time event will be marked on the chart paper by a time marker. Artifacts arising from the movements of the limbs in EKG will be avoided by instructing the subjects to not to move their limbs. VR and latencies will be calculated from R-R interval changes in EKG.

Handgrip test (HGT)

Just before the test, baseline BP will be recorded in sitting posture. Then the subjects will be instructed to press the dynamometer with their dominant hands with maximum possible force. This gave the value of maximum voluntary contraction (MVC). The 30% of the MVC will be calculated and the subjects will be instructed to press the dynamometer continuously at 30% of their MVC for 4 minutes by their dominant hand. During the isometric contraction, BP will be recorded at 1st, 2nd, 4th and 6th minutes.

The EKG will be recorded continuously on Polyrite.

Cold presser test (CPT)

Prior to the test, the baseline blood pressure will be recorded. The subjects will be asked to immerse their hand up to the wrist in 10^{o}C cold water for 1 minute (Low, 1984). BP will be measured at 1st and 2.5th minute of hand immersion. The EKG will be continuously recorded on the Polyrite.

Statistical Analysis

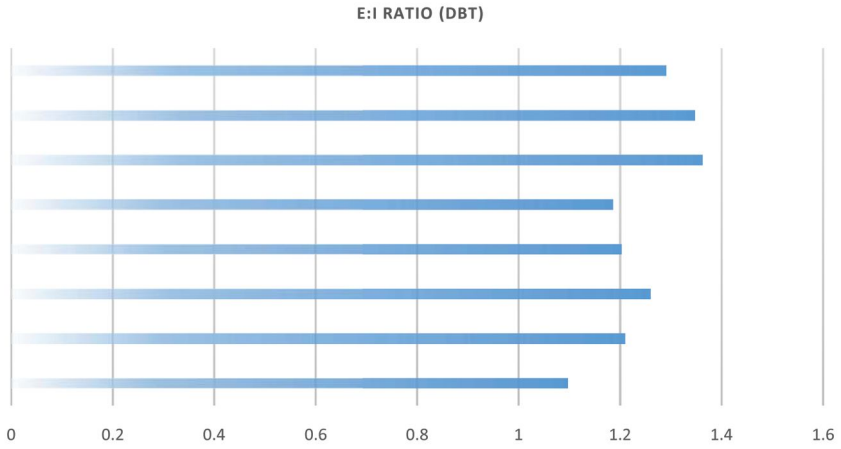
The data was supposed to be statistically analyzed by using unpaired t-Test between the two test groups and Anova among all the three groups. But because of a very few number of neck-shoulder pain patients, the results would have been skewed and statistically non-relevant. Since, it was an observational study; we feel that whatever result we got; though not statistically analyzed because of the paucity of data in one particular group, we could get a trend favoring our hypothesis.

Results

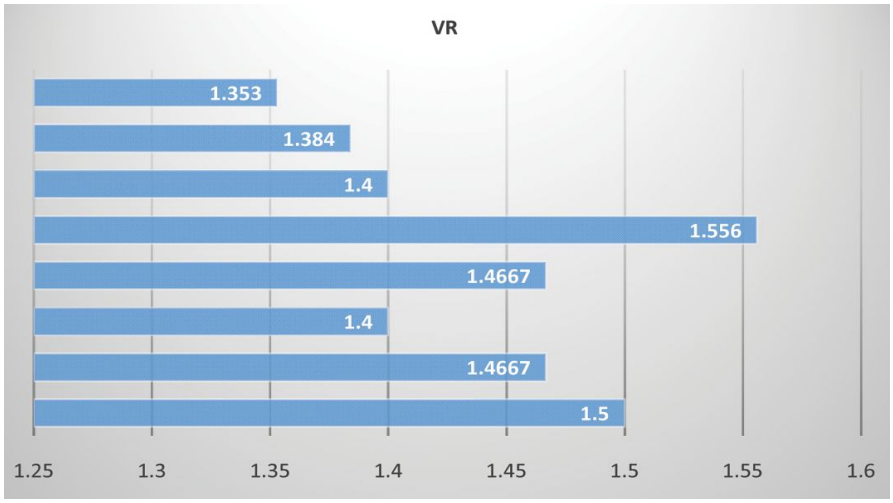
Sr. No.	Age	Sex	PSNS				SNS	
			DBT		VM	LST	LST	HGT	CPT
			E:I Ratio	ð HR	VR	30:15 Ratio	ð SBP	Rise in DBP	Rise in DBP
1	52	F	1.097	22	1.5	1.058	-6	12	2
2	36	F	1.21	16	1.4667	1.0625	-8	16	6
3	43	F	1.26	19	1.4	1.461	4	18	6
4	52	F	1.203	15	1.4667	1.105	-6	42	-14
5	36	F	1.186	3	1.556	1.02	-4	18	-2
6	29	M	1.363	7	1.4	1.217	14	8	-2
7	37	F	1.348	19	1.384	1.0625	4	14	-4
8	28	M	1.291	5	1.353	1.277	-2	38	40

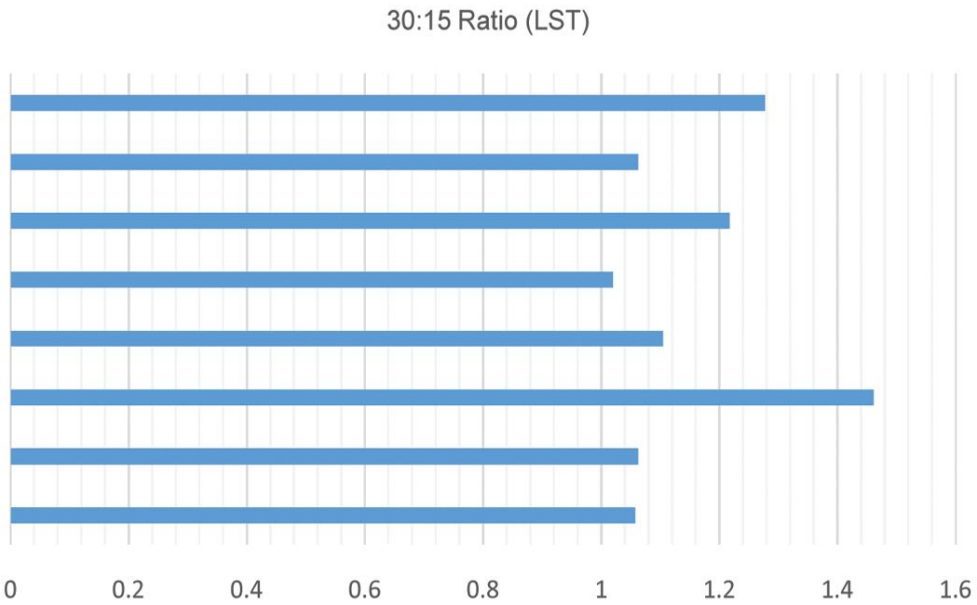
Both the limbs of ANS were studied using standard battery of autonomic function tests. The results are tabulated & graphically represented as follows.

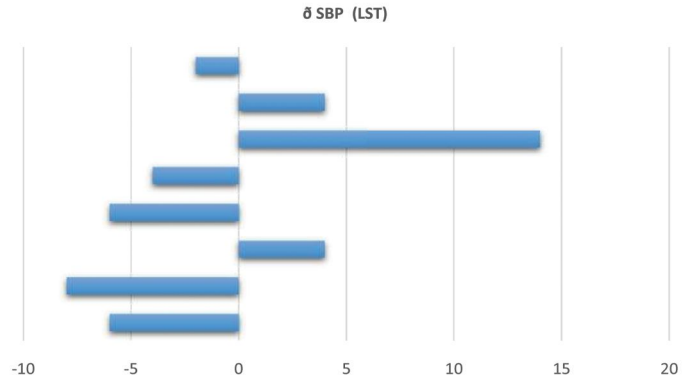
Graph 1: Autonomic Reactivity as measured by HR & BP changes in low back pain patients.



Graph 2: Autonomic Reactivity as measured by HR & BP changes in low back pain patients







Graph 3: Autonomic Reactivity as measured by HR & BP changes in low back pain patients

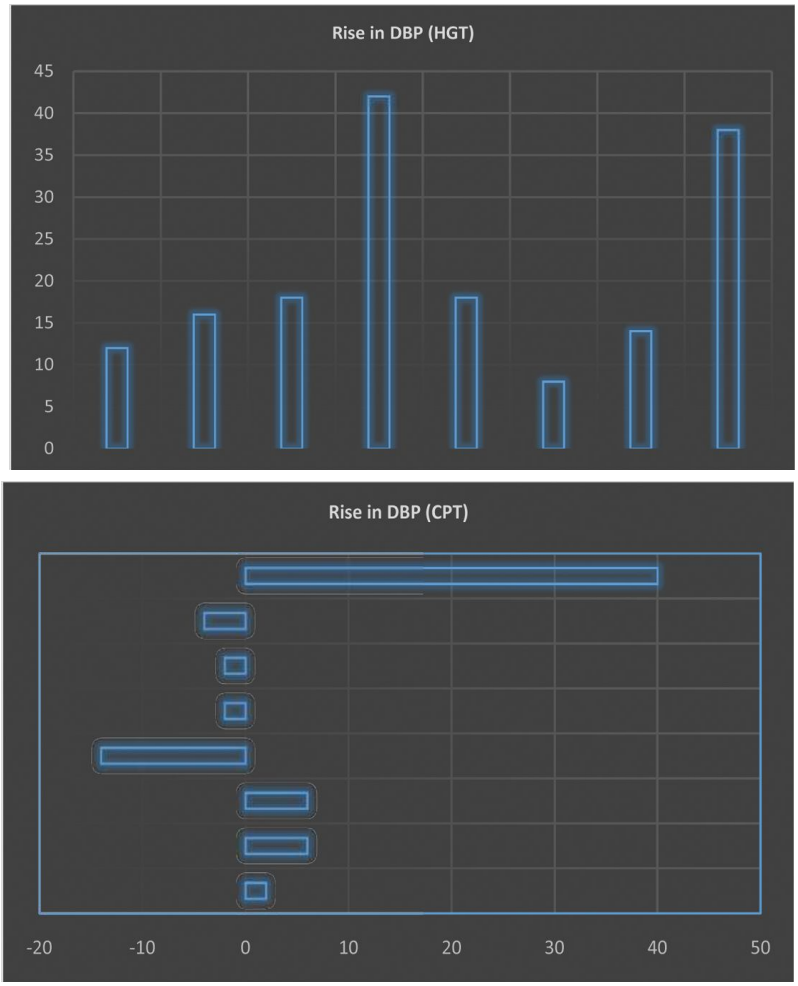
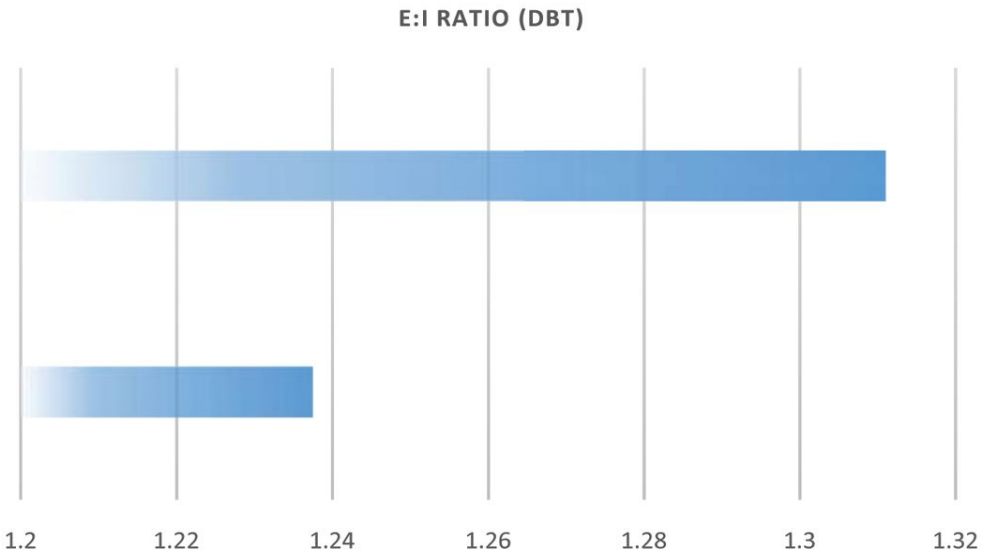


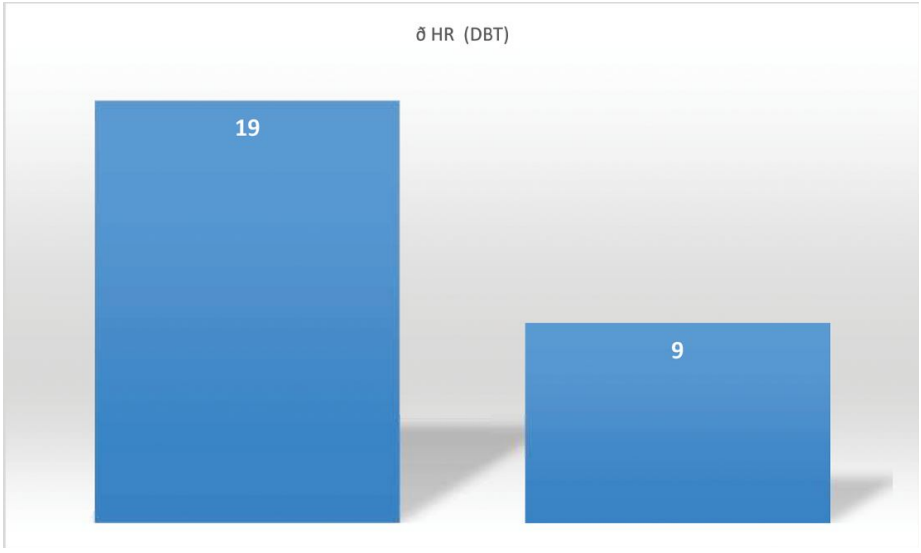
Table 2: Autonomic Reactivity as measured by HR & BP changes in low back pain patients.

Sr. No.	Age	Sex	PSNS				SNS		
			DBP		VM	LST	LST	HGT	CPT
			E:I Ratio	ð HR	VR	30:15 Ratio	ð SBP	Rise in DBP	Rise in DBP
1	38	F	1.2375	19	1.333	1	-2	8	2
2	50	F	1.311	9	1.375	1.285	-18	20	0

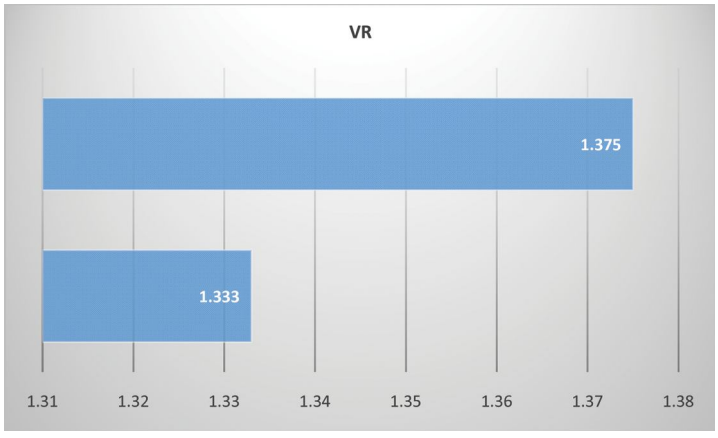
Autonomic Reactivity as measured by HR & BP changes in neck shoulder pain patients



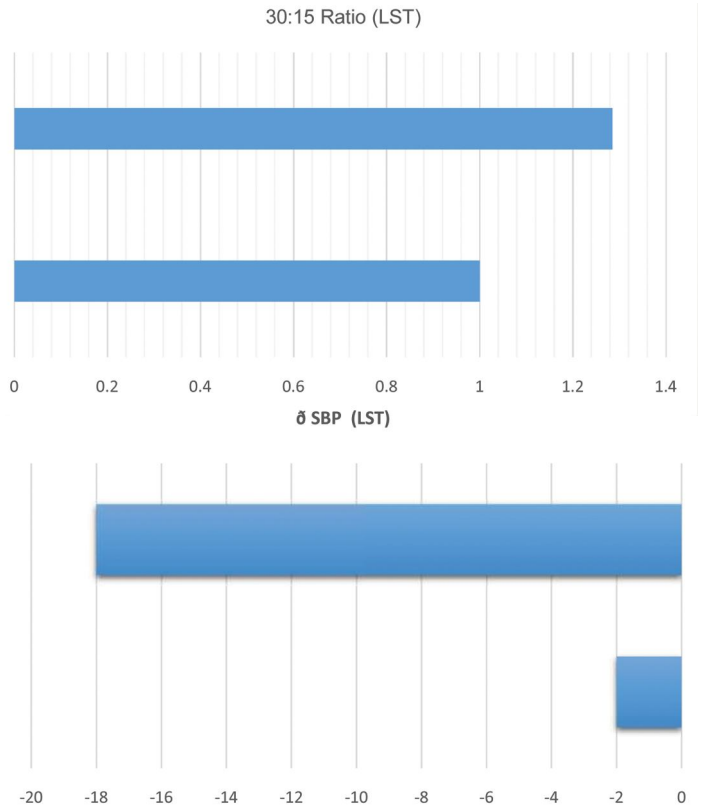
Autonomic Reactivity as measured by HR & BP changes in neck shoulder pain patients

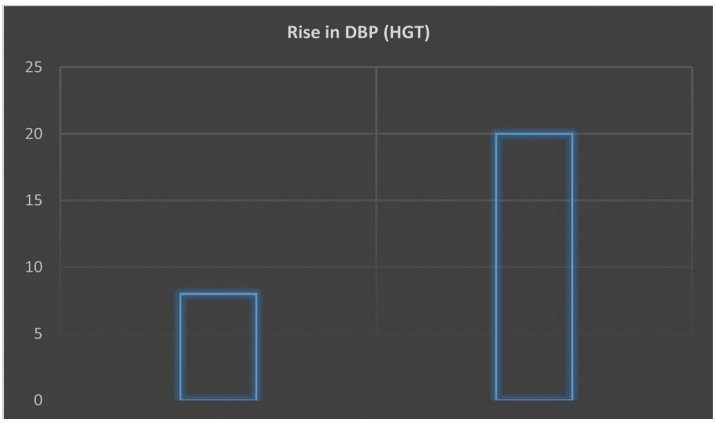


Autonomic Reactivity as measured by HR & BP changes in neck shoulder pain patients

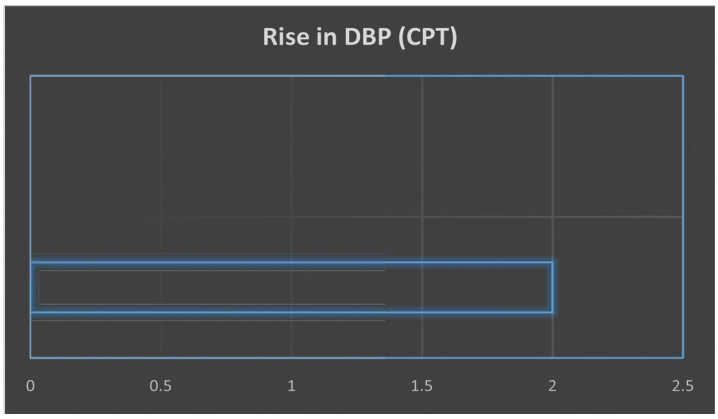


Autonomic Reactivity as measured by HR & BP changes in neck shoulder pain patients





Autonomic Reactivity as measured by HR & BP changes in neck shoulder pain patients



Discussion

To start with the study we had two primary objectives: One was to evaluate the autonomic imbalance, if any; in MSDs. The second was to look for any difference in autonomic control in low back pain & neck shoulder pain patients.

The prevalence of low back pain patients especially in older age is far more compared to neck shoulder pain patients. We couldn't analyze many neck shoulder pain patients because the study was designed to have a comparison between the two groups which are age & sex matched. The general trend of our study indicates that the parasympathetic reactivity was within normal range as compared with the normative data. But there was a significant trend of reduction in the rise in DBP in CPT & a trend of decreased SBP in LST. This trend indicates that Sympathetic overactivity in low back pain patients can be the cause of this autonomic imbalance or it may be a predictor of prognostic evaluation in such patients. We realize that the discrepancy between parasympathetic and sympathetic control of these patients were due to lack of normative to compare. Autonomic latency is a key factor in baroreflex mechanism as well as autonomic responses. We infer that such studies should be done on a population basis to concur on a conclusive decision.

Conclusion

We conclude that sympathetic overactivity plays a major role in the patients suffering from low back pain whereas the role of parasympathetic reactivity from the presence study is not clear. The best way to arrive at investigative & prognostic evaluation of patients suffering from low back pain would be CPT & HGT as a standard marker of sympathetic reactivity.

We intended to find out the correlation between the back pain patients and the autonomic imbalance which can manifest in terms of autonomic neuropathy, especially cardiovascular autonomic disturbance.

With a limited no. of patients at our hand, we can predict that autonomic evaluation of MSDs can be a useful tool to assess, evaluate & prognosticate them.

References

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