International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Time Domain Analysis of Heart Rate Variability in Tension Type Headache

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Received: 12/06/2015 *Revised: 25/06/2015* *Accepted: 29/06/2015*

ABSTRACT

Background: Tension type headache (TTH) is one of the most frequent causes of consultation in both general practice and neurological clinics. Peripheral muscular factors and central sensitization have been speculated in the underlying etiopathogenesis of TTH. In a few earlier studies in TTH patients, autonomic dysfunction and sympathetic hypofunction has been suggested.
Aims and objectives: Reduced heart rate variability (HRV) is the earliest indicator of cardiac autonomic neuropathy. The study objective was to use time domain analysis of HRV to evaluate the status of autonomic nervous system in TTH patients.
Methods: We measured various time domain parameters of HRV in 50 diagnosed patients of TTH selected as per International Headache Society Diagnostic Criteria (age 20-50 years) and age and sex matched controls. HRV recording and analysis was done using physiopac and HRV Analysis Software 1.1 Finland.
Results: At comparable cycle length we found statistically significant difference ($p<0.05$) between patients and control group for NN50 (number of R-R intervals differing by >50 ms from adjacent intervals), pNN50 (number of R–R intervals differing by >50 ms from adjacent intervals divided by the total number of all R–R intervals) components in time domain of HRV.SDNN (standard Deviation of normal to normal intervals) and RMSSD (root-mean square of successive differences) components of HRV although not significantly different were found to be lower in TTH patients as compared to controls.
Conclusion: Thus short-term time domain analysis indicates altered sympatho-vagal balance in TTH patients and maybe used as an indicator of autonomic dysfunction in outpatient settings.

Keywords: Time domain analysis, Tension type headache, parasympathetic hypofunction

INTRODUCTION

Headache pain contributes not only a large burden of disability in general population but also loss of work days, diminished quality of life and considerable health care cost. [1,2] Primary headaches occur independently and are not caused by another medical condition. Migraine, cluster, and tension-type headache are the more familiar types of primary headache. The disability attributable to tension-type headache (TTH) is supposed to be larger worldwide than that due to migraine. [3,4] As per International classification of Headache

Disorders, Second Edition: TTH pain is bilateral, pressure like, mild to moderate intensity that can last from 30 minutes to 7 days and has only one accompanying symptom (e.g. nausea, vomiting, photophobia, phonophobia). Subclassified according to frequency 3 forms of TTH are distinguished: infrequent episodic TTH (fewer than 12 headaches per year); frequent episodic TTH (between 12 and 180 days per year) and chronic TTH (at least 180 days per year). [5]

Different pathophysiological factors influencing TTH have been suggested. Peripheral pain mechanisms are most likely to play a role in episodic TTH while central pain mechanisms are implicated in chronic TTH. [6] Autonomic insufficiency has an insidious onset, which is impossible to identify correctly due to the compensatory mechanism inherent within autonomic nervous system. In few earlier studies in TTH patients, a sympathetic hypofunction has been suggested. [7,8] However there are very few extensive studies on involvement of autonomic nervous system or altered sympathovagal balance in TTH patients.

Heart rate variability (HRV) is a useful and non-invasive tool for the detection of sympathetic-parasympathetic balance of autonomic nervous system in patients. Decreased resting HRV has been related to an increased risk of all-cause mortality and sudden cardiac deaths in patients. [9] In the present study HRV was analyzed in time domain to assess changes in beat-to-beat intervals that occur between consecutive heart beats. The aim of this investigation was to determine the extent to which autonomic nervous system was affected in TTH.

MATERIALS AND METHODS

The study was conducted in a major Teaching Hospital and Medical College in Mumbai with prior permission of ethics committee.

Inclusion Criteria:

Study population involved 100 subjects comprising 50 diagnosed patients of TTH (as per International Headache Society Diagnostic Criteria) from OPD's of tertiary care institute in Mumbai and 50 normal subjects; aged between 20-50 years. [5] Controls were selected on voluntary participation from employees and relatives accompanying patient to various OPD's of the institute.

Exclusion Criteria:

Subjects of age less than 20 years and more than 50 years were excluded from the study. Also subjects with history of medical illness or medication known to affect autonomic nervous system; smokers and alcoholics were excluded.

***Procedure*:**

The study was explained to the subjects both orally and in writing, and formal written consent was obtained. HRV recordings were obtained in the morning, 2 hours after a light breakfast. All subjects were asked to void urine before testing and to relax for 15 minutes in supine posture prior to the recording. Basal heart rate and systolic and diastolic blood pressure were recorded in subjects and controls. 15 minutes electrocardiogram (ECG Lead II) was recorded by INCO-Niviqure ECG & Data acquisition systems with the subjects eyes closed at supine rest and at normal respiratory frequency of 12–18/minute and Task Force recommendations for HRV were followed for analysis. [9] Data was transferred to HRV Analysis Software 1.1 developed by Biomedical Signal Analysis Group, Department of Applied Physics and University of Kuopio, Finland. A stationary 256-second RR series was chosen and RR series was extracted after artefact and ectopic exclusion. Calculated time domain indices included root-mean square of

successive differences (RMSSD), number of R-R intervals differing by >50 m sec from adjacent intervals (NN50) and proportion of RR intervals having a difference of >50msec (pNN50). [9,10]

Statistical analysis:

Statistical analysis SPSS-11 was used for all statistical analyses. Student's independent t-test was performed to study the statistical significance of differences in all basic parameters: age, basal heart rate, basal systolic BP and basal diastolic BP and HRV indices for supine rest. Data were expressed as mean ± Standard Deviation and p value equal to or less than 0.05 was taken as significant.

RESULT

Tests for normality of distribution found normal distribution for age and sex parameters between TTH patients and controls. The basal heart rate was significantly decreased in TTH patients as compared to healthy controls. However, systolic and diastolic blood pressure was not significantly different in TTH patients as compared to controls [Table 1].

Table 1: Baseline Demographic and Clinical characteristics of subjects

	TTH	Controls
No. of Cases	50	50
Age (Years)	35.96 ± 8.12	35.70± 8.33
Male: Female	24:26	25:25
Disease Duration (years)	--	6.0±1.81
Basal heart rate	78.96±7.225	82.02±7.731*
Basal Systolic BP	113.16±6.415	114.84±5.801
Basal Diastolic BP	77.2± 5.345	78.2±5.272

*p value <0.05, considered significant

Mean RR and SDNN did not differ significantly between the 2 groups. RMSSD was not significantly different in cases and controls. However, NN50, pNN50 and triangular index values were significantly decreased in TTH patients as compared to controls ($p<0.05$) [Table 2].

Table 2: Comparison of Time domain parameters in cases and controls

	Cases	Controls
SDNN (s)	0.081 ± 0.118	0.139 ± 0.203
RMSSD (ms)	68.552 ± 86.316	79.452 ± 50.266
NN50	67.92 ± 65.731	90.42 ± 45.551*
pNN50 (%)	18.894 ± 17.372	49.45 ± 21.766*

*p value <0.05, considered significant

DISCUSSION

The pathogenesis of headache is not well understood; however it seems that hyperexcitability of nociceptive pathways may play an important role in tension type headache. This sensitization process typically results in increased muscle tenderness and decreased pressure pain thresholds, particularly in patients with chronic TTH. It has also been shown that sympathetic facilitation of mechanical sensitization and facilitation of the local and referred pain reactions in muscle trigger points (TrPs) exists, confirming sympathetic responses elicited by muscle TrPs. It therefore seems sensible that impairments in the autonomic nervous system are associated with TTH. [11] With regard to TTH, hypofunction of the sympathetic nervous system has been shown by pupillometry, cardiovascular reflex testing by the tilt test and by measuring dopamine and beta-hydroxylase activity and nor-epinephrine levels during the cold pressor test. [7,12-14]

In the present study we found a significant decrease in resting heart rate in TTH patients as compared to controls. Similar finding has been reported in previous study by Deniz Yerdlen et al. where resting heart rate in patients with episodic TTH was found to be significantly

lower than that of patients with chronic TTH and control subjects suggestive of sympathetic dysfunction in episodic TTH. [15] In HRV time domain parameters SDNN is the most representative and global variability indicator. RMSSD measure estimates high-frequency variations in heart rate analysis and reflects an estimate of parasympathetic regulation of heart. [9] At rest, SDNN and RMSSD were lower in TTH patients as compared to controls although the difference was not significant. NN50 and pNN50 which are indicators of parasympathetic activity and considered as vagal indices were significantly less in TTH patients as compared to controls. Data from the present study is indicative of parasympathetic hypofunction and hence suggestive of parasympathetic autonomic neuropathy. However study in a larger sample size and using 24 hour time-domain analyses would further validate our findings.

CONCLUSION

We conclude that time domain analysis of HRV could reveal subtle yet important changes in autonomic activity in TTH patients.

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How to cite this article: Bidikar MP, Jagtap G, Chakor R. Time domain analysis of heart rate variability in tension type headache. Int J Health Sci Res. 2015; 5(7):161-165.

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