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Original Research Article

Frequency Domain Analysis of Heart Rate Variability in Tension Type Headache: A Case Control Study

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ABSTRACT

Background: Tension-type headache (TTH) is the most common primary headache. Headache pain impacts most of the population at some point in life at an enormous cost to day to day functioning. While autonomic dysfunction is known in functional headaches very few studies describe its role in TTH. Heart Rate Variability (HRV) is a non-invasive indicator of autonomic nervous system activity and is a quantitative marker of sympathetic and parasympathetic modulations in various autonomic disorders.
Aims and objectives: The study objective was to assess HRV in TTH and compare with controls. Also, we aimed to study if short-term 5 minute HRV recording is an effective indicator of autonomic dysfunction in TTH patients.
Methods: HRV was recorded 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. The overall autonomic tone, parasympathetic and sympathetic functions and sympatho-vagal balance were quantified by using various parameters.
Results: We found statistically significant difference ($p<0.05$) between patients and control group for the low frequency (LF) component of HRV. However, no statistically significant difference was found for high frequency (HF) component of HRV and LF/HF ratio between cases and controls.
Conclusion: There is a paucity of studies on autonomic dysfunction in TTH. In the present study we found that autonomic dysfunction is present in TTH. Early recognition and treatment of this may improve quality of life of TTH patients.

Keywords: Frequency domain analysis, Tension type headache, sympathetic hypofunction

INTRODUCTION

Tension-type headache (TTH) is the most common primary headache. The lifetime prevalence of TTH in the general population ranges in different studies from 30 to 78%. The average age of onset of TTH is 25-30 years and prevalence peaks between ages 30-39 years. The female to male ratio of TTH is 5:4 that means women are affected only slightly more than men. [1,2] At

the same time, it is the least studied of the primary headache disorders, despite the fact that it has the highest socio-economic impact. [3] 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). In episodic TTH, there are less than 15 attacks and in chronic TTH there are at least 15 attacks per month. [4]

Various muscular factors leading to excitation and sensitization of peripheral and central nociceptive pathways have been implicated in pathogenesis of TTH. [5] Other investigators hypothesized that TTH patients have different stress adaptive mechanisms than controls and migraineurs, involving delayed cardiovascular adaptation and reduced pain control system inhibition. [6] Previous published studies of autonomic nervous system (ANS) involvement in TTH have suggested sympathetic hypofunction in TTH. [7,8] Heart rate variability (HRV) or the beat-to-beat alteration in heart rate is a non-invasive indicator of autonomic nervous system activity. Frequency-domain analysis of HRV has been shown to be quantitative and sensitive parameter of both sympathetic and parasympathetic components of ANS.

There is lack of prospective studies evaluating autonomic function in TTH. The present study was undertaken with the aim of evaluating autonomic nervous system activity by HRV analysis in TTH patients as a measure of the resting sympathetic and parasympathetic activity.

MATERIALS AND METHODS

The study was conducted in a major Teaching Hospital and Medical College in Mumbai between 10 am to 12 noon to avoid diurnal variation in autonomic functions. All experimental procedures were approved by The Ethics Committee and subjects gave written informed consent prior to their participation. Subjects were non-smokers, had no history of taking alcohol or tobacco products and with no personal or parental history of cardiovascular, respiratory or any other known systemic disease. They did not regularly consume large caffeine (< 350 mg / day). Subjects were examined in quiet room at room temperature. 50 diagnosed patients of TTH selected as per International Headache Society Diagnostic Criteria (age 20-50 years) and age and sex matched controls were evaluated. After reporting subjects were asked to relax for 15 minutes in supine posture. Then ECG was recorded for 5 minutes in lead 2 in supine position and breathing normally. INCO-Niviqure ECG & Data acquisition systems were used for recording. Data acquired was fed into HRV Analysis Software 1.1 developed by Biomedical Signal Analysis Group, Department of Applied Physics and University of Kuopio, Finland.

The overall autonomic tone, parasympathetic and sympathetic functions and sympatho-vagal balance were quantified by using various parameters. Frequency domain (spectral) measurement of HRV were obtained by Fast Fourier Transform, and included very low frequency power (VLF, < 0.04 Hz, ms2), low frequency power (LF, 0.04-0.15 Hz, ms2), high frequency power (HF, 0.15 - 0.4 Hz, ms2) and their normalised unit (nu) values. HF is related to respiratory sinus arrhythmia and mediated solely by parasympathetic activity, whereas LF is related to baroreflex control and depends upon sympathetic and parasympathetic mechanisms. In short term recordings VLF rhythm is related with changes in mean heart rate. The component of very low frequency is estimated less often since its interpretation in short recording is unclear. [9,10]

RESULT

Table 1 gives a comparison of demographic and basal characteristics of subjects and controls. Heart rate variability analysis was done in 50 TTH patients and results were compared with heart rate variability analysis in 50 controls.

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 Blood Pressure	113.16±6.415	114.84±5.801
Basal Diastolic Blood Pressure	77.2±5.345	78.2±5.272

*p value <0.05, considered significant

The mean age of patients with TTH was 35.96±8.12 and that of controls was 35.70±8.33. The basal heart rate was significantly decreased in patients with TTH as compared to healthy controls. Other clinical characteristics like diastolic and systolic blood pressure remained comparable in the two groups. Comparison of various parameters among cases and controls was done using unpaired t-test.

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

	Cases	Controls
Low Frequency (%)	34.90±11.32	40.60±11.28*
Low Frequency (LF)	44.95±16.97	49.52±13.84*
High Frequency (%)	49.03±15.47	53.42±10.77
High Frequency (HF)	44.50±16.72	44.9±14.31
LF/HF	1.05±0.84	1.06±0.676

*p value <0.05, considered significant

Regarding short term HRV in frequency domain analysis in the TTH group, LF power indicating sympathetic activity was significantly decreased ($p<0.05$). There was no significant difference in LF/HF ratio which represents balance between sympathetic and parasympathetic activity in cases and controls.

DISCUSSION

HRV parameters have emerged as powerful, simple and convenient bedside tools to quantify integrity of ANS in both adults and children. Activity of the sympathetic and parasympathetic nervous system fluctuates continuously which results from mutual interactions. The LF power reflects modulation of sympathetic tone with contribution from the parasympathetic tone. HF power reflects modulation by the parasympathetic nervous system with respiration and blood pressure changes. [11] Statistically significant difference was found between TTH group and controls for low frequency (LF) suggesting sympathetic autonomic hypofunction. However no significant difference was found in HF suggesting normal parasympathetic function. LF/HF ratio was not significantly different in cases and controls indicating unaltered sympatho-vagal balance. This is in accordance with previous studies which reported sympathetic hypofunction by conventional cardiovascular reflex autonomic function tests. [12,13] Takeshima et al. also reported pupillary sympathetic hypofunction in TTH. [8]

Various mechanisms such as sensitization of second order neurons of the spinal cord dorsal horn/ trigeminal nucleus level, sensitization of supra-spinal neurons as well as decreased anti-nociceptive activity from supra-spinal structures have been implicated in pathogenesis of TTH. This sensitization process typically results in increased muscle tenderness and decreased pain thresholds, particularly in patients with chronic TTH. It has been shown that sympathetic facilitation of the local and referred pain reactions results in muscle trigger points thereby suggesting impairment in sympathetic function in TTH. [14]

Stress and mental tension are the most conspicuous precipitating factors in TTH. Chronic stress can increase sensitivity

to pain, lower pain threshold in sensory receptors making individuals more prone to headache pain and intensity. The autonomic sympatho-adrenal system and the hypothalamo-pituitary adrenal axis are considered to be the main neuro-endocrione systems involved in integrated stress response. Whether sympathetic hypofunction could play a role in pathogenesis of TTH or stress induced in TTH leads to sympathetic hypofunction needs to be elucidated with further investigation. [15]

CONCLUSION

There is a paucity of studies on autonomic dysfunction in TTH. In the present study we found that sympathetic hypofunction is present in TTH. Early recognition and treatment of this may improve quality of life of TTH patients.

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