HEART RATE VARIABILITY IN CERVICAL SPONDYLOSIS

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Abstracts: **Background & objectives:** Cervical spondylosis (CS) is a degenerative disease of cervical spine carrying significant morbidity. Modern lifestyle and technology has taken a toll by involving much younger age group. Autonomic nervous system influences the functions of nearly all organ systems by maintaining homeostasis, achieved by a complex integration of autonomic and somatic sensory information and descending influences from higher centres. This study assessed the level of autonomic activity in patients with CS. **Methods:** Basal heart rate variability was recorded in two groups comprising of thirty patients with CS and thirty healthy age and sex matched controls. Statistical analysis was done by using student t-test. **Results:** CS patients showed a higher degree of sympathetic tone (high LF/HF ratio) as compared to control group. **Conclusion:** Higher sympathetic tone in CS patients might predispose them to cardiovascular risk, affect the prognosis or complicate other comorbid conditions.

Key Words: autonomic activity, cervical spondylosis, heart rate variability (HRV).

Abbreviations: ANS- Autonomic nervous system, CS- Cervical spondylosis, HRV- heart rate variability, HF-high frequency, HR-heart rate, LF- low frequency, ms- millisecond, ms^2- milliseconds squared, NN50- normal to normal intervals greater than 50 ms, nu- normalized units, RMSSD- root mean square of standard deviation, SDNN- standard deviation of normal to normal intervals, VLF- very low frequency.

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Introduction:

Cervical spondylosis is a broad term which describes the age related chronic disc degeneration. Etiological factors are usually multifactorial including poor posture, anxiety, depression, neck strain and sporting or occupational activities. Aging is the major risk factor that contributes to the onset of cervical spondylosis. The degenerative changes start in the intervertebral disc with osteophyte formation which can compress one or several nerve roots at the intervertebral foramina; this compression accounts for 75% of cervical radiculopathies. The nerve roots most commonly affected are C6 and C7[1-4]. Autonomic nervous system (ANS) influences the functions of nearly all organ systems. It is responsible for maintaining homeostasis of the internal environment, achieved by a complex integration of autonomic and somatic sensory information and descending influences from higher centres. The activity and relative balance between sympathetic and parasympathetic nervous system is regulated by afferent inputs directed primarily to brain. Dysfunction of the ANS may result from diseases that affect either central nervous system (CNS) or peripheral autonomic nervous system[5-6].

Material and Methods:

This prospective random case control study was conducted in the Department of Physiology in collaboration with Department of Orthopaedics, Pt. B. D. Sharma PGIMS, Rohtak in patients with cervical spondylosis and normal healthy subjects. The study sample comprised of group I consisting of thirty randomly selected age and sex matched healthy controls and group II of thirty patients diagnosed with cervical spondylosis (age group 30-60 years of either sex). Written informed consent was taken from all the participants included in both the study groups. This study was approved by the institutional ethical committee. The whole procedure was explained in detail to each subject in his/her own language to allay any fear or apprehension. Consent was taken from every individual to undergo whole procedure. The tests were conducted during working hours (9am-1pm) to avoid diurnal variation. All the subjects were tested under similar laboratory conditions and allowed to acclimatize themselves to the experimental and environmental conditions.

Inclusion criteria –The patients with history of symptoms of cervical spondylosis for at least 6 months, restriction of neck movements, impaired dermatomal sensations and reflexes (triceps,

biceps and supinator jerks), radiating pain and radiologically diagnosed cases of CS (Plain X-ray-AP and Lateral view) were included in the study.

Exclusion criteria –The patients with acute onset of symptoms likely due to prolapsed intervertebral disc, history of smoking, any chronic drug intake in recent past which may alter the autonomic functions, history of any neck surgery and/or cervical spine injury, any infection, inflammation or malignancy or comorbid systemic disease like diabetes and hypertension were excluded from the study.

Autonomic activity in the two study groups was assessed by means of basal heart rate variability (HRV), analysed in time and frequency domains in the Department of Physiology. POWERLAB 26T POLYRITE D system with appropriate recommendations was used for recording. The subject was asked to lie down comfortably. Then 3 disposable pre-gelled electrodes were attached to left arm, right arm and left leg for ECG recording. The basal recording of ECG (lead II) was taken for 5 minutes and assessed by time and frequency domain methods[7].

Statistical analysis was done by student t-test using SPSS software. Significance of result was predicted on the basis of p value (significance level p< 0.05).

Result:

Basal heart rate and R-R intervals were compared between normal healthy subjects (group I) and patients of cervical spondylosis (group II).

Table 1. Basal heart rate and R-R intervals

Parameter	Group I (Mean ± SD)	Group II (Mean ± SD)	p value
MeanHR (beats/min)	77.73 ± 7.62	78.33 ± 7.98	0.652
Max R-R interval (ms)	893.28 ± 74.80	875.84 ± 79.77	0.404
Min R-R interval (ms)	667 ± 57.87	676.38 ± 67.88	0.583
Mean R-R interval (ms)	780.20 ± 75.40	769. 87 ± 75.16	0.307

The basal heart rate and minimum R -R interval were slightly higher in group II as compared to group I. Maximum and mean R-R interval were lower in group II, but the difference was statistically insignificant.

Table 2. Time domain analysis

Parameter	Group I (Mean ± SD)	Group II (Mean ± SD)	p value
SDNN (ms)	42.56± 19.23	36.60± 15.03	0.107
RMSSD	27.19± 12.40	20.07± 9.61	*0.011
NN 50	21.12± 24.88	13.07± 19.25	**0.036

* Statistical high significance (p<0.01)

** Statistical significance (p<0.05)

Low values of all the time domain parameters of basal HRV (SDNN, RMSSD and NN50) in group II were seen. However, the values of RMSSD (20.07±9.61, p <0.01) and NN50 (13.07±19.25, p <0.05) were significantly low in cervical spondylosis cases as compared to normal healthy controls.

Table 3. Frequency domain analysis

Parameter	Group I (Mean± SD)	Group II (Mean± SD)	p value
VLF (ms^2)	1353.53± 1452.02	1063.59± 1064.72	0.20
LF (nu)	54.59± 13.02	57.34± 17.67	0.255
LF (ms^2)	423.97± 517.49	297.71± 268.29	0.139
HF (nu)	32.36± 10.74	30.16± 13.93	0.256
HF (ms^2)	228.25± 213.24	152.88± 160.38	0.076
LF/HF ratio	2 ± 1.20	2.86±2.34	*0.042

* Statistical significance (p<0.05)

On comparison of frequency domain analysis of HRV, there were insignificant low values of LF(ms^2), HF(nu) and HF(ms^2) in group II as compared to

group I whereas value of LF/HF ratio was significantly higher (2.86±2.34, p <0.05) in group II than in group I (2±1.20).

Discussion:

Cervical spondylosis is a common progressive degenerative disease affecting the cervical spine caused by natural aging process. It is characterized by compression of spinal nerves due to degenerative changes like osteophytes, bony spurs and obliteration of disc spaces between the cervical vertebrae leading to nerve impingement. This neural compression can lead to multitude of symptoms, most common being axial neck pain and cervical radiculopathy[1].

Autonomic nervous system plays a major role in determining heart rate, stroke volume and peripheral vascular resistance to meet the appropriate requirement of the body. Numerous studies have demonstrated that increased sympathetic and decreased parasympathetic nervous system activity hikes the risk of ventricular tachycardia, ventricular fibrillation and sudden cardiac death[8]. Analysis of heart rate variability (HRV) has nowadays become one of the most popular methods of autonomic nervous system evaluation. It is based on the observation that even at rest the duration of RR intervals is not constant but continually fluctuates around the mean value. Extremely complex neural mechanisms are responsible for these fluctuations. They are based mainly on interactions between the sympathetic and parasympathetic nervous system.

Heart rate variability (HRV) describes the oscillation of the intervals between consecutive heart beats (R-R intervals), which are related to the influences of the ANS on the sinus node. HRV is a non-invasive autonomic function test and has considerable potential to assess the role of ANS fluctuations in health, disease mechanisms and actions of medications[6]. Verrier et al reviewed the recent paper by the Heart Rate Working Group comprised of European and U.S. investigators which states that heart rate is a pivotal variable that is precisely regulated in health but disrupted in disease. Heart rate is mainly indicative of the actions of the sinoatrial node and not directly related to the conducting system or the ventricular myocardium. An enhanced adrenergic activity is arrhythmogenic and efferent vagal tone is cardioprotective by opposing its action[9]. Heart rate variability is generally assessed based on time-domain or frequency-domain analysis. Although the frequency-domain analysis of HRV is much better understood, it is also mostly used for research purposes. Time-domain HRV analysis has the widest application in routine clinical evaluation and some of its indices have become well-documented, independent risk factors of cardiovascular events[10]. RMSSD and NN50 measure the short term variation in heart rate and thus are highly correlated. RMSSD is the most valuable time domain parameter for routine evaluation at rest as it provides highly reproducible results and is not influenced by mean resting heart rate[7,9]. SDNN and RMSSD are qualitative markers of vagal activity. Kleiger et al had documented that RMSSD and NN50 are correlated with SDNN and are marker of parasympathetic activity[11,12]. Low values of time domain variables observed in this study documents reduced parasympathetic tone in patients of cervical spondylosis. Srihari et al did laboratory evaluation of ANS in patients with cervical compressive myelopathy (CCM) by means of HRV and conventional autonomic function tests. Among the HRV parameters, there was increase in the total power and decrease in RMSSD, suggesting low HRV[13]. A reduced HRV has been identified as a strong indicator as a risk related to adverse events in healthy individuals and patients with large number of diseases, reflecting the vital role that ANS plays in maintaining health[14].

HRV partitions total variability of heart rate into components that reflect different autonomic influences on heart rate. The high frequency (HF) band of HRV power spectrum estimates the cardiac vagal control and the low frequency (LF) band reflects both sympathetic and parasympathetic tone. Malliani et al have proposed that LF/HF ratio is better predictor of relative levels of sympathetic as well as parasympathetic activities as opposed to absolute values of either[15]. Ruoru et al did a retrospective study on the HRV in patients with CS and deduced that it is one of the significant factors influencing the HRV. Cervical spondylosis was found to be positively correlated with SDNN, SDANN and LF[14]. So higher LF/HF ratio of basal HRV

among group II in our study suggests increased sympathetic and decreased parasympathetic tone[9,16-19].

Conclusion:

Basal HRV of group II (CS) showed an overall decreased HRV(SDNN) and a reduction in vagal tone (RMSSD and NN50) as analysed by time domain parameters. Significantly high LF/HF ratio (2.86 ± 2.34, $p< 0.05$) as evidenced by frequency domain analysis revealed a relatively higher sympathetic tone in patients with CS. This result might suggest an increased cardiovascular risk in cervical spondylosis patients and the need for HRV at the time of diagnosis, for prognostic purpose and prescription of medications.

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Source of Financial Support- Nil

Conflict Of Interest- None