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Original Research Article

Galvanic Skin Response in Patients with Cervical Spondylosis

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ABSTRACT

Cervical spondylosis is a broad term which describes the age related chronic disc degeneration. The degenerative changes start in the intervertebral disc with osteophyte formation and lead to physiological degenerative cascade that contributes to biomechanical changes that result in neural and vascular compression. 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 centers. The aim of our study was to assess the level of autonomic activity by studying the galvanic skin response in patients with cervical spondylosis and to compare it with healthy controls. Galvanic skin response (GSR) is an electro-dermal response based on the temporary change in skin electrical resistance and determines the change in electric conductivity of the skin caused by increase in activity of sweat glands. Tonic skin conductance varies with sympathetic activity. The GSR in patients of cervical spondylosis, recorded as an absolute conductance in microsiemens (μS) was found to be significantly increased ($p< 0.05$), implying a higher level of sympathetic activity.

Keywords: Cervical spondylosis, Autonomic nervous system, Galvanic skin response.

INTRODUCTION

Cervical spondylosis is a broad term which describes the age related chronic disc degeneration. Etiological factors are usually multi-factorial, 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 later affect the cervical vertebrae. The intervertebral discs with osteophyte formation, lead to physiological degenerative cascade that contributes to biomechanical changes that result in neural and vascular compression. [1,2] *Autonomic nervous system* (ANS) influences the functions of nearly all organ systems. It is responsible for maintaini1ng homeostasis of the internal environment, achieved by a complex integration of autonomic and somatic sensory information and descending influences from higher centers. 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. [3,4] Tests of autonomic functions are broadly divided into two categories: Invasive tests and non-invasive tests. [5] *Non-invasive tests* include basal heart rate

variability, postural challenge tests (head up tilt testing), Valsalva maneuver, sustained hand grip test, cold pressor test and sudomotor (sweating) function test. Non-invasive tests are commonly used due to non requirement of sophisticated instruments. Combinations of these tests are generally employed in assessment of autonomic nervous system. [6,7] *Galvanic skin response (GSR)* is based on the temporary change in skin electrical resistance. It is an electro-dermal response which determines the change in electric conductivity of the skin caused by increase in activity of sweat glands. Tonic skin conductance varies with sympathetic activity. [8]

Aims and objectives: To study the basal galvanic skin response (at rest) in patients with cervical spondylosis and to compare it with healthy controls, in order to assess the level of sympathetic activity.

MATERIALS 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 co-morbid systemic disease like diabetes and hypertension were excluded from the study.

GSR was recorded in supine position on POWERLAB 26T POLYRITE D system with sensitivity set at 40µS. Two silver metallic electrodes were attached on index and middle finger and they were mechanically stimulated to record absolute conductance in microsiemens (µS). The data obtained was compiled, tabulated and statistically analyzed.

Statistical analysis: Recordings of group I (controls) were compared with group II (patients with cervical spondylosis) by applying student t-test. SPSS software version 20 was used. Significance of result was predicted based on p value with significance set at < 0.05.

OBSERVATIONS AND RESULTS

Basal galvanic skin response was compared in normal healthy controls (group I) and patients with cervical spondylosis (group II) the following results were obtained.

Table 1: Basal GSR of group I and group II

Parameter	Group I (Mean ± SD)	Group II (Mean ± SD)	Mean% difference	p value
GSR (µS)	8.52 ± 6.52	12.90 ± 10.40	51.40%	*0.047

*statistical significance ($p<0.05$)

The basal value of GSR in group II was significantly higher ($p < 0.05$) as compared to group I.

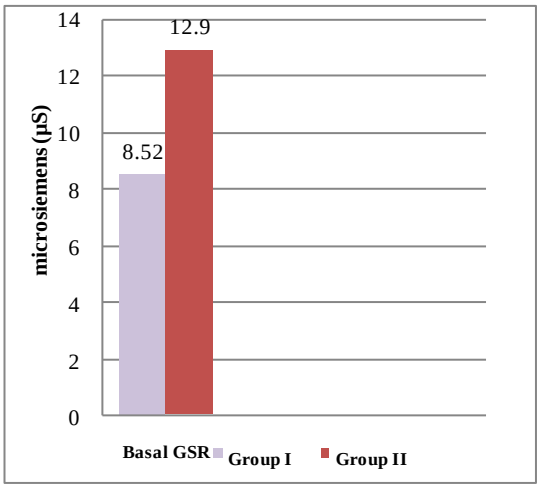

Figure 1: Comparison of basal GSR in group I and group II.

DISCUSSION

Galvanic skin response is an electrodermal response that represents a change in the electrical conductivity of the skin. The activity of sweat glands in response to sympathetic stimulation results in increased skin conductance. *Sympathetic skin response (SSR)* is based on the temporary change in skin electrical resistance in response to activation of sweat glands by various endogenous and exogenous stimuli. Galvanic skin response (GSR) is a method of measuring the electrical conductance of the skin related to the sweat gland responses. The sweat glands are controlled by the post sympathetic cholinergic system. Thus, skin conductance has been used as an indication of psychological or physiological arousal. [9]

Electrical stimulation causes a released sweat response. Sweat secretion is accompanied by change in skin conductance due to sweat electrolytes. Mechanical shear stress causes a phosphorylation cascade that removes phosphate groups from proteins and kinases, activating endothelial NO synthase. Nitric oxide is produced, facilitating the release of cyclic guanosine monophosphate, and a change in potassium permeability. The relaxation of the smooth muscle and vasodilatation of the vessels allows an exchange between vessels and the sweat glands, which facilitates the production of sweat. [10,11]

The release of acetylcholine (Ach) is regulated by the hypothalamus and, in the case of the sweat response, acts as a response to an increase in blood and/or skin temperature. The mechanical response initiated by shear stress is not dependent on a temperature increase, and in the GSR method, it appears that electrical stimulation acted as a mechanical shear stress activator. [11]

Basal GSR was significantly higher ($p < 0.05$) in patients with CS than in healthy controls. This indicates that in CS the sympathetic tone at rest is higher. Goizueta-San Martin et al studied sympathetic skin response in normal subjects and concluded that it is an objective, easy to perform and reproducible test to study the integrity of the sympathetic autonomic nervous system. [12] Li et al in their study observed that GSR is useful in detecting autonomic dysfunction in various disease conditions as well as its role in prognosis. [13] Toussirot et al studied the contribution of autonomic nervous system (ANS) to adjustments of cardiovascular function in patients with ankylosing spondylitis (AS). It was demonstrated that there is deviant balance of the ANS in AS patients, mainly a decreased parasympathetic tone as evidenced by higher HR and lower baroreflex slope. [14] Thayer et al reviewed the evidence of vagal function as a cardiovascular risk factor and concluded that decreased vagal function precedes the development of a number of risk factors, both modifiable and non – modifiable. [15]

Keeping in view some of the observations of the cited articles, it is a well known fact that any disease process of chronic nature alters the sympatho-vagal balance in the body. A persistently high level of sympathetic tone exposes the individual to the harmful effects of this

imbalance leading to exacerbation of symptoms of the disease concerned, psychological stress and cardiovascular instability. This alteration of the fine sympatho-vagal balance in the body is said to appear much earlier than the symptoms. Therefore, an early assessment of the autonomic functions in any chronic disorder might be beneficial for early diagnosis; proper drug prescription and a prognostic follow up of the patient.

Limitations of the study- GSR is a subjective test of assessing the level of sympathetic activity. Large variations may be there regarding age, sex, environmental conditions, psychological makeup of the patients and the stage of the disease process. Further, there is a lack of substantial normative data available.

SUMMARY AND CONCLUSION

Galvanic skin response (basal) is a very simple, fast and non-invasive method of assessing the sympathetic autonomic nervous system. It was found to be significantly higher in patients with CS as compared to control group ($p<0.05$), implying over-activity of the sympathetic system. An enhanced adrenergic activity is arrhythmogenic and efferent vagal tone is cardioprotective by opposing its action. [16] Thus, these patients may be predisposed to development of hypertension and cardiovascular risk, along with possible exacerbation of their symptoms. Thus, in such patients, an early diagnosis of a possible autonomic imbalance can serve to be an important tool to manage their symptomatology, co-morbid conditions and proper prescription of medicines. Last but not the least such non-invasive and quick tests can also be used for prognostic purpose.

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