International Journal of Science and Healthcare Research
Vol.2; Issue: 3; July-Sept. 2017
Website: www.gkpublication.in/ijshr.html
Original Research Article *ISSN: 2455-7587*

Effect of Cold Stimulation Induced Pain on Galvanic Skin Response in Medical Undergraduates of Kathmandu University School of medical Sciences (KUSMS)

Dr. Reena Kumari Jha[1], Miss Shreya Amatya[2], Dr. Ojaswi Nepal[3], Miss Manisha Bade[1], Mr. Mukesh Kumar Jha[1]

[1]Lecturer, Department of Physiology, Kathmandu University School of Medical Sciences
[2]Human Biology Student, Kathmandu University School of Medical Sciences
[3]Associate Professor, Department of Physiology, Kathmandu University School of Medical Sciences

Corresponding Author: Dr. Reena Kumari Jha

ABSTRACT

Background: Pain, a complex neuro-physiological process is known to elicit sympathetic responses which are monitored by measuring galvanic response of the skin. Galvanic skin response (GSR) is a change in potential recorded from the surface of the skin and represents pseudomotor activity.
Objectives: To evaluate the changes in skin conductance during the pain induced by cold stimulation.
Methods: Our study was an experimental study with the sample size of 40 including 20 males and 20 females from medical undergraduate students. Acute pain was induced by cold pressor test (immersion of hand in cold water at 4^{o}C). Changes in GSR were recorded by the AD instrument. Statistical analysis was done by using Paired "t" test.
Results: Results showed that skin conductance was significantly increased ($P<0.05$) from 4.24±2.53 microSiemens to 5.36±2.7 microSiemens in male and from 3.44±1.52 microSiemens to 4.26±1.6 microSiemens in female during cold pressor test. Immersion of hand in ice-water stimulates nociceptors, which in turn may produce a reflex via the central nervous system.
Conclusions: Our GSR findings point towards autonomic adjustments suggesting more of sympathetic over activity during cold induced acute pain.

Key words: Cold pressor test, galvanic skin response, pain

Introduction

Cold pressor test typically involves immersion of a participant's dominant hand in ice cold water for period of time. Immersion of limb in cold water has long been known to induce pain. [1] The International Association for the Study of Pain (IASP) defines pain as an "unpleasant sensory and emotional experience, associated with actual or potential tissue damage. [2] Pain is known to influence the sympathetic nervous system that is monitored by measuring galvanic response of the skin. Galvanic skin response (GSR) is defined as the changes in the electrical properties of a person's skin and can be used to measure emotional and sympathetic response by means of the activity of sweat glands. [3] When a painful stimulus (eg. Cold pressor test) is applied to an individual; pain elicits a sympathetic response by increasing sweat gland activity that increases skin conductance. Therefore, a transient increase in skin conductance is proportional to sweat secretion and these physiological changes can be measured as galvanic skin response (GSR). [4]

Cold stimulation increases the skin conductance thus, it is a good indicator of acute pain. [4] The study conducted by Harrison [5] showed during the heel lance procedure, skin conductance activity significantly increased upon lance and

remained elevated following completion of the procedure. The skin conductance peak is specific to the stimulus that induces the response and is evident within one to two seconds after stimulation. [6] Ledowski et al [7] assessed postoperative pain by monitoring skin conductance and showed sympathetic activity measured as skin conductance per second is positively correlated with subjective pain intensity evaluated by numeric rating scale among postoperative patients in the recovery room.

As pain is always subjective, therefore difficult to measure but is an important aspect of clinical medical care. Several rating tools (e.g. the visual analog score) have therefore been developed in an attempt to quantify this experience. [8] When patients cannot verbally communicate the pain as in infant, small children, unconscious or delirious patients; a fast reacting, objective, sensitive, specific method to monitor pain is needed. [7] Thus the main objective of the present study is to quantify the changes in skin conductance during the pain induced by cold stimulation.

METHODS

This is an experimental study done in Department of Physiology of Kathmandu University School of Medical Sciences, Chaukot during the period of one year from October 2015 to September 2016. Forty healthy medical undergraduates including twenty males and twenty females, aged between 18 -24 years, were selected by random sampling method. Subjects having symptom of pain and those taking analgesic were excluded from the study. The protocol was approved by the Institutional Review Committee of Kathmandu University School of Medical Sciences/Dhulikhel Hospital (IRC-KUSMS) at 20th March 2016. All participants provided a written informed consent before any study related procedure was performed.

Each subject was called individually to departmental research lab, asked to sit on the chair comfortably and relax for five minutes. Meantime electrodes of galvanoscope were wrapped around last two phalanges of index and middle finger of right hand and the baseline galvanic skin response (GSR) was recorded for one minute, called skin conductance level (SCL) by AD instrument. Acute pain was induced by cold pressor test (immersion of palm in cold water at 4°C) and the GSR was recorded till the pain was perceived, called skin conductance response. Immediately after removal of hand, GSR was recorded again for one minute.

The data of galvanic skin response thus obtained were exported to Microsoft Excel and then to Statistical Package for the Social Sciences (SPSS) for further analysis. Results were analyzed by paired t test. In all tests performed, p value <0.05 was considered to be significant.

RESULTS

Forty healthy subjects, twenty males and twenty females with a mean age of 21.4 years and 20 years, mean height 1.73 meter and 1.55 meter, mean weight 66.9 kg and 50.2kg respectively were enrolled in the present study. The demographic characteristics are presented in Table 1.

Table 1: Demographic characteristics of the subjects

Category	Gender		
	Male	Female	p-value
Age(yrs)	21.4± 1.66	20 ±1.41	<0.05
Height(meter)	1.73 ± 0.04	1.55 ± 0.12	<0.05
Weight(kg)	66.9± 12	50.2 ±5.92	<0.05
BMI	22.38± 4.21	21.19 ± 4.09	>0.05

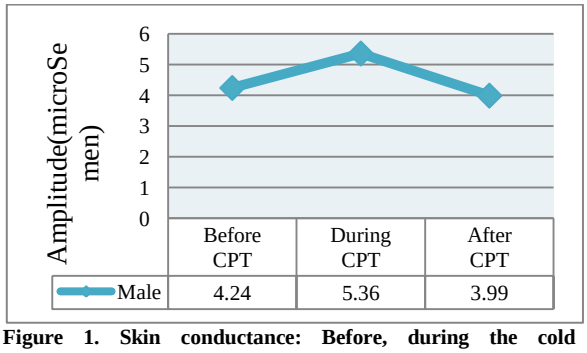

Figure 1. Skin conductance: Before, during the cold stimulation, and after the cessation of cold stimulation in male subjects.

In male, the mean value of the skin conductance was 4.24±2.53 microSiemens before the cold stimulation, which increase

significantly during cold stimulation to 5.36±2.7 microSiemens ($p<0.05$). The skin conductance returned to a near baseline value of 3.99 microSiemens, till one minute after cessation of cold stimuli (figure 1).

In female, the mean value of the skin conductance was 3.44 ± 1.52 microSiemens before the cold stimulation, which increase significantly during cold stimulation to 4.26 ± 1.6 microSiemens ($p<0.05$). The skin conductance returned to a near baseline value of 3.82 microSiemens, at one minute after cessation of cold stimulation (figure 2).

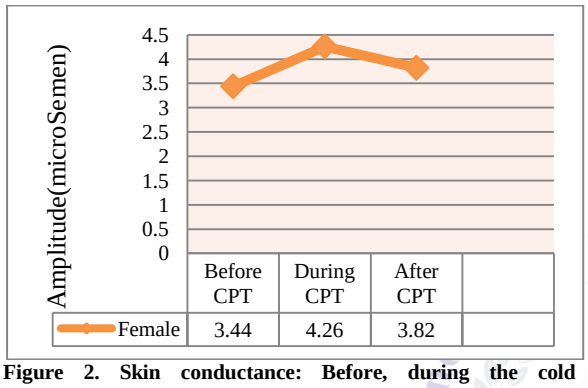

Figure 2. Skin conductance: Before, during the cold stimulation, and after the cessation of cold stimulation in female subjects.

DISCUSSION

In the present study we have recorded skin conductance during pain induced by cold stimulation in healthy subjects. As pain is always subjective, objective pain measuring tool is needed for special situation like those who can't communicate verbally (infant and children), those who are in coma, delirium. Many studies [7,9] observed that there is a strong relationship between postoperative pain and the skin conductance.

In our study skin conductance response was significantly increased in both male and female during pain induced by cold pressor test. Similar result was obtained by many studies. [4,10-14] When we terminate the pain stimulus, the skin conductance levels come back close to baseline, which was in accordance with the study conducted by Strom [6] and Khambam. [4] Each time the skin nerves are activated, the palmar and plantar sweat glands fill. This leads to a diminished skin resistance and the skin conductance increases before the sweat is reabsorbed and skin conductance again decreases. [13]

Stress is a condition that puts mind in a state of fear or anxiety. Stress such as pain is known to influence skin conductance. [15] Galvanic skin response is a result of polysynaptic reflex arch activation. The efferent part of the reflex consists of myelinated sympathetic fibers that originates from interomediolateral horn of thoracolumbar (T1 – L2) segments of spinal cord and terminates on paravertebral ganglia. Post ganglionic fibers are non myelinated and innervates the eccrine sweat glands. The central part of the reflex arc is not fully understood yet. It is presumably polysynaptic with a connection to a structure of hypothalamus, ventrolateral part of the brainstem, medial and basal part of the frontal lobe and medial part of the temporal lobe. The afferent tract of the reflex arch depends on stimulus modality. [16]

Any kind of stress including pain is known to influence sweat production. [10] The sweat ducts behaves like a resistors, as they filled with sweat, their resistance lowers and conductance increases. The amplitude of the conductance depends on the amount of sweat delivered to the ducts and on the number of sweat glands which are activated. This activation is controlled by the brain via the sympathetic division of the autonomic nervous system. Human sweat glands receive signals primarily from sympathetic cholinergic fibers that use the neurotransmitter, acetylcholine. Thus the pain induced by cold pressor stimulates sympathetic nerves which increases sweat production that decreases the resistance and increases conductance before the sweat is reabsorbed. [17] Changes in skin conductance may therefore be a sensitive and specific tool for predicting pain intensity.

CONCLUSION

Our GSR findings pointed towards autonomic adjustments suggesting more of

sympathetic over activity during cold induced acute pain. Thus the evaluation of skin conductance during cold stimulation pain in healthy subjects can be used as a simple and sensitive method for detecting pain and nociceptitive stimulation.

ACKNOWLEDGEMENTS

My sincere thanks go to all the undergraduate students who have made the research project possible. Moreover, sincere thanks to Professor Bhupendra Kumar Kapoor MD and Associate Professor Dr. Ojaswi Nepal MD, who have reviewed language usage generally as well as the scientific content of the research project.

REFERENCES

1. Ponser J, Telekes A, Crowley D, Philipson R, Peck AW. Effects of an Opiate ion Cold-induced Pain and the CNS in Healthy Volunteers. Pain. 1985; 23:73-82.
2. Barrett KE, Ganong WF. *Ganong's review of medical physiology*. McGraw-Hill Medical: New York, 2010:165
3. Galvanic Skin Response Version 3.0 http://www.tmsi.com/products/accessories 2012.
4. Khambam SKR, Naidu MUR, Rani PU, Rao TRK. Effect of cold stimulation-induced pain on pharmacodynamic responses in healthy human volunteers. *Int J Nutr Pharmacol Neurol Dis* 2012; 2: 26.
5. Harrison D, Boyce S, loughnan P, Dargaville P, Strom H, and Johnston L. "Skin conductance as a measure of pain and stress in hospitalized infants." Early Human Development 2006; 82:603-608.
6. Storm H. Changes in skin conductance as a tool to monitor nociceptive stimulation and pain. Curr Opin Anesthesiology. 2008;21:796-804.
7. Ledowski, T, Bromilow J, Paech MJ, Strom H, Schug A. "The assessment of postoperative pain by monitoring skin conductance." The Association of Anaesthetists of Great Britain and Ireland 2007;62:989-993.
8. Younger J, McCue R, Mackey S.: Pain outcomes: A brief review of instruments and techniques, Current Pain and Headache Reports. 2009; 13(1):1531-3433.
9. Storm H, Myre K, Rostrup M, Stokland O, Lien MD, Raider JC. Skin conductance correlates with perioperative stress. Acta Anaesthesiologica Scandinavica. 2002;46: 887–895
10. Shah SH, Nahar PS. "Effect of Gender Differences on Pain Parameters and Galvanic Skin Resistance in Response to Acute Cold Pain." Indian journal of Basic &Applied Medical research 2012;1(3):193-98.
11. Loggia ML, Juneau M, Bushnell MC. Autonomic responses to heat pain: Heart rate, skin conductance, and their relation to verbal ratings and stimulus intensity. *International Association for the Study of Pain* 2010; 152:592-98.
12. Chroni E, Argyriou A, Polychronopoulos P, Sirrou V. The Effect of Stimulation Technique on Sympathetic Skin Response in Healthy subjects. *Clinical Autonomic Response* 2006; 16:396-400.
13. Lidberg L, wallin B. Sympathetic Skin Nerve Discharge in Relation to Amplitude of Skin Resistance Response. *The journal of psychophysiological response* 1981; 18(3):268-70.
14. Shah SJ, Patel HM. Effect of examination stress on parameters of autonomic functions in medical students. *Int J Sci Res* 2014; 3: 273–276.
15. Dorshkind K, Horseman NS. Anterior pituitary hormones, stress, and immune system homeostasis. Bioessays. 2001; 23:288–94.
16. Elie B, Guiheneuc P. Sympathetic Skin response; normal results in different experimental conditions. Electroencepha Clin Neurophysiol. 1990;76:258-267
17. Gladman G, Chiswick ML. Skin Conductance and Arousal in the Newborn. *Archives of Disease in Childhood* 1990; 65:1063-1066.

How to cite this article: Jha RK, Amatya S, Nepal O et al. Effect of cold stimulation induced pain on galvanic skin response in medical undergraduates of Kathmandu University School of medical Sciences (KUSMS). International Journal of Science & Healthcare Research. 2017; 2(3): 55-58.

******