

Effect of Periglossal Electrical Stimulation on Haemodynamic Parameters in Stroke Patients- An Experimental Study

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ABSTRACT

Introduction: Tongue stimulation has been used in rehabilitation of wide variety of patients like sleep apnea, multiple sclerosis and stroke patients. It helps in improving swallowing functions, balance and reducing sleep apnea symptoms. Tongue stimulation is also being used in stroke rehabilitation for improving balance.

Aim: To find out the effect of periglossal electrical stimulation on haemodynamic parameters in stroke patients.

Materials and Methods: The present study was an experimental study in which, 30 stroke patients in the age group of 30-60 years, admitted during the period between October 2020-March 2021, were included. Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Respiratory Rate (RR) and oxygen saturation were measured before stimulation.

All patients were given 15 minutes of tongue stimulation once. All the haemodynamic parameters were measured during the stimulation, immediately after tongue stimulation and 15 minutes after the completion of stimulation.

Results: There were 15 males and 15 females in the study. There were no significant changes in HR, RR and oxygen saturation during tongue stimulation ($p>0.05$). Although, there were statistically significant changes in SBP, DBP during tongue stimulation, they were clinically insignificant and returned to baseline within 15 minutes after stimulation.

Conclusion: Tongue stimulation has been found to be safe and effective for rehabilitation of stroke patients with respect to haemodynamic variables.

Keywords: Blood pressure, Heart rate, Oxygen saturation

INTRODUCTION

Stroke is one of the leading causes of morbidity and mortality in the world [1]. Approximately, 40-60% of stroke patients remain dependent at six months after stroke and 33-59% of the patients remain dependent at one year [2]. Multidisciplinary approach and consistent rehabilitation are needed to decrease the disability of the patients [2]. Various therapeutic techniques have been used to rehabilitate the stroke patients. Tongue stimulation has been used in wide variety of neurological conditions like parkinsonism, multiple sclerosis, spinal cord injury, traumatic brain injury and stroke patients for improving balance, gait, eye movement control, cognitive functions and speech [3]. Tongue stimulation has also been used to induce neuroplasticity in stroke patients [3-5]. Tongue is unique with rich innervation where sensory supply is provided by trigeminal, facial and glossopharyngeal nerve and hypoglossal nerve provides motor supply and vagus nerve supplies posterior most aspect of the tongue [6].

Tongue stimulation has been found to reduce HR variability and reduce hypoxia in sleep apnea patients [7]. Tongue position also influences the whole body [8]. This position alters with emotions and mental state, thus proving as an instrument for psychological observation; feeling of fear places the tongue anteriorly [8]. When the tongue is positioned against the palate, the parasympathetic system decreases its systemic activity, but if it is positioned against the soft palate, the reverse happens [9,10]. Tongue, in addition to alimentary functions and phonation, functions as one of the important accessory muscles of respiration that helps to stiffen the upper airway walls and enlarge the upper airway lumen [8,11].

Moreover, studies have been undertaken to find out the effect of tongue stimulation along with rehabilitation techniques in improving motor functions in stroke patients. The purpose of this study was to understand the effect of tongue stimulation on haemodynamic parameters in stroke patients, as hardly any study has been done on this aspect.

MATERIALS AND METHODS

This experimental study, with pre-postexperimental design was conducted between October 2020-March 2021, in Narayana Superspecialty Hospital, Gurugram, Haryana, India. This was approved by Institutional Ethics Committee (IEC) of Narayana Superspecialty Hospital, Gurugram, Haryana and Amity University, Uttar Pradesh, Noida (AUUP/IEC/2018-AUG/06). Thirty subacute stroke patients in the age group of 30-60 years of age and both genders were included in the study after obtaining informed consent.

Inclusion criteria: Patients in subacute stage of recovery (between 2 weeks to 4 weeks after stroke onset) and who were clinically stable to undergo rehabilitation were included in the study.

Exclusion criteria: Patients with arrhythmias, history of seizures, history of head and neck surgery, and dysphagic patients were excluded from the study.

Comprehensive assessment of patients was done which includes HR, SBP, DBP, RR and oxygen saturation. Patients were given 15 minutes of electrical stimulation (Healer Combo Therapy Machine) using pen electrode at the frequency of 20 Hz (hertz), pulse width of 200 milliseconds and intensity set according to the tolerable threshold of the patients which ranged between 2.5 mA (milliampere) to 3.5 mA [12]. Tongue stimulation has been given as a part of the rehabilitation protocol which has got approval from IEC of Amity University, Noida, Uttar Pradesh and Narayana Health. Cardiopulmonary parameters were assessed during the tongue stimulation (5 minutes after the initiation of tongue stimulation), immediately after tongue stimulation and 15 minutes after completion of tongue stimulation. Tongue was examined after the stimulation for any evidence of redness.

STATISTICAL ANALYSIS

Data was analysed using Statistical Analysis System (SAS) software 9.4 version. Demographic data was represented by means of

descriptive statistics. Repeated measures ANOVA analysis was used to analyse the mean changes in HR, SBP, DBP, RR and oxygen saturation.

RESULTS

Thirty stroke patients in the age group of 30-60 years were included in the study. The mean age was 56.03±2.72 years and there were 15 males and 15 females.

There were no significant changes in HR, RR and oxygen saturation of the patients during tongue stimulation [Table/Fig-1,2]. There was a mild decrease in mean HR (2 beats) which returned to normal immediately after the stimulation, whereas the RR and oxygen saturation remained the same during the tongue stimulation. Although, there were statistically significant increase in SBP, DBP during tongue stimulation, they were clinically insignificant and repeated measures analysis revealed that SBP, DBP returned to baseline within 15 minutes after tongue stimulation ($p>0.05$) [Table/Fig-1,2].

Variables	Before stimulation	During tongue stimulation	After tongue stimulation	15 minutes after stimulation
Heart rate (beats/min)	87.37±1.63	85.87±1.63	88.00±1.63	87.50±1.63
Systolic blood pressure (mmHg)	129.53±2.87	136.30±2.87	134.00±2.87	129.80±2.87
Diastolic blood pressure (mmHg)	78.80±1.46	80.27±1.46	81.00±1.46	80.70±1.46
Respiratory rate (breaths/min)	17.37±0.24	17.87±0.24	17.87±0.24	17.73±0.24
Oxygen saturation (%)	97.27±0.20	97.37±0.20	97.63±0.20	97.50±0.20

[Table/Fig-1]: Haemodynamic changes during tongue stimulation.

Variables	Repeated measures ANOVA	Estimate±SE	p-value	
Heart rate (beats/min)	Baseline vs	During stimulation	1.500±0.928	0.1098
		After stimulation	-0.633±0.928	0.497
		15 minutes after stimulation	-0.133±0.928	0.8861
Systolic blood pressure (mmHg)	Baseline vs	During stimulation	-6.767±1.289	<0.0001*
		After stimulation	-4.467±1.289	0.0008*
		15 minutes after stimulation	-0.267±1.289	0.8366
Diastolic blood pressure (mmHg)	Baseline vs	During stimulation	-1.467±0.645	0.0255*
		After stimulation	-2.200±0.645	0.001*
		15 minutes after stimulation	-1.933±0.645	0.0536
Respiratory rate (breaths/min)	Baseline vs	During stimulation	-0.500±0.171	0.0544
		After stimulation	-0.500±0.171	0.0544
		15 minutes after stimulation	-0.367±0.171	0.053
Oxygen saturation (%)	Baseline vs	During stimulation	-0.100±0.197	0.6124
		After stimulation	-0.367±0.197	0.0656
		15 minutes after stimulation	-0.233±0.197	0.2386

[Table/Fig-2]: Repeated measures ANOVA of dependent variables. * $p<0.05$ was considered statistically significant

DISCUSSION

Electrical stimulation of tongue has been used in rehabilitation of various kinds of patients. The results of the study showed that there were no significant changes in HR, RR and saturation of the patients during tongue stimulation. Mean changes in HR were less than 2 beats during stimulation and there were no changes in RR and saturation during stimulation. Although, there were statistically significant changes in SBP and DBP during tongue stimulation, they were clinically insignificant and repeated measures analysis revealed that SBP and DBP returned to baseline within 15 minutes after tongue stimulation [Table/Fig-1,2]. Mean changes in SBP were

around 6 mmHg during stimulation but it returned to baseline within 15 minutes after stimulation. Similarly, mean changes in DBP were less than 3 mmHg during stimulation which was clinically insignificant [Table/Fig-1,2].

Tongue stimulation, given to anterior 2/3rd of the tongue, can stimulate parasympathetic system and can slower HR [13]. However, since the tongue stimulation was given for a shorter period and intermittent stimulation was given, it did not cause any significant change in HR. Thus, there was no effect of tongue stimulation on the autonomic nervous system and no significant changes in haemodynamics of the patients. The results were similar to the study done by the Shi X et al., where tongue acupuncture did not cause any significant changes in HR and BP [14].

Electrical stimulation of the lingual nerve in cats (which carries the sensation to brain through trigeminal and facial nerve) evoked blood flow increases in lower lip and palate, which is reduced by simultaneous Cervical Sympathetic Trunk (CST) stimulation [15]. CST stimulation evoked vasoconstriction in tongue [9]. This could be plausible explanation for the insignificant changes in BP during tongue stimulation in human.

Tongue can be used as a useful interface for inducing neuroplasticity in stroke patients through electrical stimulation as it does not cause clinically significant haemodynamic changes. Combination of the tongue stimulation along with balance exercises, swallowing exercises, and upper limb exercises can improve respective functions and further studies can be done to explore its benefits.

Limitation(s)

The study was limited by a smaller sample size.

CONCLUSION(S)

This study shows that tongue stimulation has been proved to be a safe technique in stroke rehabilitation with respect to haemodynamic variables. Further follow-up study can be done in a larger sample size and different age groups in order to generalise the results of the study.

Authors contribution: JJ- Conducted the study, written the manuscript. JS- Conceptualised the study, guided in making the study protocol and writing the manuscript. SK-Screening the patients and provided inputs in execution of the study. SG- Provided inputs in study protocol and manuscript writing. TM- Helped in screening the stroke patients and has provided inputs in execution of the study.

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