

Salivary Secretion and Heart Rate Variability Modified By AuriculopunctureJose F. Rivas-Vilchis^{1*}, Maria I.F. Luengas-Aguirre², Gabriel J. Manrique-Diaz³¹MD, PhD, Professor, Especialización en Acupuntura y Fitoterapia, Universidad Autónoma Metropolitana at Iztapalapa, San Rafael Atlixco 186, Ciudad de México, México 09340.²DDS, PhD, Professor, Departamento de Atención a la Salud, Universidad Autónoma Metropolitana at Xochimico, Calzada del Hueso 1100, Ciudad de México, México 04960.³DDS, Research Assistant, Departamento de Atención a la Salud, Universidad Autónoma Metropolitana at Xochimilco, Calzada del Hueso 1100, Ciudad de México, México 04960.**Corresponding Author:** Dr. Jose F. Rivas-Vilchis, Department of Health Sciences, División de Ciencias Biológicas y de la Salud, Unidad Iztapalapa, Universidad Autónoma Metropolitana. San Rafael Atlixco 186, Ciudad de México, México 09340.**Type of Publication:** Original Research Paper**Conflicts of Interest:** Nil**Abstract**

Background: Heart rate variability (HRV) is an accurate, non-invasive measure of the autonomic nervous system (ANS) activity. Auriculotherapy is used to treat dysfunctions of salivary secretion. The goal of the current study was to examine the relationship between unstimulated salivary flow rate (uSFR) with HRV frequency domain indices before and after the application of manual acupuncture in Salivary Gland 2 (SG2), and Solar Plexus (SP) ear points.

Methods: This study is designed as an experimental non-randomized, single-center trial to check if manual acupuncture in Salivary Gland 2 (SG2) and Solar Plexus (SP) auricular acupoints modifies the uSFR and HRV indices in healthy subjects with different basal uSFR. Twenty-six healthy subjects were divided into two groups according to its basal uSFR: A) lesser or B) higher. Before and after the application of auriculotherapy uSFR and HRV were measured.

Results: Auriculopuncture produced an increase in uSFR, and a decrease in HF in group A, in both cases significant. Pearson correlation coefficient analysis of the differences pre- and post-treatment between the uSFR and frequency domain indices of the HRV showed a negative correlation with HF; positive with LF, and LF/HF was found in group A significant in all cases. Conclusions: This study shows that Auriculopuncture in auricular points SG2 and SP had a more significant effect in the group with lesser uSFR; with a significant increase in uSFR that was correlated with changes in HRV compatible with a rise in sympathetic activity.

Keywords: Salivary secretion, auriculomedicine, heart rate variability, autonomic nervous system.

Introduction

The knowledge of the variables involved in the regulation of salivary secretion is of extreme importance due to the numerous disorders that are accompanied by dry mouth, especially chronic degenerative diseases (1,2). The activity of the autonomic nervous system plays a

fundamental role in the regulation of salivary secretion (3,4). The variability of heart rate (HRV) is a physiological variable that is related to the activity of the autonomic nervous system and is a valuable tool as a predictor and evolution factor of various disorders that are accompanied by alterations of the autonomic nervous system (SNA) (5,6). The HRV is evaluated by analyzing the RR intervals in electrocardiographic records. The variability indices are calculated using different algorithms in the time or frequency domains (7). The use of indices of the frequency domain bands: high frequency (HF), low frequency (LF) and the relationship LF/HF is recommended to assess the sympathetic/parasympathetic balance of the SNA (8,9).

Various acupuncture points are advocated for the treatment of hyposalivation (10-12). However, there are conflicting reports about the efficacy of acupuncture to modify the clinical course of salivary secretion disorders (13). Some of these contradictions may derive from the fact that these studies compare populations with heterogeneous basal state of salivary secretion and receiving different kinds of acupuncture treatment. Besides, we have unpublished data that indicate that the effect of acupuncture on variables related to the activity of the autonomic nervous system depends on the state of hypo or hyper-functionality of this system. The aim was to compare the effect of an intervention with auriculopuncture on unstimulated salivary flow rate (uSFR) and HRV in two samples of healthy subjects with different baseline levels of uSFR.

Materials and Methods

Subjects

This study is designed as an experimental non-randomized, single-center trial to check if manual acupuncture in Salivary Gland 2 (SG2) and Solar Plexus (SP) auricular acupoints modifies the uSFR and HRV

indices in healthy subjects with different basal uSFR. We studied 26 healthy subject members of the community of students of the educational institution. The inclusion criteria were no ingestion of drugs in a previous period of 3 days and no smoking, and without apparent diseases. Measurements were carried out with prior standard instructions given to participants that included the report to laboratory either in fasting state or 3–4 h after a light meal, refrain from coffee, tea, chewing gum or smoking 24 h before the test, and exhaustive physical activities 28 h before the test. The study conforms to the principles of the revised version of the Declaration of Helsinki (World Medical Association 2013) (14). All subjects gave their informed consent in writing, and the Institutional Ethics Committee approved the study (2.4.2018-3).

Measurement of unstimulated salivary flow rate (uSFR)

We measured the secretion of uSFR during 5 min with Whatman paper strips of 1x17 cm with a scale in millimeters, wrapped in a low-density polyethylene bag, and sterilized with ethylene oxide (15).

Heart rate variability

The variability of the heart rate was evaluated between 9:00 and 11:00 a.m. in a quiet study room with an ambient temperature of 25 °C, with the participant lying in the supine decubitus position. The process was explained to the participants in detail. After a rest period of 10 minutes, an electrocardiogram was recorded for 5 minutes. The segments of the 5-minute electrocardiogram were amplified, digitized and stored in a computer, using the SphygmoCor device (AtCor Medical, Model EM3, Sydney, Australia). The device considers only normal heartbeats, ignoring ectopic beats, to derive the statistical parameters from the normal R-R intervals (N-N intervals) of the electrocardiogram. The indices of the frequency

domain were obtained with the AtCor Medical HRV software,

Which include high-frequency power (HF) band (0.15 to 0.40 Hz) and low-frequency power (LF) band (0.04 to 0.15 Hz) and the LF:HF ratio from the spectral analysis of successive intervals NN (16,17).

Acupuncture treatment

The selection of Salivary Gland 2 (SG2) and Solar Plexus (SP) auricular acupoints was based on previous reports about their effectiveness to diminish the clinical manifestations of patients with hyposalivation [18]. Manual point location was as described in a standardization report (19), Figure 1.

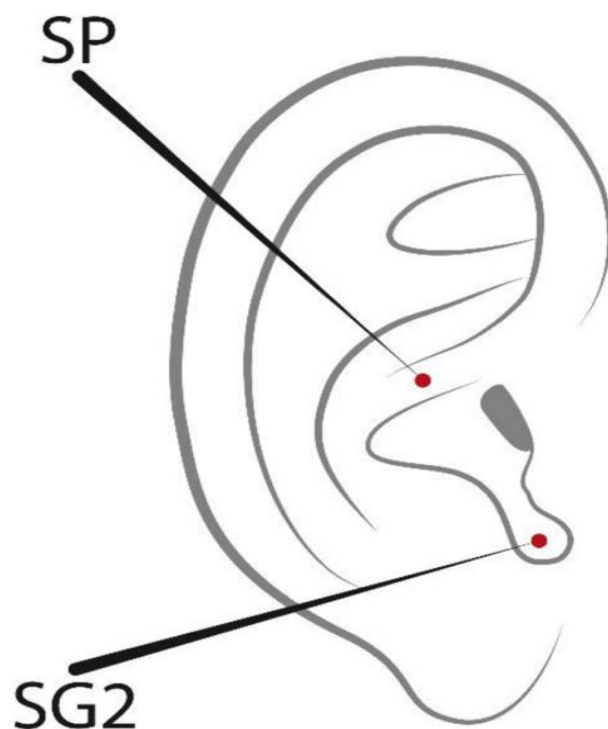


Figure 1: Auricular acupoints. **SG2:** salivary gland 2, **SP:** solar plexus.

After asepsis in the points mentioned above, acupuncture was applied with disposable stainless steel needles of 3 mm length and 0.22 mm in diameter. The needles were inserted perpendicular to a depth of approximately 3 mm at the right ear, and no additional manual or electrical

stimulation was performed, and the needles remained inserted for 1 min. A medical doctor specialized in acupuncture, and with more than 20 years of clinical experience (JFRV), conducted the auriculoacupuncture treatment.

Statistical analysis

For the analysis, the population was divided into two groups using the median (7.4 ml) of uSFR in the sample: A) subjects with lesser salivary secretion (USFR < 7.4 ml) and B) higher salivary secretion (USFR > 7.4 ml). The data are reported as mean \pm standard deviation. Paired t-Student tests were used to determine the differences between baseline versus treated values. The analysis of the correlation of variables was made through the Pearson correlation coefficient. The analysis was performed with the software SPSS 16.0 (SPSS IBM, USA). A P value <0.05 was considered significant.

Experimental procedure

All records were made with subjects in a supine position. The experimental steps were as follows:

1. Rest period 10 min.
2. Unstimulated salivary flow rate record (uSFR).
3. ECG record of 5 min.
4. Auriculopuncture application.
5. ECG record of 5 min.
6. uSFR second registration.

Results

Population

The characteristics of the groups studied: subjects of group A with a lesser salivary flow rate (<7.4 ml) and group B higher salivary flow rate (> 7.4 ml) are shown in Table 1.

Table 1: Demographic characteristics of groups: **A** subjects with the lesser salivary flow and **B** subjects with the higher salivary flow.

Variable	Group A	Group B
Female	11 (68.7%)	7 (70%)
Male	5 (31.3%)	3 (30%)
Age (n ± SD)	22.5 ± 2.4	20.8 ± 1.9

Effect of treatment with Auriculopuncture

Group A. Changes in uSFR and frequency domain indices in subjects of group A with lesser salivary secretion (<7.4 ml) are shown in Table 2. Treatment with auriculopuncture increased uSFR significantly. On the other hand, it did not modify the frequency domain indices of the HRV in a significant way.

Group B. Changes in uSFR and frequency domain indices in subjects of group B with lesser salivary secretion (<7.4 ml) are shown in Table 2. Treatment with auriculopuncture in group B consistently decreased uSFR, but not statistically significant. On the other hand, it did not modify the frequency domain indices of the HRV in a significant way.

Table 2. Unstimulated salivary flow rate and frequency domain indices in subjects with lesser salivary secretion, group A, before and after ear manual acupuncture in SG2 and SP at the right ear.

Parameter	Basal	Treated	p
Group A			
uSFR*	5.6 ± 0.91	6.3 ± 1.4	0.032*
nuHF (ms ² ; 0.15-0.4 Hz)*	54.0 ± 14.4	49.2 ± 14.9	0.417
nuLF (ms ² ; 0.04-0.15 Hz)*	45.4 ± 12.5	50.8 ± 14.9	0.320
LF/HF*	0.9 ± 0.6	1.2 ± 0.8	0.296
Group B			

uSFR*	11.3 ± 3.8	10.4 ± 2.7	0.480
nuHF (ms ² ; 0.15-0.4 Hz)*	55.3 ± 13.7	53.1 ± 11.0	0.623
nuLF (ms ² ; 0.04-0.15 Hz)*	44.7 ± 13.7	46.9 ± 11.0	0.629
LF/HF*	1.0 ± 0.6	1.1 ± 0.5	0.539

Numbers in table are: *mean ± SD

uSFR = unstimulated salivary flow rate.

HF= high-frequency, LF= low-frequency, LF/FH= low-frequency to high frequency ratio.

P-value of the t-student test for paired values.

* P< 0.05

Pearson correlation coefficients between salivary secretion and frequency domain indices in the groups studied

Group A.

The analysis using the Pearson correlation coefficient of the changes related to Auriculopuncture in uSFR versus the frequency domain indices of the HRV in group A with the lesser salivary flow is shown in Table 3. The analysis of the Pearson correlation coefficient of the differences in the pre- and post-treatment values of uSFR versus the differences in the HRV frequency domain indices in subjects with lesser salivary secretion (group A) showed the following correlations: uSFR versus HF negative, and positive versus LF and LF/HF, in all cases significant.

Table 3: Pearson's correlation coefficient between the differences in the pre- and post-treatment values of unstimulated salivary flow rate and the differences in the frequency domain indices of the heart rate variability in subjects with the lesser unstimulated salivary flow rate, group A; and the higher unstimulated salivary flow rate, group B.

Parameter	Group A		Group B	
	r	P	r	P
uSFR versus HF	-0.5816	0.0185*	-0.2751	0.2751
uSFR versus LF	0.5481	0.0262*	0.2711	0.2711
uSFR versus LF/HF	0.6037	0.0145*	-0.1800	0.1800

r: Pearson's correlation coefficient.

uSFR: unstimulated salivary flow rate.

HF: high-frequency domain; LF: low-frequency domain;

LF/HF: low-frequency to high-frequency ratio.

* $p < 0.05$

Group B. The analysis using the Pearson correlation coefficient of the changes related to auriculopuncture in uSFR versus the frequency domain indices of the HRV in subjects with higher salivary flow (group B) is shown in Table 3. The analysis of the Pearson correlation coefficient of the differences in the pre and post-treatment values of uSFR versus the differences in the frequency domain indices of the heart rate variability in subjects with higher salivary secretion (group B) showed the following correlations: uSFR versus HF negative; versus LF positive, and versus LF/HF negative, in all cases non-significant.

Discussion

In summary, treatment with auriculopuncture produced a differentiated effect on uSFR in the groups studied: uSFR increased significantly in subjects with lesser basal uSFR; whereas it decreased in a non-significant way in subjects with higher baseline uSFR. Regarding the frequency domain indices of HRV in both groups, the parasympathetic/sympathetic balance of the subjects shifted to a high sympathetic tone after treatment; however, these changes were not significant from the statistical point of view. Nonetheless, these findings agree

with the known facts that the uSFR has the salivary secretion of the submaxillary gland as an essential component, which is mainly related to the sympathetic activity of the autonomic nervous system (20).

The analysis by the Pearson correlation coefficient between the changes originated by the auriculopuncture in the uSFR versus the changes in the indices of the HRV frequency domain in group A showed that the uSFR correlates negatively with the HF index and positive with the LF and the LF/HF ratio; in all cases significantly. These results are consistent with a previous report on the effect of chewing gum on the parasympathetic/sympathetic balance assessed through HRV which found that chewing increased the sympathetic tone and stimulated salivary secretion (21). On the other hand, it has been reported that patients with Sjögren's syndrome present parasympathetic/sympathetic dysfunction, commonly with decreased parasympathetic activity (22,23). Additional studies are needed to determine the mechanisms by which auriculotherapy increases uSFR and if it is also capable of modifying stimulated salivary secretion; as well as the long-term effects of auriculotherapy on the parasympathetic/sympathetic evaluated through the HRV variability and on the dysfunctions of the salivary secretion.

Results demonstrated the ability of this auricular treatment to modify salivary secretion in healthy subjects, especially those with lesser salivary flow rate. In the future, clinical investigators may perform further studies with the treatment of auriculopuncture described in patients with hyposalivation, especially that related to autonomic dysfunctions, to assess their probable therapeutic benefits.

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