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Auriculopuncture as a regulating intervention of salivary flow

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Abstract

One of the assumptions of the application of acupuncture, when used based on the principles of traditional Chinese medicine, is that it favors the recovery of homeostasis of organic functions. Besides, experimental data showed that acupuncture produces opposite effects on the same variable. Furthermore, the effect of acupuncture depends on the initial physiological or pathophysiological state of the patient or experimental subject. We discuss the effect of ear acupuncture on unstimulated salivary flow and present a hypothetical model that suggests a possible bidirectional relationship between the effect of ear acupuncture on basal salivary flow. We hypothesize that the directionality of the effect of auriculopuncture on salivary flow depends on the basal state of salivation and allows reaching a state of equilibrium of this physiological function. The hypothesis predicts that ear acupuncture as a treatment that could facilitate the balance and modulation of a physiological phenomenon such as salivation in healthy subjects, and phase transitions, could play an essential role in regulating salivary flow homeostasis. Future research is needed to empirically evaluate the fullness of this bidirectional effect model of both ear acupuncture and body acupuncture. If such work demonstrates usefulness and predictive validity, this model will have significant implications for clinicians and experimental acupuncture.

Keywords: Auriculopuncture; Salivary flow; Mechanism; Bidirectional regulation; Mechanism; Singularity

1. Introduction

It is said that the treatment of diseases with acupuncture is based mainly on the adjustment of the body internal environment, and the cure of the disease is achieved by recovering the harmony of Yin and Yang [1]. However, these traditional statements do not always have an experimental basis and derive mainly from clinical observations or traditional beliefs. Besides, most basic studies in acupuncture focus on the linear correlation between "intervention and effect" but ignore the comprehensive network regulatory effects of acupuncture as complex interventions.

The global effect of acupuncture on the functional regulation of organ systems is a topic of increasing interest. Therefore, some biomedical researchers now propose that acupuncture has a bidirectional regulatory function that allows homeostasis to be maintained or restored. Bidirectional regulation refers to the fact that the effect of acupuncture depends on the physiological or pathophysiological state of the organism. In other words, acupuncture points can produce antagonistic effects such as excitation or inhibition [2]. For example, acupuncture with Tiaoshen Jianpi can improve the clinical symptoms and quality of life of patients with IBS-C and IBS-D by regulating different functional states (constipation and diarrhea) of the same disease (irritable bowel syndrome), reflecting the bidirectional regulation of acupuncture [3].

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We hypothesized that the effect of ear acupuncture, either increasing or decreasing unstimulated salivary flow rate (uSFR), relates to the basal level of salivary flow in healthy subjects.

2. Material and methods

We studied 36 healthy subjects in a single-center, non-randomized experimental trial to verify whether manual acupuncture at salivary gland 2 (SG2) and solar plexus (SP) right auricular acupuncture points modify salivary flow according to the basal uSFR. We measured the uSFR and applied auriculopuncture treatment as previously described [4]. The selection of Salivary Gland 2 (SG2) and Solar Plexus (SP) auricular acupoints was based on reports describing their effectiveness in diminishing the clinical manifestations of patients with hyposalivation [5], Figure 1.

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

3. Results

3.1. Unstimulated salivary flow rate

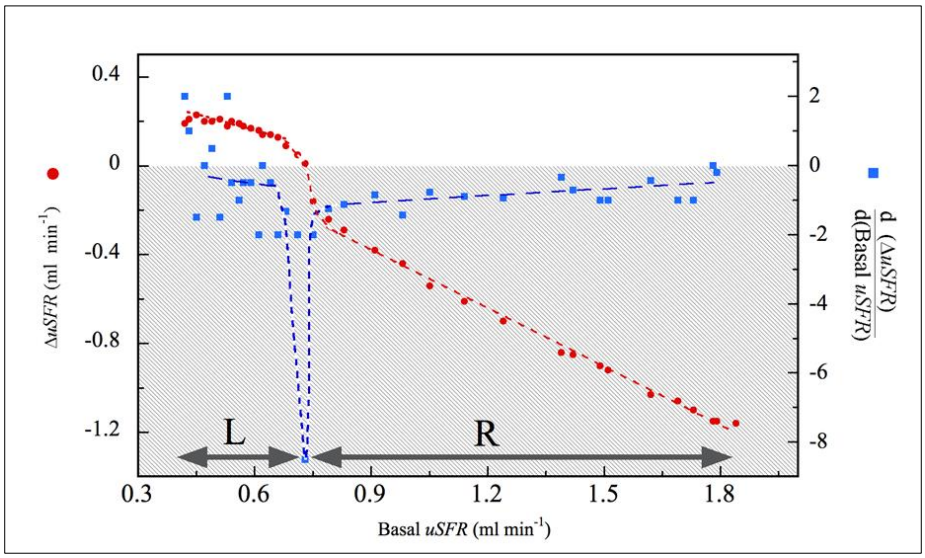

Figure 2 Salivary flow changes elicited by auriculopuncture in subjects ranked from lowest to highest unstimulated salivary flow rate (uSFR in ml•min-1), red points. The first derivative of unstimulated salivary flow rate in ml•min-1/basal uSFR of each subject, blue squares. L or left side corresponds with subjects with the lesser basal uSFR; R or right side corresponds with subjects with the higher basal uSFR

Figure 2 shows the changes in uSFR (ΔuSFR in ml•min^{-1}) produced by ear acupuncture in the total number of subjects ranked by increasing baseline uSFR (blue squares). The effect of ear acupuncture was related to baseline uSFR. The auriculopuncture treatment increased uSFR in individuals with the lower basal salivary flow (left side) and decreased it in individuals with the higher basal salivary flow (right side).Figure 2. Salivary flow changes elicited by auriculopuncture in subjects ranked from lowest to highest unstimulated salivary flow rate (ΔuSFR in ml•min^{-1}), red points. The first derivative of unstimulated salivary flow rate in ml•min^{-1}/basal uSFR of each subject, blue squares. L or left side corresponds with subjects with the lesser basal uSFR; R or right side corresponds with subjects with the higher basal uSFR.

Otherwise, the first derivative curve of the ΔuSFR curve elicited by auriculopuncture treatment on salivary flows of subjects ranked from lowest to highest uSFR curve is also shown in Figure 2, blue squares. The derivative in the transition zone forms a pronounced negative peak that corresponds to the change in the effect of the ear acupuncture on the uSFR. As a result of the polarity switch in the effect of ear acupuncture, we saw a discontinuity in the uSFR experimental values and the derivative peak. In this manner, a point corresponded to a mathematical singularity [6]. Furthermore, the first derivative of a singularity shows a discontinuity, in this case, for experimental subject nineteen, where two different derivative values occurred.

4. Discussion

Various acupuncture points are advocated for modifying hyposalivation [7 – 9]. However, there are inconsistent reports about the efficacy of acupuncture in modifying the salivary flow in different disorders [10 – 12]. Some of these contradictions may derive from the fact that heterogeneous populations with different basal states of salivary flow or receiving different kinds of acupuncture treatment are compared in these studies. Furthermore, auricular acupuncture modifies salivary flow in healthy subjects [13].

On the other hand, it has been proposed that acupuncture acts on different organic mechanisms in healthy or diseased subjects [14]. Furthermore, various experimental studies showed that acupuncture does not act unidirectionally modifying a physiological variable. Instead, it modifies a variable according to the baseline functional status. For instance, acupuncture at HT7 significantly inhibited a decrease in dopamine release during ethanol withdrawal and an increase in dopamine release after the ethanol challenge in ethanol-dependent rats. This dual paradoxical effect of acupuncture on accumbal dopamine release implies that acupuncture enables the function of the brain reward pathway to return to its physiological operating level [15].

Thus, two probable mechanisms have been proposed for the bidirectional effect of acupuncture and recovery of homeostatic balance: first, two afferent pathways of a different nature, and second, activation of different nervous and humoral mechanisms at the central level. Similarly, it has been proposed that the effect of acupuncture includes bidirectional regulation, holistic and integrative regulation, self-limiting regulation, and quality regulation [16].

The stress reaction, the central adaptive regulation, and the autonomic nervous regulation have been proposed as possible mechanisms of bidirectional regulation caused by acupuncture. Therefore, studies on the bidirectional regulation of acupuncture should be carried out despite the methodological difficulties in carrying out these studies [17].

Similarly, acupuncture is proposed to activate peripheral neural pathways that are input from the brain stem and brain circuits. Activation of central nerve pathways produces complex interactions with neurohumoral regulatory systems. These complex interactions have not been fully described [18].

4.1. Salivary flow, auricular acupuncture, and singularity

Data provides evidence that acupuncture normalizes hyper-secretive or hypo-secretive states of the uSFR in healthy subjects. Furthermore, the decrease in the range of uSFR after treatment with auricular acupuncture indicates that the treatment produces a homogenization of the uSFR. Besides, the experimental data shown allow us to propose the presence of a physiological singularity in the uSFR, with the existence of a point in the basal uSFR in which the treatment with auricular acupuncture used does not modify the uSFR. In other words, there is a physiological equilibrium point where ear acupuncture produces no change in uSFR. Otherwise, ear acupuncture below or above this uSFR level produces differentiated effects on uSFR.

This singularity phenomenon occurs in astronomical motions, quantum mechanics, and thermodynamics, particularly heat capacity changes during matter phase transitions [19]. Therefore, the regulation of salivary flow could represent a

transition phase from one regulatory process to another in a different direction. The change in the effect of auriculotherapy treatment on salivary flow can be considered a transition phase within a range of salivary flow in healthy subjects. Phase transitions commonly occur in nature at all levels of matter organization. Phase transitions have been classified based on the behavior of free energy as a function of other thermodynamic variables. Under this scheme, phase transitions are labeled by the lowest derivative of the free energy discontinuous at the transition. First-order phase transitions exhibit a discontinuity in the first derivative of the free energy concerning some thermodynamic variable.

Phase transitions play many essential roles in biological systems, and it has been proposed that some biological systems might lie near critical points. Examples include neural networks in the salamander retina [20]. This study described that the neural system also follows the laws of thermodynamics, leading to increased internal energy, free energy, and decreased entropy when the system is activated [21]. Besides, based on modeling, some authors have suggested that cortical networks could dramatically enhance stimulus representation by operating at the sub-critical to the critical transition region [22].

5. Conclusion

On the other hand, the differentiated effect of auricular acupuncture on uSFR supports the idea that acupuncture favors the balance of physiological functions. In this way, this effect is consistent with the theories that mention that acupuncture promotes homeostatic mechanisms. Likely these two aspects of the action of auricular acupuncture in uSFR correspond to the Yin-Yang theory that refers to the oscillating effects of acupuncture. Neurological systems participating in the flow regulation might be linear critical points that could be modified for acupuncture treatments. Phase transitions could play some essential roles in regulating the effect of auriculopuncture.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Statement of ethical approval

This study was performed following the ethical principles for medical research involving human subjects of the Declaration of Helsinki [23].

Statement of informed consent

The protocol, including the informed consent document, had approval from the Institutional Ethics Committee of the Universidad Autónoma Metropolitana. All participants agreed to participate in the study, received detailed information about the purpose of this investigation, and signed an informed consent document.

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