MedPharmRes

Journal of University of Medicine and Pharmacy at Ho Chi Minh City
homepage: http://www.medpharmres.vn/ and http://www.medpharmres.com/

Original article

An investigation of the change in facial pain threshold after auricular acupuncture in healthy volunteers: a pilot study

Minh Man Pham Bui[a], Ngoc Chau Le[*a] and Dieu Thuong Thi Trinh*[a]

[a]*Faculty of Traditional Medicine, University of Medicine and Pharmacy at Ho Chi Minh City, Vietnam.*

Received February 24, 2023: Revised April 12, 2023: Accepted May 15, 2023

Abstract: ***Introduction:*** Auricular Acupuncture (AA) is both a diagnostic method and a treatment used to relieve pain and alleviate addictions. The effects and biological mechanisms of AA on the human body have been increasingly observed in clinical and experimental studies based on the gate control theory and the endogenous opioids theory. The purpose of this study was to investigate changes in facial pain thresholds among healthy volunteers after applying AA to acupoints on both auricles. ***Methods:*** This was a pilot study with a crossover randomized controlled trial design. 66 healthy volunteers with normal hemodynamic indexes were randomly assigned to one of two groups to receive AA treatment at the Shenmen point, Sympathetic point, Adrenal gland point, Jaw point, and Tooth point of either the left or right auricle (phase 1). 7 days later, participants received sham acupuncture at the same points (phase 2). ***Results:*** In phase 1, the results showed that AA at these points in either auricle increased the pain threshold of the facial skin statistically significantly ($p<0.05$). No statistically significant difference was detected in the sham acupuncture phase. ***Conclusions:*** This suggests that AA can be used as a non-pharmacological adjunct to facial pain relief.

Keywords: Auricular acupuncture; facial pain threshold.

1. INTRODUCTION

Auricular Acupuncture (AA), also known as Auricular Therapy, is both a diagnostic method and a treatment used to relieve pain and alleviate addictions. The principles of AA are based on the Acupuncture of Traditional Chinese Medicine and upon Neuro-reflex therapy that were discovered in Europe [1]. An important basis in AA is the sensory correspondences between the areas of the pinna or tympanic membrane with other parts of the body, which are arranged in an inverted fetal pattern [2]. Auricular reflex points can be determined by measuring the skin resistor of points on the pinna or by observing physical changes in the auricular skin (such as color or protrusions while pressure is being applied [1]. AA is used for rapid relief of chronic pain and anxiety (effect felt within minutes of treatment). It can also be used to relieve the unpleasant symptoms of opioid withdrawal by reducing cravings for opioids [3].

The effects and biological mechanisms of AA on the human body have been increasingly observed in clinical and experimental studies, particularly the analgesic effects [1]. When the downstream neurotransmitter pathway is activated, endogenous opioids (beta – endorphins) which inhibit pain perception are released. Furthermore, according to the gate control theory (spinal segmentation mechanism), auricular acupuncture aids in the activation of pain-suppressive stimuli by myelinated afferent fibers (Aβ), as opposed to stimuli with damage from poorly myelinated (Aδ) or unmyelinated (C) fibers [4, 5, 6]. The trigeminal nerve, which is responsible for sensation in the face, has ramifications for the skin of the pinna [7]. The World Health Organization's acupuncture map includes two points that are specifically listed as having

*Address correspondence to Dieu Thuong Thi Trinh at the Faculty of Traditional Medicine, University of Medicine and Pharmacy at Ho Chi Minh City, Vietnam; Tel: +84-933-000-880, E-mail: thuong.ttd@ump.edu.vn.

functional effects on the maxillofacial region: the Tooth (LO1) and Jaw points (LO3) [8]. Referring to additional research worldwide, it can be seen that the Shen Men point (TF4), Sympathetic point (AH6a), and Adrenal gland point (TG2) on the pinna are commonly used in many diseases due to their effect on the autonomic nervous system [3, 9, 10, 11]. Clinical studies have shown that using AA on acupoints mentioned above has analgesic effects on facial pain relief [9, 10, 12]. However, previous studies mainly conducted interventions on patients with pain symptoms that can be explained based on the physiological basis of the disease related to the trigeminal nerve. The authors have not found any studies on healthy individuals to investigate whether acupuncture is truly related to the pain threshold in the facial area, which is governed by the trigeminal nerve. This research will provide a foundation for using acupuncture to treat facial pain caused by trigeminal nerve pathology. In addition, this is the first study in Vietnam to investigate the effect of AA on the facial pain threshold of healthy volunteers. Our finding suggests that AA can be used as a non-pharmacological adjunct to facial pain relief.

2. MATERIALS AND METHOD

2.1. Study settings

This study was conducted in the Acupuncture Experimental Research Lab, Faculty of Traditional Medicine, University of Medicine and Pharmacy at Ho Chi Minh City from February 2021 to September 2022.

2.2. Study design and participants

Study design: This was a pilot study with a crossover randomized controlled trial design. Crossover studies have two advantages over parallel studies and non-crossover longitudinal studies. First, the influence of confounding covariates is reduced because each crossover participant serves as their control. In a randomized non-crossover study, different treatment groups are often found to be unbalanced on several covariates. In a crossover randomized controlled trial design, such imbalances are unlikely (unless covariates were to change systematically during the study). Second, crossover designs are statistically more efficient and require fewer participants than non-crossover designs (including repeated measurement designs) [13]. Because pain threshold is subjective, each individual will have a different pain experience, making it difficult to conduct a parallel 2-arm study, and the crossover design helps eliminate this subjectivity.

Participants criteria included: Participants were between the ages of 18 and 30, with a BMI of 18 to 23 kg/m2, a heart rate of 60 to 99 beats per minute (bpm), a supine blood pressure of less than 140/90 mmHg, and no medical conditions. The participants had no prior exposure to auricular acupuncture. On the day of the AA, none of the participants reported a psychological stress issue (as evaluated by using Depression Anxiety Stress Scale-21 with stress point less than 15 points [14]).

Participant's elimination criteria: Exclusion criteria included volunteers who were over the age limit, had acute diseases, used stimulants (coffee, alcohol, or cigarettes) within 24 hours of the study, exercised immediately before the study, or took heart rate or blood pressure medications within the previous month. Additionally, pregnant or menstruating females were excluded.

Criteria to stop research: Participants who expressed a desire to withdraw from the study or overreacted to parasympathetic stimulation symptoms at the stimulus site, such as dizziness, nausea, vomiting, and allergy, met the criterion. These incidents would be reported as adverse events.

2.3. Sample size and sampling

The sample size n is calculated using the following formula:

$$n = \frac{2xC}{ES^2} \; ; C = \left(z_{\frac{\alpha}{2}} + z_{\beta}\right)^2 ; ES = \frac{\mu_1 - \mu_2}{\sigma}$$

Formula note: n is the sample size needed for each group in this study, and ES is effect size. ES value equivalent to Cohen's D in the previous study is 0.51 [15]. The sample size required to detect an effect with power = 0.8 of standardized effect size (alpha = 0.05; beta = 0.20; C =7.85). Accordingly, the sample size for each group is 33, the total sample of the study is 66.

2.4. Conducting method

Research subject reception

Participants were recruited, and the procedures were explained. Volunteers would sign an informed consent form prior to participating in the study.

Randomization

In this study, after the informed consent forms were signed, participants were randomly assigned to two groups, each receiving a different set of treatments. Participants in group A received AA at TF4, AH6a, TG2, LO1, and LO3 points in the left auricle (phase 1), and one week later, sham acupuncture at the same points (phase 2). Participants in group B received AA at TF4, AH6a, TG2, LO1, and LO3 points in the right auricle (phase 1), and one week later, sham acupuncture at the same points (phase 2).

Equipment

Device for measuring pain thresholds: The facial pain thresholds before and after AA or sham acupuncture were measured on both sides with the Multi-capacity Digital Force Gage FDIX of Wagner Inc (Newton Unit of Measurement).

Auricular acupuncture: We used the press needles (0.06 - 0.5mm diameter, 1.3-3.0mm length) for auricular acupuncture. For sham auricular acupuncture, we used pieces of tape that are similar in appearance to press needles. This sham acupuncture method was mentioned in Zhang's study (2014) [16].

Auricular acupuncture process

Participants were exposed to the environment for 10 minutes in order to stabilize their breathing rate, blood pressure, and heart rate, as well as to stop sweating [17].

The facial pain thresholds were recorded before and after performing AA or sham acupuncture. **Table 1** describes the location of facial pain threshold survey points.

Figure 1. Acupoints location

Table 1. Location of facial pain threshold survey points

Neural Regulation	Point	Area	Specific location
V1	Above	Head	Left = 1 cm left and 1 cm anterior of the vertex (intersection of the line connecting the tops of the auricle and the longitudinal center of the head). Right = 1 cm right and 1 cm anterior of the vertex (intersection of the line connecting the tops of the auricle and the longitudinal center of the head)
	Middle	Forehead	Left = 1 cm above the centre of the left eyebrow Right = 1 cm above the centre of the right eyebrow
	Below	Nose	Left = 1 cm left of the tip of the nose Right = 1 cm right of the tip of the nose
V2	Above	Forehead	Left = 2 cm to the left of the left outer corner of the left eye Right = 2 cm to the right of the right outer corner of the right eye
	Middle	Cheek	Left = the intersection of the horizontal line from the side of the left nose and the straight line from the outer corner of the left eye Right = the intersection of the horizontal line from the side of the right nose and the straight line from the outer corner of the right eye
	Below	Perioral area	Left = 1 cm to the left of the bottom of the philtrum Right = 1 cm to the right of the bottom of the philtrum
V3	Above	Head	Left = 5 cm above the left helix Right = 5 cm above the right helix

Middle	Jawline	Left = the outer left of the jawbone Right = the outer right of the jawbone
Below	Chin	Left = 1 cm to the left of the bottom of the chin Right = 1 cm to the right of the bottom of the chin

The acupuncturist has a medical doctor's license and has been trained in acupuncture. Acupuncture was done at including Shenmen (TF4), Sympathetic point (AH6a), Adrenal gland points (TG2), Jaw (LO3), and Tooth (LO1). The location of acupoints was determined according to the World Federation of Acupuncture and Moxibustion Societies - WHO Regional Office for the Western Pacific in 2013 [8].

Both before and after acupuncture, auricles were cleaned with 70% alcohol, regardless of laterality.

In phase 1, the acupuncturist used 4 needles per patient (0.06 - 0.5mm diameter, 1.3-3.0mm length), with one needle for each acupoint. Every 5 minutes, the acupuncturist stimulated the acupoints by gently pressing down until a sensation of burning, soreness, numbness, distension, or heat was felt (this sensation is known as "de qi") was felt for approximately 30 seconds. This was repeated 3 times while the volunteers rested. The needles were then removed.

In phase 2 (7 days later), the acupuncturist performed all the aforementioned routines except for using four pieces of tape instead of needles.

The auricular acupuncture process was described in **Figure 2.**

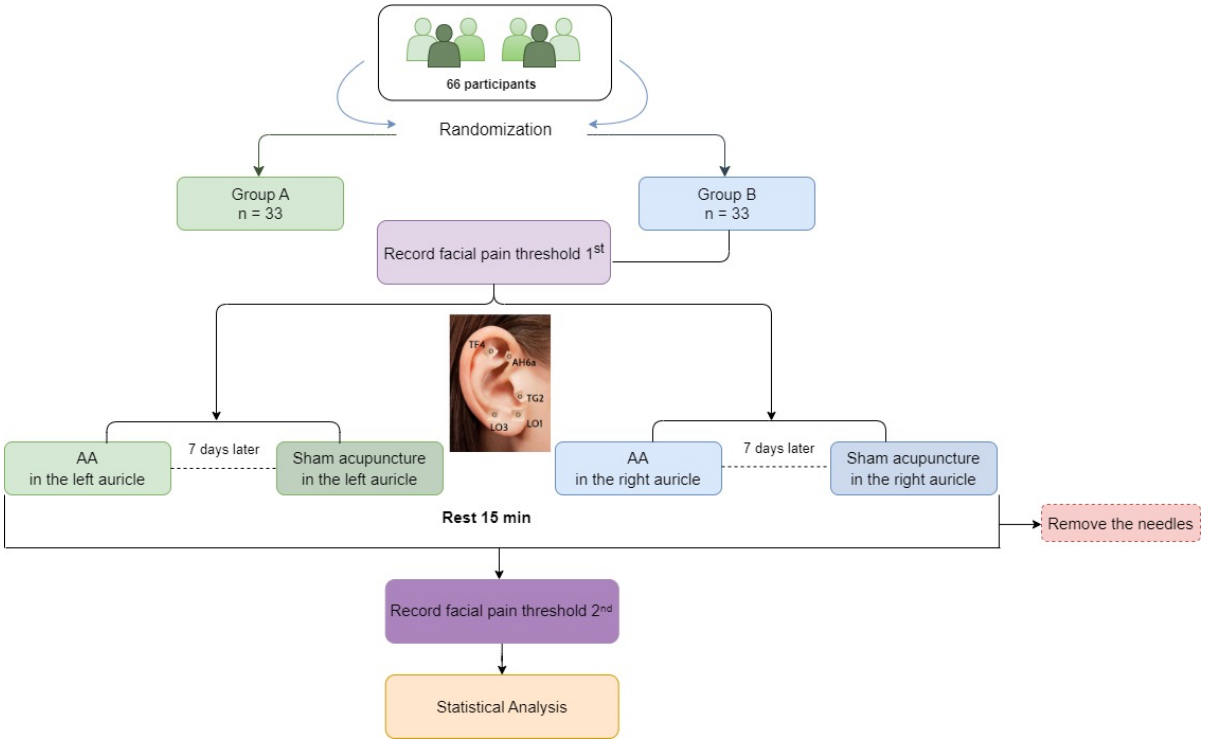

Figure 2. Diagram of intervention in two groups

2.6. Outcome Measurement

The facial pain thresholds on 9 points on both sides (see **Table 1**) before and after inserting needles was the primary outcome, quantitative variable, measured with the Multi-capacity Digital Force Gage FDIX of Wagner Inc (Newton Unit of Measurement).

2.7. Statistical method

For statistical analysis, Wilcoxon sign-rank test and Independent t-test were done in R studio v2022.02.3+492.pro3. The significant level was set as $p<0.05$.

3. RESULTS

3.1. Participant flow

There were no participants who dropped out or were excluded from the study. All 66 participants were recorded and their data were transferred to a blinded analyst. It took 40 minutes to finish one phase per participant and a total of 30 days for the whole study.

3.2. General characteristics of the study population

Table 2. General characteristics of participants included in each group at the start of the trial. There were no significant differences in sex, age between the experimental and control group ($p > 0.05$). The difference in basic characteristics of the experimental and control groups was not significant (t test, $p > 0.05$). Each participant's heart rate, blood pressure, respiratory rate, SpO2, and BMI were within the normal range, which is necessary for safety participants.

Table 2. General characteristics of the study sample

Characteristics	Group 1 (Left ear)	Group 2 (Right ear)	p-value
Gender (No.,%)			
Male	6	7	
Female	27	26	
Age (years) Median (IQR)	22.84 (22-23)	22.78 (21-24)	0.8501
HR (bpm) Median (IQR)	72 (67-78)	75.5 (71-85)	0.7113
SBP (mmHg) Median (IQR)	107 (104-111)	109.5 (101-116)	0.5697
DBP (mmHg) Median (IQR)	66 (63-68)	69 (63-71)	0.0409

3.3. Comparison of facial pain thresholds before and after applying auricular therapy at Shen Men, Sympathetic, Adrenal gland, Jaw, and Tooth of the left ear

The pain thresholds on the facial skin increased statistically significantly ($p<0.05$) after participants in group A received AA at TF4, AH6a, TG2, LO1, and LO3 points in the left auricle. In contrast, sham acupuncture did not significantly affect the facial pain thresholds. The results are described in Tables 3 and 4 below.

Table 3. The pain thresholds on the face before and after applying AA at Shen Men, Sympathetic, Adrenal gland, Jaw, and Tooth of the left auricle

			Min (N)	1st Qu. (N)	Median (N)	Mean (N)	3rd Qu. (N)	Max (N)	p
V1L	Above	Before	2.200	2.800	3.700	3.958	4.800	7.300	**0.0001**
		After	3.100	4.200	4.900	5.330	5.900	8.900	
	Middle	Before	0.600	2.000	2.300	2.621	3.200	6.700	**0.0001**
		After	1.300	2.800	3.500	3.691	4.500	7.100	
	Below	Before	0.600	1.100	1.300	1.588	1.900	3.600	**0.0001**
		After	1.200	1.800	2.500	2.661	3.200	5.700	
V1R	Above	Before	1.000	3.300	3.900	4.000	4.500	7.900	**0.0001**
		After	1.800	4.700	5.300	5.209	5.900	8.200	
	Middle	Before	0.900	1.800	2.500	2.582	3.400	4.500	**0.0003**
		After	1.800	2.800	3.400	3.667	4.600	5.900	
	Below	Before	0.700	1.100	1.500	1.764	2.300	4.300	**0.0001**

		After	1.200	1.900	2.400	2.642	3.300	5.700	
V2L	Above	Before	1.000	2.000	2.600	2.873	3.300	6.900	**0.0001**
		After	1.900	3.200	3.600	4.155	4.800	9.000	
	Middle	Before	1.100	1.700	2.600	2.836	3.400	5.900	**0.0001**
		After	1.600	2.400	3.500	3.952	5.300	6.700	
	Below	Before	0.500	1.000	1.200	1.239	1.400	2.100	**0.0004**
		After	0.900	1.500	1.900	1.958	2.400	3.200	
V2R	Above	Before	1.200	2.200	2.700	2.864	3.300	6.800	**0.0002**
		After	1.400	3.300	4.200	4.155	4.900	7.400	
	Middle	Before	1.200	2.000	2.500	2.839	3.300	6.600	**0.0001**
		After	1.800	3.100	3.500	4.021	4.500	7.200	
	Below	Before	0.700	0.900	1.200	1.230	1.400	2.300	**0.0001**
		After	1.100	1.400	1.800	1.912	2.400	3.100	
V3L	Above	Before	1.200	2.800	3.400	3.409	4.000	6.000	**0.0001**
		After	2.100	3.700	4.600	4.773	5.500	8.200	
	Middle	Before	1.500	2.400	3.000	3.206	3.900	5.700	**0.0001**
		After	2.500	3.600	4.500	4.685	5.500	8.200	
	Below	Before	1.200	1.600	2.200	2.352	2.800	4.800	**0.0003**
		After	1.800	2.700	3.400	3.527	4.400	6.500	
V3R	Above	Before	1.600	2.800	3.600	3.597	4.300	6.700	**0.0001**
		After	2.700	3.600	4.500	4.718	5.400	7.700	
	Middle	Before	1.500	2.400	3.000	3.279	4.000	5.800	**0.0002**
		After	2.100	3.800	4.200	4.388	4.500	7.600	
	Below	Before	1.200	2.000	2.400	2.570	3.000	4.800	**0.0001**
		After	1.800	2.900	3.400	3.612	4.500	5.500	

Note: L = the left half of the face, R = the right half of the face.

Statistical tests: Wilcoxon signed-rank test.

Table 4. The pain threshold on the face before and after applying sham acupuncture at Shen Men, Sympathetic, Adrenal gland, Jaw, and Tooth of the left auricle

			Min (N)	**1st Qu. (N)**	**Median (N)**	**Mean (N)**	**3rd Qu. (N)**	**Max (N)**	**p**
V1L	Above	Before	2.300	3.400	4.000	4.297	5.100	8.300	0.1842
		After	2.500	3.400	3.900	4.319	5.300	8.500	
	Middle	Before	1.400	2.300	3.200	3.061	3.600	6.300	0.2418
		After	1.400	2.300	3.000	2.994	3.600	6.000	
	Below	Before	0.800	1.300	1.700	1.830	2.300	4.100	0.7914
		After	0.700	1.400	1.700	1.858	2.200	4.400	
V1R	Above	Before	2.000	3.200	3.700	4.383	5.200	8.200	0.1241
		After	2.000	3.300	4.000	4.445	5.200	8.500	

	Middle	Before	1.200	2.300	2.700	2.867	3.400	5.300	0.5965
		After	1.100	2.500	2.800	2.912	3.300	4.800	
	Below	Before	0.900	1.200	1.600	1.815	2.200	5.200	0.1255
		After	0.800	1.400	1.700	1.912	2.400	4.400	
V2L	Above	Before	1.600	2.400	3.200	3.355	3.800	6.500	0.1255
		After	1.800	2.600	3.200	3.458	4.000	6.400	
	Middle	Before	0.800	2.300	3.000	3.448	4.500	9.400	0.1495
		After	1.200	2.400	3.100	3.564	4.300	10.000	
	Below	Before	0.600	1.000	1.200	1.312	1.600	2.900	0.2565
		After	0.800	2.300	3.000	3.448	4.500	9.400	
V2R	Above	Before	1.400	2.400	3.100	3.267	3.800	6.200	0.1301
		After	1.400	2.700	3.000	3.397	3.700	6.800	
	Middle	Before	1.300	2.200	2.800	3.085	3.900	7.000	0.6088
		After	1.300	2.300	2.900	3.106	3.700	5.900	
	Below	Before	0.500	1.100	1.300	1.352	1.600	2.600	0.2565
		After	0.600	1.200	1.300	1.388	1.700	2.300	
V3L	Above	Before	1.100	3.200	3.600	3.933	4.600	7.100	0.6464
		After	2.500	3.500	3.800	4.018	4.500	6.600	
	Middle	Before	1.400	2.700	3.300	3.691	4.400	5.900	0.0930
		After	1.700	3.000	3.600	3.797	4.500	5.800	
	Below	Before	1.300	2.100	2.600	2.679	3.200	5.000	0.0933
		After	1.300	2.200	2.600	2.842	3.600	4.800	
V3R	Above	Before	1.600	3.000	3.500	3.870	4.400	6.800	0.1768
		After	2.100	3.200	3.600	3.982	4.700	7.000	
	Middle	Before	2.000	2.900	3.400	3.579	4.000	6.300	0.2011
		After	1.500	2.800	3.500	3.688	4.100	6.200	
	Below	Before	1.300	2.100	2.500	2.794	3.200	5.200	0.2433
		After	1.200	2.200	2.600	2.861	3.400	5.600	

Note: L = the left half of the face, R = the right half of the face.

Statistical tests: Wilcoxon signed-rank test.

3.4. Comparison of facial pain thresholds before and after applying auricular therapy at Shen Men, Sympathetic, Adrenal gland, Jaw, and Tooth of the right ear

The pain thresholds on the facial skin increased statistically significantly ($p<0.05$) after participants in group B received AA at TF4, AH6a, TG2, LO1, and LO3 points in the right auricle. In contrast, sham acupuncture did not significantly affect the facial pain thresholds. The results are described in Tables 5 and 6 below.

Table 5. The pain thresholds on the face before and after applying AA at Shen Men, Sympathetic, Adrenal gland, Jaw, and Tooth of the right auricle

			Min (N)	**1st Qu. (N)**	**Median (N)**	**Mean (N)**	**3rd Qu. (N)**	**Max (N)**	**p**
V1L	Above	Before	1.300	3.600	4.500	4.509	5.100	7.700	**0.0016**

		After	2.900	4.300	5.300	5.300	5.900	8.700	
	Middle	Before	0.700	2.300	3.000	2.936	3.600	5.500	**0.0120**
		After	1.700	2.800	3.800	3.591	4.400	5.800	
	Below	Before	0.900	1.200	1.500	1.661	2.000	3.400	**0.0139**
		After	0.800	1.500	1.900	2.042	2.400	4.200	
V1R	Above	Before	2.200	3.400	4.000	4.470	5.500	6.900	**0.0010**
		After	3.400	4.200	5.300	5.673	7.300	8.600	
	Middle	Before	1.100	2.300	2.800	2.803	3.300	4.500	**0.0028**
		After	1.500	3.200	3.600	3.703	4.400	6.100	
	Below	Before	0.500	1.300	1.600	1.712	1.900	3.400	**0.0029**
		After	0.600	1.800	2.200	2.258	2.800	3.600	
V2L	Above	Before	1.500	2.500	2.800	3.067	3.800	5.400	**0.0009**
		After	2.100	2.900	3.600	3.836	4.600	7.200	
	Middle	Before	1.500	2.200	3.100	2.985	3.400	5.200	**0.0013**
		After	2.200	2.900	3.400	3.679	4.200	7.700	
	Below	Before	0.400	1.000	1.300	1.306	1.600	2.100	**0.0006**
		After	0.400	1.300	1.500	1.673	2.200	2.600	
V2R	Above	Before	1.300	2.100	2.800	2.991	3.900	5.200	**0.0005**
		After	1.700	3.000	3.800	3.930	4.800	6.800	
	Middle	Before	1.300	2.300	3.000	3.124	3.700	5.600	**0.0001**
		After	1.500	3.600	4.100	4.194	4.800	6.900	
	Below	Before	0.300	1.000	1.300	1.276	1.600	2.000	**0.0001**
		After	0.800	1.500	1.900	1.852	2.100	3.400	
V3L	Above	Before	1.700	3.100	3.500	3.597	4.200	5.400	**0.0010**
		After	1.900	3.800	4.200	4.442	5.400	7.200	
	Middle	Before	1.600	2.500	3.000	3.239	3.600	6.000	**0.0057**
		After	2.500	3.200	3.500	3.961	4.300	7.500	
	Below	Before	1.200	1.800	2.700	2.482	3.000	4.000	**0.0043**
		After	1.300	2.400	3.000	3.139	3.900	5.500	
V3R	Above	Before	1.300	2.600	3.500	3.400	4.100	5.400	**0.0002**
		After	2.500	3.900	4.500	4.718	5.400	7.600	
	Middle	Before	1.400	2.500	3.300	3.248	3.800	5.900	**0.0009**
		After	2.300	3.400	4.300	4.409	4.900	8.100	
	Below	Before	1.000	1.800	2.300	2.315	2.600	4.800	**0.0001**
		After	1.400	2.900	3.400	3.433	3.800	5.900	

Note: L = the left half of the face, R = the right half of the face.

Statistical tests: Wilcoxon signed-rank test

Table 6. The pain thresholds on the face before and after applying sham acupuncture at Shen Men, Sympathetic, Adrenal gland, Jaw, and Tooth of the right auricle

			Min (N)	1st Qu. (N)	Median (N)	Mean (N)	3rd Qu. (N)	Max (N)	p
V1L	Above	Before	2.200	3.600	4.300	4.545	5.300	7.000	0.7376
		After	2.500	3.600	4.200	4.530	5.300	7.500	
	Middle	Before	1.400	2.200	3.000	3.003	3.600	4.700	0.4798
		After	1.400	2.200	3.200	2.979	3.600	4.500	
	Below	Before	0.600	1.200	1.500	1.730	1.800	5.400	0.7778
		After	0.700	1.200	1.400	1.712	2.000	5.500	
V1R	Above	Before	2.600	3.500	4.300	4.452	5.000	7.500	0.2798
		After	2.600	3.500	4.300	4.494	5.200	7.400	
	Middle	Before	1.600	2.200	3.000	2.942	3.500	4.400	0.5366
		After	1.600	2.400	2.800	2.936	3.400	4.500	
	Below	Before	0.800	1.200	1.600	1.706	2.000	3.600	0.5722
		After	0.500	1.300	1.700	1.788	1.900	4.800	
V2L	Above	Before	1.800	2.800	3.400	3.406	3.800	6.800	0.9719
		After	1.800	2.800	3.300	3.403	3.800	6.700	
	Middle	Before	1.500	2.500	3.100	3.195	3.400	5.600	0.1424
		After	1.300	2.800	3.100	3.276	3.700	6.000	
	Below	Before	0.400	0.900	1.200	1.261	1.500	2.100	0.2346
		After	0.500	1.000	1.200	1.318	1.700	2.500	
V2R	Above	Before	1.800	2.800	3.100	3.333	3.700	5.000	0.4798
		After	2.100	2.800	3.300	3.391	3.700	5.500	
	Middle	Before	1.200	2.500	3.300	3.152	3.900	5.000	0.9438
		After	1.300	2.400	3.000	3.079	3.700	5.500	
	Below	Before	0.500	1.200	1.300	1.388	1.600	2.400	0.3575
		After	0.400	1.200	1.400	1.509	1.600	5.500	
V3L	Above	Before	2.000	3.500	4.000	4.042	4.800	5.900	0.1887
		After	2.200	3.500	4.200	4.118	4.800	6.400	
	Middle	Before	2.100	3.200	3.600	3.655	4.200	5.900	0.5722
		After	1.900	3.200	3.500	3.645	4.100	5.800	
	Below	Before	1.000	2.000	2.700	2.645	3.300	4.600	0.2960
		After	1.200	2.000	2.700	2.745	3.400	4.200	
V3R	Above	Before	2.300	3.500	3.800	4.030	4.500	6.800	0.3669
		After	2.400	3.500	3.900	4.058	4.500	6.600	
	Middle	Before	1.800	3.000	3.300	3.467	3.800	5.800	0.6720
		After	2.100	3.000	3.300	3.500	3.900	6.000	
	Below	Before	0.900	2.000	2.500	2.582	3.000	4.500	0.9719

After	1.100	1.900	2.400	2.570	3.200	4.500

Note: L = the left half of the face, R = the right half of the face.

Statistical tests: Wilcoxon signed-rank test

4. DISCUSSION

The main finding of this study is that AA at TF4, AH6a, TG2, LO1, and LO3 of either the left or the right auricle significantly increased the pain threshold on both sides of the face ($p<0.05$).

This finding is consistent with the function of these acupoints as described in the World Federation of Acupuncture and Moxibustion Societies: AA in the Shenmen, Sympathetic point, Adrenal gland point, Jaw point, and Tooth point groups is effective in relieving pain and and anxiety [8].

Besides, the results of the study are consistent with the structure and main function of the trigeminal nerve, which is to provide sensation and inner movement to the face. Three branches on either side of the trigeminal nerve connect to various areas of the face. In the Meckel cave of the cranial cavity, these branches connect to the trigeminal ganglia. The ophthalmic (V1), maxillary (V2), and mandibular (V3) nerves are the various branches [7]. There is limited research on the specific mechanism of action of auricular acupuncture on the trigeminal nerve, but some theories have been proposed. Auricular acupuncture involves the stimulation of specific points on the ear, which are believed to correspond to different areas of the body. One theory suggests that auricular acupuncture may modulate the activity of the trigeminal nerve by activating the vagus nerve. The vagus nerve has anti-inflammatory and analgesic properties, and it can modulate pain processing in the central nervous system [18]. Stimulation of the vagus nerve can also activate the release of endogenous opioids and other neuromodulators that can reduce pain perception and increase pain threshold [18]. Another theory proposes that auricular acupuncture may modulate the activity of the hypothalamic-pituitary-adrenal (HPA) axis, which is a pathway that regulates the body's response to stress and inflammation. Acupuncture has been shown to affect the activity of the HPA axis, which can modulate pain processing in the central nervous system [19]. Overall, the mechanism of action of auricular acupuncture on the trigeminal nerve is likely similar to that of traditional acupuncture, involving the modulation of multiple pathways and systems in the central and peripheral nervous system [20, 21, 22]. However, further research is needed to fully understand the specific mechanisms underlying the effects of auricular acupuncture on the trigeminal nerve.

This study also has similarities with previous studies. According to Simmons and Oleson's research, when applying AA, the threshold of dental pain increased statistically significantly ($p<0.0001$) when compared to the threshold of background tooth pain (dental pain threshold was determined using a hand-held dental pulp tester). When compared to the pre-intervention pain threshold, the average pain threshold increased by 18% ($p<0.01$), while the control group increased by only 0.85% [12]. In a group of patients with the temporomandibular joint disorder, the pain intensity (according to the VAS scale) decreased by 61% after 1 week and by 84% after 1 month of AA ($p<0.01$) [9]. Furthermore, in the same study, the group of participants who received AA improved significantly in lower jaw function and quality of life-related to mastication over time ($p<0.01$) [9]. Iunes' study discovered pain relief in tender points in the mandibular posterior region ($p=0.04$) and the right side of the submandibular region ($p=0.02$) after AA, as well as pain relief with left lateral temporomandibular joint activity ($p<0.01$) [10]. The pain scores on the face pain scale (FPS-R) differed significantly between the two groups of dementia residents with acute pain in nursing homes. The AA group's facial pain score was 1.84 ± 0.23, compared to 2.22 ± 0.81 in the sham AA group. Caregivers' satisfaction and patient acceptance were significantly higher in the AA group than in the sham AA group [23].

New point

The above studies, however, have not yet comprehensively evaluated how AA affects the facial pain thresholds in healthy people. In addition, these studies only investigated the pain-relieving effects of AA in the left ear, without assessing the effect of AA in the right auricle. Meanwhile, our study looked at how the physiological pain threshold changed in healthy volunteers who received auricular acupuncture.

Conclusion

In conclusion, we examined changes in the facial pain thresholds after AA at TF4, AH6a, TG2, LO1, and LO3 of either the left or the right auricle in 66 healthy volunteers using a pilot study design. The results showed that AA at these points in either auricle increased the pain threshold of the facial skin statistically significantly ($p<0.05$). Our study is among the first to investigate the effects of AA on the facial pain threshold.

LIST OF ABBREVIATIONS

AA: Auricular acupuncture

ETHICAL STATEMENT

All participants received the informed consent form (ICF) before to participation in the study. When the patient signed the ICF, the research officially began. All participant data is kept private and secured in a cabinet that only the researchers have access to.

The study protocol was approved by the Institutional Review Board (IRB-VN01002/IRB00010293/FWA00023448).

FUNDING

Funding for this study was provided in parts by research grants from University of Medicine and Pharmacy at Ho Chi Minh city.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ACKNOWLEDGEMENTS

The authors would like to thank the Faculty of Traditional medicine, University of Medicine and Pharmacy at Ho Chi Minh city for kindly providing us with the Acupuncture Laboratory.

AUTHORS' CONTRIBUTION

Designing the study: Minh Man Pham Bui and Ngoc Chau Le; Methodology: Minh Man Pham Bui and Ngoc Chau Le; Validation: Minh Man Pham Bui and Dieu Thuong Thi Trinh; Writing original draft: Minh Man Pham Bui and Ngoc Chau Le; Writing review and editing: Minh Man Pham Bui and Dieu Thuong Thi Trinh.

ORCID ID

Minh Man Pham Bui https://orcid.org/0000-0003-3277-5567.
Ngoc Chau Le https://orcid.org/0009-0006-5397-2606.
Dieu Thuong Thi Trinh https://orcid.org/0000-0002-3886-3210.

REFERENCES

1. Hou PW, Hsu HC, Lin YW, Tang NY, Cheng CY, Hsieh CL. The History, Mechanism, and Clinical Application of Auricular Therapy in Traditional Chinese Medicine. Evidence-based complementary and alternative medicine : eCAM. 2015;2015:495684. Epub 2016/01/30. doi: 10.1155/2015/495684. PubMed PMID: 26823672; PubMed Central PMCID: PMCPMC4707384.
2. Gori L, Firenzuoli F. Ear acupuncture in European traditional medicine. Evidence-based complementary and alternative medicine : eCAM. 2007;4(Suppl 1):13-6. Epub 2008/01/30. doi: 10.1093/ecam/nem106. PubMed PMID: 18227925; PubMed Central PMCID: PMCPMC2206232.
3. Ahlberg R, Skårberg K, Brus O, Kjellin L. Auricular acupuncture for substance use: a randomized controlled trial of effects on anxiety, sleep, drug use and use of addiction treatment services. Subst Abuse Treat Prev Policy. 2016;11(1):24. Epub 2016/07/28. doi: 10.1186/s13011-016-0068-z. PubMed PMID: 27451854; PubMed Central PMCID: PMCPMC4959048.
4. Oleson T. Neurophysiological Basis of Auricular Acupuncture. 2001. p. 97-112.
5. Safi S, Ellrich J, Neuhuber W. Myelinated Axons in the Auricular Branch of the Human Vagus Nerve. Anat Rec (Hoboken). 2016;299(9):1184-91. Epub 2016/06/28. doi: 10.1002/ar.23391. PubMed PMID: 27342906.
6. Woolf CJ, Mannion RJ. Neuropathic pain: aetiology, symptoms, mechanisms, and management. Lancet. 1999;353(9168):1959-64. Epub 1999/06/17. doi: 10.1016/s0140-6736(99)01307-0. PubMed PMID: 10371588.
7. Pinessi L, Gentile S, Rainero I. Neurology book. Neuroanatomofisiologia e semeiotica neurologica-Neurological anatomy, physiology and semiology: Edi. Ermes; 2012.
8. Trade ISoA. Auricular Acupuncture Point (WFAS STANDARD-002: 2012): Issued by World Federation of Acupuncture-Moxibustion Societies (WFAS) on May, 2013. World Journal of Acupuncture - Moxibustion. 2013;23(3):12-21. doi: 10.1016/S1003-5257(13)60055-0.
9. de Salles-Neto FT, de Paula JS, Romero J, Almeida-Leite CM. Acupuncture for pain, mandibular function and oral health-related quality of life in patients with masticatory myofascial pain: A randomised controlled trial. J Oral Rehabil. 2020;47(10):1193-201. Epub 2020/07/16. doi: 10.1111/joor.13055. PubMed PMID: 32668487.
10. Iunes DH, Chaves Éde C, Moura Cde C, Côrrea B, Carvalho LC, Silva AM, et al. Role of Auriculotherapy in the Treatment of Temporomandibular Disorders with Anxiety in University Students. Evidence-based complementary and alternative medicine : eCAM. 2015;2015:430143. Epub 2015/10/27. doi: 10.1155/2015/430143. PubMed PMID: 26495012; PubMed Central PMCID: PMCPMC4606196.
11. Wang J, Zhang J, Sun D. Randomized Crossover Study of Auricular Plaster Therapy to Relieve Dental Anxiety in Children. Front Psychiatry. 2022;13:862575. Epub 2022/06/18. doi: 10.3389/fpsyt.2022.862575. PubMed PMID: 35711607; PubMed Central PMCID: PMCPMC9193370.
12. Simmons MS, Oleson TD. Auricular electrical stimulation and dental pain threshold. Anesth Prog. 1993;40(1):14-9. Epub 1993/01/01. doi: PMC2148627. PubMed PMID: 8185085; PubMed Central PMCID: PMCPMC2148627.
13. Lim CY, In J. Considerations for crossover design in clinical study. Korean J Anesthesiol. 2021;74(4):293-9. Epub 2021/08/05. doi: 10.4097/kja.21165. PubMed PMID: 34344139; PubMed Central PMCID: PMCPMC8342834.
14. Le MTH, Tran TD, Holton S, Nguyen HT, Wolfe R, Fisher J. Reliability, convergent validity and factor structure of the DASS-21 in a sample of Vietnamese adolescents. 2017;12(7):e0180557. doi: 10.1371/journal.pone.0180557.
15. Vaira LA, Massaiu A, Massaiu G, Salzano G, Maglitto F, Lechien JR, et al. Efficacy of auriculotherapy in the control of pain, edema, and trismus following surgical extraction of the lower third molars: a split-mouth, randomized, placebo-controlled, and triple-blind study. Oral and maxillofacial surgery. 2023. Epub 2023/02/04. doi: 10.1007/s10006-023-01140-y. PubMed PMID: 36735078.
16. Zhang CS, Yang AW, Zhang AL, May BH, Xue CC. Sham control methods used in ear-acupuncture/ear-acupressure randomized controlled trials: a systematic review. Journal of alternative and complementary medicine (New York, NY). 2014;20(3):147-61. Epub 2013/10/22. doi: 10.1089/acm.2013.0238. PubMed PMID: 24138333; PubMed Central PMCID: PMCPMC3948482.
17. Trinh D-TT, Nguyen Q-CT, Bui M-MP, Nguyen V-D, Thai K-MJE-BC, Medicine A. Heart Rate Variability during Auricular Acupressure at Heart Point in Healthy Volunteers: A Pilot Study. 2022;2022.
18. He W, Wang X, Shi H, Shang H, Li L, Jing X, et al. Auricular acupuncture and vagal regulation. Evidence-based complementary and alternative medicine : eCAM. 2012;2012:786839. Epub 2013/01/11. doi: 10.1155/2012/786839. PubMed PMID: 23304215; PubMed Central PMCID: PMCPMC3523683.
19. Li S, Wang Y, Gao G, Guo X, Zhang Y, Zhang Z, et al. Transcutaneous Auricular Vagus Nerve Stimulation at 20 Hz Improves Depression-Like Behaviors and Down-Regulates the Hyperactivity of HPA Axis in Chronic Unpredictable Mild Stress Model Rats. Frontiers in neuroscience. 2020;14:680. Epub 2020/08/09. doi: 10.3389/fnins.2020.00680. PubMed PMID: 32765210; PubMed Central PMCID: PMCPMC7378324.
20. Wang C, Liang J, X Z. Auricular acupuncture regulates pain-related proteins in the trigeminal ganglion of rats with chronic constriction injury. Neural Regeneration Research. 2019;14(6):1066-70.
21. Xue P, Li X, J L. Auricular acupuncture for trigeminal neuralgia: A systematic review and meta-analysis. Evidence-based complementary and alternative medicine. 2018:1-14.
22. Yeh CH, Chiang YC, Hoffman SL, Liang Z, Klem ML, Tam WW, et al. Efficacy of auricular therapy for pain management: a systematic review and meta-analysis. 2014;2014.
23. Zhang J-J, Yu L, Mei J-H, Wang H-X, Gao H-X, Fu J-F, et al. Effect of Auricular Acupressure on Acute Pain in Nursing Home Residents with Mild Dementia: A Single-Blind, Randomized, Sham-Controlled Study. Evidence-Based Complementary and Alternative Medicine. 2022;2022:6406383. doi: 10.1155/2022/6406383.