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RESEARCH ARTICLE

The Use of Auricular Examination for Screening Hepatic Disorders

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Abstract

Researches on auricular acupuncture (AA) have examined mainly its treatment effects. This study aimed to investigate the accuracy and precision of using auricular examination (AE) as a complementary diagnostic tool for screening hepatic disorders. Twenty patients suffering from liver dysfunction and 25 controls aged 18–60 years were recruited from an acute hospital. Participants were examined using three AE methods including visual inspection, electrical skin resistance measurement, and tenderness testing on the liver AA zone of both ears. Significant differences were found in visual inspection and electrical skin resistance on the AA zones between the two groups. Patients suffering from liver dysfunction tended to have at least one abnormality in skin color, appearance, presence of papules, abundance of capillary and desquamation on the ear (Relative Risk—Right ear: RR=2.9, 95% confidence interval (CI) 1.4, 6.2; Left: RR=1.8, 95% CI, 1.01, 3.1). The sensitivity for visual inspection was 0.7 for both ears; specificity was 0.76 for the (R) and 0.6 for the (L) ear. The mean difference in electrical skin resistance was 4.3 MΩ (95% CI, 1.7, 6.9) for the (L) ear; 4.5 MΩ (95% CI, 1.5, 7.6) for the (R) ear. Our results suggest that malfunction of the liver appeared to be reflected by the presence of morphological changes on the liver AA zone. Visual inspection and electrical skin resistance on the liver AA zone are potentially sensitive to screen hepatic disorders.

1. Introduction

Auricular acupuncture (AA) as a microsystem of acupuncture was described implicitly in the Yellow Emperor Classic of Internal Medicine; and more scientifically and formally proposed by Nogier, a French acupuncturist, in the 1950s [1]. The microsystem defines the phenomenon that circumscribed body area reflects different parts of the whole body; so that changes in AA zones may reflect the status of the corresponding body areas [2–4]. The arrangements of the reflections usually are not in scale to the body part, but in a systematic order [4]. The order may be presented in the form of an inverted fetus with the head towards the ear lobe, the trunk in the middle and the legs towards the upper rim of the auricle. This linkage between the AA zone and the corresponding organ is referred to as the organ projection area, which allows AA to serve as a diagnostic tool. AA pioneers claimed that they were able to identify the physical condition through simple auricular examination (AE) in ancient time [3].

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Auricular assessments usually include visual inspection, detection of electricity property, testing of tenderness spots, and staining [5]. Most modern scientific research on auriculotherapy focused on its intervention effects [6,7]. Some studies explored the use of AA in broader disciplines, e.g., nursing [8], while others investigated the treatment effect of AA for patients with specific conditions, e.g., prostate cancer [9]. Very few well controlled scientific research has been conducted to examine the diagnostic accuracy of AE.

A simple, non-invasive, convenient, and economical clinical examination is potentially useful for health screening and prophylactic purposes. Several clinical studies have investigated the diagnostic accuracy of AA, and they usually examined the change in skin resistance in AA zones. Indeed it has been shown that measuring electrical skin resistance of dermal zones has the potential to serve as a diagnostic tool for internal organ pathologies [10]. In fact, high degree of diagnostic accuracy has been reported by some of the research [11]. More specifically, a study demonstrated electrical resistance of ear acupuncture points has 75.2% correct detection rate for corresponding musculoskeletal pain [12]. Another study demonstrated that patients with gastric ulcer and duodenal ulcers had a different skin resistance when compared with normal control subjects [13]. The present study aimed to examine the accuracy and precision in using AA zone examination as a screening test for hepatic disorders.

2. Materials and Methods

2.1. Study design and sample size

This was a double blind case-control study. As no previous research has reported any effect size relevant to the outcome measures used in this study, we started by recruiting five liver patients and five control subjects. The relevant outcome variables were then measured and input into a sample size software (PASS2005, Utah, USA). It was estimated that 46 subjects, i.e., 23 in each of the experimental and control groups, would be needed in order to achieve 0.8 power at the 0.05 significance level to test the hypothesis that at least 30% more subjects in the experimental group would have noticeable change on the ear.

2.2. Participants

A total of 20 patients (PAT group) were recruited from the Department of Gastroenterology and Hepatology in a local acute hospital. These patients suffered from a wide variety of liver diseases, including acute and chronic conditions, as well as different degrees of severity. They could suffer from liver cancer, or acute hepatitis; or were hepatitis carriers. In addition, 25 controls (CON group) were recruited from other wards in the same hospital. For all the 45 participants, we performed liver function tests on each of them. It was confirmed that the patients were all currently suffering from liver dysfunction, defined as derangement of liver function in blood test. To be specific, all patients had abnormal findings in two or three liver enzymes level, namely alkaline phosphate (ALP), aspartate aminotransferase (AST), and alanine aminotransferase (ALT). The detected levels of all the three enzymes in the CON group were within normal range (ALP: 47–137 U/L; AST: 15–40 U/L; ALT: 6–53 U/L), and had no known history of any liver diseases.

The assessor (SW), who was a physiotherapist with qualification in acupuncture, was blinded from the health status of the subjects. Three auricular examinations including visual inspection, skin electrical resistance measurement, and tenderness testing were carried out on both ears of the participants in room light. The location of the AA zones was adopted from the China National Standardization of AA Zones [14]. Ethics approval was given by the University and carried out with the ethical standards set forth in the Helsinki Declaration of 1975. Informed consent was obtained from all participants prior to data collection.

2.3. Visual inspection

The assessor performed visual inspection on the liver AA zone (Figure) [15] in the ears to detect any noticeable changes in terms of skin color and color change, appearance, presence of papules, abundance of capillary and desquamation. “Present” was given if any of the special features were noticed; otherwise “Absent” was recorded.

2.4. Electrical skin resistance measurement

For electrical property of the liver AA zone, the electrical skin resistance was detected using the ohmmeter function of a multimeter with two pointer-electrodes (972A, Hewlett-Packard Development Company, USA). The inactive electrode was placed on the upper ear root with minimal pressure, where no AA zone was located. The active electrode was placed on the liver AA zone. The pressure applied onto the AA zones was sustained at a light touch level that was just strong enough to detect the reading. Electrical resistance was recorded in Mega Ohms (MΩ) and the electrodes were sustained for 10 seconds. Each AA zone was tested three times. Intra-rater reliability was high as the intra-class correlation

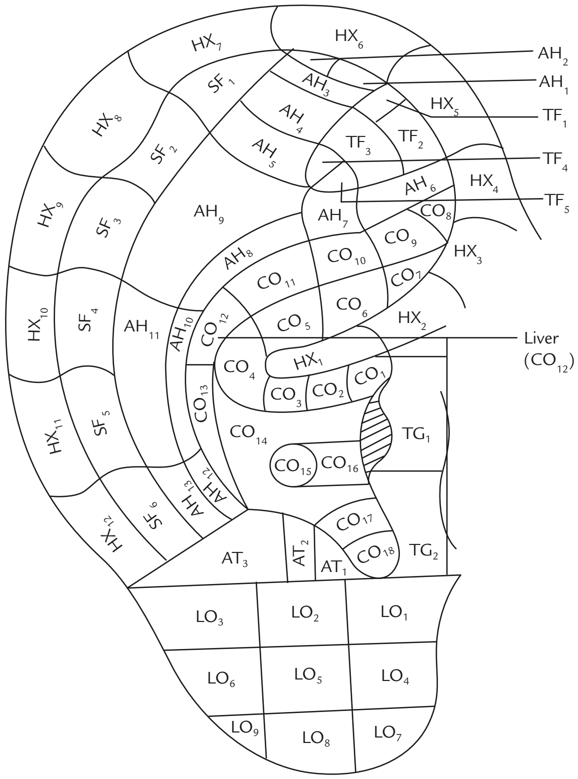

Figure The auricular acupuncture zone (adapted from *Chinese Auricular Acupuncture*, 1995:30).

coefficient ICC(2,1) was 0.87 (95% CI, 0.81, 0.91). The average resistance of the three trials was then calculated and used in subsequent statistical analysis.

2.5. Tenderness testing

The AA zone of Tooth (LO10) was used as the reference zone. Pain threshold of the tooth zone was measured by applying force up to 5 Newton (N) by the use of a pressure algometer with a pointer of 0.25 mm radius. The force measured served as a reference value and the same force was applied onto the liver AA zone. The subject was then asked to grade the severity of pain as compared to the reference zone: score "0" referred to less painful or having similar pain level as he/she felt on the reference zone; "1" referred to mildly more painful; while "2" referred to experiencing significantly greater pain. The same and only assessor performed the testing for all subjects.

2.6. Statistical analysis

Pearson chi-squared and Fishers' exact test were used to analyze the difference in visual inspection and tenderness between the PAT and CON subjects. Two-sample t-test was used for analyzing electrical skin resistance. The effect sizes (relative risk for visual inspection and tenderness, and mean difference for electrical skin resistance) along with their 95% confidence intervals were calculated. Because of multiple testing, the *p* values reported have been adjusted for using the Sharpened Bonferroni method [16]. SPSS for Windows V15.0 was used for all data analysis. The statistician was blind to group allocation.

3. Results

There were more males in the PAT than in the CON group (75% *vs*. 50%, $p=0.019$); however gender was not significantly associated with any of the outcome variables and hence was not adjusted for in subsequent analyses. Mean (±SD) age was not significantly different (PAT group: 39.4±2.8; CON group: 32.5±2.1-years-old; $p=0.051$) between the two groups. Nine (45%) of the 20 patients had their ALP outside the normal range; 19 (95%) had their AST and ALT deviated from the normal range.

3.1. Visual inspection

As compared to control subjects, more participants in the PAT group (70% *vs*. 40%; RR=1.8; 95% CI, 1.01, 3.1; $p=0.045$) had at least one noticeable change on the (L) ear. The sensitivity of this examination was 0.7 and the specificity was 0.6. The difference was much greater in the (R) ear (70% *vs*. 24%; RR=2.9; 95% CI, 1.4, 6.2; $p=0.004$); with a sensitivity of 0.7 and a specificity of 0.76.

3.2. Electrical skin resistance measurement

PAT patients had an average electrical skin resistance of 14.8±4.1 MΩ for the (L) ear and 14.5±4.4 for the (R) ear, which were lower than the corresponding findings found in the control subjects ((L) ear: 19.1±4.9; (R) ear: 19.0±6.1). The mean difference for the (L) ear was 4.3 (95% CI, 1.7, 6.9; $p=0.008$), and for the (R) ear was 4.5 (95% CI, 1.5, 7.6; $p=0.009$).

3.3. Tenderness testing

Similar findings were observed in the two groups, and consistent between the two ears (Table). To be specific, 68% of PAT patients (compared to 75% for the (L) ear and 65% for the (R) ear in the controls) reported that the tenderness experienced at the liver zone was not greater than the reference zone. The sensitivity of detecting hepatic dysfunction by this part of AE was not ideal; only 0.32 for both ears. Although the specificity was high [(L) 75%, (R) 65%], the false positive rate [(L) 53%, (R) 57%] and false negative rate [(L) 38%, (R) 47%] were not low.

Table Tenderness testing on liver zone

	Group		p value
	Healthy (n=25)	Patient (n=20)	
(L) ear			
0*	15 (75.0%)	17 (68.0%)	0.822
1*	4 (20.0%)	7 (28.0%)	
2*	1 (5.0%)	1 (4.0%)	
(R) ear			
0*	13 (65.0%)	17 (68.0%)	0.746
1*	4 (20.0%)	6 (24.0%)	
2*	3 (15.0%)	2 (8.0%)	

*0 = pain not greater than the reference zone; 1 = pain mildly greater than the reference zone; 2 = pain significantly greater than the reference zone.

4. Discussion

4.1. Testing using a standardized approach

Studies on traditional Chinese medicine (TCM) are sometimes viewed as not objective enough because the procedures and observational techniques employed in many TCM studies are not reproducible or not standardized. Indeed, to date, no standardized methods in measuring electrical resistance on AA zones are available. Practitioners typically use a detector that gives only audio or visual (qualitative) feedback for examining the electrical resistance of AA zone. Only very few scientific researchers used devices that displayed the actual value (quantitative feedback) of the electrical property. However, variations in AE techniques may affect the accuracy of measurements of electrical resistance. For example, electrical resistance would be affected by the choice of placement of the inactive pole, and the pressure of the probe on AA zone. For some AE equipment, a connection of the inactive pole to the upper limb is required. As a result, the force of the hand grip would influence the readings. When the pressure on the electrode increases, the electrical resistance drops and vice versa. Moreover, if the two electrodes are located too far apart, the body composition between the two electrodes may also influence the readings. In this study, we adopted a more objective approach. We placed the inactive pole at a standard zone on the ear in order to shorten the path of the electrical circuit and minimize the effects from other body areas. A consistent, minimal light touch that is just adequate to detect the electrical skin resistance on the AA zone was maintained. This can minimize the influence of various factors contributed by the subject. In addition, the inactive pole was placed at the ear root where no AA zone is found. The electrical resistance measurement on the target AA zone would not be affected by the placement of inactive pole because it does not represent any other body areas.

4.2. Visual inspection

Dysfunction of the liver could be reflected by the morphological changes appear on the corresponding AA zone (the organ projection area) [17]. Our results are consistent with those findings reported in previous studies. For example, a study testing the diagnostic accuracy of silicosis by inspecting the lung AA zone reported that 74% of 223 patients had positive findings, compared with 14% in the controls [18]. Another study examined the presence of white or brown plum blossom-like pits in stomach AA zone reported 98% accuracy in diagnosing stomach cancer [11].

Visual inspection was graded "Presence" or "Absence" as morphological changes observed on the AA zones may suggest different pathologies; one morphological change may not imply a more severe pathology than another. As a health screening test and for primary investigation purposes, this dichotomy differentiation using "Presence" or "Absence" of liver dysfunction may have over-simplified the situation, but it could serve as a simple and quick screening method to be performed in clinical settings.

4.3. Electrical skin resistance measurement

From the auriculotherapy point of view, somatotopic pathological change of a body area could be reflected by increased skin conductivity and decreased electrical resistance on its corresponding AA zone [17]. A study reported that 95% of 20 patients with cardiac diseases, compared to none in 30 healthy controls, had a positive 10 μA or more deflection of current at the "heart" AA zone [19]. The present study demonstrated that patients with liver diseases also had a lower mean electrical skin resistance.

From a physiological perspective, changes in electrical resistance on AA zones could be a result of alterations of the electrical resistance on the underlying cell membranes [20]. There are lots of blood capillaries, nerve and sweat glands on the external ear. Low electrical resistance can be explained by the sympathetic control of blood vessels [12]. The activation of sudomotor sympathetic nerves might cause a change in skin moisture and result in a decrease of electrical resistance [21]. During the study, the room temperature has been controlled at 24°C; and no subjects have reported sweating during the study.

There is abundant nerve supply to the external ear. The vagus nerve supplies nerve branches to most of the pulmonary system and the alimentary tract and associated secretion glands including the liver [22]. Significant differences between the two studied groups in both visual inspection and electrical resistance measurement could imply that the vagus nerve potentially acts as the pathway transmitting signals between the liver and the liver AA zone. Wang commented on the topographic distribution of areas with lowered electrical resistance with respect to the ear chart [20], and postulated that when a particular body part or system is not functioning well, the electrical resistance on its cell membranes would be lower. The signal is then picked up and sent to the central nervous system through the meridians. The nerve cells stimulated in the central nervous system would send signals to the corresponding AA zone and change its electrical property consequently. To date, there has been no solid evidence for supporting the presence of meridians or the linkage of organ projection area in an auricular zone with its respective organ. But Cho et al (1998) demonstrated a correlation between acupoint stimulation and the activities of the corresponding brain cortices area as measured by functional magnetic resonance image [23].

4.4. Testing of tender spots

Testing on tenderness level of AA zones is a possible clinical method to localize the origin of the disease and the respective area can be selected as treatment zones. We did not find any significant differences in the tenderness testing between patients and controls. Although specificity was at an acceptable level, the sensitivity was low. Moreover, its value in making diagnosis remained doubtful with high false-positive and false-negative rates, which implied that many patients were wrongly diagnosed as healthy and many normal people were incorrectly diagnosed as having a disease. As a medical diagnostic test, a higher diagnostic accuracy is needed. This unsatisfactory result could be partly due to the lack of a most suitable measuring instrument or procedure. No scientific tenderness testing method has been developed. The present study has developed a specific way to suit the needs of AE. We measured the relative tenderness level compared to the reference AA zone. The grading of the tenderness level was classified as “0”—similar or less tender than the reference AA zone; “1”—mildly more tendered than, and “2”—significantly more tendered than the reference AA zone. This was still a gross classification method. A more precise and well defined evaluation method should be developed in future study.

Our results are not consistent with reports by clinical practitioners who observed that patients with a particular disease may feel more tenderness at its corresponding AA zone. For instance, in a study investigating AA diagnostic accuracy on thyroid disease by assessing electrical resistance and tenderness level on AA zones [24], the authors found that a lot more patients (80% *vs.* 6% of controls) reported tenderness on palpation at the thyroid AA zone. Oleson [12] tried to explain this from a neurophysiological perspective using an animal experiment, which found that the skin acupuncture points on dogs’ bodies had a significantly higher concentration of substance P than control skin points [25]. Substance P is a spinal neurotransmitter found in nociceptive, afferent C-fibers, which helps in pain transmission and stimulates the subcutaneous release of histamine, and leads to hypersensitivity of sensory neurons. As a result, an increase in substance P concentration would decrease the pain threshold and made the AA zone more tendered to touch.

These clinical studies mainly judged the tenderness level by subjective complains and reactions such as frowning, screaming, or withdrawal of the subjects. As individuals would have different pain thresholds and one subject may react differently towards the same intensity of pain from another one, their study design was not objective. The tenderness testing is an AE determined by subjective feelings. Previous studies did not record how much pressure they applied on the AA zones, and whether or not the subjects were hypersensitive to pain only in specific AA zone (corresponding to the disease region) or in all AA zones. In the present study, the pain perception of the AA zone was tested by applying a mechanical stimulus (force) onto the zone. The tenderness sensation is subject to individual’s nociceptive perception. Some people have higher general pain threshold regardless the existence of any diseases. Practitioners of TCM often evaluate the tenderness level on AA zones by observing the response when a certain force is applied onto it. For example, they observe if the subject frowns, blinks, shows comprehensive expression or tries to withdraw from the force. By doing so, we can reduce individual differences in pain perception. However, the drawback of this evaluation method is that no baseline pain level is established when the reaction of the subject towards pain varies a lot.

4.5. Limitations of the study

Many areas in auriculotherapy remain uncertain. There are no standard ways of carrying out AE. Postulations of mechanisms and laterality of auriculotherapy are still debatable. Moreover, there are nearly a hundred AA zones on the external ear; each covers only a tiny area on the ear. The adjacent AA zones are very close to each other, locating the AA zone inaccurately would end up in stimulating other inappropriate AA zone. In addition, this study was conducted only on a relatively small sample and the order of subject presentation was not randomized. Further investigations, on much larger samples, on the development of AE as a more precise diagnostic tool are therefore warranted.

5. Conclusion

We conclude that hepatic disorders appear to be reflected by a reduction in electrical skin resistance and apparent morphological changes on the liver AA zone. Simple and inexpensive AE could therefore potentially be used to serve as a health screening test for liver disorders and hence worth further investigations.

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