ACUPUNCTURE & ELECTRO-THERAPEUTICS RES., INT. J., Vol. 28, pp.167-173, 2003

0360-1293/95 $20.00 + .00

Detection of Ear Acupuncture Points by Measuring the Electrical Skin Resistance in Patients Before, During and After Orthopedic Surgery Performed under General Anesthesia

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(Received 11 November 2002; Accepted with Revisions 10 March 2003)

ABSTRACT:

The aim was to study the detection of ear acupuncture points (EAP) by measuring the electrical skin resistance under general anesthesia. EAP with lower skin resistance were examined in 25 patients scheduled for elective orthopedic surgery on the day before, during the operative procedure and a few hours after it. EAP, detected in more than 25% of patients were further analyzed using a logistic regression model and compared to those in 15 healthy volunteers. The following EAP were identified in more than 50% of patients: Clavicle, Lung, Shenmen and points corresponding to the site of surgery. Point Clavicle was found in 16 patients (64%) throughout the study period. Shenmen was detected in 15 patients (60%) before surgery, whereas during and after surgery it was represented in 5 (20%) of them. EAP corresponding to the site of surgery were detected in 20 patients (80%) during the operative procedure. These EAP were detected more frequently in patients in comparison with healthy volunteers. The side of examination showed no significant differences throughout the study The frequently found patterns of EAP with lower skin resistance in patients during orthopedic surgery can be useful for treatment of preoperative anxiety and postoperative pain relief.

Key Words: Ear Acupuncture; Electrical Skin Resistance; Acupuncture Point Detection; Orthopedic Surgery.

Introduction

The measurement of the electrical skin resistance is widely used, in addition to the registration of local tenderness and skin discoloration, to find the precise location and to identify the ear acupuncture points (EAP) [1].
There is experimental and clinical evidence that the major lesions (pain, inflammation, surgery) will be reflected on the surface of the ear and can be identified using the measurement of skin resistance, although the physical basis of these measurements is not clearly understood. Oleson et al. [2] succeeded in statistical verification of auricular somatotopic body representation, measuring skin conductance of the painful auricular areas in patients with musculoskeletal pain. Later Kawakita et al. [3] showed an increased frequency of auricular points with low electrical impedance corresponding to the peritonitis, induced during surgery in rats. Also using experimental induction of inflammation in their research on analgesic effects of auricular acupuncture, Cecherelli et al. [4] found a lower electrical skin resistance at corresponding points in rats, anesthetized with chloral hydrate. Measuring the electrical skin resistance with slightly modified method Falk et al. [5] differentiated the EAP from the control zones (sham EAP) in patients with cocaine abuse.
We used a simple technique of the skin resistance measurement on the external ear in patients scheduled for elective orthopaedic surgery under general anesthesia. EAP were identified according to WHO classification [6].

Materials and Methods

Study group

The skin surface of external ear was examined by means of electrical resistance measurement in 25 patients (mean age 66.3 years) scheduled for elective orthopedic surgery. Twenty of them received a hip joint replacement. A surgical *Hallux valgus* correction was performed in another 5 patients. Fifteen healthy volunteers, matched to the patient group according to age, were examined and results compared to the preoperative findings in patients. All the examined subjects signed the informed consent to participate in the study freely.

Anesthesia procedure

Surgery was performed under general anesthesia with endotracheal intubation and controlled mechanical ventilation. Anesthesia was induced with 3-5 mg/kg thiopental, 1-2 mcg/kg fentanyl and 0.1 mg/kg cis-atracurium and maintained with 0.4-1.2 isoflurane (exspired concentration) in an oxygen-air mixture. Additional doses of 0.5-2 mcg/kg fentanyl during surgery were added as required to maintain the appropriate depth of anesthesia under hemodynamic monitoring [8]. Piritramid (an opioid analgesic drug), delivered through a patient controlled analgesia pump, was used after surgery for postoperative pain relief.

Device

We detected EAP that had lower skin resistance, using SVESA neural pen (Neuralstift SVESA 1070, SVESA, Muenchen, Germany). The neural pen generates maximal electric potential of 2 V. During the examination, the minimal constant direct current flows through the following circuit: tip of the SVESA pen - ear of studied subject - body of the examining person – handle of the SVESA pen. The lower skin resistance results in a higher current and in a higher potential on the gate of internal consequently connected booster. If the potential on the gate of the booster exceeds 1 V during the examination, the booster will be activated. It is able to amplify the signal and thus to lighten up a diode, which serves as the indicator

(see Figure 1). A referent "zero" value of resistance was adjusted for every measurement on the lateral margin of ear lobule, which is free of acupuncture points [7].

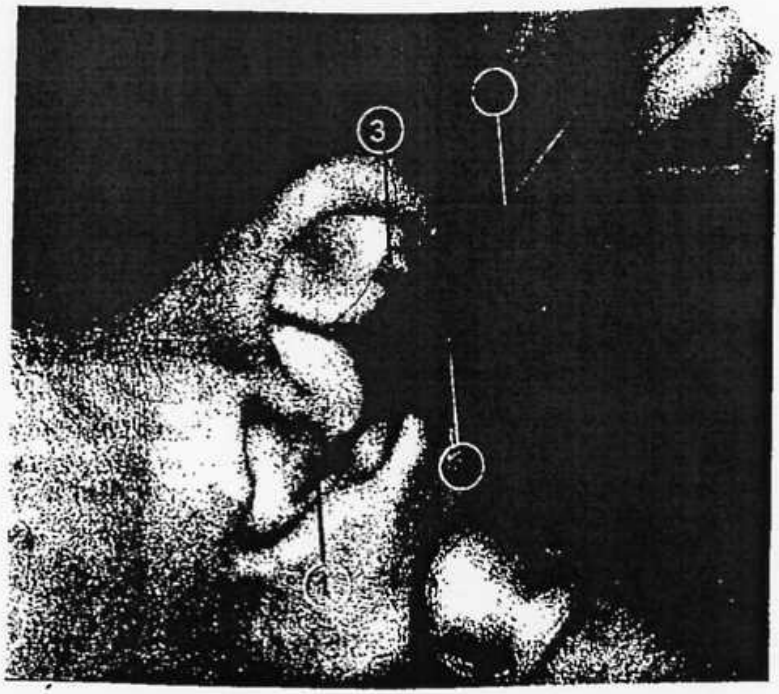

Fig. 1: Detecting auricular acupuncture points with SVESA neural pen (1-tip of SVESA pen; 2–light indicator; 3–button for adjustment of "zero" resistance value; 4- handle of SVESA pen).

Ear examination

The ears were disinfected with alcohol before the examination procedure. The first EAP examination was performed in the evening before surgery. The second examination took place during the most painful phase of surgery, which was the surgical manipulation on the femur. The third ear examination was performed several hours after the surgery in the postoperative care unit, when the patients were awake, but slightly sedated with piritramid (see above).

The skin surface of antero-lateral side of the ear was examined using the SVESA neural pen. All examinations were done by the same person. A referent "zero"-value of resistance was adjusted at the beginning of each examination (see Device). Detected points were compared to the map of EAP and classified according to protocol cited above [6]. Both ears were examined. The EAP was considered to be found, if it was represented at least on one side. However, if the EAP was detected on both sides, it was included in further analysis only once. We defined the "frequently detected" EAP as those found in more than 5 of patients (25%). The frequency of EAP detection was further analyzed statistically and compared to those in 15 healthy volunteers.

Statistics

The logistic regression model with logit link and exchangeable covariance structure was fit to analyze the dichotomous data (EAP detected or not). The individual contrasts were analyzed using the χ^2-test. The differences between the patient and the control group were tested with the exact Fisher-test. P-values were Bonferroni adjusted. The analysis was performed using the SAS procedure GENMOD [9].

Acupuncture points:

1. Clavicle (MA-SF5)
2. Lung (MA-IC1)
3. Shenmen (MA-TF1)
4. Hip (MA-AH4)
5. Foot (MA-AH)

Fig. 2: Ear acupuncture points with lower skin resistance, detected in more than 25% of patients (WHO nomenclature is given in parenthesis).

Results

1. The following EAP were detected in more than 50% of patients: Clavicle, Lung, Shenmen and EAP corresponding to the site of surgery (see Table 1 and Figures 2 & 3).

Table 1. Frequency of ear acupuncture points detection in patients before, during and after the orthopaedic surgery (n=25) and in healthy volunteers (n=15).

Point	Before OP (%)	During OP (%)	After OP (%)	Volunteers
Clavicula	16 (64)	17 (68)	15 (60)	9 (60)
Lung	13 (52)	14 (56)	9 (36)	6 (40)
Shenmen	15 (60)	8 (32)	4 (16)	1 (7)
OP site	7 (28)	20 (80)	9 (36)	4 (27)

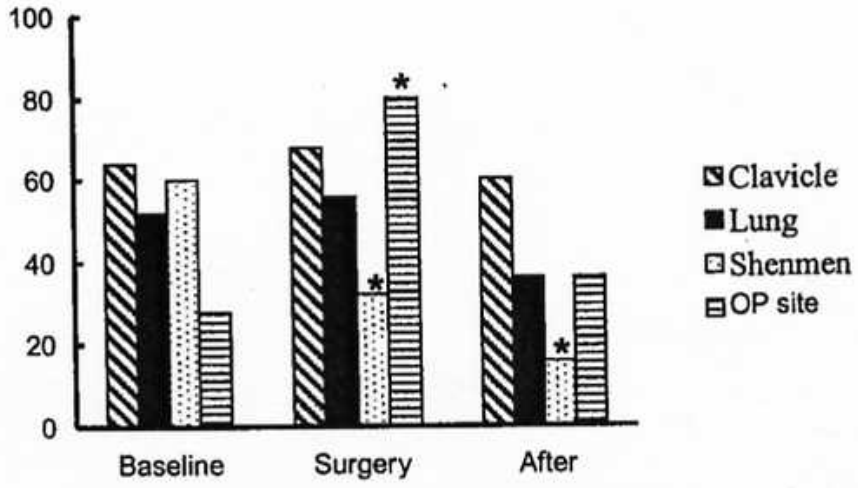

Fig. 3: Frequency distribution (%) of ear acupuncture points throughout the study in patients (n=25). Differences (*) vs. baseline statistically significant (P<0.05).

2. The point Clavicle was found in 16 patients (64%) before, during and after the operative procedure and in 9 out of 15 volunteers (60%). Shenmen was found in 15 patients (60%) before the surgery, whereas during and after the operative procedure it was represented only in 5 patients ($P<0.05$; see Figure 3).
3. The area corresponding to the hip joint (mapped in the lower third of *Crus anthelicis superior*) was detected more frequently during the operative procedure ($P<0.05$) in 20 patients scheduled for total hip replacement.
4. The patients scheduled for *Hallux valgus* surgery showed lower skin resistance in the corresponding ear area (upper third of *Crus anthelicis superior*) also only during the operative procedure (4 out of 5 patients).
5. The point Shenmen was detected in the patient group before surgery more frequently in comparison with healthy controls (15 vs. 1; $P<0.05$; see Figure 4).
6. The side of examination showed no significant differences throughout the study.

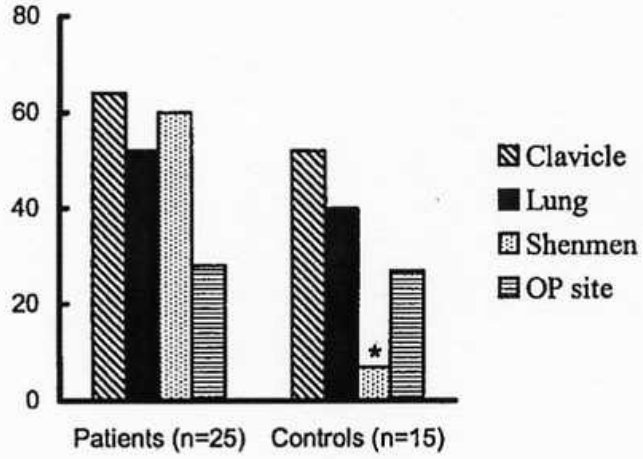

Fig. 4: Frequency distribution (%) of ear acupuncture points in patient group at baseline vs. volunteers. Difference (*) statistically significant ($P<0.05$).

Discussion

We performed a single blinded observational study on the detection of EAP measuring electrical skin resistance in patients scheduled for orthopedic surgery compared with healthy volunteers. To our knowledge, there is no data about the detection of EAP under general anesthesia using this technique. Cecherelli et al. [10] found a reduced number of auricular painful points in patients taking benzodiazepines in comparison with patients who did not take such drugs. Therefore, we did not expect that the frequency of EAP detection by means of electrical skin resistance measurement during the surgery under general anesthesia would exceed the pre-and postoperative level.
The high incidence of identifying the point Shenmen in patients before surgery can be explained with the increased level of preoperative anxiety. The detection and subsequent needling of that point was effective to treat that disorder in sham controlled studies with healthy volunteers and ambulatory surgery patients [11,12].
Although all the patients received appropriate standard analgesia with fentanyl during surgery (see Methods), the highest detection frequency of the points, corresponding to the surgery

sites, was registered during the operative procedure under general anesthesia. It was probably due to acute pain in the most painful phase of the surgery, whilst the hemodynamic parameters remained constant. Moreover, it seems that the measurement of skin resistance/conductance is more sensitive to intra-operative pain than standard monitoring of the depth of anesthesia. Measuring the electrical skin conductance on the thenar and hypothenar eminence of the hand in 11 patients scheduled for elective laparoscopic cholecystectomy under general anesthesia, Storm et al. [13] found out that fluctuations of the skin conductance positively correlated with the level of catecholamines in serum and had no correlation with the depth of hypnosis as monitored by measuring Bispectral Index.
Our findings would support a classical physiological theory on the changes of skin resistance/conductunce due to the activation of sympathetic nervous system, where the activation of sudomotor sympathetic nerves leads to the changes of skin moisture [14]. Nevertheless, the topographic distribution of the areas with lower skin resistance, correlated with the acupuncture charts, developed by Nogier [15], still needs explanation.
One of the flaws of our study was the fact that the investigator who performed the measurement of electrical skin resistance on the ear was not blinded. In order to obtain more reliable data in such observational design it is necessary to blind the assessor. Another point to improve would be the method of EAP detection, using the SVESA neural pen. Although the method is simple and easily performed in a hospital environment, it provides reproducible data only in the hands of experienced investigator.

In general our findings support the theory of a somatotopic representation of the body on the human auricle [2,15]. The frequently found points with lower skin resistance in patients during orthopedic surgery can be useful for treatment of preoperative anxiety (Shenmen) and/or postoperative pain relief (Lung point and the points corresponding to the site of surgery) in addition to standard ear acupuncture prescriptions.

Acknowledgement

The authors thank Professor Dr. R. Koch, Institute for Medical Informatics, University of Dresden, Germany, for the advice about statistics.

References

1. Margolin, A., Avants, K.S., Chang, P., Birch, S., Kosten, T.R., A single-blind investigation of four auricular needle puncture configurations. American Journal of Chinese Medicine. Vol. 2, 105-114, 1995.

2. Oleson, T.D., Kroening, R.J., Bresler, D.E., An experimental evaluation of auricular diagnosis: the somatotopic mapping or musculoskeletal pain at ear acupuncture points. Pain. Vol. 8, 217-229, 1980.

3. Kawakita, K., Kawamura, H., Keino, H., Hongo, T., Kitakohji, H., Development of the low impedance points in the auricular skin of experimental peritonitis rats. American Journal of Chinese Medicine. Vol. 19, 199-205, 1991.

4. Ceccherelli, F., Gagliardi, G., Seda, R., Corradin, M., Giron, G., Different analgesic effects of manual and electrical acupuncture stimulation of real and sham acupuncture points: a blind controlled study with rats. Acupuncture & Electro-Therapeutics Research, The International Journal. Vol. 24, 169-179, 1999.

5. Falk, C. X., Birch, S., Avants, S. K., Tsau, Y., Margolin, A., Preliminary results of a new method for locating auricular acupuncture points. Acupuncture & Electro-Therapeutics Research, The International Journal. Vol. 25, 165-177, 2000.

6. Third WHO Regional Working Group on Standartization of Acupuncture Nomenclature, Seoul, 1987.

7. http://members.aol.com/svesa/neuralstiftbeschr.htm.

8. Kissin, I., General anesthetic action: an obsolete notion. Anesthesia & Analgesia. Vol. 76, 215, 1993.

9. SAS/STAT® User's Guide, Version 8, Cary, SAS Institute Inc., NC, 1999.

10. Ceccherelli, F., Altafini, L., Varotto, E., Stefecius, A., The effect of benzodiazepines administration on auricular symptomatological evidence. Acupuncture & Electro-Therapeutics Research, The International Journal. Vol. 15, 95-106, 1990.

11. Wang, S.M., Kain, Z.N., Auricular acupuncture: a potential treatment for anxiety. Anesthesia & Analgesia. Vol. 92, 548-553, 2001.

12. Wang, S.M., Peloquin, C., Kain, Z.N., The use of auricular acupuncture to reduce preoperative anxiety. Anesthesia & Analgesia. Vol. 93, 178-180, 2001.

13. Storm, H., Myre, K., Rostrup, M., Stokland, O., Lien, M.D., Raeder, J.C., Skin conductance correlates with perioperative stress. Acta Anaesthesiologica Scandinavica. Vol. 46, 887-895, 2002.

14. Fowles, D.C., Mechanisms of electrodermal activity. In: Thomson RF, Patterson M, eds. Bioelectrical research techniques: Part C. Receptor and effector processes, Academic Press, New York, 1974.

15. Nogier, P.F.M., Treatise of auriculotherapy. Maisonneuve, Paris, 1972.