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Original Contribution

Prehospital analgesia with acupressure at the Baihui and Hegu points in patients with radial fractures: a prospective, randomized, double-blind trial☆

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Abstract

Background: Pain during transportation is a common phenomenon in emergency medicine. As acupressure has been deemed effective for pain management by the National Institutes of Health, we conducted a study to evaluate its effectiveness in prehospital patients with isolated distal radial fracture.

Methods: This was a prospective, randomized, double-blind study. Thirty-two patients were enrolled. Acupressure was performed either at "true" points or at "sham" points. Vital signs and pain and anxiety scores were recorded before and after the acupressure treatment. Normally distributed values were compared using the Student *t* test.

Results: Pretreatment scores for pain and anxiety were similar in the 2 groups (47.6 ± 8.9 vs 51.2 ± 8.7 visual analog scale [VAS] score for pain, 52.4 ± 6.0 vs 47.5 ± 9.3 VAS score for anxiety). At the hospital, patients in the true-points group had significantly lower pain (36.6 ± 11.0 vs 56.0 ± 13.3 VAS score, $P < .001$) and anxiety scores (34.9 ± 22.2 vs 53.4 ± 19.7 VAS score, $P = .022$).

Conclusion: Acupressure in the prehospital setting effectively reduces pain and anxiety in patients with distal radial trauma.

1. Introduction

Fracture of the radius joint at *loco typico* is a common injury requiring immediate medical attention because the patient experiences severe pain in the deviated and dislocated joint [1]. Given that this is not a life-threatening injury, the current practice in central Europe is such that the patient is accompanied to the hospital by paramedics who are allowed neither to administer medication for pain nor to perform invasive procedures that may alleviate the patient's discomfort [2]. Failure to treat the acute pain leads to a cascade of responses, including increased adrenergic activity and increased plasma catecholamine levels. The resulting tachycardia and hypertension are likely to provoke myocardial ischemia in patients with vascular disease and impair coronary perfusion [3-7]. Poor wound

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perfusion due to increased sympathetic activity may elevate the risk of wound infection and impair physiologic bone repair [8].

The technique of acupuncture, which originated in China during the Xia dynasty (2140-1711 BC), is used to treat pain. *Acupuncture* is a collective term. It comprises a number of treatment modalities such as acupressure, Shiatsu, auricular acupuncture, Korean hand acupuncture, moxibustion, laser and electroacupuncture, and others [9,10]. The National Institutes of Health (NIH) Consensus Development Conference on the Integrated Approach to the Management of Pain classified acupuncture as an effective tool for pain treatment [11,12]. Some acupuncturists practice the so-called meridian theory, which involves acupuncture by the use of needles to remove blockades of a hypothetical substance named *chi*. The continuous flow of chi (ie, life energy) is believed to be a vital aspect of health. The technique aims to improve health by inserting hair-thin needles into specific points on the body that are believed to enhance the flow of chi [13,14]. Several theories and models have been proposed to explain how acupuncture possibly works compared to the scientific principles of modern medicine. Scientific publications have shown that acupuncture alters neuronal activity in subcortical and cortical structures [15]. It was also proved that some of the effects (such as alteration of blood pressure) caused by acupuncture can be reversed by morphine antagonists. Thus, it would be justifiable to conclude that acupuncture causes endogenous morphines to be released [16,17]. The theory of acupressure is similar to that of acupuncture, based on Western patterns of explanation as well as Chinese energy flow models. Acupressure uses manual pressure, instead of needles, on specific points [13,18].

According to local laws, paramedics may not administer any drugs to alleviate pain. We therefore investigated new types of fast-acting and noninvasive pain treatment that can be administered by paramedics in the prehospital setting. Previously published data have shown that both acupressure and active warming of patients reduce pain as well as the level of anxiety and motion sickness in patients being treated for minor trauma in the prehospital setting [19-22]. Thus, acupressure proved advantageous in paramedic-based rescue systems. Subsequently, a general acupressure point system for minor trauma analgesia in emergency care was published [23]. However, the stimulation of 8 acupressure points was deemed excessively complicated for routine paramedic use. The current study attempts to determine whether 2-point acupressure can be effective in the prehospital treatment of distal radius fractures; the primary goal is pain relief, whereas secondary goals are reduction of anxiety and general satisfaction with medical care.

2. Methods

After an institutional review board approval for the study had been obtained, 70 patients (>19 years old) were screened for a prospective, randomized, placebo-controlled, double-blind investigation.

The study was conducted in a paramedic-based rescue system in a city of more than 1.5 million inhabitants over a 5-month period (November to March). Patients were screened in a consecutive manner by paramedics specifically trained to perform acupressure according to the study design. All enrolled participants gave their informed consent.

2.1. Participants

Patients aged 19 to 99 years with an isolated fracture of the distal radius and with visible axial deviation and dislocation were included in the study. Patients who were unable to give informed consent because of poor German language skills were excluded. Further exclusion criteria were the following: (*a*) the presence of any neurologic or psychiatric disorder in the patient's medical history, (*b*) the use of analgesics for chronic pain, and (*c*) a pain visual analog scale (VAS) score of greater than 80. For these patients, an ambulance with an emergency physician was

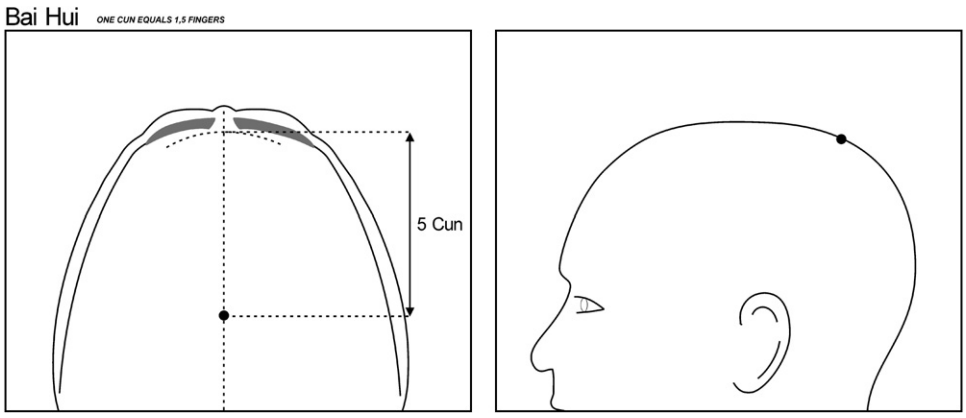

Fig. 1 "Bai Hui" (GV20, Baihui—standardized nomenclature for acupuncture based on World Health Organization [WHO] recommendations). To find the pressure point, one has to take 5 CUN upwards to the glabella; The "CUN" is the standard unit of measurement for the body used in acupuncture, it is defined according to the person whose body is to be treated; 1 CUN equals the width of the thumb, in the middle, at the crease or approximately 2.5 cm.

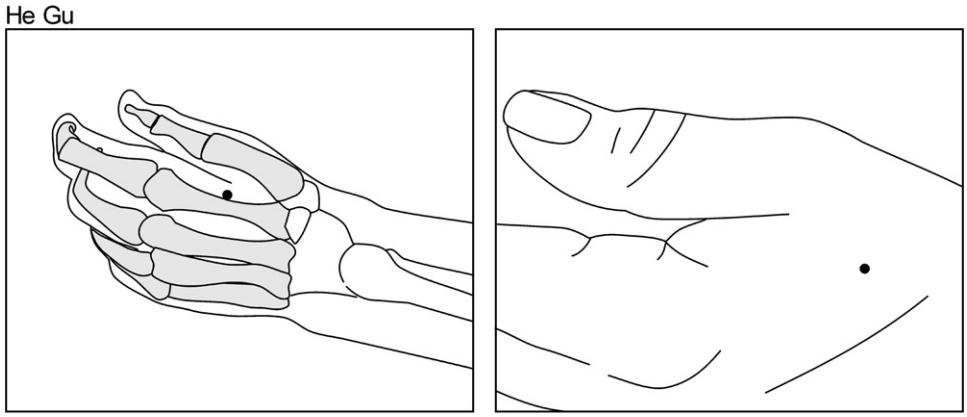

Fig. 2 "He Gu" (LI4, Hegui—standardized nomenclature for acupuncture based on WHO recommendations). The pressure point is in the midst of the second metatarsal bone on the side of the thumb.

called for professional medical pain control. The day after admission, the patients' individual diagnoses were confirmed from the hospital records based on clinical examination and, if required, radiographs. No patient had to be excluded from the final data analysis because of a diagnosis other than single radius fracture or other concomitant injuries.

2.2. Protocol and blinding procedure

Two paramedics were sent to each patient. To ensure that treatment and data collection were blinded, the paramedics were assigned to either perform treatment or collect data. Treatment consisted of temporary-splint placement for immobilization of the fracture and application of acupressure for 3 minutes at each acupressure point (slight circulating pressure of approximately 20 lb, no crescendo or decrescendo, no massaging). Data collection consisted of registering vital signs before and after the acupressure treatment, pain and anxiety VAS scores, and overall satisfaction scores. Patients were randomized to the treatment or the control (sham acupressure points) groups via sealed envelopes, which were to be opened by the paramedic assigned to perform the acupressure treatment. Patients assigned to the treatment group were stimulated at the acupressure points GV20 (Baihui) (Fig. 1) and LI4 (Hegu) (Fig. 2), whereas patients assigned to the control group were stimulated at sham acupressure points BL17 (Geshu) (Fig. 3, indicated for chronic anemia) and TE14 (Jianliao) (Fig. 4, indicated for chronic shoulder arthrosis). Both LI4 (Hegu) and TE14 (Jianliao) were stimulated on the contralateral arm to avoid contact with the injured area. All completed data sheets were sealed in envelopes by the paramedic assigned to collect data and were delivered to the study coordinator when the patient arrived at the hospital. To ensure that the blinding procedure of each paramedic was maintained and that treatment was administered correctly, a physician otherwise not involved in the prehospital management performed on-site audits of the treatment administered by the paramedics and their collection of data.

2.3. Measurements

Scores for pain, anxiety, and overall satisfaction using VAS (0-100) before acupressure and at the end of the emergency transport were compared. Morphometric and

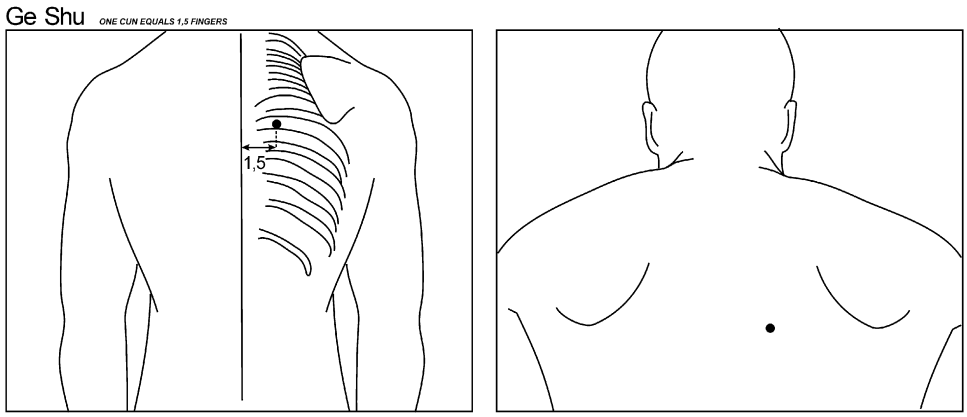

Fig. 3 "Ge Shu" (BL17, Geshu—standardized nomenclature for acupuncture based on WHO recommendations). The pressure point is at the crossing of 2 lines; one runs horizontally through the inferior angle of the scapula, and the other runs parallel to the spine at a distance of 1.5 CUN (1 CUN equals 1 thumb width or 2.5 cm).

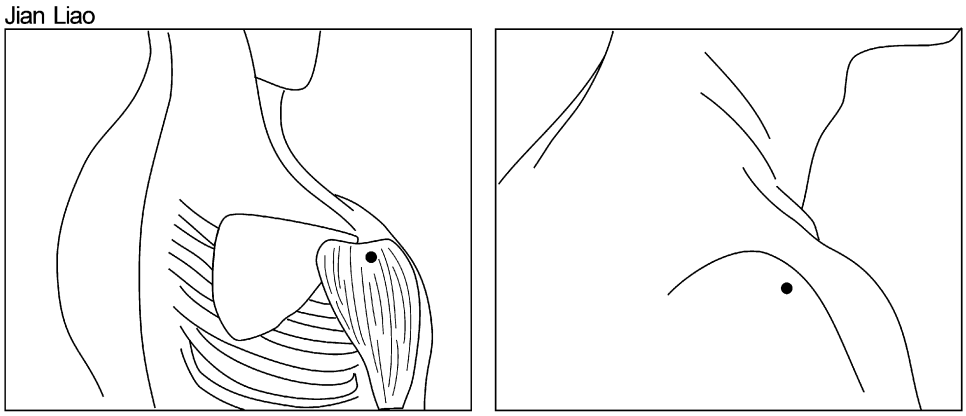

Fig. 4 "Jian Liao" (TE14, Jianliao—standardized nomenclature for acupuncture based on WHO recommendations). The pressure point is in the midst of the deltoid muscle at its proximal site of insertion.

demographic data were also recorded. These included the type of injury, sex, and age of patients. Hemodynamic parameters included noninvasive blood pressure measurement and heart rate. Pain and anxiety were rated by the patient on a 100-mm VAS. Zero signified "no pain" or "no anxiety," and 100 meant "maximum pain" or "maximum anxiety." The measurement of hemodynamic parameters and the rating of pain and anxiety were done at the site of the accident and on arrival at the hospital. At the hospital, the patients' overall satisfaction was measured on a 100-mm VAS. Zero was rated as "maximal satisfaction" and 100 signified "absolute dissatisfaction."

2.4. Data analysis

The results were evaluated on an intention-to-treat basis after admission to the study. Normally distributed values in the 2 groups were compared using the Student *t* test. Results were presented as means ± SDs; $P \leq .05$ was considered statistically significant.

3. Results

Of the 70 patients deemed eligible for participation in the study, 8 patients refused to participate, 30 did not meet the inclusion criteria (3 patients with poor German language skills, 21 patients taking medication for chronic pain, 2 patients with a VAS score of >80, 4 patients taking antidepressant medication). Thus, 32 patients met the inclusion criteria and were randomized to the treatment group or the control group. One subject randomized to the treatment group withdrew his consent before the completion of the study for unknown reasons. Thus, 15 patients were randomized to the treatment group and 16 patients to the

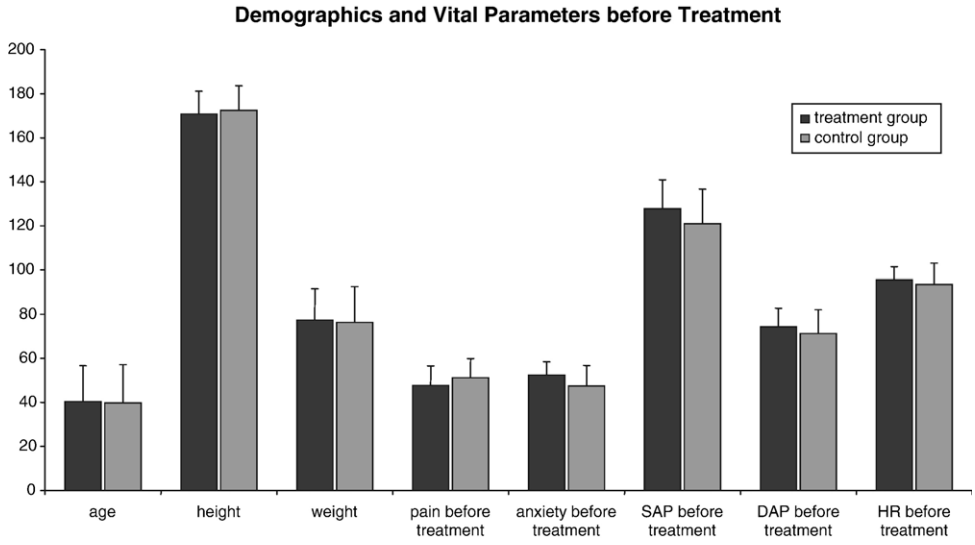

Fig. 5 Data are shown as mean ± SD. None of these factors differed significantly: age in years, height in centimeters, weight in kilograms, pain and anxiety in VAS 0-100, systolic arterial pressure (SAP) and diastolic arterial pressure (DAP) in mm Hg, and HR in beats per minute. HR indicates heart hate.

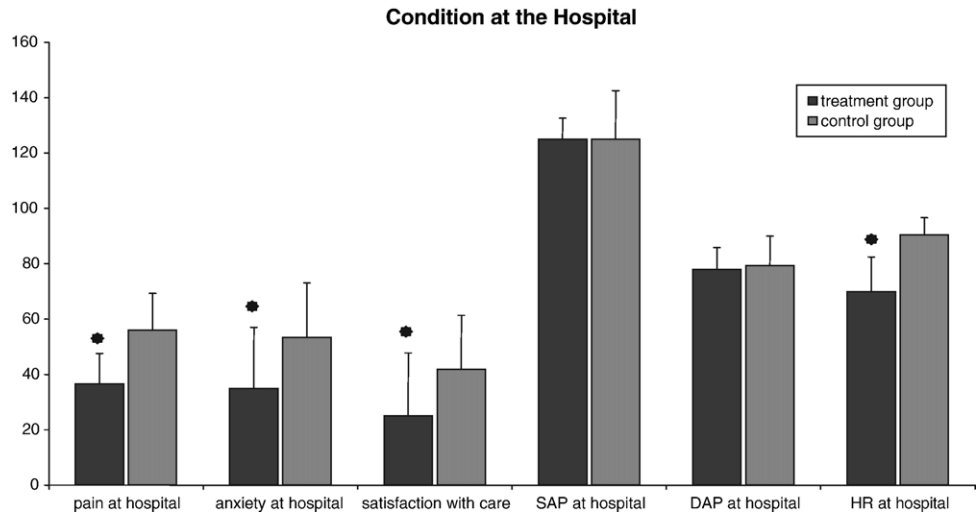

Fig. 6 Data are shown as mean ± SD. Marked bars indicate significant difference at $P < .05$.

control group. Baseline morphometric and demographic analysis revealed no significant differences between the groups (Fig. 5). Pretreatment pain received a rating of 47.6 ± 8.9 in the treatment group vs 51.2 ± 8.7 in the control group, whereas anxiety was rated 52.4 ± 6.0 in the treatment group vs 47.5 ± 9.3 in the control group. Visual analog scale scores were also nonsignificantly different in the 2 groups. On arrival at the hospital, patients assigned to the treatment group had significantly lower pain (treatment group 36.6 ± 11.0 vs control group 56.0 ± 13.3) and anxiety (treatment group 34.9 ± 22.2 vs control group 53.4 ± 19.7) scores than did those in the control group (Fig. 6). In addition, patients in the treatment group had a significantly lower heart rate than those in the control group (69.9 ± 12.5 vs 90.4 ± 6.2 beats/min), although there was no significant difference in blood pressure readings (Fig. 6). The patients' general satisfaction with medical care was significantly higher in the treatment group than in the control group (25.1 ± 22.6 vs 41.8 ± 19.6).

4. Discussion

According to the current paramedic-based care system prevalent in central Europe and Austria, analgesic medication may only be administered by physicians. Thus, the paramedic may not administer treatment to relieve pain en route to the hospital. Consequently, many patients complain of anxiety and dissatisfaction with their prehospital care [24]. Recently published studies by the Austrian Red Cross have shown that actively warming patients when being transported to the hospital provides greater comfort and alleviates some of the pain associated with minor trauma [20,21]. Likewise, the use of acupressure for prehospital treatment of pain was shown to be beneficial [22,23]. It may be argued that conducting such studies hinders a constructive change in statutory regulations for prehospital management because the presentation of results such as those obtained in the present study may create the impression that medication for the treatment of pain is not required at all. It was most decidedly not our intention to create this impression. However, we do admit that our study group did not believe it had any real chance to alter statutory regulations by lobbying. We focused on an active quest for new therapy modalities to achieve rapid and effective reduction of pain in our patients rather than political action.

Although acupuncture as well as acupressure have been widely accepted by general practitioners and pain therapists trained in western medicine, their mechanism of action remains controversially discussed. In a detailed review, Edzard Ernst investigated potential models to explain the efficacy of these forms of therapy. These include (*a*) stimulation of A delta fibers in the skin and muscle-conducting impulses to the spinal gray matter, thus inhibiting painful stimuli from the periphery and reducing the perception of pain; (*b*) activation of enkephalin-containing interneurons in the substantia gelatinosa of the spinal gray matter, thus inhibiting the conduction of pain signals to the brain; (*c*) release of β-endorphin and met-enkephalin in the brain; (*d*) activation of 2 descending pain control systems in the midbrain; and (*e*) modulatory effects on the central pain network in the hypothalamus and the limbic system [25]. However, in this context it is important to mention that our investigation was not intended to provide a final explanation for the neurophysiology of acupuncture and acupressure. Our goal was to illustrate the effectiveness of this method for pain relief in the preclinical setting.

Different traditions and styles of acupuncture are in use [9,10,13]. Acupuncturists from various schools may recommend different points for a particular patient. There is, however, good agreement on the location of traditional and commonly used points. Acupressure, a nondrug treatment of pain, is essentially risk-free, noninvasive,

and cost-effective. The immediate pain relief effected by acupressure lasts for approximately 30 minutes or may even persist for a few days [26-29]. Although the recently published acupressure system for emergency trauma analgesia was shown to be effective for pain treatment, the stimulation of 8 different points proved too complicated for routine application.

This study was designed to prove that a 2-point system of acupressure is an appropriate and easy technique of first aid in prehospital emergency medicine.

The procedure requires no equipment at all. Any physician, nurse, paramedic, or emergency medical technician may administer acupressure immediately at the site of accident. Second, application of the treatment at a few points is easy to learn. Four paramedics in our rescue team were trained for 2 afternoons. The training consisted of a theory section during which the history of acupuncture and studies demonstrating the efficacy of the treatment were presented. In the practical section, the paramedics were instructed about the sites of acupressure and the nature of pressure to be applied (slight circulating pressure of approximately 20 lb, no crescendo or decrescendo, no massaging). No certificates of training were issued. The training was conducted under the supervision of a physician who works as a certified acupuncturist (pain therapy). While conducting the study, on-site audits were performed by a physician who was not otherwise involved in collecting data for the study. The physician was present during the transport to check the work processes of the team.

Therefore, acupressure can be performed by individuals engaged in any medical specialty. Even physicians with little or no experience in first aid or emergency medicine can learn the technique within a few hours. Last but not the least, it is practically free of cost; the helper merely uses his or her fingers to apply pressure.

The exclusion criteria used in the study appear to be very extensive, as shown by the exclusion of patients with any neurologic or psychiatric disorder. Specifically, the paramedic asked the patients about the presence of any of the following neurologic diseases: stroke followed by a permanent neurologic deficit whether in the face (such as the facial nerve) or in the upper or lower extremity, regular headaches, or tremor in the extremities (regardless of the cause). The following were included in psychiatric disorders: confusion (limited orientation to persons, space, or time), any bipolar disorders, schizophrenia, epilepsy, dementia, or other diseases of the extrapyramidal system (such as Parkinson disease or dystonia). The mechanism of action of acupressure is still not clearly proven in scientific terms. One suspects mechanisms of action in the nervous system—intentionally not specified in the present study—because of which we used extensive criteria to exclude diseases attributed to this system of action. The patients' medical history was recorded on the basis of their clinical appearance, a specific inquiry, and assessment of any long-term medication the patients were taking. On-site history taking by the paramedic obviously does not permit a conclusive diagnosis. After admission to the hospital, no patient included in the study had a neurologic or psychiatric disease as specified in the exclusion criteria.

Blinding of patients is a very important issue in any study on acupressure. The fact that our study had no null group may well be raised as a point of criticism. A null group could have proven that the very presence of the rescue team and the patient's anticipated prompt arrival at the hospital might alone have alleviated pain. A further point of criticism may be the control group. Why did we specifically select the points BL17 (Geshu) and TE14 (Jianliao)? These are not located in the same dermatome as those in the treatment group. These points were selected on a random basis: they are easy to find, they help cure chronic diseases (such as anemia and arthrosis of the shoulder) according to traditional acupuncture, and they are supposed to have no effect on acute injury. We cannot refute the point of criticism that, in the treatment group, acupressure was applied on LI4 (Hegu) and that this point, being closer to the injured joint, might have caused the patients to suspect that true therapy and not sham treatment was being administered. However, neither the treatment group nor the control group was aware of the acupressure points being used in the other group. Therefore, no patient could assert that he or she was receiving pressure only on the shoulder or the back. Before treatment, all patients were informed that acupressure releases their "inner energies."

Considering that pain provokes autonomic responses that markedly increase adrenergic nerve activity and plasma catecholamine concentrations, the statistically significant changes in VAS scores for pain are also clinically relevant. Particularly, elderly patients in unstable cardiovascular condition require effective pain control immediately after trauma because the mortality rate secondary to tachycardia is significantly increased in this population [30-34]. Failing to alleviate their pain is unethical, in addition to being costly, if one considers the late complications of traumatic pain such as myocardial ischemia and infarction, as well as wound infection or impaired bone healing [8].

If we believe our patients, anxiety is also reduced by the alleviation of pain and discomfort. Although the perception of pain on the basis of a VAS score is well proven in the published literature [35-37], the same is not true for anxiety. One may request patients to depict their anxiety on a VAS, as what has been done in other studies, but a clear distinction between anxiety and perception of pain cannot be established on the basis of this score. Patients with true acupressure were generally more satisfied than those in the sham group. Probably, this evaluation must also be viewed in the light of, or as a consequence of, good pain therapy and not as an independent parameter.

Our results show that acupressure on GV20 (*Baihui*) and LI4 (*Hegu*) used as part of first aid after distal radial fractures is effective in alleviating pain, as shown in a selected patient population. The major disadvantage of this

point combination is its limited indication, namely, fractures at the distal end of the radius. Therefore, the results cannot be extrapolated to other fracture sites. The use of other specific acupressure points in emergency medicine cannot be recommended without prior scientific research.

Nevertheless, the advantages of studying a small number of points are obvious: it saves time and does not require much manipulation of the traumatized patient's body. In fact, the NIH issued a position statement promoting acupressure for the treatment of various medical conditions, such as pain, in medical care. Successful trials were also performed for specific conditions [11]. The NIH panel of scientists encouraged further research to determine other areas in which acupuncture may be useful, as well as research on point combinations for specific indications. Given the promising outcome of our study, the use of specific point combinations for traumatic conditions in emergency care warrants further investigation.

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