ORIGINAL RESEARCH

Acupuncture Therapy Fully Improves the Heart Rate Variability Indexes of Elderly Patients with Fractures

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ABSTRACT

Objective • To investigate the effect of acupuncture on perioperative heart rate changes in elderly patients with hip or femur fractures undergoing surgery .

Methods • A total of 120 patients with hip or femur fractures aged over 70 years and ASA ≥ II were selected for selective fracture osteotomy and reduction with internal fixation or arthroplasty. They were divided into Group H and Group N according to whether they suffering from comorbidities, and then divided into the HS group (complication group), HD group (complication control group), NS group (without complication group), and ND group (without complication control group) (n = 30). Patients received acupuncture therapy at bilateral Neiguan and Zusanli acupoints before anesthesia on the first and second days after surgery. They were also subjected to 24-h dynamic electrocardiogram (ECG) monitoring before surgery and on the third day after surgery. Blood pressure, heart rate, SPO_2, and cardiac oxygen consumption after acupuncture were recorded. SDNN and Triangular Index were recorded.

Results • The systolic blood pressure and myocardial oxygen consumption in the H group were significantly lower than those in the N group ($P < .05$). In addition, SDNN and Triangular Index in the HS group were increased after the operation when compared with those before the operation ($P < .05$). Postoperative INDEXES of SDNN and Triangular in the HS group and HD group were lower than those in the NS group and ND group before surgery ($P < .05$), while the postoperative indexes of SDNN and Triangular in the HD group were lower than those in HS group, NS group and ND group ($P < .05$).

Conclusion • Our study preliminarily revealed the perioperative efficacy of electroacupuncture at Neiguan and Zusanli acupoints: In conclusion, electroacupuncture at Neiguan and Zusanli acupoints demonstrates promise in improving perioperative safety and reducing cardiovascular adverse reactions in elderly patients with fractures undergoing surgery. (*Altern Ther Health Med.* [E-pub ahead of print.])

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INTRODUCTION

Elderly patients are often complicated with coronary heart disease, hypertension, arrhythmia, and other cardiovascular diseases. Besides, their post-traumatic stress response may lead to cardiovascular adverse events, which will not only aggravate the original disease but also reduce the heart rate variability of patients.[1-3] At present, there are many perioperative cardiovascular drugs available for patients, but all of them have certain side effects and high costs.[4-6] Aiming for safe and painless postoperative recovery, reducing the incidence of stress, decreasing the chance of adverse cardiovascular reactions, and ensuring medical safety during the perianesthesia period in elderly patients with fractures are directions that need to be further explored.

Electroacupuncture therapy has the advantages of protecting the myocardium, simple economy, safety, little interference to the body, and fewer complications.[7] Acupuncture therapy has been widely used in the treatment of cardiovascular diseases. It is accepted by the public due to its advantages of small trauma, simple and convenient operation, and low economic cost. Studies have shown that acupuncture has a certain protective effect on myocardial ischemia damage, and this effect is also specific. It was found that acupuncture at Neiguan acupoint was significantly more effective than acupuncture at Lieque in improving myocardial ischemia in rats, so it was concluded that acupuncture was specific for the treatment of myocardial ischemia.[8-10] In addition, acupuncture has a certain regulatory effect on blood pressure, vascular function, and circulatory system functions such as heart rhythm. The purpose of this study was to explore the efficacy of acupuncture therapy on heart rate variability index and the effect of electroacupuncture therapy on cardiovascular

protection of elderly patients with fractures undergoing selective fracture osteotomy and reduction with internal fixation or arthroplasty.

SUBJECTS AND METHODS

Subjects

This study was a prospective, randomized, controlled, single-blind clinical trial. The approval of the hospital ethics committee was obtained. The patient or family member signed the informed consent. A total of 120 patients with hip or femur fractures aged over 70 years and American Society of Anesthesiologists (ASA) ≥ II were selected for selective fracture osteotomy and reduction with internal fixation or arthroplasty. They were divided into the H group and N group according to whether they suffering from comorbidities, and then divided into the HS group (complication group), HD group (complication control group), NS group (without complication group), and ND group (without complication control group) (n = 30). The patients included in the H group should have at least one of the following underlying diseases: hypertension, diabetes, coronary heart disease, myocardial ischemia, arrhythmia, clinically confirmed ischemic cardiomyopathy, and coronary heart disease. Exclusion criteria: (1) patients with cardiac insufficiency, liver and kidney insufficiency; (2) history of abnormal coagulation function; (3) psychiatric patients who were unable to cooperate in the study.

Methods

Open the vein channel, on the day of surgery after entering anesthesia between preparation, HS and NS groups before anesthesia, the first day after the operation, the postoperative day closed in on both sides and foot three miles of acupuncture, acupuncture group regarding the positioning of scheme's international standardized criteria, needle selection han d brand stainless steel needle (Tianjin tot (Shenzhen medical material co., LTD. Company production), one-time use. The two sides of Neiguan and Zusanli were selected. After the acupuncture was carried out, the Huatuo electronic acupuncture instrument (Suzhou Medical Supplies Factory Co., LTD.) was connected for stimulation. The waveform was a continuous wave, the frequency was 10Hz, the current intensity was suitable for the patient's endurance, and the locking time was 30 min. The control group rested peacefully for 30 min without any operation. 24-h dynamic electrocardiogram was performed before and on the third day after surgery.

Observation Indicators

(1) General clinical characteristics such as gender, age, height, and weight were recorded in the four groups; (2) Blood pressure, heart rate, SPO_2 and cardiac oxygen consumption before operation and at 10 min, 20 min and 30 min after acupuncture were recorded; (3) Standard deviation of all normal-to-normal intervals (SDNN) index and Trianglar index were used to analyze the central rate variability of two postoperative amBUlatory electrocardiograms. Since variance is mathematically equal to the total power of spectral analysis, SDNN reflects all the cyclic components responsible for variability in the period of recording. Trianglar index is the total number of all N-N intervals divided by the histogram height of all N-N intervals measured on a discrete scale of 7.8125 ms and without adjustment for record length. (4) Cardiac oxygen consumption (RPP) = systolic blood pressure (SBP) × heart rate (HR). RPP <12000, normal value; RPP >12000, myocardial ischemia; RPP >15000, angina pectoris.

Statistical processing

SPSS 27.0 statistical software was used to analyze and process the data. All values were expressed as means ± standard deviation (SD). Univariate ANOVA was used for comparison among groups, and *t* test was used for comparison between the two groups. $P < .05$ was statistically significant.

RESULTS

General information between the two groups

There were 16 males and 14 females in the HS group, with an average age of 81.10±9.31 years, an average height of 161.78±7.26 cm, and an average weight of 54.66±8.78 kg. There were 15 males and 15 females in the HD group, with an average age of 82.59±8.57 years, an average height of 160.03±7.14 cm, and an average weight of 54.73±9.89 kg. There were 17 males and 13 females in the NS group, with an average age of 83.10±9.18 years, an average height of 158.35±8.20 cm, and an average weight of 56.33±10.05 kg. There were 14 males and 16 females in the ND group, with an average age of 80.89±10.32 years, an average height of 159.32±8.56 cm, and an average weight of 53.87±10.32 kg. There were no significant differences in gender, age, height, and weight among the four groups ($P < .05$, Table 1).

Comparison of SPO_2, heart rate, and diastolic blood pressure

There was no difference in SPO_2 at 0, 10, 20, and 30 min after acupuncture between the H group and N group ($P > .05$). There was no difference in heart rate at 0, 10, 20, and 30 min after acupuncture between the H group and N group ($P > .05$). There was no difference in diastolic blood pressure at 0, 10, 20, and 30 min after acupuncture between the H group and N group ($P > .05$, Table 2).

Table 1. Comparison of general conditions between the two groups

	HS Group	HD Group	NS Group	ND Group
Gender (M/F)	16/14	15/15	17/13	14/16
Age (year)	81.10±9.31	82.59±8.57	83.10±9.18	80.89±10.32
Height (cm)	161.78±7.26	160.03±7.14	158.35±8.20	159.32±8.56
Weight (kg)	54.66±8.78	54.73±9.89	56.33±10.05	53.87±10.32

Table 2. Comparison of SPO_2, heart rate, and diastolic pressure among groups

Indicators	Groups	Entry 0 min	Entry 10 min	Entry 20 min	Entry 30 min
SPO_2(%)	H group	97.6±1.6	98.5±1.1	98.4±1.3	98.3±1.4
	N group	97.8±1.4	98.3±1.2	97.9±1.5	97.9±1.9
Heart rate (times /min)	H group	80.5±6.7	77.6±7.7	80.5±9.6	80.8±5.8
	N group	80.6±6.8	77.7±7.9	77.9±8.4	78.9±5.6
Diastolic pressure (mmHg)	H group	76.5±9.8	74.1±7.5	73.2±6.3	72.8±9.8
	N group	75.8±9.9	76.8±7.9	74.5±7.5	75.6±8.8

Comparison of systolic blood pressure and myocardial oxygen consumption

The systolic blood pressure and myocardial oxygen consumption at 0, 10, 20, and 30 min after acupuncture in the H group were significantly lower than those in the N group ($P < .05$, Table 3).

Table 3. Comparison of systolic blood pressure and myocardial oxygen consumption among groups

Indicators	Groups	Entry 0 min	Entry 10 min	Entry 20 min	Entry 30 min
Systolic blood pressure (mmHg)	H group	155.5±15.8	139.8±15.3[a,b]	138.6±16.5[*#]	135.2±14.4[a,b]
	N group	155.6±15.9	150.5±18.2	147.7±15.7	150.5±15.8
Myocardial oxygen consumption	H group	12430±235	11349±248[a,b]	10688±155[*#]	10326±160[a,b]
	N group	12441±246	12381±251	12496±179	12385±182

[a]$P < .05$;
[b]Comparison of control group, $P < .05$

Comparison of heart rate variability and cardiovascular adverse events

Intra-group comparison of heart rate variability analysis: The indexes of SDNN and Trianglar in the HS group were significantly higher than those in the NS group and the ND group after the operation, and the difference was statistically significant ($P < .05$). After the operation, SDNN and Trianglar Index in the HD group were lower than those in the HS group, NS group, and ND group, and the differences were statistically significant ($P < .05$). Hospital deaths from four groups of patients did not happen, the HS group occurred in 1 case of stubborn sex low blood pressure (systolic blood pressure is lower than 80 mmHg cut to correct), 1 case of dynamic electrocardiogram (ECG) T wave inversion, 6.7% incidence of adverse cardiovascular events, HD group 4 cases of refractory hypotension, 2 cases of dynamic electrocardiogram (ECG) T wave inversion, 20.0% incidence of adverse cardiovascular events; the NS group had 1 case of postoperative ST segment depression and the incidence of cardiovascular adverse events was 3.3%; the ND group had 1 case of intraoperative sudden ventricular premature beats and the incidence of cardiovascular adverse events was 3.3%; the HD group had a higher incidence of cardiovascular adverse events than the other three groups, the difference was statistically significant ($P < .05$), as shown in Table 4.

Table 4. Heart rate variability and cardiovascular adverse events in each group

Groups	Before operation		Post-operation		Incidence of cardiovascular adverse events
	SDNN	Trianglar index	SDNN	Trianglar index	
HS group	78.80±32.10[b]	17.69±4.10[b]	88.29±33.29[a]	20.74±4.37[a]	6.7%
HD group	77.26±31.78[b]	18.81±4.05[b]	76.65±29.92	17.76±4.59	20%
NS group	94.96±30.01	19.95±4.06	96.99±26.13	19.14±4.31	3.3%
ND group	97.29±24.34	20.44±3.92	97.53±25.65	20.96±2.70	22%

[a]$P < .05$: Intra-group comparison was statistically significant
[b]$P < .05$: inter-group comparison gap was statistically significant

DISCUSSION

In this study, we investigated the effect of acupuncture treatment on postoperative heart rate variability indexes in elderly patients with fractures. Our findings indicate that electroacupuncture can effectively reduce systolic blood pressure and myocardial oxygen consumption, improve the heart rate variability index, reduce the incidence of perioperative cardiovascular adverse reactions, and improve perioperative safety in elderly patients with fractures.

The incidence of fractures in the elderly is increasing year by year, and surgical treatment has become the main means of treatment for them.[13,14] However, the risk of postoperative infection increases significantly in the elderly due to poor physiological reserves, decreased immune function, and poorer surgical tolerance.[15] It seriously affects the effect of surgical treatment and prolongs hospitalization time.[16] Therefore, it is clinically important to find a good assessment tool to detect postoperative infections in elderly fractures promptly and take appropriate preventive measures to prevent the occurrence of postoperative infections. HRV reflects the activity of the cardiac autonomic nervous system and can quantitatively assess the balance of cardiac sympathetic and vagal tone and disease prognosis.[17] Previous studies have shown that a decrease in HRV is associated with an increase in sympathetic tone, a decrease in the threshold for ventricular fibrillation, and an increase in cardiovascular morbidity and mortality, while an increase in HRV is associated with an increase in parasympathetic tone, an increase in the threshold for ventricular fibrillation, and a cardioprotective effect.[18,19]

Clinical practice has proved that acupuncture can reduce adverse cardiovascular reactions.[20-22] Neiguan Point is derived from Lingshu Meridian, which belongs to the Hand Jueyin pericardium Meridian and is one of the eight meridian points with the functions of nourishing the mind, calming the mind, eliminating phlegm and reviving the mind, lowering the stomach, clearing collaterals and relieving pain. Zusanli, from Lingshu·Benshu, is one of the main acupoints of "Foot Yangming Stomach Meridian". It is a big acupoint to strengthen the body and mind, with the effects of invigorating the spleen and stomach, invigorating qi and generating blood, eliminating accumulation and guiding stagnation, dreading channels, and dreading collaterals. Therefore, Neiguan and Zusanli acupoints were selected for electroacupuncture stimulation in this study. The results of this study showed that systolic blood pressure and myocardial oxygen consumption in the study group were lower than those in the control group ($P < .05$), but diastolic blood pressure did not change significantly, which was considered to be closely related to the regulation of cardiac vegetative nerve function, which reduced sympathetic nerve excitability and increased vagal nerve tension, thus leading to a drop in blood pressure. The occurrence of cardiovascular events is caused by the excessive excitation of the sympathetic nervous system and the disorder of neuroendocrine, to avoid the activation of adverse neuroendocrine Acupuncture therapy can reduce sympathetic nervous excitability, thus improving heart rate variability and reducing perioperative adverse cardiovascular events.

The results of this study showed that intra-group comparison of rate variability analysis showed that SDNN and Trianglar

indexes in the HS group were increased after operation compared with those in NS and ND groups, and the difference was statistically significant ($P < .05$). The inter-group comparison showed that SDNN and Trianglar indexes in the HS group and HD group were lower than those in NS and ND groups before the operation. The difference was statistically significant ($P < .05$), and the SDNN and Trianglar Index in the HD group were lower than those in the HS group, NS group, and ND group, the difference was statistically significant ($P < .05$). HRV refers to the slight changes in the R-R interval between continuous heartbeats, which reflects the tension and balance of cardiac sympathetic and vagal nerve activities. It is used to judge cardiac autonomic nerve function, understand the balance of sympathetic and vagal nerves, and reflect the condition and prevention of cardiovascular diseases.[23,24] The integration of cardiac autonomic nerves may be a valuable indicator for predicting sudden cardiac death and arrhythmias.

Clinical studies have proved that the HRV of patients with ischemic heart is significantly reduced, and the degree of disease is strongly correlated with the injury of the vagus nerve.[25] SDNN and Trianglar Index in the study group are lower than those in the control group, with statistical differences, indicating that the HRV of the study group is reduced. It has been confirmed that the HRV of patients with cardiovascular diseases is significantly reduced, but the perioperative heart rate variability of patients can be improved and perioperative adverse events of cardiovascular diseases can be reduced through acupuncture therapy in this experiment. Acupuncture could affect various indicators of HRV, and its changes were conducive to improving the integration function of the cardiac autonomic nervous system and inhibiting sympathetic nervous tension.[26]

In this study, no death occurred in the four groups during the perioperative period. In the HS group, there was 1 case of intraoperative refractory hypotension (systolic blood pressure lower than 80mmHg was difficult to correct), 1 case of ambulate t-wave inversion, and the incidence of cardiovascular adverse events was 6.7%. In the HD group, there were 4 cases of refractory hypotension and 2 cases of ambulate t-wave inversion. 20.0% incidence of adverse cardiovascular events, NS group, 1 case occurred after ST-segment down 3.3% incidence of adverse cardiovascular events, ND group occurred 1 case of intraoperative paroxysmal ventricular premature beat two law, 3.3% incidence of adverse cardiovascular events, HD incidence of adverse cardiovascular events is higher than the other three groups, a statistically significant difference ($P < .05$). It is suggested that improving the heart rate variability index and improving the integration function of the cardiac autonomic nerve can reduce the incidence of perioperative adverse cardiovascular events. However, due to the limited sample size of this study, a large number of further sample studies are needed.

CONCLUSION

In conclusion, we first and preliminarily revealed the efficacy of electroacupuncture therapy at Neiguan and Zusanli acupoints in heart rate variability indexes of the perioperative period in elderly patients with fractures. Electroacupuncture therapy effectively reduces systolic blood pressure and myocardial oxygen consumption, improves heart rate variability index, and significantly reduces sympathetic nerve activity; besides, electroacupuncture therapy also has a relatively enhanced vagus nerve tension mainly benign regulation, which fully reduces the incidence of perioperative cardiovascular adverse reactions, and improves perioperative safety of patients. In future studies, we can further explore the action mechanism of electroacupuncture on heart rate variability indexes.

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CONFLICT OF INTEREST

None.

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