SUPPLEMENT

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Potential beneficial effects of foot bathing on cardiac rhythm

Abstract

Purpose: Foot bathing therapy is a simple technique that induces sensations of comfort and relaxation. The aim of this study was to examine the effect of foot bathing therapy on heart rate variability (HRV) parameters in a healthy population.

Methods: Participants were twenty healthy female subjects (median age=20.67 years, SD=1.04). The recording ECG was applied for 5 minutes before and for 5 minutes after foot bathing therapy of 10 minutes. Subjects rested for 10 minutes without recording ECG in order to stabilize autonomic parameters. The digital signals were then transferred to a laptop and analyzed using LabChart® software (MLS310/7 HRV Module).

Results: Almost all HRV parameters increased and heart (pulse) rate and LF/HF ratio decreased after foot bathing therapy compared with before foot bathing therapy.

Conclusions: These results indicate for the first time in humans that foot bathing might induce a state of balance between sympathetic and parasympathetic systems and might be helpful to prevent possible cardiac arrhythmias.

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An important event in pain control was the discovery that stimulation of large type Aβ sensory fibers from peripheral tactile receptors can depress transmission of pain signals. This presumably results from local lateral inhibition in the spinal cord. It explains why such simple maneuvers as rubbing are often effective in relieving pain. And it probably also explains why liniments are often useful for pain relief [1]. This mechanism and the simultaneous psychogenic excitation of the central analgesia system are probably also the basis of pain relief by acupuncture, reflexotherapy and other massage therapies [1].

Foot bathing is a simple technique that induces sensations of comfort and relaxation [2]. Wrapped warm footbath techniques were perceived as suitable methods for relaxing bedridden palliative care patients. The procedure involved patients' legs and feet from the knees down, which were gently immersed in a basin of warm water [3, 4].

In a heart rate variability study [2], it was suggested that warm water footbaths led to relaxation via an increase in parasympathetic response and a decrease in sympathetic response, elevation of serum IgA and reduction in cortisol levels. These findings indicate the potential benefit of conducting further tactile trials using multiple parameters of measurement drawn from the differing clinical fields of psychoneuroimnunology, neurophysiology, psychology and thermal physiology.

In a recent study, it has been reported that left foot reflexological treatment decreased the cardiac index. The researchers concluded that reflexology massage applied to the upper part of the left foot may have a modest specific effect on the cardiac index of healthy volunteers [5]. In a reflexology and heart rate variability (HRV) study, almost all HRV parameters increased and heart (pulse) rate and LF/HF ratio decreased by reflexological therapy in healthy persons. They suggested that reflexology might induce a state of balance between sympathetic and parasympathetic systems and might be helpful to prevent possible cardiac arrhythmias [6].

HRV is the physiological event of variation in the time interval between heartbeats. HRV have different parameters such as SDNN and SDANN. It is measured by the variation in

the beat-to-beat interval in electrocardiogram (ECG). Other terms used for HRV are "cycle length variability" and "RR variability". R is a point corresponding to the peak of the QRS complex of the ECG wave and RR is the interval between successive Rs [7]. Normally, there are complex interactions between the sympathetic and parasympathetic nervous system inputs. HRV parameters are indexes of sympathovagal balance or imbalance for cardiac rhythm. Temporal fluctuations in cardiac cycles are mainly determined by the activity of sympathetic and parasympathetic systems innervating the heart. HRV is defined as fluctuations of the sinus rhythm, which are affected by internal and external factors of body [8]. Thus, HRV reflects the interaction between the sympathetic and parasympathetic nervous systems and provides information about the autonomic nervous system.

Dysfunction in the autonomic nervous system is associated with many cardiovascular disturbances, such as sudden death, coronary artery disease, heart failure and cardiovascular risk factors including smoking, diabetes, hyperlipidemia and hypertension [9]. A good indicator of cardiovascular function is heart rate variability (HRV), as assessed by time-depended measures derived from an electrocardiogram [10]. The sympathovagal balance can also be tested with the low frequency/high frequency (LF/HF) rate, a heart rate variability parameter. Decreased heart rate variability (a lower variance in heart rate) and increased LF/HF ratio (increase in sympathetic and/or decrease in parasympathetic activity) has been shown to be associated with cardiovascular disease [11]. We hypothesized that footbathing, like reflexotherapy, can result in an increase in HRV parameters, such as the standard deviation of the NN intervals (SDNN) and the standard deviation of the averages of NN intervals (SDANN), and a decrease in heart rate and LF/HF rate; therefore, we measured these HRV parameters before and after footbathing therapy in a healthy population.

Methods

Subjects

Twenty-six healthy female subjects (median age = 20.67 years, SD = 1.07) participated in this study. Exclusion criteria were health problems, such as psychiatric, respiratory, metabolic, cardiac, or autonomic nervous system diseases that might change the heart rate. The Ethical Committee of the Faculty of Medicine of the University of Turgut Ozal approved this study.

Footbath Therapy

Subjects' legs and feet from the knees down were gently immersed in a basin of warm water of 36-37°C for 10 minutes. All therapies were applied in morning between 9:00-10:00 a.m.

ECG (HRV)

The recording ECG was applied for 5 minutes before and for 5 minutes after footbathing therapy of 10 minutes. Subjects

TABLE 1. HRV parameters before and after footbath therapy

HRV parameters	Before Foothbath (Mean ± SD)	After Foothbath (Mean ± SD)	*t*	*P*
Maxi NN (ms)	1026.13 ± 189.1	1023.35 ± 170.22	0.05	>0.05
Mini NN (ms)	565.62 ± 111.82	566.99 ± 122.81	0.09	>0.05
Mean NN (ms)	765.59 ± 92.54	774.49 ± 108.02	0.93	>0.05
Pulse Rate (1/min)	79.4 ± 9.14	77.22 ± 8.77	2.62	0.02
SDNN (ms)	54.07 ± 20.35	65.27 ± 27.01	2.29	0.03
SDANN (ms)	56.49 ± 30.13	61.96 ± 40.36	0.79	>0.05
RMSSD (ms)	56.41 ± 30.08	61.87 ± 40.31	0.79	>0.05
pNN50 (%)	72.01 ± 53.27	96.85 ± 63.4	2.22	0.04
Total power (ms^2)	2799.75 ± 2461.7	4177.58 ± 4219.71	1.71	>0.05
VLF (ms^2)	692.89 ± 685.98	1141.67 ± 1110.46	2.24	0.04
LF (ms^2)	769.69 ± 713.83	981.27 ± 752.02	2.54	0.02
HF (ms^2)	848.75 ± 892.06	1281.63 ± 1294.45	1.48	>0.05
LF/HF	1.29 ± 0.91	1.44 ± 1.28	0.69	>0.05

rested for 10 minutes without recording ECG to stabilize the autonomic parameters. ECG was recorded using PowerLab 26T (AD Instruments, Australia), a device used for multimodal monitoring of bio signals. According to the standard Einthoven Triangle, three self-adhesive ECG electrodes were applies to the right wrist and right and left legs. The digital signals were then transferred to a laptop and analyzed using LabChart® software (MLS310/7 HRV Module). A full continuous ECG could be viewed and saved for later analysis, and software-based filters were used to exclude movement artifacts and ectopic beats prior to HRV analyses (see Figure 1).

Maximal NN or RR intervals (maxi NN) (ms), the mean of all NN intervals (mean NN) (ms), the standard deviation of the NN intervals (SDNN) (ms) and the standard deviation of the averages of NN intervals in all 5 minute segments of the entire recording (SDANN) (ms), the square root of the mean of the sum of the squares of differences between adjacent NN intervals (RMSSD) (ms), the variance of all NN intervals (≤0.4 Hz) (total power) (ms^2), power in the very low frequency range (0.003-0.04 Hz) (VLF) (ms^2), power in high frequency range (0.15-0.4 Hz) (HF) (ms^2), minimal NN intervals (mini NN) (ms), the percent of difference between adjacent NN intervals that are greater than 50 ms (pNN50) and power in low frequency range (0.04-0.15 Hz) (LF) (ms^2) were calculated from ECG recordings.

Results

SDNN, pNN50, VLF and LF were increased and pulse rate was decreased after foot bathing therapy compared with before foot bathing therapy (see Table 1).

Discussion

Decreased heart rate variability (a lower variance in heart rate) and increased LF/HF ratio (increase in sympathetic and/or decrease in parasympathetic activity) has been shown to be associated with cardiovascular disease [11]. In the present study, some HRV parameters including SDNN, pNN50, VLF and LF increased and heart (pulse) rate decreased after foot bathing therapy compared with before foot bathing therapy in healthy persons. Since foot bathing is believed to decrease the sympathetic activity and increase the parasympathetic activity, these results indicate for the first time in humans that foot bathing might induce a state of balance and harmony between sympathetic and parasympathetic nervous systems; therefore, foot bathing may be accepted as a complementary therapy method for many cardiac problems, especially tachycardia and other cardiac arrhythmias.

These results were consistent with a recent study [2]. In that study, the immediate effects of wrapped warm footbaths on the autonomic, neuroimmunological and psychological activities in healthy middle-aged volunteers were examined.

Serum IgA and serum cortisol levels showed that both lying down and footbath resulted in a relaxed state. They concluded that footbaths can be an effective method of relaxation, since it induces both a significant increase in parasympathetic activity and significant decrease in sympathetic activity. Also, it was claimed the beneficial effects of footbaths in controlling spasticity after stroke [14].

Reduced HRV has been shown to be a predictor of mortality after myocardial infarction [12, 13]. Some other clinical conditions may also be associated with the lower HRV, including congestive heart failure, diabetic neuropathy, depression, sudden infant death syndrome risk and poor survival in premature babies.

Foot bathing therapy is a noninvasive and harmless therapeutic application, and it can be confidently used to restore sympathovagal imbalances in cardiac rhythm. In the present study, foot bathing therapy was applied to healthy subjects and future studies should now include patients with various cardiac problems.

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