

Using Heart Rate Variability Analysis to Assess the Effect of Music Therapy on Anxiety Reduction of Patients

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Abstract

Music therapy has been considered to reduce the anxiety of patients, but the mechanism of music therapy remains to be investigated. Psychophysiological researchers have revealed that the autonomic activities relate to the anxiety. Heart rate variability (HRV) analysis has been used to assess the autonomic activities hence it may be a useful tool for evaluate the effects of music therapy on anxiety reduction of patients. In this study, we attempted using HRV analysis to display the effect of music therapy on autonomic balance. 68 patients attending extracorporeal shock wave lithotripsy (ESWL) were included, among them 34 patients (music therapy group) were randomly selected to undergo a music therapy (listening to a natural music) to reduce their anxiety for upcoming operation, the rest patients were be the control group. The short-term (5 minutes) HRV parameters of all patients before and undergoing music therapy were computed. The results revealed that the standard deviation of RR intervals (SDRR) and high frequency spectral power (HF power) of HRV significantly increased in the music therapy group while they did not change in the control group. Since SDRR and HF power of HRV are considered as markers for vagal activities music therapy seems to increase the vagal activity of patients. This study demonstrated that listening to the music has the influences on autonomic control. Using HRV analysis can help evaluating the effects of music therapy.

1. Introduction

Spielberger[1] defined that anxiety is an emotional state involving subjective feelings of tension, apprehension, nervousness and worry experienced by a person. Preparing for surgery can be a stressful situation for patients and their families. Most patients awaiting elective surgery experience preoperative anxiety. The most three distinct dimensions of anxiety: 1. fear of unknown, 2. fear of feeling ill, 3. fear of one's life. Patients worried most about the waiting period preceding surgery and were least concerned about possible

awareness intraoperatively [2]. Many studies have been conducted that demonstrate the effects of music on a person's physiological and emotional state in anxiety-producing situations. In the surgical areas, several studies have examined the anxiolytic effects of relaxing music on patients' anxiety. Winter found that patients experienced a significant decrease in state anxiety scores [3]. In this situation, music could be a diversionary therapy [4]. The application of music as therapy to reduce fear and anxiety is highly relevant to the work of the preoperative nurse, with regard to more individualized and holistic approach to patient care [5].

The effect of music on heart and blood pressure has been a favourite topic for a long time. Bason and Celler [6] found that the human heart rate could varied over a certain range by entrainment of the sinus rhythm with external auditory stimulus which presumably acted through the nervous control mechanisms, and resulted from a neural coupling into the cardiac centers of the brain. Moreover, the musical rhythm was considered as a pacemaker on respiratory pattern that serves both metabolic and behavioural functions [7]. Music is known to influence a physiological parameter such as heart rate or blood pressure; hence music can be used therapeutically for patients who have problems with heart disease or hypertension. Several studies have used music therapy to help coronary care [8,9]. They found that patients recovering from acute myocardial infarction may benefit from music therapy in a quiet, restful environment.

Although music therapy has been considered to reduce the anxiety of patients, the mechanism of music therapy remains to be further investigated. Psychophysiological researchers have revealed that the autonomic activities relate to the anxiety. Heart rate variability (HRV) analysis has been used to assess the autonomic activities hence it may be a useful tool for evaluate the effects of music therapy on anxiety reduction of patients. White [9] has used HRV to evaluate the music therapy for myocardial infarction patient. In this study, we attempted using HRV analysis to display the effect of music therapy on autonomic balance and anxiety of patient attending to an operation.

2. Subjects and methods

68 patients were recruited in this study (57 male, 11 female) ranging in age from 23 to 72. They were randomly assigned to experimental (music) group (n=34) and control group (n=34). Prior to the ESWL treatment, subjects completed the knowledge questionnaire and the s-STAI to get their ESWL experiences and anxiety level. Then the subjects lay on the operating table and took rest in the dark alone. Soon after the rest, baseline of blood pressure, heart rate were taken and the ECG were monitored for 5 min. Immediately following the baseline measurement, music were played to the experimental group through earphones while subjects of the control group would wear the earphones too but still remained in silence, and the ECG would be monitored for next 5 min. After 5 min music played, blood pressure and HRV were taken again. The experimental procedures are shown in Figure 1.

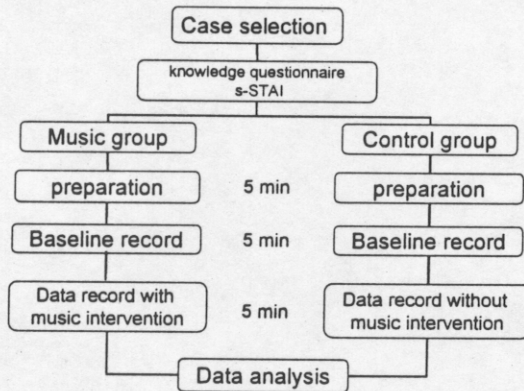


Figure 1. The experimental procedures for this study. Included patients were grouped into music or control group. After 5 minutes preparation, the ECG and blood pressure were recorded 5 minutes during baseline and experimental situations.

2.1. HRV signal processing

ECG was recorded and A/D converted with 500Hz of sampling rate by a notebook and analyzed using a program developed by Matlab software version 6.1 (The Mathworks Inc.). This program support the automatic detection and manual editing of R-waves on ECG. The R-R intervals were calculated sequentially for 5min and converted to instantaneous heart rate values, which were linearly interpolated to produce a continuous heart rate signal. The power spectra of the HRV were computed via Fast Fourier Transformation (FFT). These processing procedures were detailed described in [10]. The frequencies of the HRV were divided into mainly two bands, 0.04-0.15Hz (low frequency , LF) and 0.15-

0.4Hz (high frequency , HF).The percentage values of the LF and HF components to the total power (0.017-0.5Hz) (LF nu and HF nu) and the LF/HF ratio were calculated.

2.2. Statistical methods

Descriptive statistical analysis and Pearson's chi square test were used to describe the subjects, the knowledge questionnaire and the s-STAI in this study. Statistical analysis of the physiological measurements of blood pressure, heart rate and HRV were conducted using the independent t-test and paired t-test for pre and post-experimental conditions. The limitation of significance was set at 5%.

3. Results

The anxiety level of patients is about mild to moderate, and the intervention of preoperative music made them relaxed. Table 1 show the measures of both music and control groups during baseline and experimental situations.

Table 1. The physiological measures of both music and control groups during baseline and experimental situations. P-values are obtained using paired t-test for pre and post-experimental conditions in both groups.

Measures	Music therapy	Music group		Control group	
		mean±std	p value	mean±std	p value
Systolic BP (mmHg)	before	130±19	0.040*	129±18	0.005*
	after	128±18		127±16	
Diastolic BP (mmHg)	before	84±11	0.208	82±11	0.158
	after	83±12		81±11	
Mean RR interval (ms)	before	815±115	0.083	806±117	0.715
	after	824±116		799±12	
SDRR (ms)	before	36±18	0.282	38±17	0.301
	after	40±27		39±21	
LF (ms ²)	before	236±248	0.051	267±351	0.412
	after	167±164		293±432	
HF (ms ²)	before	171±265	0.910	270±307	0.433
	after	173±222		210±296	
LF nu	before	47±16	0.089	51±15	0.370
	after	42±14		48±14	
HF nu	before	30±16	0.003*	30±17	0.869
	after	39±18		31±16	
Ln LF	before	4.9±1.2	0.018*	5.0±1.0	0.746
	after	4.5±1.3		5.1±1.1	
Ln HF	before	4.3±1.5	0.196	4.4±1.4	0.398
	after	4.4±1.2		4.5±1.3	
LF/HF	before	2.5±2.3	0.006*	2.5±2.3	0.926
	after	1.6±1.2		2.6±2.1	

*p<0.05

SDRR: standard deviation of RR intervals

Ln LF and Ln HF: logarithm of LF and HF

3.1. Blood pressure comparison

Some researches used blood pressure to observe the impact of music. As shown in Figure 2, the systolic blood pressure of both music and control group decreased after the intervention of music.

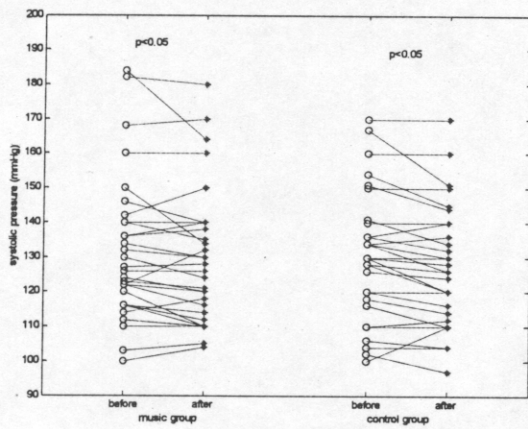


Figure 2. The systolic blood pressures of both music (left) and control (right) group decreased after the intervention of music. 'o' and '*' linked by a line represent the systolic blood pressure before and after intervention of music, respectively. Such annotations also appear in the following figures.

3.2. HRV comparison

The figure 3 shows the change of HF nu before and after music intervention of both music and control (no music) groups. The results showed that the HF nu of HRV measures increased significantly in the music group but it did not change significantly in the control group.

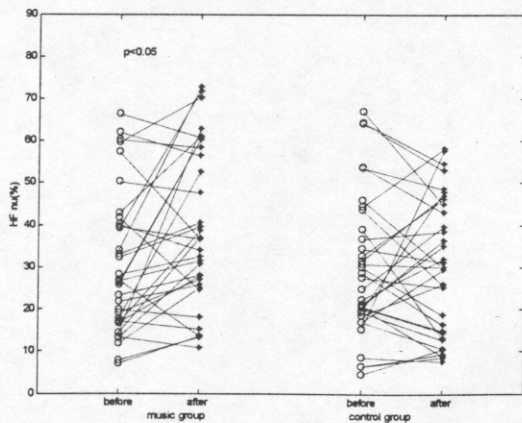


Figure 3. HF nu (Normalized HF power) significantly increased in music group but it did not change in control group.

Moreover, two measures of HRV, the LF/HF and Ln LF decreased significantly in the music group as shown in figure 4 and figure 5, respectively. Patients who had previous experience of ESWL showed less change of HRV than non-experienced patients.

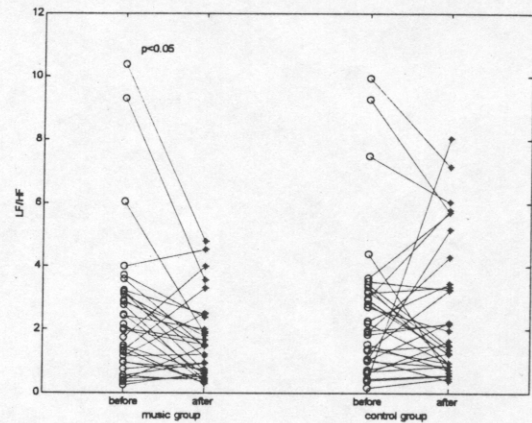


Figure 4. LF/HF significantly decreased in music group but it did not change in control group.

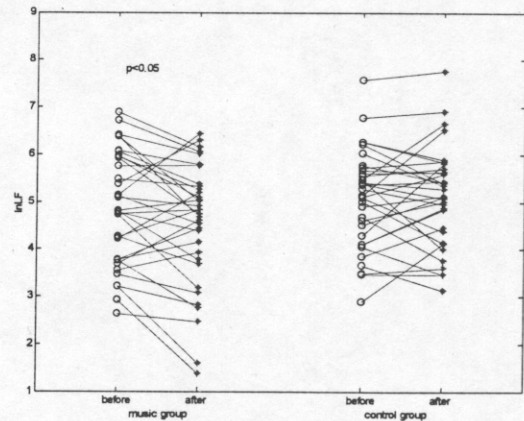


Figure 5. Ln LF (logarithm of LF power) significantly decreased in music group but it did not change in control group.

4. Conclusions and Discussion

In this study, we compared the physiological measures including blood pressure and HRVs of patients before and after music therapy to reveal the effects of music on preoperative anxiety reduction. The blood pressure was used as a physiological indicator for anxiety in some studies. Our results revealed that it could not be a good indicator because it decreased in both music group and control group coincidentally. However, some HRV measures changed significantly in music group but did not change in control group. In result, the decrease of Ln LF, LF/HF and the increase of HF nu in the music group

concurrently revealed that vagal tone increased while listening to music. Since an increased vagal activity means relaxation, our findings suggested that music therapy could decrease the preoperative anxiety of patients undergoing ESWL. In conclusion, the measurement model of HRV would be a good promising tool for detection of relaxation responses and is helpful to assess the effects of music therapy.

Acknowledgements

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