

# Analysis in Cardiac Stability over Thirty Minute Periods

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## Abstract

*Cardiac stability with little change in heart rate is important when studying the effect of cardiac interventions. The aim of this study was to analyse changes in heart rate during conditions expected to be stable. Subjects were studied during quiet relaxation to allow analysis of cardiac stability over thirty minute periods. Ten subjects with no known cardiac disease were enrolled, and gave ethical consent. Their ages were  $42 \pm 15$  years (mean  $\pm$  standard deviation). Subjects were given time for normal relaxation, but without any controlled conditions. After the study was explained, subjects were then asked to sit quietly on an office chair, while a single channel ECG was recorded to a computer for offline analysis. After a few weeks, subjects were instructed briefly in Zen meditation techniques, and rerecorded in similar conditions. There was a tendency for heart rate to fall and RR intervals to increase over the 30 min period, but overall this was not statistically significant, due primarily to individual subject variation resulting from respiratory effects, especially with the deeper regular breathing during meditation. There were small but significantly reduced heart rates with increased RR intervals during the meditation session, in comparison with relaxed sitting: mean RR interval increasing from  $0.78 \pm 0.10$  s to  $0.87 \pm 0.13$  s ( $p=0.002$ ), with the mean minimum RR (associated with highest heart rate) increasing from  $0.70 \pm 0.10$  s to  $0.74 \pm 0.10$  s ( $p=0.008$ ). With preceding uncontrolled relaxation, cardiac changes over a 30 minute period were small, and meditation generated an additional small overall reduction in heart rate, with increased RR intervals.*

## 1. Introduction

Heart rate analysis has been used in many clinical studies, including for diabetes [1], heart transplant [2,3], Alzheimer's disease and vascular dementia [4], and sleep [5], as well as for studies of multifractal characteristics [6], variation over 24 hours [7], during sleep [8,9] and Zen

meditation [10].

For such studies, it is important to have information on stability of heart rate over extended recording periods.

We therefore in this study chose to analyse stability over 30 minute periods.

In addition, we also analysed the effect of meditation in comparison with relaxation.

## 2. Methods

ECGs were recorded over a 30-min period, and analysed for changes in heart rate for all subjects, and the effect of meditation analysed.

### 2.1. Study subjects

Ten subjects with no known cardiac disease were enrolled, and gave ethical consent. Their ages were  $42 \pm 15$  years (mean  $\pm$  standard deviation).

None of the subjects exhibited any ectopic beat during the recording periods.

### 2.2. Study conditions

Subjects were given time for normal relaxation, but without any controlled conditions. After the study was explained, subjects were then asked to sit on an office chair, while a single channel ECG was recorded to a computer for offline analysis. After a few weeks, subjects were instructed briefly in Zen meditation techniques including respiratory exercise for lower abdominal muscle respiration [10], and rerecorded in similar conditions.

Subjects were asked to remain seated and still, without talking for the 30 minute recording period.

### 2.3. ECG recordings

Single lead ECGs were obtained with three electrodes applied directly to the chest. The ECG amplifier gain was set at 1000. The output of the amplifier was connected to

an analogue-to-digital converter at a sample rate of 250 Hz, and stored to a computer for off-line analysis.

## 2.4. QRS detection

ECG were filtered using time domain Savitzky-Golay filtering [11,12] and each ECG beat was detected by identifying the fast response associated with each QRS as

well as by coarse grained local maxima procedures, followed by a cardiologist's confirmation.

## 2.5. Heart rate analysis

The inter beat RR intervals were determined and the instantaneous inter beat heart rate calculated.

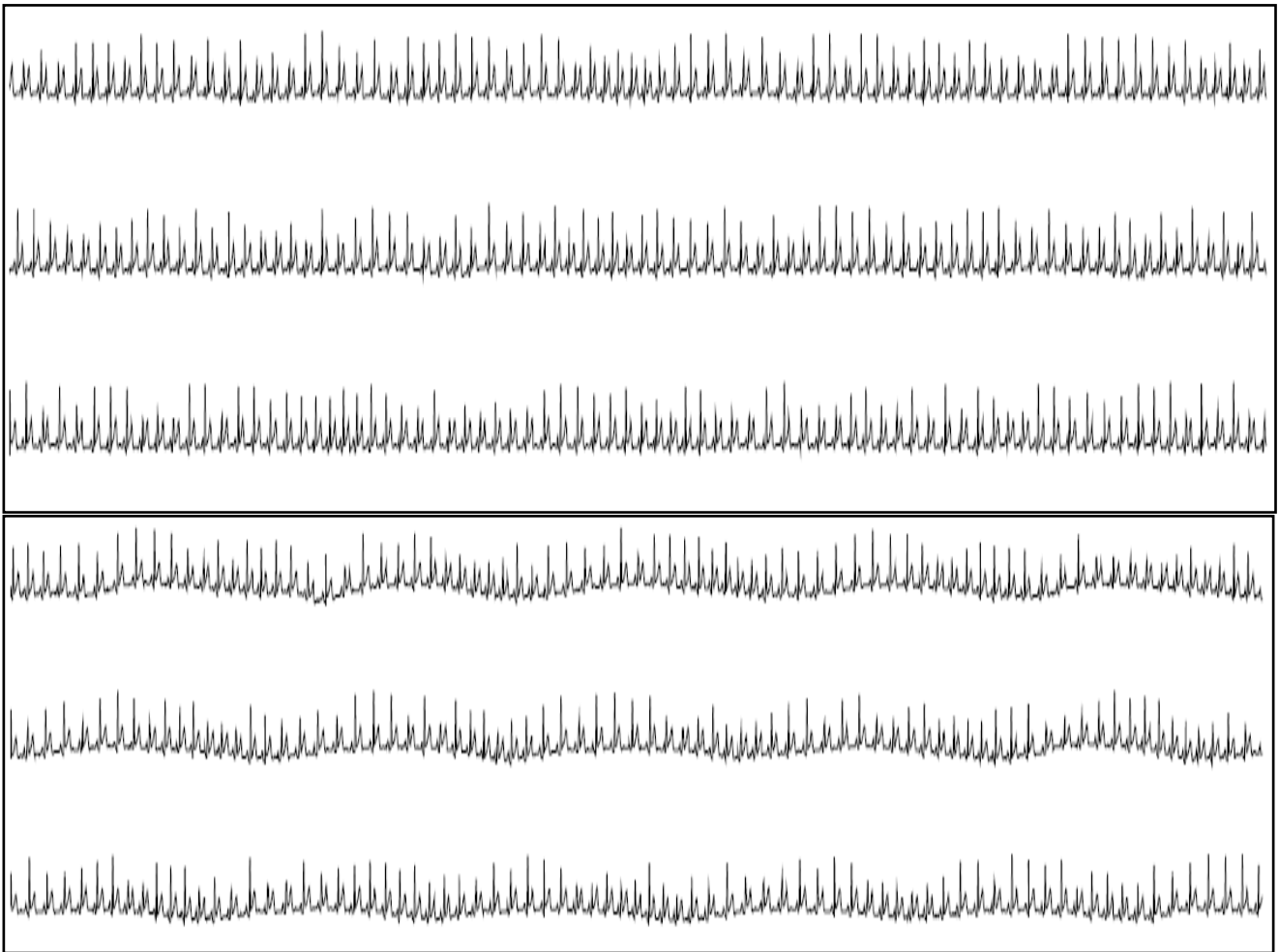


Figure 1. An ECG example from relaxation (above) and during meditation (below). Three minutes from each 30-min recording is shown. It can be seen that regular respiratory changes are larger during meditation.

### 3. Results

#### 3.1. Heart rate changes over 30 min period

There was a tendency for heart rate to fall and RR intervals to increase over the 30 min period, but overall this was not statistically significant, due primarily to individual subject variation resulting from respiratory effects, especially with the deeper regular breathing during meditation (Figures 1 and 2).

#### 3.2. Comparison of heart rate between relaxation and meditation

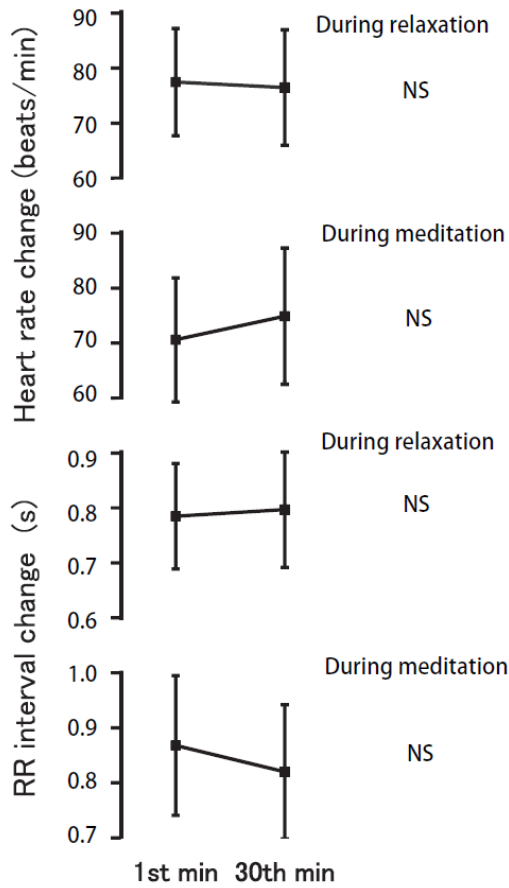


Figure 2. Change in instantaneous heart rate and RR over the 30-min periods during relaxation and during meditation.

There were small but significantly reduced heart rates with increased RR intervals during the meditation session, in comparison with relaxed sitting: mean RR interval increasing from  $0.78 \pm 0.10$  s to  $0.87 \pm 0.13$  s ( $p=0.002$ ), with the mean minimum RR (associated with the mean maximum instantaneous heart rate) increasing from  $0.70 \pm 0.10$  s to  $0.74 \pm 0.10$  s ( $p=0.008$ ) (Figure 3).

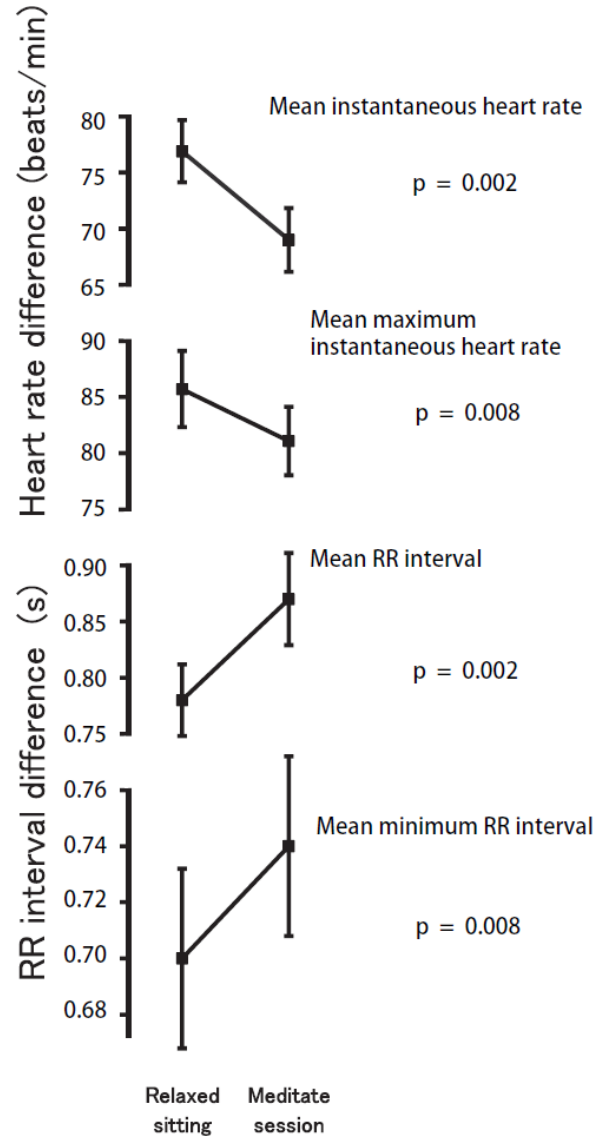


Figure 3. Paired difference for mean instantaneous heart rate and mean RR, between relaxed and meditation periods.

## 4. Discussion and conclusion

With the uncontrolled relaxation preceding the ECG recording periods, cardiac changes over a 30 minute period were small. All subjects had time to stabilise before the recording period, and in some case this period was over an hour. Therefore, as expected further changes were small.

When mean heart rate for the relaxed period was compared with the meditation period, it was shown that meditation generated a small overall reduction in heart rate, with increased RR intervals.

## Acknowledgement

We acknowledge the support of the Great Britain Sasakawa Foundation.

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