PULSE WAVE ANALYSIS FOR CARDIOVASCULAR INFORMATION MONITORING IN PATIENTS WITH CHRONIC HEART FAILURE: EFFECTS OF COQ10 TREATMENT

Gong Zhang (Correspond)
University of Winnipeg, Winnipeg, Manitoba, Canada
gzhang@sbgh.mb.ca

Xiaolin Kong
Anhui Agricultural University, Hefei, Anhui, China

Simon Liao
University of Winnipeg, Winnipeg, Manitoba, Canada

James Deng
University of Winnipeg, Winnipeg, Manitoba, Canada

ABSTRACTS

For patients with chronic heart failure, the coenzyme Q10 can improve the symptom. This study is to using a pulse wave analysis system to evaluate the cardiac hemodynamics of patients with coenzyme Q10 treatment. A total of 10 people participated in the study. We found that treatment for 3 months with coenzyme Q10 resulted in a significant decrease in Systolic blood pressure at rest, and a significant increase in SI and CI. All these parameters remained unchanged in the placebo group.

KEY WORDS

heart failure, pulse wave Analysis, COQ10

INTRODUCTION

Coenzyme Q10 (CoQ10) is a ubiquinone present in both animal and plant cellular membranes. It is ubiquitously found in the diet with daily intakes ranging from 3 to 5 mg/day (Weber et al. 1997). CoQ10 plays a key role in mitochondrial cell physiology as part of the electron transfer chain. For the patients with chronic heart failure, Oral supplementation of coenzyme Q10 has been shown to improve the cardio function. A meta-analysis was conducted using 8 of 14 randomized controlled trials of CoQ10 supplementation in chronic heart failure between 1984 and 1994. The other 6 trials failed to meet inclusion criteria. A separate meta-analysis was performed for stroke volume, cardiac output, ejection fraction, cardiac index, end diastolic volume index, systolic time intervals, and total work capacity. All of the parameters improved with CoQ10, except the latter two (Soja et al., 1997).

The effect of CoQ_{10} in Heart failure (HF) has been assessed using a variety of measures. With patients with New York Heart Association (NYHA) class II (73%) or III (28%) HF, the safety and clinical efficacy of oral CoQ_{10} 50–150 mg daily (average 100) was evaluated. Based on a designed measuring scale of clinical signs and symptoms, patients experienced a significant reduction from baseline in systolic (149.4 vs 143.8 mm Hg; $p < 0.05$) and diastolic (83.7 vs 82.0 mm Hg; $p < 0.05$) blood pressure and heart rate (78.4 vs 75.1 beats/min; $p < 0.05$). At least a one-point improvement in signs and symptoms was noted on average for each patient. By the conclusion of the study, nearly 29% of patients with NYHA class III HF were subsequently reallocated to class II based on symptoms.

A pulse wave velocity device has been developed for noninvasive detection for cardiac information. It can noninvasive evaluate cardiovascular index, pulse, systolic pressure, diastolic pressure and other cardiovascular parameters of daily activities in normal subjects(McDonald 1974, Nichols and Edwards 2001). This study is to evaluate the Nano COQ 10 treatment on the cardiovascular response to patients with CHF.

MATERIAL AND METHODS

Study Population

After excluded the patients with unstable angina or with myocardial infarction, ten patients with New York Heart Association functional class III or IV disease were eligible for inclusion in this study were studied. All patients were in normal rhythm.

Study Design

This study was organized as a randomized, double-blinded, placebo controlled crossover trial. The patients underwent the first evaluation with pulse wave

device, then, they were randomized to receive placebo or 150 mg Nano COQ10 for three month. In this period, they were undertaking the study every week.

Nano COQ10

Although COQl0 is classified as a lipid soluble substance, its degree of solubility is extremely limited. Commercially available COQl0 capsules contain either oil-based suspensions (softgels), or dry powder blends (hard gels). When tested in the laboratory, these products show a total lack of dissolution according to current USP methodology. Such lack of dissolution properties are often indicative of poor absorption and bioavailability. The tested nano particulate COQ10 (10%) has a diameter below 250 nanometers (a million of a millimeter). That makes it possible for Nano particulate COQ10 to be 100% water solubility, which proves to have a higher bioavailability that other lipophilic COQ10.

Pulse Wave Device

To measure haemodynamic parameters the so called thermo-dilution method is still most widely used. It is an invasive method requiring a pulmonalis catheter (a catheter is inserted into a big vein and advanced through the right side of the heart into the arteries of the lung). Up to now the only noninvasive method was impedance-cardiography which uses adhesive electrodes fitted to the thorax. Measurements take about 10-25 minutes and are not easy to use in clinical routine due to the complex wiring of the patient. Motivated by the increasing financial awareness in healthcare a rising number of new methods for pulse-wave analysis have emerged on the market. These methods are fast and constitute no burden for the patient. This device directly extracts health beat, blood pressure, and analysis pulse contour to determine the stroke volume, cardiac index. The measurement is non-invasive and takes about 90 seconds.

The study of arterial pulse wave analysis (PWA) has shown its potentials to indicate vital cardiovascular parameters that can be derived from PWA include pressure pulse contour, arterial elasticity, stroke index and cardiac output. Based on the hemodynamic analysis of the theory of elastic cavity (Liu & Li, 1987), the vital cardiac parameters can be calculated from the following equations:

- Blood flow continuous equation:

$$\begin{aligned} Q_{in} &= Q_{out} + \frac{dV}{dt_1} \\ 0 &= Q_{out} + \frac{dV}{dt_2} \end{aligned} \tag{1}$$

where Q_{in} is the volume of blood flowing into the artery and Q_{out} is the volume of blood flowing into the vein. t1 and t2 are the systolic and diastolic period, respectively.

- Equation between pressure remainder and blood flow:

$$\frac{p - p_v}{R} = Q_{out} \tag{2}$$

where p is the arterial pressure, p_v is the veinal pressure, and R, indicating the peripheral resistance of cardiovascular system.

- Aarterial pressure volume equation:

$$AC = \frac{dV}{dp} \tag{3}$$

where AC is a constant dependent on the arterial compliance.

Based on the above three equations, the analytic equation of elastic cavity can be calculated:

$$\begin{aligned} AC\frac{dp}{dt_1} + \frac{p - p_v}{R} &= Q_{in} \\ AC\frac{dp}{dt_2} + \frac{p - p_v}{R} &= 0 \end{aligned} \tag{4}$$

Computing the integral of Equation. (4):

$$\begin{aligned} AC(p_s^* - p_d) + \frac{A_s}{R} &= S_v \\ AC(p_d - p_s^*) + \frac{A_d}{R} &= 0 \end{aligned}$$

where S_v is the stroke volume during heart beat. And the meanings of A_s, A_d, p_s and p_d can refer to Figure1.

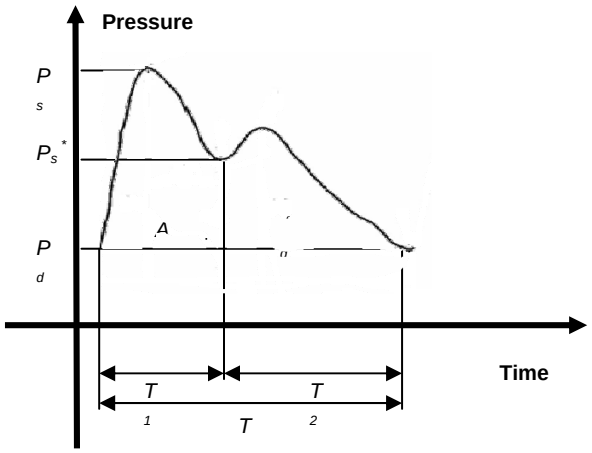

Figure1. The Graph of sphygmogramatic parameters.

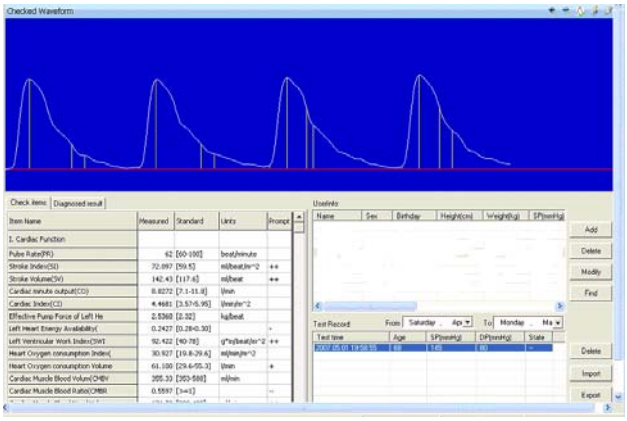

Figure 2. The software to analysis pulse wave

Testing Protocol

After a 10 minutes rest, required for stabilization of hemodynamic parameters, the testing was done by the PWD.

RESULTS

Five patients in each group completed the study. The study sample consisted of 6 men and 4 women, and the mean age in both groups was 59 years. No adverse reactions were attributed to the study drug, and no gastrointestinal side effects occurred.

Nonvasive hemodynamic variables at baseline and 3 months are shown in Table 1. In the Q_{10} group the stroke index (SI) increased significantly and the cardiac index (CI) increased significantly. Systolic blood pressure decreased significantly.

No significant changes occurred in the placebo group when comparing baseline and 3 months weeks.

Table 1. Baseline Parameters

	Coenzyme Q_{10} group (n = 5)	**Placebo-group (n = 5)**	**Stat**
Age (years)/range	60/35-68	56/37-71	ns
Pulse (beats/min)	72 +/- 8	67 +/- 11	ns
CI (1/min/m$^{2)}$	2.28 +/- 0.38	2.65 +/- 0.25	*P*<0.05
SI(ml/stroke/ m$^{2)}$	38.34+/- 4.47	41.28+/- 3.25	ns
BP systolic (mm Hg)	141 +/- 16	138 +/- 12	ns
BP diastolic (mm Hg)	87 +/- 9	91 +/- 12	ns

CI: cardiac index.
SI: stroke index
BP: blood pressure

Table 2. Parameters Comparison

	COQ10 baseline	**COQ10 3 months**	**Stat.**	**Placebo baseline**	**Placebo 3 months**	**Stat.**
Pulse (beats/min)	72 +/- 8	68 +/- 11	ns	67 +/- 11	69 +/- 9	ns
CI (1/min/m$^{2)}$	2.28 +/- 0.38	2.71 +/- 0.49	*P*<0.05	2.65 +/- 0.25	2.71 +/- 0.26	ns
SI(ml/stroke/ m$^{2)}$	38.34+/- 4.47	49.76+/- 5.91	*P*<0.05	40.28+/- 3.25	42.62+/- 4.38	ns
BP systolic (mm Hg)	141 +/- 16	134 +/- 12	*P*<0.05	138 +/- 12	139 +/- 8	ns
BP diastolic (mm Hg)	87 +/- 9	83 +/- 6	ns	91 +/- 7	87 +/- 12	ns

DISCUSSION

Since coenzyme Q_{10} was isolated about 40 years ago numerous studies have taken place concerning treatment of congestive heart failure with COQ10. The majority of the investigations are uncontrolled, but seven double-blinded, placebo controlled studies including from 14 to 641 patients treated with coenzyme Q_{10} in doses from 60 to 200 mg per day for 1 to 12 months have been performed (Hofman-Bang et al 1992, Judy et al 1986, Permanetter 1992)

Our study is the investigating treatment of congestive heart failure with COQ 10 in a double-blinded, placebo controlled manner. We found that treatment for 3 months with coenzyme Q_{10} resulted in a significant decrease in Systolic blood pressure at rest, and a significant increase in SI and CI. All these parameters remained unchanged in the placebo group.

The fact that BP systolic decreased and that SI increased suggests an improvement in left ventricular function in the coenzyme Q10-treated group.

CONCLUSION

Treatment with Nano COQ_{10} 150 mg per day resulted in a significant decrease in Systolic blood pressure and stroke index and cardiac index indicating improvement in left ventricular function in patients suffering from congestive heart failure in NYHA class 2 to 3.

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