Effect of Nasal Continious Positive Airway Pressure Ventilation on Left Ventricular Performance in Patients with Congestive Heart Failure

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Abstract

Background: Positive intrathoracic pressure reduces preload and afterload by decreasing left ventricular (LV) transmural pressure which in turn can increase LV ejection fraction. Continuous positive airway pressure (CPAP) administered via face or nasal mask can augment cardiac output in patients with congestive heart failure (CHF), but the clinical usefulness of CPAP as a nonpharmacological method of therapy in these patients needs to be further studied .

Methods: Nasal CPAP was applied to 21 patients (13 male, 8 female, mean age 6513 yrs) with low LV ejection fraction (288 %) who were under standart heart failure treatment. The etiology of CHF was ischemic heart disease in 15 patients and idiopathic dilated cardiomyopathy in 6. Twelve of the patients were in NYHA Class II and 9 were in III. Baseline blood pressure (BP), heart rate (HR), respiratory rate (RR), oxygen saturation (SpO2) values were noted. After the measurement of cardiac output (CO) and cardiac index (CI) by Doppler echocardiography, nasal CPAP (8 cm H2O) was applied for 10 minutes to the patients . All the measurements were repeated at the end of this period while on CPAP.

Results: CPAP was tolerated by all of the patients.There was no significant change in HR (8218 /min vs. 8318/min) and diastolic BP(6315 mmHg vs. 6818mmHg), but a slight elevation in systolic BP (11323 mmHg vs. 12029mmHg) ($p<0.02$) was observed.Respiratory rate decreased from 244/min to 212/ min ($p=0.0001$), and oxygen saturation increased from 935% to 954% ($p=0.01$). CO (3.71.0 vs. 4.01.0 lt/min) ($p=0.02$) and CI (2.20.6 vs. 2.40.6 lt/min/m2) ($p=0.04$) increased significantly.

Conclusions: CPAP improves LV function and some of the respiratory parameters in patients with chronic CHF. Thus, it may be useful as an adjunct to medical therapy of syptomatic patients with CHF.

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Key words: *CPAP, Congestive heart failure*

Introduction

Despite advances in medical therapy of congestive heart failure (CHF), morbidity and mortality for this disorder remain high(1). Studies have indicated a role for continuous positive airway pressure (CPAP) as a non-pharmacologic adjunctive therapy for CHF. CPAP increases intrathoracic pressure , thereby decreasing left ventricular (LV) preload and afterload(2). Increased intrathoracic pressure reduces LV transmural pressure during systole and leads to a decrease in LV afterload(3). CPAP may also reduce the need for ventilator treatment in acute cardiogenic pulmonary

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edema by improving gas exchange and decreasing respiratory work (4).Besides by direct or reflex mechanisms CPAP inhibits sympathetic nervous system activity (1,4,5) which may contribute to hemodynamic improvement.

The aim of this study was to evaluate the acute effect of CPAP on left ventricular function in CHF patients by noninvasive methods.

Methods

Study Patients : CHF patients of ischemic or idiopathic etiology who were symptomatic despite standart heart failure treatment , and whose LV ejection fraction (EF) were less than 40% were included.

Exclusion criteria : Patients were excluded if they were,

–older than 75 years
–hemodynamically unstable
or if they had ,
–serious arrhythmias (VT/VF)
–acute myocardial ischemia
–severe valvular disease
–sepsis or pneumonia
–facial fractures or lacerations
–recent bronchial or tracheal surgery

Study was approved by the local ethic committee and signed informed written consent was obtained from each patient.

Study Protocol: Baseline blood pressures (BP), heart rate (HR), respiratory rate (RR) and oxygen saturation (SpO2) values were noted.LV ejection was calculated by 2-D echocardiography using fractional area change method(6). Cardiac output (CO) and cardiac index (CI) were measured noninvasively by Doppler echocardiography(7) , the average of minimum 5 measurements were taken. Nasal CPAP (8 cmH2O) was applied for ten minutes. All the measurements were repeated at the end of this period while on CPAP. Study was terminated if the patient could not tolerate pressure ventilation, or diastolic BP fell below 90 mmHg.

BP, HR and pulse oxymetry measurements were made noninvasively by Propaq 106 (Protocol Systems Inc.) device, 2-D echocardiography was performed by using ATL UM 9, and nasal positive pressure ventilation was applied by BIPAP Ventilatory Support System (Respironics Inc.) device.

Statistical Analysis

To compare data obtained at baseline and after CPAP application we performed Student's t test for paired values . $p<0.05$ was considered to be significant.

Results

21 patients with CHF were studied . 15 patients had ischemic and 6 had idiopathic dilated cardiomyopathy. Mean ejection fraction for the study group was 288%, the functional capacity was class II in 12 , and class III in 9. The characteristics of the subjects are shown in table 1.

All of the patients completed the study. Four patients state that they did better with CPAP, five of them felt not comfortable on CPAP , and the remaining felt no difference with or without CPAP. There were no complications due to nasal positive airway pressure ventilation. There was no significant change in HR (8218 /min vs. 8318/min) and diastolic BP(6315 mmHg vs. 6818 mmHg), but a slight elevation in systolic BP (11323 mmHg vs. 12029 mmHg) ($p=0.02$) was observed. There was also a significant increase in SpO2 (935 % vs. 954) ($p<0.001$) and decrease in RR (244/min vs. 212/min) ($p<0.0001$). CO (3.71.0 vs. 4.01.0 lt/min) ($p=0.02$) and CI (2.20.6 vs. 2.40.6 lt/min/m2) $p=0.04$) increased significantly. The

Table 1. Patient characteristics

Number of patients	21
Male / female	13/8
Age (yrs)	6513
Functional capacity	
NYHA class II	12
NYHA class III	9
Etiology of heart failure	
ischemic heart disease	15
idiopathic dilated cardiomyopathy	6
Mean ejection fraction (%)	288

hemodynamic and respiratory parameters before and after CPAP application are shown in table 2 and figure 1.

Table 2. Hemodynamic and respiratory parameters

	Basal	CPAP	P
RR (min)	244	212	0.0001
SpO2 (%)	935	954	0.001
HR (min)	8218	8318	NS
SBP (mmHg)	11323	12029	0.02
DBP (mmHg)	6315	6818	NS
CO (lt/min)	3.71	4.01	0.02
CI (lt/min/m2)	2.20.6	2.40.6	0.04

Discussion

Changes in intrathoracic pressure (ITP) affect the pressure gradients for both systemic venous return and LV ejection.Under normal conditions, CO depends primarily on preload, and small changes in afterload do not greatly alter this output. Thus, increases in ITP usually decrease CO in normal subjects, owing to the decrease in venous return.In congestive heart failure LV output depends primarily on afterload. Increases in ITP may actually increase CO if the ITP-induced decrease in afterload is sufficiently great or if the heart function is significantly impaired(8). Positive pressure ventilation has been demonstrated to decrease cardiac afterload and decrease respiratory muscle work(3,9). By increasing ITP in patients with CHF, CPAP was shown to unload inspiratory muscles and reduce LV afterload(3). CPAP can acutely augment CO in patients with poorly compensated CHF(10,11). Baratz et al studied the acute hemodynamic effects of CPAP in patients with acute decompensation of CHF , and showed significant increases in cardiac index and oxygen delivery without a change in pulmonary capillary wedge pressure(PCWP)(10). Bradley et al further demonstrated that only CHF patients with baseline PCWP>12 mmHg, which reflects high LV diastolic pressure, experience an increase in cardiac index with CPAP(11). In some other studies chronic improvements in LV ejection fraction have been reported with nightly application of CPAP in patients with CHF(12,13,14,).

We studied CHF patients with low LV ejection fraction and poorly controlled symptoms under standart treatment. CPAP application was well tolerated and no side effects were seen. A significant decrease in respiratory rate supports the findings of other studies which claimed decreased respiratory muscle work with CPAP. Oxygen saturation was also improved. Cardiac output and cardiac index, both measured by doppler echocardiography, were shown to improve after CPAP application. These findings are consistent with previous studies which showed improvements in pulmonary and cardiac function with CPAP. Our findings must be supported by other studies which will investigate the chronic or nightly use of CPAP in the same patient group.

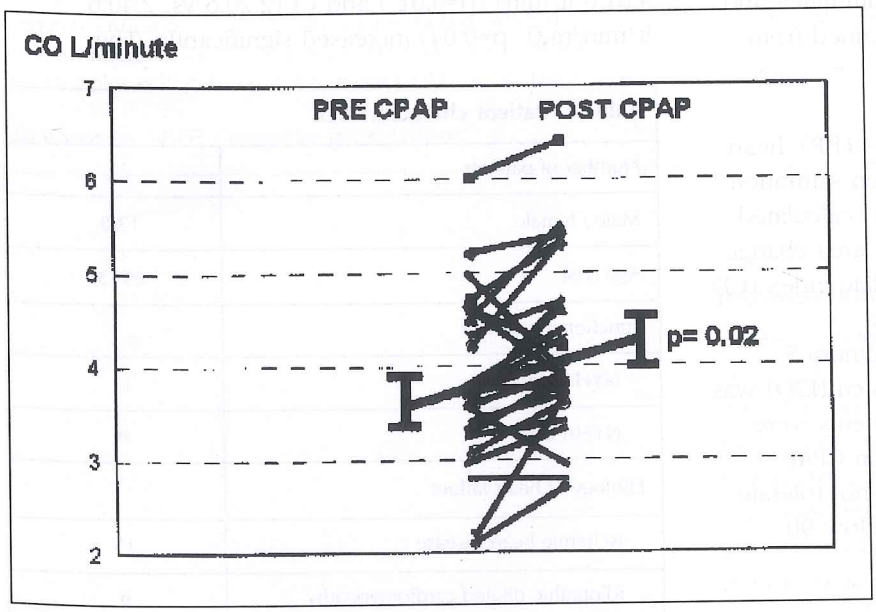

Figure 1. Cardiac output (CO) before and after 8 cm H_2O nasal CPAP

Conclusions

Nasal positive pressure ventilation is safe and well tolerated by the patients.

Nasal CPAP can improve cardiac output and oxygen saturation in patients with low left ventricular ejection fraction. CPAP also reduces respiratory rate which in turn may reduce respiratory work. Thus, positive pressure ventilation may offer a noninvasive adjunct to improving left ventricular function and augmenting cardiac performance in patients with CHF.

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