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CLINICAL STUDY

Effects of nocturnal oxygen therapy on heart function in SDB patients undergoing dialysis

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Abstract

There is a close relationship between sleep disordered breathing (SDB) and heart failure. We performed home oxygen therapy (HOT) in patients with SAS undergoing dialysis, and investigated its effects on the heart function. The subjects were 10 SDB patients on dialysis. On retiring at night, oxygen was transnasally administered at 1.0 L/min. The human atrial natriuretic peptide (hANP), brain natriuretic peptide (BNP), total protein, Alb, cholesterol and phosphorus levels were measured before the start of oxygen therapy and after 6 weeks. The mean SpO₂ increased from 93.5% [91.5, 97.0] to 96.3% [94.8, 97.4] (median [interquartile range]) ($p = 0.015$). The hANP ($p = 0.0039$), BNP ($p = 0.0098$) and serum Alb ($p = 0.015$) levels significantly improved. There were no significant changes in the cholesterol, phosphorus or total protein levels. These results suggest that nocturnal oxygen therapy improves indices of heart failure, contributing to the prevention and treatment of heart failure in dialysis patients with SDB.

Keywords

BNP, dialysis, hANP, heart failure, SDB

History

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Introduction

Tada et al.¹ and Kosmadakis and Medcalf² reported that the incidence of sleep disordered breathing (SDB) was high in patients undergoing dialysis. Unruh et al.³ indicated that there was a strong association of HD with severe SDB and nocturnal hypoxemia independent of the age, BMI and higher prevalence of chronic disease.

Sasayama et al.⁴ reported that the introduction of home oxygen therapy (HOT) improved the heart function in non-dialysis patients with SDB. Furthermore, Javaheri and Wexler⁵ indicated that the treatment of sleep apnea, both obstructive and central, results in a decrease in sympathetic activity and an improvement in systolic function, which are known surrogates of mortality. However, no study has reported the effects of HOT for SDB on the heart function in dialysis patients. In this study, we performed HOT in dialysis patients with SDB, and examined its influence on the heart function.

Materials and methods

In patients undergoing maintenance dialysis in our hospital, SpO₂ monitoring was conducted using a sleep apnea-testing system (Smart Watch PMP-300E, Pacific Medico, Tokyo, Japan).

In these subjects, overnight saturation monitoring was transcutaneously performed to examine the mean oxygen saturation and lowest arterial oxygen saturation. An oxygen desaturation index (ODI) was computed. Ten patients diagnosed with SAS, with a mean SpO₂ of 95% or lower or a minimum SpO₂ of 90% or lower, participated in this study (Table 1). Heart failure was evaluated according to the New York Heart Association functional classification (NYHA) 1–2 (Table 2).

In these patients, HOT was introduced. Using a transnasal camera, oxygen was administered at 1 L/min. Oxygen administration was started before retiring, and completed on waking (6–9 h). After 6 weeks, the human atrial natriuretic peptide (hANP), brain natriuretic peptide (BNP), total protein, Alb, cholesterol and phosphorus levels were measured, and compared with those before the start of HOT. We collected samples after dialysis for hANP and BNP and before dialysis for other parameters. We measured hANP using CLIEA and BNP CLIA techniques. We performed chest X-ray after dialysis. For statistical analysis, Wilcoxon's signed-rank sum test was used.

The protocol of this study was approved by the Human Ethics committee of Moriguchi Keijinkai Hospital. Informed consent was obtained from all patients prior to participation.

Results

During the 6-week period, no patient required a change of dry weight (DW). HOT increased the mean SpO₂ from 93.5%

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Table 1. Baseline characteristics of 10 patients.

Case	Age	Gender	Dialysis duration (months)	Diabetes mellitus	PCI	CABG	AVR	HT	ACE-i/ARB
1	64	M	20	–	+	–	–	–	–
2	76	M	32	–	–	–	–	+	+
3	71	M	39	+	+	–	–	+	+
4	46	F	76	+	–	–	–	+	+
5	73	M	54	+	–	–	–	+	+
6	63	M	44	+	+	–	–	+	+
7	71	M	12	–	–	–	+	+	+
8	75	F	8	+	–	–	–	+	+
9	79	F	44	–	–	–	–	+	+
10	73	M	19	–	–	–	–	+	+
Total	72 [63.8, 75.3]	M:F=7:3	35.5 [17.3, 46.5]	5	3	0	1	9	9

Notes: Values are expressed as median with [interquartile range].

PCI=percutaneous coronary intervention, CABG=coronary artery bypass graft, AVR=aortic valve replacement, HT=hypertension, ACE-i=angiotensin converting enzyme inhibitor, ARB=angiotensin II receptor blocker.

Table 2. Changes in parameters after nocturnal home oxygen therapy (HOT).

	HOT		<i>p</i> -Value
	Before	After	
NYHA I	4	4	
II	6	6	
TP (g/dL)	6.85 [6.2, 7.0]	6.75 [6.3, 7.0]	0.88
T-Cho (mg/dL)	140 [114, 176]	131 [119, 159]	0.49
TG (mg/dL)	97.5 [56.5, 135]	91.5 [48.5, 121]	0.73
iP (mg/dL)	4.65 [4.1, 5.0]	4.95 [3.9, 6.2]	0.45
CTR (%)	58.2 [51.6, 63.8]	57.6 [49.7, 63.9]	0.94

Notes: Values are expressed as median with [interquartile range], *p*-value for Wilcoxon signed rank sum test.

NYHA=New York Heart Association functional classification, TP=total protein, T-Cho=total cholesterol, CTR=cardiothoracic ratio.

[91.5, 97.0] to 96.3% [94.8, 97.4] (median [interquartile range]) ($p=0.015$). The minimum SpO₂ significantly improved. The ODI (3%) also improved (Figure 1). There were no changes in the NYHA classification and cardiothoracic ratio (CTR) (Table 2).

A blood biochemical test showed a significant increase in the serum albumin level and significant decreases in the hANP and BNP levels (Figure 1).

There were no significant differences in the cholesterol, phosphorus or total protein levels (Table 2).

Discussion

Kasai reported that there was a close relationship between SDB and heart failure.⁶ According to Bordier, SDB is observed in 50% of patients with chronic heart failure.⁷

In patients with SDB, HOT may prevent hypoxemia related to central sleep apnea by increasing the inhaled oxygen concentration and improving the intra-alveolar oxygen reserve.^{8,9} As a result, it may reduce sleep apnea through an

improvement in peripheral tissue oxygen supply, the suppression of sympathetic activities and a reduction in ventricular loading. In Japan, the results of nocturnal oxygen therapy in chronic heart failure patients with SDB have been published. In the oxygen-treated group, the apnea hypopnea index (AHI) was significantly lower than in the control group.⁸ HOT is advantageous in correcting the elevated sympathetic activities, decreasing the frequency of sleep apnea and improving the sleep structure/symptoms. The enhancement of appetite related to an improvement in daytime activity through these actions¹⁰ may have contributed to the increase in the albumin level.

BNP and hANP are useful as indices of heart failure.^{11–13} BNP may also be a prognostic factor for cardiovascular mortality in dialysis patients. Zoccaliet al.¹⁴ indicated that BNP was a prognostic factor for total and cardiovascular mortality, independent of the left ventricular mass (LVM) and ejection fraction. Goto et al.¹⁵ reported that the elevated levels of BNP indicated an increased risk of cardiac events. Zoccali et al.^{16,17} emphasized that SDB promoted left ventricular hypertrophy in dialysis patients, being a cardiovascular risk factor. Therefore, it is important to decrease the levels of BNP and hANP in dialysis patients.

Several studies have reported the influence of oxygen therapy on BNP and hANP in non-dialysis heart failure patients with SDB. Svatikova et al.¹⁸ performed CPAP and overnight monitoring in patients with OSAS, and reported that there was a significant decrease in the hANP level, although there were no changes in the BNP level. Shigemitsu et al.¹⁹ administered oxygen to patients with chronic heart failure at night for 4 months, and indicated that there was a significant decrease in the BNP level, whereas there were no significant changes in the hANP level. They concluded that oxygen administration prevented the progression of heart failure.

In our study, HOT decreased the BNP and hANP levels even in dialysis patients. HOT for SDB in dialysis patients may prevent the progression of heart failure.

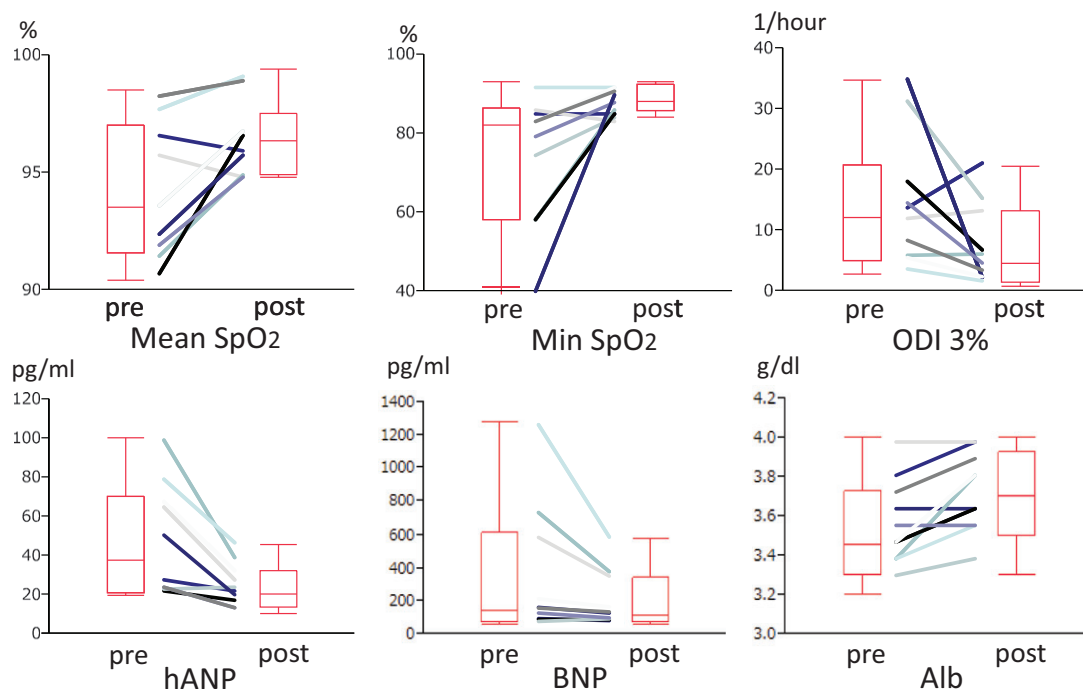


Figure 1. Changes in parameters after nocturnal home oxygen therapy (HOT).

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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