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Effect analysis of nasotracheal suction mechanical ventilation treatment of cerebral ischemic stroke induced by sleep apnea

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Abstract. – OBJECTIVE: To investigate the difference between the clinical effects of nasotracheal suction (NTS) mechanical ventilation and noninvasive positive pressure ventilation (CPAP) treatment of cerebral ischemic stroke (IS) induced by sleep apnea.

PATIENTS AND METHODS: Fifty-three patients diagnosed with cerebral IS caused by sleep apnea from February 2013 to February 2014 were selected for this study from our hospital. After the approval of the hospital's Ethics Committee and patients' signed consent, the patients were randomly divided into a test group (n=29 cases) and a control group (n=24 cases). All patients were given conventional treatment for stroke. The control group received the noninvasive ventilator application with CPAP model. The test group was treated with nasal endotracheal suction of mechanical ventilation treatment. Using the NIHSS scale and Barthel index, we compared the status of the nervous system on admission and after seven days stroke recovery treatment of the two groups. Through the comparison of apnea-hypopnea index (AHI), oxygen desaturation index (ODI), LSaO2 and MSaO2 of the two groups on the seventh day, we compared the efficacy of the obstructive sleep apnea-hypopnea syndrome (OSAHS).

RESULTS: The NIHSS score and Barthel index score of mild, moderate and severe were compared on the OSAHS patients at admission, and the difference was not statistically significant ($p > 0.05$). After treatment, all patients showed lower NIHSS score and increased Barthel scores, and the difference had statistical significance ($p < 0.05$). For the mild OSAHS patients, we compared the NIHSS score and Barthel index score of the test and control group, and the difference was not statistically significant ($p > 0.05$). For the moderate and severe OSAHS patients, the NIHSS score of the test group decreased significantly. However, the Barthel index scores increased significantly, and the difference had statistical significance ($p > 0.05$). The AHI, LSaO2, MSaO2, and ODI index of the two groups of patients were compared with the treatment, and the differences were not statistically significant ($p > 0.05$). After treatment, the AHI and the ODI index of the two groups decreased, LSaO2 and MSaO2 index increased, and AHI and ODI index of the test group decreased more than that of the control group. However, the LSaO2 and the MSaO2 index increased, and the difference had statistical significance ($p > 0.05$). The total effective rate of patients of the test group was higher than that of the control group, but no effectiveness and overall mortality was lower than the control group. The difference was statistically significant ($p > 0.05$).

CONCLUSIONS: Compared with noninvasive ventilator therapy, nasotracheal suction mechanical ventilation and noninvasive positive pressure ventilation treatment of cerebral IS induced by sleep apnea can naturally improve the prognosis of nervous system recovery, and improve the respiratory ventilation function. This may be a better treatment option for moderate and severe sleep apnea patients that is worthy of clinical application.

Key Words:
Obstructive sleep apnea-hypopnea syndrome, Ischemic stroke, Nasotracheal suction mechanical ventilation, Noninvasive ventilator.

Abbreviations

NIHSS = National Institutes of Health Stroke Scale; $LSaO_2$ = lowest arterial oxygen saturation; $MSaO_2$ = mean arterial oxygen saturation; BMI = body mass index; CPAP = continuous positive airway pressure.

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Introduction

Obstructive sleep apnea-hypopnea syndrome (OSAHS), is a multisystem, potentially lethal sleep respiratory disease. Obstructive sleep apnea-hypopnea syndrome is an independent risk factor for ischemic stroke (IS). Obstructive sleep apnea-hypopnea syndrome can cause cardiovascular abnormalities, which increases the likelihood of stroke onset. A stroke can cause OSAHS exacerbations, which form a vicious circle and brings greater difficulty for clinical treatment[1-3]. Current noninvasive ventilation with nasal continuous positive airway pressure ventilation is the preferred method of non-surgery treatment for OSAH, but for moderate to severe OSAHS patients with a stroke, it has a weak effect. Nasotracheal suction of mechanical ventilation therapy can help patients with OSAHS get sufficient sputum drainage and maintain airway patency[4,5]. The study further analyzes the clinical outcome of the nasotracheal suction treatment of mechanical ventilation and noninvasive positive pressure ventilation in patients with IS induced by sleep apnea, and the results are summarized as follows.

Patients and Methods

Trial Subject

Fifty-three patients with cerebral IS diagnosed as cerebral IS induced by sleep apnea from February 2013 to February 2014 were selected to participate in this study. Their OSAHS diagnosis conforms to the "Obstructive sleep apnea-hypopnea syndrome diagnosis and treatment guidelines"[6]□and their stroke diagnosis conforms to the diagnostic standard for the fourth national cerebrovascular disease academic meeting has confirmed by CT or MRI. Patients excluded from the study had the following conditions: serious cerebral vascular malformation, patients who suffered from a mental disorder or a disorder of consciousness after onset, severe pulmonary infection, previous nose disease, chronic lung disease and neuromuscular disease. Through the comparison and analysis of the application of the dynamic electrocardiogram in all these patients with 24h, we found that the heart rate variability was different, and there was a correlation with arrhythmic events.

After the study had received approval from our hospital's Ethics Committee and the informed consents of patients, they were randomly divided into a test group (n = 29 cases) and a control group (n = 24 cases). In the control group, 13 male cases and nine female cases, aged (62.7 ± 7.3), with a body mass index (27.3 ± 1.9) kg/m^2. Eight patients had a history of snoring, 11 cases with cardiovascular or cerebrovascular diseases, nine cases with a smoking history, seven cases with a drinking history□six patients with CT and MRI mapping of frontal lobe infarction, 10 cases of basal ganglia, five patients with temporal lobe, eight cases of cerebellum. In the test group, 18 cases were male, and 11 cases were female, aged (63.1 ± 7.2), with a body mass index (26.9 ± 1.7) kg/m^2. Six patients had a history of snoring, 10 cases had cardiovascular or cerebrovascular diseases, 10 cases had a smoking history, eight cases had a drinking history; four cases with CT and MRI mapping of the frontal lobe infarction, eight cases with basal ganglia, five patients with temporal lobe, and seven cases of cerebellum. Gender, age, BMI, history of snoring, cardiovascular and cerebrovascular disease history, smoking, drinking, and infarct proportion of the two groups of patients were compared. The differences were not statistically significant ($p > 0.05$). According to OSAHS standard, the control group had eight mild cases, 11 moderate cases, five severe cases. In the test group, there were nine mild cases, 13 moderate cases, and seven severe cases. The OSAHS classification of two groups of patients were compared and showed no significant difference ($p > 0.05$). All patients were given conventional treatment for stroke. The control group received the noninvasive ventilator application with CPAP model. The test group was treated with nasal endotracheal suction of mechanical ventilation treatment.

Test Method

Sleep Monitoring

Patients underwent polysomnography (America Embla polysomnography, Broomfield, CO, USA) on the seventh day for not less than 7h sleep apnea detection. All subjects were prohibited from taking all kinds of sedative drugs, alcohol, tea, and coffee 6h before the sleep monitoring. The tracing projects included oronasal airflow, chest exercise, and the ventral fingertip transcutaneous oxygen saturation when sleeping. All data were analyzed automatically by instruments and then by the manual record statistics.

Conventional Therapy for Patients with Stroke

Including: (1) the anti-platelet aggregation; (2) improved cerebral metabolism and cerebral circulation; (3) the symptomatic treatment; (4) the nutrition support.

The Nerve Function Deficit Score

The neural function defect score standard assesses the cerebral apoplexy nerve function defect and the curative effect according to the evaluation of NIHSS score and Barthel index. All patients were conscious without sensory aphasia. The same physician recorded the nerve function deficit score according to the same standard.

Respiratory Therapy

After all patients had been diagnosed with sleep apnea inducing IS. The patients in the control group received noninvasive ventilation treatment at a pressure for not less than four hours every night. The test group received uplink nasal endotracheal suction operation on that basis. The Weinmann vent ST ventilator (Hamburg, Germany) was used for seven consecutive day of treatments.

The Observation Index

Compared AHI, ODI, the lowest oxygen saturation of arterial blood ($LSaO_2$) and mean arterial oxygen saturation ($MSaO_2$) when sleeping on the seventh day of the two groups, NIHSS score and Barthel index of the two groups on admission and the seventh day. Heart rate variability differences of patients of the two groups were contrasted (using Holter, GE Marquette MAC-1200 Company, Palatine, IL, USA), SDNN is the standard deviation of sinus bradycardia R-R (NN) interval, 50 ms ≤ SDNN < 100 ms is mild to moderate reduction, SDNN < 50 ms is severe reduction.

Statistical Analysis

Data were analyzed using SPSS19.0 statistical software for processing. The measurement data was shown by mean standard deviation (±s). The t-test compared the groups, and count data were represented by the number of cases or percentage, groups were compared by χ^2 test; $p < 0.05$ meants that the difference had statistical significance.

Results

Comparison of NIHSS Score and Barthel Index Score of the Two Groups of Patients

The NIHSS score and Barthel index score of mild, moderate and severe OSAHS patients were compared with admission. The difference was not statistically significant ($p > 0.05$). After treatment, all patients showed lower NIHSS scores and increased Barthel scores, and the difference had statistical significance ($p < 0.05$). For the mild OSAHS patients, the NIHSS score and Barthel index score were compared between the two groups. The difference was not statistically significant ($p > 0.05$). For moderate and severe OSAHS patients, the NIHSS score of the test group decreased more significantly. The Barthel index scores increased more significantly, and the difference had statistical significance ($p < 0.05$) (Table I).

Comparison of the Respiratory Index of Patients of the Two Groups

The AHI, $LSaO_2$, $MSaO_2$, and ODI index of two groups of patients were compared with treatment, and the differences were not statistically significant ($p > 0.05$). After treatment, the AHI and ODI index of the two groups decreased. The $LSaO_2$ and $MSaO_2$ index increased, and AHI and ODI index of the test group decreased more apparently than that of the control group. Its $LSaO_2$ and $MSaO_2$ index increased, and the difference had statistical significance ($p < 0.05$) (Table II).

Comparison of Heart Rate Variability in the Patients of the Two Groups

The SDNN of test group was significantly higher than the control group, with higher mild to moderate variation ratio, the control group with higher severe variation ratio, the differences were statistically significant ($p < 0.05$); the average heart rate of the experimental group were significantly lower than the control group, the difference was statistically significant ($p < 0.05$) (Table III).

Comparison of Clinical Effectiveness and Mortality of Two Groups of Patients

The total effective rate of patients of the test group was higher than that of the control group, but no efficiency and overall mortality was significantly lower than the control group. The difference was statistically significant ($p < 0.05$) (Table IV).

Table I. Comparison of NIHSS score and Barthel index of two groups for the patients with different degree of OSAHS score.

		NIHSS score		Barthel index score	
		On admission	The 7th day	On admission	The 7th day
Mild OSAHS patients	test group	11.40 ± 3.01	8.54 ± 1.41	50.43 ± 6.48	60.53 ± 9.36
	control group	12.30 ± 2.96	9.03 ± 1.69	50.12 ± 7.79	59.79 ± 9.18
	t	0.254	0.362	0.947	0.656
	p	0.103	0.114	0.323	0.955
Moderate OSAHS patients	test group	14.99 ± 1.37	9.32 ± 1.69	47.34 ± 4.62	55.12 ± 7.18
	control group	15.02 ± 1.26	11.77 ± 2.48	47.32 ± 5.23	53.97 ± 5.71
	t	0.475	2.369	0.633	2.939
	p	0.303	0.033	0.107	0.028
Severe OSAHS patients	test group	18.58 ± 3.82	11.45 ± 2.31	41.13 ± 5.65	54.20 ± 3.49
	control group	18.01 ± 2.39	14.85 ± 1.04	40.79 ± 6.01	49.13 ± 9.32
	t	0.747	3.023	0.332	3.654
	p	0.412	0.023	0.926	0.021

Discussion

Because of the upper respiratory tract obstruction and insufficient pulmonary ventilation, OSAHS causes apnea in patients. The main clinical symptoms are sleepiness and snoring that can be complicated by chronic pulmonary heart disease, hypertension, stroke and other cardiovascular and cerebrovascular diseases, and can even lead to sudden death at night[7,8]. The OSAHS is a risk factor for causing stroke, and the complication of stroke is very common in patients with OSAHS. At the same time, more than 70% patients are accompanied by OSAHS amongst stroke patients. Due to its mutual influence complex mechanism, intermittent hypoxia and hypercapnia OSAHS patients can activate the sympathetic nervous system, increase catecholamine levels in hematuria of patients, accelerate heart rate, and increase vascular sensitivity. Peripheral vasoconstriction leads to chronic ischemia, increasing erythropoietin and causing an increase in polycythemia with blood hypercoagulability. Because the OSAHS blood gas characteristics are intermittent, vascular systolic and diastolic alternately with local tissue reperfusion injury promotes the occurrence of atherosclerosis. The inflammatory reaction caused by hypoxemia prompts various cytokine productions, which is one of the important factors of arteriosclerosis[9-12]. These factors inducing cardio-cerebral vascular diseases can all cause a stroke. Stroke will also promote OSAHS symptoms to increase, and cause the brain tissue irreversible damage, resulting in a vicious spiral.

It is thought that noninvasive ventilation with continuous positive airway pressure (CPAP) is an efficient method of the treatment for OSAHS. The main pathogenesis of OSAHS is summed up as the upper airway collapse and respiratory muscle dysfunction. Through positive pressure air flow input to the airway in the patients' respiratory process, CPAP resists narrow or closed pharyngeal cavity caused by upper airway collapse during sleep, resulting in the AHI decreasing to the normal level[13-15]. It makes patients accommodate assisted ventilation during sleep, and nocturnal hypoventilation symptoms disappear with normal oxygen saturation. In the treatment of OSAHS, the positive effect of CPAP has been recognized, but some OSAHS patients with the noninvasive ventilation have a serious respiratory failure due to respiratory muscle weakness resulting in different degrees. In the early days of CPAP treatment, problems of retention and obstruction of the airway often restrict the treatment effects of CPAP and led to treatment failure[16-19].

Nasotracheal suction treatment of mechanical ventilation can fundamentally solve the sputum's inadequate drainage[20]. The procedure for the initial stage of CPAP is as follows: detain the suction tube, uncover the ventilation mask, and adjust the sputum suction tube pressure to the appropriate level. At the same time avoid airway insertion of the sputum suction tube which may cause respiratory tract injury. Nasotracheal suction ventilation therapy combined with noninvasive mechanical ventilation makes

Table II. Comparison of respiratory index of patients of two groups.

Group	AHI (time/h)		$LSaO_2$ (%)		$MSaO_2$ (%)		ODI (time/h)	
	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment
Test group	6.32±00.57	2.93±10.22	72.63±5.21	92.12±4.18	82.14±5.02	94.84±1.79	35.14±15.32	20.80±17.64
Control group	6.15±00.33	4.23±00.92	74.02±6.28	85.73±3.11	83.96±6.15	90.72±2.89	33.64±13.25	29.57±17.23
t	0.362	3.025	0.847	3.627	0.307	3.458	0.415	3.969
p	0.641	0.024	0.625	0.018	0.122	0.017	0.826	0.013

oxygen tension ascend and carbon dioxide descend so that the brain tissue hypoxia can be improved significantly. The treatment is remarkable for OSAHS patients with cerebral stroke[21]. Most patients recover consciousness, and they can expectorate and spontaneously breath with assisted ventilation[17-19]. From the study, we compared the NIHSS score and Barthel index score of mild, moderate and severe OSAHS patients on admission, and the difference was not statistically significance[22,23]. After treatment, all patients showed lower NIHSS scores and increased Barthel scores, and the difference had statistical significance. For the mild OSAHS patients, we compared the NIHSS score and Barthel index score of the test group and the control group. The difference was not statistically significant. For moderate and severe OSAHS patients, the NIHSS score of the test group decreased more significantly. The Barthel index scores increased more significantly, and the difference had statistical significance. We compared the AHI, $LSaO_2$, $MSaO_2$, and ODI index of the two groups of patients before treatment, and the differences were not statistically significant. After treatment, the AHI and ODI index of the two groups of patients decreased, the $LSaO_2$ and $MSaO_2$ index increased, and the AHI and ODI index of the test group decreased. Its $LSaO_2$ and $MSaO_2$ index increased more apparently, and the difference had statistical significance. The total effectiveness rate of patients of the test group was higher than that of the control group. However, overall mortality was significantly lower than the control group, and the difference was statistically significant. Nasotracheal suction mechanical ventilation plays a significant role in ensuring the treatment effect of early CPAP. It keeps the airway unobstructed and prevents secretion retention, therefore, reducing the use of noninvasive ventilation, improving prognosis, and reducing complications[24,25]. However, it is more relevant to CPAP patients with stroke.

Conclusions

Nasotracheal suction mechanical ventilation and noninvasive positive pressure ventilation treatment of cerebral IS induced by sleep apnea can apparently improve the prognosis effect of the nervous system recovery, and improve the respiratory ventilation function.

Table III. Comparison of heart rate variability in the patients of the two groups.

Groups	Number of cases	SDNN (ms)	Mild	Moderate	Severe	Average heart rate of 24h
Experimental group	29	91.37 ± 12.29	13 (44.83)	10 (34.48)	6 (20.69)	73.24 ± 9.48
Control group	24	66.83 ± 5.49	4 (16.67)	10 (41.67)	10 (41.67)	86.39 ± 10.42
T (X^2)		4.856	3.569	2.947	3.417	2.659
p		< 0.001	< 0.001	0.036	0.024	0.018

Table IV. Comparison of clinical effectiveness and mortality of two groups of patients [cases (%)].

Group	Cases	Effective	Ineffective	Death
Test group	29	21 (72.41)	8 (27.29)	5 (17.24)
Control group	24	14 (58.33)	10 (41.67)	7 (29.17)
X^2		4.125	4.038	4.627
p		< 0.001	<0.001	< 0.001

Conflict of Interest

The Authors declare that they have no conflict of interests.

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