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Effects of Noninvasive Mechanical Ventilation With Obesity Hypoventilation Syndrome

Thesis

**Submitted for Partial Fulfillment of
Doctor Degree of Chest Diseases**

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List of Abbreviations

A	<i>Cross-sectional airway area</i>
A-CPAP	<i>Auto titrating continuous positive airway pressure</i>
AHI	<i>Apnea hypopnea index</i>
AI	<i>Apnea index</i>
ANP	<i>Atrial Natriuretic Peptide</i>
APAP	<i>Auto titration positive airway pressure</i>
ASDA	<i>American Sleep Disorder Associates</i>
Av O₂ in all desaturations	<i>Average O₂ in all desaturations</i>
BC	<i>Before Christ</i>
BiPAP	<i>Bi-level positive airway pressure</i>
BMI	<i>Body Mass Index</i>
CBC	<i>Complete Blood Count</i>
CBT	<i>Core Body Temperature</i>
CHF	<i>Congestive Heart Failure</i>
Cm/H₂O	<i>Centimeter Water</i>
CO₂	<i>Carbon Dioxide</i>
COPD	<i>Chronic Obstructive Pulmonary Disease</i>
CPAP	<i>Continuous Positive Airway Pressure</i>
CRF	<i>Chronic Renal Failure</i>
CSA	<i>Central Sleep Apnea</i>
CSB	<i>Cheyne-Stokes breathing</i>
DI	<i>Desaturation Index</i>
DM	<i>Diabetes Mellitus</i>
ECG	<i>Electro-cardiogram</i>
EDS	<i>Excessive Daytime Somnolence</i>
EEG	<i>Electro-encephalogram</i>
EMG	<i>Electro-myogram</i>
ENT	<i>Ear, nose and throat</i>
EOG	<i>Electro-oculogram</i>
EPAP	<i>Expiratory Positive Airway Pressure</i>

ES	<i>Electrical Stimulation</i>
ESS	<i>Epworth Sleepiness Scale</i>
F-CPAP	<i>Fixed Pressure Continuous Positive Airway Pressure</i>
FDA	<i>Food and Drug Administration</i>
FEF25-75	<i>Forced expiratory rate at 25% and 75% of forced vital capacity</i>
FEV1	<i>Forced expiratory volume in the first second</i>
FRC	<i>Functional Residual Capacity</i>
FS	<i>Failed Surgery</i>
FTT	<i>Failure to thrive</i>
FVC	<i>Forced vital capacity</i>
GGEMG	<i>Genioglossus electromyography</i>
HCT	<i>Hematocrit value</i>
HF	<i>High frequency</i>
HI	<i>Hypopnea index</i>
HRV	<i>Heart Rate Variability</i>
Hz	<i>Hertz</i>
ICSI	<i>Institute for Clinical Systems Improvement</i>
ICU	<i>Intensive Care Unit</i>
IPAP	<i>Inspiratory positive airway pressure</i>
IPAPMax	<i>Maximum IPAP of inspiratory time</i>
IPAPMin	<i>Minimum IPAP of inspiratory time</i>
IPPV	<i>Intermittent positive pressure ventilation</i>
Kg. m²	<i>Kilogram per square meter</i>
L/min	<i>Liter per minute</i>
LAUP	<i>Laser-assisted uvulopalatoplasty</i>
LF	<i>Low Frequency</i>
LOC	<i>Left eye electrode</i>
LSAT	<i>Lower Oxygen Saturation</i>
LVEF	<i>Left Ventricular Ejection Fraction</i>
MAD	<i>Mean apnea duration</i>
MDI	<i>Metered dose inhalers</i>
MHD	<i>Mean hypopnea duration</i>
MI	<i>Myocardial Infarction</i>

mm	<i>millimeter</i>
mm/sec	<i>Millimeter per second</i>
MMA	<i>Maxillomandibular advancement</i>
mmHg	<i>Millimeter mercury</i>
Min O₂ value	<i>Minimal O₂ value</i>
MPA	<i>Medroxyprogesterone acetate</i>
MRI	<i>Magnetic Resonance Imaging</i>
MS	<i>Mallampati score</i>
MSLT	<i>Multiple sleep latency test</i>
MVV	<i>Maximum Voluntary ventilation</i>
nCPAP	<i>Nasal continuous positive airway pressure</i>
NIDDM	<i>Non-insulin dependent diabetes mellitus</i>
NIH	<i>National Institutes of Health</i>
NPSG	<i>Nocturnal Polysomnography</i>
NREM	<i>Non-rapid eye movement</i>
OAs	<i>Oral Appliances</i>
ODI	<i>Oxygen desaturation index</i>
ODI₁₀	<i>Oxygen desaturations index <10%</i>
ODI₄	<i>Oxygen desaturations index ≥4%</i>
OHS	<i>Obesity hypoventilation syndrome</i>
OI	<i>Obstructive index</i>
OSA	<i>Obstructive Sleep Apnea</i>
OSAHS	<i>Obstructive Sleep Apnea Hypopnea Syndrome</i>
OSAS	<i>Obstructive Sleep Apnea Syndrome</i>
OSDB	<i>Obstructive sleep disordered breathing</i>
PA	<i>Positive alarm</i>
PaCO₂	<i>Partial pressure of arterial carbon dioxide</i>
PAV	<i>Proportional Assisted Ventilation</i>
Pclose	<i>Closing pressure</i>
Pcrit	<i>Critical pressure</i>
PCV	<i>Pressure Controlled Ventilation</i>
PEEP	<i>Positive end expiratory pressure</i>
P_{ET}CO₂	<i>End tidal carbon dioxide</i>

PI	<i>Intraluminal pressure</i>
PSG	<i>Polysomnography</i>
PSGD	<i>Diagnostic polysomnography</i>
PSGT	<i>Titration polysomnography</i>
PSV	<i>Pressure Supported Ventilation</i>
Pti	<i>Tissue pressure</i>
Ptm	<i>Transmural pressure</i>
RAS	<i>Reticular activating system</i>
RCT	<i>Randomized controlled system</i>
RDI	<i>Respiratory disturbance index</i>
REM	<i>Rapid eye movement</i>
RERA	<i>Respiratory effort related arousal</i>
ROC	<i>Right eye electrode</i>
RREP	<i>Respiratory related evoked potential</i>
SaO₂	<i>Arterial oxygen saturation</i>
SAS	<i>Sleep apnea syndrome</i>
SCN	<i>Suprachiasmatic nucleus</i>
SDB	<i>Sleep disordered breathing</i>
SOB	<i>Shortness of breath</i>
SRBD	<i>Sleep related breathing disorders</i>
SWS	<i>Slow wave sleep</i>
TCRFTA	<i>Temperature-controlled radiofrequency tissue ablation</i>
TMJ	<i>Temporomandibular joint</i>
TRD	<i>Tongue-retaining devices</i>
TV	<i>Tidal Volume</i>
UARS	<i>Upper airway resistance syndrome</i>
UPPP	<i>Uvulopalatopharyngoplasty</i>
V'E	<i>Minute ventilation</i>
WHO	<i>World Health Organization</i>

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Group I(Before treatment with NIMV)

No	Age	Sex	BMI	pH	PaO2	PaCO2	HCO3
1	55.00	Male	53.00	7.30	57.40	53.80	32.00
2	50.00	Male	54.00	7.32	56.00	59.10	33.00
3	60.00	Male	55.00	7.31	57.70	51.80	32.00
4	59.00	Female	57.00	7.31	58.00	50.90	31.00
5	56.00	Male	58.00	7.31	51.20	55.40	33.00
6	57.00	Male	53.00	7.30	57.70	51.00	30.00
7	50.00	Male	56.00	7.30	51.30	55.20	36.00
8	54.00	Male	58.00	7.30	55.80	54.00	34.00
9	58.00	Female	51.00	7.34	53.00	59.00	34.00
10	59.00	Female	53.00	7.31	51.20	55.40	33.00
11	53.00	Male	55.00	7.35	54.00	59.00	33.00
12	60.00	Female	55.00	7.33	57.20	55.90	33.00
13	56.00	Male	53.00	7.34	56.90	50.00	34.00
14	55.00	Male	50.00	7.34	53.00	59.00	29.90
15	57.00	Male	55.00	7.30	51.30	60.00	36.00
16	58.00	Female	56.00	7.31	50.80	56.00	36.00
17	56.00	Male	54.00	7.35	57.90	56.00	32.00
18	52.00	Female	55.00	7.34	58.00	51.20	31.00
19	55.00	Male	59.00	7.32	51.00	59.00	34.00
20	54.00	Male	55.00	7.33	51.30	55.50	33.30
21	59.00	Male	55.00	7.33	50.20	51.20	30.00
22	59.00	Male	56.00	7.35	55.40	56.60	32.30
23	58.00	Female	57.00	7.35	53.30	59.90	36.10
24	59.00	Male	54.00	7.32	52.10	60.10	35.00
25	57.00	Male	55.00	7.33	56.80	59.90	33.30
26	55.00	Male	53.00	7.30	57.40	53.80	32.00
27	50.00	Male	54.00	7.32	56.00	59.10	33.00
28	60.00	Male	55.00	7.31	57.70	51.80	32.00
29	59.00	Female	57.00	7.31	58.00	50.90	31.00

No	Age	Sex	BMI	pH	PaO2	PaCO2	HCO3
30	56.00	Male	58.00	7.31	51.20	55.40	33.00
31	57.00	Male	53.00	7.30	57.70	51.00	30.00
32	50.00	Male	56.00	7.30	51.30	55.20	36.00
33	54.00	Male	58.00	7.30	55.80	54.00	34.00
34	58.00	Female	51.00	7.34	53.00	59.00	34.00
35	59.00	Female	53.00	7.31	51.20	55.40	33.00
36	53.00	Male	55.00	7.35	54.00	59.00	33.00
37	60.00	Female	55.00	7.33	57.20	55.90	33.00
38	56.00	Male	53.00	7.34	56.90	50.00	34.00
39	55.00	Male	50.00	7.34	53.00	59.00	29.90
40	57.00	Male	55.00	7.30	51.30	60.00	36.00
41	58.00	Female	56.00	7.31	50.80	56.00	36.00
42	56.00	Male	54.00	7.35	57.90	56.00	32.00
43	52.00	Female	55.00	7.34	58.00	51.20	31.00
44	55.00	Male	59.00	7.32	51.00	59.00	34.00
45	54.00	Male	55.00	7.33	51.30	55.50	33.30
46	59.00	Male	55.00	7.33	50.20	51.20	30.00
47	59.00	Male	56.00	7.35	55.40	56.60	32.30
48	58.00	Female	57.00	7.35	53.30	59.90	36.10
49	59.00	Male	54.00	7.32	52.10	60.10	35.00
50	57.00	Male	55.00	7.33	56.80	59.90	33.30

Group I(After treatment with NIMV)

No	BMI Post	pH Post	PaO2 Post	PaCO2 Post	HCO3 Post
1	53.00	7.37	84.90	43.00	28.00
2	54.00	7.38	86.00	42.90	29.00
3	55.00	7.36	85.30	42.70	28.00
4	57.00	7.38	88.00	42.30	26.00
5	58.00	7.36	76.90	42.80	29.00
6	53.00	7.38	85.30	42.00	26.00
7	56.00	7.38	85.80	43.70	29.90
8	58.00	7.37	75.90	44.00	30.00
9	51.00	7.38	76.90	43.80	29.00
10	53.00	7.37	88.00	43.50	29.80
11	55.00	7.39	88.00	43.70	30.80
12	55.00	7.39	85.90	43.80	28.20
13	53.00	7.39	84.90	44.20	29.00
14	50.00	7.37	85.00	41.00	27.90
15	55.00	7.35	88.00	43.70	30.00
16	56.00	7.39	88.00	42.80	28.00
17	54.00	7.39	85.30	44.00	30.00
18	55.00	7.38	87.00	42.70	29.00
19	59.00	7.39	88.20	43.70	29.80
20	55.00	7.37	75.00	43.30	30.10
21	55.00	7.38	74.90	42.30	28.00
22	56.00	7.39	85.10	42.20	29.80
23	57.00	7.39	83.90	42.50	30.80
24	54.00	7.38	83.90	42.50	30.50
25	55.00	7.39	88.20	43.70	29.80
26	53.00	7.37	84.90	43.00	28.00
27	54.00	7.38	86.00	42.90	29.00
28	55.00	7.36	85.30	42.70	28.00

No	BMI Post	pH Post	PaO2 Post	PaCO2 Post	HCO3 Post
29	57.00	7.38	88.00	42.30	26.00
30	58.00	7.36	76.90	42.80	29.00
31	53.00	7.38	85.30	42.00	26.00
32	56.00	7.38	85.80	43.70	29.90
33	58.00	7.37	75.90	44.00	30.00
34	51.00	7.38	76.90	43.80	29.00
35	53.00	7.37	88.00	43.50	29.80
36	55.00	7.39	88.00	43.70	30.80
37	55.00	7.39	85.90	43.80	28.20
38	53.00	7.39	84.90	44.20	29.00
39	50.00	7.37	85.00	41.00	27.90
40	55.00	7.35	88.00	43.70	30.00
41	56.00	7.39	88.00	42.80	28.00
42	54.00	7.39	85.30	44.00	30.00
43	55.00	7.38	87.00	42.70	29.00
44	59.00	7.39	88.20	43.70	29.80
45	55.00	7.37	75.00	43.30	30.10
46	55.00	7.38	74.90	42.30	28.00
47	56.00	7.39	85.10	42.20	29.80
48	57.00	7.39	83.90	42.50	30.80
49	54.00	7.38	83.90	42.50	30.50
50	55.00	7.39	88.20	43.70	29.80

Group A (Oxygen mask group) after 4 months of treatment

No	pH	PaO2	PaCO2	HCO3
12	7.35	55.60	53.30	33.00
13	7.33	56.00	59.10	35.10
14	7.34	57.00	50.90	30.00
15	7.33	57.00	55.40	32.00
16	7.34	56.60	57.70	33.00
17	7.32	54.90	55.80	33.00
18	7.30	54.30	59.00	33.00
19	7.30	54.30	59.00	33.00
20	7.32	55.00	58.00	35.00
21	7.33	55.00	58.00	35.00
22	7.32	56.00	57.00	32.00
23	7.31	55.70	51.20	30.00
24	7.33	55.00	58.00	35.00
25	7.32	55.90	53.00	31.00
26	7.31	55.00	56.00	32.00
27	7.33	56.00	51.00	31.00
28	7.34	57.00	55.00	32.00
29	7.34	58.00	53.00	31.00
30	7.34	57.00	54.00	31.00
31	7.35	55.60	53.30	33.00
32	7.34	57.00	50.90	30.00
33	7.33	57.00	55.40	32.00
34	7.32	54.90	55.80	33.00
35	7.30	54.30	59.00	33.00
36	7.33	55.00	58.00	35.00
37	7.32	56.00	57.00	32.00
38	7.31	55.70	51.20	30.00
39	7.33	55.00	58.00	35.00
40	7.32	55.90	53.00	31.00
41	7.31	55.00	56.00	32.00
42	7.33	56.00	51.00	31.00
43	7.34	57.00	55.00	32.00
44	7.34	57.00	55.00	31.00
45	7.34	57.00	54.00	31.00

Group B(CPAP group) after 4 months of treatment

No	pH	PaO2	PaCO2	HCO3
1	7.37	85.00	44.00	28.00
2	7.38	88.20	43.70	29.00
3	7.37	86.00	43.00	28.00
4	7.37	85.10	42.70	26.00
5	7.36	85.00	43.50	29.00
6	7.38	88.70	44.00	26.00
7	7.37	86.00	42.00	29.50
8	7.36	88.10	44.90	28.00
9	7.35	88.20	44.20	29.00
10	7.35	88.20	44.20	29.80
11	7.35	88.20	44.20	29.00

GROUP II

Case No.	BMI kg/m ²	FVC Pre-operative		FVC % of predict.		FEV ₁ Pre-operative		FEV ₁ % of predict.	
		value (L)	% of predict.	One month post-operative	Three months post-operative	value (L)	% of predict.	One month post-operative	Three months post-operative
Case 1	45.6	2.10	65.21	66.15	69.61	1.40	64.9	67.2	69
Case 2	47.2	1.99	63.07	64.21	67.47	1.34	62.10	69.4	64.2
Case 3	49.3	1.80	62.90	64.14	66.3	1.32	61.2	66.5	65.3
Case 4	48.1	1.81	62.12	63.36	66.52	1.37	62.01	66.31	66.11
Case 5	49.1	1.79	61.89	63.13	65.29	1.31	60.02	63.32	64.12
Case 6	50.1	1.72	61.30	62.84	66.7	1.30	60.00	62.3	62.1
Case 7	48.7	1.80	62.21	63.95	67.61	1.34	62.21	61.51	64.31
Case 8	47.4	1.94	72.10	73.04	77.5	1.67	69.10	71.4	76.2
Case 9	49.2	2.01	64.90	66.94	69.3	1.39	66.2	68.5	67.3
Case10	48.0	2.21	71.21	72.15	76.61	1.55	65.2	64.5	69.3
Case11	47.3	2.56	77.90	79.94	83.3	2.09	75.9	79.2	79
Case12	51.5	1.79	62.74	64.88	68.14	1.29	62.91	66.21	69.01
Case13	49.3	2.76	79.82	81.06	86.22	1.90	76.32	78.62	81.42
Case14	48.7	1.83	69.89	70.33	77.29	1.49	63.89	66.19	68.99
Case15	47.6	2.47	77.98	75.42	83.38	1.97	77.97	74.27	73.07
Case16	46.1	2.12	64.91	69.35	69.31	1.47	64.21	62.51	69.31
Case17	48.1	1.79	70.19	72.63	77.59	1.45	61.19	66.49	67.29
Case18	46.8	1.90	63.49	68.93	69.89	1.40	61.97	61.27	66.07
Case19	45.2	2.30	76.97	74.41	83.37	1.55	67.97	64.27	79.07
Case20	61.3	1.69	60.22	68.66	68.62	1.29	60.10	63.4	60.2
Case21	48.1	2.29	67.12	62.56	72.52	1.45	62.12	66.42	67.22
Case22	46.8	1.83	63.49	66.93	67.89	1.31	61.97	61.27	66.07
Case23	51.5	1.75	60.74	64.18	68.14	1.30	60.91	63.21	61.01
Case24	46.1	1.98	64.21	64.65	69.61	1.37	63.91	66.21	69.01
Case25	48.7	2.01	63.21	68.65	68.61	1.34	63.21	62.51	67.31
Case26	48.1	2.39	69.21	63.65	73.61	1.55	68.19	67.49	72.29
Case27	49.1	2.11	66.89	62.33	72.29	1.43	65.02	69.32	69.12
Case28	48.1	2.13	65.12	68.56	69.52	1.39	64.01	68.31	68.11
Case29	47.2	2.00	64.07	68.51	67.47	1.31	63.10	66.4	69.2
Case30	48.7	2.01	67.90	64.34	71.3VII	1.49	66.89	69.19	72.99

NO	BMI			FEF 25-75 PRE-OPERATIVE		FEF 25-75 ONE MONTH POST-OPERATIVE		FEF 25-75 THREE MONTHS POST-OPERATIVE	
	PRE	1MONTH POST	3MONTH POST	value (L/S)	% of predict.	value (L/S)	% of pred.	value (L/S)	% of predict.
Case 1	45.6	43.2	40.9	1.56	39.90	1.78	41.3	2.26	50.8
Case 2	47.2	45.0	42.0	1.45	35.12	1.69	40.12	2.09	55.2
Case 3	49.3	46.7	42.8	1.90	43.90	1.99	44.1	2.38	54.2
Case 4	48.1	45.9	43.3	1.78	41.97	1.89	43.7	2.15	53.1
Case 5	49.1	46.6	43.2	1.63	38.21	1.90	44.1	2.31	56.1
Case 6	50.1	46.2	44.0	1.78	40.34	1.95	43.4	2.30	53.7
Case 7	48.7	46.3	42.9	1.77	43.98	1.96	46.8	2.44	56.8
Case 8	47.4	45.5	42.7	1.66	40.21	1.85	43.1	2.24	52.1
Case 9	49.2	46.4	44.9	1.53	37.98	1.74	39.8	2.14	50.7
Case10	48.0	44.9	42.3	1.43	35.9	1.67	37.8	2.07	49.8
Case11	47.3	45.1	43.0	1.86	45.45	1.91	46.5	2.21	57.5
Case12	51.5	47.9	43.8	1.84	46.02	1.97	47.2	2.34	56.2
Case13	49.3	46.0	44.3	2.89	82.10	2.99	82.4	3.09	85.4
Case14	48.7	46.5	43.2	1.49	34.76	1.58	35.6	1.97	50.6
Case15	47.6	44.9	41.9	1.95	50.27	2.05	51.7	2.55	58.8
Case16	46.1	44.0	42.4	1.76	44.79	1.85	46.9	2.21	54.4
Case17	48.1	45.2	43.7	1.49	47.01	1.55	48.1	1.94	50.4
Case18	46.8	44.2	41.3	1.69	40.67	1.96	43.7	2.06	53.7
Case19	45.2	43.6	41.3	1.79	43.98	1.85	45.8	2.12	56.8
Case20	61.3	55.1	52.4	1.98	42.12	2.30	46.2	2.52	52.1
Case21	48.1	45.6	41.0	1.57	39.98	1.75	41.8	2.51	60.8
Case22	46.8	44.2	41.3	1.69	40.67	1.96	43.7	2.06	53.7
Case23	51.5	47.9	43.8	1.84	46.02	1.97	47.2	2.34	56.2
Case24	46.1	44.0	42.4	1.76	44.79	1.85	46.9	2.21	54.4
Case25	48.7	46.3	42.9	1.77	43.98	1.96	46.8	2.44	56.8
Case26	48.1	45.2	43.7	1.49	47.01	1.55	48.1	1.94	50.4
Case27	49.1	46.6	43.2	1.63	38.21	1.90	44.1	2.31	56.1
Case28	48.1	45.9	43.3	1.78	41.97	1.89	43.7	2.15	53.1
Case29	47.2	45.0	42.0	1.45	35.12	1.69	40.12	2.09	55.2
Case30	48.7	46.5	43.2	1.49	34.76	1.58	35.6	1.97	50.6