



Clinical and Breathing Behavior in Subjects Undergoing Bronchoscopy Supported with Noninvasive Mechanical Ventilation

Claudia C Giugliano^{1*}, Felipe A Cerpa¹, Juan E Keymer¹, Rodrigo A Perez¹, Carolina P Romero¹, Hugo R Budini¹, Daniel Caceres¹, Agustín Camus¹, Sebastian Fernandez-Bussy² and Jeronimo Graf¹

¹Department of Intensive Care Medicine, Clínica Alemana de Santiago, Clínica Alemana-Universidad del Desarrollo, Chile

²Pneumology Intervention Unit, Clínica Alemana de Santiago, Clínica Alemana-Universidad del Desarrollo, Chile

Abstract

Introduction: Bronchoscopy is an invasive procedure used increasingly in intensive care units, with diagnostic and therapeutic purposes. There is a group of subjects in whom the risk of being intubated increase morbidity and mortality. The use of noninvasive mechanical ventilation (NIV) prevents hypoxemia during bronchoscopy, thus avoiding acute respiratory failure.

Objectives: Describe the clinical behavior of subjects who were supported with NIV and the complications associated with bronchoscopy that may result in endotracheal intubation.

Methods: Descriptive study of 25 procedures in adult subjects with indication of bronchoscopy, who presented acute respiratory failure and the need for NIV during hospitalization or were supported with NIV for bronchoscopy for risk reduction.

Results: No subjects had any complication that required an artificial airway and invasive mechanical ventilation. There was no statistical difference in clinical outcomes.

Conclusion: There were no complications associated with the technique; subjects remained clinically stable during and after the procedure. There is need more studies to standardize the technique and demonstrate that it is safe and reproducible in other centers.

Keywords: Bronchoscopy; Non-invasive mechanical ventilation; Bronchoalveolar lavage; Critical care unit

Abbreviations: HR: Heart Rate; f: Respiratory Rate; SpO₂: Oxygen Saturation; IPAP: Inspiratory Positive Pressure; EPAP: Expired Positive Pressure; PIP: Peak Inspiratory Pressure; VT: Expired Tidal Volume

Introduction

Bronchoscopy is an invasive procedure for examination of the tracheobronchial tree, which is very important in the diagnosis and treatment of pulmonary diseases [1]. The use of diagnostic or therapeutic bronchoscopy has been increasing in the Intensive Care Units (ICU) in the last years [2], because of the possibility of performing it next to subject's bed, describing less complication [2]. During the bronchoscopy procedure, the bronchoscope diameter plays an important role in airway obstruction [2]. In subjects with native airway, the bronchoscope occupies approximately 10% of the trachea internal diameter, causing decrease in tidal volume (VT), increased respiratory work, altered respiratory mechanics and gas exchange, causing hypoxemia and hypercapnia [1,2]. In a bronchoscopy without complications, the arterial oxygen pressure (PaO₂) decreases between 10 to 20 mmHg. In hypoxemic subjects, there is an increased risk of developing acute respiratory failure (ARF) and arrhythmias during bronchoscopy. A bronchoscopy contraindication in non-intubated subjects is severe hypoxemia, being the option the orotracheal intubation and mechanical ventilation to ensure adequate gas exchange during bronchoscopy [3]. This is the reason because of some clinicians are reticent to perform bronchoscopy in hypoxemic subjects, despite increasing the possibility of a correct diagnosis [4]. The problem of intubates hemato-oncological, immunosuppressed or chronic respiratory subjects, is the increase of morbidity and mortality. During bronchoscopy, samples are usually taken for secretion culture. When suction is applied, volume and positive pressure at the end of expiration

(PEEP) are reduced, facilitating alveolar closure and thus venous admission, both of which are detrimental to pulmonary mechanics, altering lung mechanics and respiratory work. After a bronchoscopy the normalization time may take several hours in subjects with severe pulmonary parenchymal alterations. In subjects with severe hypoxemia (PaO₂/Fio₂<200), NIV improves gas exchange during and after bronchoscopy, thus reducing complications. Although bronchoscopy with NIV has evidence to support its use (1,14,15), there is still unknown, and subjects must be intubated to perform it, or simply is not performed.

Methods

A descriptive transversal study was included adults subjects from Clínica Alemana de Santiago Critical Care Unit, between March 2015 and May 2016, with ARI diagnostic, who required a diagnostic or therapeutic bronchoscopy. Of the 25 performed bronchoscopies, 17 procedures had to be managed with NIV during their hospitalization, while the other 8, was supported during the procedure to reduce the risks associated with being subjects with basic pathologies such as hemato-oncological, immunosuppressed or chronic respiratory

***Corresponding author:** Claudia C Giugliano, Department of Intensive Care Medicine, Clínica Alemana de Santiago, Clínica Alemana-Universidad del Desarrollo, Chile, Tel: +56222106421; E-mail: cgiuglianoj@alemana.cl

Received February 09, 2018; **Accepted** February 12, 2018; **Published** February 19, 2018

Citation: Giugliano CC, Cerpa FA, Keymer JE, Perez RA, Romero CP, et al. (2018) Clinical and Breathing Behavior in Subjects Undergoing Bronchoscopy Supported with Noninvasive Mechanical Ventilation. J Respir Med 2: 106.

Copyright: © 2018 Giugliano CC, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

pathologies. When exposed to hypoxemia, they are at increased risk of severe respiratory failure and consequently being intubated, which increases their morbidity and mortality. A NIV V60 Respironics® and a Fitlife Respironics® facial mask were used for all bronchoscopy. The facial mask was modified, was removed the partition wall located in the zone of the anti-asphyxiation valve at the elbow of the mask, leaving a space to introduce the flexible bronchoscopy, which is close when it is not inserted (Figure 1). The NIV was programmed in bilevel mode, the programmed pressures depend on the needs of each subject, looking for VT between 6-8 ml/kg IBW. The inspired oxygen fraction (FiO₂) was programmed in 100% two minutes before the procedure, continuous hemodynamic monitoring was performed through bedside monitor of the room. There was a trained team, a bronchopulmonary medical doctor with expertise in bronchoscopy technique, the resident medical doctor of the unit who indicated sedation with Propofol and Fentanyl, to achieve SAS (Sedation-Agitation Scale) of 1-2, a nurse who administered the drugs, and 2 respiratory therapist, one that continuously programmed NIV during the bronchoscopy to achieve the target VT and the second, which recorded the data. For data collation, a record sheet was designed with; Age, sex, APACHE II, diagnosis, bronchoscopy motive, heart rate (HR), respiratory rate (f), oxygen saturation (SpO₂), SAS, ventilatory mode and pressures (IPAP- EPAP), ventilator leakage, expired tidal volume (VT_e). All these variables were recorded two minutes before, during (every minute) and 5 minutes after the procedure. Complications were evaluated during and up to 24 hours following the procedure. Among the complications to be observed were: refractory oxygen desaturation, arrhythmias, airway bleeding, agitation, acute coronary syndrome, cardiac arrest, orotracheal intubation and death. This study was approved by the Scientific Teaching Department and Ethics Committee of Clinica Alemana de Santiago, and all participants or their representatives signed the informed consent prior to the procedure. STATA 12 was the statistical analysis software used to analyze the data. Statistical analysis was performed using descriptive statistics, median and interquartile range, and T-Student's test was used for the comparison of paired samples, with a significance level of 0,05 (p>0.05).

Results

A total of 25 bronchoscopies assisted with NIV were performed, which an average duration of 6 minutes. Of these, 19 (76%) were only diagnosis bronchoscopy and 6 (24%) were for diagnosis and treatment (Table 1). The gender distribution was 56% male, with a mean age of 67 (17-71) years and mean APACHE II of 13 (10-16). The ICU admission diagnoses were grouped in acute hypoxemic insufficiency (40%), chronic respiratory failure (12%), hemato-oncological (32%) and others (16%) like neuromuscular pathologies and suspected alveolar haemorrhage. Of the study group, 68% of the subjects were connected to NIV before

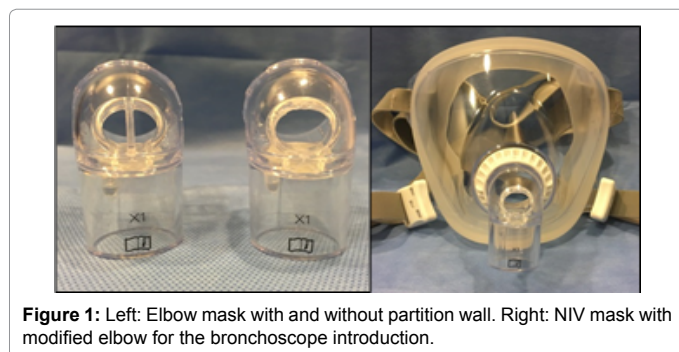


Figure 1: Left: Elbow mask with and without partition wall. Right: NIV mask with modified elbow for the bronchoscope introduction.

Mean (intercuartile range) or n° (%)	
Bronchoscopy Procedures	25
Age, years	67 (17-71)
Sex ratio (m/f)	14-11
APACHE II Score	13 (10-16)
Underlying Diagnosis	
Hypoxemic respiratory insufficiency	10 (40%)
Chronic respiratory insufficiency	3 (12%)
Hemato-Oncologic	8 (32%)
Other	4 (16%)
Indication for bronchoscopy	
Diagnostic	19 (76%)
Therapeutic	0 (0%)
Diagnostic and therapeutic	6 (24%)

Table 1: Patient characteristics, values given as mean (interquartile range) or n° (%).

Variables	2 min before bronchoscopy	During bronchoscopy	5 min after bronchoscopy
HR (beats/min)	91 (74-112)	91 (76-106)	90 (71-106)
f (breaths/min)	22 (21-32)	23 (21-28)	25 (21-28)
SpO ₂ (%)	99 (96-100)	99 (98-100)	100 (97-100)
IPAP (cmH ₂ O)	12 (10-14)	20 (18-25)	12 (10-16)
EPAP(cmH ₂ O)	8 (6-8)	8 (7-10)	7 (6-8)
PIP (cmH ₂ O)	8 (7-9)	18 (15-21)	14 (11-18)
Leak (L/min)	6 (1-21)	88 (75-96)	0 (0-7)
VT _e (ml)	428 (335-500)	340 (270-460)	389 (336-489)
Complications		0/25	0/25

Table 2: Clinical and ventilatory variables, values given as mean (interquartile range).

bronchoscopy, and the most common reasons for their connection were increased respiratory work (32%) and desaturation (28%). In relation to ventilatory mode, before bronchoscopy 16% were in CPAP mode, and after that, 12% return to CPAP mode. The remaining 32% of the procedures did not meet clinical or gasometric NIV connection criteria and were connected to NIV to assist bronchoscopy because of the high risk of hypoxemic failure. Of these procedures, two had diagnosis of diffuse pulmonary disease, two hemato-oncologic, two suspicions of alveolar hemorrhage, one airway obstruction by a foreign body and one abdominal septic shock. None of these subjects required post-procedure NIV. The clinical variables were recorded before, during and after the procedure (Table 2). Before bronchoscopy mean HR was 91 (74-112) beats/min, f 22 (21-32) breaths/min, SpO₂ 99% (96-100), IPAP and EPAP of 12 (10-14) cm H₂O and 8 (6-8) cm H₂O respectively. The ventilator mean leaks was 6 (1-21) L/min and the mean VT_e 428 (335-500) ml. During the bronchoscopy procedure the mean HR was 91 (76-106) beats/min, the median f was 23 (21-28) breaths/min, SpO₂ 99% (98-100), IPAP of 20 (18-25) cm H₂O, and EPAP of 8 (7-10) cm H₂O, mean leakage of 8 (75-96) L/Min and VT_e of 340 (270-460) ml. And finally, after bronchoscopy the median HR was 90 (71-106) beats/min, f 25 (21-28) breaths/min and SpO₂ of 100% (97-100), IPAP of 12 (10-16) cm H₂O and EPAP of 7 (6-8) cm H₂O, leak of 0 (0-7) L/min and VT_e of 389 (336-489) ml. During and 24 hours after the bronchoscopy, there were no desaturations, arrhythmias, airway bleeding, agitation, acute coronary syndrome, cardiac arrest, orotracheal intubation or death, in any of the 25 procedures. When assessing the difference on the registered variables before and after the bronchoscopy procedure

Variables	2 min before bronchoscopy	5 min after bronchoscopy	P value
HR (beats/min)	92 ± 20.9	90.5 ± 18.6	p=0.52
f (breaths/min)	28 ± 17.44	24.2 ± 5	p=0.26
SpO ₂ (%)	97.88 ± 2.7	98.2 ± 2.1	p=0.64
IPAP (cmH ₂ O)	11.2 ± 5.8	12.6 ± 5.4	p=0.33
EPAP (cmH ₂ O)	7.5 ± 1.4	7.8 ± 1.5	p=0.27
PIP (cmH ₂ O)	8.4 ± 2.5	14.4 ± 5	p=0.0*
Vte (ml)	439.6 ± 160.2	474.9 ± 162.32	p=0.22
Leak(L/min)	14.5 ± 2.8	8.6 ± 12.9	p=0.11

Table 3: Comparison before and after variables, values given as mean ± SD.

we can observe that HR mean was 92 ± 20.9 and 90.5 ± 18.6 beats/min (p=0.52), previous and posterior f was 28 ± 17.44 and 24.2 ± 5 breaths/min (p=0.26), for SpO₂ it was 97.88 ± 2.7 and 98.2 ± 2.1% (p=0.64). In the ventilatory variables IPAP previous and posterior was 11.2 ± 5.8 and 12.6 ± 5.4 cmH₂O (p=0.33), EPAP of 7.5 ± 1.4 and 7.8 ± 1.5 cmH₂O (p=0.27), inspiratory peak pressure (PIP) of 8.4 ± 2.5 and 14.4 ± 5 cmH₂O (p=0.00), Vt of 439.6 ± 160.2 and 474.9 ± 162.32 ml (p=0.22) and leakage of 14.5 ± 23.8 and 8.6 ± 12.9 L/min (p=0.11), where only the difference between PIP was statistically significant (Table 3).

Discussion

A lot of reports describe the use of NIV to prevent hypoxemia during bronchoscopy, preventing desaturation and thus acute respiratory failure or its exacerbation [1-15], by maintaining spontaneous ventilation during the procedure, it ensures V/Q balance and hemodynamic stability. Randomized trials provide evidence for the use of NIV in ARF to prevent orotracheal intubation in subjects with exacerbations of COPD, acute cardiogenic pulmonary edema and in immune compromised subjects [6,10,13] reducing rates of intubation, length of hospital stay, and mortality [11,12]. There were performed 25 bronchoscopy procedures, where no subject required orotracheal intubation at 24 hours after the procedure, unlike what was found by Baumann et al. 2011, where 10% of the subjects required orotracheal intubation at 8 hours after the procedure, a difference that may be due to the greater severity of their population [14], but which is debatable, because Korkmaz et al. [15] had a 32% of orotracheal intubation at 24 hours after the bronchoscopy with an APACHE II similar to that in this study.

Conclusion

Clinical and ventilatory variables remained stable before bronchoscopy in relation to the baseline, without the need for greater ventilatory support, making this technique a safe procedure for subjects with ARF diagnosis that require a diagnostic or therapeutic bronchoscopy. With regard to leakage measured by the NIV, these

exceeded 60LPM during the bronchoscopy, mainly due to suction, which could be compensated by the constant setting of the NIV to reach the target VT, thereby preventing disconnection and hypoxemia.

Authors' contributions

CG, FC, JG and SFB have made substantial contributions to the conception and design of the study. SFB performed the bronchoscopies. JEK, RP, CR, HB and DC collected the data. CG, RP and AC performed the analysis and interpretation of data. CG and FC drafted the manuscript.

References

- Esquinas A, Zuñil M, Scala R, Chiner E (2013) Bronchoscopy during non-invasive mechanical ventilation: A review of techniques and procedures. *Arch Bronconeumol* 49: 105-112.
- Estella A (2012) Bronchoscopy in mechanically ventilated patients. *Global Perspectives on Bronchoscopy*.
- Antonelli M, Conti G, Rocco M, Arcangeli A, Cavaliere F, et al. (2002) Noninvasive positive-pressure ventilation vs conventional oxygen supplementation in hypoxemic patients undergoing diagnostic bronchoscopy. *Chest* 121: 1149-1154.
- Heunks L, Bruin CJR, Hoeven JG, Heijden HFM (2009) Non-invasive mechanical ventilation for diagnostic bronchoscopy using a new face mask: An observational feasibility study. *Intensive Care Med* 36: 143-147.
- Ozyilmaz E, Ozsancak A, Nava S (2014) Timing of noninvasive ventilation failure: causes, risk factors, and potential remedies. *BMC Pulmonary Med* 14: 19.
- Penuelas O, Frutos-Vivar F, Esteban A (2007) Noninvasive positive-pressure ventilation in acute respiratory failure. *CMAJ* 177: 1211-1218.
- Weiss Y, Deutschman C (2000) The role of fiberoptic bronchoscopy in airway management of the critically ill patient. *Crit Care Clin* 16: 445-451.
- Antonelli M, Conti G, Riccioni L, Meduri GU (1996) Noninvasive positive-pressure ventilation via face mask during bronchoscopy with BAL in high-risk hypoxemic patients. *chest* 110: 724-728.
- Ambrosino M, Warracino F (2011) Unusual applications of noninvasive ventilation. *Eur Respir J* 38: 440-449.
- Hill NS, Brennan J, Garpestad E, Nava S (2007) Noninvasive ventilation in acute respiratory failure. *Crit Care Med* 35: 2402-2407.
- Lightowler JV (2003) Non-invasive positive pressure ventilation to treat respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease. *BMJ* 326: 185.
- Keenan SP, Sinuff T, Cook D, Hill NS (2003) Which patients with acute exacerbation of chronic obstructive pulmonary disease benefit from noninvasive positive pressure ventilation? *Ann Intern Med* 138: 861-870.
- Hess DR (2013) Noninvasive ventilation for acute respiratory failure. *Respir Care* 58: 950-972.
- Baumann H, Klose H, Simon M, Ghadban T, Braune S, et al. (2011) Fiber optic bronchoscopy in patients with acute hypoxemic respiratory failure requiring noninvasive ventilation- A feasibility study. *Crit Care* 15: R179.
- Korkmaz P, Basarik B, Gurgun A, Sezai M, Bacakoglu F, et al. (2016) Can fiberoptic bronchoscopy be applied to critically ill patients treated with noninvasive ventilation for acute respiratory distress syndrome? Prospective observational study. *BMC Pulmonary Med* 16: 89.