Caso clínico

Airway pressure release ventilation in newborns

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Abstract

Airway pressure release ventilation is a mechanical ventilation method that uses a controlled positive airway pressure in order to maximize alveolar recruitment, with prolonged inspiratory times, therefore allowing spontaneous breathing during both phases of the respiratory cycle.

The authors describe their experience in twelve cases of newborn patients with acute respiratory failure treated with airway pressure release ventilation when oxygenation did not improve with pressure control ventilation. The mean age of patients was 13 ± 16.5 days. The fractional concentration of oxygen (FiO2) decreased from 62.9 ± 23.6 cmH2O for pressure control ventilation to 44 ± 14.0 cmH2O for airway pressure release ventilation. The mean partial arterial oxygen pressure increased from 54.6 ± 11.9 mmHg to 92 ± 32 mmHg. The mean partial carbon dioxide pressure decreased from 53.2 ± 15.6 mmHg to 43.1 ± 10 mmHg and the peak inspiratory pressure fell from 16.8 ± 5.9 cm H2O to 16.6 ± 5.3, respectively.

Airway pressure release ventilation may improve oxygenation in pediatric patients with acute respiratory failure when conventional mechanical ventilation fails.

Keywords: Airway pressure release ventilation, acute respiratory failure.

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Ventilation with airway pressure release, called APRV (Airway pressure release ventilation), is a relatively new mode of mechanic ventilation, that has show an improvement in alveolar recruitment, oxygenation and gas exchange, while keeping an acceptable airway peak inspiratory pressure.[1-2] It begins with an elevated basal pressure and follows a deflation without producing alveolar collapse. This modality consists in a high pressure (high P) adjustment towards a predetermine low pressure limit (low P), leading to a venting mechanism that uses controlled positive pressure in the airway, with the purpose to maximize the alveolar recruitment through collateral bronchial communications, and allows spontaneous respiration during both phases of the respiratory cycle.[3] It allows a greater alveolar recruitment, due to a long inspiratory phase, making it unnecessary to increase the tidal volume or to add positive pressure to the airway. By allowing spontaneous breathings, it also improves cardiac filling.[4-5] This modality of mechanic ventilation has been used with encouraging results in newborns, pediatric patients and adults with respiratory distress.[6-9] In this article, 12 cases of newborns with acute respiratory failure (ARF) are presented, whose blood gas and chest x-ray parameters did not improved with pressure controlled ventilation, and were then treated with APRV.

Case Report

Twelve patients that developed ARF were treated with APRV. The underlying causes of the respiratory failure and the demographic data and etiology of respiratory failure are shown in Table 1.

Table 1. Demographic characteristics and causes of ARF in reported cases

Patient	Age (days)	Weight	Diagnosis
1	31	1100 g	BPD
2	07	950 g	BPD
3	07	680 g	RDS
4	01	1290 g	RDS
5	04	1160 g	RDS
6	58	1690 g	BPD
7	17	1390 g	ATL
8	04	2330 g	RDS
9	10	1370 g	RDS
10	02	3000 g	RDS
11	15	1055 g	BPD
12	02	3300 g	ASFX

BPD: Bronchopulmonary Dysplasia; RDS: Respiratory Distress Syndrome; ATL: atelectasia

Source: Medical records

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Abbreviations: APRV, Airway pressure release ventilation; FiO_2, fraction of inspired oxygen; ARF, Acute Respiratory Failure; $PaCO_2$, arterial carbon dioxide tension; PaO_2, arterial oxygen tension; PCV, pressure controlled ventilation; PEEP, positive end-expiratory pressure; PIP, peak inspiratory pressure.

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Table 2. Venting parameters comparison			
Measured value	PCV ventilation Average ±SD	APRV ventilation Average ±SD	Significancy P≤0,05
FIO_2(%)	62,9±23,6	44±14,0	P≤0,05
PIP (cmH_2O)	16,8±5,9	16,6±5,3	P>0,05
PaO_2 (mmHg)	54,6±11,9	92±32	P≤0,05
$PaCO_2$ (mmHg)	53,2±15,6	43,1±10	P>0,05

Source: medical records

Before applying APRV, patients were ventilated using PCV, with sequential PIP and PEEP increments, in an attempt to achieved maximum oxygenation. The venting parameters prior to APRV conversion are shown in Table 2.

All the patients were ventilated with Galileo Gold Hamilton Medical AG (Switzerland). APRV ventilatory variables were established in accordance with the values used by Garcia et al in their study,[13] which are described as follow: low T of 0.2-0.4 sec, high T of 2 to 4.5 sec, PEEP 0-2 cm H_2O, and high P values were modified from 22-34 cm H_2O to 15-20 cm H_2O. The change of ventilatory modality from PCV to APRV was selected on the basis of the deterioration of the results of arterial blood gases, chest radiographs and pulse oximetry. The venting parameters in APRV mode are shown in Table 2. A total of 11 patients were extubated from APRV in an average of 2 days, an only one died due to multi-organ failure.

Discussion

For data analysis, the Cochrane Collaboration Statistical Package, Rev Man Version 5.1 was used. The results obtained in this case analysis, showed how the APRV improved the oxygenation and the alveolar ventilation reflected in the clinical decrease in $PaCO_2$, although this was not statistically significant, a PEEP can be maintain in level 0, being this the releasing phase or pressure drop, the point of improvement in alveolar ventilation. Similarly, an improvement in the PaO_2 can be observe with less inspiratory pressure and a lesser oxygen inspired fraction (FIO_2), resulting in less pulmonary parenchyma injury, produced also by diminishing the frequency of changes in airway pressure of the APRV.

Demirkol et al,[3] indicated the airway optimization, improving the recruitment through open lung stabilization.

Meanwhile, in their case report, García et al[10] showed that when APRV is used proactively, there is an improvement in blood gas and accelerated weaning, so the use of this venting technique can be complemented proactively, and not for rescue as shown in this series.

In different studies[10-11], parameters such as high P above 20 to 25cm H_2O has been used; in the case of exposed patients, the average high P was 16,6cm H_2O, achieving the same improvement in oxygenation, diminishing the possible complications of barotrauma.

The obtained PaO_2 improvements in this study after placing APRV were statistically significant with a lower FIO_2, supporting the hypothesis of open lung stabilization, which is show with a statistically significant decreased in

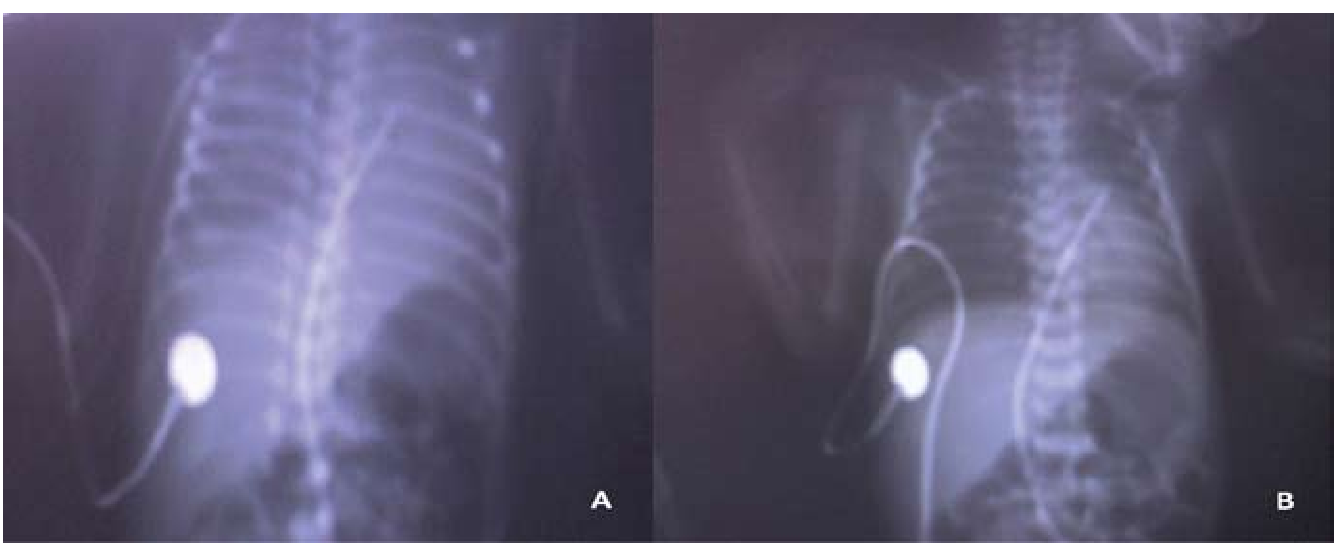

Figure 1. Radiological comparison: before and after APRV application (A. before APRV and B. 3 hours after APRV). Source: Clinical File Women's Hospital

FIO_2 parameters, but not in $PaCO_2$, which showed decreased levels after APRV mode was applied, with no statistically significant differences.

Another advantage shown with the use of APRV is the radiological improvement within 3 hours (Figure 1), that is evidence with an improvement in the alveolar recruitment without any hemodynamic impairment. Demirkol study refers that APRV can offer potential clinical advantages, and so it should be considered as an alternative modality in mechanic ventilation for the pediatric population[3] and in this report the improvements on PaO_2 and $PaCO_2$ with a lower pressure and lower FIO_2 values are evidenced, being this an advantage for managing the ventilation in newborns with ARF.

In conclusion, the use of APRV achieved an improvement in blood gas parameters, radiological imaging, and contribute to break the habit of using mechanic ventilation. In future controlled clinical essays, the efficacy of implementing this type of ventilation in newborns can be proved.

Conflict of interests: the authors declare no conflict of interests with the publication of the study.

References

1. Dart BW, Maxwell RA, Richart CM, Brooks DK, Ciraulo DL, Barker DE. Preliminary experience with airway pressure release ventilation in a trauma/surgical intensive care unit. J Trauma2005; 59:71–6.
2. Petsinger DE, Fernandez JD, Davies JD. What is the role of airway pressure release ventilation in the management of acute lung injury Respir Care Clin 2006; 12:483–8.
3. Demirkol D, Karabocuoglu M, Citak A. Airway Pressure Release Ventilation: An Alternative Ventilation Mode for Pediatric Acute Hypoxemic Respiratory Failure. Indian J Pediatr 2010; 77:1322–1325.
4. Downs JB, Stock MC. Airway pressure release ventilation: a new concept in ventilatory support. Crit Care Med 1987; 15:459–61.
5. Stock MC, Downs JB, Frolicher DA. Airway pressure release ventilation. Crit Care Med 1987; 15:462–6.
6. Habashi NM. Other approaches to open-lung ventilation: airway pressure release ventilation. Crit Care Med 2005; 33:S228-40.
7. Foland JA, Martin J, Novothy T, Super DM, Dyre RA, Mhanna MJ. Airway pressure release ventilation with a short release time in a child with acute respiratory distress syndrome. Respir Care 2001; 46:1019–23.
8. Krishnan J, Morrison W. Airway pressure release ventilation: a pediatric case series. Pediatr Pulmonol 2007; 42:83–8. 9. Schultz TR, Costarino AT, Durning SM. Airway pressure release ventilation in pediatrics. Pediatr Crit Care Med2001; 2:243–6.
9. Garcia P, HenryJ, HughesS, Boylan C. A case series of infants on APRV in the neonatal ICU. 1 página. Recuperado el 2 de junio de 2011, de http://www.rcjournal.com/ abstracts/2007/?id=aarc07_236.
10. Blake B, Perrette Julianne, Gilmore M. Case Study: retrospective study of using APRV in neonates with overwhelming sepsis. 1 página. Recuperado 30 de mayo de 2011, de http://www. rcjournal.com/ abstracts/2005/?id=OF-05-058%20Blake.