Original Article

Iran J Pediatr
Mar 2011; Vol 21 (No 1), Pp: 45-50

Pneumothorax after Mechanical Ventilation in Newborns

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Received: *Jan 20, 2010*; Final Revision: *Jul 05, 2010*; Accepted: *Sep 07, 2010*

Abstract

Objective: Air leak syndromes including pneumothorax, pneumomediastinum and pulmonary interstitial emphysema are frequent in neonatal period. Mechanical ventilation with positive pressure is one of the most common causes of these syndromes. The aim of this study was to evaluate predisposing factors and incidence of pneumothorax in newborns under mechanical ventilation.

Methods: This descriptive cross sectional study was performed in 400 newborns under mechanical ventilation in intensive care unit of a teaching hospital in Iran from April 2004 to December 2008. Predisposing factors leading to ventilation and incidence of air leak syndromes were studied. Sex, gestational age, birth weight, type of delivery, history of surfactant replacement therapy, ventilator settings and mortality rate were recorded. Statistical analysis was done using SPSS software. Univariate analysis and regression analysis were considered.

Findings: Among 400 patients under mechanical ventilation, 102 neonates developed pneumothorax (26%). Fifty six (54.9%) of them were boys and 46 (45.1%) girls. 54.9% of newborns with pneumothorax were preterm and 45.1% term. Birth weight less than 2500g was recorded in 59.8%. Fifty two percent of these neonates were born by cesarean section vs. 32% of newborns without pneumothorax. The most common type (62.7%) of ventilation leading to pneumothorax was Inspiratory Positive Pressure Ventilation (IPPV). Surfactant replacement therapy was recorded in 32.4% of cases with pneumothorax compared to 60.4% of neonates under ventilation without pneumothorax, which was significantly different (*P*= 0.017).

Conclusion: In newborns surfactant replacement therapy can reduce the risk of pneumothorax caused by mechanical ventilation.

Iranian Journal of Pediatrics, Volume 21 (Number 1), March 2011, Pages: 45-50

Key Words: Newborns; Ventilation, Machanical; Pneumothorax; IPPV; Pulmonary Surfactant

Introduction

Pneumothorax is more frequent in the neonatal period than at any other time in life[1]. Symptomatic pneumothorax occurs in 0.08% of all live births[1] and in 5% to 7% of infants with birth

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weight of less than 1500 gr[2,3]. The risk for pneumothorax is higher in infants with respiratory distress syndrome, meconium aspiration syndrome, and pulmonary hypoplasia and in infants who need resuscitation at birth. Continuous positive airway pressure and positive pressure ventilation further increase the incidence of pneumothorax[2,3]. Surfactant, use of synchronized or volume ventilation, and high-rate, low-tidal-volume ventilation decrease the incidence of pneumothorax[4-7].

Pneumothorax and pneumomediastinum should be suspected in any newborn infant who shows signs of respiratory distress, displays restlessness, irritability, or has a sudden change in condition.

The objective of this study was to assess air leak syndromes in neonates under mechanical ventilation.

Subjects and Methods

This cross sectional descriptive study was performed in neonates under mechanical ventilation in NICU of 22nd Bahman Teaching Hospital of Mashhad, Iran affiliated to Azad University from 2004 until 2008.

Immediately after ventilation a portable chest x-ray was performed and interpreted by a radiologist. Treatment decisions and ventilation settings were made by the clinical team under the direction of an attending neonatologist. The study was approved by the Institution Review Board.

All of the newborns were under the same ventilator (Baby log 8000-Drager). The patients were monitored with continuous pulse oxymetry and any change in O_2 saturation was recorded. All nurses were trained and licensed especially to work in NICU.

All these newborns were examined for the predisposing factors leading to ventilation such as respiratory distress syndrome, meconium aspiration syndrome, pneumonia and birth asphyxia. Other variables like sex, term vs. preterm delivery, unilateral vs. bilateral pneumothorax, birth weight, respiratory management including ventilator settings and mortality rate after pneumothorax were recorded by a general practitioner. The neonates having pneumothorax before ventilation or with malposition of tracheal tube were excluded from the study. All analyses were performed with SPSS 15. Statistical significance was set at $P<0.05$. Univariate analysis and regression analysis were considered.

Findings

A total of 400 newborns under mechanical ventilation in the NICU were the subjects of this study. The most common underlying cause of ventilation was lung disorders especially respiratory distress syndrome. It was detected in 241 of 400 (60.25%) neonates in our study; a second cause of ventilation was asphyxia in 10.7%.

One hundred and two (26%) cases developed pneumothorax. Fifty six (54.9%) of these were boys and 46 (45.1%) girls. Pneumothorax was present 66.6% in the right side (Fig. 1), 12.8% in the left side and 0.6% bilateral. In 102 neonates with pneumothorax 51 (54.3%) had respiratory distress syndrome. Therefore, RDS seems to be the most frequent underlying lung disorder, although

Table1: Frequency of underlying pulmonary causes in pneumothorax cases

Pulmonary disorders	Frequency (%)
Respiratory Distress Syndrome	51 (54.3)
Meconium Aspiration Syndrome	16 (17)
Transient Tachypnea of Neonate	1 (1.1)
Post Surgery of Tracheoesophageal Fistula	6 (6.4)
Aspiration Pneumonia	9 (9.6)
Diaphragmatic Hernia (Pulmonary Hypoplasia)	11 (11.7)

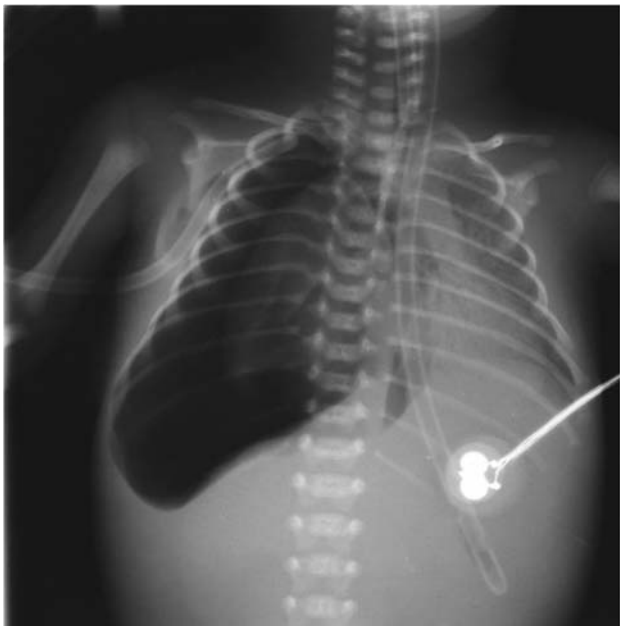

Fig. 1: Day 3 radiograph shows a right-sided tension pneumothorax in a 1.1-kg infant who was intubated for respiratory distress syndrome

not the cause of pneumothorax. Frequency of other pulmonary disorders associated with pneumothorax is listed in Table 1.

Newborns with pneumothorax (case group) were compared to those without pneumothorax (control group) in many different aspects. Univariate analysis showed significant difference for some factors which are listed in Table 2. Multivariate regression logistic (Backward Stepwise) after 6 steps revealed that surfactant replacement therapy was the only significant factor between case and control groups (*P*=0.017)(Table 3).

Depression of diaphragm and mediastinal shift suggestive of tension pneumothorax were detected in 35.3% and 43.1% of case group respectively (Fig. 2). Twenty one (20.6%) newborns had bilateral pneumothorax, two of them associated with pneumomediastinum.

The most common type of ventilation leading to pneumothorax was Inspiratory Positive Pressure Ventilation (IPPV) in 62.7% and Continuous Positive Airway Pressure (CPAP) in 10% of cases. Endotrcheal CPAP, Endonasal CPAP and Intermittent Mandatory Ventilation (IMV), other modes of ventilation, were used in 5%, 5% and 27.3% of cases respectively. Mortality rate after developing pneumothorax was 40.8%, compared with 32% in the control group which was not significantly different (*P*=0.4).

Table 2: Comparison of different factors in case and control groups in univariate analysis

Parameteres	Control group	Case group	*P*-value
Male	28.8%	54.9%	0.01
Mean gestational age (week)	34	31	<0.001
Cesarean section	32%	52%	0.015
Surfactant replacement therapy	60.4%	32.4%	0.001
Mean birth weight (gr)	2390	1900	0.003
Positive inspiratory pressure	17.3	22.7	<0.001
Positive end expiratory pressure	3.8	4.2	0.002

Table 3: Comparison of different significant factors in case and control groups in multivariate logistic Regression Backward Stepwise (Wald)

	Variables in the Equation					
	B	SE	Wald	df	Sig	Exp(B)
Step 1[a] Surfactant therapy	2.023	1.439	1.975	1	0.160	7.560
Type of delivery	0.507	1.688	0.090	1	0.764	1.661
Birth Weight	-0.001	0.001	0.519	1	0.471	0.999
PIP	-0.072	0.057	1.596	1	0.206	0.930
PEEP	-2.507	1.325	3.581	1	0.058	0.082
Sex	0.503	0.956	0.276	1	0.599	1.653
Gestational Age	0.050	0.171	0.085	1	0.771	1.051
Constant	7.179	6.637	1.170	1	0.279	1311.758
Surfactant therapy	3.107	1.298	5.727	1	0.017	22.358
PEEP	-1.969	1.195	2.712	1	0.100	0.140
Constant	3.690	3.874	0.907	1	0.341	40.049

a. Variable(s) entered on step 1: Surfactant therapy, type of delivery, birth weight, PIP, PEEP, sex, gestational age

PIP: Positive Inspiratory Pressure / PEEP: Positive End Expiratory Pressure

Discussion

Pneumothorax is a life-threatening condition with high morbidity and mortality. The value of new ventilatory techniques in reducing air leaks has been debated. Pneumothorax during respiratory distress is associated with an increased risk of intraventricular hemorrhage, chronic lung disease and death[7]. It has been suggested that early recognition and treatment are beneficial to avoid damage as a result of hypoxemia, hypercapnia, and impaired venous return[8].

The incidence of developing pneumothorax after mechanical ventilation was 26% which is partially similar to some other studies. The incidence of pneumothorax varies among medical centers with similar populations of infants[7].

Baumer in a randomized controlled trial study reported a series of 924 ventilated newborns, 23.7% of whom developed pneumothorax[9]. Bosche et al reported pneumothorax in 19% of 859 extremely premature newborns under mechanical ventilation[10].

Ngerncham et al found the male sex as one of the risk factors of pneumothorax during the first 24h of life[11]. Study of Benterud et al during 2001-2005 revealed that Cesarean section was associated with more frequent need for ventilation, and development of pneumothorax in neonates[12].

Fig. 2: CXR shows opaque lungs with air bronchogram due to respiratory distress syndrome in a 1-day-old infant

Fig. 3: CXR reveals collapse of the right lung, mediastinal shift and depression of right diaphragm due to right-sided tension pneumothorax

In this study the incidence of pneumothorax is higher (66.7%) in right side. This is similar to the study of Ilce et al in 2003 who reported that 53% of pneumothoraces were in the right hemithorax[13].

Regarding type of ventilation, Buckmaster et al revealed no significant difference in mortality rate between different types of ventilation[14]. Morley et al reported the incidence of pneumothorax after CPAP was 9%, which was fairly similar to present study[15].

One of the factors in development of pneumothorax is the artificial ventilation setting. An increased risk of pneumothorax was associated with maximal PIP. Klinger et al reported that decreasing the risk of pneumothorax requires intensive control of ventilation, including optimizing positive end-expiratory pressure and minimizing peak inspiratory pressure[16].

The most common predisposing factors which led to mechanical ventilation were pulmonary disorders and birth asphyxia. Among lung disorders, respiratory distress syndrome was the most common cause of mechanical ventilation (Fig. 3). It was seen in 60.25% of mechanically ventilated neonates in the present study. In 102 neonates with pneumothorax, 51 (54.3%) cases had respiratory distress syndrome. Meconium aspiration syndrome and diaphragmatic hernia are the other most common pulmonary causes for mechanical ventilation.

Singh et al in 90 newborns in NICU from 1989 until 1991 found that hyaline membrane disease was the most common cause of artificial ventilation in newborns[17].

There is some controversy about complications of surfactant replacement therapy in different studies. Meberg et al reported that in infants who had received surfactant for RDS the incidence of air leak syndromes during mechanical ventilation was low[18]. Study of Geary et al in 2008 revealed that successful early management of extremely preterm infants with surfactant treatment followed by CPAP is associated with reduction in the incidence and severity of bronchopulmonary dysplasia[19].

In our study, univariate analysis revealed significant difference of sex, mean gestational age, cesarean section, mean birth weight, surfactant replacement therapy and mean PIP and PEEP between case and control groups. In regression analysis only surfactant replacement therapy significantly reduced the risk of pneumothorax in ventilated newborns. Only 32.4% of newborns with pnemothorax received surfactant compared to 60.4% of neonates under ventilation without pneumothorax. This difference between the two types of analysis may be due to internal relationship of other variables with each other or because of low sample volume. More studies is suggested with matching of variables in a larger sample volume.

Conclusion

Surfactant replacement therapy can reduce the risk of pneumothorax in newborns during mechanical ventilation.

Acknowledgment

It is necessary to thank the personnel of NICU of 22nd Bahman Hospital, especially the nursing for their kind cooperation. This study was approved by the Institutional Review Board of Islamic Azad University of Mashhad.

Conflict of Interest: None

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