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Factors Associated with Pneumothorax in Premature Neonates of Interior Sindh

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ABSTRACT

Background: Pneumothorax is a life-threatening condition varying from 10% in low-birth-weight premature neonates to 1% in full term neonates. There are few risk factors associated with pneumothorax including gender, maturity level at birth, birth weight, persistent membrane rupture for more than 24 hours, development of respiratory distress syndrome. Early recognition and timely management are very important to avoid complications and mortality.

Objective: To find out the frequency of pneumothorax in preterm neonates and the associated factors in a tertiary care hospital of interior Sindh.

Methodology: A case control study was conducted at the Pediatric department of Maternity and Child Health Care Center Institute, Nawabshah, during November 2020 to December 2021. For the suspected diagnosis of pneumothorax cases the clinical indicator including respiratory distress, cyanosis and increase oxygen demand were used. For the confirmation of suspected diagnosis, the chest X-ray was done. The confirmed cases of pneumothorax and the control group were further investigated for the possible association of risk factors including gestational age, gender, birth weight, head circumference, APGAR score at 1st and 5th minute of life, maternal age, antenatal steroid therapy and mode of delivery. The data was analyzed by using SPSS version 20.

Results: The mean gestational age of study participants was 32.4 ± 3.2 weeks in pneumothorax group while 35.1 ± 2.4 in non-pneumothorax group. The maternal age in pneumothorax cases was 33.2 ± 2.4 years while in control was 29.9 ± 1.7 years. The birth weight in non-pneumothorax control (975 ± 253gm) was little more than the cases (897 ± 172gm) but the association was non-significant. In the control group, majority of the participants (57.4%) were moderately preterm i.e. in between 32 weeks to 35 weeks while the 55.6% cases of pneumothorax were early preterm (28-31 weeks) and the association was strongly significant (p-value ≤0.05).

Conclusion: It can be concluded that the mortality rate of 46% with neonatal pneumothorax highlights the severity of the diseases and the need of close monitoring of neonate and the prevention before its occurrence. The risk factors like gestational age (preterm) and antenatal steroid reported strong significant association and the respiratory distress syndrome was the most common cause of neonatal pneumothorax.

Keywords: Pneumothorax; Premature Neonates; Respiratory Distress Syndrome; Antenatal Steroids; Preterm

Introduction

Pneumothorax is a life-threatening condition varying from 10% in low-birth-weight premature neonates to 1% in full term neonates. There is a high frequency of pneumothorax in preterm neonates in comparison to full term neonates. It has been found that the incidence of pneumothorax is up to 7% in babies who were having very low birth weight i.e. less than 1500gm. Respiratory distress syndrome is one of the cause of pneumothorax in about 2% preterm cases. It has been reported that the incidence rate increases up to 25% in term neonates and 34.7% in preterm neonates just because of positive pressure ventilation. On the other hand, the Nasal Continuous Airway Pressure (n-CPAP) and High Flow Nasal Cannula (HFNC) further increasing the incidence rate of pneumothorax. Mortality due to pneumothorax is about 38.6%.

The underlying pathophysiology of pneumothorax involves over distension of alveoli leading to alveolar rupture resulting in air entry into the pleural space, termed as pneumothorax. Because of defective gas exchange mechanism, the mediastinum shifts to opposite side which leads to cardiovascular dysfunction and increase risk of mortality. There is an increase in intrapleural pressure in tension pneumothorax which causes the lung to collapse so affects the venous return and ultimately causes systemic hypotension, respiratory or cardiac failure. Studies found a strong significant association of neonatal pneumothorax with the intraventricular hemorrhage (IVH) leading to death.

There are few risk factors associated with pneumothorax including gender, maturity level at birth, birth weight, persistent membrane rupture for more than 24 hours, development of respiratory distress syndrome and respiratory support given. Chest tube placement is the most commonly used treatment modality in pneumothorax cases, other treatment option includes needle aspiration. Early recognition and timely management is very important to avoid complications and mortality. Therefore, there is a need to identify the association of population specific risk factors to prevent pneumothorax.

Objective

To find out the frequency of pneumothorax in preterm neonates and the associated factors in a tertiary care hospital of interior Sindh.

Methodology

A case control study was conducted at the Pediatric department of Maternity and Child Health Care Center Institute, Nawabshah, Sindh during November 2020 to December 2021. The study got approval from the concerned institute. The sample size was calculated by using Open Epi calculator. The inclusion criteria for the cases were preterm neonates delivered between 28 and 36 weeks of gestation. These neonates were further classified into early preterm (28-31 weeks), moderate preterm (32-35 weeks), and late preterm (35-36 weeks). Additionally, only those neonates who exhibited signs and symptoms of respiratory distress were included in the study. Those cases were excluded who were having either neonatal sepsis or any congenital malformation. Informed written consent was taken from the guardian. For the control group the baby born next to pneumothorax baby, having gestational age of ±3 days, was included while those participants were excluded from the control group who were either having any congenital malformation or chance of developing pneumothorax.

For the suspected diagnosis of pneumothorax in cases the clinical indicator including respiratory distress, cyanosis and increase oxygen demand were used. For the confirmation of suspected diagnosis, the chest X-ray was done. The confirmed cases of pneumothorax and the control group were further investigated for the possible association of risk factors including gestational age, gender, birth weight, head circumference, APGAR score at 1^{st} and 5^{th} minute of life, maternal age, antenatal steroid therapy and mode of delivery.

The data was analyzed by using Statistical Package for Social Science (SPSS) version 20. The numerical variables were presented as mean with standard deviation while for the categorical variables frequency and percentage was used. Chi-square test was used to find out the association of predictive risk factors with the occurrence of pneumothorax. p-value less than 0.05.

Results

The mean gestational age of study participants was 32.4 ± 3.2 weeks in pneumothorax group while 35.1 ± 2.4 in non-pneumothorax group. The mean birth weight in pneumothorax and non-pneumothorax group was 897 ± 172gm and 897 ± 172gm. The head circumferences at the time of birth in pneumothorax and non-pneumothorax group were 31.6 ± 3.6 and 36.9 ± 1.9 respectively. A very good APGAR score (8.0 ± 1.3) was noted in non-pneumothorax group as compare to pneumothorax group (6.2 ± 1.9). The characteristics of study participants are mentioned in Table 1.

Association of multiple risk factors between cases and controls, were noted. The maternal age in pneumothorax cases was 33.2 ± 2.4 years while in control was 29.9 ± 1.7 years. The birth weight in non-pneumothorax control (975 ± 253gm) was little more than the cases (897 ± 172gm) but the association was non-significant. In the control group, majority of the participants (57.4%) were moderately preterm i.e. in between 32 weeks to 35 weeks while the 55.6% cases of pneumothorax were early preterm (28-31 weeks) and the association was strongly significant (p-value ≤0.05). Antenatal steroid therapy was only received

Table 1. Characteristics of Study Participants (n=81)

Variables	Mean ± SD	
	Pneumothorax (n=27)	Non- pneumothorax (n=54)
Gestational age (weeks)	32.4 ± 3.2	35.1±2.4
Baby weight (gm)	897 ± 172	975 ± 253
Baby length	45.9 ± 1.8	56.1 ± 3.2
Head circumference	31.6 ± 3.6	36.9 ± 1.9
APGAR Score	6.2 ± 1.9	8.0 ± 1.3

by 7.4% cases of pneumothorax while the 94.4% controls received antenatal steroid and the results were significant (p-value ≤0.05). About 44.4% cases and 46.3% controls went under spontaneous vaginal delivery. Prolonged ruptured membrane was mostly noted in cases (48.1%) while no association was found. Gender had no association with the occurrence of pneumothorax. About 11.1% cases reported APGAR score of 3-7 in 1st minute of life while 4-7 in 12.9% controls. After 5 minutes of delivery the APGAR score raised to 5-7 in 18.5% cases and 6-8 in 18.5% controls. There was no significant association of APGAR score at 1st and 5th minute. Association of risk factors with the occurrence of pneumothorax have been mentioned in Table 2.

The most common cause of pneumothorax in premature neonates was respiratory distress syndrome (40.7%), followed by meconium aspiration syndrome (22.2%), birth asphyxia syndrome (18.6%), transient tachypnea of newborn (14.8%) and the pneumonia was least common (3.7%) with strong significant association (p-value ≤0.05), as mentioned in Table 3. Looking over the outcome of pneumothorax in premature neonates, the mortality rate was 46% while 54% cases were recovered and discharged to go home as shown in Figure 1.

Discussion

Pneumothorax is a very common complication of respiratory diseases in neonates. It has been reported that neonates either with low birth weight or premature, are more prone to develop pneumothorax. Baumer et.al reported that the 9.2% neonates were born early preterm and all were having pneumothorax, keeping in mind the incidence of neonatal pneumothorax in United States ranging from 7-12%. Current study found that the 55.6% cases of pneumothorax were early preterm (28-31 weeks) and the association was strongly significant. Miljana et.al found that 71.6% neonates of pneumothorax were premature. In the premature neonates, the weak lung and pressure ventilation combinedly leads to neonatal pneumothorax.[7] It has been found that the incidence rate of pneumothorax is 1.85-2% in neonates who are on mechanical ventilation while the incidence rate rises to 3% if the pre-term and low birth weight neonate is on mechanical ventilation.

Current study found male predominance in moderate and late preterm group but was non-significant when comparing two study groups (pneumothorax versus non-pneumothorax) and the finding is favored by multiple

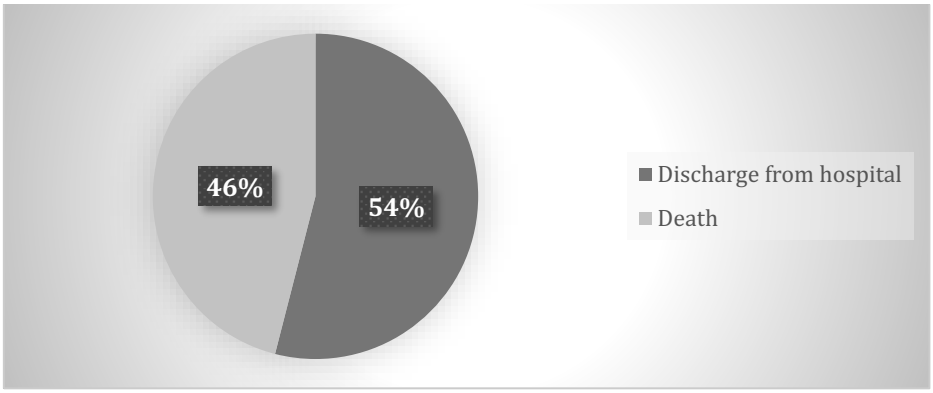

Figure 1. Outcome with Pneumothorax

Table 2. Risk factors associated with Pneumothorax in Preterm neonates

Characteristics	Pneumothorax (n=27)	Non- pneumothorax (n=54)	p-value
Maternal age	33.2 ± 2.4	29.9 ± 1.7	0.41
Birth weight (gm)	897 ± 172	975 ± 253	0.65
Gestational age			
Early preterm (28-31 weeks) Moderate preterm (32-35 weeks) Late preterm (35-36 weeks)	15 (55.6%) 9 (33.3%) 3 (11.1%)	9 (16.7) 31 (57.4) 14 (25.9)	0.01
Antenatal steroid therapy			
Yes No	2 (7.4%) 25 (92.6%)	51 (94.4%) 3 (5.6%)	0.003
Spontaneous vaginal delivery (SVD)	12 (44.4%)	25 (46.3%)	0.61
Prolonged ruptured membrane	13 (48.1%)	22 (40.7%)	0.57
Gender			
Male Female	17 (62.9%) 10 (37%)	32 (59.3%) 22 (40.7%)	0.36
Apgar score 1st minute	3-7 in 3 (11.1%)	4-7 in 7 (12.9%)	0.19
Apgar score 5 minute, Me (Iq)	5-7 in 5 (18.5%)	6-8 in 10 (18.5%)	0.27

studies.[9] Likewise, there was no any significant association of predictive factors including birth weight and APGAR score at 1st and 5th minute, with the occurrence of pneumothorax in preterm neonates. Literature supports the current finding. Although the role of antenatal steroid, on lung maturation, improvement in survival rate, a fall in incidence rate of respiratory distress syndrome and decrease in mortality rate, is well established but still it is only administered in less than 20% pregnancies in developing countries. Current study favored this finding by reporting that only 7.4% cases of pneumothorax received antenatal steroid therapy while the 94.4% controls received it and the results were significant (p-value ≤0.05). Antenatal steroid causes lung maturation, produces surfactant, decreases vascular permeability and washout of excess fluid from the lung.

Literature review revealed that the two most important etiological factors for neonatal pneumothorax are preterm birth and respiratory distress syndrome while the inadequate surfactant production is the reason behind respiratory distress syndrome. Current study favored this finding by reporting respiratory distress syndrome as the most common cause of pneumothorax in premature neonates (40.7%) followed by meconium aspiration syndrome (22.2%), birth asphyxia syndrome (18.6%), transient tachypnea of newborn (14.8%) and the pneumonia (3.7%) with strongly significant association. It has been suggested that the preterm neonates have immature lung so unable to produce adequate quantity of surfactant or might be some pathological conditions like asphyxia, pneumonia, gestational diabetes mellitus, gestation hypertension and the preeclampsia causes either defective synthesis or function of surfactant ultimately leading to respiratory distress syndrome, resulting in development of pneumothorax.[9] Vibede et.al reported that the cause of pneumothorax in 43% cases was respiratory distress syndrome.

Current study found the mortality due to pneumothorax in premature neonates was 46%, relatively lower mortality rate was reported by Matary et.al i.e., 29.1%. Comparison of multiple studies revealed the mortality range between 25-35%.[10] As Pakistan is a developing country, there is lack of health facilities in rural areas, high illiteracy and poor nutrition might be the reasons behind the high

Table 3. Underlying causes of Pneumothorax

Causes of Pneumothorax	n= 27 (%)	p-value
Respiratory distress syndrome	11 (40.7)	0.004
Meconium aspiration syndrome	6 (22.2)	
Transient tachypnea of newborn	4 (14.8)	
Birth asphyxia syndrome	5 (18.6)	
Pneumonia	1 (3.7)	

mortality rate of pneumothorax.
Strength of current study is the addition of risk factors associated with the occurrence of pneumothorax in the literature. It will be helpful to draw up strategies against pneumothorax associated morbidity and minimizing the mortality rate. Study limitations include small sample size and single centered study. Future recommendations are well-designed study should be performed on larger scale.

Conclusion

It can be concluded that the mortality rate of 46% with neonatal pneumothorax highlights the severity of the diseases and the need of close monitoring of neonate and the prevention before its occurrence. The risk factors like gestational age (preterm) and antenatal steroid reported strong significant association and the respiratory distress syndrome was the most common cause of neonatal pneumothorax.

Reference

1. Jeng MJ, Lee YS, Tsao PC, Soong WJ. Neonatal air leak syndrome and the role of high-frequency ventilation in its prevention. Chin Med J. 2012;75(11): 551-9.
2. Vibede L, Vibede E, Bendtsen M, Pedersen L, Ebbesen F. Neonatal pneumothorax: a descriptive regional Danish study. Neonatology. 2017;111(4): 303-8.
3. Drovandi L, Cianchi I, Pratesi S, Dani C. Fibrin glue pleurodesis for pneumothorax in extremely preterm infants: a case report and literature review. Ital J Pediatr. 2018;44:1-5.
4. Dargaville PA, Gerber A, Johansson S, De Paoli AG, Kamlin COF, Orsini F, et al. Incidence and outcome of CPAP failure in preterm infants. Pediatrics. 2016; 138(1).
5. Bhat Yellanthoor R, Ramdas V. Frequency and intensive care related risk factors of pneumothorax in ventilated neonates. Pulm Med. 2014;2014.
6. Huan N-C, Sidhu C, Thomas R. Pneumothorax: classification and etiology. Clin Chest Med. 2021; 42(4):711-27.
7. Joshi A, Kumar M, Rebekah G, Santhanam S. Etiology, clinical profile and outcome of neonatal pneumothorax in tertiary care center in South India: 13 years experience. J Matern -Fetal Neonatal Med. 2022;35(3):520-4.
8. Duong HH, Mirea L, Shah P, Yang J, Lee S, Sankaran K. Pneumothorax in neonates: trends, predictors and outcomes. J Perinat Med. 2014;7(1):29-38.
9. Plojoux J, Froudarakis M, Janssens JP, Soccal PM, Tschopp JM. New insights and improved strategies for the management of primary spontaneous pneumothorax. Clin Respir J. 2019;13(4):195-201.
10. Baumer J. International randomised controlled trial of patient triggered ventilation in neonatal respiratory distress syndrome. Arch. Dis. Child. Fetal Neonatal Ed. 2000;82(1):F5-F10.
11. Fanaroff AA, Stoll BJ, Wright LL, Carlo WA, Ehrenkranz RA, Stark AR, et al. Trends in neonatal morbidity and mortality for very low birthweight infants. Am J Obstet Gynecol. 2007;196(2):147. e1-. e8.
12. Jovandaric MZ, Milenkovic SJ, Dotlic J, Babovic IR, Jestrovic Z, Milosevic B, et al. Neonatal pneumothorax outcome in preterm and term newborns. Medicina. 2022;58(7):965.
13. Aurilia C, Ricci C, Tana M, Tirone C, Lio A, Gambacorta A, et al. Management of pneumothorax in hemodynamically stable preterm infants using high frequency oscillatory ventilation: report of five cases. Ital J Pediatr. 2017;43:1-5.
14. Prabha PN, Georg R, Francis F. Profile and outcomes of neonates requiring ventilation: The Kerala Experience. Curr Pediatr Res. 2014;18(2):5762.

15. Morley CJ, Davis PG, Doyle LW, Brion LP, Hascoet J-M, Carlin JB. Nasal CPAP or intubation at birth for very preterm infants. N Engl J Med. 2008;358(7):700-8.
16. Terzic S, Heljic S, Panic J, Sadikovic M, Maksic H. Pneumothorax in premature infants with respiratory distress syndrome: focus on risk factors. J Pediatr Neonatal Individ Med. 2016;5(1):e050124-e.
17. Lim HS, Kim H, Jin JY, Shin YL, Park JO, Kim CH, et al. Characteristics of pneumothorax in a neonatal intensive care unit. J Korean Soc Neonatol. 2011;18 (2):257-64.
18. Kemp MW, Jobe AH, Usuda H, Nathanielsz PW, Li C, Kuo A, et al. Efficacy and safety of antenatal steroids. American Journal of Physiology-Regulatory, Integrative and Comparative Physiology. 2018;315 (4): R825-R39.
19. Prediger B, Mathes T, Polus S, Glatt A, Bühn S, Schiermeier S, et al. A systematic review and time-response meta-analysis of the optimal timing of elective caesarean sections for best maternal and neonatal health outcomes. BMC Pregnancy Childbirth. 2020;20:1-18.
20. Hadzic D, Skokic F, Husaric E, Alihodzic H, Softic D, Kovacevic D. Risk factors and outcome of neonatal pneumothorax in Tuzla Canton. Materia socio-medica. 2019;31(1):66.
21. Rubarth LB, Quinn J. Respiratory development and respiratory distress syndrome. Neonat Network. 2015;34(4):231-8.
22. Dotson K, Johnson LH. Pediatric spontaneous pneumothorax. Pediatr Emerg Care. 2012;28(7):715-20.
23. Al Matary A, Munshi HH, Abozaid S, Qaraqei M, Wani TA, Abu-Shaheen AK. Characteristics of neonatal pneumothorax in Saudi Arabia: three years' experience. Oman Med J. 2017;32(2):135.
24. Correia C, Rocha G, Flor-de-Lima F, Guimaraes H. Respiratory morbidity in late preterm infants. Minerva Pediatr. 2016;70(4):345-54.