# The factors affecting persistent pneumothorax and mortality in neonatal pneumothorax

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**SUMMARY: Esme H, Doğru Ö, Eren Ş, Korkmaz M, Solak O. The factors affecting persistent pneumothorax and mortality in neonatal pneumothorax. Turk J Pediatr 2008; 50: 242-246.**

**The aim of this study was to present our experience in management of neonatal pneumothorax and factors contributing to persistent pneumothorax and mortality. Forty-two newborns were analyzed according to gestational age, birth weight, Apgar score, age of admittance, type of delivery, mother's age, side of pneumothorax, causes of pneumothorax, accompanying disorders, tube thoracostomy and mechanical ventilation durations, mean hospital stay, and deaths. Sixteen patients (38%) weighed less than 2500 g and 28 (66%) were preterm. The mean Apgar score at 5$^{th}$ minute was 6.2 (2-10). The pneumothorax was bilateral in 9 patients (21%). There was a defined underlying lung pathology in 26 (61%) patients and accompanying disorder in 14 (33%). Mean tube thoracostomy duration was 5 days (2-12). Twenty-five patients (59%) needed mechanical ventilation. Overall 10 babies died. Our findings indicated that underlying primary lung pathology, need for mechanical ventilation, and bilateral pneumothorax were major determinants of persistent pneumothorax and mortality in newborns.**

***Key words: neonatal pneumothorax, persistent pneumothorax, mortality.***

Pneumothorax (PTX) is a frequently encountered surgical problem requiring urgent intervention in neonatal intensive care units. The incidence is reported between 1 and 2%[1]. The incidence of clinically important PTX is considerably less and at present is thought to be about 0.07%[2]. However, the incidence of PTX varies with the underlying lung disease as well as with resuscitation and ventilation methods: 5% to 20% incidence in infants with respiratory distress syndrome (RDS), with and without the use of assisted ventilation, and 20% to 50% incidence in term infants with meconium aspiration syndrome[3].

Although neonatal PTX is one of the few treatable causes of respiratory difficulty in the early days of life, the mortality rate remains unjustifiably high, at approximately 20%[4]. Additionally, PTX during respiratory distress is associated with an increased risk of intraventricular hemorrhage, chronic lung disease, and death[5,6]. Therefore, it is important to consider the predisposing factors, clinical findings, and rationale of therapy for PTX. The aim of this study was to review our experience in management of neonatal PTX in order to identify associated morbidity and mortality, and factors contributing to persistent PTX and mortality.

## Material and Methods

We retrospectively reviewed 42 patients who were hospitalized for PTX requiring tube thoracostomy in the neonatal intensive care units at two different medical centers between January 2000 and June 2005. They were analyzed according to gestational age, birth weight, Apgar score, type of delivery, side of PTX, causes of PTX, accompanying disorders, tube thoracostomy and mechanical ventilation durations, and the mean hospital stay. The variables studied and correlated with mortality and tube thoracostomy duration included patient gestational age, birth weight, side of PTX, type of delivery, Apgar score, need for mechanical ventilation, underlying primary lung pathology, and accompanying disorder.

For diagnosis, chest X-ray and computed tomography, which was used to eliminate congenital anomalies from PTX in some patients, were used. We used chest tube placement in the treatment of PTX. Because PTX affecting less than 15% of a patient's hemithorax can resolve spontaneously, no surgical intervention was used in these patients if they were asymptomatic. These patients were not included in the study. For symptomatic patients who had PTX occupying less than 15% of hemithorax, we used 18-gauge venous catheter. Those patients were also excluded from the study. The intercostal drain was left for 24 h following cessation of air leak and complete lung expansion and then removed without clamping. Tube thoracostomy prolonged over seven days was accepted as persistent PTX.

Statistical analysis: continuous variables were compared using the unpaired Student's t-test and differences between categorical variables were assessed using the chi-square test. A P-value of $<0.05$ was considered statistically significant.

## Results

During the specified period, 42 newborns [26 male (61%), 16 female (38%)] were diagnosed with PTX. There were 12 term, 28 preterm, and 2 postmature newborns in the study population. The median gestational age of patients was 35 (30-43) weeks and mean birth weight was 2648 g (1700-3570). Sixteen patients (38%) had low birth weight (less than 2500 g). Mean Apgar score was 6.2 (2-10) at 5$^{th}$ minute. Twenty-three deliveries (54%) were by cesarean section. Totally, 55 pneumothoraces occurred in 42 neonates; unilateral PTX occurred in 33 (78.6%) [left side (n:14, 33%), right side (n:19, 45%)] and bilateral PTX in 9 (21.4%). Tension PTX was noted in two newborns. Mean tube thoracostomy duration was 5 days (2-12). Drainage for 1 to 3 days sufficed in 9 patients (21%) and drainage for 4 to 7 days was necessary in 20 patients (47%). More than 7 days were required in 14 patients (33%) because of continued air leak. Twenty-five patients (59%) needed mechanical ventilation.

In 26 (61%) newborns, the underlying cause of PTX could be identified, whereas in 16 (38%) no reason for PTX could be found. The most common cause of PTX was RDS in 9 (21%) newborns (Table I). RDS was the underlying disease process in the majority of preterm newborns, whereas meconium aspiration and/or pneumonia predominated in term newborns. The most common accompanying disorder was premature rupture of membranes in 3 (7%) newborns (Table II). Overall 10 babies (23%) died. Nine of them needed mechanical ventilation. Among the non-survivors, there was defined underlying lung pathology in 9 (90%). Mean Apgar score was 4.3. Of all deaths, 4 (40%) had accompanying disorder, 5 (50%) had bilateral PTX, 6 (60%) had cesarean section, 6 (60%) had low birth weight, and 5 (50%) were premature.

**Table I.** Causes of Pneumothorax

| | n (%) |
|---|---|
| Respiratory distress syndrome | 9 (21) |
| Meconium aspiration | 6 (14) |
| Pneumonia | 4 (9) |
| Mechanical ventilation | 4 (9) |
| Emphysema | 2 (4) |
| Resuscitation at birth | 1 (2) |
| Spontaneous | 16 (38) |

**Table II.** Accompanying Disorders

| | n (%) |
|---|---|
| Premature rupture of membranes | 3 (7) |
| Intraventricular hemorrhage | 3 (7) |
| Septicemia | 2 (4) |
| Hydrocephalus | 2 (4) |
| Inappropriate ADH syndrome | 2 (4) |
| Atelectasis | 1 (2) |
| Hyperbilirubinemia | 1 (2) |
| Upper gastrointestinal hemorrhage | 1 (2) |
| Pneumomediastinum | 1 (2) |
| Pectus excavatum | 1 (2) |
| Esophageal atresia | 1 (2) |
| Tracheoesophageal fistula | 1 (2) |
| Hydronephrosis | 1 (2) |

ADH: Antidiuretic hormone.

There was a significant relationship between mortality and the side of PTX, Apgar score, need for mechanical ventilation, and underlying primary lung pathology, but not with type of delivery, birth weight, gestational age, and accompanying disorders. Additionally, there was a significant relationship between persistent

PTX and the side of PTX, birth weight, need for mechanical ventilation and underlying primary lung pathology, but not with type of delivery, gestational age, Apgar score and accompanying disorders. Observations and statistics are outlined in Tables III and IV.

of newborns with PTX had persistent PTX. In our study, persistent PTX was observed in 14 (33%) newborns. The high persistent PTX rate was considered to be associated with underlying primary lung pathology (61%) and need for mechanical ventilation (59%).

**Table III.** Factors Affecting Mortality in 42 Cases of Newborn Sustained Pneumothorax

| | Survivors (n=32) | Fatalities (n=10) | p-value |
|---|---|---|---|
| Gestational age (weeks) | 35.8±3 | 35.8±3 | 0.379 |
| Birth weight (gram) | 2655±446 | 2624±703 | 0.779 |
| Bilateral pneumothorax* | 4 (12%) | 5 (50%) | 0.023∗ |
| Cesarean section* | 17 (53%) | 6 (60%) | 0.496 |
| Apgar score (≤5) | 6.8±1 | 4.3±1 | 0.000∗ |
| Underlying primary lung pathology* | 17 (53%) | 9 (90%) | 0.038∗ |
| Need for mechanical ventilation* | 16 (62%) | 9 (90%) | 0.031∗ |
| Accompanying disorders* | 8 (25%) | 4 (40%) | 0.433 |

*: number of patients. Data presented as mean±SD, or percentage as indicated. ∗: P<0.05. A P-value of <0.05 was considered statistically significant.

**Table IV.** Factors Affecting Tube Thoracostomy Duration in 42 Cases of Newborns Sustained Pneumothorax

| | TTD ≤7 days (n=28) | TTD >7 days (n=14) | p-value |
|---|---|---|---|
| Gestational age (weeks) | 35.8±3 | 34.4±2 | 0.582 |
| Birth weight (gram) | 2912±571 | 2515±426 | 0.015∗ |
| Bilateral pneumothorax* | 2 (7%) | 7 (50%) | 0.003∗ |
| Cesarean section* | 18 (64%) | 5 (37%) | 0.079 |
| Apgar score (≤5) | 6.2±3 | 5.3±2 | 0.582 |
| Underlying primary lung pathology* | 14 (50%) | 12 (85%) | 0.015∗ |
| Need for mechanical ventilation* | 7 (25%) | 5 (35%) | 0.041∗ |
| Accompanying disorders* | 13 (46%) | 12 (85%) | 0.055 |

TTD: Tube thoracostomy duration. *: number of patients. Data presented as mean±SD, or percentage as indicated. ∗: P <0.05. A P-value of <0.05 was considered statistically significant.

## Discussion

Pneumothorax in the newborn has a significant mortality and morbidity. The development of a PTX with ensuing hypoxia and hypercapnia is a potentially life-threatening event, and 23% of the newborns in our study died. This high mortality rate is consistent with the literature[7,8]. Even though it is not fatal, the morbidity is probably significant. Continued air leak and persistent PTX could alter respiratory and cardiovascular hemodynamics, and also exacerbate the effects of oxygen toxicity and barotraumas by prolonging oxygen and ventilatory assistance. On the other hand, the continued air leak could have contributed to the increased requirement for both oxygen and ventilatory assistance, thereby creating a vicious cycle[9]. Bahatia et al.[9] reported that 17%

Newborns with aspiration of blood, meconium or mucus, hyaline membrane disease, and vigorous resuscitation after delivery have a high incidence of PTX. Newborns requiring assisted ventilation, especially with high positive inspiratory pressure or continuous positive end expiratory pressure, more frequently experience PTX. Other risk factors include RDS, pneumonia, emphysema, pulmonary hypoplasia, urinary tract anomalies, and neuromuscular disease[10]. In our study, the underlying cause of PTX could be identified in 26 (61%) patients, whereas no reason for PTX could be found in 16 (38%) patients. We found that underlying primary lung pathology had a significant effect on tube thoracostomy duration and mortality.

Many neonates with RDS and hypoxemia are managed by increasing the inflating pressure and application of positive end-expiratory

pressure. Both maneuvers increase the potential for tension PTX, which requires immediate tube thoracostomy to stabilize the intrapleural pressure[11]. Watkinson et al.[12] reported that 8.7% of ventilated babies developed at least one PTX during the first two weeks of life. This is similar to the rates of 10% and 13.4% recently reported elsewhere[13,14]. In our study, all newborns who died had underlying primary lung pathology except one patient, and all but one required mechanical ventilation. The majority of our patients had PTX due to a cause other than mechanical ventilation such as RDS, meconium aspiration, pneumonia, and emphysema. This finding supports the suggestion that neonatal PTX develops because of underlying pulmonary pathology rather than being a complication of mechanical ventilation. Twelve of 14 patients who had persistent PTX were mechanically ventilated patients. We found that the duration of tube thoracostomy was prolonged with the use of mechanical ventilation. This may be due to prolonged air leak caused by the increased inflating pressure.

Bilateral PTX occurred in 9 (21%) neonates. In patients with bilateral PTX, the increases in mortality and duration of tube thoracostomy were significant. Four of 5 deceased patients with bilateral PTX had underlying primary lung pathology. Therefore, we suggest that RDS and meconium aspiration, as diseases that affect both lungs, are the main reason for the increase in mortality and morbidity. The Apgar score at 5$^{th}$ minute is an important parameter in evaluation of the newborn. We found low Apgar scores in 50% of non-survivors and in only 12% of survivors.

Definitive treatment of PTX consists of prompt insertion of a chest tube following confirmation by X-ray examination. Supplying extra oxygen to such patients theoretically hastens the resolution of the PTX, but the true cost-effectiveness of such treatment must be questioned[15]. Fibrin glue is an effective treatment for intractable PTX but has significant risks[16]. For asymptomatic patients who had PTX occupying less than 15% of hemithorax, no surgical intervention was used and they were treated symptomatically. Because the air absorbs at a rate of only 1.2% (50 to 75 ml/d), the patients should be followed-up with radiographs once daily[17]. Exceptions to this management include general anesthesia and the need for mechanical ventilation, which mandate insertion of an intercostal drain regardless of the size of PTX. For symptomatic patients who had PTX occupying less than 15% of hemithorax, we used 18-gauge venous catheter. PTX occupying more than 15% of hemithorax, or increasing in size, or associated with pleural effusion requires tube thoracostomy[17].

The use of venous catheter is a matter of controversy. Some authors recommend it because of its low invasiveness and relative simplicity, or for economic considerations[18]. However, the lumen of the venous catheter may not be adequate to drain air from the thoracic cavity, especially in a large PTX. This device may easily kink or break, which prevents air drainage. Therefore, we used venous catheter in less severe cases of PTX. In our study, there were no major complications in newborns that required tube thoracostomy. In two cases, the tube kinked and we corrected this by withdrawing the tube a few centimeters. In one case, bleeding from the incision site was stopped with a suture.

In conclusion, our findings indicated that underlying primary lung pathology, need for mechanical ventilation, and bilateral PTX were major determinants of persistent PTX and mortality in neonatal PTX. Physicians and other healthcare providers in the newborn intensive care unit should carefully watch for factors influencing morbidity and mortality in neonatal PTX in order to avoid unexpected conditions.

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