Original Article

Role of Lung Ultrasound for the Diagnosis of Neonatal Respiratory Disorders

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ABSTRACT

Objective: The present study aimed to assess the role of lung ultrasound for the diagnosis of neonatal respiratory disorders.

Study Design: Prospective cross-sectional study

Place and Duration of Study: This study was conducted at the Intensive Care Unit (NICU) of CMH, Lahore from July 2021 to December 2022.

Materials and Methods: Neonates of gestational age ≥28 weeks with respiratory distress syndrome were enrolled. Chest X-rays (CXR) and Lung Ultrasound (LUS) were performed during the admission and repeated before or after 7 days depending on the need for examination. Different etiologies associated with neonatal respiratory distress such as respiratory distress syndrome (RDS), pleural effusion (PE), congenital diaphragmatic hernia (CDH), transient tachypnea of the newborn (TTN), pulmonary interstitial emphysema (PIE), pulmonary atelectasis (PA), meconium aspiration syndrome (MAS), and pneumothorax (PTX) were interpreted based on chest X-rays findings. Descriptive statistics were done using SPSS version 27.

Results: Of the total 96 neonates, there were 51 (53.1%) male and 45 (46.9%) female neonates. Out of total neonates, the incidence of full-term, late preterm neonates (34-36 gestational weeks), and preterm (<34 gestational weeks) were 50 (52.1%), 22 (22.9%), and 24 (25%) respectively. About 88 (91.7%) neonates were delivered through cesarean section (CS) mode of delivery. The mean gestational age and birth weight of neonates was 36.8±2.94 weeks and 2480.9±748.67 grams respectively. Invasive ventilation, non-invasive ventilation, and surfactant therapy were different respiratory support used in 38 (39.6%), 16 (16.7%), and 28 (29.2%) respectively. Sensitivity and specificity of lung US diagnosed neonates for pneumonia, pneumothorax, respiratory distress syndrome, pulmonary atelectasis, and meconium aspiration syndrome 96.4/100%, 89.5/97.9%, 93.7/100%, 100/98.9%, and 91.8/100% respectively.

Conclusion: The present study concluded that Lung Ultrasound (LUS) is a safe, reliable, and an alternate modality for the diagnosis of neonatal respiratory distress.

Key Words: Neonatal respiratory distress, Lung Ultrasound, Respiratory distress syndrome

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INTRODUCTION

Respiratory disorders are the most prevalent cause of neonate's intensive care unit (NICU) admission and contributes to the morbidity and early mortality in the majority of neonates (0-7 days of age).[1,2] Preterm newborns are more likely to suffer from neonatal respiratory distress syndrome (NRDS). Surfactant deficiency is the primary cause of alveolar collapse and atelectasis in neonates after their birth. Neonatal respiratory distress disorders clinical characteristics include cyanosis, nasal flaring, tachypnea, chest retraction, and grunting. The risk for the development of this syndrome inversely varies with gestational age (GA)[3,4]. Numerous studies focused on the reduction of morbidity and mortality rate related to NRDS. NRDS detection and treatment varies worldwide. Early detection is an essential step for the effective treatment of neonates with NRDS.

The diagnosis of NRDS could be effectively done using Chest radiography (CXR); a prominent and comprehensive technique[4,5]. CXR, on the other hand, poses the danger of exposing the newborn to ionizing

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radiation. Younger children are significantly more vulnerable to the possible harmful effects of CXR[6,7]. Children ages <1 year are ten to fifteen times more susceptible to developing cancer after receiving the same dosage of ionizing radiation than adults [8]. The basis of newborn respiratory disorders diagnosis are plain chest X-ray (CXR) and clinical signs, which frequently provides a diagnostic challenges because of lower specificity and sensitivity associated with the signs and symptoms. As a result of the inaccurate diagnosis, this may result in delayed or improper care[9,10]. Several studies have examined lung ultrasound (LUS) testing as an alternative modality for the diagnosis of neonatal lung disorders throughout the last decade. LUS imaging can be highly beneficial in newborns because of the neonatal anatomical traits of short thoracic breadth with a thin chest wall. This provides for a reasonable, if indirect, lung's visualization[11]. LUS imaging is particularly advantageous since it is a radiation-free procedure; a less technicality as compared to other sonographic exams[12]. LUS is useful not only for diagnosing pulmonary diseases, but also for differential diagnosis, severity grading, and therapy of RDS in newborns. The present study aimed to assess the role of lung ultrasonography in the diagnosis of neonatal respiratory distress syndrome.

MATERIALS AND METHODS

A total of 96 neonates were prospectively investigated in this cross-sectional study conducted at the Intensive Care Unit (NICU) of CMH, Lahore from July 2021 to December 2022. Neonates of GA≥28 weeks with respiratory distress syndrome were enrolled. Neonates with chromosomal aberrations, heart failure, multiple congenital anomalies, and hydrops fetalis were excluded. The Epi sample size calculator was used for sample size calculation by taking 80% power of test, 5% margin of error, 95% confidence interval, and 2.5% risk ratio. The final sample size was 96. Chest X-rays (CXR) and Lung Ultrasound (LUS) were performed during the admission and repeated before or after a week (7-days) depending on the need for examination. Different etiologies associated with neonatal respiratory distress such as respiratory distress syndrome (RDS), pleural effusion (PE), congenital diaphragmatic hernia (CDH), transient tachypnea of the newborn (TTN), pulmonary interstitial emphysema (PIE), pulmonary atelectasis (PA), meconium aspiration syndrome (MAS), and pneumothorax (PTX) were interpreted based on chest X-rays findings. All the neonates were investigated in Supine position with constant light intensity exposure; as a phototherapy device was switched off. Stressful situations were avoided with gentle handling and keeping the voice tones and touching quietly and other causes for crying.

Descriptive statistics was done using SPSS version 27. Mean and standard deviation was used for the description of Continuous variables whereas frequencies and percentages represented the categorical variables. Chi-square test was used for comparing the categorical variables with continuous variables. A two-sided p-value < 0.05 was considered statistically significant.

RESULTS

Of the total 96 neonates, there were 51 (53.1%) male and 45 (46.9%) female neonates. Out of total neonates, the incidence of full-term, late preterm neonates (34-36 gestational weeks), and preterm (<34 gestational weeks) were 50 (52.1%), 22 (22.9%), and 24 (25%) respectively. About 88 (91.7%) neonates were delivered through cesarean section (CS) mode of delivery.

Table No. 1: Patient's characteristics

Variables	Value N (%) (Mean ± SD)
Gender N (%) Male neonates Female neonates	 51(53.1) 45 (46.9)
Gestational age (weeks)	36.8±2.94
Birth Weight (g)	2480.9±748.67
Types of Term-pregnancy Full-term Late preterm (34-36 gestational weeks) Preterm (<34 weeks)	 50 (52.1) 22 (22.9) 24 (25)

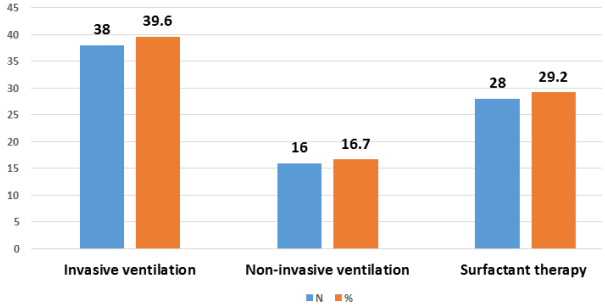

Figure No. 1: Different treatment therapy as respiratory support used for neonates

The mean gestational age and birth weight of neonates was 36.8±2.94 weeks and 2480.9±748.67 grams respectively. Invasive ventilation, non-invasive ventilation, and surfactant therapy were different respiratory support used in 38 (39.6%), 16 (16.7%), and 28 (29.2%) respectively. Sensitivity and specificity of lung US diagnosed neonates for pneumonia, pneumothorax, respiratory distress syndrome, pulmonary atelectasis, and meconium aspiration syndrome 96.4/100%, 89.5/97.9%, 93.7/100%, 100/98.9%, and 91.8/100% respectively. Demographic details and baseline characteristics (Table-1). Different treatment therapy as respiratory support are illustrated in Figure-1. The specificity and sensitivity of lung ultrasound (LUS) are shown in Table-2.

Table No. 2: Specificity and sensitivity of lung ultrasound (LUS)

Diagnosis	Patients (N)	True Positive Value	True Negative Value	False Positive Value	False Negative Value	Sensitivity	Specificity
Respiratory distress syndrome (RDS)	16	19	79	0	2	93.7%	100%
Pneumonia	29	37	59	4	0	96.4%	100%
Transient tachypnea of newborn (TTN)	23	26	74	0	0	100%	100%
Meconium aspiration syndrome (MAS)	9	14	86	0	0	91.8%	100%
Congenital diaphragmatic hernia (CDH)	2	3	97	0	0	100%	100%
Pleural effusion (PE)	1	2	98	0	0	100%	100%
Pneumothorax	9	9	87	2	2	89.5%	97.9%
Atelectasis	7	9	89	2	0	100%	98.5%

DISCUSSION

The current investigation assessed the role of lung ultrasound in the diagnosis of NRDS and reported that Lung ultrasonography (LUS) is a safe, dependable, and alternative method for diagnosing infant respiratory distress. LUS has shown accuracy in the most common respiratory newborn illnesses diagnosis such as RDS, pneumonia, CDH, TTN, pleural effusion, pneumothorax, pulmonary atelectasis, and MAS. LUS detected NRDS with good sensitivity and specificity. CXR is becoming a commonly used reference tool in the diagnosis of NRDS [13]. Del Rey et al [14] reported that the specificity and sensitivity of CXR in detecting NRDS was 84% and 91% respectively. However, Tsou PY et al[15] showed that the specificity and sensitivity of CXR in detecting NRDS was 89.53% and 88.23% respectively.

Raimondi et al[16] asserted that, unlike the transabdominal method, the transthoracic procedure could check all lung fields rather than just the base. This finding is consistent with Liszewski et al[17], who concluded that the transthoracic method may be a superior diagnostic strategy for minimizing false-positive diagnoses and has the therapeutic advantage of decreasing needless extra testing and therapies. Another study analysis revealed that studies with a detection gap of less than 6 hours between CXR and LUS had substantially higher specificity than detection time <24 hours cases [18].

Corsini et al [19] reported that post surfactant therapy, the RDS related sonographic appearance does not vary immediately. Vergine et al [20] revealed that LUS did not show any significant changes following surfactant replacement treatment, but that alterations occurred 4 hours later. According to Chen et al. [21], RDS can be characterized as mild, moderate, or severe depending on the extent and scope of lung consolidation and if it causes substantial consequences.

The RDS severity is mainly associated with treatment approaches that might be assessed by lung ultrasonography in conjunction with clinical signs. Based on variation in neonate's circumstances and ultrasound images, the treatment option or medication should be changed. LUS can aid in the reduction of the use of costly medications [22]. Neonates suffering from RDS might require mechanical ventilation or surfactant replacement treatment. For moderate to severe RDS, Exogenous PS should be the preferred choice for diagnosis [23,24]. The key RDS markers for LUS includes air bronchograms for lung consolidation, white lung anomalies, absence or decreased lung sliding, and pleural line which is comparable to the El Amrousy et al [25] findings.

The LUS findings for pneumonia in infants and newborns are comparable, with air bronchograms, lung consolidation, and pleural line abnormalities, with or without pleural effusion, being the most common. LUS clearly discriminated between viral and bacterial pneumonia results in children [26]. Furthermore, LUS for identifying the pulmonary atelectasis in neonates, the specificity and sensitivity in the current study was 98.5% and 100%. Aldecoa et al showed similar results[27]. Additionally, Razak et al.[28] discovered that LUS had a 100% sensitivity in identifying lung atelectasis in children.

CONCLUSION

The present study concluded that Lung Ultrasound (LUS) is a safe, reliable, and an alternate modality for the diagnosis of neonatal respiratory distress.

Author's Contribution:

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Conflict of Interest: The study has no conflict of interest to declare by any author.

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