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Radiographic Evaluation of Neonatal Respiratory Distress: Cross-Sectional Study on Chest X-ray Findings in the Neonatal Intensive Care Unit

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ABSTRACT

Introduction: Neonatal Respiratory distress (NRD) is a common reason for admission to the Neonatal Intensive Care Unit (NICU). While clinical diagnosis is essential, imaging evaluation can help confirm lung lesions, their extent, and associated abnormalities. However, radiation exposure from imaging modalities such as Computed Tomography (CT) and Chest X-ray (CXR) is a concern, particularly for neonates. This study aims to identify the various CXR findings in neonates with respiratory distress in the NICU.

Methods: A quantitative cross-sectional study was conducted on 59 neonates with respiratory distress in the NICU from November 2019 to November 2020. Ethical clearance was obtained, and data were collected through portable CXR. The collected data were analyzed using Microsoft Excel 2016 and Statistical Package of Social Services (SPSS) IBM version 23.

Results: CXR findings of 59 neonates with a mean age of 15.9 ± 7.4 days were evaluated. The majority were premature neonates, and the most common clinical diagnosis was respiratory distress syndrome (RDS). Hypoaeration was the most common finding in lung fields, followed by normal aeration. Parenchymal changes were observed in most cases, with reticulations/haziness being the most common, followed by consolidation. Pleural effusion was seen in a few cases, predominantly in preterm neonates with RDS.

Conclusions: The study underscores the prevalence of hypoaeration, reticulations, and consolidations in NICU patients with RDS, emphasizing the importance of early diagnosis and future research in neonatal chest imaging for respiratory distress

Keywords: *Lung; Pleural Effusion; Radiation Exposure; Respiratory Distress Syndrome; Tomography*

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INTRODUCTION

Neonatal Respiratory distress (NRD) is one of the most common causes of the admission in Neonatal Intensive Care Unit (ICU). NRD is a clinical diagnosis presenting with tachypnoea, chest wall retraction, and noisy respiration. However, imaging evaluation may help confirm the lung lesions, their extent, and associated abnormalities. Computed Tomography (CT) and Chest X-ray (CXR) are commonly used imaging modalities for imaging evaluation in NRD.[1,2]

Radiation exposure to neonates is an issue with both CT and CXR as the adverse effects of irradiation are higher among the neonates, which may be more common among premature neonates. Despite this issue, imaging evaluation and better interpretation become necessary while managing neonates with respiratory distress. Chest X-ray may have the upper hand over CT in neonates due to higher radiation dose with CT (typically 100 -500 times that of CXR).[3]

This study aimed to find out various Chest X-ray findings in neonates in the NICU presenting with respiratory distress.

METHODS

This was a quantitative cross-sectional study done on 59 neonates in the NICU with signs and symptoms of respiratory distress from November 2019 to November 2020. The study was done after ethical clearance from the Institutional Review Committee after obtaining verbal and written informed consent from guardians. Those neonates whose guardians refused to give consent were not included in this study.

Neonates admitted in the NICU with clinical signs of neonatal respiratory distress and who had portable Chest X-rays done were included in this study. Non-probability convenience sampling technique was used. To reduce the measurement bias, predesigned performa was used for data collection. Regular supervision and periodic checks of the data collection procedures were performed to enhance the quality of the study.

A sample size of 59 was determined by following the formula applying a 95% confidence interval and a 10% margin of error.

The following parameters were evaluated in the chest radiographs:

1. Aeration of lung fields

Normally aerated lungs extend to the sixth and eighth ribs. Hyperaeration involves an extension beyond these rib levels, a flattened diaphragm, increased lung field lucency, and more horizontal ribs. Hypoaeration involves lung extension to less than six ribs anteriorly and eight ribs posteriorly.[4]

1. Parenchymal changes - Reticulations/ haziness; consolidation; collapse

Reticulation is the linear opacities that represent the thickening of inter and intralobular septa seen primarily in respiratory distress syndrome.[5]

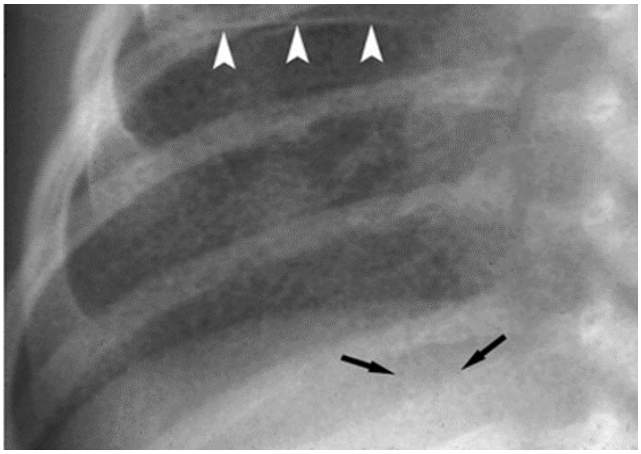

Figure 1: *Chest X-ray of RDS shows reticulations/haziness at the medial aspect of the lung base with prominent horizontal fissures.*[5]

Consolidation is an umbrella term including any pulmonary pathology that converts aerated lung to tissue like echotexture. Chest X-ray shows patchy or confluent alveolar shadowing with air bronchograms within or increased interstitial shadowing. Collapse is the area of increased opacity in lung parenchyma with associated features of volume loss.[6]

1. Pleural effusion

In chest X-ray, pleural effusion appears as opaque hemithorax with blunting of costophrenic angle with the absence of vascular markings.[7]

Data were collected in predesigned proforma and entered in Microsoft Excel 2016 and Statistical Package of Social Services (SPSS) IBM version 23. The discrete data were represented in frequency (%) and categorical data were represented in Mean ± SD.

RESULTS

Chest X-rays of 59 neonates with an age range of 1-30 days of life (DOL) and a mean age of 15.9 ± 7.4 DOL were evaluated. DOL represents the day of radiographs were taken. Most of these neonates were premature (n=44) with a minimal gestation period at birth at 31 weeks. Thirty-five neonates were female and 24 were male. (Table 1)

Table 1: Demographic profile of the neonate with respiratory distress

Characteristics		Number (%)
Sex	Male	24(40.68)
	Female	35(59.32)
Period of Gestation (Weeks)	31 weeks	1(1.7)
	32 weeks	6(10.17)
	33 weeks	13(22.05)
	34 weeks	3(5.08)
	35 weeks	3(5.08)
	36 weeks	3(5.08)
	37 weeks	15(25.42)
	38 weeks	15(25.42)
Age (Day of radiographs)	<10	13(22.04)
	10-20	27(45.76)
	20-30	19(32.20)

Most of the neonates were clinically diagnosed with respiratory distress syndrome (RDS) (n=29), followed by Transient Tachypnoea of Newborn (TTN) (n=8) and Meconium aspiration syndrome (MAS) (n=7). (Table 2) Xray findings of the 15 neonates were not exclusive to any of the above diagnoses due to lack of other findings which could be possibly due to delayed transition or infection.

Table 2: Distribution of chest x-ray findings according to clinical diagnosis. (n=59)

	Respiratory Distress Syndrome(n=29)	Meconium Aspiration Syndrome (n=7)	Transient Tachypnea of Newborn (n=8)	Others (n=15)
Hypoaeration	26	0	2	10
Hyperaeration	0	2	3	0
Reticulations/ haziness	20	6	5	10
Consolidation	24	4	2	0
Collapse	8	3	1	0
Pleural effusion	15	2	1	1

Most of the abnormalities in Chest X-rays were unilateral, seen in either the right or left lung. Bilateral lung abnormalities were seen in only seven neonatal radiographs. RDS was unilateral more towards the right side(65.52%). MAS and TTN were present more commonly on the left side measuring 71.4% and 62.5% respectively (Table 3).

Table 3: Chest X-ray findings of disease based on the laterality

Disease	Xray Findings		
	Right side	Left side	Bilateral
RDS(n=29)	19	7	3
MAS(n=7)	1	5	1
TTN(n=8)	1	5	2
Others(n=15)	8	5	2

Most of the neonates with hypo aeration of the lung were preterm with respiratory distress syndrome. Among preterm neonates, 25% had normal aeration, while 46.7% of term neonates had normal aeration.

Parenchymal changes were seen in 53 chest radiographs and pleural effusion in two radiographs without parenchymal changes (named as idiopathic or spontaneous neonatal pleural effusion as there was no identifiable cause). Pleural effusion was seen in a total of 19 radiographs, most of them were in preterm neonates with RDS. Among preterm neonates, 88.6% had parenchymal changes and 40.9% had pleural effusion, whereas 93.3% of term neonates had parenchymal changes. (Table 4) The most common parenchymal changes were reticulations/ haziness (n=41), followed by consolidation (n=30). Reticulations/ haziness were more common in term neonates than preterms (80% vs 65.9%), however, consolidations were more common in preterms than term neonates (63.6% vs 13.3%).

Table 4: Chest X-ray pattern in term and preterm neonates with respiratory distress

Chest Xray Findings		Preterm	Term	Total
Parenchymal Changes	Present	39	14	53
	Absent	5	1	6
Reticulations/Haziness	Present	29	12	41
	Absent	15	3	18
Consolidation	Present	28	2	30
	Absent	16	13	29
Collapse	Present	10	2	12
	Absent	34	13	47
Pleural Effusion	Present	18	1	19
	Absent	26	14	40

Among the causes of respiratory distress in neonates, RDS was more common in preterm while MAS and TTN were more common in Term neonates. (Table 5)

Table 5: Cause of Respiratory Distress in preterm and term neonates

Cause of Respiratory Distress	Preterm	Term	Total
Respiratory Distress Syndrome(n=29)	27	2	29
Meconium Aspiration Syndrome (n=7)	1	6	7
Transient Tachypnea of Newborn (n=8)	1	7	8
Others (n=15)	15	0	15
Total	44	15	59

DISCUSSION

Adaptation to breathing after birth is important, failure of which results in inadequate gas exchange within the lung, and presents as respiratory distress. Early diagnosis of neonatal respiratory distress is important, as a lack of immediate life-saving measures may result in perinatal morbidity and mortality.[8]

Imaging in neonatal respiratory distress has a very important role in identifying the cause of respiratory distress as well as following up on the progression or resolution of the pathology. Chest X-ray has long been used for the assessment of chest pathologies. It is still used as a first-line tool in the evaluation of neonates with neonatal distress despite the improved diagnostic modalities like CT and ultrasonography due to its affordability & wide/easy availability.[9,10]

The most common cause of neonatal respiratory distress was RDS in our case (49.2%), similar to the study done by Nagendra et al. and Mottaghi et al. However, the study done by Mehta et al. and Gouyon et al. showed TTN as the most common cause of neonatal respiratory distress (35.7% and 72%). This might be due to the small sample size and inhomogeneous sample (more preterms than term neonates) in the present study.[9,11,12,13]

Abnormal findings in chest radiographs were seen in 93.2% of neonates with respiratory distress, which is higher than in the study done by Mehta et al., This might be due to fewer cases of TTN in the present study as compared to the study done by Mehta et al. (35.7% TTN cases). Haziness/ reticulation was the most common parenchymal abnormality in the present study (69.5%), followed by consolidation (50.8%). Similar findings were seen in the study done by Mottaghi et al. (74.5% & 51% respectively).[9,12]

Classic radiographic findings of respiratory distress syndrome are hypoaeration, haziness in lungs, and consolidation/air-bronchogram. The present study also showed these classical findings in the majority of the chest radiographs in neonates with respiratory distress syndrome, hypo aeration in 89.7%, haziness/reticulations in 69%, and consolidation in 82.8%. The present study also showed pleural effusion in 51.7% of respiratory distress syndrome, which is in contrast to the study done by Mehta et al. where neither of the neonates with respiratory distress syndrome had pleural effusion.[9,14]

Hyperaeration, heterogeneous opacities, and air leak are classical radiographic findings in meconium aspiration syndrome, however, the present study showed hyperaeration in only 28.7% of neonates with meconium aspiration syndrome. We didn't find any case of air leaks in the present study. Hyperaeration is also one of the classical radiographic findings in TTN, however, the present study showed hyperaeration only in 37.5% of neonates with TTN. On the contrary, the present study showed hypoaeration in 25% of the TTN cases. These variations might be due to a small sample size with an even smaller proportion of MAS and TTN cases in the present study.[14]

Marini et al. found reticulonodular shadowing in most of the chest radiographs of patients with TTN, as seen in the present study. Similarly, Patel et al. found hyperaeration along with linear streaky opacities (reticulations) in most of the chest radiographs of patients with TTN. We also found similar findings in the present study. Like previous studies, Patel et al. also found coarse reticulations as a major finding in chest radiographs of patients with MAS.[15,16]

Similar to the study done by Jain et al. RDS was more common in preterm while MAS and TTN were more common in term babies. Although small size limits the external validity of the study.[10]

The study identified chest X-ray abnormalities in neonates with respiratory distress in the NICU, with hypoaeration and parenchymal changes being common. Reticulations, haziness, and consolidations were the most common parenchymal changes, while pleural effusion was observed in some cases, especially in preterm neonates.

The study had limitations including a small and inhomogeneous sample, limited data on other causes of respiratory distress, and potential lack of generalize ability due to its specific NICU setting, small sample size, and time frame. Radiation exposure remains a concern in neonates, particularly preterms, highlighting the need for exploring radiation-free imaging alternatives for diagnosing various causes of neonatal respiratory distress. Caution is advised when applying the study findings to broader populations or settings.

CONCLUSION

This study revealed a high prevalence of hypoaeration, reticulations, and consolidations in neonates with Respiratory Distress Syndrome (RDS) in the Neonatal Intensive Care Unit. These chest X-ray findings underscore the significance of prompt diagnosis and management of RDS in neonatal care. Further research is warranted to expand our understanding of chest imaging in neonatal respiratory distress.

CONFLICT OF INTEREST

None

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None

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