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Comparison Between Lung Ultrasonography and Thorax Photo in The Diagnosis of Neonatal Respiratory Distress Syndrome

Muhammad Reza, Risa Etika, Martono Tri Utomo*

Department of Child Health, Faculty of Medicine, Airlangga University

*Corresponding author: Martono Tri Utomo, Department of Child Health, Dr. Soetomo General Hospital, Jl. Mayjen Prof. Dr. Moestopo No. 6-8, Surabaya, Indonesia. Email: mrmartono73@gmail.com. Phone: +6281703667063

Abbreviations

RDS: Respiratory Distress Syndrome

AIS: Alveolar-Interstitial Syndrome

TTN: Transient Tachypnoea Of The Newborn

NICU: Neonatal Intensive Care Unit

ARDS: Acute Respiratory Distress Syndrome

ALI: Acute Lung Injury

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Conflict of Interest: Author declares that there is no conflict of interest

Ethical Clearance: Approved by researched ethical committee Dr. Soetomo General Hospital Surabaya

Keyword: Neonatal respiratory distress syndrome, prematurity, thorax photo, lung ultrasonography

Abstract

Background: Respiratory distress syndrome is one of the most common problems in preterm neonates, especially during the first day of life. Chest X-rays take time to implement and interpret. Pulmonary ultrasonography has been developed as a diagnostic modality for neonatal respiratory distress syndrome.

Objective: To analyze the comparison of chest X-ray examination and lung ultrasound in the diagnosis of neonatal respiratory distress syndrome

Method: This study conducted in July until September 2019. Subjects were preterm neonates, born and treated in the NICU of Dr. Soetomo General Hospital, aged less than 24 hours and chest X-ray was carried out before the age of 24 hours. The x-ray instrument used was the Sirius Star Mobile X-Ray Unit, and the ultrasound device used was the GE V-Scan Dual Probe. Statistical analysis test was carried out using the McNemar and Kappa test

Results: Totally, 33 infants were concluded. With mean gestation age of 29.64 weeks and a birth weight of 1,230 grams. The A-line abnormality were seen in 4 samples. Accompanied by a double lung point image and alveolar-interstitial syndrome. There was no lung pulse or pleura effusion in all samples. The Mc Nemar statistical test value stated that there was no significant difference between the two instruments, with a significant Kappa result of $p < 0.05$ and a value of 0.633.

Conclusions: Lung ultrasound can be used as a more rational approach to diagnosing and treating respiratory distress syndrome.

Background

The infant mortality rate is one of the main health indicators for a country and the world, including the neonate group (aged 0-28 days). Globally, based on WHO data, the neonatal mortality rate is estimated at 32 deaths per 1000 live births in 2015 (WHO, 2016). The health demographic survey in Indonesia based on data from the health ministry shows that during 2016 there was an average neonatal mortality rate of 25.5 deaths per 1000 live births. The average preterm birth rate in developed countries is about 5-7% but it is estimated to have a much larger number in developing countries. Indonesia is rank ninth in the world among countries with an average rate of premature births per 100 live births (15.5%) (Ministry of Health, 2017). Respiratory distress syndrome is one of the most common problems in preterm neonates, especially during the first day of life. This is due to surfactant deficiency that gives rise to lung immaturity, both structural and physiological. Decreased pulmonary compliance causes the lung to collapse and atelectasis occurs, indicated by hypoventilation, hypoxemia, and respiratory acidosis. The overall incidence rate of respiratory distress reaches 6.7% (Kumar and Bhat, 2016) and increasing in preterm neonates. The most common cause of respiratory distress in preterm neonates is respiratory distress syndrome (RDS) at 24-27 weeks' gestation; 92% experienced RDS, 88% at 28-31 weeks' gestation, and 76% at 32-34 weeks' gestation.

With the advances in science, the use of antenatal steroid therapy and the introduction of exogenous surfactants as prevention in respiratory distress syndrome therapy have improved the clinical picture and decreased disease morbidity and mortality of the disease. Surfactants are usually found in mature lungs. The function of surfactants is to keep the alveoli sacs open and filled with air. Preterm neonates don't have a sufficient amount of surfactant, they have difficulty in expanding the lung. Surfactant therapy has provided a dramatic improvement in the outcome of respiratory distress syndrome patients. Surfactant therapy must be given as soon as possible so that an accurate early diagnosis with minimal side effects is needed for its future effects (Miller and Carlo, 2018).

To determine the diagnosis of RDS, it is necessary to have supporting investigations besides physical examination. Chest X-rays take time to implement and interpret. The radiation can develop an impact on the development of the child in the future. Pulmonary ultrasonography has been developed as a diagnostic modality for neonatal respiratory distress syndrome. Apart from being fast and non-invasive, ultrasound can be performed repeatedly without radiation effects. The use of ultrasound is a practical alternative in an emergency, allowing patients to be examined while receiving other treatments without having to be transferred to the radiology room (Liu, et al, 2013). Many other studies have investigated the use of lung ultrasound in neonatal respiratory distress syndrome. Pulmonary ultrasound has a very high sensitivity (Hiles, et al., 2012) and reliable (Liu, et al., 2015) to detect the etiology of RDS and distinguish it from transient tachypnoea of the newborn (TTN), pneumonia, and meconeal aspiration syndrome. (Copetti, et al., 2016). Other studies have stated that the accuracy is not good enough to replace chest X-rays as the gold standard in diagnosing RDS (Abdelsadek, et al., 2015). However, it is quite useful and efficient in differentiating neonatal respiratory distress syndrome (Rachuri, et al., 2017). Based on these problems, it is necessary to conduct a study to compare the accuracy of lung ultrasound with chest X-ray in premature neonates in determining the diagnosis of respiratory distress syndrome, so that fast and precise management can be carried out.

Methods

This study began in July 2019, until a minimum of 31 samples were met. The research subjects were preterm neonates, born and treated in the NICU room of Dr. Soetomo, Surabaya. The inclusion criteria were neonates aged less than 24 hours at the time of receiving treatment and a chest X-ray was carried out before the age of 24 hours. Patients who met the inclusion criteria were recorded in gender, weight, gestational age, mode of delivery, history of prenatal lung maturation, breathing aid therapy during lung ultrasound (NIV, invasive ventilation). Chest X-ray was performed in an anteroposterior position and transthoracic lung ultrasound in supine and lateral decubitus position. The exclusion criteria were clinical signs of congenital malformations, maternal infection history during pregnancy, rupture of membranes for greater than 18 hours, *meconium*-stained *amniotic fluid*, a pulmonary ultrasound that was not performed immediately after chest X-ray, infants who had been given surfactant therapy, and parents disagreeing to be included in the research. The x-ray instrument used was the Sirius Star Mobile X-Ray Unit, and the ultrasound device used was the GE V-Scan Dual Probe. Statistical analysis test was carried out using the McNemar and Kappa test to obtain significance and agreement between lung ultrasound and chest X-ray as the gold standard diagnosis. Ethical clearance was given, number 1302 / KEPK / VII / 2019 dated July 16, 2019.

Results

This study was conducted from July 2019 until the sample was fulfilled in September 2019. After going through the exclusion process, 33 patients were obtained as the study sample with a mean gestation age of 29.64 weeks and a birth weight of 1,230 grams. Born through cesarean section were 18 (54.5%) with the most common cause: pre-eclampsia, hypertension, and premature rupture of membranes. Eleven (33.3%) samples were born with asphyxia and had undergone resuscitation at birth. A total of 21 samples were male (63.6%) and 12 samples (36.4%) female. The entire study sample was divided into three groups according to gestational age with the largest number of samples being 28-31 weeks of gestation, namely 21 (63.6%) samples, then 32-34 weeks, namely 9 (27.3%) samples and <28 weeks 3 (9.1%) sample. Very low birth weight (1,000–1,499 grams) is the largest sample size in this study. In preterm neonates who experienced clinical signs of RDS, only 4 (12.1%) samples had received complete lung maturation therapy; 3 samples from the 32-34 week group, and 1 sample from the 28-31 week group. Twenty-three (69.7%) samples had received lung maturation therapy but were not complete according to the proper protocol, and the remaining samples did not receive lung maturation therapy at all (Table 1). Of the total 33 samples, a total of 29 samples were diagnosed with RDS, based on lung ultrasound or chest X-ray, and the other two samples were diagnosed with TTN(Table 2).

Lung consolidation with subpleural air bronchogram was found in 29 samples of the 2nd-degree respiratory distress syndrome group (Figure 2) based on chest X-ray and looked a little faint at grade 1 (Figure 1). In contrast to the sample group with grade 3 and 4 respiratory distress syndrome, consolidation and air bronchogram images are more visible. Although sometimes obscured by the alveolar-interstitial syndrome image found in the lung posterior region. White-lung appearance was found in 14 samples diagnosed with grade 3 (Figure 3) and grade 4 (Figure 4) RDS. The remaining sample group was diagnosed with grade 1 and 2 RDS, 15 samples showed alveolar-interstitial syndrome (AIS). From the lung ultrasonography, the A-line abnormality were seen in 4 samples with the TTN (Figure 5). Accompanied by a double lung point image and AIS. There was no lung pulse or pleura effusion in all samples. The Mc Nemar statistical test value stated that there was no significant difference between the two instruments, with a significant

Kappa result of p <0.05 and a value of 0.633 indicating the agreement value between the two instruments used (Table 3).

Discussion

This study was conducted to find significant results, agreement value, and whether there was a difference between lung ultrasound examination and chest X-ray in diagnosing neonatal respiratory distress syndrome. The gestational age range with the incidence of RDS in preterm neonates in this study was less than 34 weeks. The most incidence was found in the 28-31 weeks gestation group, namely 63.6% of the total sample. These results are consistent with other studies that show the incidence of RDS increases with lower gestational age (Dargaville 2006). This study also shows that the largest group was babies born with very low weight. As in previous studies, gestational age is an absolute value in determining the degree of lung immaturity, where a low gestational age indicates immature alveoli cells. The incidence of perinatal asphyxia was 33.3% in this study. Previous studies have revealed a linkage of the incidence of asphyxia to the incidence of respiratory distress syndrome. APGAR scores less than 6 at the tenth minute are thought to cause cardiovascular shock and associated with pulmonary hypertension. Pulmonary vasoconstriction causes endothelial cell damage resulting in alveolar cell epithelial damage. Furtherly disrupts surfactant activity then decreased pulmonary compliance, resulting in respiratory distress syndrome. The common cause of maternal complications in this study was pre-eclampsia and gestational hypertension. Previous studies of infants born to pre-eclamptic mothers had a 1.5 greater risk of developing respiratory distress syndrome. Another study also said that gestational hypertension has a close relationship with the incidence of respiratory distress syndrome and the most maternal indications for cesarean section are pre-eclampsia and gestational hypertension (Asztalos EV, et al., 2013).

Pleural line abnormalities evaluation on respiratory distress syndrome is very specific and useful for diagnosis, but it is difficult to do with the transabdominal met (Liu, 2017). We use the transthoracic method for its superiority over transabdominal, as stated in previous studies that the technique reduced false-positive diagnoses, additional investigations, and unnecessary interventions. Lichtenstein and Mauriat (2012) said that the ecographic picture of the alveolar-interstitial syndrome (AIS) when accompanied by a pleural line abnormality, has 100% sensitivity and specificity in diagnosing respiratory distress syndrome. The appearance of lung ultrasound in respiratory distress syndrome is similar to that of acute lung injury (ALI) and acute respiratory distress syndrome (ARDS) in adults, where abnormalities of the pleural lines and AIS are involved. In this study, it was proven that there was a picture of AIS in all existing research subjects, including the involvement of abnormalities from pleural lines (Lichtenstein, 2017). In the acute phase of RDS, the clinical picture can change significantly over time, built on by the natural severity of the disease and the impact of the care given especially resuscitation and breathing support (Lichtenstein, 2014). This increases the risk of bias due to the likelihood of changes occurring due to increased disease severity or, conversely, the response to treatment. Therefore, to reduce bias, we performed a lung ultrasound immediately after the chest X-ray.

The statistical calculation obtained using the Kappa test with $p < 0.05$ and a Kappa value of 0.633 stated that the agreement value between the lung ultrasound and chest X-ray was 63.3%. While the McNemar test value of 1,000 stated that there was no significant difference between the two instruments.

Conclusion

Based on a comparative study of lung ultrasound with chest X-ray in diagnosing RDS in preterm neonates at Dr. Soetomo Surabaya, we can obtained accurate results and correlated with the suitability of the results given so that it can be concluded that lung ultrasound can be used as an option in diagnosing neonatal respiratory distress syndrome.

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Table 1. Subjects characteristics

Variabel	N, (33)	%
Mode of delivery		
Sectio Caesarea	18	54,5
Spontaneous labor	15	45,4
Gender	8	
Boy	21	63,6
Girl	12	36,4
Gestational age		
<28 weeks	3	9,1
28-31 weeks	21	63,6
32-34 weeks	9	27,3
Birth weight		
<1000 gram	8	24,2
1000-1499 gram	16	48,5
≥ 1500 gram	9	27,3
Lung maturation history		
Not given	6	18,2
Not completed	23	69,7
Completed	4	12,1
Asfixia	11	33,3
Breathing support		
NIV	29	87,8
Invasive Ventilation	4	12,2

Table 2. Diagnosis result between lung ultrasound and chest X-ray in the diagnosis of RDS

Methods		Chest X-ray		Total
		RDS	Not RDS	
Lung Ultrasound	RDS	29	1	30
	Not RDS	1	2	3
Total		30	3	33

Table 3. Comparison between lung ultrasound and chest X-ray in the diagnosis of RDS

Variable	Value
Mc Nemar Test	1.000
Kappa Significancy	P 0.000
Kappa Value	0.633

Figure1. First grade of RDS

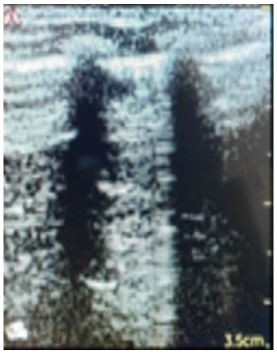


Figure 2. Second grade of RDS

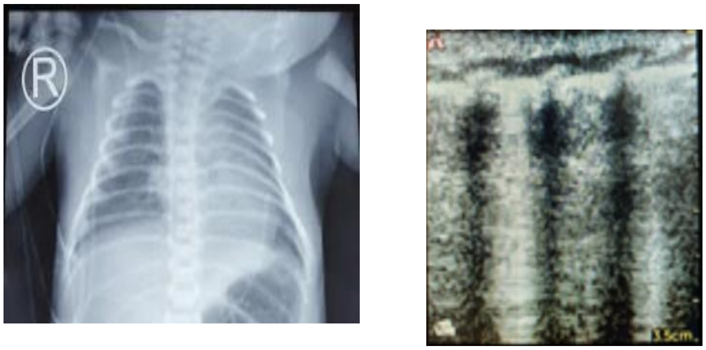


Figure 3. Third grade of RDS

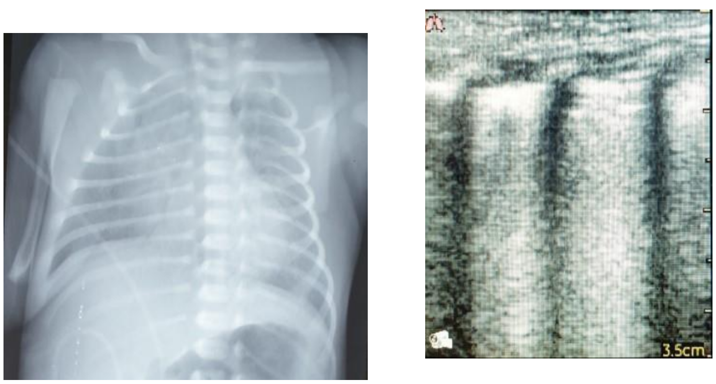


Figure 4. Fourth grade of RDS

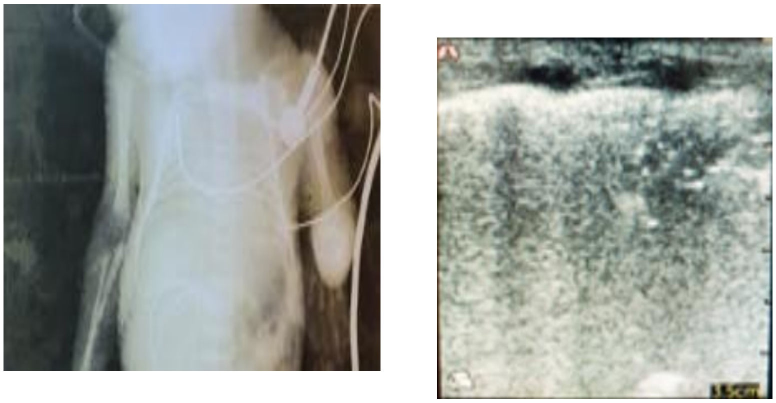
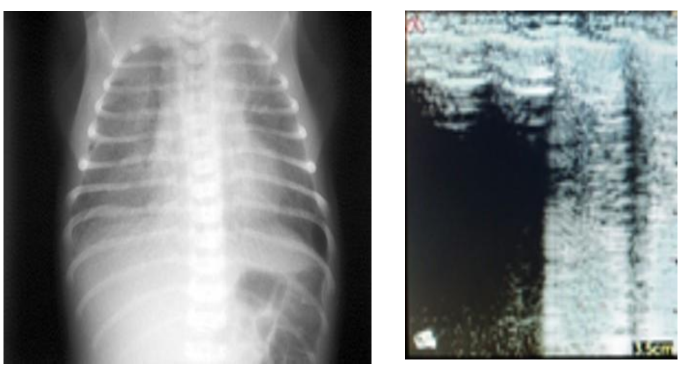


Figure 5. TTN appearance



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