# The Value of the Trans-Abdominal Ultrasound in Evaluation of Neonatal Respiratory Distress Syndrome

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## ABSTRACT:

**BACKGROUND:**

Chest x-ray has been the traditional method of diagnostic evaluation of patients of neonatal respiratory distress syndrome of prematurity. Lung sonography has been lately explored as an alternative modality.

**OBJECTIVE:**

To evaluate diagnostic ability of trans-abdominal lung ultrasonography in detection of pulmonary manifestations of neonatal respiratory distress syndrome and compared the findings with Chest x-ray.

**PATIENTS AND METHODS:**

A cross section analytical study was performed at the NICU ward of Al-Yarmouk teaching Hospital; from January to august 2016, the study was done on 65 infants neonates included two groups one with neonatal respiratory distress syndrome group and other control group . Case were 50 premature newborns with neonatal respiratory distress syndrome ( gestational age from 24-35wks) and a control group of 15 premature newborns (gestational age30-35wks). The diagnosis of neonatal respiratory distress syndrome was made by clinical data and chest x-ray. The trans-abdominal lung ultrasonography was performed in all patients within the first 12 h of life.

**RESULTS:**

We seen that neonate are born by cesarean section 32(64%) and those neonates born by normal vaginal delivery 18(36%), while the male gender born with neonatal respiratory distress syndrome 33(66%) and female neonate with RDS 17( 34%), The trans-abdominal lung ultrasound showed 100% sensitivity,81 % specificity, The good correlation between stages of neonatal respiratory distress syndrome by lung ultrasound and chest x-ray findings

**CONCLUSION:**

This study show that using of an ultrasound for the diagnosis of neonatal respiratory distress syndrome is accurate and reliable tool with many advantages over other techniques as it is non-ionizing, low-cost and be performed at bedside, making this technique ideal for use in neonatal intensive care unit.


**KEY WORDS:** neonatal respiratory distress syndrome; trans-abdominal lung ultrasound..

## INTRODUCTION:

Neonatal respiratory distress syndrome (NRDS), previously known as Hyaline Membrane Disease(HMD), occurs predominantly in premature infants.[1] is the commonest respiratory disorder in preterm infants & typically affects infants <35 weeks gestational age (GA) [2]. The condition makes it hard for the baby to breathe.[3] It`s referred to as lung disease of prematurity. The term hyaline membrane disease[4]is now less commonly used in clinical practice [4] .Neonatal respiratory distress syndrome(NRDS)is currently used to described surfactant deficiency and should not be used for other causes of respiratory distress.[5]

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It is also responsible for 30% - 40% of newborns' hospital admission [6] and babies born after 35 weeks rarely develop NRDS[7].

By understanding the embryology of lung growth and development one can appreciate why and how NRDS develops. There are four stages of lung development: embryonic, pseudoglandular, canalicular and alveolar[5,8,9]. The components of pulmonary surfactant are synthesized in the Golgi apparatus of the endoplasmic reticulum of the type II alveolar cell [10].The main components of the surfactant arelecithin, phosphatidylglycerol, apoproteins and cholesterol[11,12].

The significant cause of NRDS is deficiency of alveolar surfactants due to immaturity of Type II pneumocyte[6] .The rarer genetic form of the

disease is not associated with premature birth and occurs in full-term babies[13] .

The symptoms can be delayed up to 6-8 hours[14] which are included: cyanosis ,expiratory grunt[15], Shallow breathing[3],Nasal flaring[15],tachypnoea > 60 breaths/minute[15] and substernal and intercostal retractions[3]. The following investigations are used to detect the condition[3] : Lab tests and chest x-ray which has 4stages to determine severity of disease[16][17].

Lung ultrasound examination of the lung bases is based on the acoustic phenomenon of "mirror image," which is a supradiaphragmatic projection of the liver or spleen[18].The ultrasound appearance of normal lung is "black".[19]and depended on B-line and Comet-tail artifacts &B-line arises from the pleural line,[20]both B-lines and comet-tails are related to the presence of the alveolar gas–liquid interface[21]

The normal lung is "black"(22), while the diseased lung is 'black and white' (with white lines corresponding to B lines) and the markedly diseased lung is 'white' (diffusely bright) [23].The Sonographic diagnosis of NRDS is based on bilateral symmetrical B-lines[23]. also B-line can be seen at other lung disease such as congenital pneumonia (24)which usually appears with pleural effusion [22] with complementary laboratory tests will help to give final diagnosis [25].,also B-line scan be seen in transient tachypnea of newborn(TTN), the LUS shows compact B-lines[ 26]which rarely numerous and mainly on one side ( non symmetrical)[ 27] and usually shows mild pleural effusion [ 28]

## THE AIM OF STUDY:

to evaluate diagnostic ability of trans-abdominal lung ultrasonography (TALS) in detection of pulmonary manifestations of neonatal respiratory distress syndrome as compared with chest X-ray

## PATIENTS AND METHODS:

A cross section analytical study was performed at the neonatal care unit (NICU ) of Al-Yarmouk teaching Hospital; from January to august 2016.

The study was done on 65 infants neonates included two groups one with NRDS group and other control group . Case were 50 premature newborns with NRDS (weight from 600- 1875g )and( gestational age from 24-35wks) and a control group of 15 premature newborns (weight about 900- 2595 g) and (gestational age30-35wks ) without respiratory distress( lung diseases were excluded by clinical examination and CXR) were involved in this control study ,.It should be noted that the infants in the control group had been admitted for other reasons (like as low birth weight and difficulty in labor). Included neonates in the study admitted to the neonatal intensive care unit (NICU )for at least a day due to neonatal respiratory distress syndrome (NRDS) , The information of all infants were taken from their hospital medical informations and premature data were collected. The basic information included gender, weight and type of delivery and include 18 neonate with normal vaginal delivery and 32 neonate delivery by with cesarean section

NRDS diagnosis had been established based on main clinical criteria( tachypnea, nasal flaring , cyanosis, retraction and grunting which are recorded by different pediatricians and the chest X-ray findings which are seen by my supervisor radiologist.

2.1. Inclusion and exclusion criteria

2.1.1. Inclusion criteria :Age between 24wks-35wks with neonatal respiratory distress syndrome diagnosis clinically.

3.1.2. Exclusion criteria: congenital anomalies, gestational age more than 35 wks or less than 24 wks ,any unilateral LUS findings and NRDS accompanied by other complications were excluded from this study.

2.2. Patient preparation: No special preparation no sedation or fluid restrictions were needed.

2.3. Technique

2.3.1. Imaging protocol

All patients underwent ultrasound examination of the lung bases through a trans-abdominal approach by a Shimadzu ultrasound device ( sarano 2008)within the first 12 h of life.

The trans-abdominal LUS was done using a 5 MHz convex probe array included the trans-hepatic and trans-splenic areas in supine position to examine both lung bases through a sub-costal approach. The average time of LUS examinations was 4-5 min. Ultrasound gel was kept warm before doing the examinations to avoiding neonate thermal loss.

A routine plain chest X-ray obtained in supine position to each neonate before performing initial ultrasound. LUS was done after each chest X-ray was requested.

2.4.Statistical analysis: The quantitative data are expressed as the mean ± standard deviation. The significance level was set at $p < 0.05$. Statistical analysis was performed with SPSS 22.

## RESULTS :

The trans-abdominal LUS was done for 65 premature newborns of both genders included

with NRDS 50 premature newborns with (mean weight 1.056±362 and mean gestational age 29.2±2.056 wks.)(Table 6) which diagnosis as NRSD bases on clinical features and radiological findings and a control group of 15 premature newborns (mean weight 1.895±675) & (mean gestational age 32.8±2.236wks) (Table 6) without respiratory distress(lung diseases were excluded by clinical examination and CXR were involved in this control study ,.It should be noted that the infants in the control group had been admitted for other reasons (like as low birth weight and difficulty in labor).

In our study we seen that neonate are born by CS 32(64%) and those neonates born by NVD 18(36%) with significant P- value $< 0.013$ , while the male gender born with RDS 33(66%) and female neonate with RDS 17( 34%) with significant P- value $< 0.013$ table( 6 )

**Table 6 :Demographic data of patients and control groups.**

| | RDS( n=50) | Control (n=15) | P value |
|---|---|---|---|
| Weight(g) | 600- 1875<br>1.056±362 | 900- 2595<br>1.895±675 | |
| GA(weeks) | 24-35wks<br>29.2±2.056 wks. | 30-35wks<br>32.8±2.236wks | |
| Gender<br>Male<br>Female | <br>33(66%)<br>17(34%) | <br>9(60%)<br>6(40%) | $< 0.013$ |
| Type of delivery<br>NVD<br>CS | <br>18(36%)<br>32(64%) | <br>4(26.7%)<br>11(73.3%) | $< 0.013$ |

A stage I LUS findings with B-lines during only expiration and normal LUS during inspiration were found in 17 neonates(34%) table (7). while stage II with B-line during inspiration and white lung during expiration in 22(44%)neonates(table 7) and stage III with white lung during inspiration and expiration in 11(22%)neonates (table 7). In comparison with chest X-ray staging which shows that stage I in CXR found in 15(31.9%) neonates and stage II 21(44.6%) & stage III&IV in 11(23.5%).(table 8)

**Table 7: Chest X-ray of NRDS stages at presentation( show P value $< 0.05$) .**

| Stage | No. | % |
|---|---|---|
| I | 17 | 34 |
| II | 22 | 44 |
| III | 11 | 22 |

**Table 8: Chest X-ray of NRDS stages at presentation( show P value $< 0.05$) .**

| Stage | No. | |
|---|---|---|
| Stage I | 15 | 31.9 |
| Stage II | 21 | 44.6 |
| Stage III | 7 | 14.9 |
| Stage IV | 4 | 8.6 |

Out of 5 neonates were diagnosed by LUS as NRDS, 2 were congenital pneumonia caused by group B hemolytic streptococci, where X-ray findings similar to those seen in stage III NRDS LUS feature ( pneumonia confirm by blood culture ,white cell count and C-reactive protein), the other 3 neonates considered NRDS by LUS with mild clinical features of NRDS had normal chest X-ray findings show LUS features of the stage I NRDS with follow up clinical feature and still normal CXR finding suggestive overlap with TTN .

The good correlation between stages of NRDS by LUS and CXR which shows that the LUS stages I, II correlated with plain radiography stage I, II respectively, while stage III LUS correlated with stage III and IV plain radiography

At table(9) show significant correlation found between the stages of NRDS assessed by the lung ultrasound and by chest radiography was noted within the study group (T=0.834, p<0,001) The table (9) also revealed high level of positive predicted value(NPV , negative predictive value(PPV) and accuracy in diagnosis of staging of NRDS by LUS indicating : PPV , NPV and accuracy for stage I=88.2%, 100%, 94.1% respectively , while PPV , NPV and accuracy for stage II=95.4%, 100%, 97.3% respectively and PPV , NPV and accuracy for stage III=81.1%, 100%, 92.3% respectively.

So our study show high sensitivity 100% and specificity 81 % in detection of NRDS staging by trans-abdominal ultrasound .

**Table 9: Comparison of NRDS stages between ultrasound and chest radiology with significant P-value *(p*<0,001).**

| Staging | sensitivity | Specificity | Positive predictive value | Negative Predictive value | Accuracy |
|---|---|---|---|---|---|
| I | 100% | 89% | 88.2% | 100% | 94.1% |
| II | 100% | 94% | 95.4% | 100% | 97.3% |
| III | 100% | 60% | 81.1% | 100% | 92.3% |
| Total | 100% | 81% | 88.2% | 100% | 94.5% |

The sonographic features Consist of normal diaphragmatic echo-complex with no retrodiaphragmatic hyperechogenicity[Figure 9 A], in the NRDS features seen as 3 stages, stage 1:Retrophrenic striped patterns of hyperechogenicity diverged radially, observed only on expiration(Figure 9B). stage II: Retrophrenic striped patterns of hyperechogenicity diverged radially (Figure 9C), stage III: Retrophrenic homogenous hyperechogenicity (white lung) ( Figure 9D).

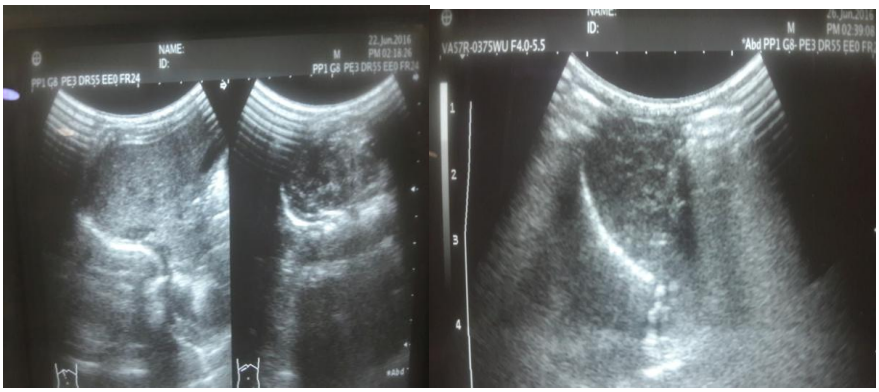

**Figure 9: A normal LUS of premature female ( 35wks) delivery by CS.**

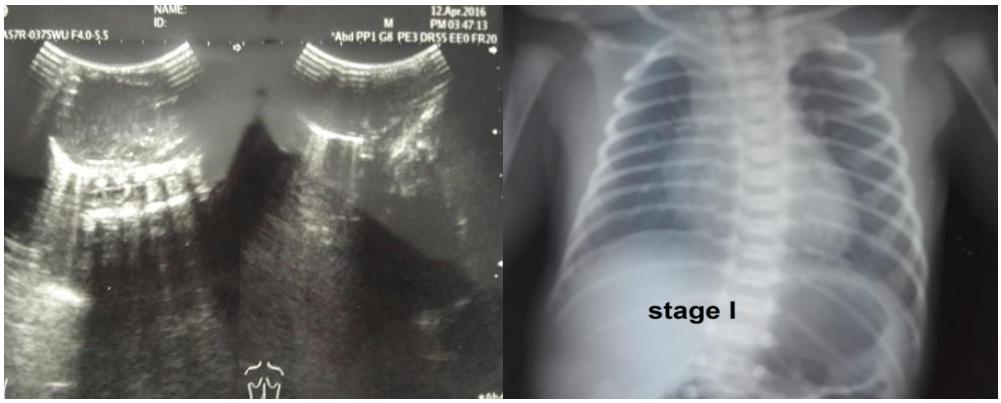


**figure 9B: premature male (30wks+4days) delivery by NVD presented with NRDS by TALS show hyperechoes at expiratory phase represented stage I NRDS correlated with CXR findings stage I show fine ground glass appearance .**

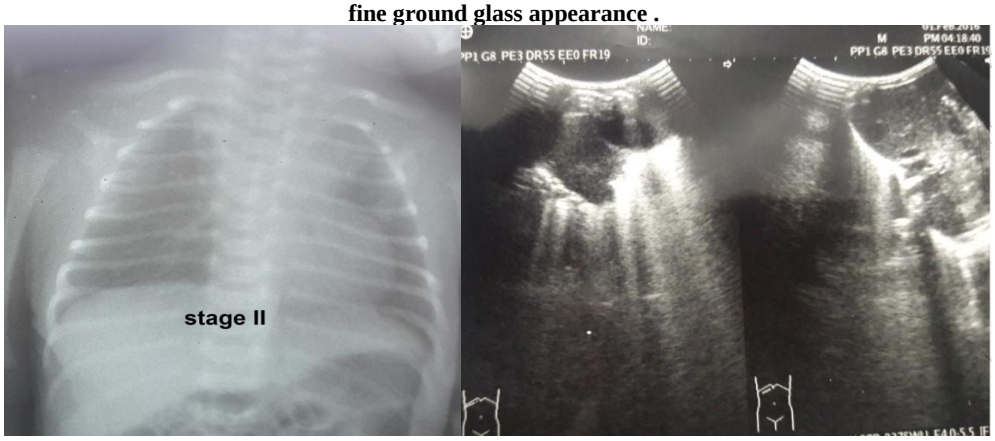


**Figure 9C: premature male (29wks) delivery by CS with NRDS by TALS show hyperechoes at both respiratory phase more at expiration represented stage II NRDS correlated with CXR findings stage II show bilateral symmetrical air bronchogram.**

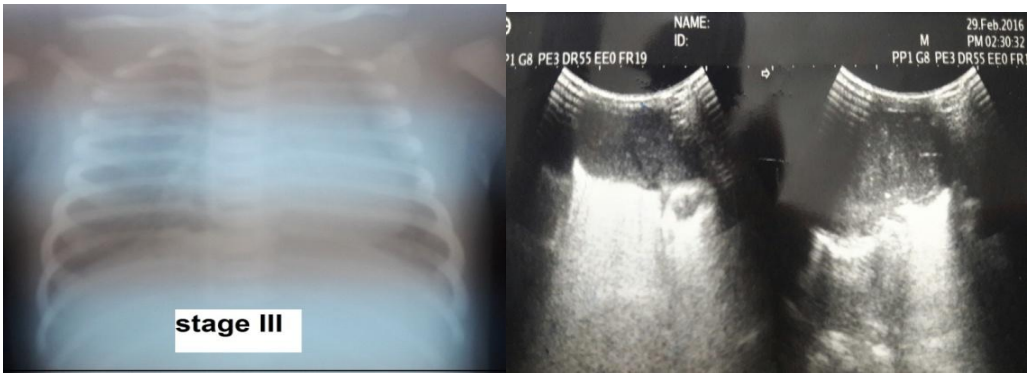


**Figure D9 :Premature female ( 26wks+6days) delivery by CS with NRDS by TALS show homogenous hyperechoes ( white lung) in both respiratory phases represented stage III NRDS correlated with CXR findings stage III show bilateral confluent alveolar shadowing with partially obscured heart border.**

## DISCUSSION :

Chest radiography has been regarded to be the standard radiological diagnostic tool for RDS, and the four-stage scale of RDS severity based on radiographic findings correlates closely with the actual disease severity[29].

In some clinical practice there is a need for exposing a neonate to ionizing radiation and this carries the risk for long-term adverse effects[27]

Although the dose received during each single exposure is low, attempts must be made when possible to reduce such exposure in radiation doses to the newborns and premature babies, who are particularly liable to the adverse effects of such radiation. In this patient population, the risk of the cancer associated with a giving of radiation dose is believed to be 2 or 3 times higher than that seen in the general population and 6-9 times higher than that seen in 60-year olds[30].Also, there is a significant variation in intra- and inter-observer agreement between radiologists on the reading of the same chest X-ray images and on the radiographic features used in diagnosis of the disease [23] .

Limitations of bedside CXR have been well described and it has been shown that, even under careful controlled exposure condition, more than 30% of the X-ray films are considered suboptimal[31].

The diagnosis of NRDS is by X-ray showing ground glass appearance and air bronchograms, although these radiological features are not pathognomonic of NRDS.[23].For this reasons, the respiratory disease in newborns must be diagnosed and monitored with alternative procedure which are not associated with these potentially risk effects.(30)

In the lung artifacts (i.e. sonographic images that have no anatomic or structural correspondent) are produced because the ultrasound waves produced by the transducer are almost entirely reflected when it encounter the interface between surface tissues and the structure with high air content. But true sonographic images are produced when the air content of the alveoli decrease , as it does in the presence of NRDS, pneumonia and pulmonary masses that are in contact with the pleura [32].

However, Bober et al. (2006)[25] found that lack of contraindications for ultrasound examination, its low costs and patient safety have contributed a lot to the clinical and diagnostic utility[25]. Also the lung ultrasound at birth may detect infants with NRDS before clinical deterioration[7].

Ultrasonography is low-cost imaging technique that has no contraindication and none of the side effects caused by exposure to the ionizing radiation. For these reasons, its use as a diagnostic tools have increased in recent years. Although at the present, its use in the investigation of chest disease in neonates is limited.[30]

Tans-abdominal lung ultrasound may be useful in rapid detection of NRDS, which may aid in immediate surfactant administration especially when immediate portable CXR is not feasible (e.g. in machine break down, power failure, non availability of technologist, etc.).[33]

In the this study, the gender distribution was 33 male neonates (65%) and 17 females(34%) which revealed significant difference (p value < 0.013) (Table 1), this was in agreement with A. Abdelsadek et al(2016) [7]and J. S. Anadkat at el ( 2012)[34] who found that respiratory distress syndrome is more in males than females.regarding the mode of delivery, 18 patients (36%)were delivered vaginally and 32 patients (64%) were delivered by section, We found that the NRDS was significantly common (p value <0.013) in neonates delivered by cesarean section (Table 1). In agreement with the study done by Levine et al. (2001)[35] who found that the newborns delivered by cesarean section have five fold increase in the incidence of neonatal respiratory disease in those delivered vaginally.

Analysis of the results obtained in our study showed high sensitivity (100%) of the ultrasound method in diagnosis of NRDS which is consistent with reports published by other authors Liu *et al*(2014)[20] and Bober *et al*. (2006)[25]which showed sensitivity of 100%.

The over-diagnosis RDS using US in our study , this was in agreement with A. Abdelsadek *et al*(2016) [7]& Hosam El-Deen *et al* ( 2015)[17] on account of the cases of pathology found on ultrasound examination but not confirmed by a chest X-ray, It is possible that this LUS pattern might have been seen more in patients who very short interval of the examination. However, it cleared in all of them on follow-up by LUS after few hours [33].

In our study the specificity of the method was 81% which is in relative discrepancy to Ahuja *et al*(2012)[33] which showed specificity 88% Liu *et al* (2014)[20]which showed specificity 92% ,We could attribute this relative discrepancy due

overlap with other neonatal disease such congenital pneumonia or TTN .

Despite the difference in specificity between our study and other studies, we found that features of LUS stage III NRDS can be present in other lung diseases such as pneumonia which also showed homogenous hyperechogencity ( white lung) by LUS which can be confirmed by doing Lab. Test to reach the final diagnosis , therefore the LUS are not specific to NRDS

## CONCLUSION:

1. Ultrasound examination showed high sensitivity in diagnosing NRDS when compared with chest radiography.

2.A significant correlation was found between ultrasound and radiographic assessment of NRDS. Given the consistently good results for TALS of the lungs in the diagnosis NRDS and LUS is safe from radiation, we believe that its use as a routine clinical tool, rather than just a research tool.

3. we can used the ultrasound examination as a alternative study for standard chest X-rays in diagnosing potential causes of neonate's respiratory disease .

**Recommendations** :

we recommend for doing research to follow up of lung ultrasound features after the treatment of neonatal respiratory distress syndrome

Also we recommended for doing more research to compare the finding of LUS between NRDS and other causes of respiratory distress disease in newborn such as pneumonia and transient tachypnea of newborn.

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