applications, this modality is operator dependant. Therefore, it is considerable to ensure that operators acquire sufficient training and practice with this specific modality. Second, the exposure levels used in diagnostic LUS, the long- term biological effects of ultrasound on neonatal lung are still under study. Importantly, tissue damage may occur in certain identifiable applications, so it is considerable to ensure that cautious clinical use of LUS is required to minimize the possible damage. Finally, the accuracy diagnosis of smaller pneumothorax, pneumomediastinum, and pneumopericardium by LUS remains challenging, and therefore, CXR is required to rule out them for neonates with suspected NRDS.[(11)(14)]

Conclusion:

Chest radiography is the standard diagnostic tool for RDS, however, ultrasound examination is highly beneficial in diagnosis of US RDS pattern in the first three days of life.

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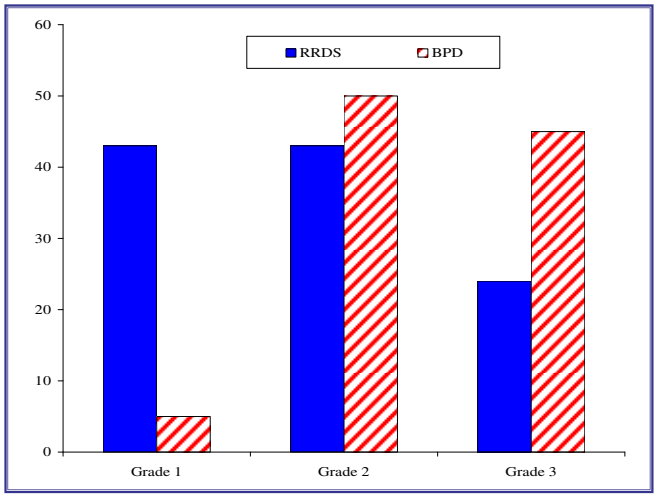
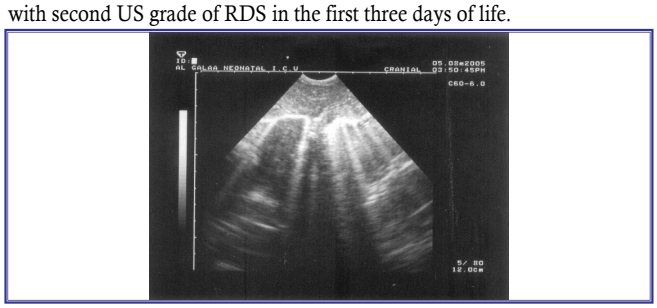
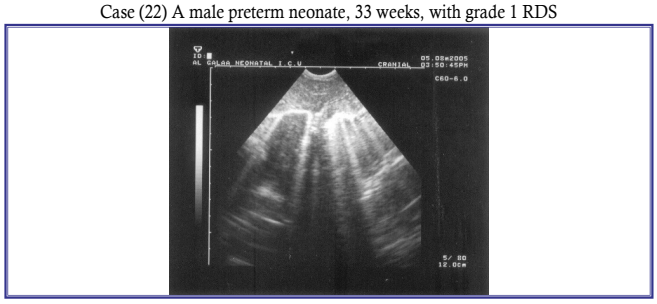


Fig. (3) Comparison between ultrasound findings of Resolved RDS (Gp. 1) and BPD (Gp. 2) in the first three days of life.

This figure shows statistical significant increase in incidence of BPD with second US grade of RDS in the first three days of life.



Case (22) A male preterm neonate, 33 weeks, with grade 1 RDS



Case (48) A male preterm neonate, 30 weeks, with grade 2 RDS

Table (8) Distribution of different grades of ultrasound findings of respiratory distress done in the first three days of life among different disease groups:

Grades		Rds	BPD	R. Rds	Live	Dead
		Gp1&3	Gp2	Gp1	Gp1&2	Gp3
Us1_3	1	24	1	24	25	0
	2	29	10	24	34	5
	3	12	9	8	17	4
Total		65	20	56	76	9
X		9.75		12.8	4.75	
P		0.0 02*		0 008*	0.09	

This table shows statistical significant association in different ultrasound grades in relation to RDS group, resolved RDS and BPD groups.

Discussion:

The diagnosis of RDS is usually based on the clinical picture and chest X- ray, which exposes the infants to ionized radiation, and the four- stage scale for RDS severity based on radiographic findings correlates closely with the actual disease severity.[1]

Cleveland, found that radiographic findings are usually present a short time after births but sometimes do not reach high severity until 12- 24 hours of life. In the clinical practice there is a continuous need for exposing a neonate to radiation in order to evaluate effectiveness of administered therapy, and this carries the risk of long term adverse effects.[10]

RDS ultrasound using the transabdominal approach shows reterohepatic hyperechogenicity which is diagnosticof the disease. The origin of the hyperechogenicity must be related to the particular nature of the disease. The normally aerated lung is highly reflective and presents barrier to sound transmission.[1]

Lung ultrasound in the current study was done using the transabdominal approach, Bober& Swietliński,[1] used the same approach for assessing lung aeration and this technique is based on the artifact phenomenon, which occurs within the phrenopulmonic border. Bober& Swietliński,[1] found the physical conditions for sound transmission different in a neonate with RDS, because of decreased lung aeration (atelectasis), where a sound beam can be transmitted further beyond the phrenopulmonic border into the lung parenchyma.

Copetti et.al.[6] used the trans- thoracic approach in assessing lung aeration and found that by this approach all the lung fields were examined and not only the base. Also, they concluded that this technique allowed evaluation of the pleural line which is not possible with the transabdominal approach.

In a recent meta analysis done studying the comparison between transthoracic scanning technique and transabdominal scanning technique for the diagnosis of NRDS demonstrates that transthoracic scanning technique has higher accuracy. It reveals that transthoracic scanning technique is superior to transabdominal scanning technique in the diagnostic accuracy of NRDS.[11]

According to the current studies, the main LUS diagnostic criteria of NRDS include bilateral white lung, pleural line abnormalities, and lung consolidation. Liu et.al found that the co- existence of lung consolidation, pleural line abnormalities, and bilateral white lung or disappearance of lung consolidation, pleural line abnormalities, and A- lines disappearance occurs with a sensitivity and specificity of 100% for predicting NRDS.[12]

Analysis of the results obtained in this study showed high sensitivity (80%) of ultrasound method in diagnosis of RDS in the first three days of life and Pieper et.al.[13] who found 80% sensitivity of ultrasound on day 3 of life. Bober& Swietliński[1] found in the first week ultrasound diagnosis of RDS 92% specificity. There was a strong positive correlation between ultrasound and X- ray imaging in the description of RDS severity. Ultrasound examination cannot replace chest X- ray in the respiratory failure work- up as it overestimates the diagnosis, but it can be useful in excluding RDS as a cause of respiratory insufficiency in newborns. It can also demonstrate areas of decreased aeration and it may also monitor the effects of administered therapy.[1]

Although LUS has very high diagnostic performance for detecting neonatal RDS, it is also important to consider certain limitations in relation to the use of lung ultrasound. First, as with lots of ultrasonic

retrophrenic striped patterns of hyperechogenicity diverging radially, detected only during expiration. RDS in its 2nd stage is characterized ultrasonographically by retrophrenic striped patterns of hyperechogenicity diverging radially, seen during inspiration, which merge together into areas of homogenous echo enhancement. RDS in its 3rd stage is characterized ultrasonographically by retrophrenic homogenous hyperechogenicity observed irrespective of respiratory phase.

Since RDS is a more severe and diffuse condition than TTN, the absence of spared areas (with A- lines) seems the most noticeable sign and, contrary to TTN, in the absence of any treatment, LUS appearance will not improve quickly. LUS is also useful in diagnosing the complications of RDS, such as pulmonary haemorrhage, pneumothorax (PNX) or atelectasis.[8]

Patients:

Inclusion criteria: Preterm neonates (< 37 weeks gestation), having respiratory distress syndrome (RDS).

Exclusion criteria. Full term neonates. Respiratory distress of causes other than respiratory distress syndrome, Neurological causes leading to hyperventilation like seizures.

For the relatively thinner chest walls and smaller thoraxes in neonates, a high frequency linear probe is preferred, which enables better image quality and allows the entire surface of the lungs to be visualized. Lung ultrasound is performed in a supine, lateral or prone position in neonates. Each hemithorax is divided into anterior, lateral, and posterior regions by the anterior and posterior axillary lines, longitudinal and transverse scans are performed in all areas.

Methods:

Full history and meticulous examination, laboratory investigations, radiological assessment of different stages of RDS. Postero- anterion view of the chest was done initially on admission in the NICU for diagnosis and grading of RDS according to Halliday et.al.[8] where they grade RDS into four grades.

- Grade1: Fine reticulo- granular mottling with good lung expansion.
- Grade2: Mottling with air bronchograms.
- Grade3: Diffuse mottling, heart borders are just discernable prominent air bronchograms.
- Grade4: Bilateral confluent opacification of the lungs.[8]

Chest x- ray was done weekly for follow up and diagnosis of BPD, where staging of BPD was done into four stages according to severity of x-ray findings.

Chest ultrasound was done using a Toshiba US machine which was used with a 6.5MHz curvilinear probe. The high frequency probe gave excellent resolution and adequate penetration. Hard copy images were obtained using a Sony black and white printer.

The ultrasonographic method of assessing lung aeration is based on the artifact phenomenon, which occurs within the phrenopulmonic border.[9]

The examination was done in the same manner as described by (Avni et.al.[7] Saggital transhepatic scanning was undertaken from beneath the inferior end of the rib cage, scanning superiorly in order to visualize the base of the lung. The same was done on the left side, using the spleen as a stand off.[7]

The degree of lung aerationas described by Bober& Swietlinski[1] longitudinal and oblique cross sections through the right lobe of the liver and the spleen. Patterns of echogenicity above the diaphragm were observed during numerous respiratory cycles, and hen the images were printed on thermo sensitive papers.[1]

The first examination was aimed at determining the presence or absence of RDS US pattern which is consisting of diffuse retro- hepatic retero- splenic hyper- echogenicity replacing the normal diaphragm echo-pattern, and estimation of RDS severity according to Bober& Swietlinski[1] Staging. This was done initially on admission during the first 3 days of life. The subsequent examinations done twice weekly were for follow the evolution of the reterodiaphragmatic appearance.

Results:

The present study is a prospective study; it included 85 preterm newborns (47 males& 38 females, mean gestational age was 33.4weeks) admitted in the neonatal intensive care unit of Al Galaa teaching hospital because of Respiratory distress syndrome (RDS) diagnosed clinically and radiological.

According to their fate the total number under study was subdivided into:

1. Group-1 (Resolved RDS): Fifty six (65.8%) preterm neonates resolved from RDS gestational age 34.2± 1.5 weeks, and they were discharged in fair general and ventilator (clinical, radiological and CBG are fair) conditions.
2. Group-2 (BPD): Twenty (23.6%) preterm neonates developed BPD clinically and radiologically, they were 13 (65%) males and 7 (35%) females, with mean gestational age, they were 29 (50.2%) males and 27 (49.8%) females, with mean 32.3± 2.2 weeks, whether they were mechanically ventilated or not.
3. Nine (10.6%) preterm neonates died within the first three weeks of life, they were 5 (55.5%) males and 4 (44.5%) females.

Table (2) Statistical analysis of the modes of delivery& Sex among the groups under study

			Total (n= 85)	Gp. 1 (n= 56)	Gp. 2 (n= 20)	Dead (n= 9)
Mode Of Delivery	Vaginal	N	48	31	12	5
		%	56.5	55.5	60	55.5
	Cesarian	N	37	25	8	4
		%	43.5	44.5	40	45.5
	X^2		0.133	0.643	0.80	0.63
	P		0.936	0.423	0.371	0.52
Sex	Male	N	47	29	13	5
		%	55.3	50.2	65	55.5
	Female	N	38	27	7	4
		%	44.7	49.8	35	45.5
	X^2		1.04	0.071	1.80	0.08
	P		0.594	0.789	0.18	0.18

Introduction:

Lung disease is the most common cause of neonatal respiratory distress, which can result in respiratory failure and death in certain cases. RDS is the most common clinical condition encountered among neonates treated in the NICUs. Chest radiography is an important diagnostic tool used in the diagnosis of RDS however; the ultrasound has been used as a diagnostic method with a non invasive technique and accuracy in diagnosis.[1]

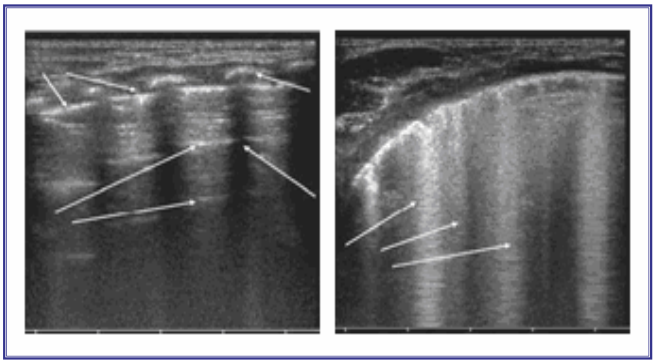
All diagnostic ultrasound methods are based on the fact that ultrasound is reflected by an interface between media with different acoustic impedance.[2] Ultrasound is limited in normal functioning and aerated lungs because no acoustic mismatch occurs in the ultrasound beam when it encounters air during examination.[3]

A normal neonatal lung scan does not look different than an adult one. The superficial layers of the thorax consist of subcutaneous tissue and muscles. Ribs, on longitudinal scans appear as curvilinear structure associated with posterior acoustic shadowing. Pleura appear as a regular echogenic line (the pleural line) moving continuously during respiratory movement. Pleural movement has been described as the (lung sliding) sign seen by ultrasound.[4]

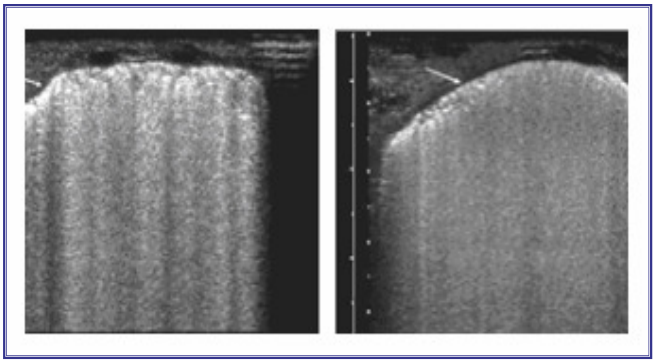
When examining the lung it was found that beyond the pleural lung interface, the lung is filled with air and does not allow further visualization of normal lung. However, the large change in acoustic impedance at pleural lung interface results in horizontal artifacts which are seen as a series of echogenic parallel lines, below the pleural line, these lines which were found were defined as A-Lines, as shown in figure (1).[4] With ultrasound the normal lung is black, while the diseased lung is black and white.[5]

The fetal lung is very rich in fluid; therefore, there are vertically oriented (comet- tail) artifacts rising from the pleural line called B-Lines, B-Lines can be seen in healthy full term and they are representing fluid rich pleural intrapleural septa which are surrounded by air. They are not compact, mainly on the right side but without a typical localization and they disappear completely within (24- 36) hours.[6]

RDS ultrasound shows reterohepatic and reterosplenic hyper echogenicity which is diagnostic of the disease. The origin of the hyperechogenicity must be related to the particular nature of the disease. The normally aerated lung is highly reflective and presents barrier to sound transmission.[1] However, it has been detected that when alveolar air is replaced by fluid, the lungs become hypo- echoic with good sound transmission seen during examination. The interface of the walls of the bronchi and air produce highly reflective linear echoes that stand out within the consolidated lung.[7]



A-Lines B-Lines



RDS

Fig. (1- A) Normal lung, longitudinal scan of the thorax, A-Lines and posterior acoustic shadowing of the ribs, B-Lines with "comet tail" artifacts

Fig. (1- B) RDS: Evidence of very compact B-Lines and not well defined pleural line.[6]

In RDS alveolar collapse is typical. Air is present in all the air passages (bronchi, bronchioles and alveolar ducts). An air bronchogram is typically visible and reterohepatic hyper- echogenicity is typically diagnostic since it is found only in cases of RDS. The US might allow diagnosis of RDS even before clinical symptoms are present so that the management can be initiated rapidly.[7]

In RDS B-Lines are compact lines, diffuse and symmetrically distributed in both lungs. This pattern determines a picture of "white lung". The pleural line is always extensively thickened, irregular not well defined and coarse as shown in fig. (1).[6]

Table (1) The three stages ultrasound scale for RDS severity

Stages Of Rds	Findings On Us Examination
1	Retrophrenic striped pattern of hyperecchogenicity diverging radially, observed only on expiration.
11	Retrophrenic striped pattern of hyperecchogenicity diverging radially, observed only during inspiration, also merging together into areas of hemogenous echo enhancement on expiration.
111	Retrophrenic homogenous hyperechogenicity observed irrespective of respiratory phase.

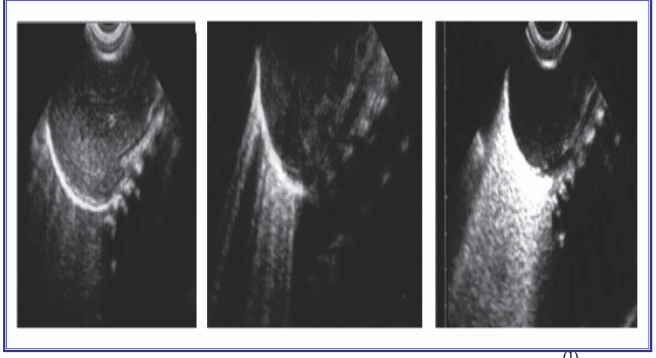


Fig (2) Different ultrasound stages of respiratory distress syndrome.[1]

RDS in its 1st stage is characterized ultrasonographically by

Lung Ultrasound Examination in Neonatal Respiratory Distress Syndrome

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Summary

Background& Objectives: Transthoracic ultrasound (US) of the chest is useful in the evaluation of a parenchymal, pleural, and chest wall diseases. Furthermore, it is used to guide interventional procedures of the chest and pleural space. The utility of a lung ultrasound was used in the different phases of neonatal respiratory distress syndrome (RDS). We investigated lung ultrasound as a method to detect respiratory condition in preterm neonates throughout the course of RDS.

Methods: This study is a prospective study done on 85 preterm newborns with different grades of respiratory distress syndrome, admitted in neonatal intensive care unit (NICU) in El Galaa teaching hospital in Cairo. Included in the study were Preterm neonates (< 37 weeks gestation), having respiratory distress syndrome (RDS). Postero- anterior view of the chest was done initially on admission in the NICU for diagnosis and grading of RDS. Lung ultrasound: The first examination was aimed at determining the presence or absence of ultrasound pattern for RDS consisting of diffuse retro- hepatic retero- splenic hyper- echogenicity replacing the normal diaphragm echo- pattern, and estimation of RDS severity. This was done initially on admission during the first 3 days of life. The subsequent examinations were done twice weekly were to follow the evolution of the retro- diaphragmatic appearance. Results after ultrasound examination were Group 1(Resolved RDS): Fifty six (65.8%) preterm neonates resolved from RDS gestational age 34.2±1.5 weeks. Group 2(BPD): Twenty (23.6%) preterm neonates developed BPD clinically and radiologically, they were 13(65%) males and 7(35%) females, with mean gestational age, they were 29 (50.2%) males and 27 (49.8%) females, with mean 32.3± 2.2 weeks, whether they were mechanically ventilated or not. It was concluded that chest ultrasound has a great advantage in the preterm neonates in diagnosing different stages of RDS and in follow up to detect bronchopulmonary dysplasia (BPD).

الموجات الصوتية على الرئة فى الأطفال حديثى الولادة الذين يعانون من الكرب التنفسى

مقدمة: الكرب التنفسى واحد من أهم أسباب ضيق التنفس فى الأطفال ناقصى النمو، وتزداد هذه النسبة حتى ٦٠% بالنسبة للأطفال قبل ٢٩ أسبوع عمر رحمى وتقل كلما زاد العمر الرحمى حتى ٣٩ أسبوع.

الهدف: دراسة نتائج الموجات الصوتية للرئة للأطفال الذين يعانون من كرب تنفسي.

الخطوات: قد أجرى هذا البحث على ٨٥ طفل ناقصى النمو كانوا يعانون من الكرب التنفسى وقد احتاج هؤلاء الأطفال للمساعدة فى التنفس عن طريق الأكسجين أو أجهزة التنفس الصناعي. تم عمل موجات صوتية للصدر وتم عمل أشعة عادية على الصدر أشعة (×) كل أسبوع.

النتائج: تعتبر الموجات الصوتية على الصدر فى الأطفال ناقصى النمو واحدة من أهم أساليب التشخيص والمتابعة لكل من مرض الكرب التنفسى، ومن الدراسة السابقة تبين لنا ان تعتبر الأشعة العادية على الصدر (أشعة إكس) الوسيلة التقليدية لتشخيص الكرب التنفسى والحثل الرئوى الشعبى ولكن يأتى دور الموجات الصوتية على الصدر فى الأطفال حديثى الولادة كوسيلة مبكرة للتشخيص.

التوصيات: بناء عليه فإننا ننصح باستخدام الموجات الصوتية للصدر فى الأطفال حديثى الولادة كوسيلة سهلة وسريعة لتشخيص أمراض الرئة المختلفة وعلى رأسهم كلا من الكرب التنفسى والحثل الرئوى الشعبى، هذا بالإضافة إلى متابعة حالات الكرب التنفسى بالموجات الصوتية حتى يتثنى لنا التنبؤ بمرض الحثل الرئوى الشعبي.