Lung Ultrasound Findings in the Diagnosis of Transient Tachypnea of Newborn in Late Preterm and Term Neonates

Abstract

Background:Transient tachypnea of the newborn (TTN) is a prevalent etiology of respiratory distress (RD) in neonates.The condition is a result of the accumulation of fetal lung fluid owing to defective processes responsible for its removal.However, differentiating TTN from various etiologies of RDs may provide challenges. Lung ultrasound (LUS) has effectively been used to diagnose and differentiate infant RD.The objective of this research was to evaluate the ultrasonographic findings in the diagnosis of TTN in late preterm and full-term neonates.

Methods: All neonates had been exposed tofull taking of history, full clinical assessment, chest X-ray, routine laboratory tests, and LUS assessment was performed on 80 late preterm and full-term neonates diagnosed with TTN by clinical and radiological findings and performed on control group.

Results: Among 80 neonates who were diagnosed to have TTN**,** double lung point sign (DLP) was present in 62 (77. 5 %), pleural line abnormalities had been observed in 80 (100%), alveolar interstitial syndrome (AIS) was observed in 68 (85.0%), while white lung was present only in 12 TTN cases (15%), and no pleural effusion was found in any of the patients. While these findings weren't detected in the control group**.**

Conclusion: LUS could be accurately and reliably used in the diagnosis and screening of TTN. Most common findings in TTN were pleural line abnormalities followed by AIS and DLP.

Keywords: TTN, double lung point, lung ultrasound, alveolar-interstitial syndrome

Abbreviations:TTN: Transient tachypnea of the newborn; RD: respiratory distress; LUS: Lung ultrasonography; RDS: respiratory distress syndrome; AIS: alveolar-interstitial syndrome; MAS: meconium aspiration syndrome; CXR: chest x ray.

Introduction:

Transient tachypnea of the newborn (TTN) is a lung condition that occurs in newborns promptly following birth[1]. It arises due to insufficient absorption of fetal lung fluids. TTN is the most frequent cause of breathing difficulties among full-term babies who are referred to a neonatal intensive care unit (NICU). Among rare cases, TTN may result in respiratory failure due to a lack of oxygen[2].

TTN is a diagnosis that is only established after other potential etiologies of respiratory distress (RD) have been excluded, such as respiratory distress syndrome (RDS), pneumonia, meconium aspiration syndrome (MAS), and congenital cardiac disease[3]. The diagnosis of TTN is often determined mostly via clinical examination. Newborns with TTN exhibit signs of RD and have characteristic features on chest radiography, including significant peri-hilar vascular patterns, lung hyper-inflation, and fluids in the fissures[4]. Although the symptoms may cause discomfort, they are often not fatal. Indeed, symptoms are temporary, often resolving within 1 to 3 days following delivery[5].

Lung ultrasonography (LUS) is a non-invasive and radiation-free method which is readily accessible at the patient's bedside. It is often utilized for diagnosing various respiratory disorders in newborns, such as TTN, pneumonia, RDS, and other lung conditions. Nevertheless, it is recommended that LUS should not be conducted in isolation, but rather in conjunction with the clinical observations of sufferers[6].

The appearance of TTN during ultrasonography examinations may also vary. The prevailing ultrasonographic presentations of TTN include the double lung point (DLP), interstitial syndromes or white lungs, and pleural line abnormalities[7].

These aberrations might be perplexing for the clinician who wants to use LUS into the diagnostic procedure. In order to provide more clarification on this matter, we undertook recent prospective research to examine the ultrasound observations used for diagnosing TTN in late preterm and full-term infants.

Subjects and methods:

This was an observational prospective work that was performed at NICU of Tanta University Hospitals. The work was permitted by the local ethics committee of the faculty of medicine, Tanta University. And The newborns' parents or legal guardians provided written informed permission. During the period from February 2022 till January 2023, 120 newborns with gestational age ≥ 35 weeks (determined by calculating from the initial day of the most recent menstrual cycle and using the New Ballard score[8]had been included in the work.

The neonates involved in the research were categorized into two distinct categories. Group I (TTN group) consisted of 80 newborns who had a diagnosis of TTN according to clinical and radiological findings. Group II (control group), on the other hand, included 40 neonates who did not exhibit any signs of respiratory distress.

Neonates presented with an identified RD other than TTN, gestational age less than 35 weeks, chest deformity, major congenital abnormalities, congenital pleural effusion and/or hydrops fetalis, pneumothorax, structural heart diseases, severe hemodynamic instability correlated with sepsis were excluded from this study.

Methods

All neonates had been exposed tofull taking of history, comprehensive clinical assessment such as Downes' score [9], to assess degree of respiratory distress in neonates with TTN, chest x ray, and routine laboratory tests such as complete blood picture, C-reactive protein, liver and renal functioning tests, random blood sugar, serum electrolytes, blood culture and blood gases.

Lung ultrasound (LUS):

An LUS was conducted with the neonate lying on their back by single neonatologist utilizing a **Siemens Acuson X300 ultrasound equipment (Siemens Health Care GmbH, Erlangen, Germany)** that had a linear probe with a frequency range of 10-12 MHz. The LUS was carried out within 24 hours after delivery. The lower anterior, upper anterior, and lateral transverse portions of each hemithorax have been evaluated using the same method. The saved images were subsequently provided to a diagnostic radiologist, who was unaware of the patient's clinical state, for the purpose of evaluating and interpreting the images.

Observation Indices:

(1) The pleural linerefers to regular, smooth, and linear echoes which are bright and move in time with the patient's breathing. This movement is known as lung sliding [10].

(2) A-lines are horizontal artifacts generated when ultrasound beams are blocked by airflow in the lungs. They appear as a sequence of linear hyper-echoic echoes which run parallel to and beneath the pleural line, equally dispersed from each other[11]. (figure 1c)

(3) B-lines are defined as pathological artifacts. The lines are vertical and have a high level of echogenicity. They resemble lasers and extend from the pleura to the border of the screen, causing the A-lines to disappear[12].

(4) Lung consolidation: On ultrasonography, lung consolidation appears as "hepatization" and might be accompanying air bronchograms or fluids bronchograms in the pulmonary tissues[13].

(5) White lung is a condition in which there are compact B-lines or loss of A-lines in all 6 areas of the lung. White lung and compact B-lines are clinical presentations of severe alveolar-interstitial syndrome (AIS) resulting from the accumulation of a significant volume of lung fluids, which includes both pulmonary interstitial and alveolar fluids[14].

(6) AIS is identified by the existence of over 3 B-lines in the pulmonary field, accompanied by the absence of A-lines. It is noteworthy that the acoustic shadows of the ribs might be observed. Severe AIS symptoms include white lung or a compacted B-line[15]. (figure 1b) The double lung point refers to the sharp demarcation point that appears on an ultrasound between both the lower and upper lung regions. This point is caused by variations in the severity or characteristics of the lesions[13]. (figure 1a).

Statistical analysis:

Statistical analysis was conducted using the SPSS version 20.0 (SPSS Inc., Chicago, IL, US). Continuous data are often reported as the mean and the standard deviation, or as the median with the interquartile range (25 to 75) for variables that do not follow a normal distribution. On the other hand, discrete data is displayed as absolute numbers and percentages. The statistical tests used for contrasting both groups included Fisher's exact test, the Chi-square test, the Mann-Whitney test, and/or the unpaired Student's t-test, as deemed appropriate. Statistical significance was set at $p < 0.05$.

Results:

A total of 130 patients were eligible for this study. Forty neonates had no signs of RD.And based on an evaluation of the patients' medical records, clinical manifestations, arterial blood gas tests, echocardiography, and chest x-ray exams, a ten individuals have been excluded from the study due to the following reasons: 3 individuals were found to have congenital pneumonia, 4

individuals received diagnosis with RDS, 2 had congenital heart disease, and 1 had pneumothorax, and the remaining 80 patients were diagnosed with TTN and proceeded to ultrasound examination as illustrated in flowchart **(figure 2).**

Assessment of descriptive, TTN cases included in the work had mean gestational age (GA) 36.48±1.61 weeks and control group with mean GA 36. 70 ± 1. 52. No statistically significant differences existed among the TTN group and the control group regarding sex, APGAR 1 min and APGAR 5 min, anthropometric measurements, antenatal risk factors, vital signs, and laboratory results of complete blood count. while a statistically significant difference existed among the two studied groups regarding mode of delivery as CS is associated with an increased occurrence of TTN. **(Table 1)**

Downes' score was 4. 65 ± 0. 92 in TTN patients. All the cases of TTN received oxygen support in the form of HHHFNC and duration of O2 therapy was 2. 93 ± 1. 02 as shown in **(Table 2).**

Regarding lung ultrasound findings in TTN group, among 80 neonates diagnosed to have TTN, DLP sign was present in 62 (77. 5 %), pleural line aberrations had existed in 80 (100%), alveolar interstitial syndrome (AIS) was observed in 68 (85.0%), while white lung was present only in 12 TTN cases (15%), and no pleural effusion was found in any of the patients. While these findings weren't detected in the control group. **(Table 3).**

Discussion

TTN is a harmless and temporary disorder that may occur in newborns immediately after they are born. This condition is a result of a delay in the removal of fluids from the lungs of the fetus following birth. This results in inefficient exchange of gases, difficulty in breathing, and rapid breathing. The duration of symptoms might range from a few hours to more than two or three days. Though it is uncommon, hypoxemia may occur[2]. Lung ultrasonography is

increasingly used in the diagnosis of TTN. It allows visualization of the neonate's lungs and real-time assessment of conditions like TTN. Key ultrasound findings in TTN are thickened, irregular pleural lines, DLP, white lung, and pleural effusions. LUS is non-invasive, radiation-free, and avoids transporting unstable infants.

With respect to gestational age, our results revealed no significant difference among the TTN group and the control group. These results were in line with the work conducted by Rachuri et al.[16]which also observed no statistically significant difference in gestational age between neonates experiencing respiratory distress and the control newborns.

Our research demonstrated that no significant difference existed among 2 groups regarding sex. This came in contrary to Derbent et al.[17]who carried out on the newborn with TTN and control group and found that The TTN group had a greater number of male participants in contrast to the control group. Also, another retrospective study by Kasap et al.[18] found that 66.3% of TTN patients were males.

As regards mode of delivery, a significant difference existed among the 2 groups as CS is correlated with elevated frequency of TTN. This came in agreement with Derbent et al.[17]who carried out on 85 newborns with TTN, and control group and the work demonstrated a substantial increase in the percentage of CS within the TTN group. Another retrospective study by Kasap et al.[18] carried out on 95 newborns with TTN and showed that 79% of the patients were delivered by cesarean section.

As regards Apgar 1, 5 min, no significant difference existed among the 2 groups. This agreed with Machado et al.[19] who compared a group of twenty-one term babies with a diagnosis of TTN to another twenty-one newborns with the same gestational age but no diagnosis of TTN. no statistically substantial variation was existed among the groups' 1- and 5-minute Apgar scores.

However, in Costa et al.[20]Apgar score at 1 and 5 minutes was greater in controls when contrasted to patients with transient tachypnea.

Regarding lung ultrasound findings in TTN group, among 80 neonates were diagnosed to have TTN, double lung point sign (DLP) was present in 62 (77. 5 %), pleural line abnormalities were found in 80 (100%), alveolar interstitial syndrome (AIS) was observed in 68 (85.0%), while white lung was present only in 12 TTN cases (15%), and no pleural effusion was found in any of the patients. While these findings weren't detected in the control group.

This agreed with Srinivasan et al.[21]who found that DLP was seen in 47 cases, accounting for 94% of the total. The detection of DLP has a sensitivity of 94% and a specificity of 100% when identifying TTN. The detection of AIS has a sensitivity of 94% and a specificity of 88% when it comes to identifying TTN. Only 3 (6%) TTN individuals had total loss of A-lines without DLP, resulting in severe white out lungs. All patients (100%) with transient tachypnea of the newborn (TTN) had anomalies in the pleural line.

Also, Ibrahim et al.[3]found that DLP was present in 33 TTN cases with 69. 6% sensitivity, 100% specificity for diagnosing TTN. The disrupted pleural line was present in all TTN cases and revealed sensitivity of 93. 5%, specificity of 88. 9%. complete or Partial disappearance of A-lines was existed in 43 (69. 6%) TTN cases with sensitivity of 91. 3%, specificity of 77. 8 in TTN detection

Liu and his colleagues[22]LUS was done to all cases and control, and they reported that DLP was present in 46 (76. 7%) TTN cases with sensitivity of 76. 7% and specificity of 100%. However, pleural-line aberrations, AIS and white-lung were present in all TTN cases (100%) pleural effusion was exist in 20% of TTN cases.

Limitation:This research has limitations in that all lung ultrasonography exams were conducted by a single neonatologist, and it was a single-center study.

Conclusion:

The study's findings conclusively suggest that lung ultrasonography is a very accurate and dependable method for diagnosing TTN. Most common findings in TTN were pleural line abnormalities followed by AIS and DLP. Thus, Lung ultrasonography has the potential to serve as an early screening technique in the neonatal critical care unit for diagnosing TTN.

Statements and Declarations

Ethical approval and Consent

The study received approval from the ethical committee of the Faculty of Medicine, Tanta University. It began in February 2022 and concluded in January 2023. An informed written permission was acquired from the parents or legal guardians of the neonates who were included in the study.All individual subjects involved in the research provided informed consent

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Table (1): Demographical, Antenatal risk factors, Clinical Characteristics, and laboratory findings of the studied groups

	Group (I) TTN group (n = 80)		Group (II) Control group (n = 40)		Test of Sig.	P
	No.	**%**	**No.**	**%**		
Sex						
Male	46	57. 5	21	52. 5	χ^2= 0. 202	0. 653
Female	34	42. 5	19	47. 5		
Gestational age (weeks)	36. 48 ± 1. 61		36. 70 ± 1. 52		t= 1. 310	0. 194
Mode of delivery						
NVD	2	2. 5	21	50. 0	χ^2= 23. 309	<0. 001
CS	78	97. 5	19	50. 0		
APGAR 1 min	6.0 (5.0 – 6.50)		6.0 (5.0 – 7.0)		U= 687. 50	0. 247

APGAR 5 min	9.0 (9.0 – 9.0)		9.0 (9.0 – 9.0)		U= 669. 0	0. 064
Antenatal risk factors						
DM	12	15.0	5	12.5	0.105	0.745
HTN	11	12.5	4	10.0	0.125	^{FE}p=1.00
PROM	14	17.5	3	7.5	1.829	0
Placental disorders (previa, insufficiency)	10	12.5	3	7.5	0.556	0.176
						^{FE}p=0.71
Multiple pregnancies (twins)	8	10.0	1	2.5	1.920	2
Others (UTI, chorioamnionitis)	8	10.0	1	2.5	1.920	
						^{FE}p=0.35
						9
						^{FE}p=0.35
						9
Pulse (bpm)	136. 15 ± 3. 20		132. 68 ± 5. 88		t= 1.346	0.183
Mean blood pressure (mmHg)	60. 23 ± 5. 45		57. 97 ± 9. 09		t= 1.863	0.066
Temperature(°c)	36. 75 ± 0. 29		36. 56 ± 0. 47		t= 0.147	0.884
Birth Weight (kg)	2. 88 ± 0. 51		2. 67 ± 0. 87		t= 1. 473	0. 145
Birth length (cm)	48. 34 ± 1. 44		48. 13 ± 1. 14		t= 0. 110	0. 913
Ponderal index	2. 66 ± 0. 16		2. 54 ± 0. 43		t= 1. 350	0. 181
Head circumference (cm)	33. 50 ± 1. 10		33. 64 ± 1. 12		t= 1. 834	0. 071
Hb(g/dL)	14. 89 ± 1. 41		14. 42 ± 1. 45		t= 1. 479	0. 143
PLT ($x10^3/mm^3$)	222.5 (186 – 264.5)		223 (188 – 245)		U= 795. 50	0. 965
TLC count ($x10^3/mm^3$)	9. 04 ± 1. 84		8. 89 ± 2. 16		t= 0. 323	0. 747
IT ratio	0. 12 ± 0. 02		0. 12 ± 0. 03		t=0. 916	0. 362

χ^2: Chi square test; t: Student t-test; FE: Fisher Exact; U: Mann Whitney test; NVD: Normal Vaginal Delivery; CS: Cesarean section, DM: Diabetes mellitus; HTN: Hypertension; PROM: Premature rupture of membranes; UTI: Urinary tract infection;Hb: Hemoglobin; PLT: Platelets; TLC: Total leucocytic count; IT ratio: Immature to total neutrophilic count; p: p value.

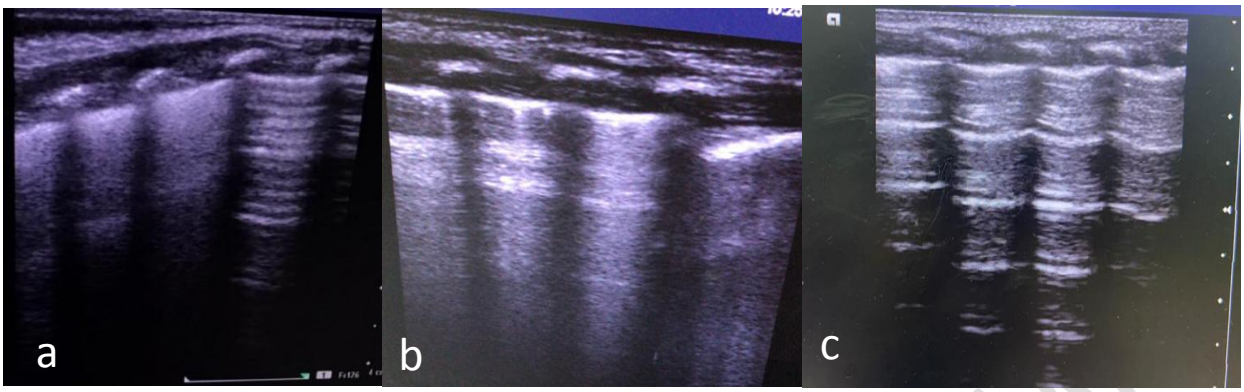
Table (2): Downes' score, oxygen support, and duration of O_2 therapy in the TTN group:

	TTN group (n = 80)	
	No.	**%**
Downes ' score	4. 65 ± 0. 92	
Duration of O_2 therapy (days)	2. 93 ± 1. 02	
Oxygen support (HHHFNC)	80	100. 0

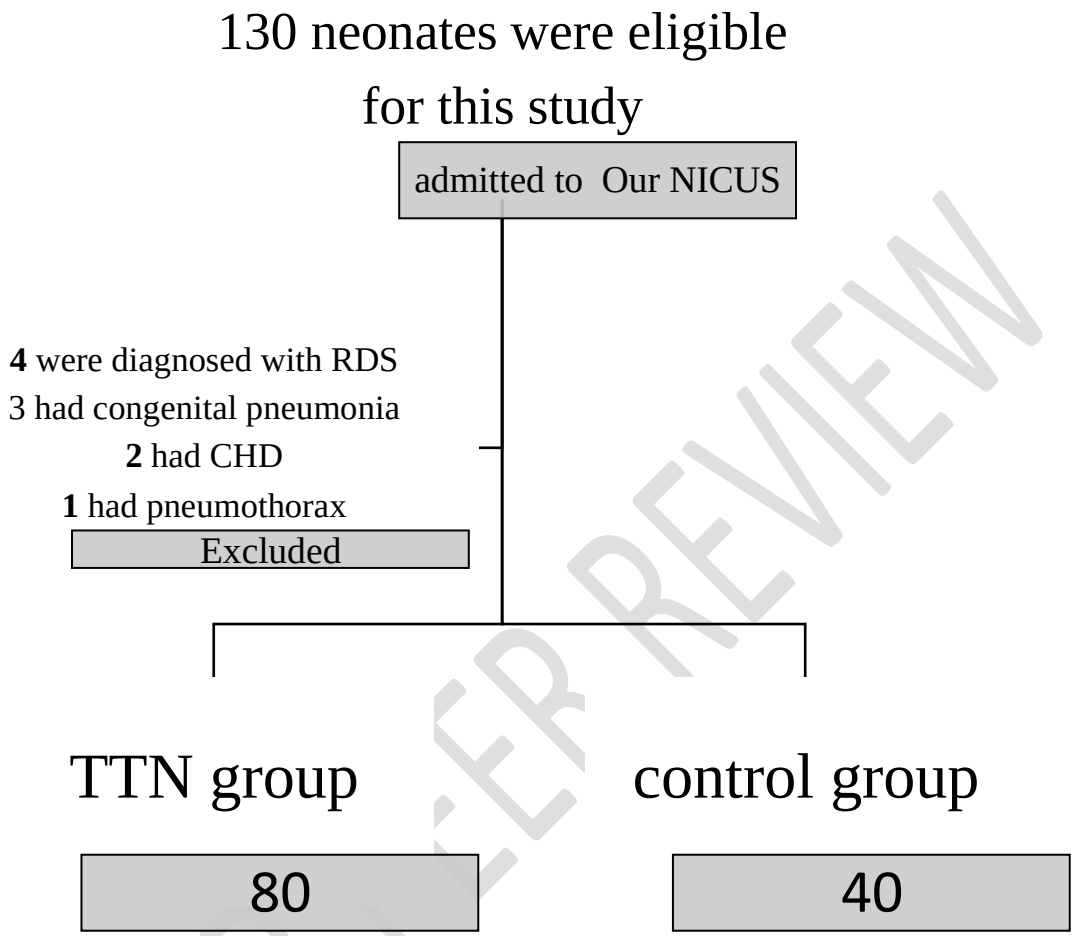
HHHFNC: Heated Humidified High Flow Nasal Cannula.

Table (3): Lung ultrasound findings in the studied groups:

US finding	Group(I) (TTN group) (n = 80)		Group (II) (Control group) (n = 40)		p
	No.	%	No.	%	
Double lung point					
No	18	22.5	40	100.0	<0.001*
Yes	62	77.5	0	0.0	
Pleural line abnormalities					
No	0	0.0	40	100.0	<0.001*
Yes	80	100.0	0	0.0	
Alveolar interstitial syndrome					
No	12	15.0	40	100.0	<0.001*
Yes	68	85.0	0	0.0	
White lung					
No	68	85.0	40	100.0	FEp= 0.026*
Yes	12	15.0	0	0.0	
Pleural effusion					
No	40	100.0	40	100.0	–
Yes	0	0.0	0	0.0	



(Figure 1): a, shows double lung point; b, illustrates interstitial syndrome & c, shows pleural line & horizontal A- lines.



(**Figure 2): Flowchart of enrollment. CHD: congenital heart disease; RDS, respiratory distress syndrome; TTN, transient tachypnea of the newborn**