ORIGINAL ARTICLE

ACCURACY OF LUNG ULTRASOUND TO DIAGNOSE TRANSIENT TACHYPNEA OF NEWBORN

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ABSTRACT

Objective: To determine the accuracy of lung ultrasound to diagnose transient tachypnea in neonates

Method: This Cross-sectional study was conducted at Neonatology Department, Sadiq Abbasi (Civil) Hospital Bahawalpur from January 2019 to October 2022 and comprised of neonates diagnosed as transient tachypnea of newborn. They were divided into 2 groups based on Chest radiograph findings comparable to each other in demographics. Lung Ultrasonography examinations were performed in all patients in a peaceful condition. Each lung was split up in three zones bounded by anterior axillary and posterior axillary lines as anterior, posterior and lateral. Lung Ultrasonography results compared with CXR findings.

Results: Out of 148, Lung Ultrasonography diagnosed transient tachypnea of newborn in 74% while Chest radiograph was suggestive in 39% however, Lung Ultrasonography also diagnosed 61% transient tachypnea of newborn in neonates having normal Chest radiograph examination. The commonest Lung Ultrasonography indexes of transient tachypnea of newborn were A-lines abnormalities 100%, B-lines abnormalities 94.5 %, interstitial syndromes 81.6%, white lungs 36.6%, double lung point 86.77%, consolidation 21% and pleural effusions 10%. The sensitivity of LUS to diagnose transient tachypnea of newborn was 86.5% and the sensitivity and the specificity of Double Lung Point to diagnose transient tachypnea of newborn were 92.2% and 80% respectively. Accuracy of lung ultrasound was 62.8% whereas that of double lung point was 87.1%.

Conclusion: Lung Ultrasonography has fair and double lung point has good diagnostic accuracy in diagnosing transient tachypnea in neonates

Keywords: Neonatology, Fetal lung fluid, transient tachypnea of newborn, Dyspnea, Neonatal Lung Ultrasound

How to cite this article: Anwar M, Akram T, Ilyas N, Ali MA, Wase K, Bilal M. Accuracy of lung ultrasound to diagnose Transient Tachypnea of newborn. Pak Postgrad Med J 2022;33(4): 99-104

DOI: https://doi.org/10.51642/ppmj.v33i04.518

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INTRODUCTION

Respiratory diseases in the newborn are commonest of all diseases responsible not only of admission in NICU[1] but also a major cause of neonatal mortality[2]. Among all respiratory disorders, the most common is Transient Tachypnea of newborn (TTN) a self-limiting disorder with the average stay in the ward ranges from a few hours to days[3]. Its prevalence ranges from 0.5% to 2.8% of all deliveries[4]. In contrast to TTN, there are so many non-self-limiting causes of respiratory distress in neonates requiring more advance care than TTN with a high mortality rate. So, TTN should be differential urgently from other serious respiratory diseases like RDS, MAS, Pneumonia, and PPHN[5]. Conventionally clinical history and clinical signs, findings of arterial blood gas analysis, and examination of chest radiography (CXR) are important for diagnosing TTN but put to one side TTN from other causes of lung disease may be a tough job during the first few hours after birth[6]. CXR played a central title role in diagnosing many lung diseases but the picture of CXR is confusing in different disorders making difficult to diagnose TTN accurately in the first few hours of life[7]. TTN nearly produces1/3 to ½ of dyspnea in newborns so the prompt well time diagnosis on an urgent basis is a key for the best possible prognosis[8]. From last 2 decades, lung ultrasound emerge as a new modality in replacement of CXR for more accurate diagnosis in such a magical way that examination by ultrasonography is not confined to cardiology or radiology only rather it is widely used by other specialties like obstetrics, emergency medicine in adults, in PICU and recently in Neonatal medicine[9]. Every disease of neonates had shown specific findings on lung ultrasound[10]. Many lung diseases are more accurately and easily diagnosed by the use of bedside lung ultrasound by examining physician[6]. Because lung ultrasound is simple, low priced, authentic, decisive and a very powerful noninvasive tool with no radiation damage[6]. It has been utilized with flying colors in the diagnosis and the differential diagnosis of neonatal respiratory disorders[9] so a study is designed to find out the diagnostic accuracy of lung ultrasound to diagnose TTN in low resource countries.

METHODS

The present cross-sectional study was organized at The Neonatology Department, Civil Hospital, Bahawalpur from January 2019 to October 2022. All neonates with gestational age ≥34 weeks admitted in NICU with a clinical diagnosis of TTN i.e. developed tachypnea in less than 6 hours of birth requiring supplemental O_2 inhalation via a nasal catheter or nCPAP were included in this study. Ethical Committee of Civil Hospital Bahawalpur, Punjab, Pakistan allowed to organizing this study. Informed written consent was taken from every parent or guardian.

The neonates were divided into two groups based on chest radiograph (CXR) findings: Group A consisted of neonates diagnosed as TTN with abnormal CXR findings and group-B consisted of neonates diagnosed as TTN with normal CXR findings. Bedside lung ultrasound signs were documented in every patient in all the 3 parts of each lung, marked by the anterior and posterior axillary lines. Ultrasound of both lungs was performed by placing the probe at right angles parallel to the ribs. Ultrasound looked over the anterior, posterior and lateral chest walls of each lung in lying flat on back position in the unobtrusive state were executed at 4 hours of age in the Nursery by both (a senior registrar of radiology and a neonatologist) and then acquired portable CXR image. Clinical findings compared with CXR and lung ultrasound (LUS) separately. The radiologist re-examination and categorized the ultrasound findings as stated by the study protocol. The Ultrasound signs comprised of pleural lines, A-lines, B-lines, alveolar interstitial syndrome or white lung, double-lung point (DLP), lung consolidation accompanying air bronchograms or fluid broncho-grams, pneumothorax and pleural effusion were well defined as follows[6, 11, 12]. **Pleural lines** normally a consistent echogenic streak below the superficial layers of the chest that move throughout the respiratory cycle, while abnormal pleural lines defined as the pleural line that showed a loss of continuity, thickened, asymmetric, and or blurry appearance. **A-line** is a chain of echogenic, matching line midway between everyone below the pleural line. **B-lines**, also called as ultrasound lung comets are hyperechoic small-based artifacts spread out parallel to laser rays from the pleural line to the end of the screen. **Alveolar interstitial syndrome (AIS)** are the occurrence of > 3 B-lines in each inspected area. **White lung** was demarcated as the existence of compact B-lines in the 6 areas without horizontal reverberation. **Lung consolidation** was taken as zones of hepatization along with air bronchograms and/or fluid bronchograms. **Double lung point (DLP)** was change in the harshness or features of the pathological changes in different regions of the lung, lengthwise scrutiny demonstrates fair variations among the higher and lower lung areas; this acute breakpoint between the upper and lower lung areas is identified as the DLP. **Pleural effusion** was anechoic-relying on collections circumscribed by the diaphragm and the pleura. **Pneumothorax** was taken where four ultrasonography signs are valuable for ruling in and ruling out pneumothorax; the nonappearance of lung sliding, Nonappearance of B lines and lung pulse and occurrence of lung point (where a seashore sign alter to a stratosphere sign). Neonates having Hypoxic ischemic encephalopathy, meconium aspiration, polycythemia, congenital heart disease, major congenital malformations, intrauterine growth retardation (IUGR) and the baby died within 72 hours were excluded.

The Sample size was premeditated on the fact that TTN constituted from 0.5% to 2.8% of all deliveries by using the formula: n=N*X / (X + N-1), where, $X=Z_{\alpha/2}^2 *p*(1-p)/E^2$ and N is population size; E is the margin of error; X is assumed value i.e. 5% in this study, $Z_{\alpha/2}$ is the critical value of the Normal distribution, e.g. a confidence level of 95%, p is the sample proportion. The sample size was calculated to be 74.

Demographic data, including age, gender, gestational age, mode of delivery, heart rate, respiratory rate, blood oxygen saturation (O_2 Sat), fraction of inspired oxygen (FiO_2), blood potassium level and glucose level, arterial blood gases. CXR findings and US findings were recorded and entered into a predesigned proforma. Findings of LUS were studied in relation to CXR findings.

The sensitivity of lung ultrasonography and the sensitivity and the specificity of double lung point (DLP) were calculated to find out the accuracy of lung ultrasound. The results were analyzed using Microsoft Excel and SPSS version 20.

RESULTS

A total of 148 neonates between gestational age ≥34 weeks to 41+6 weeks with a clinical diagnosis of TTN based on the clinical history, physical examination and investigations admitted in NICU were signed up for this study and the cohort was distributed randomly into 2 groups. Each group consisted of 74 subjects. Demographically both groups were comparable with each other (P > 0.05) as shown in table No.1.

Out of the 148, 74% (109 cases) neonates were diagnosed as TTN on the basis of lung ultrasound findings while CXR was suggestive of TTN in 39% (74 cases) neonates, but there were 61% neonates (45 cases) in which no findings suggested present in CXR but lung ultrasound suggest the diagnosis of TTN (Table No.2).

Pleural line anomalies, A-line irregularities, and Alveolar interstitial lung syndrome (AIS) were realized in all (100%) neonates with TTN. The pleural line anomalies were looked at as denser, blurry lines with vanishing shadow in nature as compared to the normal appearance of pleural lines. A-lines abnormalities were incompletely fading in all cases and completely disappeared in 65% (71 cases) instead of partially disappeared (Figure no.1).

B-lines were present in 94.5 % (103 cases). AIS was present in 81.6% (89 cases) and white lung was observed in 36.6% (40 cases) (Figure No.2).

Out of 109 cases in whom lung ultrasound was suggestive of TTN, DLP was observed in 62% (68 cases) (Figure 3); out of 68 cases, DLP was present in 86.77% (59 cases) in those TTN neonates in which CXR was suggestive of TTN also. However, DLP was also present 13.23% (9 cases) in those neonates in which CXR was normal (Figure No.3). Consolidation either unilateral or bilateral were noted in 21% (23 cases). Pleural effusion was present in 10% (11 cases) in 109 cases. We did not found pneumothorax in any case. From these results, we calculate the sensitivity of lung ultrasound to diagnose TTN was 86.5% and sensitivity and specificity of DLP to diagnose TTN was 92.2% and 80% respectively (Table No. 3).

Table No.1. Comparison of demography (n=148)

Demographic sorts	Group 1 (n=74)	Group 2 (n=74)	P value
Age (Minutes) at the time admission mean ± SD	35.59± 6.86	35.54±8.85	0.46
Term Babies (≥ 37 weeks)	44 (59.45%)	36 (48.65%)	0.19
Preterm (34 to 36+6 weeks)	30 (40.55%)	38 (51.35%)	0.19
Males	47 (63.51%)	39 (52.7%)	0.40
Females	27 (36.49%)	35(47.3%)	0.40
Cesarean delivery	35 (47.3%)	29 (39.19%)	0.31
Spontaneous vaginal delivery	39 (52.7%)	45 (60.81%)	0.31
Birth weight in kg mean ± SD	2.46 ± 0.59	2.47 ± 0.54	0.37
White blood cell count mean ± SD	16.06 ± 6.86	15.35 ± 7.47	0.54
Hemoglobin in g/dL mean ± SD	15.29 ± 2.96	15.58± 2.37	0.51
Apgar score at 5th minute mean ± SD	7.59 ± 0.61	7.98 ± 0.68	0.62

Table No.2. Distribution of patients on the basis of CXR findings and the Lung gs. (n=148)

Lung Ultrasound	CXR Findings		Total
	TTN Positive	TTN Negative	
TTN Positive	64 86.5%	45 61%	109 74%
TTN Negative	10 13.5%	29 39%	39 26%
Total	74	74	148

Sensitivity	86.49%	76.55% to 93.32%
Specificity	39.19%	28.04% to 51.23%
Positive Predictive Value	58.72%	53.70% to 63.55%
Negative Predictive Value	74.36%	60.40% to 84.65%
Accuracy	62.84%	54.52% to 70.63%

Table No.3. Distribution of patients on the basis of CXR findings and the Double Lung Point: An Ultrasound finding. (n=148).

Double Lung Point	CXR Findings		Total
	TTN Positive	TTN Negative	
TTN Positive	59 92.2%	9 20%	68 62.4%
TTN Negative	5 7.8%	36 80%	41 37.6%
Total	64	45	148

Sensitivity	92.19%	82.70% to 97.41%
Specificity	80.00%	65.40% to 90.42%
Positive Predictive Value	86.76%	78.44% to 92.19%
Negative Predictive Value	87.80%	75.40% to 94.42%
Accuracy	87.16%	79.39% to 92.80%

1. neonates. Neonatology. 2019;115(1):77-84.

Figure 1. Lung Ultrasound showed Alveolar interstitial syndrome with pleural line abnormalities, A-lines disappeared in full-term neonates with TTN.

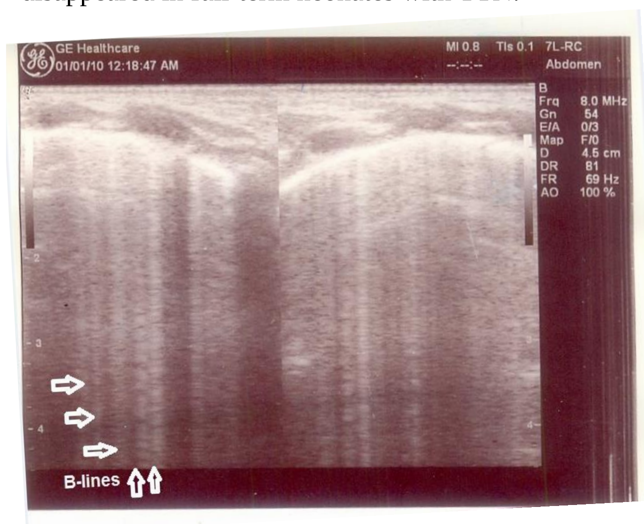
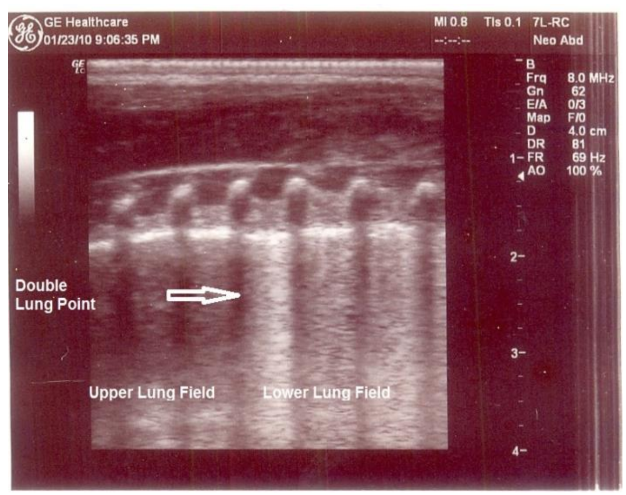


Figure 2: B lines in neonates with Transient Tachypnea of Newborn



Figures 3. Lung Ultrasound showed Double lung Point in neonates with TTN

DISCUSSION

The results of this study confirmed that the usage of LUS to diagnose neonatal respiratory diseases is not only a simple rather precise and trustworthy way of examination of newborns for early diagnosis of TTN. Out of the 148 cases, LUS suggested the diagnosis of TTN in 74% neonates while CXR was expressed only in 39% neonates furthermore LUS also suggests i.e. 61% the diagnosis of TTN in those neonates in which CXR was normal with no findings but lung ultrasound suggest TTN. Similar interpretations had been perceived in studies conducted at Italy[13-16], china [17, 18], india[19] and Iran[20].

The core pathological mechanism of TTN is the persistence of water content in the neonatal lung, which is presented as an interstitial syndrome on ultrasonography[21]. Hence, the interstitial syndrome is the supreme significant commonest ultrasonic feature of TTN[16]. Pleural line, Interstitial syndrome and A-line is not a continuous feature of TTN[16].

Abnormalities of Pleural line, A-line appeared looked denser, blurry lines with vanishing shadow in nature as compared to normal appearance is observed in all cases of TTN. They were incompletely fading in all cases and completely died out in 65% of cases instead of partially disappeared.

The Alveolar interstitial lung syndrome was present in 81.6% of cases and in severe cases of TTN are manifested as white lung i.e. 36.6%. A similar reflection had been noted by Jing Liu *et al*[6], Vergine M *et al* [10], Copetti R *et al* [12], and Patel S *et al*[19] which coincides with our reflections. The A-line abnormalities among pleural line abnormalities are nonspecific for TTN because these abnormalities are observed in other respiratory disorders too like RDS[22], pulmonary hemorrhage[6] and neonatal pneumonia[23].

B line abnormalities are not only originated in TTN but these B line abnormalities are also brought into being in RDS[20, 23]. In this study, B lines abnormalities are present in 94.5% of cases and sensitivity calculated to be 90.6%. Zarei E *et al*[20] perceived B line abnormalities less (32.8%) than our observation i.e.73.4%. The reason was maybe fewer patients in the Zarei E *et al* study. But Jing Liu[23] had perceived similar results as in the present study and sensitivity and specificity of B-line abnormalities calculated to be 33.8% and 91.3% respectively in diagnosing TTN and in another study Jing Liu[6] had slightly much better results i.e. B line sensitivity of 100% and a specificity of 95.3%. The present study demonstrated the occurrence of a white lung and compact B -line is a sensitive and specific hint of severe TTN rather than the presence of DLP. The present study exposed, the white lung was frequently detected into some extent severe cases of TTN, while DLP was more repeatedly appreciated in neonates with fewer severe TTN.

In addition to other pleural line abnormalities, the key ultrasonic examination signs of TTN found to be Double lung point (DLP) was present in 86.77% cases in this study, which are similar to the conclusions made by Jing Liu *et al*[6], Vergine M *et al* [10], Patel S *et al* [19] and Chen SW *et al*[24] i.e. 76.7%, 71.4%, 81.5%, and 34.1% respectively. This deviation might be due to altered disease severity. The DLP was appreciated the unilateral side and interstitial lung syndrome or white lung on the contralateral side; pleural effusion could be on one side of the chest only. This aspect pointed to water content inside the lung tissue i.e. the level of pulmonary edema is diverse in different areas of the lung was a consistent story in TTN. Consequently, LUS get favor for advance understanding of lung disorders such as TTN.

The Sensitivity and specificity of DLP in making a diagnosis of TTN was calculated at 92.2% and 80% respectively in this study, which are in agreement with the results calculated to be 100% of Copetti R *et al* [12], Jing Liu *et al* [23], M Ibrahim *et al* [22] and Zarei E *et al*[20] while M Ibrahim *et al* [22] had found a bit less value of sensitivity i.e. 69.6% of DLP make a diagnosis of TTN and less severity of the disease may be the one reason for this.

Pleural effusion was present in 17.4% which are in agreement with Jing Liu *et al*[23] and Chen SW *et al*[24] from the results, we calculated the sensitivity of lung ultrasound to diagnose TTN was 86.5% which matched with the results i.e. 93.3%, 89.09% and 100% by Vergine M *et al*[10] Zarei E *et al*[20] Corsini L[25] respectively. Study has limitations of smaller sample size.

CONCLUSIONS

Lung Ultrasonography has fair and double lung point has good diagnostic accuracy in diagnosing transient tachypnea in neonates.

Disclaimer: None
Conflict of Interest: None.

Source of Funding: None.

ETHICAL APPROVAL

The study was approved by the Department of Medical Education, Quaid-e-Azam Medical College, Bahawalpur vide Reference No.465/DMC/QAMC Bahawalpur Dated 26.09.2018

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AUTHOR’S CONTRIBUTIONS

MA: Manuscript writing, Data Interpretation, Data collection, Research work
TA: Data Interpretation, Data collection, Study Design
NI: Data Interpretation, Data collection, Research Work
MAA, KW, MB: Data collection, Research Work