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LUNG SONOGRAPHY, A NEW IMAGING MODALITY IN THE DIAGNOSIS OF PEDIATRIC PNEUMONIA.

Radiodiagnosis

Imran Hamid	Postgraduate student department of radiodiagnosis and imaging SKIMS Srinagar
Sheikh Riaz Rasool*	Professor department of radiodiagnosis and imaging SKIMS Srinagar *Corresponding Author
Irfan Robbani	Professor department of radiodiagnosis and imaging SKIMS Srinagar
Tariq Ahmad Gojwari	Professor department of radiodiagnosis and imaging SKIMS Srinagar
Feroze Shaheen	Professor department of radiodiagnosis and imaging SKIMS Srinagar
Mushtaq Ahmad Bhat	Professor department of pediatrics and neonatology, SKIMS Srinagar

KEYWORDS

INTRODUCTION

Pneumonia is defined as inflammation of the lung parenchyma. It is the leading cause of death under 5 years of age globally and accounts for an estimated 1.2 million (18% total) deaths annually.

The diagnosis of pneumonia in children is based on clinical symptoms, Good clinical examination, Laboratory Investigations which includes; Peripheral WBC count, ESR, Procalcitonin, CRP. Imaging modalities which includes; Chest Radiography, Lung Ultrasonography, CT Scan.[1]

Chest radiography is the primary imaging study used to confirm the diagnosis of pneumonia. Chest radiography is indicated in an infant or toddler, who presents with fever with any one of the following; tachypnea, nasal flaring, retractions, grunting, rales, decreased breath sounds, respiratorydistress.

In older children and adults, the diagnosis of pneumonia is often based on clinical presentation. Chest radiography is indicated in complicated cases, in whom treatment fails to illicit a response, or in those who require hospitalization. In complicated cases of pneumonia, CXR is

performed 6 weeks after treatment to verify resolution of pneumonia and to screen for any underlying predisposing condition such as sequestration.

Computed tomography scanning is increasingly used in clinical practice, but various groups have questioned its usefulness in evaluating pneumonia.[2]

Lung ultrasound has become an essential part of chest imaging in pediatric population. Point of care use of portable or hand held ultrasonography is highly sensitive and specific in diagnosing pneumonia in children by determining lung consolidations and air bronchograms or effusions. Small effusions can be localized for aspiration at the bedside. Lung sonography is emerging as a potential alternative to chest radiography, being radiation free, relatively affordable, and feasible at the point of care. USG has a number of advantages as it is easy to do it at child's bedside, takes little time to perform and interpret the results, allows close follow up and avoids the use of ionising radiations, which is particularly important in pediatric patients because children are fourtimesmore sensitive than adults for the induction of cancer (3,4,5,6,7)

This Study was undertaken to study the Efficacy of Lung Sonography in the diagnosis of pediatric pneumonia compared to chest radiography.

PATIENTS AND METHODS:

It was a hospital based prospective observational study conducted in the Department of Radio diagnosis and Imaging at Sher-i-Kashmir Institute of Medical Sciences, Srinagar in collaboration with the Department of Pediatrics and Neonatology. All patients in the age group of 2 months to 16 years with clinical diagnosis of pneumonia as per WHO guidelines were included in the study. Pre-established cases of pyrexia and cough other than pneumonia were excluded from the study. In all cases, informed consent was taken from guardian of the patient before entering the study.

Diagnosis of pneumonia was confirmed clinically as per WHO guidelines.[2]

All patients were subjected to CXR which was done in erect posture. The x ray was reported by an expert radiologist in accordance with WHO criteria for the standardized interpretation of pediatric chest radiographs [29]. The consolidation on chestx ray was defined as dense, often homogeneous, confluent alveolar infiltrate or fluffy, mass-like or cloud-like, density that erases heart or diaphragm borders (silhouette sign) with or without air bronchograms. The pleural effusion was defined as fluid collection in pleural space. The lung ultrasound was done in all patients within 24 hours of obtaining CXR. The LUS was performed on sonosite and GE LOGIQ P5 ultrasound machine with the use of linear array transducer (6-13MHz) and curved array transducer (2-5MHz). For Lung sonography, a six zone scanning technique was used for imaging the chest. The probes were placed perpendicularly, transversely, and obliquely in the mid-clavicular line anteriorly and posteriorly and in the mid- axillary line from axilla to diaphragm. The definition of pneumonia on LUS was the sonographic findings of lung consolidation with air bronchograms and sub-centimetric pneumonia as focal consolidation with sonographic air bronchograms less than 1 cm in diameter that are un-detectable on CXR.
Sonographic results were defined as [18,19]

1. Normal**:** Presence of A-lines without B- lines and regular pleuralline.
2. Consolidation**:** Hypoechogenic area of varying size and shape with poorly defined borders with airbronchograms.
3. Pleural effusion**:** Presence of fluid greater than 3 mm in width within pleural space. (Figure-1)

The CXR and LUS were compared with each other for consolidation, air bronchogram and pleural effusion.

RESULTS

The current study was conducted in total number of 70 patients over a period of two years, which included 40 male and 30 female patients. Patientsranged in age from 2 months to 16 years (mean age of 4.62 years, SD±3.57 years, median: 4 years, interquartile range 5 years). Cough was the most common symptom in 91.4% of the cases followed by difficulty breathing in 58.7% of cases followed by fever in 52.8% of cases. **(Table 1)**

Table 1

S.NO	Characteristic	Mean/No.(%)
1	Age	4.62 years
2	Male sex	57%
3	Cough	91.4%
4	Difficulty Breathing	58.7%
5	Fever	52.8%

Lung sonography showed consolidation in 65(92.9%) out of 70 clinically diagnosed cases of pneumonia whereas only 59(84.3%) patients revealed consolidation on CXR. Pleural effusion was present on LUS in 18(25.7%) patients, whereas only 7 (10%) patients showed effusion on CXR. The difference between LUS and CXR regarding the detection of consolidation and effusion was statistically significant (p-value <0.0001). Air bronchogram was present in 46(65.7%) patients on LUS compared to CXR which showed air bronchogram in only 11(15.7%) patients. The difference was statistically significant (p-value 0.041). **(Table 2)**

Table:2

	LUS N=70(%)	CXR N=70(%)	p-value	S
Consolidation	65(92.9%)	59(84.3)	<0.0001	+
Air bronchogram	46(65.7%)	11(15.7%)	0.041	+
Pleural effusion	18(25.7%)	7(10%)	<0.0001	+
Abscess	2(2.85%)	1(1.42%)		

Comparison regarding consolidation, air bronchogram and pleural effusion between LUS and CXR In our study, out of 70 patients, 58(82.86%) showed features of pneumonia on both LUS and CXR. 6 out of 58 patientsshowed associated sub-centimetric consolidation in same or other lobe on LUS, which was not detected by CXR. Eleven patients were negative on CXR, out of which 7 patients revealed features of pneumonia on LUS. Five patients were negative on LUS out of which one patient showed features of pneumonia on CXR. Four patients were negative on both LUS and CXR, out of which two patients were found to have features of lung abscess on LUS, however only one patient showed features of lung abscess on CXR. The difference between CXR and LUS in detecting features of pneumonia is statistically significant (p-value <0.0001). **(Table 3)**

Table 3

	USG positive	USG negative	Total	P value
Chest x				
ray	58	1	59(84.3%)	
positive				
Chest x				
ray	7	4	11(15.7%)	<0.000
negative				1
Total	65(92.9%)	5(7.1%)	70(100%)	

DISCUSSION:

Early diagnosis and management of pneumonia is critical to short- and long-term health outcomes. Clinical examination is highly sensitive but lacks specificity and results in over diagnosis contributing to theoveruse of antibiotics [8]. Chest X- ray is considered as the investigation of choice for diagnosis of pneumonia. One of the limitations of radiography is the risk of damage from ionizing radiation, which is greater for children than for adults because children are more sensitive to ionizing radiation exposure [9, 10]. Other concerns with radiography are great variability in the interpretation, lack of reproducibility and delay in availability of the film [11,12]. Weinberg et al first described the use of LUS in evaluating CAP[13]

Numerous studies have reported high diagnostic accuracy of ultrasonography imaging and indicated that LUS is excellent tool for detecting pneumonia in children [14,15]. For these reasons, LUS should be the main alternative to CXR or, at the least, the first-line examination. The LUS features of pneumonia mainly include sub pleural lung consolidation, pleural line abnormalities, confluent B-lines and synpneumonic pleural effusions [15].

In our study, there were a total of 70 patients which included 40 male patients (57%) and 30 female patients (43%). Ageranged from 2 months to 16 years (mean age of 4.62 years, SD±3.57 years, median: 4 years, interquartile range 5 years). Cough was the most common symptom in 91.4% of the cases followed by difficulty breathing in58.7% of cases followed by fever in 52.8% of cases. This is in near agreement with study conducted by GiulioIorioetal[16], in which 47 patients of pneumonia in the age group of 1 month to 12 years (57.4% males and 42.6% females) were included in the study, where cough was the most common symptom of studypatients.

CXR showed consolidation in59(84.3%) patients. Out of 59 patients, consolidation with air bronchogram was present in 11(15.72%) patients, and consolidation with pleural effusion was present in 7 (10%) patients, whereas only consolidation was present in 41 (58.57%) patients. LUS showed consolidation in 65(92.9%) patients. Out of 65 patients, subpleural consolidation with air bronchogram was present in 22(31.4%) patients, consolidation with confluent B- lines was present in 10(14.3%) patients, consolidation with pleural line abnormalities was present in 9(12.9%) patients, consolidation with air bronchogram and pleural effusion was seen in 18(25.7%) patients, consolidation with air bronchogram withassociatedsub-centimetric consolidation in same or other lobe was present in 6(8.5%) patients. LUS detected consolidation in 65(92.9%) patients out of 70 whereas CXR detected consolidationin only 59 (84.3%) patients. The difference was statistically significant(p-value <0.0001). This was in accordance with the study conducted by MC Ho et al [22] which showed 92.6%(151 patients out of 163) cases of pneumonia detected by CXR compared to 97.5% (159 patients out of 163) detected by LUS. Similar results were found in studies performed by Tirdia PR et al[17].

LUS showed air bronchogram in 46(65.7%) patients out of 70, whereas air bronchogram was seen in only 11(15.7%) patients on CXR. The difference was statistically significant (p value 0.041). This is in agreement with study conducted by Mohamed, et al[20] which showed air bronchogram in 23% (9 out of 40) cases on CXR compared to 63% (25 out of 40) cases detected on LUS.

Pleural effusion (synpneumonic) was seen in 18 (25.7%) patients on LUS whereas CXR revealed pleural effusion in only 7 (10%) patients. The difference was statistically significant (p value< 0.0001).This was seen in near agreement with Study conducted by TirdiaPR, Vajpayee S, Singh J et al [17] which showed synpneumonic pleural effusion in 15.83% patients by LUS compared to 5.03% patients byCXR.In our study, LUS had a sensitivity of 92.85% and specificity of 100% compared to sensitivity of 84.28% and specificity of 100% by CXR. The PPV and NPV of LUS in diagnosing pneumonia in children are 100% and 80% respectively where as PPV and NPV of CXR are respectively 100% and 36.36%.Therefore, our study confirms that LUS is more sensitive but equally specific compared to CXR in diagnosing pneumonia inchildren.Thisisinnearagreementwith study conducted by Mohamed, et al [20]which showed 86.67% sensitivity and 100% specificity of LUS compared to sensitivity of 68.42% and specificity of 100% by CXR while diagnosing pneumonia in children. Pereda[15] in meta analysis found that LUS had a sensitivity of 96% and specificity of 93%. Various other studies revealed sensitivity of 86% to 97.9% and specificity of 94.5% to 100% of LUS while diagnosing pneumonia in children[23,24]

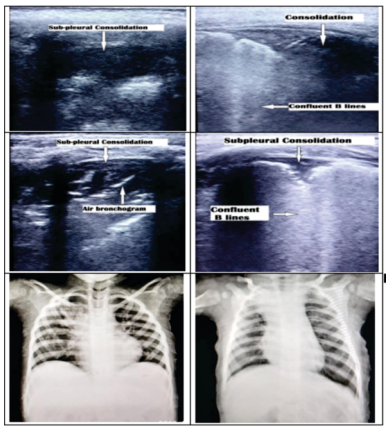

Figure_1

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