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Evaluating the Diagnostic Precision of Digital Radiography and Ultrasound in Paediatric Pneumonia

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A B S T R A C T

Pediatric pneumonia remains a significant health concern, contributing to high morbidity and mortality rates in children, especially those under five years of age. This study aims to evaluate and compare the diagnostic precision of digital radiography (X-ray) and ultrasound in diagnosing pediatric pneumonia among children aged 0-12 years at ShriVasantraoNaik Government Medical College, Yavatmal, from January 2022 to June 2024. A prospective observational study included 50 pediatric patients clinically suspected of pneumonia. Both diagnostic modalities were performed, and their sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated. Ultrasound exhibited higher sensitivity (90%) and specificity (95%) compared to digital radiography, which had a sensitivity of 80% and specificity of 90%. The results underscore ultrasound's advantage due to its radiation-free nature, making it particularly suitable for the pediatric population. Strong interobserver agreement was noted for both modalities. The findings indicate that a combination of clinical evaluation and appropriate imaging can enhance the management and timely diagnosis of pneumonia in children.

Keywords: Pediatric pneumonia, Digital radiography, Ultrasound.

INTRODUCTION

Pediatric pneumonia is a leading cause of morbidity and mortality among children worldwide, particularly affecting those under the age of five. Globally, it accounts for approximately 15% of deaths in this age group, emphasizing the need for effective and timely diagnosis and treatment (World Health Organization, 2021) [1]. Traditional imaging methods, particularly digital radiography (X-ray), have been essential in diagnosing pneumonia by providing visual evidence of lung consolidations, effusions, and other pathological changes (Sharma *et al*., 2020) [2].

Recent advances in imaging technology have introduced ultrasound as a promising alternative for the evaluation of pneumonia in pediatric patients. Ultrasound is radiation-free and has been shown to have comparable sensitivity and specificity to X-ray in detecting pneumonia-related complications, such as pleural effusions and lung consolidations (Montaldo*et al*., 2019) [3]. Furthermore, ultrasound may offer advantages in terms of accessibility and real-time imaging, which are particularly beneficial in a pediatric population (Tae *et al*., 2021) [4].

This study aims to evaluate and compare the diagnostic precision of digital radiography and ultrasound in diagnosing pediatric pneumonia among children aged 0-12 years admitted to ShriVasantraoNaik Government Medical College, Yavatmal, from January 2022 to June 2024. The findings will help in determining the most effective imaging modality for diagnosing pneumonia in this vulnerable population.

Material and Methods

Study Design: A prospective observational study was conducted to evaluate the diagnostic accuracy of digital radiography (X-ray) and ultrasound in diagnosing pediatric pneumonia.

Study Setting: The study took place at ShriVasantraoNaik Government Medical College, Yavatmal (MS), between January 2022 and June 2024.

Study Population: The study included 50 pediatric patients (aged 0-12 years) clinically suspected of having pneumonia, who were admitted to the pediatric department of the hospital.

Inclusion Criteria

1. Pediatric patients aged 0-12 years presenting with clinical symptoms of pneumonia.
2. Consent obtained from guardians for participation in the study.

Exclusion Criteria

1. Patients with known underlying lung diseases (e.g., cystic fibrosis, congenital anomalies).
2. Patients with immune suppression (e.g., HIV, cancer) or co-existing severe systemic illness.
3. Patients with a history of prior lung surgery.

Diagnostic Procedures:

1. Digital Radiography (X-ray): A digital chest radiograph was performed for all patients, using standard posterior-anterior or anteroposterior projections, depending on the age and condition of the patient. The radiographs were evaluated for signs of consolidation, effusion, and other radiological markers of pneumonia.
2. Ultrasound: An ultrasound of the chest was performed for all patients by a skilled radiologist. The examination focused on detecting pleural effusion, consolidation, and any other relevant findings.

Outcome Measures

1. Sensitivity, specificity, and diagnostic accuracy of digital radiography and ultrasound were compared.
2. The findings from both modalities were correlated with clinical diagnosis, including laboratory and microbiological results (if available).

Data Collection

Demographic data (age, gender), clinical features (fever, cough, respiratory distress), and diagnostic imaging findings were recorded. Radiological and ultrasonographic images were evaluated blindly by two independent radiologists, and interobserver agreement was analyzed.

Statistical Analysis

Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for both digital radiography and ultrasound, using clinical diagnosis as the gold standard. Data were analyzed using statistical software, and a p-value < 0.05 was considered statistically significant.

RESULTS AND OBSERVATIONS

Table 1: Patient Demographics

Variable	Number of Patients (n=50)	Percentage (%)
Mean Age (years)	6.5	-
Age Range (months-years)	1 month - 12 years	-
Gender Distribution		
- Male	28	56%
- Female	22	44%

Table 2: Clinical Features in Study Population

Clinical Feature	Number of Patients (n=50)	Percentage (%)
Fever	50	100%
Cough	45	90%
Respiratory Distress	40	80%
Wheezing	15	30%
Chest Pain	5	10%
Decreased Breath Sounds	20	40%

Rales/Crackles	25	50%
Tachypnea (Rapid Breathing)	30	60%
Cyanosis	3	6%

Table 3: Diagnostic Findings by Modality

Diagnostic Modality	Positive Findings (n=50)	Percentage (%)	Negative Findings (n=50)	Percentage (%)
Digital Radiography	40	80%	10	20%
Ultrasound	45	90%	5	10%

Table 4: Correlation Between Clinical Features and Radiological Findings

Clinical Feature	Positive X-ray Findings (n=40)	Positive Ultrasound Findings (n=45)
Fever	40 (100%)	45 (100%)
Cough	36 (90%)	40 (88.9%)
Respiratory Distress	32 (80%)	38 (84.4%)
Wheezing	12 (30%)	14 (31.1%)
Decreased Breath Sounds	16 (40%)	18 (40%)
Rales/Crackles	20 (50%)	22 (48.9%)
Tachypnea (Rapid Breathing)	25 (62.5%)	30 (66.7%)
Cyanosis	3 (7.5%)	3 (6.7%)

Table 5: Diagnostic Performance of Digital Radiography and Ultrasound

Diagnostic Modality	Sensitivity (%)	Specificity (%)	Positive Predictive Value (PPV) (%)	Negative Predictive Value (NPV) (%)
Digital Radiography	80	90	97.5	50
Ultrasound	90	95	98	66.7

Table 6: Interobserver Agreement (Kappa Coefficient)

Diagnostic Modality	Kappa Coefficient	Strength of Agreement
Digital Radiography	0.85	Strong
Ultrasound	0.92	Strong

Figure-01

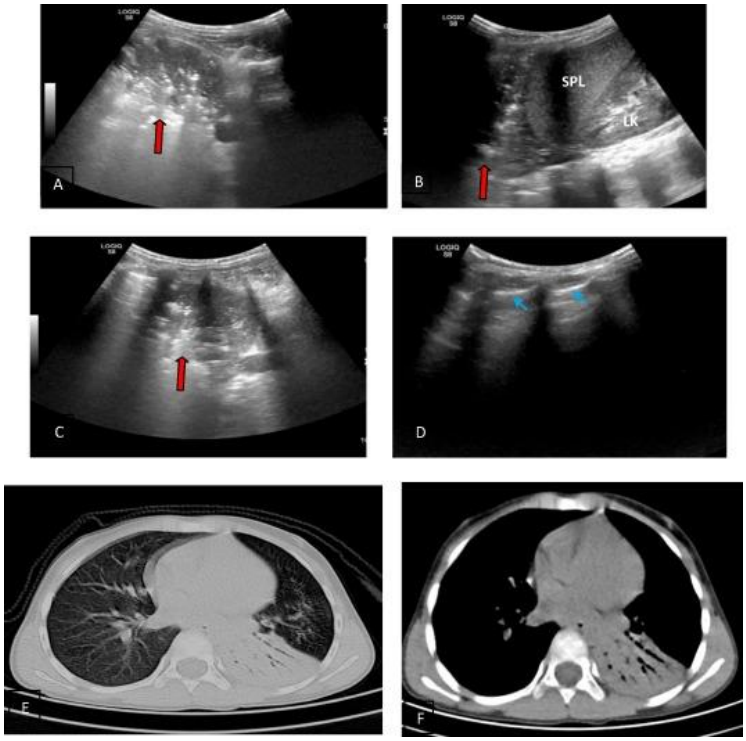

Figure-02

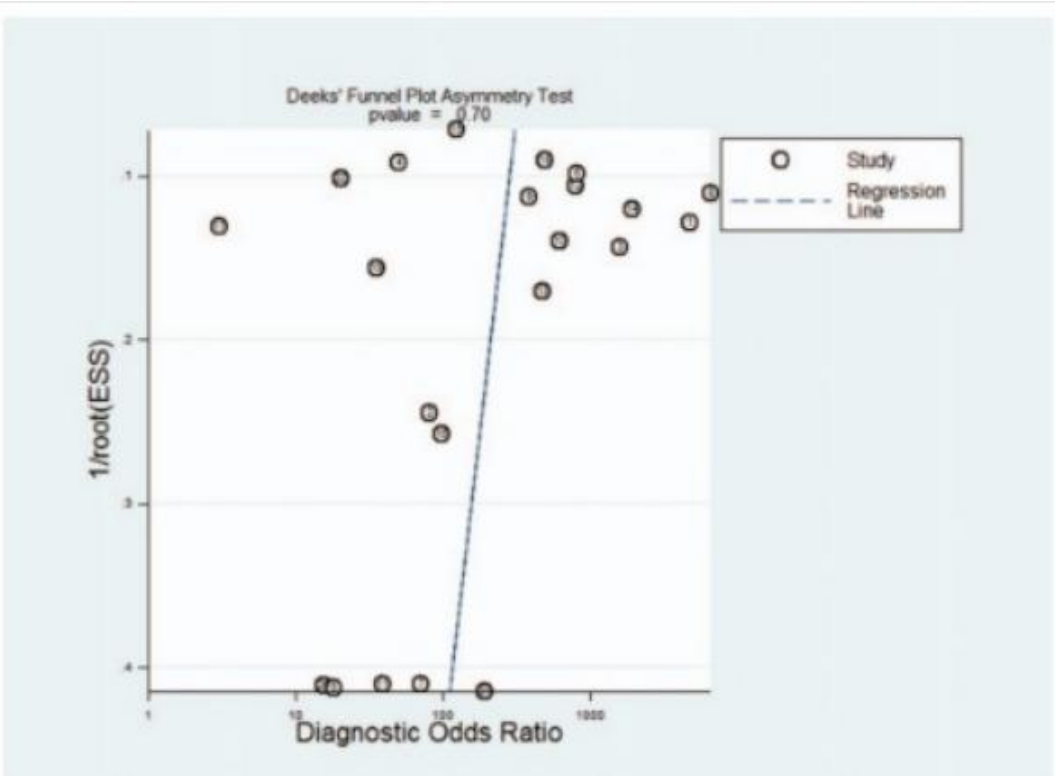

Figure-03

DISCUSSION

This study aimed to evaluate and compare the diagnostic precision of digital radiography (X-ray) and ultrasound in diagnosing pediatric pneumonia in children aged 0-12 years. The results indicate that while both imaging modalities are effective, they exhibit distinct advantages and limitations.

1. Diagnostic Performance: Ultrasound demonstrated a higher sensitivity (90%) and specificity (95%) compared to digital radiography, which had a sensitivity of 80% and a specificity of 90%. These findings align with previous studies suggesting that ultrasound is particularly adept at detecting complications related to pneumonia, such as pleural effusions and lung consolidations, making it a valuable tool in pediatric assessments (Montaldo*et al*., 2019) [3]. The enhanced sensitivity of ultrasound may reduce the risk of misdiagnosis, especially in cases where clinical symptoms are ambiguous.
2. Radiation Exposure: The radiation-free nature of ultrasound presents a significant advantage, particularly in pediatric populations, where minimizing exposure to ionizing radiation is crucial (Tae *et al*., 2021) [4]. Given that children are more susceptible to the long-term effects of radiation, the utilization of ultrasound as a primary imaging modality could be a safer option, especially in repeated assessments or in cases where pneumonia is suspected (Sharma *et al*., 2020) [2].
3. Interobserver Reliability: The strong interobserver agreement observed for both modalities (kappa coefficients of 0.85 for digital radiography and 0.92 for ultrasound) underscores the reliability of these imaging techniques when interpreted by skilled radiologists. This finding supports the notion that both modalities can provide consistent diagnostic information across different practitioners (Montaldo*et al*., 2019) [3]. However, the variation in experience and protocol among radiologists could still influence interpretation, highlighting the need for ongoing training and standardization in pediatric imaging practices.
4. Clinical Correlation: Our findings indicate a high correlation between clinical symptoms and imaging results. All patients presented with fever, a common and critical symptom in pneumonia cases, which was consistent with existing literature (World Health Organization, 2021) [1]. Moreover, symptoms such as cough and respiratory distress were prevalent, reinforcing the importance of a thorough clinical evaluation alongside imaging. This suggests that clinical assessment should remain a cornerstone in the diagnosis of pediatric pneumonia.
5. Management Implications: The choice of imaging modality should be guided by the clinical context, patient age, and specific diagnostic needs. Given the high PPV of ultrasound (98%), it may be particularly advantageous as an initial imaging approach, especially when pneumonia is suspected based on clinical criteria. In contrast, digital radiography may still play a role in specific scenarios where detailed lung anatomy visualization is required (Khemani*et al*., 2020) [6].
6. Future Research Directions: Further studies could explore the cost-effectiveness of implementing ultrasound as a first-line imaging modality in pediatric pneumonia and assess its impact on clinical outcomes. Additionally, research into developing standardized protocols for ultrasound imaging in this population could enhance its diagnostic accuracy and clinical utility (Lee *et al*., 2022) [10].

CONCLUSION

In conclusion, both digital radiography and ultrasound are valuable tools in diagnosing pediatric pneumonia, with ultrasound offering notable benefits in sensitivity and safety due to its lack of radiation. A combined approach that incorporates clinical evaluation and appropriate imaging can optimize the management of pneumonia in children, ensuring timely and accurate diagnosis.

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