Section: Radiodiagnosis

Original Research Article

COMPARISON OF CHEST ULTRASOUND AND CHEST X-RAY IN PEDIATRIC PULMONARY TUBERCULOSIS- A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Tuberculosis remains a significant cause of morbidity and mortality worldwide, particularly among children. The diagnosis of pulmonary tuberculosis in pediatric patients is challenging due to the limitations of current diagnostic methods. The objective is to compare the diagnostic accuracy of chest ultrasound and chest X-ray in pediatric pulmonary tuberculosis.

Materials and Methods: A cross-sectional study was conducted among 130 children under the age of 14 suspected of having pulmonary tuberculosis. Chest X-ray and ultrasound findings were correlated with sputum test and Cartridge-Based Nucleic Acid Amplification Test (CBNAAT) results.

Results: The study found that chest ultrasound was more accurate in detecting pleural effusion-related conditions, while chest X-ray was more accurate in detecting lymphadenopathy. The CBNAAT positivity rates varied based on different chest ultrasound findings, with consolidation and pleural effusion with consolidation showing higher positivity rates.

Conclusion: Chest ultrasound emerges as a valuable diagnostic tool in pediatric pulmonary tuberculosis, particularly for detecting pleural effusion-related conditions. The study highlights the importance of comprehensive diagnostic evaluations and the potential for increased utilization of chest ultrasound in clinical practice.

Keywords: Pediatric pulmonary tuberculosis, chest ultrasound, chest X-ray, CBNAAT, diagnostic accuracy.

INTRODUCTION

One of the leading causes of death and morbidity in the globe is tuberculosis. Every year, more than 1 million children under the age of 15 get it, and more than half of them go undiagnosed or unreported.[1] Due to limited diagnostic capability and lack of sensitive diagnostic test, the youngest children have the highest percentage of these “missing children”. The HIV epidemic, homelessness, drug misuse, poverty, and immigration have all contributed to the worsening of this issue.

It is difficult to diagnose pulmonary tuberculosis due to paucibacillary illness, ambiguous signs and symptoms and challenges in collecting sufficient sputum samples. In children, a primary infection can develop in any lung zone. The most prevalent radiographic characteristic of primary pulmonary tuberculosis is lymphadenopathy. Additional parenchymal abnormalities include interstitial opacification and alveolar consolidation. Most often in the right hilar and right paratracheal areas, a Ghon's complex is established in the afflicted area, with Ghon's focus and draining lymph nodes exhibiting adenopathy. Known as progressive primary pulmonary tuberculosis, 5–10% of children exhibit enlargement and caseous necrosis of the original focus. As a result, endobronchial expansion and military dissemination may occur.[2]

In post pubescent children, adult type post primary pulmonary TB can also be seen with cavities in upper lobe and apices of lung lobes at the bottom. Chest ultrasonography is a promising diagnostic tool, particularly for pediatric patients with tuberculosis, offering several advantages over chest X-ray. Its benefits include the absence of ionizing radiation,

allowing for repeated use without cumulative radiation exposure risks, bedside mobility and accessibility, cost-effectiveness, and real-time imaging capabilities. Ultrasound can detect lung consolidations, evaluate pleural thickness and chest wall involvement, and provide vital information for diagnosis and treatment. In pediatric patients, chest ultrasound is especially valuable due to the challenges of interpreting chest X-rays in this population, such as the presence of the thymus and small size of implicated structures. Overall, chest ultrasonography has emerged as a valuable diagnostic tool in thoracic imaging, particularly for pediatric tuberculosis diagnosis.[3] Hence, the present study was carried to compare chest ultrasound with chest X-ray findings for pediatric pulmonary tuberculosis.

MATERIALS AND METHODS

The present cross-sectional study was conducted among 130 children under the age of 14 who were suspected of having pulmonary tuberculosis at the Department of Radiodiagnosis in collaboration with the Department of Chest and TB at Rohilkhand Medical College and Hospital in Bareilly. The study spanned over a period of one year, from August 1, 2023, to July 31, 2024. The study was done after approval from the Institutional Ethics Committee.

The inclusion criteria consisted of children who had sputum positive for Mycobacterium tuberculosis, as well as those who tested positive for CBNAAT (Cartridge-Based Nucleic Acid Amplification Test). Additionally, children with a chest X-ray suggestive of pulmonary tuberculosis with pleural effusion were also included in the study. These criteria helped identify children with confirmed or suspected pulmonary TB, allowing for further evaluation and analysis. The exclusion criteria composed of children who were unable to provide an adequate sample for pathological testing, thereby limiting the accuracy of diagnostic results. Additionally, children with exclusively extrapulmonary tuberculosis, meaning those with TB outside of the lungs, were also excluded from the study.

After IEC approval, children under 14 years of age group presenting with any of the following symptoms:

- Cough > 2 weeks
- Fever > 2 weeks
- Definitive weight loss / failure to thrive
- History of contact / Exposure to pulmonary TB in past 2 years
- Gradually enlarging painless lymph node, especially in neck
- Swelling in the back- Gibbus deformity

Or having sputum smear tested positive for Mycobacterium Tuberculosis and CBNAAT were enrolled and informed consent was taken from every patient/parent and X-ray chest PA view was taken.

Ultrasound examination of chest was carried out by Samsung HS 70, HS 40 and V 7 machines. A curvilinear probe of frequency 2-5 MHz and linear probe of frequency 5- 12 MHz was used to scan the chest. The children were scanned in sitting and supine position in left and right lateral decubitus position to examine lungs and pleura. The chest was divided into 6 regions: the left and right; upper, middle and lower zones. The findings of chest X-ray and ultrasound was noted and correlated.

The data was entered into Microsoft excel spreadsheet. Analysis was done using SPSS licenced version 23.0. Descriptive analysis was done by calculating proportions, mean and standard deviation. Appropriate statistical tests were applied depending on the distribution and type of data.A $p < 0.05$ was considered statistically significant.

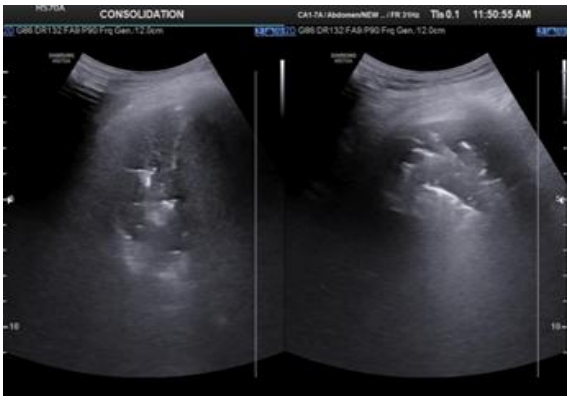

Figure 1: consolidation on USG

Figure 2: Pleural Effusion On USG

Figure 3: Consolidation On X-Ray

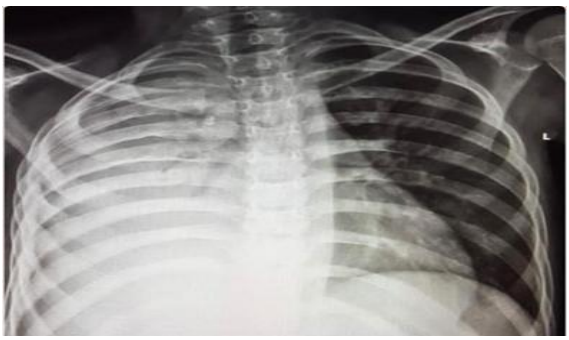

Figure 4: Pleural Effusion On X-Ray

RESULTS

In our research involving 130 cases, the age group of 9 to 14 years constituted the majority, accounting for 70.8% of the total (table 1). This was followed by the 5 to 9 years age group, which represented 23.1% of the cases, while those in the 1 to 5 years age group comprised 6.2%. The average age of the participants in this study was calculated to be 11.28 years, with a standard deviation of 3.12 years.

Table 1: Age distribution.

Age group (In Years)	Frequency	Percentage
1-5	8	6.2
5-9	30	23.1
9-14	92	70.8
Total	130	100.0

Table 2: chest x-ray findings vs sputum test:

	Sputum test					
Chest x-ray findings	Negative		Positive		Total	
	Number	%	Number	%	Number	%
No findings	5	100.0	0	0.0	5	100.0
Consolidation, Cavitation	3	100.0	0	0.0	3	100.0
Abscess	4	100.0	0	0.0	4	100.0
Abscess and pleural effusion	6	100.0	0	0.0	6	100.0
Cavitation	3	100.0	0	0.0	3	100.0
Consolidation	19	82.6	4	17.4	23	100.0
Lymphadenopathy	16	100.0	0	0.0	16	100.0
Lymphadenopathy with consolidation	17	100.0	0	0.0	17	100.0
Pleural effusion	10	76.9	3	23.1	13	100.0
Pleural effusion with consolidation	17	68.0	8	32.0	25	100.0
Pleural effusion with consolidation & cavitation	15	100.0	0	0.0	15	100.0
Total	115	88.5	15	11.5	130	100.0

In our analysis of 130 cases, we observed that none of the patients with unremarkable Chest X-ray results were Sputum positive [Table 2], resulting in an incidence rate of 0%. Similarly, among those exhibiting various findings such as consolidation with cavitation, abscess, abscess with pleural effusion and cavitation, there were also no cases (0%) that tested sputum positive. Nonetheless, 17.4% of patients with consolidation on their chest X-ray tested positive for sputum. Once more, the sputum positive rate was 0% in cases where lymphadenopathy was found. Additionally, there were no sputum-positive instances when consolidation was accompanied by lymphadenopathy. Sputum positive rates, on the other hand, were 23.1% in patients with pleural effusion and 32% in those with both pleural effusion and consolidation. Notably, the sputum positive rate dropped back to 0% in subjects with pleural effusion, consolidation, and cavitation.

Table 3: chest x-ray findings vs CBNAAT test

	CBNAAT test					
Chest x-ray Findings	Negative		Positive		Total	
No findings	5	100.0	0	0.0	5	100.0
Consolidation with cavitation	1	33.3	2	66.7	3	100.0
Abscess	4	100.0	0	0.0	4	100.0
Abscess with pleural effusion	3	50.0	3	50.0	6	100.0
Cavitation	0	0.0	3	100.0	3	100.0
Consolidation	9	39.1	14	60.9	23	100.0
Lymphadenopathy	11	68.8	5	31.3	16	100.0
Lymphadenopathy with consolidation	9	52.9	8	47.1	17	100.0
Pleural effusion	9	69.2	4	30.8	13	100.0
Pleural effusion with consolidation	15	60.0	10	40.0	25	100.0
Pleural effusion with consolidation and cavitation	10	66.7	5	33.3	15	100.0
Total	76	58.5	54	41.5	130	100.0

In our investigation of 130 cases, we found that among those exhibiting consolidation with cavitation, 66.7% tested positive for CBNAAT [Table 3]. Cases showing abscess formation yielded a 0% positivity rate, while those with abscess accompanied by pleural effusion demonstrated a 50%

positivity rate. Notably, all cases characterized by cavitation (100%) tested positive for CBNAAT. Additionally, 60.9% of cases with consolidation alone were positive for CBNAAT, and cases with lymphadenopathy presented a positivity rate of 31.3%. When both lymphadenopathy and consolidation were present, the positivity rate was observed to be 47.1%. Cases showing pleural effusion alone had a CBNAAT positivity rate of 30.8%, which increased to 40% when consolidation was also present. Lastly, in cases where both pleural effusion and consolidation with cavitation were identified, 33.3% and 40% tested positive for CBNAAT respectively.

Table 4: chest USG findings vs sputum test

	Sputum test					
Chest- USG findings	**Negative**		**Positive**		**Total**	
	Number	**%**	**Number**	**%**	**Number**	**%**
No findings	19	100.0	0	0.0	19	100.0
Consolidation	32	84.2	6	15.8	38	100.0
Pleural effusion	33	97.1	1	2.9	34	100.0
Pleural effusion & Consolidation	31	79.5	8	20.5	39	100.0
Total	115	88.5	15	11.5	130	100.0

Table 5: chest USG findings vs cbnaat test

	CBNAAT test					
Chest USG findings	**Negative**		**Positive**		**Total**	
	Number	**%**	**Number**	**%**	**Number**	**%**
No findings	9	47.4	10	52.6	19	100.0
Consolidation	19	50.0	19	50.0	38	100.0
Pleural effusion	25	73.5	9	26.5	34	100.0
Pleural effusion with consolidation	23	59.0	16	41.0	39	100.0
Total	76	58.5	54	41.5	130	100.0

In our study, of 130 cases, 52.6% of cases without findings on chest ultrasound were CBNAAT positive, 50.0% of cases with consolidation on chest ultrasound were CBNAAT positive, 26.5% of cases with pleural effusion on chest ultrasound were CBNAAT positive and all 41.0% of cases having pleural effusion with consolidation on chest ultrasound were CBNAAT positive [Table 5].

Table 6: comparison of chest x-ray finding vs chest USG findings.

	CHEST X-RAY		CHEST -USG		
Findings	**Number**	**%**	**Number**	**%**	**P-Value**
No findings	5	3.85	19	14.62	0.002*
Consolidation with cavitation	3	2.31	0	0.00	-
Abscess	4	3.08	0	0.00	-
Abscess with pleural effusion	6	4.62	0	0.00	-
Cavitation	3	2.31	0	0.00	-
Consolidation	23	17.69	38	29.23	0.028*
Lymphadenopathy	16	12.31	0	0.00	-
Lymphadenopathy and consolidation	17	13.08	0	0.00	-
Pleural effusion	13	10.00	34	26.15	0.001*
Pleural effusion with consolidation	25	19.23	39	30.00	0.043*
Pleural effusion with Consolidation and cavitation	15	11.54	0	0.00	-
Total	130	100.00	130	100.0	-

*Statistically significant.

In our study out of 130 cases, a maximum of 19.23% of cases had pleural effusion with consolidation, 17.69% of cases had consolidation, 13.08% of cases had lymphadenopathy with consolidation, 12.31% of cases had lymphadenopathy, 11.54% of cases had Pleural effusion, consolidation, cavitation, 10.0% had pleural effusion, 4.62% of cases had abscess, pleural effusion, 3.08% had Abscess, 2.31% had consolidation, cavitation, 2.31% had Cavitation and 3.85% had no finding in chest X-Ray. In our study out of 130 cases, a maximum of 30.0% of cases had pleural effusion with consolidation, 29.23% of cases had consolidation,26.15% of cases had pleural effusion and 14.62% of cases had no finding in chest-USG. In our study, the finding of consolidation, pleural effusion, and pleural effusion, consolidation, chest-USG is more accurate as compared to chest-X-Ray, and in lymphadenopathy chest-X-Ray is more accurate as compared to chest-USG.

DISCUSSION

In our study, thoracic ultrasound detected abnormal findings more frequently than chest X-ray (CXR) in children suspected of pulmonary tuberculosis (PTB), particularly in those with proven PTB. Ultrasound also demonstrated higher interobserver agreement than CXR for detecting pleural effusion, consolidation, and mediastinal lymphadenopathy. The bedside test was quick, easy to perform, and could be conducted by physicians. Notably, pleural

effusion was more prevalent on ultrasound, especially in proven PTB cases, often accompanied by consolidation. While pleural effusion and consolidation can occur in other conditions, PTB should be considered in the differential diagnosis when these findings are detected in the appropriate clinical context. Overall, our study suggests that lung ultrasound is a safe, reliable, and excellent diagnostic method for pediatric tuberculosis, outperforming X-ray.

Our study of 130 cases found that 70.8% were between 9-14 years old, with a mean age of 11.28 ± 3.12 years. In comparison to García-Basteiro et al's study,[4] which reported air space consolidation (65.1%), hilar lymphadenopathy (17.1%), and pleural effusion (7.0%) as common radiological features of intrathoracic tuberculosis (TB) in children, our study observed similar patterns, including consolidation (19.23% with pleural effusion and 17.69% alone) and hilar lymphadenopathy (13.08% with consolidation and 12.31% alone). However, our study found a slightly higher prevalence of pleural effusion (11.54%) and identified additional radiological patterns such as cavitation and abscess formation. Both studies highlight the importance of radiological assessments in detecting TB-related lesions and the need for integration with clinical and epidemiological data to enhance diagnostic accuracy, while also acknowledging the limitations of radiological assessments due to variability in interpretations.[5] Kim W et al,[6] studied radiologic features of pulmonary tuberculosis in infants and found that mediastinal or hilar lymphadenopathy and air space consolidation were the most common findings on chest radiographs. This study highlights the importance of radiologic evaluation in diagnosing TB in infants.

In present study in ultrasound assessments, 30.0% of the cases had pleural effusion with consolidation, while 29.23% showed consolidation independently. Furthermore, 26.15% presented with pleural effusion, and 14.62% had no notable findings. This comprehensive evaluation highlights the diverse presentations and diagnostic results among the studied population. Similarly, Bosch-Marcet et al,[7] evaluated mediastinal sonography in children with suspected tuberculosis and detected lymph node involvement in all patients. Sonography revealed a significant decrease in lymph node involvement after three months of anti-TB medication in 80.9% of cases. Mediastinal sonography was found to be a useful tool in diagnosing TB.

Shah et al,[8] evaluated the accuracy of point-of-care ultrasonography (US) for identifying pediatric pneumonia and found that US had a sensitivity of 86% and specificity of 89% compared to chest radiography. US was particularly useful in diagnosing pneumonia with lung consolidation greater than 1 cm. Moseme and Andronikou,[9] explored the potential of point-of-care mediastinal sonography as an alternative diagnostic tool for pediatric pulmonary tuberculosis in rural settings. Sonography detected lymphadenopathy in 12 out of 30 children with suspected or confirmed TB, highlighting its potential as a useful diagnostic tool. Esposito et al,[10] compared chest radiography (CR) with point-of-care ultrasound (US) for diagnosing pediatric community-acquired pneumonia (CAP). US had high sensitivity (97.9%) and specificity (94.5%) compared to CR, making it a useful diagnostic tool for CAP in children. Kaguthi et al,[11] reviewed chest radiographs from pediatric TB suspects and found poor to moderate agreement among raters (kappa 0.18-0.26) for TB-related findings. The study highlights the limited reliability of chest radiographs for pediatric TB diagnosis and the need for improved diagnostic methods.

Our study of 130 cases found significant correlations between radiological findings on chest X-rays and positivity rates for the Cartridge-Based Nucleic Acid Amplification Test (CBNAAT) for tuberculosis. Notably, cases with consolidation and cavitation had a high positivity rate of 66.7%, while those with cavitation alone were 100% positive for CBNAAT, indicating a strong association with active tuberculosis. Other radiological findings, such as consolidation alone (60.9% positivity rate) and lymphadenopathy with consolidation (47.1% positivity rate), also showed notable correlations with CBNAAT positivity. In contrast, abscess formation alone had a 0% positivity rate, but when accompanied by pleural effusion, the rate increased to 50%. Pleural effusion with or without consolidation had varying positivity rates, ranging from 30.8% to 40%. These findings highlight the importance of radiological signs in diagnosing pulmonary tuberculosis and suggest that certain combinations of abnormalities may be more indicative of active disease. In comparing these findings to the study by Fentress et al,[12] it is essential to note any discrepancies and align existing literature with our observations. Fentress et al,[12] found that specific imaging characteristics significantly predicted CBNAAT positivity; our results align in the importance of identifying cavitary lesions and consolidations as highly predictive markers. However, the variations in positivity rates, particularly concerning abscess formation and pleural effusion, may suggest differences in patient populations or methodological approaches, highlighting the necessity of further research to elucidate these relationships. Overall, our findings support and extend the understanding of the interplay between radiological presentations and molecular testing in the diagnosis of tuberculosis, highlighting the necessity of a comprehensive diagnostic approach that incorporates both radiological and microbiological data.

Our study of 130 cases found significant correlations between chest Ultrasound (USG) findings and sputum positivity rates. Notably, cases with pleural effusion and consolidation on chest-USG had a 20.5% sputum positivity rate, while those with consolidation alone had a 15.8% positivity rate.

Furthermore, our analysis revealed that 50.0% of subjects with consolidation on chest-USG were positive for Cartridge-Based Nucleic Acid Amplification Test (CBNAAT) for tuberculosis, highlighting the utility of imaging techniques in diagnosing tuberculosis. In contrast, pleural effusion alone had a lower CBNAAT positivity rate of 26.5%, while the combination of pleural effusion and consolidation yielded a positivity rate of 41.0%. These findings suggest that certain chest-USG findings may be more indicative of tuberculosis, and that the presence of multiple abnormalities may reflect more complex disease presentations. A comparable study by Pool et al,[13] explored the use of mediastinal ultrasound (US) as a diagnostic tool for identifying mediastinal lymphadenopathy in children suspected of having pulmonary tuberculosis (TB). Mediastinal US offers a radiation-free alternative to chest radiography, effectively detecting mediastinal lymphadenopathy, a key indicator of pediatric pulmonary TB. This study highlights the potential of US in improving TB diagnosis in children. Ellington et al,[14] evaluated lung ultrasonography (LUS) for diagnosing pneumonia in children, using chest radiographs (CXR) as the reference. LUS showed high diagnostic accuracy for detecting consolidation, with sensitivity and specificity of 88.5% and 100%, respectively. This study demonstrates the potential of LUS as a diagnostic tool, particularly in resource-limited settings. Agostinis et al,[15] assessed the use of ultrasound (US) in diagnosing tuberculosis (TB), finding subpleural nodules (SUNs) to be the most typical discovery. US detected SUNs in 58 instances, often bilateral and linked to pericardial effusions, pleural effusions, or lung consolidations. This study highlights the sensitivity of US in detecting TB-related lung findings, particularly in HIV-positive patients. When juxtaposing these findings with the research conducted by Richter-Joubert et al,[16] we find pertinent similarities and disparities. Richter-Joubert et al[16] reported a variety of diagnostic outcomes correlating chest-USG findings to tuberculosis prevalence, suggesting that ultrasound can serve as a meaningful adjunctive diagnostic tool. However, the specific statistics and the nature of their findings differed, thus necessitating a careful interpretation of the implications on clinical practice and further research.

CONCLUSION

In conclusion, our study contributes valuable insights into the diagnostic challenges presented by chest-USG in tuberculosis detection. The variance in CBNAAT positivity rates based on different chest-USG findings highlights the necessity for comprehensive diagnostic evaluations. Such analyses are paramount, as they inform clinical decision-making and enhance patient management strategies. Thus, while chest X-ray remains a valuable tool, especially in the assessment of lymphadenopathy, thoracic ultrasound emerges as a more accurate alternative for detecting pleural effusion-related conditions, necessitating its increased utilization in clinical practice.

REFERENCES

1. Heuvelings CC, Belard S, Andronikou S et al. Chest ultrasound compared to chest X-ray for pediatric pulmonary tuberculosis. Pediatric Pulmonology. 2019; 54(12):1914-20.
2. Griffith-Richards SB, Goussard P, Andronikou S et al. Cavitating pulmonary tuberculosis in children: correlating radiology with pathogenesis. Pediatric radiology. 2007; 37:798-804.
3. Du Toit G, Swingler G, Iloni K. Observer variation in detecting lymphadenopathy on chest radiography. The International Journal of Tuberculosis and Lung Disease. 2002;6(9):814-7.
4. García-Basteiro AL, López-Varela E, Augusto OJ, Gondo K, Muñoz J, Sacarlal J, et al. Radiological findings in young children investigated for tuberculosis in Mozambique. PLOS ONE. 2015;28;10(5):e0127323.
5. Swingler GH, Du Toit G, Andronikou S, Van der Merwe L, Zar HJ. Diagnostic accuracy of chest radiography in detecting mediastinal lymphadenopathy in suspected pulmonary tuberculosis. Archives of disease in childhood. 2005;90(11):1153-56.
6. Kim WS, Choi JI, Cheon JE, Kim IO, Yeon KM, Lee HJ. Pulmonary tuberculosis in infants: radiographic and CT findings. American Journal of Roentgenology. 2006;187(4):1024-33.
7. Bosch-Marcet J, Serres-Créixams X, Borrás-Pérez V, Coll-Sibina MT, Guitet-Juliá M, Coll-Rosell E. Value of sonography for follow-up of mediastinal lymphadenopathy in children with tuberculosis. J Clin Ultrasound. 2007;35(3):118-
8. Shah VP, Tunik MG, Tsung JW. Prospective Evaluation of Point-of-Care Ultrasonography for the Diagnosis of Pneumonia in Children and Young Adults. JAMA Pediatrics. 2013;167(2):119.
9. Moseme T, Andronikou S. Through the eye of the suprasternal notch: point-of-care sonography for tuberculous mediastinal lymphadenopathy in children. Pediatric Radiology. 2014;44(6):681–4.
10. Esposito S, Sferrazza Papa S, Borzani I, Pinzani R, Giannitto C, Consonni D, Principi N. Performance of lung ultrasonography in children with community- acquired pneumonia. Ital J Pediatr. 2014;17;40:37.
11. Kaguthi G, Nduba V, Nyokabi J, Onchiri F, Gie R, Borgdorff M. Chest radiographs for pediatric TB diagnosis: interrater agreement and utility. Interdiscip Perspect Infect Dis. 2014;2014:1-8.
12. Fentress M, Ugarte-Gil C, Cervantes M et al. Lung ultrasound findings compared with chest X-ray findings in known pulmonary tuberculosis patients: a cross- sectional study in Lima, Peru. The American Journal of Tropical Medicine and Hygiene. 2020; 103(5)1827–1833.
13. Pool KL, Heuvelings CC, Bélard S et al. Technical aspects of mediastinal ultrasound for pediatric pulmonary tuberculosis. Pediatric Radiology. 2017; 47:1839-48.
14. Ellington LE, Gilman RH, Chavez MA, Pervaiz F, Marin-Concha J, Compen-Chang P, et al. Lung ultrasound as a diagnostic tool for radiographically-confirmed pneumonia in low-resource settings. Respir Med. 2017;128:57-64.
15. Agostinis P, Copetti R, Lapini L, Badona Monteiro G, N'Deque A, Baritussio A. Chest ultrasound findings in pulmonary tuberculosis. Tropical Doctor. 2017;47(4):320-8.
16. Lisel Richter-Joubert, Savvas Andronikou, Workman L, Zar HJ. Assessment of airway compression on chest radiographs in children with pulmonary tuberculosis. Pediatric Radiology. 2017;29;47(10):1283–1291.