CHEST SONOGRAPHY IN COMMON PAEDIATRIC CHEST DISEASES
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ABSTRACT

BACKGROUND
The aim of the study is to determine the utility of chest sonography in common paediatric diseases and to present chest sonography images with possible explanation for the same.

MATERIALS AND METHODS
This retrospective study was conducted in Department of Paediatric Medicine, Bharati Medical College, Sangli. The patients admitted in paediatric ward, NICU, PICU with respiratory complaints and findings were subjected to chest sonography after chest x-ray. The chest sonography images were interpreted and an attempt was made to correlate with findings of chest x-ray. The information given by chest sonography was analysed and possible cause of image was evaluated.

RESULTS
The chest sonography appearances were found to be specific and in certain instances more informative than chest x-ray. It can differentiate between collapse and consolidation easily. The limitation of chest sonography was- it can assess only peripheral lung regions with inability to assess deeper lesions, especially with aerated peripheral lung.

CONCLUSION
The chest sonography is superior to chest x-ray in diagnosing minimal effusion and minimal pneumothorax. Also, when there is difficulty in differentiating pulmonary from pleural pathology. Though, chest sonography cannot replace chest x-ray, it is very useful additional investigation and often times very helpful with additional diagnostic information.

KEYWORDS
A Lines, Air-Bronchogram, Anechoic Space, B Lines (Ultrasound Lung Comets), Consolidation, Fluid Bronchogram, Segmental White Lung, Sliding Sign, Transabdominal Ultrasound, White Lungs.

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BACKGROUND
Chest sonography is a fast evolving modality of chest imaging. Many radiologists are not yet familiar with various images presented by different chest pathologies in paediatric ages. This is an attempt to demonstrate various pathologies seen on chest sonography in paediatric patients.

Chest sonography was performed in paediatrics patients, when the chest x-ray was not able to provide all the information required to make a complete diagnosis or when it could not adequately explain the clinical picture. Typical sonographic appearances of chest pathologies are described. Also, observations regarding usefulness and limitations of sonography and x-ray chest are noted.

AIMS
To describe and demonstrate the chest sonography images in various chest pathologies in paediatric age group.

MATERIALS AND METHODS
Setting and Design
Tertiary care institutional setup in a rural medical college. Review of paediatric chest sonography images was done. All the chest sonography studies were performed by one author (PRK) and chest x-ray films were reviewed by the second author (NPM). The findings of both modalities were compared and correlated with clinical assessment.

Study Duration
September 2014 to October 2015. Follow-up variable, upto 2 weeks. Retrospective, descriptive study.

This was a single institute, retrospective study approved by the Institute Ethics Committee. Need to obtain informed consent was waved. Review was performed of chest sonography images performed during September...
2014 to October 2015. Chest sonography was performed in 150 patients. All of them had chest x-ray done earlier. Both studies were correlated and evaluated with clinical picture.

**Machine**
Sonosite M-turbo machine was used. Sonography performed with multifrequency paediatric abdominal phased array, multifrequency probe (5 to 7 Mhz). For intercostal approach linear array, high frequency probe (7 to 10 Mhz) was used. Few images are from voluson E8 (GE).

**RESULTS**
Of the 150 patients studied by chest sonography, 65 showed consolidation pattern, 60 had pleural effusion pattern, 15 cases were of atelectasis, 5 cases showed partial collapse, 3 had pneumothorax pattern while 2 had lung abscesses.

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consolidation</td>
<td>65</td>
<td>43.33%</td>
</tr>
<tr>
<td>Effusion</td>
<td>45</td>
<td>30%</td>
</tr>
<tr>
<td>Atelectasis</td>
<td>30</td>
<td>20%</td>
</tr>
<tr>
<td>Collapse</td>
<td>5</td>
<td>3.33%</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>3</td>
<td>2%</td>
</tr>
<tr>
<td>Abscess</td>
<td>2</td>
<td>1.33%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>150</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

*Table 1. Number of Patients and Percentages of Pathologies Seen*

In the images shown below one can see the ultrasonographic appearance of images as seen in the monitor in both normal and pleural/lung parenchymal pathologies.

1. Normal Chest Sonography Appearance- Normal aerated lungs and no pleural pathology (subcostal approach).

2. Pleural Space Pathology
A) Pneumothorax

![Figure 3. Stratosphere Sign (Pneumothorax) Parallel Straight Lines Below the Bright Lung-Pleural Interface Line. Compare with Earlier Figure](image)

![Figure 4. Clear Anechoic Area in Chest in Pleural Space. (Arrow) It has Clear Margins. Posterior Chest Wall is Clearly Seen Indicating Through Transmission of Sound Energy to Chest Wall. In Normal Aerated Lung, Posterior Chest Wall is not Seen Because Sound Energy Gets Totally Reflected at Soft Tissue Air Interface](image)
C) Loculated Pleural Effusion

Figure 5. Note the Bi-Convex Shape of Fluid Collection, Thick Walls and Echogenic Projections

Figure 6. Complex Effusion - Septae are Seen in the Effusion

D) Pleural Thickening

Figure 7. Note Lamellar Shape (Short Arrow). This will not Change with Respiratory Excursion. No Colour Splash in Colour Box over the Lesion. Longer Arrow Shows Aerated Lung Margin

2. Pulmonary Pathology Appearances

Consolidation

Figure 8. Consolidation. Homogenous Opacity above the Dome with Through Transmission of Sound (Arrow)

Image on right shows adjacent normal aerated lung (longer Arrow).

Figure 9. Bronchogram. Image on Left Shows Air Bronchogram - Tubular White Opacities (Arrow) in Consolidated Lung. The Image on Right Shows White Parallel Lines with Anechoic Contents (Arrow) - Fluid Bronchogram

A> Interstitial Fluid

Figure 10. B-Lines - Lines Perpendicular to Pleural Surface and Going Across the Entire Image Area (Arrow)

B> Atelectasis (Collapse)

Figure 11. Collapse - Image on Left with Partial Collapse Lung Appearance is like Consolidation with Loss of Volume (Arrow)

Image on right with total collapse, the lung becomes hyperechoic (white lung) very common image in neonatal R.D.S. (arrow).
C> Forming Lung Abscess/Consolidation with Breakdown

Figure 12. Consolidation (c) with Area of Breakdown (b)

DISCUSSION

The patterns are discussed in detail, below

Pleural Pathology

A. Pneumothorax-

- In real time imaging - Loss of gliding sign at pleural lung interface is very definitive evidence of pneumothorax. Normally, visceral pleura glides over parietal pleura due to change in lung size during respiration. In pneumothorax, parietal pleura is separated from visceral pleura with loss of gliding motion.
- On B-mode - Absent comet-tail artefact (A lines) is evidence of pneumothorax. Comet tail artefact is due to gliding of visceral pleura. In pneumothorax, visceral pleura is separated by air in pleural space, so no gliding and no comet tail artefact.
- On M-mode - The characteristic appearance of sandy shore sign (of normal aerated lung) is replaced by stratosphere sign (of pneumothorax). In this appearance, the wavy lines are replaced by straight lines.

B. Pleural effusion- Fluid in pleural space is easily detected as anechoic area. Fluid anywhere will be anechoic as it does not contain interface to produce echo. Hence, effusion will be seen as anechoic to hypoechoic space between two pleural layers. Floating echodensities may be seen in fluid. Moving septations may be present. Shape corresponding to pleural space. Lung movements reflected within pleural fluid. Use of colour Doppler will show colour splash.

C. Pleural thickening-Pleural thickening is due to fibrosis. It will be seen as lamellar hypoechoic space between two pleural layers. It will not change shape with respiration like effusion. No splash of colours with colour Doppler.

<table>
<thead>
<tr>
<th>Pleural Effusion</th>
<th>Pleural Thickening</th>
</tr>
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<tbody>
<tr>
<td>Wedge or triangular</td>
<td>Lamellar</td>
</tr>
<tr>
<td>Changes shape with phase of respiration</td>
<td>No change in shape with phase of respiration</td>
</tr>
<tr>
<td>Colour splash is seen in colour box with respiratory movements</td>
<td>No colour splash is seen in colour box with respiratory movements</td>
</tr>
<tr>
<td>May contain echogenic foci or septae</td>
<td>Usually anechoic</td>
</tr>
<tr>
<td>Movements seen in the fluid</td>
<td>No movements</td>
</tr>
</tbody>
</table>

Pulmonary Pathology

A. Consolidation - Homogeneous hyperechoic lung. Normal air-containing lung reflects sound energy - hence, no image is seen beyond the surface. In consolidation, the air is replaced by fluid allowing the sound to pass through. So, lung is imaged similar to liver in consolidation. It will be wedge shaped, which is normal shape of lung segment.

- Well-defined peripherally by visceral pleura.
- Ill-defined centrally because of air-containing alveoli.
- Sonographic airbronchogram, air-containing bronchi in the consolidated lung.
- Sonographic fluid bronchograms are seen and the bronchi also contain fluid.

B. Interstitial Fluid- B lines represent interstitial fluid. When the fluid is in subpleural location, it will cause a break in echoreflective surface as well as an artefactual line because of reverberation.

C. Atelectasis- The lung becomes hyperechoic (white lung) because it presents too many interfaces to sound beam due to collapsed alveoli. The fluid inside is probably enough only to separate the walls of alveoli, but not enough to be imaged.

D. Collapse- With partial collapse lung appearance is like consolidation with loss of volume. The fluid within collapsed lung gives appearance-like consolidation, but loss of volume will be evident as well-defined segment or lobe is outlined by overlying visceral pleura.

E. Lung Abscess- In early stages of abscess formation, the breakdown in consolidated lung is seen as ill-defined anechoic area without clear margins. In later stages, the well-formed abscess is seen as fluid collection with clear walls. The fluid may have echogenic debris inside.

Septations may develop in the abscess later on. If an attempt is made to drain the abscess, air bubble or air pockets maybe seen in the abscess cavity. If the causative organism is anaerobic, air bubbles may be seen in the abscess without any intervention.

CONCLUSION

Chest sonography is a recent approach to identify chest pathology detected in chest x-ray. It definitely gives more
information and helps to differentiate between pleural effusion and pleural thickening, consolidation and atelectasis. It is very sensitive in diagnosing small amount of effusion or pneumothorax. In paediatric age group, it is excellent in follow-up by reducing radiation load to patient, checking response to treatment and early detection of changes.

**ABBREVIATIONS**
NICU - Neonatal intensive care unit.
PICU - Paediatric intensive care unit.
A Lines - Horizontal lines parallel to pleural line.
B Lines - White lines perpendicular to pleural line.

**REFERENCES**