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ORIGINAL RESEARCH

Clinical, Pathological, And Radiological Aspects Of Pediatric Empyema Thoracis - A Tertiary Care Hospital Experience

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ABSTRACT

Introduction:Pediatric empyema thoracis remains a significant healthcare challenge, particularly in developing countries where delayed diagnosis and inadequate initial management lead to increased morbidity. The condition, characterized by the presence of pus in the pleural cavity, often arises as a complication of bacterial pneumonia. Despite advancements in imaging and antibiotic therapy, variability in clinical presentations and treatment responses necessitates further evaluation of its epidemiological, pathological, and radiological characteristics. This study aims to analyse the clinical, microbiological, and radiological features of pediatric empyema thoracis to optimize diagnostic and therapeutic approaches.

Materials and Methods: A retrospective study was conducted at KIMS Hospital, Kurnool, Andhra Pradesh, from 2020 to 2022, involving 50 pediatric empyema cases. Data were collected from medical records department (MRD), including demographic details, clinical symptoms, laboratory investigations, microbiological findings, radiological assessments, treatment modalities, and outcomes. Pleural fluid analysis, bacterial cultures, and antibiotic sensitivity testing were performed. Radiological evaluation included chest X-ray and high-resolution computed tomography (HRCT) when required. Treatment approaches consisted of intercostal tube drainage (ICT) with antibiotics, with surgical intervention performed in selected cases.

Results: Most cases (58%) were in the 3–5-year age group, with a male predominance (70%). Fever (100%) and cough (70%) were the most common symptoms. Staphylococcus aureus was the most frequently isolated pathogen (24%), followed by Streptococcus pneumoniae (16%). Radiological findings showed pleural effusion in all cases (100%), with consolidation in 58%. Treatment involved ICT with antibiotics in 40% of cases, while 60% required additional surgical intervention.

Conclusion: Pediatric empyema thoracis remains a significant clinical entity with diverse microbiological profiles and radiological patterns. Early diagnosis, guided by imaging and microbiological analysis, is crucial for effective management. A multimodal approach, including antibiotics, pleural drainage, and surgical intervention, when necessary, is essential for optimizing outcomes.

Keywords: Pediatric empyema thoracis, pleural effusion, Staphylococcus aureus

INTRODUCTION

Pediatric empyema thoracis remains a significant clinical challenge worldwide, particularly in developing countries, where delayed presentation and inadequate initial management contribute to increased morbidity. [1] Empyema thoracis, defined as the presence of pus in the pleural cavity, often results from bacterial pneumonia and can lead to severe complications if not diagnosed and treated promptly. The advent of effective antibiotics and improved imaging modalities has transformed the diagnosis and management of pediatric empyema, yet variability in clinical presentations and treatment responses necessitates a comprehensive evaluation of its clinical, pathological, and radiological aspects. [2]

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The epidemiology of empyema thoracis in children has evolved over the past few decades. While Streptococcus pneumoniae remains the most implicated pathogen, the rise of antibiotic-resistant strains and the impact of widespread pneumococcal vaccination have altered the microbiological profile. Other organisms, including Staphylococcus aureus and Streptococcus pyogenes, are also frequently identified. [3,4] The disease burden varies geographically, with developing regions reporting higher incidence rates due to factors such as malnutrition, inadequate vaccination coverage, and delayed healthcare access. [5]

Clinically, empyema thoracis in children presents with persistent fever, respiratory distress, pleuritic chest pain, and cough, often following an episode of community-acquired pneumonia. The disease progresses through three pathological stages: the exudative stage, characterized by sterile pleural effusion; the fibrinopurulent stage, marked by bacterial invasion and fibrin deposition; and the organizing stage, wherein fibroblasts proliferate, leading to pleural thickening and potential lung entrapment. Understanding these stages is crucial for timely intervention and optimal patient outcomes. [6]

Radiological evaluation plays a pivotal role in diagnosing and staging empyema thoracis in children. Chest radiography remains the initial imaging modality, typically revealing a homogenous pleural opacity with loss of costophrenic angle. However, ultrasonography has gained prominence due to its ability to differentiate free-flowing effusion from loculated collections and septations, thereby guiding therapeutic decisions. Computed tomography (CT) of the chest is reserved for complicated cases, providing detailed anatomical information about pleural thickening, loculations, and underlying lung pathology. [7] The integration of radiological findings with clinical and laboratory parameters enhances diagnostic accuracy and aids in determining appropriate treatment strategies.

The management of empyema thoracis in children has evolved significantly, with a multimodal approach encompassing antibiotics, pleural drainage, and, in selected cases, surgical intervention. While small, uncomplicated effusions may resolve with antibiotic therapy alone, moderate to large effusions often require ultrasound-guided drainage via thoracostomy. The role of fibrinolytic therapy and video-assisted thoracoscopic surgery (VATS) has gained traction in managing fibrinopurulent and organized empyema, offering minimally invasive alternatives to open thoracotomy. [8,9] The choice of intervention depends on disease stage, clinical stability, and institutional expertise.

This study aims to evaluate the clinical presentation, pathological characteristics, and radiological findings of pediatric empyema thoracis in a tertiary care hospital. By analysing patient demographics, laboratory parameters, microbiological profiles, imaging features, and treatment outcomes, we seek to provide valuable insights into optimizing diagnostic and therapeutic approaches. Understanding these aspects will contribute to better disease management, improved patient outcomes, and the formulation of evidence-based guidelines tailored to pediatric populations in resource-limited settings.

MATERIALS AND METHODS

This retrospective study was conducted at KIMS Hospital, Kurnool, Andhra Pradesh, over a period of two years (2020-2022) to analyse the clinical, pathological, and radiological aspects of pediatric empyema thoracis. Based on predefined inclusion and exclusion criteria, 50 cases were included in the study. Data were collected from medical records department (MRD), including demographic details, clinical presentation, laboratory investigations, radiological findings, microbiological reports, treatment modalities, and outcomes.

Clinical evaluation encompassed symptoms such as fever, cough, breathlessness, and chest pain, with detailed history and physical examination findings recorded. Laboratory investigations included complete blood count, inflammatory markers like C-reactive protein (CRP), and pleural fluid analysis for cytology, biochemistry, and microbiological assessment. Bacterial culture and antibiotic sensitivity testing were performed on pleural fluid samples to identify causative pathogens and guide appropriate antimicrobial therapy.

Radiological evaluation involved chest X-rays to assess pleural effusion, hydropneumothorax, consolidation, lung collapse, and mediastinal shift. In select cases, high-resolution computed tomography (HRCT) of the chest was performed to determine the extent of lung involvement, pleural thickening, loculations, and underlying lung pathology. Treatment approaches included intercostal tube drainage (ICT) with antibiotics, while cases with persistent effusion or loculations underwent surgical intervention, such as decortication.

To establish a definitive diagnosis, a histopathological examination of pleural tissue was conducted in cases suspected of tuberculosis or chronic pleuritis. The collected data were analysed to study the distribution of cases across different age groups, symptomatology, causative microorganisms, radiological patterns, and treatment outcomes. The institutional ethical certificate was obtained from the ethics committee. Statistical analysis was performed to determine associations between various clinical and pathological parameters.

RESULTS

The study included 50 cases of empyema, with a male predominance (35 males and 15 females). The highest number of cases was observed in the 3–5-year age group, accounting for 58% of the total cases, followed by the 6–12-year age group (20%). The lowest

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incidence was recorded in infants below one year, constituting only 4% of cases

.**Table 1. Age and sex wise Distribution of Pediatric Empyema Thoracis Cases**

Age groups (in years)	Males	Females	Total
<1 years	1	1	2(4%)
1-2 years	5	4	9(18%)
3-5 years	20	9	29(58%)
6-12 years	9	1	10(20%)
Total	35	15	50(100%)

Regarding symptomatology, fever was a universal finding, present in all cases (100%). Cough was observed in 70% of cases, while breathlessness and chest pain were reported in 56% and 40% of cases, respectively.

Table 2. Analysis of symptomatology

Symptom	No of cases	Percentage
Fever	50	100%
Cough	35	70%
Breathlessness	28	56%
Chest pain	20	40%

The treatment modalities included intercostal tube drainage (ICT) with antibiotics in 20 cases, while 30 cases required additional surgical intervention in the form of decortication.

Table 3: Modes of Treatment

Modes of treatment	No. of cases
ICT + Antibiotics	20
ICT + Antibiotics + Decortication	30

Microbiological analysis identified Staphylococcus aureus as the most common pathogen, isolated in 24% of cases, followed by Streptococcus pneumoniae (16%) and Klebsiella (8%). Mycobacterium tuberculosis and Streptococcus pyogenes were each identified in 4% of cases. Notably, 40% of cases had sterile cultures.

Table 4: Etiological Agents Causing Empyema Thoracis in Children

Microorganism	<3 years	3-5 years	6-12 years	TOTAL
M. Tuberculosis	1	0	1	2(4%)
Staphylococcus aureus	7	4	1	12(24%)
Streptococcus pneumoniae	5	2	1	8(16%)
Streptococcus pyogenes	1	0	1	2(4%)
Klebsiella	3	1	0	4(8%)
Escherichia coli	1	0	1	2(4%)
Culture sterile	7	10	3	20(40%)

Antibiotic sensitivity testing revealed that Staphylococcus aureus was most responsive to cloxacillin, amoxiclav, and ceftazidime, while Streptococcus pneumoniae exhibited sensitivity to ampicillin, cefotaxime, and ceftriaxone. Pseudomonas species were susceptible to piperacillin, ceftazidime, and ciprofloxacin, whereas Klebsiella responded to piperacillin, amikacin, and ceftazidime. Escherichia coli showed sensitivity to amikacin, gentamycin, and ceftriaxone, while Mycobacterium tuberculosis was managed with anti-tubercular therapy (ATT).

Table 5: Culture and Antibiotic Sensitivity

Organism	Sensitive Antibiotics
Staphylococcus aureus	Cloxacillin, Amoxiclav, Ceftazidime
Streptococcus pneumoniae	Ampicillin, Cefotaxime, Ceftriaxone
Streptococcus pyogenes	Amoxycillin, Ampicillin, Cefotaxime
Pseudomonas	Piperacillin, Ceftazidime, Ciprofloxacin
Klebsiella	Piperacillin, Amikacin, Ceftazidime
Escherichia coli	Amikacin, Gentamycin, Ceftriaxone
M. tuberculosis	ATT

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Radiological findings at the time of diagnosis demonstrated pleural effusion in all cases (100%), followed by consolidation (58%), hydropneumothorax (24%), lung collapse (32%), mediastinal shift (20%), and chylothorax (20%).

Table 6: Radiological findings at the time of Diagnosis

Chest X-Ray findings	No. of Cases
Pleural Effusion	50(100%)
Hydropneumothorax	12(24%)
Consolidation	29(58%)
Collapse	16(32%)
Mediastinal Shift	10(20%)
Chylothorax	10(20%)

Cytohistological correlation was done in 30 cases which revealed that in infants under one year, both cases had pus-filled effusions and were diagnosed histopathologically as tuberculosis. In the 1-2 years age group, most cases had purulent effusions, diagnosed cytologically as exudates and histopathologically as chronic non-specific pleuritis. A similar pattern was observed in the 3-5 years age group, where seropurulent effusions were diagnosed as exudates and chronic non-specific pleuritis. In the 6-12 years age group, tuberculosis was diagnosed in all cases with pus-filled effusions. These findings highlight the diverse etiologies and clinical presentations of pediatric empyema, underscoring the need for timely diagnosis and appropriate management strategies.

Table 7: Cytohistological Correlation

Age	Males	Females	Nature of effusion	Cytological diagnosis	Histopathological diagnosis
<1 year	1	1	Pus	Exudate	Tuberculosis
1-2 years	11	2	Pus	Exudate	Chronic Non-Specific Pleuritis
3-5 years	8	4	Seropurulent	Exudate	Chronic Non-Specific Pleuritis
6-12 years	3	0	Pus	Exudate	Tuberculosis

Figure 1: Left upper lobectomy

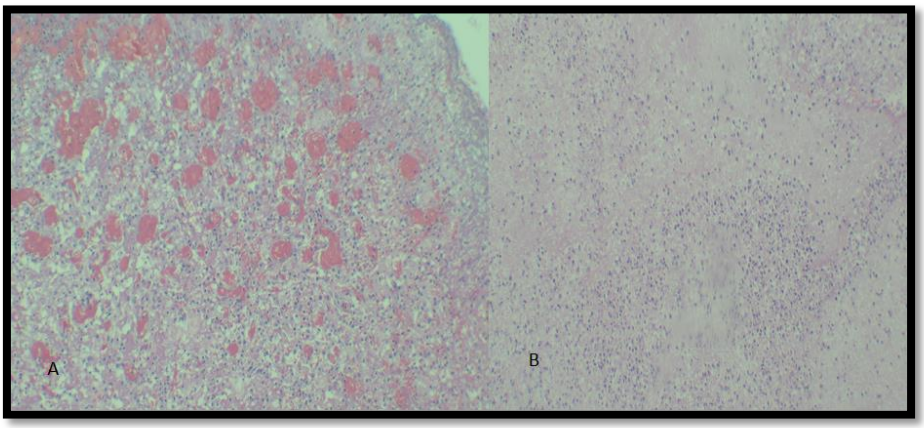

Figure 2: Histopathological examination of the pleural plaque specimen: A: Numerous congested blood vessels (40 X); B: Non–specific inflammation (10 X).

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DISCUSSION

Pediatric empyema thoracis presents a significant clinical challenge, particularly in resource-limited settings. This study provides essential insights into the clinical, pathological, and radiological characteristics of the condition, which contribute to a comprehensive understanding of its epidemiology, diagnosis, and management strategies.

The findings indicate that empyema thoracis was most prevalent among children aged 3 to 5 years, corroborating the results of prior studies conducted by Singh D et al. [12], Mandal et al. [10], and Sadani et al. [11], which similarly identified a higher incidence within this age group. Furthermore, the observed male predominance is in line with earlier epidemiological reports (Mandal et al. [10], Sadaniet al. [11], and Singh D et al. [12], although the underlying reasons for this gender disparity remain to be elucidated.

Fever emerged as the most common presenting symptom, followed by cough, breathlessness, and chest pain. Singh D et al [12] reported 90.22% fever positive patients while Mandal et al. [10] reported that fever was present in more than half of their patients, reinforcing the necessity of recognizing persistent febrile illness with concomitant respiratory distress as potential indicators of empyema, particularly in cases following pneumonia. The progression of the disease through exudative, fibrinopurulent, and organizing stages underscores the imperative for early diagnosis to avert complications such as pleural thickening and lung entrapment.

A notable proportion of culture-negative cases, amounting to 40%, suggests either previous antibiotic administration or the presence of fastidious organisms that are challenging to culture. Microbiological analysis identified Staphylococcus aureus as the predominant isolated pathogen, followed by Streptococcus pneumoniae among culture-positive cases. Correspondingly, other studies have reported similar findings, establishing S. aureus as the most frequently observed organism in patients with thoracic empyema. For instance, Sadani et al. [11] reported isolating S. aureus in 20.5% of their patient cohort, while Toppo et al. [13] and Kumar et al. [14] also identified S. aureus as the most prevalent pathogen. The occurrence of antibiotic-resistant strains underscores the necessity for targeted antimicrobial therapy that is informed by sensitivity testing.

Radiological evaluation remains integral to the diagnosis and staging of empyema. Chest X-rays confirmed pleural effusion in all cases examined. Subsequently, all patients received treatment involving intercostal tube (ICT) placement and the administration of additional antibiotics, where applicable, in cases of antibiotic-sensitive infections. Although intercostal tube drainage paired with antibiotics is a fundamental aspect of treatment, a substantial proportion of cases necessitated surgical intervention, particularly decortication, in order to achieve clinical resolution.

Cytological and histopathological correlation done in 30 cases and it played a crucial role in distinguishing the underlying etiologies of empyema thoracis. Cytological analysis of pleural fluid helped classify effusions providing initial diagnostic insights. In cases involving tuberculosis, pleural fluid often exhibited high protein content, lymphocytic predominance, and increased adenosine deaminase (ADA) levels, reinforcing the need for further histopathological confirmation. Histopathological examination of pleural tissue in suspected chronic cases revealed granulomatous inflammation, caseous necrosis, and the presence of acid-fast bacilli, indicative of tuberculosis. Additionally, in non-tuberculous cases, chronic nonspecific pleuritis and fibroproliferative changes were observed, correlating with prolonged disease progression. (Fig 1, Fig 2 (a,b).These findings underscore the importance of integrating cytological and histopathological evaluations for an accurate diagnosis and effective treatment planning.

CONCLUSION

In conclusion, pediatric empyema thoracis remains a complex and evolving disease entity requiring a multidisciplinary approach for optimal management. Early recognition, timely intervention, and tailored treatment strategies based on clinical, pathological, and radiological findings can significantly improve patient outcomes. The integration of advanced diagnostic tools and minimally invasive surgical techniques holds promise for enhancing disease management, particularly in resource-limited settings.

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