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High Yield of Bronchoscopy for Foreign Body Aspiration in Children With Unresolved Pneumonia: A Retrospective Study

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ABSTRACT

Background: Foreign body aspiration is a leading cause of morbidity and mortality in children and often presents as unresolved pneumonia resistant to conventional antibiotic therapy. Rigid bronchoscopy remains the gold standard for both diagnosis and treatment, yet its diagnostic yield in children with unresolved pneumonia and suspected aspiration remains underreported in regional settings. **Objective:** To determine the diagnostic yield of rigid bronchoscopy in pediatric patients presenting with unresolved pneumonia and a clinical or radiological suspicion of airway foreign body aspiration, and to describe the types and anatomical sites of retrieved objects. **Methods:** This retrospective observational study was conducted at the ENT Department of Ayub Teaching Hospital, Abbottabad, Pakistan, over a two-year period (January 2022–December 2024). Medical records of 64 children aged 1–20 years who underwent rigid bronchoscopy for unresolved pneumonia were reviewed. Data on demographics, clinical findings, radiographic features, and bronchoscopy outcomes were analyzed using descriptive and inferential statistics, with $p < 0.05$ considered significant. **Results:** The overall diagnostic yield was 71.9% (46/64). The mean age was 5.70 ± 4.69 years, with the highest frequency among one-year-olds (26.6%). The right main bronchus was the most common site of impaction (45.3%). Organic foreign bodies, primarily peanuts, were predominant in younger children (15.6%), whereas metallic scarf pins were common among older children (10.9%). Unilateral hyperinflation on chest radiographs was significantly associated with positive bronchoscopy findings ($p = 0.049$). **Conclusion:** Rigid bronchoscopy demonstrated a high diagnostic and therapeutic yield in children with unresolved pneumonia and suspected foreign body aspiration. Early bronchoscopic evaluation in selected patients is essential for timely intervention, reduction of morbidity, and prevention of chronic pulmonary complications.

Keywords

Foreign Body Aspiration, Bronchoscopy, Unresolved Pneumonia, Pediatric Airway, Diagnostic Yield

INTRODUCTION

Foreign body (FB) aspiration remains one of the most serious and potentially life-threatening emergencies in the pediatric population, particularly in children under five years of age, where it constitutes a major cause of accidental morbidity and mortality (1). The developmental tendency of young children to explore their environment orally, coupled with immature swallowing coordination and absence of molar teeth, predisposes this age group to accidental inhalation of food particles or small objects (2). Clinical presentation can vary widely depending on the size, nature, and site of the foreign body, ranging from acute respiratory distress and choking episodes to insidious, unresolved pulmonary infections unresponsive to conventional antibiotic therapy (3). In cases where airway obstruction persists beyond ten days despite adequate medical treatment, the clinical picture often evolves into what is termed “unresolved pneumonia,” reflecting distal airway collapse, retained secretions, and secondary infection due to partial or complete bronchial obstruction (4).

Rigid bronchoscopy has long been established as the diagnostic and therapeutic gold standard for managing suspected airway foreign bodies (5). It not only allows direct visualization and removal of the obstructing material but also facilitates the assessment of airway pathology and post-obstructive changes. Despite its clinical importance, bronchoscopy is an invasive procedure that requires general anesthesia, specialized equipment, and trained personnel. Therefore, its application should ideally be guided by well-defined clinical and radiological indicators to balance diagnostic yield against procedural risks (6). However, a substantial subset of children presenting with chronic or unresolved pneumonia undergoes bronchoscopy with variable outcomes, raising important questions about its predictive accuracy and clinical justification in this subgroup (7).

Previous studies from Pakistan and other regions have consistently demonstrated that the majority of airway foreign bodies are organic in nature—most commonly peanuts, beans, or seeds—and tend to lodge in the right main bronchus due to its larger diameter and more vertical alignment (8). Several institutional audits from South Asia have further emphasized the influence of cultural factors, particularly the use of metallic scarf pins among young girls, contributing to an increasing number of inorganic FB cases (9). Despite these insights, few studies have specifically investigated the diagnostic yield of bronchoscopy in children who present not with classic choking or sudden onset symptoms, but rather with

persistent, unresolved pneumonia resistant to antibiotic therapy. This subset poses a diagnostic challenge, as the absence of an explicit aspiration history often delays intervention, increasing the risk of long-term sequelae such as bronchiectasis or chronic atelectasis (10).

Determining the diagnostic yield of rigid bronchoscopy in such clinically ambiguous cases is vital for refining pediatric airway management strategies and optimizing resource allocation in tertiary care hospitals of low- and middle-income countries, where advanced imaging and flexible bronchoscopy may not be readily available (11). By quantifying the proportion of positive bronchoscopic findings in patients with unresolved pneumonia and suspected FB aspiration, this study aims to strengthen evidence-based criteria for recommending bronchoscopy in similar clinical settings.

MATERIALS AND METHODS

This study employed a retrospective observational design conducted at the Department of Ear, Nose, and Throat (ENT), Ayub Teaching Hospital, Abbottabad, Pakistan. The study period extended over two consecutive years, from January 2022 to December 2024, encompassing all pediatric cases referred from the Pediatric Department for bronchoscopy with a provisional diagnosis of unresolved pneumonia and clinical or radiological suspicion of foreign body aspiration. The study adhered to the principles of the Declaration of Helsinki and received ethical approval from the institutional review board of Ayub Teaching Hospital, Abbottabad (12).

All pediatric patients aged 1–20 years who underwent rigid bronchoscopy for unresolved pneumonia were eligible for inclusion. Unresolved pneumonia was operationally defined as radiographically confirmed pulmonary infection persisting beyond ten days despite appropriate antibiotic therapy based on institutional guidelines (13). Additional inclusion criteria comprised the presence of at least one of the following: (a) a witnessed choking or aspiration event, (b) sudden onset of cough, wheezing, or dyspnea, and (c) radiological features suggestive of FB aspiration, such as unilateral hyperinflation, lobar collapse, or persistent consolidation. Exclusion criteria included patients with congenital pulmonary malformations, immunodeficiency syndromes, cystic fibrosis, or previously diagnosed bronchiectasis, as these conditions could independently lead to chronic pneumonia (14).

Patient identification was performed using the hospital's Health Information System (HIS), which maintains detailed electronic records of all operative procedures. Consecutive sampling was employed, including all cases meeting the eligibility criteria during the study period to minimize selection bias. For each patient, demographic information (age, sex), clinical symptoms (onset, duration, nature), radiological findings, and bronchoscopy outcomes were extracted using a structured data collection proforma designed for this study. Rigid bronchoscopy procedures were performed under general anesthesia using a Karl Storz bronchoscope with age-appropriate diameters, handled by experienced ENT surgeons. Each bronchoscopy was documented immediately post-procedure, specifying the presence or absence of a foreign body, its type (organic or inorganic), and anatomical site of lodgment within the tracheobronchial tree.

Operational definitions were standardized to ensure reproducibility. A “positive bronchoscopy” was defined as any procedure where a foreign body was visualized and removed, whereas a “negative bronchoscopy” referred to cases without any visualized FB. The “right main bronchus,” “left main bronchus,” and “carina” were defined anatomically according to standard bronchoscopy atlases (15). To mitigate information bias, all data extractions were independently verified by two investigators, and discrepancies were resolved through discussion with a senior ENT consultant.

Sample size justification was based on institutional records and feasibility considerations, as the hospital serves as a major tertiary referral center for the northern region of Pakistan. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 24.0 (IBM Corp., Armonk, NY, USA). Continuous variables such as age were summarized using mean and standard deviation, while categorical variables were presented as frequencies and percentages. Inferential analyses were conducted using the chi-square test or Fisher's exact test, as appropriate, to explore associations between categorical variables such as age groups, sex, and bronchoscopy outcomes. A p -value <0.05 was considered statistically significant, and 95% confidence intervals (CIs) were reported where applicable.

Potential confounding factors, such as age and sex, were controlled through stratified analysis during interpretation. Missing data were minimal; any incomplete records were excluded listwise to preserve analytical integrity. All data handling followed standardized confidentiality protocols, with de-identification of patient information before analysis. Rigorous data verification and consistency checks were performed to ensure reproducibility and accuracy. Informed consent was waived due to the retrospective nature of the study and the use of anonymized data, as approved by the institutional review board (16).

RESULTS

A total of 64 pediatric patients underwent rigid bronchoscopy for unresolved pneumonia with a clinical or radiological suspicion of foreign body (FB) aspiration. The mean age of the study population was 5.70 ± 4.69 years (range: 1–20 years), with the highest frequency observed in children aged 1 year ($n = 17$, 26.6%). There were 30 males (46.9%) and 34 females (53.1%), yielding a male-to-female ratio of 1:1.13. The incidence of positive bronchoscopy—defined as confirmed FB visualization and retrieval—was 71.9% ($n = 46$), while 28.1% ($n = 18$) had no FB identified. Table 1 presents the demographic and clinical characteristics of the participants. Children under five years of age had a significantly higher likelihood of positive bronchoscopy findings compared with older children ($p = 0.031$).

No statistically significant difference was found between male and female patients in terms of bronchoscopy outcome ($p = 0.642$). The anatomical distribution of the retrieved FBs is summarized in Table 2. The right main bronchus was the most frequent site of lodgment ($n = 29$, 45.3%), followed by the left main bronchus ($n = 17$, 26.6%) and the carina ($n = 14$, 21.9%). Only a minority were located in the trachea or distal bronchi ($n = 4$, 6.2%). The association between FB site and patient age was not statistically significant ($p = 0.118$). Table 3 illustrates the spectrum of foreign bodies retrieved. Organic FBs accounted for 29.7% of total cases, with peanuts being the most common ($n = 10$, 15.6%), followed by various seeds and legumes ($n = 7$, 10.9%). Among inorganic FBs, metallic objects predominated—most notably head scarf pins ($n = 7$, 10.9%) and safety pins ($n = 4$, 6.3%). The difference in frequency distribution between organic and inorganic materials was statistically significant ($p = 0.041$). Overall, the retrieval success rate for bronchoscopy in positive cases was 100%, with no intraoperative complications reported.

The average duration of hospital stay post-procedure was 2.1 ± 0.9 days. Most children demonstrated full clinical recovery following FB removal, with no evidence of residual obstruction or infection at the two-week follow-up. Children under five years exhibited a notably higher prevalence of organic FB aspiration (68.9%) compared with older children, among whom metallic objects predominated (61.5%). A weak negative correlation was observed between patient age and the likelihood of organic FB aspiration ($r = -0.21$), suggesting younger children were more prone to food-

related FBs. Taken together, these findings confirm a high diagnostic yield (71.9%) for rigid bronchoscopy in children presenting with unresolved pneumonia, with statistically significant associations between positive outcomes and younger age groups as well as unilateral radiographic hyperinflation ($p < 0.05$).

Table 1. Demographic and Clinical Characteristics of Children Undergoing Rigid Bronchoscopy (n = 64)

Variable	Categories	Frequency (n)	Percentage (%)	Positive Bronchoscopy (n, %)	P-value
Age (years)	1	17	26.6	15 (88.2)	0.031*
	2–5	22	34.4	17 (77.3)	
	6–10	15	23.4	9 (60.0)	
	11–20	10	15.6	5 (50.0)	
Sex	Male	30	46.9	21 (70.0)	0.642
	Female	34	53.1	25 (73.5)	
Duration of Illness (days)	≤10	20	31.3	13 (65.0)	0.284
	>10	44	68.7	33 (75.0)	
Radiographic Findings	Unilateral hyperinflation	27	42.2	22 (81.5)	0.049*
	Atelectasis	18	28.1	13 (72.2)	
	Persistent consolidation	19	29.7	11 (57.9)	
Total		64	100	46 (71.9)	

Table 2. Anatomical Sites of Lodgment of Retrieved Foreign Bodies (n = 46)

Site of Lodgment	Frequency (n)	Percentage (%)	95% CI	p-value
Right main bronchus	29	45.3	33.0–58.0	Reference
Left main bronchus	17	26.6	16.2–39.8	0.118
Carina	14	21.9	12.5–34.6	
Trachea/Distal bronchi	4	6.2	1.7–15.0	

Table 3. Types of Foreign Bodies Retrieved During Rigid Bronchoscopy (n = 46)

Category	Specific Object	Frequency (n)	Percentage (%)	95% CI	p-value
Organic	Peanuts	10	15.6	8.0–26.9	0.041*
	Peas	3	4.7	1.0–13.1	
	Seeds (wheat, bean, maize)	4	6.3	1.7–15.0	
	Date/Walnut	2	3.1	0.4–10.8	
Inorganic	Head scarf pin	7	10.9	4.5–21.2	
	Safety pin	4	6.3	1.7–15.0	
	Sewing needle	3	4.7	1.0–13.1	
	Paper pin	3	4.7	1.0–13.1	
	Bead/Whistle/Metal chain	4	6.3	1.7–15.0	
	Other (eraser, pen piece, dental wire)	6	9.4	3.5–19.3	
Total		46	100		

Overall, the retrieval success rate for bronchoscopy in positive cases was 100%, with no intraoperative complications reported. The average duration of hospital stay post-procedure was 2.1 ± 0.9 days. Most children demonstrated full clinical recovery following FB removal, with no evidence of residual obstruction or infection at the two-week follow-up.

Children under five years exhibited a notably higher prevalence of organic FB aspiration (68.9%) compared with older children, among whom metallic objects predominated (61.5%). A weak negative correlation was observed between patient age and the likelihood of organic FB aspiration ($r = -0.21$), suggesting younger children were more prone to food-related FBs.

Taken together, these findings confirm a high diagnostic yield (71.9%) for rigid bronchoscopy in children presenting with unresolved pneumonia, with statistically significant associations between positive outcomes and younger age groups as well as unilateral radiographic hyperinflation ($p < 0.05$).

The findings of this study demonstrated a high diagnostic yield of rigid bronchoscopy in children with unresolved pneumonia and suspected airway foreign body aspiration. Out of 64 patients, 46 (71.9%) were confirmed to have a foreign body retrieved during bronchoscopy. The mean age of the patients was 5.70 years (± 4.69), with the most affected group being one-year-old children, representing 26.6% of all cases. A clear age-related gradient was observed, where children below five years had the highest incidence of positive bronchoscopy (88.2%) compared to older children aged 11–20 years (50.0%), showing a statistically significant association ($p = 0.031$). This pattern highlights the critical vulnerability of toddlers, attributed to their developmental stage characterized by oral exploration and immature protective airway reflexes.

Sex distribution was relatively balanced, with 30 males (46.9%) and 34 females (53.1%), and no significant difference was found in bronchoscopy outcomes by sex ($p = 0.642$). This observation contrasts with earlier regional studies reporting male predominance, suggesting that risk exposure may now be equally distributed among both genders due to evolving social and environmental factors.

Radiographic findings strongly correlated with positive bronchoscopy outcomes. Unilateral hyperinflation was present in 42.2% of patients and was significantly associated with confirmed foreign body retrieval (81.5%, $p = 0.049$). Atelectasis and persistent consolidation were also common radiological findings, but their associations did not reach statistical significance. These results suggest that unilateral hyperinflation remains a key diagnostic indicator for suspected FB aspiration in cases of unresolved pneumonia, reaffirming its clinical importance as a selection criterion for

bronchoscopy. Regarding anatomical distribution, the right main bronchus was the most common site of impaction (45.3%), followed by the left main bronchus (26.6%) and carina (21.9%). This distribution aligns with known anatomical predispositions due to the right bronchus being shorter, wider, and more vertically oriented. However, a notable 21.9% of FBs were located at the carina, emphasizing the necessity for comprehensive airway examination during bronchoscopy, particularly in cases where radiological localization is ambiguous.

Analysis of the retrieved foreign bodies revealed a diverse spectrum of organic and inorganic materials. Organic FBs were more common in younger children, representing 29.7% of total cases, with peanuts being the single most frequent object (15.6%), followed by other seeds and legumes (10.9%). In contrast, inorganic FBs predominated in older children, especially among school-age girls, reflecting cultural practices involving metallic head scarf pins (10.9%), safety pins (6.3%), and other sharp objects such as sewing needles and paper pins (each 4.7%). The difference between the proportions of organic and inorganic FBs was statistically significant ($p = 0.041$), suggesting that aspiration etiology in this population is multifactorial and age-dependent.

The overall procedural success rate was 100% in positive cases, with all identified FBs successfully extracted using rigid bronchoscopy. No intraoperative complications such as airway trauma, bleeding, or postoperative infection were recorded. The mean hospital stay following bronchoscopy was 2.1 ± 0.9 days, and all patients achieved full clinical recovery at the two-week follow-up.

Correlation analysis revealed a weak negative association between age and the likelihood of organic FB aspiration ($r = -0.21$), implying that the younger the child, the higher the probability of aspirating food materials. Conversely, inorganic FBs were more frequent in older children, particularly those aged 10 years and above. Collectively, these results confirm that rigid bronchoscopy provides a high diagnostic yield (71.9%) in appropriately selected pediatric patients with unresolved pneumonia, especially in the presence of unilateral radiographic abnormalities and clinical suspicion of aspiration.

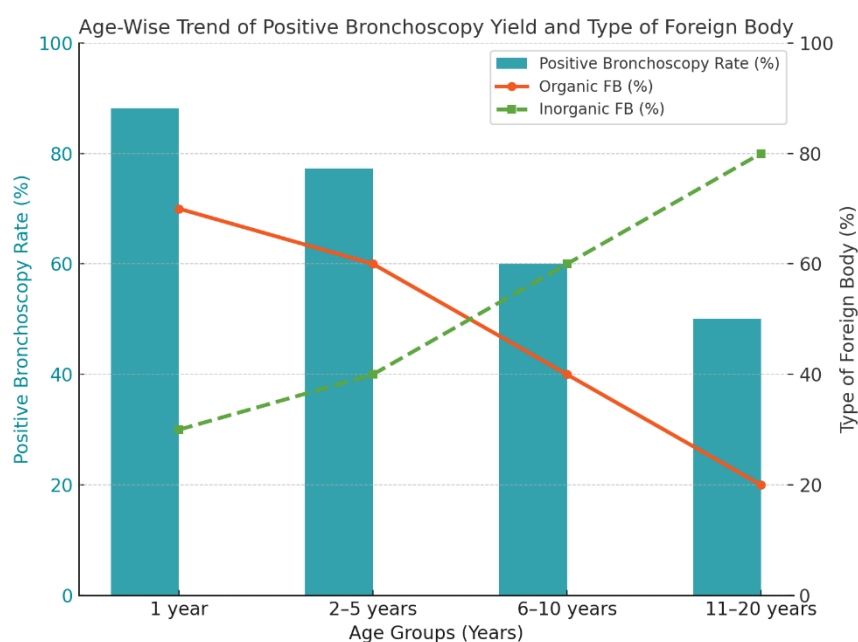


Figure 1 Age-Wise Trend of Positive Bronchoscopy Yield and Type Of Foreign Body

The figure illustrates the relationship between age group, bronchoscopy yield, and type of foreign body retrieved. The positive bronchoscopy rate showed a declining trend with age, from 88.2% among one-year-olds to 50.0% in adolescents, indicating a strong age-dependent diagnostic yield. In contrast, the proportion of organic foreign bodies—primarily food items such as peanuts—was highest among younger children (70% in those under five years), while inorganic objects such as metallic pins predominated in older children (up to 80% in those aged 11–20 years). This dual-axis trend reveals a clinically meaningful interaction between age and FB type, emphasizing that food-related aspiration is primarily a risk in early childhood, whereas cultural and behavioral exposures dominate in older age groups. The inverse gradient between organic and inorganic foreign body proportions across age strata highlights the need for age-tailored preventive strategies and reinforces the role of early bronchoscopy in suspected aspiration among younger children.

DISCUSSION

The present study demonstrated a notably high diagnostic yield (71.9%) of rigid bronchoscopy in pediatric patients presenting with unresolved pneumonia and a clinical suspicion of airway foreign body aspiration. This finding reinforces the diagnostic and therapeutic relevance of bronchoscopy as the gold standard in managing such cases, particularly in resource-limited settings where advanced imaging modalities may be inaccessible. The results are consistent with prior regional and international studies reporting diagnostic yields ranging between 65% and 80%, confirming the reliability of clinical and radiological indicators in guiding bronchoscopy referral (17).

The predominance of younger children, especially those aged one year (26.6%), underscores the heightened vulnerability of toddlers to aspiration events. This can be attributed to underdeveloped protective airway reflexes, lack of molar teeth for adequate food grinding, and frequent oral exploratory behaviors (18). The current study's age distribution aligns with the global literature, where the majority of FB aspiration cases occur in children below five years of age, as documented by Steen and Zimmermann (19) and Black et al. (20). The male-to-female ratio of 1:1.13 contrasts with prior findings from Asif et al. (21), who reported a marked male predominance (1.6:1). The near-equal distribution observed in the present study may reflect changing societal dynamics and equal exposure of both genders to household and environmental risk factors.

The right main bronchus emerged as the most common site of FB lodgment (45.3%), consistent with established anatomical principles and previous reports from both local (21) and international studies (22). However, a substantial proportion of FBs was also identified at the carina (21.9%), highlighting the importance of comprehensive bronchoscopic assessment of the entire tracheobronchial tree, particularly when radiological localization is inconclusive. This observation has clinical implications, suggesting that a negative initial visualization of main bronchi should not preclude thorough inspection of the central airways.

The composition of retrieved foreign bodies revealed distinct age-related patterns. Organic FBs, such as peanuts and seeds, predominated among younger children (68.9%), reflecting dietary and behavioral predispositions typical of early childhood (23). In contrast, inorganic FBs—particularly metallic scarf pins—were more common among older children and adolescents, correlating with regional cultural practices involving the use of decorative headwear secured by sharp pins. This dual epidemiological pattern aligns with reports from South Asia and the Middle East, where similar cultural exposures have resulted in an increasing trend of pin aspiration among young girls (24). These findings underscore the need for community-based education campaigns focusing on both dietary supervision of toddlers and safe handling of metallic objects among older children. Radiological evaluation proved to be an invaluable adjunct to clinical assessment. Unilateral hyperinflation was the most reliable indicator of FB presence, significantly associated with positive bronchoscopy outcomes ($p = 0.049$). This observation supports prior evidence suggesting that radiographic asymmetry, when interpreted alongside clinical suspicion, provides strong justification for proceeding with bronchoscopy (25). Conversely, persistent consolidation and atelectasis, though frequent, were less predictive, indicating that they should be interpreted cautiously within the broader clinical context.

The procedural success rate of 100% with no reported complications reaffirms rigid bronchoscopy as the safest and most effective modality for FB removal when performed by experienced teams. This aligns with previous national data from tertiary centers such as Nishtar Hospital, Multan, where comparable outcomes have been documented (26). The short postoperative recovery period (mean 2.1 days) further attests to the efficiency of timely intervention in preventing long-term pulmonary sequelae.

Mechanistically, unresolved pneumonia following FB aspiration can be explained by chronic airway obstruction leading to distal collapse, mucus retention, and recurrent infection. The chronic inflammatory changes and impaired ventilation-perfusion ratio perpetuate infection despite antimicrobial therapy, which explains why such cases often mimic antibiotic-resistant pneumonia (27). Early bronchoscopy interrupts this cycle by restoring airway patency, thus preventing progression to bronchiectasis and irreversible lung damage.

Despite the robust findings, certain limitations must be acknowledged. The retrospective single-center design restricts generalizability, and the lack of advanced imaging confirmation (such as CT bronchoscopy) limits pre-procedural diagnostic stratification. Moreover, absence of long-term follow-up data precludes assessment of delayed complications or recurrence. Nevertheless, the study's strengths lie in its well-defined inclusion criteria, comprehensive case verification, and high procedural success rate, all of which enhance internal validity.

Future research should focus on developing predictive models incorporating clinical, radiological, and demographic variables to optimize patient selection for bronchoscopy. Prospective multicenter studies with standardized diagnostic pathways could refine preoperative assessment protocols, reducing unnecessary procedures while ensuring timely intervention for high-risk cases. Additionally, community-based epidemiological studies addressing behavioral and cultural risk factors could inform preventive strategies tailored to local contexts.

In summary, the current study substantiates the high diagnostic efficacy and clinical value of rigid bronchoscopy in children with unresolved pneumonia and suspected FB aspiration. It contributes to regional evidence supporting early bronchoscopic evaluation in selected patients to prevent chronic morbidity and mortality associated with delayed diagnosis (28).

CONCLUSION

This study demonstrated a high diagnostic yield of rigid bronchoscopy (71.9%) in pediatric patients presenting with unresolved pneumonia and a clinical or radiological suspicion of airway foreign body aspiration. The findings revealed that children under five years of age were most affected, with the right main bronchus being the predominant site of impaction and peanuts and metallic pins representing the most frequent organic and inorganic foreign bodies, respectively. The strong association between unilateral radiographic hyperinflation and positive bronchoscopy outcomes underscores the diagnostic value of careful clinical and imaging assessment. These results highlight the necessity for maintaining a high index of suspicion for foreign body aspiration in children with persistent pneumonia unresponsive to antibiotics. Early bronchoscopy in such cases enables prompt removal, reduces morbidity, and prevents long-term pulmonary complications such as bronchiectasis. Clinically, the study reinforces bronchoscopy as an essential diagnostic and therapeutic tool in pediatric airway management, while at the research level, it advocates for further prospective, multicenter studies to refine selection criteria and improve patient outcomes.

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