

Can Clinical and Radiological Diagnosis Reduce the Need for Bronchoscopy in Pediatric Tracheobronchial Foreign Body Aspiration Cases?

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ABSTRACT

Objectives: To assess the diagnostic accuracy and efficacy of taking history, conducting physical examination, and assessing the radiological characteristics of children suspected of having aspirated foreign bodies (FBs), vis-à-vis tracheobronchoscopy, the gold standard diagnostic tool. An additional objective was to analyze the types and locations of aspirated FBs. **Methods:** This single-center retrospective cohort study used the archived medical data of consecutive pediatric patients who had presented with suspected tracheobronchial FB aspiration (TFBA) from January 2011 to May 2021. Data regarding clinical presentation, radiological impressions, and intraoperative findings were retrieved from electronic medical records. **Results:** The subjects comprised 44 children (22 male) with a mean age of 25.4 months (median = 17.5 months). The majority (27; 61.4%) had TFBA. Among the clinical symptoms, choking and coughing had a sensitivity of 93.9% and specificity of 30.0% and 50.0%, respectively in confirming the presence of a FB. Positive physical examination results had a sensitivity of 95.8% and specificity of 63.2%. Radiological results had a sensitivity of 60.0% and specificity of 78.9%. Organic substances constituted 47.7% of the aspirated FBs. **Conclusions:** Proper clinical assessment with history, physical examination, and imaging can highly predict the presence of TFBA in children, and help the clinician decide whether bronchoscopy is necessary.

Tracheobronchial foreign body aspiration (TFBA) is a common pediatric emergency with significant airway risk.¹ Aspirated foreign bodies (FBs) can trigger morbidities such as pneumonia, lung abscesses, bronchiectasis, and even death. Prompt and accurate diagnosis based on history, physical examination, and imaging is critical in diagnosing TFBA. This study aimed to determine whether diagnosis by clinical examination (history, physical examination, and radiological features) is comparable with tracheobronchoscopy findings (the gold standard) in children with TFBA. The types and locations of FB and the epidemiological factors were also analyzed.

METHODS

This was a single-center retrospective cohort study of consecutive pediatric patients presenting with suspected TFBA from January 2011 to May 2021 at Sultan Qaboos University Hospital. Ethical approval

was obtained prior to commencing the study. All data were collected from electronic medical records.

This study included children aged < 10 years who presented with suspected TFBA and underwent physical examination, imaging, and rigid or flexible bronchoscopy as part of their management. Those with congenital head and neck anomalies, as well as syndromic and other congenital airway-related comorbidities were excluded.

We retrieved patient characteristics such as age, sex, and nature of presentation. Signs and symptoms on presentation (cough, choking, wheezing, stridor, drooling, cyanosis, reduced air entry, bronchial breathing, and tachypnea) were noted. We also collected chest X-ray and computed tomography findings such as collapse, radio-opaque FB, hyperinflation, and consolidation. Lastly, the type of bronchoscopy performed and its findings in terms of the location and type of FB were also noted.

We evaluated the patient's signs and symptoms and radiological data to evaluate the diagnostic performance of individuals and combined predictors

of TFBA. Statistical analysis was performed using SPSS windows (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.). Categorical data were presented as the frequency and percentage, whereas continuous data were presented as the mean, median, and SD. The diagnostic accuracy—sensitivity, specificity, positive predictive value (PPV), and negative predictive value of clinical symptoms, clinical examinations, and radiological investigations—was also ascertained.

The ethical approval was obtained from Medical Research Ethics Committee, College of Medicine and Health Sciences, Sultan Qaboos University as part of the study with ref. No. MREC #2135.

RESULTS

This subject comprised 44 children (22 male; mean age = 25.4 months) who presented with suspected TFBA. The aspiration event was witnessed in 37 (84.1%) cases; 38 (86.4%) presentations were made

acutely within 24 hours of the event. Symptoms at presentation were exhibited by 41 children, while 30 presented with clinical signs on physical examination. The details of the signs and symptoms are listed in Table 1.

Clinical symptoms had a sensitivity of 100% (95% CI: 89.7–100) and specificity of 30.0% (95% CI: 6.6–65.0). Within the clinical symptoms, choking and cough had a sensitivity of 93.9% (95% CI: 86.3–100). Two children (4.8%) with unwitnessed aspiration episodes were found to have tracheobronchial FBs.

Positive physical examination results had a sensitivity of 95.8% (95% CI: 78.9–99.9) and specificity of 63.2% (95% CI: 38.4–83.7). The most common physical sign was stridor and respiratory distress with sensitivity of 56.3% (95% CI: 37.7–73.6), specificity of 60.0% (95% CI: 26.2–87.8), and PPV of 81.8%. The next common symptoms were reduced air entry and tachypnea both with sensitivity of 54.6% (95% CI: 36.4–71.9) and specificity of 80.0% (95% CI: 44.4–97.5). Bronchial

Table 1: Clinical and radiological characteristics of the patients.

Characteristics	n (%)	Sensitivity, %	Specificity, %
Clinical symptoms			
Choking	38 (86.4)	93.9	30.0
Cough	36 (81.8)	93.9	50.0
Cyanosis	23 (52.3)	62.5	70.0
Vomiting	8 (18.2)	24.2	100
Wheezing	6 (13.6)	12.5	80.0
Recurrent respiratory infections/pneumonia	5 (11.4)	12.5	100
Drooling	3 (6.8)	3.1	80.0
Clinical signs			
Respiratory distress/stridor	22 (50.0)	56.3	60.0
Reduced air entry	20 (45.5)	54.6	80.0
Tachypnea	20 (45.5)	54.6	80.0
Bronchial breathing	14 (31.8)	40.6	90.0
Wheezing	12 (27.3)	34.4	90.0
Saturation level drop	11 (25.0)	27.3	80.0
Tachycardia	11 (25.0)	31.3	90.0
Chest retractions	10 (22.7)	28.1	90.0
Radiological findings			
Pulmonary infiltrate	7 (15.9)	18.2	90.0
Consolidation	6 (13.6)	18.8	100
Collapse	5 (11.4)	15.6	100
Hyperinflation	3 (6.8)	6.3	90.0
Radiopaque foreign body	3 (6.8)	9.1	100

Table 2: Types and locations of the foreign body.

Variables	n (%)
Foreign body types	
Organic	21 (47.7)
Inorganic	5 (11.4)
Not documented	1 (2.3)
No foreign body	17 (38.6)
Location of the foreign body in the airway	
Right secondary bronchus	9 (26.5)
Left main bronchus	5 (14.7)
Subglottis	4 (11.8)
Glottis	1 (2.9)
Right main bronchus	1 (2.9)
Trachea	1 (2.9)

breath sounds had a sensitivity of 40.6% (95% CI: 23.7–59.4) and specificity of 90.0% (95% CI: 55.5–99.8). Wheezing had a sensitivity of 34.4% (95% CI: 18.6–53.2) and specificity of 90.0% (95% CI: 55.5–99.8).

Chest X-ray/computed tomography revealed positive findings in 19 (43.2%) patients [Table 1]. Pulmonary infiltrates were seen in seven (15.9%) cases, with diagnostic accuracy of 34.9%, sensitivity of 18.2% (95% CI: 7.0–35.5), and specificity of 90.0% (95% CI: 55.5–99.8). Consolidation was observed in 6 (13.6%) cases, with diagnostic accuracy of 38.1%, sensitivity of 18.8% (95% CI: 7.2–36.4), and specificity of 100% (95% CI: 69.2–100). The collapse was seen in five (11.4%) cases with diagnostic accuracy of 35.7%, sensitivity of 15.6% (95% CI: 5.3–32.8), and specificity of 100% (95% CI: 69.2–100).

All 44 patients were subjected to bronchoscopy, of whom 34 underwent rigid bronchoscopy, five underwent flexible bronchoscopy, and five were subjected to both. Bronchoscopy identified the presence of FB in 27 (61.4%) cases. The FB type was identified to be organic in 21 cases, inorganic in five cases, and remained undocumented in one case. The location of FB in the body varied [Table 2].

DISCUSSION

TFBA is a common pediatric emergency that poses a significant airway risk.¹ It can cause morbidities including pneumonia, lung abscesses or bronchiectasis, and even death. Prompt and accurate

diagnosis is crucial. Delays can lead to inflammation and formation of granulation tissue around the aspirated FB. It is not uncommon for pediatricians to initially misdiagnose symptoms of TFBA for other disorders (such as persistent fever, asthma, or recurrent pneumonia) and continue to treat for those for long periods leading to serious morbidities requiring emergency interventions.^{2,3} A complication rate of 64% was reported when diagnosis was made within 4–7 days of the aspiration episode, and 95% when delayed for > 30 days.⁴

History taking, physical examination, and imaging are critical in the diagnosis of TFBA. However, not all pediatric patients present with a typical or witnessed episode of FB aspiration. Considerable variations have been mentioned in the diagnostic criteria of TFBA because of variable clinical presentations, ranging from being asymptomatic to coughing, wheezing, noisy breathing, or showing other signs of respiratory distress. Likewise, radiological findings can vary from normal to identification of radiopacities, pneumonia, emphysema, collapse, or consolidation. Given the difficulty of accurately diagnosing young children with suspected TFBA clinically and radiologically, rigid or flexible bronchoscopic examination remains both the definitive diagnostic gold standard and a treatment modality if needed. However, this procedure is associated with significant risks such as airway trauma and pneumothorax, perioperative complications, and potential long-term effects of general anesthesia.

In this study, diagnosis of clinical symptoms had a sensitivity of 100% (95% CI: 89.7–100) and specificity of 30.0% (95% CI: 6.6–65.0), among which choking and cough had the highest sensitivity of 93.9% (95% CI: 86.2–100) for the presence of FB, in line with other studies. However, choking and cough had a poor specificity of 30.0% (95% CI: 6.67–65.25) and 50.0% (95% CI: 18.71–81.29), respectively. Children with FB are often evaluated after caregiver witnesses an aspiration event or choking episode. In this study, 37 (86.1%) children had witnessed episodes, which other studies have suggested that up to 33% of FBA episodes may be unwitnessed. In this study, two (4.8%) children with unwitnessed aspiration episodes were found to have tracheobronchial FB. Hence, TFBA should be suspected when young children present with unexplained respiratory symptoms.

In other retrospective chart reviews, the sensitivity and specificity of a witnessed choking crisis have ranged widely from 63% to 97% and 21% to 92.1%, respectively.^{5,6} In literature, the history of a choking crisis has been reported to have a sensitivity of 97% and a specificity of 63%.⁷ However, positive history of a choking crisis could not be obtained in 13% to 49% of children subsequently found to have FBA.⁸⁻¹⁰

In the present study, a positive physical examination had a sensitivity of 95.8% (95% CI: 78.9–99.9) and specificity of 63.2% (95% CI: 38.4–83.7). The most common physical sign was stridor and respiratory distress both with a sensitivity of 56.3%, specificity of 60.0%, and PPV of 81.8%. This was followed by both tachypnea and reduced air entry with a sensitivity and specificity of 54.6% and 80.0%, respectively. Bronchial breath sounds and wheezing, respectively, had sensitivities of 40.6% and 34.4% and both has specificities of 90.0%, constituting an important clinical sign for predicting TFBA. The relative usefulness of asymmetric lung findings on physical examination in our study was similar to that in other retrospective reviews. For example, the sensitivity and specificity of unilaterally decreased breath sounds in those studies ranged from 53% to 80% and 42.3% to 88%, respectively.^{5,11-13} Other studies reported physical examination as having sensitivity ranged from 70.5% to 86% and specificity ranged from 26% to 63%, supporting our findings.^{6,14,15}

In our study 19 (43.1%) patients had positive radiological findings with a sensitivity of 60.0% (95% CI: 38.7–78.9) and specificity of 78.9% (95% CI: 54.4–94.0). The sensitivity and specificity of chest radiography have varied in the literature ranging from 66% to 88% and from 30% to 71.4%, respectively.^{6,11,14} Zerella et al,¹⁶ reported normal chest X-ray findings in 42% of bronchial FB cases and 81% in tracheal ones. In other studies, normal chest X-ray was reported in 6.1%–50% of patients.¹⁷⁻¹⁹

In the current cohort, 27 (61.4%) children were confirmed to have FB on bronchoscopy, among whom 12 (27.3%) remained intubated after bronchoscopy for at least 24 hours. Flexible bronchoscopy is less invasive compared to rigid bronchoscopy. However, in this cohort, only five (11.4%) children underwent flexible bronchoscopy only.

The main limitation of this study is its retrospective nature and the small sample size.

CONCLUSION

In this study, choking and coughing were the most significant predictors of TFBA. A high index of suspicion for TFBA is required while diagnosing pediatric respiratory issues. Proper clinical assessment with history, physical examination, and imaging can highly predict the presence of TFBA. Stridor, respiratory distress, wheezing, and bronchial breathing should also raise suspicion of TFBA in previously healthy children. While bronchoscopy remains the diagnostic gold standard, it requires general anesthesia and carries the possibility of causing trauma to the pediatric airway. Skillfully conducted clinical and radiological evaluation will help avoid unnecessary bronchoscopies.

Disclosure

The authors declared no conflicts of interest. No funding was received for this study.

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