Diagnostic Accuracy and Efficacy of Clinical and Radiological Findings versus Bronchoscopy in Pediatric Tracheobronchial Foreign Body Aspiration

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Abstract

Objectives: To assess the diagnostic accuracy and efficacy of history, physical examination, and radiological characteristics in comparison to tracheobronchoscopy findings in children with foreign body aspiration, as well as to analyze the types and locations of foreign bodies and identify associated epidemiological factors.

Methods: This is a single-center retrospective cohort study of consecutive pediatric patients with suspected tracheobronchial foreign body aspiration from January 2011 to May 2020. Data regarding clinical presentation, radiological impressions, and intraoperative findings were retrieved from electronic medical records.

Results: The study included 44 children (22 males and 22 females), among which 27 (61.3%) had episodes of tracheobronchial foreign body aspiration. Among the clinical symptoms, choking and cough had high sensitivity (100%; confidence interval: 86.28%–100%) when used to confirm the presence of a foreign body. A positive physical examination had a sensitivity of 95.83% and specificity of 63.16%. Radiological findings, seen in 19 children, had a sensitivity of 60% and specificity of 78.95%. Out of all cases with foreign bodies, 80% had organic foreign bodies.

Conclusion: Proper clinical assessment with history, physical examination, and imaging can highly predict the presence of tracheobronchial foreign body aspiration. These can guide the need for bronchoscopy, especially among cases with a high index of suspicion.

Keywords: Foreign body, Aspiration, Bronchoscopy, Pediatrics

Background

Tracheobronchial foreign body aspiration (TBFA) is a common pediatric emergency which poses a significant airway risk.[1] It can cause significant morbidity and mortality in children, specifically pneumonia, lung abscesses, bronchiectasis, and death. A prompt and accurate diagnosis is therefore important in its management. History, physical examination, and imaging are critical in diagnosing TBFA. However, not all pediatric patients present with typical or an actual witnessed episode of foreign body (FB) aspiration. This study is aimed to determine the diagnostic accuracy and efficacy of predictability of history, physical examination, and radiological features compared to tracheobronchoscopy findings (the gold standard) in children with TBFA at Sultan Qaboos University Hospital (SQUH). The types and location of FB and the epidemiological factors were analyzed as well.

Methods

This was a single-center retrospective cohort study of consecutive pediatric patients presenting with suspected TBFA from January 2011 until May 2021 at SQUH, a tertiary health care hospital in Muscat, Sultanate of Oman. Ethical approval was obtained prior to commencing this study. All data was collected from electronic medical records.

This study included pediatric patients aged <10 years presenting with suspected TFBA who 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 collected patient characteristics including age, gender, and nature of presentation after suspected TFBA. Signs and symptoms on presentation such as cough, choking, wheezing, stridor, drooling, cyanosis, reduced air entry, bronchial breathing, and tachypnea were also noted. We also collected chest X-ray and computed tomography (CT) findings such as collapse, radio-opaque FB, hyperinflation, and consolidation. Lastly, the type of bronchoscopy performed and its findings were recorded, specifically in terms of the location and type of FB.

We evaluated the patient's signs and symptoms and radiological data to evaluate the diagnostic performance of individual and combined predictors of TFBA. Statistical analysis was performed using IBM SPSS Statistics version 26.0. Categorical data was presented as the frequency and percentage, whereas continuous data were presented as the mean, median, and standard deviation. The diagnostic accuracy (sensitivity, specificity, positive predictive value [PPV], and negative predictive value [NPV]) of clinical symptoms, clinical examinations, and radiological investigations were also reported.

Results

This study included 44 pediatric patients (22 males, 22 females; mean age: 25.48 months; median age: 17.5 months). Most of the children were <3 years old, and 36 (80.8%) had TBFA at this age. There were 37 children (84%) who had witnessed episodes of TFBA, whereas 38 (86%) presented acutely within 24 hours after the event. Moreover, 41 children presented with symptoms, while 30

children presented with clinical signs on physical examination. The range of signs and symptoms are listed in Table 1.

Table 1: Clinical and radiological characteristics of the patients.

Characteristics	n (%)
Clinical symptoms	
Choking	38 (88.4)
Cough	36 (83.7)
Cyanosis	23 (54.8)
Vomiting	8 (18.6)
Wheezing	6 (14.3)
Recurrent respiratory infections/pneumonia	5 (11.3)
Drooling	3 (7.1)
Clinical signs	
Respiratory distress/stridor	22 (50.0)
Reduced air entry	20 (45.5)
Tachypnoea	20 (45.5)
Bronchial breathing	14 (31.8)
Wheezing	12 (27.3)
Saturation level drop	11 (25.0)
Tachycardia	11 (25.0)
Chest retractions	10 (22.7)
Radiological findings	
Pulmonary infiltrate	7 (16.3)
Consolidation	6 (13.6)
Collapse	5 (11.4)
Hyperinflation	3 (6.8)
Radiopaque foreign body	3 (6.8)

Clinical symptoms had sensitivity of 100% (CI, 89.7–100%) and specificity of 30% (CI, 6.6–65%). Among the clinical symptoms, choking and cough have high sensitivity of 100%; (CI, 86.28%–100%). Two (7.4%) children with unwitnessed aspiration episodes were found to have tracheobronchial FB.

Positive physical examination had sensitivity of 95.83% (CI: 78.88%–99.89%) and specificity of 63.16% (38.36%–83.71%). The most common physical sign was stridor and respiratory distress with sensitivity of 56% (37.66%–73.64%), specificity of 60% (26.24%–87.84%), and PPV of 81.82%. This was followed with tachypnea and reduced air entry with the same specificity and sensitivity of 54.55% (36.35%–71.89%) and 80% (44.39%–97.48%), respectively. Bronchial breath sounds had a sensitivity of 40.62% (23.70%–59.36%) and specificity 90% (55.50%–

99.75%). Wheezing had a sensitivity of 34.38% (18.57%–53.19%) and specificity of 90% (55.50%–99.75%).

There were 19 children who had positive radiological findings on chest X-ray/CT (Table 1). Pulmonary infiltrates were seen in 7 cases (16.3%), with a diagnostic accuracy of 34.88%, sensitivity of 18.18% (6.98%–35.46%), and specificity of 90% (55.50%–99.75%). Consolidation was seen in 6 cases (13.6%), with a diagnostic accuracy of 38.1%, sensitivity of 18.75% (7.21%–36.44%), and specificity of 100% (69.15%–100.00%. Collapse was seen in 5 cases (11.4%), with a diagnostic accuracy of 35.7%, sensitivity of 15.6% (5.28%–32.79%), and specificity of 100% (69.15%–100.00%).

Out of the 44 patients, 34 underwent rigid bronchoscopy only, 5 underwent flexible bronchoscopy only, and 5 underwent both. There were 27 (61.3%) children who had a FB on bronchoscopy, among which 5 had inorganic FB, 21 had organic FB, and 1 did not have the type of FB documented. The location and type of FB varied (Table 2). FB location was not reported in all cases, but in 10 cases (i.e., more than 1/3 of cases) including 2 inorganic and 8 organic FB, the FB was in the right bronchus.

Table 2: Types and location of the foreign body.

Variables	n (%)
Foreign body types	
Organic	21 (47.7)
Inorganic	5 (11.3)
Not documented	1 (2.2)
No Foreign body	17 (38.6)
Location of the foreign body in the airway	
Right secondary bronchus	9 (26.4)
Left main bronchus	5 (14.7)
Sub glottis	4 (11.7)
Glottis	1 (2.9)
Right main bronchus	1 (2.9)
Trachea	1 (2.9)

Discussion

TBFA is a common pediatric emergency which poses a significant airway risk.[1] It can cause morbidity and mortality, including pneumonia, lung abscesses or bronchiectasis, and death. A prompt and accurate diagnosis is therefore important in its management. A delay in diagnosis and treatment might lead to inflammation and granulation tissue formation around the FB. It is not uncommon for patients to be treated for other disorders such as persistent fever, asthma, or recurrent pneumonia for a long period of time by pediatricians who are usually the first to see these

patients, resulting in delayed diagnosis and referral.[2,3] A complication rate of 64% was reported when a diagnosis was made within 4–7 days, whereas this was 95% if delayed for more than 30 days from the time of aspiration.[4]

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

In this study, clinical symptoms had sensitivity of 100% (89.7–100%) and specificity of 30% (6.6–65%), among which choking and cough had the highest sensitivities of 100% (86.28%–100%) for identifying the presence of FB, in line with the results of other studies. However, choking and cough had a poor specificity of 15.79% (3.38%–39.58%). Children with FB are often evaluated after a caregiver witnesses an aspiration event or choking episode. In this study, 86% had witnessed episodes. Other studies have shown that in up to 33% of FBA cases were unwitnessed. In this study 2 (7.4%) children with unwitnessed aspiration episodes were found to have a tracheobronchial FB. Hence, TBFA should be considered in unexplained respiratory symptoms in children. In other retrospective chart reviews, the sensitivity and specificity of a witnessed choking crisis ranges widely from 63% to 97% and 21% to 92.1%, respectively.[5,6] In literature, 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.[8,9,10]

In the present study, a positive physical examination was found to have a sensitivity of 95.83% (78.88%–99.89%) and specificity of 63.16% (38.36%–83.71%). The most common physical sign was stridor and respiratory distress both with a sensitivity of 56%, specificity of 60%, and PPV of 81.82%. This was followed with tachypnea and reduced air entry with a specificity and sensitivity of 54.55% and 80%, respectively. Bronchial breath sounds and wheezing, respectively, had sensitivities of 40.62% and 90% and specificities of 34.38% and 90%; and thus both are an important clinical sign for predicting TBFA. In other studies, the most common physical signs were wheezing (58%), stridor or noisy breathing (41%), and dyspnea (20%). In these studies wheezing and decreased breath sounds, respectively, had sensitivities of 58% and 41% and specificities of 64% and 91%. The relative usefulness of asymmetric lung findings on physical examination in our study was similar to that in other retrospective chart reviews. For example, the sensitivity and specificity of unilaterally decreased breath sounds ranged from 53% to 80% and 42.3% to 88%, respectively.[5,11,12,13] In other studies, physical examination had a sensitivity of 70.5% to 86% and a specificity of 26% to 63%,[6,15,16] which correlates with the findings of our study.

Positive radiological findings were present in 19 patients, with a sensitivity of 60% (38.67%–78.87%) and specificity of 78.95% (54.43%–93.95%). The sensitivity and specificity of chest radiography varies in the literature from 66% to 88% and 30% to 71.4%, respectively.[6,11,15] Zerella et al.[17] reported normal chest X-ray findings in 42% and 81% of bronchial and tracheal FBs, respectively. In various other studies, normal chest X-ray are seen in 6.1–50% of patients.[18,19,20]

In this cohort, 34 children underwent rigid bronchoscopy only, 5 underwent flexible bronchoscopy only, and 5 underwent both. Flexible bronchoscopy is a helpful diagnostic tool to evaluate the distal bronchial tree and is less invasive compared to rigid bronchoscopy. Out of 44 patients in this study, 27 were confirmed to have FB on bronchoscopy, among which 12 remained intubated after bronchoscopy for at least 24 hours.

The main limitation of this study is its retrospective nature. The data were collected based on the documented clinical findings. Missing data was encountered in some cases. The sample size is small but adequate to run diagnostic accuracy.

Conclusion

A high index of suspicion is required in diagnosing TBFA. Proper clinical assessment with history, physical examination, and imaging can highly predict the presence of TBFA. In this study, choking, and coughing were the most significant presenting symptoms for predicting TBFA. Stridor, respiratory distress, wheezing, and bronchial breathing should also raise a high suspicion of TBFA in previously healthy children. Bronchoscopy remains the gold standard intervention to determine the presence of FB in such children guided by their clinical presentation.

Disclosure

There are no conflicts of interest relevant to this article to disclose.

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