DOI: 10.7860/JCDR/2022/53732.16190

Original Article

Surgery Section

Predictive Accuracy of Conventional Clinico-radiological Indicators in Foreign Body Aspirations among Children: A Retrospective Study

SHINAZ SADIQ[1], MK BINU[2], CS ARAVIND[3], SV BEENA[4]

ABSTRACT

Introduction: Foreign Body Aspiration (FBA) is a common and serious paediatric emergency condition. A Suspected Foreign Body Aspiration (SFBA) is based on Clinical History (CH), Physical Findings (PF), and Chest Radiograph (RAD/CXR). The predictive accuracy of these factors as indicators of FBA and to perform Rigid Bronchoscopy (RB) based on these factors has been debated.

Aim: To evaluate the sensitivity, specificity, positive predictive value and negative predictive value of clinical history, physical findings and radiology in SFBA.

Materials and Methods: A retrospective analysis was conducted on paediatric patients with suspicion of foreign body aspiration, admitted in the Department of Paediatric Surgery at Government Medical College, Thiruvananthapuram, Kerala, India, between January 2006 and December 2020. Factors in CH, PF, and RAD were subjected to univariate and multivariate analysis to evaluate the predictive accuracy of these factors as indicators for bronchoscopy. Sensitivity, specificity, positive and NPV were calculated for the clinico-radiological indicators in predicting FBA. The association between evidence of FBA and clinico-radiological indicators was evaluated by Pearson Chi-square test; and p-values <0.05 were considered to be statistically significant.

Results: A total of 458 children (263 males and 195 females) were admitted with SFBA having mean age of 29.49±24.92 months, 389 had confirmed FBA (Group A), and 69 had no FBA (Group B). The age group of 1-2 years was found to be a statistically significant factor for FBA (p-value=0.03). Foreign Body aspiration Witnessing Event (FBEW) (p-value <0.0001, sensitivity=91%, specificity=31%), choking spell (p-value <0.0001, sensitivity=95%, specificity=25%), acute cough (p-value <0.0001, sensitivity=87%, specificity=46%), tachypnea (p-value <0.0167, sensitivity=89%, specificity=20%), decreased breath sound (p-value <0.0001, sensitivity=92%, specificity=35%), abnormal CXR (p-value <0.0001, sensitivity=94%, specificity=37%) and hyperinflation (p-value <0.0001, sensitivity=95%, specificity=31%) were found to be independent statistically significant factors in FBA. Multivariate analysis showed a PPV of 97% when the aspiration event was witnessed along with abnormal physical and radiological findings.

Conclusion: It was observed that assessment of clinico-radiological parameters is valuable in predicting FBA. The indications of RB in SFBA can be safely based on these clinico-radiological parameters.

Keywords: Acute cough, Choking spell, Hyperinflation, Rigid bronchoscopy, Tachypnoea

INTRODUCTION

The Foreign Body Aspiration (FBA) is a common cause of morbidity and mortality in children. Prior to the 20th century, one out of four children with FBA succumbed to death. Even though modern endoscopic techniques have improved the outcome dramatically, the consequences can still be devastating with a mortality rate of 1.8% and occurrence of hypoxic brain damage in 2.2% [1,2].

A high degree of suspicion, timely diagnosis, and early intervention are the key factors in the management of a child with FBA. Clinical History (CH), Physical Findings (PF), and Chest Radiographs (RAD/CXR) can offer significant clues to FBA. But since these parameters are not specific and can overlap in most paediatric respiratory conditions, none of these can always independently predict a positive FBA. Hence children with a suggestive CH with or without positive PF and/or RAD findings are managed as Suspected Foreign Body Aspiration (SFBA). The conventional management of SFBA is to proceed with RB, which is the gold standard diagnostic and therapeutic modality in FBA [3-5]. The indications of bronchoscopy in SFBA are based on 'suspicions', which could be a Foreign Body aspiration Witnessing Event (FBEW) or positive PF and abnormal RAD [6].

Many authors have expressed concerns about the indications of an invasive procedure like RB based on clinical suspicion alone, and that the clinico-radiological criteria lack predictive accuracy [2,7]. The use of Multidetector Computed Tomography (MDCT), Virtual Bronchoscopy (VB), or flexible bronchoscopy has been suggested to confirm the diagnosis and avoid negative bronchoscopies and the complications related to it [2,7,8]. But, non selective use of these investigations in all cases of SFBA may not be beneficial as it increases the overall examination time and cost in addition to other concerns like radiation risk and the possible need for general anaesthesia. The aim of this study was to assess the effectiveness of the clinico-radiological parameters in positively predicting FBA.

MATERIALS AND METHODS

A retrospective descriptive study was carried out in the Department of Paediatric Surgery, Sree Avittom Thirunal Hospital, Government Medical College, Thiruvananthapuram, Kerala, India, after obtaining Institutional Research Committee approval (A2/SBMR/44/2021/GMCT) and Human Ethics Committee clearance (HEC No. 08/18/2021/MCT) in September 2021. The data collection and analysis was performed after attaining clearance from these committees. The study duration was from January 2006 to December 2020, and children admitted during this period with suspected FBA were categorised into:

(i) Group A- Confirmed FBA (n=389); and

(ii) Group B- No FBA (n=69).

Inclusion criteria: All children less than 12 years of age, admitted with SFBA were included in the study.

Exclusion criteria: Children with neurological illness/sequelae, developmental delay, congenital laryngo-tracheo-bronchial anomalies, congenital oesophageal anomalies/dysfunctional swallowing were excluded from the study.

Data regarding patient demographics like age and sex, clinico-radiological parameters, and bronchoscopy details were collected. The following clinico-radiological parameters were collected:

a) **Clinical History (CH):** (i) witnessing the aspiration event (FBEW); (ii) duration of symptoms; (iii) choking spell/gagging episode; (iv) acute onset of cough; (v) dyspnoea

b) **Physical Findings (PF):** (i) tachypnea; (ii) unilateral decrease in air entry (decreased breath sounds); (iii) rhonchi; (iv) crepitations

c) **Radiology (RAD)/Chest X-ray (CXR):** (i) whether RAD is normal; (ii) if abnormal- visualisation of foreign body/unilateral hyperinflation/atelectasis.

STATISTICAL ANALYSIS

The data collection and statistical analysis were done with Microsoft Excel and Jamovi software for windows (version 2.0) [9]. Sensitivity, specificity, positive predictive value and negative predictive value were calculated for the clinico-radiological indicators in predicting FBA. The association between evidence of FBA and clinico-radiological indicators was evaluated by Pearson's Chi-square test; and p-values <0.05 were considered to be statistically significant.

RESULTS

A total of 458 children (263 males and 195 females) were admitted with SFBA having mean age of 29.49±24.92 months and a median age of 22.8 months (range 1 month to 145 months). Majority of the children were less than three years of age (n=375, 82%), with a peak incidence in the age group of 1-2 years (n=259, 57%) [Table/Fig-1].

Variables	Suspected foreign body aspiration (N=458)	Group A (n=389)	Group B (n=69)
Gender			
Males (M)	263	228	35
Females (F)	195	161	34
M:F	1.35	1.42	1.03
Age			
Mean age (months)	29.49±24.92	29.55±25.63	29.17±20.65
Median age (months)	22.8 (range 1-145)	22.8 (range 1-145)	24 (range 3.5-108)
Age groups			
<1 year of age	32 (7%)	24 (6%)	8 (12 %)
1-2 years of age	259 (57%)	228 (59%)	31 (45%)
>2-3 years of age	84 (18%)	70 (18%)	14 (20%)
>3 years of age	83 (18%)	67 (17%)	16 (23%)
Duration of symptoms			
<2 days (early)	197 (43%)	165 (42%)	33 (48%)
3-7 days(moderate)	155 (34%)	133 (34%)	22 (32%)
8-29 days (late)	81 (18%)	68 (18%)	12 (17%)
>30 days (very late)	25 (5%)	23 (6%)	2 (3%)

[Table/Fig-1]: Patient demographics and duration of symptoms.

Group A

Of the 389 cases in Group A (CFBA), 378 were removed by Rigid Bronchoscopy (RB), five could not be retrieved by RB and in six cases, the FB was coughed out before RB [Table/Fig-2].

It was observed that 191 FB were located in the right bronchus; 156 in the left bronchus, 32 in the trachea, and 10 in bilateral bronchi. RB was done as an emergency procedure (within 4 hours of admission) in eight patients due to severe respiratory distress; whereas the rest of the patients had a semi-emergency bronchoscopy done, with 352/383(92%) of patients in group A and 53/60 (88%) of patients in group B undergoing the procedure within 24 hours of admission. A total of 322/389 (83%) of foreign bodies were organic in nature, with peanut aspiration (n=251) as the leading cause in 65% of all FBA.

Groups	Rigid bronchoscopy	Foreign body retrieved
Group A	RB done in CFBA (n=383)	FB retrieved by RB (n=378)
		FB could not be retrieved by RB (n=5)
	RB not done (n=6)	FB coughed out prior to RB (n=6)
Group B	RB done in No-FBA (n=60)	No FB seen (Thick mucus secretion n=21 and normal findings n=30)
	RB not done (n=9)	No FB-confirmed clinically and radiologically (including MDCT) on prolonged follow-up (n=9)

[Table/Fig-2]: Categorisation of all Suspected Foreign Body Aspiration (SFBA) cases (N=458).
FB: Foreign body; RB: Rigid bronchoscopy; MDCT: Multidetector CT scan

Delayed presentations of FBA were associated with mucosal oedema, thick secretions, tissue reaction causing granulation tissue formation (33 cases, earliest presentation–within 5 days of FBA). During FB retrieval by RB, bleeding from granulation tissue and poor optics warranted a repeat procedure in 13 cases. In six cases, after an unsuccessful first attempt, FB was retrieved during the second RB. In seven cases, repeat bronchoscopy was done due to suspicion of incomplete retrieval of FB, of which four cases had retained FB fragments, and same removed. The remaining three cases had no retained FB. Of the five unsuccessful attempts, four were due to instrument error causing poor visualisation of the FB and they had to be referred to another centre to avoid undue delay in FB retrieval. In the fifth case, the FB had migrated distally preventing access by RB and it was removed by flexible bronchoscopy.

Group B

In group B (No-FBA), 60 cases underwent RB which revealed no airway FB. In the remaining nine children, the symptoms were mild and the aspiration history was inconclusive. Their parents were apprehensive of RB and opted for MDCT which revealed no evidence of FBA. They were kept under close follow-up and found to be asymptomatic with no evidence of aspiration. It was found that, of the 60 bronchoscopies which were negative for FBs, 21 cases had thick mucus secretion within the tracheobronchial tree and 14 out of these 21 cases had significant improvement in air entry on suctioning out the secretion [Table/Fig-2].

Thus, a total of 443 RB were performed (383 in group A and 60 in group B). Of the 443 bronchoscopies in the present study, 383 had confirmed FBA; with a positive bronchoscopy rate of 86%.

Complications: Minimal bleeding during manipulation from granulation tissue was noticed in 20 cases and transient bronchospasm in another 15 cases, which responded well to conservative measures. Two children presented with severe hypoxia, respiratory failure, and shock. One was a nine-month-old child with peanut aspiration and the other, was a two-year-old with peanut and milk aspiration. Both underwent emergency RB and FB retrieval followed by mechanical ventilation and other supportive measures, but unfortunately, both children succumbed.

I. Demographics

Mean age (p-value=0.67), gender (p-value=0.22) and duration of symptoms (p-value=0.69) were not significant factors in predicting FBA. Even though the majority of the children were <3 years of age, this age group was not a statistically significant predictor for FBA [Table/Fig-3]. However, the age group of 1-2 years was found to be statistically significant when compared to the rest of the age groups [Table/Fig-3].

Age group	Group A- CFBA (n)	% of SFBA cases	% of positive RB in this age group	Group B- No-FBA (n)	% of SFBA cases	% of negative RB in this age group	p-value (Chi-square test)
≤3 years vs >3 years							
≤3 years (n=375)	322	70% (322/458)	86% (322/375)	53	12% (53/458)	14% (53/375)	0.24
>3 years (n=83)	67	15% (67/458)	81% (67/83)	16	3% (16/458)	19% (16/83)	
1-2 years vs other age groups							
1-2 years (n=259)	228	50% (228/458)	88% (228/259)	31	7% (31/458)	12% (31/259)	**0.03**
Other age groups (n=199)	161	35% (161/458)	81% (161/199)	38	8% (38/458)	19% (38/199)	

[Table/Fig-3]: Comparison of age groups in predicting FBA.

II. Univariate Statistical Analysis of Clinico-radiological Indicators

a. Clinical history

FBEW in 329/458 SFBA cases, of which 300 cases had confirmed FBA. A choking spell/gagging episode was noticed by the caregivers in 228/458 SFBA cases, of which 217 cases had confirmed FBA. Acute cough was present in 434/458 SFBA cases and 376 of them had confirmed FBA. A 289/458 SFBA cases had dyspnoea, of which 247 had confirmed FBA. Among these parameters, FBEW, choking spell, and acute cough were independently found to be statistically significant in predicting FBA [Table/Fig-4]. Of the 389 CFBA, 77% had FBEW (300/389), 56% had choking spells (217/389), 97% had acute onset of cough (376/389) and 63% had dyspnoea (247/389).

b. Physical examination findings

A total of 252/458 cases of SFBA were tachypneic, of which 224 had confirmed FBA. Unilateral decrease in air entry was documented in 340/458 cases, of which 312 cases had positive FBA. Both tachypnea and unilateral decrease in breath sounds were found to be statistically significant predictors of FBA. Rhonchi and crepitations were not significant predictors in the present study [Table/Fig-4].

Of the 389 CFBA, 57% were tachypneic (252/389), 80% had a unilateral decrease in breath sounds (340/389), 62% had rhonchi (241/389) and 21% had crepitations (84/389) on auscultation.

c. Radiology (RAD)

An abnormal radiological finding (visualisation of FB/unilateral hyperinflation/atelectasis/pulmonary infiltrates/consolidation) was detected in 325/458 cases, of which 305 had confirmed FBA. Unilateral hyperinflation was noticed in 275/458 cases, of which 262 had confirmed FBA. Abnormal CXR and unilateral hyperinflation, both were significant predictors of FBA. Atelectasis was not a significant predictor in this study [Table/Fig-4]. Of the 389 CFBA, 78% had abnormal CXR findings (305/389), 67% had hyperinflation (262/389) and 11% had atelectasis (44/389).

III. Multivariate Statistical Analysis of Clinico-radiological Indicators

Witnessing the FBEW and CH were considered as major parameters and multivariate analysis was performed to assess the predictive value of association of: (a) FBEW with PF and RAD; and (b) CH with PF and RAD.

a) FBEW with PF and RAD

FB aspiration event was witnessed (FBEW+) in 329/458 cases and not witnessed (FBEW-) in 129/458 cases. The highest PPV of 97% was observed when the FB event was witnessed along with positive PF and abnormal RAD [Table/Fig-5].

b) CH with PF and RAD

A CH+, which was defined as the presence of 'any' of the four features studied (FBEW, choking, cough, dyspnoea), was present in 456/458 cases of SFBA. The remaining 2 (CH-) were evaluated for recurrent respiratory infection. CH+ with positive PF and abnormal RAD had a PPV of 95%. The PPV dropped to 55% when the PF and RAD were normal [Table/Fig-5]. The authors also did a sub-categorical analysis based on the four factors in CH that were studied (FBEW, choking, cough, and dyspnoea), and a PPV of 96-97% was observed. The classic triad of choking followed by acute cough/wheeze and decreased air entry was seen in 201/458 (44%) of all suspected FBA and in 191/389 (49%) of confirmed FBA, with a PPV of 95% [Table/Fig-6].

Parameters	Number of patients	Percentage (%)	Sensitivity	Specificity	PPV	NPV	Odd's ratio	Odd's -95% confidence interval	p-value (Chi-square test)
Clinical history									
Foreign Body aspiration Witnessing Event (FBEW)	329	72	91	31	77	58	4.65	3.02-8.85	**<0.0001**
Choking	228	50	95	25	56	84	6.65	3.39-13.06	**<0.0001**
Acute cough	434	95	87	46	97	16	5.49	2.06-11.69	**<0.0001**
Dyspnoea	289	63	86	16	64	39	1.12	0.66-1.89	0.68
Physical examination findings									
Tachypnea	252	55	89	20	58	59	1.99	1.11-3.15	0.0167
Decreased breath sound	340	74	92	35	80	59	5.93	3.45-10.2	**<0.0001**
Rhonchi	278	61	87	18	62	46	1.41	0.89-2.5	0.125
Crepitations	96	21	88	16	22	83	1.31	0.67-2.55	0.43
Radiology (RAD)									
Abnormal chest X-ray	325	71	94	37	78	71	8.90	5.01-15.78	**<0.0001**
Hyperinflation	275	60	95	31	67	81	8.89	4.63-16.65	**<0.0001**
Atelectasis	49	11	90	16	11	93	1.63	0.62-4.27	0.315

[Table/Fig-4]: Statistical analysis of the clinico-radiological indicators.
Stridor- significant parameter in Tracheal FB (15/32); p-value <0.00001; *p-value <0.05 was considered as statistically significant; PPV: Positive predictive value; NPV: Negative predictive value

Multivariate statistical analysis					
Parameters	Group A	Group B	Total	Percentage of Total SFBA cases	Positive Predictive Value (PPV)
FB event witnessed (FBEW+) n=329					
FBEW+PF+RAD+	212 (54%)	6 (9%)	218	48%	97%
FBEW+PF+RAD-	57 (15%)	13 (19%)	70	15%	81%
FBEW+PF-RAD+	16 (4%)	1 (1%)	17	4%	94%
FBEW+PF-RAD-	15 (4%)	9 (13%)	24	5%	63%
TOTAL	300 (77%)	29 (42%)	329	72%	
FB event not witnessed (FBEW-) n=129					
FBEW-PF+RAD+	73 (19%)	12 (17%)	85	19%	86%
FBEW-PF+RAD-	11 (3%)	22 (32%)	33	7%	33%
FBEW-PF-RAD+*	4 (1%)	0	4	1%	100%
FBEW-PF-RAD-	1	6 (9%)	7	1%	14%
TOTAL	89 (23%)	40 (58%)	129	28%	
Positive clinical history (CH+), n=456					
CH+PF+RAD+	285 (73%)	16 (23%)	301	65.72%	95%
CH+PF+RAD-	68 (15%)	36 (52%)	104	22.71%	65%
CH+PF-RAD+	20 (5%)	2 (3%)	22	4.80%	91%
CH+PF-RAD-	16 (4%)	13 (19%)	29	6.33%	55%
TOTAL	389 (100%)	67 (97%)	456	99.56%	
Negative clinical history (CH-), n=2					
CH-PF+RAD+	0	2 (3%)	2	0.44%	0

[Table/Fig-5]: Multivariate analysis based on the clinico-radiological indicators.
PF+=positive physical findings, PF-=normal physical findings, RAD+=abnormal radiograph, RAD-=normal radiograph; *a high PPV in this category was due to cases which had radio-opaque FB visualised in RAD

Subcategorical analysis of CH	Group A	Group B	Total	Percentage of total cases	PPV
FBEW+, decreased BS+, hyperinflation+	129 (33%)	6 (9%)	135	29%	96%
FBEW+, choking+, decreased BS+, hyperinflation+	85 (22%)	3 (4%)	88	19%	97%
FBEW+, choking+, acute cough+, decreased BS+, hyperinflation+	84 (22%)	3 (4%)	87	19%	97%
FBEW+, choking+, acute cough+, dyspnoea+, decreased BS+, hyperinflation+	68 (17%)	2 (3%)	70	15%	97%
Classic triad (choking+cough/ wheeze+decreased BS)	191 (49%)	10 (14%)	201	44%	95%

[Table/Fig-6]: Sub-categorical analysis based on Clinical History (CH).
FBEW+=aspiration event witnessed, BS: Breath sounds

DISCUSSION

The FBA can be a life-threatening emergency predominantly affecting children less than three years of age [6,10], with a peak incidence in the age group of 1-2 years [11,12]. This is probably because children of this age put foreign substances in their mouth, they lack adequate dentition for chewing, they have immature swallowing mechanisms and they run, play, cry and laugh with objects or food in their mouth. In the present study, 82% of suspected FBA and 83% of confirmed FBA occurred in children <3 years of age. The authors found that the age group of 1-2 years to be a significant factor in FBA. As with most accident statistics in literature, a male predilection has been reported for FBA (male:female=1.7:1 to 2.2:1) [10,13], which could be attributed to their higher risk-taking behaviour.

The likelihood of detecting a child with SFBA is classically based on three parameters (a) CH-FBEW, choking spell/gagging episode, acute onset of cough and/or dyspnoea; (b) PFs- decreased unilateral air entry in the chest, new onset wheeze; (c) radiological finding- detection of FB in CXR or hyperinflation/atelectasis [3,6]. But, apart from FBEW and visualisation of the FB on imaging, none of the presenting features or radiological factors are specific for FBA [3]. A positive history is considered the most sensitive predictor of the presence of FBA [14], and a witnessed aspiration event had a positive bronchoscopy rate of 87% for [6]. Mortellaro VE et al., report a positive bronchoscopy rate of 93% for FBEW+, 88% for symptomatic FBEW-, and 70% for minimally symptomatic FBEW- [15]. Positive bronchoscopy in other studies range from 60 to 73% [2,6,13,16]. Of the 443 bronchoscopies in the present study, 383 had confirmed FBA; with a positive bronchoscopy rate of 86%. The incidence of a choking spell/gagging episode in FBA ranges from 39-71% [2,15,17,18], whereas that of acute onset of cough varies from 43-96% and for dyspnoea from 13-87% [2,6,13,15,17,18]. In the present series, 91% of all witnessed aspiration events, 95% of all choking spells, and 87% of acute cough had confirmed FBA and these three factors were independent statistically significant factors in predicting FBA.

The incidence of abnormal PFs in confirmed FBA is 71-87% [6,16,17], but it can be abnormal in 50% of children with no FBA [18]. In a study on 207 patients, Kiyan G et al., reported that in children with confirmed FBA, 78% had unilateral decreased breath sounds, 51% had rhonchi,18% had crepitations; whereas in children with no FBA, 26% had decreased breath sounds, 35% had rhonchi and 15% had crepitations [13]. The authors found that unilateral decreased air entry occurred in 80% of all confirmed FBA and with a sensitivity of 92%, it was found to be a statistically significant predictor for FBA; whereas rhonchi and crepitations weren't. Radiological findings in FBA varies, with CXR being normal in 26- 62% [6,16]. In a study on 431 patients, Divarci E et al., report that the rate of positive bronchoscopy was 75.3% when the radiological findings were positive and 64% when the radiological findings were absent [6]. The rate of positive bronchoscopy was 94% when the CXR was abnormal and 63% when the CXR was normal. In this study, 95% of patients with unilateral/ localised hyperinflation had confirmed FBA. An abnormal CXR and unilateral hyperinflation were found to be independent statistically significant factors for predicting FBA in the present study. Various studies quote the rate of atelectasis in FBA to be 6-20% [6,15-17]. Multivariate analysis done by Divarci E et al., reports a PPV of 91.3% when FB aspiration event was witnessed along with positive physical and radiological findings [6]. The findings are similar (summarised in [Table/Fig-5,6]) and a PPV of 96% was found when the FB aspiration event was witnessed along with a unilateral decrease in air entry and hyperinflation.

Many authors have questioned the validity of these clinico-radiological indicators in predicting FBA and have urged to avoid unnecessary bronchoscopies in SFBA [8]. They argue that these indicators lack predictive accuracy and RB is too intrusive a diagnostic procedure that requires general anaesthesia and has a risk of serious complications like exacerbation of reactive airway disease, pneumothorax, tracheal laceration, subglottic oedema, and death [19]. Cavel O et al., study revealed a negative bronchoscopy rate of 25% and the literature review demonstrated the same to be 16-57% [8]. The use of MDCT has been advocated, which is a diagnostic tool that is superior to CXR and less invasive than RB. Even though a sensitivity of 88.9-100%, specificity of 91.7-98%, and accuracy of 90.5% has been reported for MDCT [2,4,20], most studies fail to adequately highlight false-negative cases. In a large series by Qiu W et al., on 695 children with confirmed FBA on flexible bronchoscopy, the MDCT was positive in 634, indirect signs of FBA in 13 and negative for FBA in 48 (with a relatively lower sensitivity of 93%) [19].

Manach Y et al., and Qiu W et al., report a false-negative rate of 6% and 6.9%, respectively, even though 80-98% of such false-negative cases had a clear clinical picture suggestive of FBA [4,19]. Moreover, getting MDCT done in an already distressed toddler can be a difficult, time-consuming process, necessitating sedation and

even short general anaesthesia in certain cases. If paediatric-specific low dose protocol is not followed, the radiation risk is significant; and a high chance of motion blurring (up to 30%) may make the entire exercise futile [4]. The MDCT can be useful in scenarios where the possibility of FBA is not considered initially or in asymptomatic patients or when bronchoscopy is likely to be challenging [4,21].

Hence, though useful in selected cases and is the most accurate non invasive tool, MDCT is not feasible and not required in all cases of SFBA due to its complexity and risks of radiation exposure [8]. In the institution, the authors perform MDCT only when the possibility of FBA is minimal; and the majority of the patients in the present study already had MDCT taken from peripheral centres prior to referral to our department. And hence, the protocols followed were not uniform and the indications for performing MDCT were different, which prevented us from studying the impact of MDCT on FBA systematically. However, based on available data, the authors noticed that, among the 30 patients in group A (confirmed FBA group) who had MDCT taken, the scan revealed no FB in 5/30 (false-negative rate of 30%), suspicious FB in 23% (7/30) and confirmed FB in 60% (18/30).

The VB increases the total examination time, cost, doesn't provide additional information over multi-planar images in FBA evaluation, and could also result in loss of raw CT data due to airway smoothing by the computer algorithm [4,20]. Flexible bronchoscopy is a reasonable diagnostic tool in suspected FBA, especially in ruling out FBA and avoiding unnecessary RB, thereby reducing the negative RB rate by 17-46% [8,22,23]. However, adequate and short-term sedation is difficult to achieve, and more often general anaesthesia is required for flexible bronchoscopy. In such settings, flexible and RB are equal diagnostic tools [8], with RB having the advantage of being therapeutic as well. Flexible bronchoscopy is better suited at the levels of distal and upper lung segments, and also as a follow-up procedure to rule out retained FB fragments after initial RB [8].

Routine use of the above-mentioned additional investigations in all cases of SFBA, significantly adds to the time to reach the diagnosis and hence the treatment. The two main reasons for treatment delay in FBA are misdiagnosis (64%) and parental oversight (34%) [24], which again results in delayed diagnosis and treatment. Delayed treatment of FBA is related to a higher occurrence rate of complications like recurrent pneumonia, atelectasis, bronchiectasis, and lung abscess. Moreover, this can result in longer and more difficult treatment procedures, longer hospitalisation time, and higher bronchoscopy-related complications like bronchospasm and subglottic oedema [25]. Shlizerman L et al., found that the rate of complication was two fold higher when patients presented more than two days after the onset of symptoms and also for patients who did not undergo bronchoscopy within 24 hours of hospital admission [16]. Hence, considering the significant morbidity caused by the retained FB in the airway, conventionally, negative bronchoscopies are considered acceptable in SFBAs. Even though a complication rate of 4-17% for RB has been mentioned in the literature, a review of anaesthetic considerations of RB by Fidkowski CW et al., reports the prevalence of major morbidity and mortality as 0.9% and 0.5%, respectively [26]. But many of these complications could be attributed to the FB aspiration per se and the patient's state and it is often difficult to single out the cause for the same [8]. The mortality rate in our series is similar (0.5%) and the authors had no major complications other than transient minor complications like bleeding, bronchospasm, and gingival injury.

The present study data and results of the 15 year study period confirm the classical dictum that, the key to diagnosing cases with FBA is to maintain a high degree of suspicion along with a proper analysis of the clinical scenario. Authors feel that even in cases, where the aspiration event wasn't witnessed by the caregiver, a sudden onset of respiratory symptoms or a choking spell in an otherwise normal child with no prodromal symptoms should evoke suspicion of FBA. Most often, an attentive caregiver will give significant clues to the temporal association of acute symptoms to food or events, like the child developed symptoms when he/she was eating a certain food or when he/she was playing or running around with some object in his/her mouth or that certain toy pieces are missing. This along with abnormal PF with or without radiological findings should be managed as SFBA and followed with RB without delay. A prospective study with a well defined algorithm or scoring system might be useful to validate our study findings.

Limitation(s)

The retrospective record-based nature of this study is one of its major limitations, which could possibly have an impact on the accuracy of data collected (CH, PF) and interpretation of radiology results. Failure to account for the non clinical factors like socio-economic profile, family size and parental education status as added risk factors in FBA is another limitation.

CONCLUSION(S)

The classical clinico-radiological parameters are always valuable in predicting FBA and they can be ascertained easily and quickly in almost every case of SFBA, thus ensuring treatment without delay. Investigations like MDCT or VB have a role only when the possibility of FBA is not considered initially or in asymptomatic patients or when bronchoscopy is likely to prove challenging.

REFERENCES

[1] Kim IA, Shapiro N, Bhattacharyya N. The national cost burden of bronchial foreign body aspiration in children: Cost of Foreign Body Aspiration in Children. Laryngoscope. 2015;125(5):1221-24.
[2] Gibbons AT, Casar Berazaluce AM, Hanke RE, McNinch NL, Person A, Mehlman T, et al. Avoiding unnecessary bronchoscopy in children with suspected foreign body aspiration using computed tomography. J Paediatr Surg. 2020;55(1):176-81.
[3] Sheehan CC, Lopez J, Elmaraghy CA. Low rate of positive bronchoscopy for suspected foreign body aspiration in infants. Int J Paediatr Otorhinolaryngol. 2018;104:72-75.
[4] Manach Y, Pierrot S, Couloigner V, Ayari-Khalfallah S, Nicollas R, Venail F, et al. Diagnostic performance of multidetector computed tomography for foreign body aspiration in children. Int J Paediatr Otorhinolaryngol. 2013;77(5):808-12.
[5] Cohen S, Avital A, Godfrey S, Gross M, Kerem E, Springer C. Suspected foreign body inhalation in children: What are the indications for bronchoscopy? J Paediatr. 2009;155(2):276-80.
[6] Divarci E, Toker B, Dokumcu Z, Musayev A, Ozcan C, Erdener A. The multivariate analysis of indications of rigid bronchoscopy in suspected foreign body aspiration. Int J Paediatr Otorhinolaryngol. 2017;100:232-37.
[7] Cavel O, Bergeron M, Garel L, Arcand P, Froehlich P. Questioning the legitimacy of rigid bronchoscopy as a tool for establishing the diagnosis of a bronchial foreign body. Int J Paediatr Otorhinolaryngol. 2012;76(2):194-201.
[8] Hamed DHE dine, Naguib ML, El Attar MM. Foreign body aspiration in children and role of flexible bronchoscopy: A 3 year experience. Egypt Paediatr Assoc Gaz. 2016;64(4):167-70.
[9] Şahin M, Aybek E. Jamovi: An easy to use statistical software for the social scientists. Int J Assess Tools Educ. 2019;670-92.
[10] Skoulakis CE, Doxas PG, Papadakis CE, Proimos E, Christodoulou P, Bizakis JG, et al. Bronchoscopy for foreign body removal in children. A review and analysis of 210 cases. Int J Paediatr Otorhinolaryngol. 2000;53(2):143-48.
[11] Black RE, Johnson DG, Matlak ME. Bronchoscopic removal of aspirated foreign bodies in children. J Paediatr Surg. 1994;29(5):682-84.
[12] Tan HK, Brown K, McGill T, Kenna MA, Lund DP, Healy GB. Airway foreign bodies (FB): A 10-year review. Int J Paediatr Otorhinolaryngol. 2000;56(2):91-99.
[13] Kiyan G, Gocmen B, Tugtepe H, Karakoc F, Dagli E, Dagli TE. Foreign body aspiration in children: The value of diagnostic criteria. Int J Paediatr Otorhinolaryngol. 2009;73(7):963-67.
[14] Lowe DA, Vasquez R, Maniaci V. Foreign body aspiration in children. Clin Paediatr Emerg Med. 2015;6(3):140-48.
[15] Mortellaro VE, Iqbal C, Fu R, Curtis H, Fike FB, St. Peter SD. Predictors of radiolucent foreign body aspiration. J Paediatr Surg. 2013;48(9):1867-70.
[16] Shlizerman L, Mazzawi S, Rakover Y, Ashkenazi D. Foreign body aspiration in children: The effects of delayed diagnosis. Am J Otolaryngol. 2010;31(5):320-24.
[17] Boufersaoui A, Smati L, Benhalla KN, Boukari R, Smail S, Anik K, et al. Foreign body aspiration in children: Experience from 2624 patients. Int J Paediatr Otorhinolaryngol. 2013;77(10):1683-88.
[18] Mansour B, Mha NE. Foreign body aspiration in children with focus on the role of flexible bronchoscopy: A 5 year experience. Isr Med Assoc J. 2015;17:05.
[19] Qiu W, Wu L, Chen Z. Foreign body aspiration in children with negative multi-detector Computed Tomography results: Own experience during 2011-2018. Int J Paediatr Otorhinolaryngol. 2019;124:90-93.

[20] Kocaoglu M, Bulakbasi N, Soylu K, Demirbag S, Tayfun C, Somuncu I. Thin-section axial multidetector computed tomography and multiplanar reformatted imaging of children with suspected foreign-body aspiration: Is virtual bronchoscopy overemphasized? Acta Radiol. 2006;47(7):746-51.
[21] Pitiot V, Grall M, Ploin D, Truy E, Ayari Khalfallah S. The use of CT-scan in foreign body aspiration in children: A 6 years' experience. Int J Paediatr Otorhinolaryngol. 2017;102:169-73.
[22] Righini CA, Morel N, Karkas A, Reyt E, Ferretti K, Pin I, et al. What is the diagnostic value of flexible bronchoscopy in the initial investigation of children with suspected foreign body aspiration? Int J Paediatr Otorhinolaryngol. 2007;71(9):1383-90.
[23] Martinot A, Closset M, Marquette CH, Hue V, Deschildre A, Ramon P, et al. Indications for flexible versus rigid bronchoscopy in children with suspected foreign-body aspiration. Am J Respir Crit Care Med. 1997;155(5):1676-79.
[24] Rizk H, Rassi S. Foreign body inhalation in the paediatric population: Lessons learned from 106 cases. Eur Ann Otorhinolaryngol Head Neck Dis. 2011;128(4):169-74.
[25] Chen X, Zhang C. Foreign body aspiration in children: Focus on the impact of delayed treatment. Int J Paediatr Otorhinolaryngol. 2017;96:111-15.
[26] Fidkowski CW, Zheng H, Firth PG. The anaesthetic considerations of tracheobronchial foreign bodies in children: A literature review of 12,979 cases. Anaesth Analg. 2010;111(4):1016-25.

PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Paediatric Surgery, Government Medical College, Thiruvananthapuram, Kerala, India.
2. Assistant Professor, Department of Paediatric Surgery, Government Medical College, Thiruvananthapuram, Kerala, India.
3. Associate Professor, Department of Paediatric Surgery, Government Medical College, Thiruvananthapuram, Kerala, India.
4. Professor, Department of Paediatric Surgery, Governement Medical College, Thiruvananthapuram, Kerala, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Shinaz Sadiq,
"Nimitha", Manthara, Near Chirayil Temple, Edava P.O,
Thiruvananathapuram-695311, Kerala, India.
E-mail: shinazsadiq@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jan 05, 2022
- Manual Googling: Feb 17, 2022
- iThenticate Software: Feb 21, 2022 (2%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Jan 04, 2022**
Date of Peer Review: **Feb 08, 2022**
Date of Acceptance: **Feb 19, 2022**
Date of Publishing: **Apr 01, 2022**