



ROLE OF MULTIDETECTOR-ROW CT (MDCT) IN TRACHEOBRONCHIAL FOREIGN BODY ASPIRATION DIAGNOSIS IN CHILDREN

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ABSTRACT **Background:** Bronchoscopy is considered the standard procedure of care for the diagnosis and treatment of tracheobronchial foreign body aspiration (FBA) in children. This procedure is invasive and needs general anesthesia. Multidetector-row Computed tomography (MDCT) of chest can potentially identify patients with tracheobronchial FBA, thereby avoiding unnecessary bronchoscopies. The aim of the present study was to investigate the value of chest MDCT in the evaluation of children with suspected foreign body aspiration. **Methods:** MDCT Chest was performed in 35 consecutive children with suspected foreign body aspiration after plain chest X-ray. Rigid bronchoscopy and removal of the tracheobronchial foreign body was performed under general anesthesia. **Results:** A tracheobronchial foreign body was identified on MDCT chest in 24 children. All 24 underwent rigid bronchoscopy under general anesthesia. 11 patients avoided bronchoscopy due to negative CT scan. All foreign bodies were removed successfully. The location, shape, and volume of the foreign bodies found at bronchoscopy were consistent with the CT findings. Children with negative chest CT scan were observed to have resolution of symptoms with no need for bronchoscopy. **Conclusions:** The diagnosis of foreign body aspiration into the tracheobronchial airway in children can be accomplished by using MDCT chest. It can help the surgeon plan for the bronchoscopy and safe removal of the foreign body. MDCT chest can help avoid unnecessary bronchoscopy when no foreign body is seen.

KEYWORDS : Foreign body aspiration, multidetector-row CT, virtual bronchoscopy, bronchial foreign body, rigid bronchoscopy

INTRODUCTION

Aspiration of foreign bodies into tracheobronchial tree is a common problem in children around the world and is a leading cause of accidental death among children younger than 4 years of age.¹ In India foreign body aspiration is common in children from 1 to 3 years of age. Commonly vegetable matter such as seeds are accidentally inhaled into the airway.^{1,2} If a foreign body lodges in the region of larynx immediate stridor or choking results; impaction lower down in the bronchial lumen may be less dramatic or even may be asymptomatic.^{1,2,3} As the history and physical examination findings in children with FBA are not yielding many times, diagnosis may be difficult without bronchoscopy.^{1,2,3} This emphasizes the importance of radiological investigations in the diagnosis.^{1,2,3,4} X-ray of chest is negative in a large number of cases with aspiration of nonradiopaque foreign bodies. Because of the high risk of complications associated with an overlooked aspirated foreign body, rigid bronchoscopy is often performed for definitive diagnosis and treatment, even when there is little suspicion.^{2,3,4,5} Rigid bronchoscopy, which is invasive, remains the gold standard in managing such cases of FBA with risk of complications.^{2,3,4,5} Therefore, the availability of a non invasive, harmless technique to locate the foreign body pre operatively would greatly minimise morbidity and mortality associated with the procedure. Cross-sectional imaging with computed tomography (CT) helps in evaluation of lungs and bronchi.^{1,2,3,4,5} Three dimensional reconstruction is possible with multidetector-row CT (MDCT). This enhances the diagnosis of intraluminal obstructing lesions noninvasively and planning of definitive intervention accordingly.^{1,2,3,4,5}

METHODS

This was a retrospective study of children who presented with acute respiratory distress and or history suggestive of foreign body aspiration, to the emergency department from January 2021 to June 2022. X-ray chest was performed in all the patients. Multidetector Computed tomography (MDCT) of chest was performed after admission in 35 children and these were selected as the study group. Rigid bronchoscopy (RB) under general anesthesia was performed within 24 hours in all children in whom a foreign body was diagnosed on MDCT of chest. Though retrospective in nature, institutional ethical committee (IEC) clearance was obtained for this study.

CT scan of chest was performed on a 16 slice Siemens Emotion Scanner (Siemens Erlangen Germany) without injection of contrast medium. Scanning parameters used for the noncontrast CT chest were as following: slice thickness 3 mm; pitch factor 1.5; tube voltage-110 kV; tube current- 40 mA, with an estimated radiation dose of 3.0 mSv. Axial lung window images were reformatted in coronal and sagittal planes and endoluminal viewing of tracheobronchial tree (virtual bronchoscopy) was performed.

Tracheobronchial foreign body was diagnosed on MDCT chest in 24 children. There were 14 (58.3%) males and 10 (41.6%) females with ages ranging between 5 month and 4 years old and a mean age of 2.0 years. In the present series, about 42% (10/24) of the patients were brought to hospital within 24 h after inhalation of FB, while 25% (6/24) of the patients turned after five or more days. About 46% (11/24) of the patients had oxygen saturation between 80 and 90%, while only 16% (4/24) had saturation below 80%. Breathlessness of varying degree was the most common symptom (95%), followed by cough (65%). The most common clinical sign was decreased air entry in about 91% of the patients, followed by chest retractions in 57%, rhonchi in 36% and stridor in 32%.

CT images viewed in lung window setting revealed unilateral postobstructive hyperinflation in 15/24 (62.5%) ipsilateral to the bronchial foreign body (Fig 1,2,4,5) bilateral hyperinflation in 2/24 (8.3%), postobstructive atelectasis (Fig 1) or pneumonia (Fig 3) in 5/24 (20.8%) and pneumomediastinum (Fig 4) with or without surgical emphysema (Fig 2) in 2/24 (8.3%). On three dimensional reconstructions and virtual bronchoscopy foreign body was localized in right bronchus (Fig 1,5) in 62%, in left side bronchus (Fig 2,3) in 29% and in trachea (Fig 6) in 8%.

For the patients with tracheobronchial foreign bodies on CT, the findings of unilateral hyperlucent lung and post-obstructive lobar or segmental pneumonia/infiltrates on plain chest X-ray were seen in 33.3% (8/24) and 4.1% (1/24) respectively. 15 of the 24 patients (62.5%) had no abnormalities on plain X-ray of chest.

Bronchoscopy was performed in all 24 children with a positive diagnosis of airway foreign body on CT chest within 24 hours of diagnosis. On bronchoscopy foreign body was confirmed in all 24 children and was removed simultaneously. Vegetative foreign body was removed in 80% and non vegetative foreign body was removed in 20% children on bronchoscopy. Rest of the 11 children were observed and treated symptomatically; none of them needed bronchoscopy during treatment in the hospital.

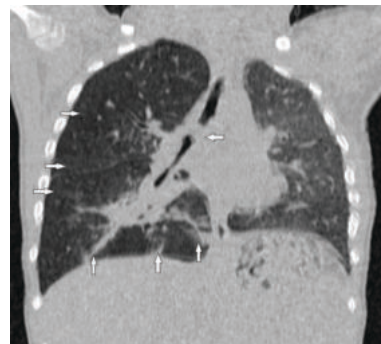


Figure 1. Three dimensional coronal reformatted CT image showing

foreign body in right main bronchus (rightward arrow) with postobstructive hyperinflation of right lung (leftward arrows) with small areas of atelectasis in right lower lobe (upward arrows).



Figure 2. Three dimensional coronal reformatted CT image showing foreign body in left main bronchus (upward arrow) with postobstructive hyperinflation of left lung (downward arrows) with surgical emphysema (rightward arrows).

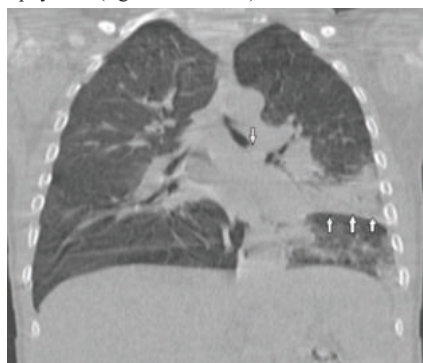


Figure 3. Three dimensional coronal reformatted CT image showing foreign body in left main bronchus (downward arrow) with postobstructive pneumonia in left upper lobe (upward arrows).



Figure 4. Axial CT image showing hyperinflated right lung (rightward arrows) with pneumomediastinum (downward arrows) due to foreign body in right main bronchus.

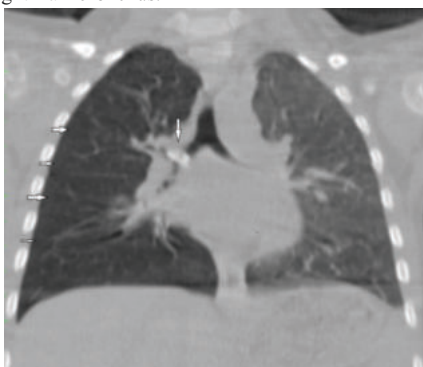


Figure 5. Three dimensional coronal reformatted CT image showing foreign body in right main bronchus (downward arrow) with postobstructive hyperinflation of right lung (rightward arrows).



Figure 6. Three dimensional coronal reformatted CT image showing foreign body in trachea (carina) (downward arrow).

DISCUSSION

In our study male predominance and average age below 2 years was similar to other reported studies. Most of the aspirations are seen in the age group of 1 to 5 years owing to the development of pincer grasp, leading to increased risk of aspiration.^{1,2,3} Majority of the FB were in right main bronchus. This is because right main bronchus is shorter, wider and more in line with trachea. Majority of the patients had breathlessness as the most common symptom. Cough was the second most common symptom. In our study, the most common clinical sign was decreased air entry of the lungs, followed by chest retractions and stridor.

We observed in our study that chest radiograph was normal in 62% cases. MDCT identified changes of postobstructive hyperinflation, atelectasis, and subcutaneous emphysema. Three dimensional reformations and virtual bronchoscopy identified and localized the foreign body to right side bronchus 62 %, left side bronchus 29% and trachea 8%. This helped to plan rigid bronchoscopy promptly for the foreign body removal. All were removed safely under general anesthesia in time. Children with no evidence of foreign body on CT scan were treated conservatively and were kept under observation till resolution of symptoms. Bronchoscopy was not needed in any of these. They were followed up periodically after discharge from the hospital.

We observed that chest radiograph was normal in more than half of the cases. MDCT with virtual bronchoscopy had a high positive and negative predictive value of 100%. Hence negative chest radiographs does not rule out FB, rather each suspected case of foreign body aspiration should be considered for MDCT chest with virtual bronchoscopy whenever possible and should be subjected to therapeutic bronchoscopy accordingly.^{6,7,8,9,10}

VB is useful as it simulates the endoluminal view of the airway using 3D reconstruction.^{6,7,8,9,10,11,12} It takes advantage of the natural contrast between the airway and the surrounding tissues to detect the exact location, size and shape of the foreign body.^{7,8} Unlike the conventional instrumental bronchoscopy, virtual bronchoscopy can provide images beyond the level of obstruction.^{6,8,9} This also helps the surgeon to plan the procedure of rigid bronchoscopy as he is sure of the position, size and nature of the foreign body; besides type of forceps also can be decided.^{6,8,9,10} A negative virtual bronchoscopy can prevent a patient from unnecessary hazards of rigid bronchoscopy and general anesthesia because it is the only imaging modality which gives almost 100% reassurance about the presence or absence of a foreign body, can study the tracheobronchial tree as far as the segmental bronchi and the bronchi below a closed obstruction.^{6,7,8,9,10,11}

In children radiation dose in MDCT chest is reduced and kept at the minimum possible level in accordance with ALARA (as low as reasonably achievable) principle.^{10,11,12}

In conclusion, MDCT with VB can be used as a method of investigation in children with suspected tracheobronchial foreign body. The correct location of the FB, the findings in the lung parenchyma and the possibility of conducting the examination without anesthesia make this modality very useful for this condition. In addition, the performance of rigid bronchoscopy with general anesthesia can be safely avoided in cases when MDCT does not show the presence of FB in the airway.

REFERENCES

1. Wang ML, Png LH, Ma J, Lin K, Sun MH, Chen YJ, Tang XC, Bi XY, Gao YQ, Zhang TS. The Role of CT Scan in Pediatric Airway Foreign Bodies. *Int J Gen Med*. 2023 Feb 15;16:547-555.
2. El Khoury P, Makhoul M, El Hadi C, Haber C, Rassi S. CT Scan in Children Suspected of Foreign Body Aspiration: A Systematic Review and Meta-analysis. *Otolaryngol Head Neck Surg*. 2023 Jul 20.
3. Even L, Heno N, Talmon Y, Samet E, Zonis Z, Kugelman A. Diagnostic evaluation of foreign body aspiration in children: a prospective study. *J Pediatr Surg*. 2005 Jul;40(7):1122-7.
4. 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 Pediatr Otorhinolaryngol*. 2017 Nov;102:169-173.
5. Bai W, Zhou X, Gao X, Shao C, Califano JA, Ha PK. Value of chest CT in the diagnosis and management of tracheobronchial foreign bodies. *Pediatr Int*. 2011 Aug;53(4):515-8.
6. Bhatt KV, Hegde JS. Evaluation of CT virtual bronchoscopy in paediatric tracheobronchial foreign body aspiration. *J Laryngol Otol*. 2010;124:875-879.
7. Honnef D, Wildberger JE, Das M, Hohl C, Mahnen AH, Barker M, et al. Value of virtual tracheobronchoscopy and bronchography from 16-slice multidetector-row spiral computed tomography for assessment of suspected tracheobronchial stenosis in children. *Eur Radiol*. 2006;16(8):1684-91.
8. Ahmed OG, Guillermin RP, Giannoni CM. Protocol incorporating airway CT decreases negative bronchoscopy rates for suspected foreign bodies in pediatric patients. *Int J Pediatr Otorhinolaryngol*. 2018 Jun;109:133-137.
9. Huang HJ, Fang HY, Chen HC, Wu CY, Cheng CY, Chang CL. Three-dimensional computed tomography for detection of tracheobronchial foreign body aspiration in children. *Pediatr Surg Int*. 2008 Feb;24(2):157-60.
10. Haliloglu M, Ciftci AO, Oto A, Gumus B, Tanyel FC, Senocak ME, Buyukpamukcu N, Besim A. CT virtual bronchoscopy in the evaluation of children with suspected foreign body aspiration. *Eur J Radiol*. 2003 Nov;48(2):188-92.
11. Ullal A, Mundra RK, Gupta Y, Mishra S. Virtual Bronchoscopy: Highly Sensitive Time and Life Saving Investigation in the Diagnosis of Foreign Body Aspiration-Our Experience. *Indian J Otolaryngol Head Neck Surg*. 2019 Oct;71(Suppl 1):378-383.
12. Wani NA, Qureshi UA, Kosar T, Laway MA. Subcutaneous emphysema due to bronchial foreign body demonstrated by multidetector-row computed tomography. *Lung India*. 2011 Oct;28(4):291-3.