

ORIGINAL ARTICLE

DIAGNOSTIC ACCURACY OF CHEST X-RAY IN TRACHEO-BRONCHIAL FOREIGN BODY ASPIRATION IN PAEDIATRIC PATIENTS

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Objective: To evaluate the diagnostic value of chest X-Ray in tracheobronchial foreign body aspiration among group of children in southern Punjab. **Methods:** The Cross sectional/comparative diagnostic procedural study was conducted in the Department of Radiology, Nishtar Medical College and Children Hospital Complex, Multan from January 2009–January 2011. Chest CT was performed in 45 consecutive children with suspected foreign body aspiration, and plain chest X-ray was evaluated at the same time. Multi-planar reformatted imaging with virtual bronchoscopy was carried out after Multi-detector CT examination. Findings on plain X-Ray and CT scan chest were noted in each patient. **Results:** All 42 (100%) patients with tracheobronchial foreign bodies were identified by chest CT. Three patients avoided unnecessary operations due to negative CT scan for foreign body with alternate diagnosis. Right main stem bronchus was the most common location of foreign body 20 (47.6%) and air trapping was the most common associated finding (28.5%). Sixteen of the 45 (35.5%) patients had no abnormalities on plain X-Ray. The difference between Multi-detector CT and plain X-Ray results was statistically significant ($p < 0.001$). The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of chest X-Ray in this study were 66.6%, 50%, 89.6%, 18.7% and 64.4% respectively. **Conclusion:** Chest X-Ray is not specific for diagnosis of foreign body aspiration and a normal chest X-Ray does not always rule out the diagnosis of foreign body aspiration in patients with a history suggestive of foreign body aspiration and positive physical examination.

Keywords: Foreign body aspiration, Chest X-Ray, Multi-detector CT scan

INTRODUCTION

Foreign body aspiration into the tracheobronchial tree remains a frequent and serious cause of respiratory problems in children. Many cases of foreign body aspiration are initially treated as asthma or respiratory infection such as bronchiolitis or croup. Classic symptoms include choking, coughing, cyanosis and sudden onset of wheezing.^{1,2}

The diagnosis and management of foreign body aspiration at the proper time are extremely important. Missed or delayed diagnosis can result in respiratory complications ranging from chronic wheezing or recurrent pneumonias to life threatening air way obstruction or lung abscess.³

In children with a foreign body in the airway, radiographic features depend on the size, location, duration, and nature of the foreign body. Chest radiography that has been used as the first imaging modality in children suspected for upper airway obstruction may show a variety of findings, including air-trapping, consolidation, atelectasis and bilateral over aeration.⁴

Bronchoscopy is often performed for definitive diagnosis and management, however, it is invasive and serious complications may occur. Recently developed multi-detector and virtual bronchoscopy is a non invasive technique that provides realistic 3D views of the tracheobronchial tree. In addition to the detection of foreign body MDCT and virtual bronchoscopy can help

the surgeon plan for operative bronchoscopy and safe removal of foreign body.^{5,6}

MATERIAL AND METHODS

Study was conducted from January 2009–January 2011 for the evaluation of clinically suspected children for foreign body aspiration. Total of 45 patients admitted with clinical suspicion of airway foreign body aspiration were included.

Latest chest X-Ray of each patient was evaluated & findings were noted. Multislice spiral CT without contrast was performed in all patients on Toshiba Aquilion 16 slice MDCT machine on request of clinical departments. Source images were transferred to work station for reformatting and virtual bronchoscopy. The presence of foreign body, its location, size and density were determined by consultant radiologist. Associated findings, i.e., air trapping, consolidation; atelectasis, mediastinal shift and pneumothorax were also noted.

Data collection was twofold, i.e., part-1 includes demographics of patients like age, sex and presenting symptoms and part-2 looked at the radiographic and CT findings. Statistically analysis was performed using SPSS. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) and accuracy indices of chest X-ray were calculated taking CT chest findings as gold standard.

Regarding ethical considerations, this study uses ionizing radiation, CT scanning, which could cause

harmful effects on population, so we included only those patients that were referred to our department for CT scan chest with clinical suspicion of foreign body aspiration, either with normal or positive chest X-ray.

RESULTS

From total 45 patients, 25 (56%) were male and 20 (44%) were female. The mean age was 48 month and the peak incidence of aspiration occurred during 1–6 year accounting for 37 (82.2 %) of the total cases.

Radiographic findings are shown in (Table-1). Chest X-Ray was normal in 16 (35.5%) cases. Thirty-nine (64.5%) were positive for foreign body with direct and indirect signs. Radio-opaque foreign body was visualized in 2 (4.4%) cases. Air trapping was most common radiographic sign seen in 12 (26.6%) patients.

Table-1: Chest X-Ray findings (n=45)

Chest X-Ray findings	No. (%)
Radio-opaque foreign body	2 (4.4)
Air trapping	12 (26.7)
Pneumonia	8 (17.8)
Atelectasis	7 (15.6)
Normal CXR	16 (35.6)

Multislice CT chest findings are shown in (Table-2). Foreign body was detected in all 42 (100%) patients that was confirmed on bronchoscopy. No foreign body was present in three patients, with alternate diagnosis of bronchiolitis and asthma. Main site of foreign body was right main stem bronchus 20 (47.6%), left main stem bronchus 10 (23.8%), and bronchus intermedius 8 (19.0%). Air trapping was most common 12 (28.5%), associated sign on CT scan, associated with mediastinal shift in 10 (23.8%) cases

Table-2: Multidetector CT Scan Chest Findings in Patients with Suspected FBA

MDCT Chest findings	No. (%)
Foreign bodies detected in patients	42
Location of foreign bodies:	
Right main stem bronchus	20 (47.6)
Left main stem bronchus	10 (23.8)
Bronchus intermedius	8 (19.0)
Carina	3 (7.1)
Trachea	1 (2.4)
Associated findings:	
Air trapping	12 (28.6)
Consolidation	8 (19.0)
Atelectasis	10 (23.8)
Mediastinal shift	10 (23.8)
Pneumothorax	2 (4.8)
No foreign body detected in patients on CT scan with alternate diagnosis	3 (6.6)

Patients with foreign body on CT scan send for bronchoscopy that confirmed the foreign bodies which were removed successfully. Three patients with negative CT scan for foreign bodies were treated medically with follow up and avoided unnecessary bronchoscopy. The

sensitivity of chest X-ray in this study was 66.6% and the specificity was 50% (Table-3).

Table-3: Sensitivity and specificity of chest X-ray

CXR	CT SCAN CHEST	
	FB-positive	FB-negative
FB-positive	26	3
FB-negative	13	3

Sensitivity= 66.6%, Specificity= 50%, PPV=89.6%, NPV=18.7%, Accuracy=64.4%

DISCUSSION

Diagnosis of foreign body aspiration begins with a patient history and physical examination that can be strengthened by radiographic findings.⁸ Metallic objects are readily identified on chest radiographs. However, most inhaled foreign bodies are radiolucent. A radiolucent foreign body can be suggested only by secondary changes that are mostly non specific and may occur also in patients without foreign body aspiration.^{9,10}

In our study 16 (35.6%) patient with suspicion of foreign body aspiration has normal chest X-Ray that is corresponding with the results of Swedstrom *et al*, i.e., 9–35% of patients with endoscopically confirmed foreign bodies do not have any abnormality on chest X-ray.¹¹ Radio-opaque foreign body was visualized on chest X-ray in only two patients. Secondary findings were seen in the remaining patients that were suggestive for foreign body aspiration.

Sensitivity and specificity of chest X-ray in foreign body detection is 66.6% and 50% respectively that are comparable with the other studies.^{12,14} Thus, although chest radiography may help, it seems neither sufficiently sensitive nor specific for the diagnosis of foreign body aspiration.

Multi-detector CT scan chest is another diagnostic technique used for detection of foreign bodies. It not only can reveal foreign bodies in the bronchial tree but also is very sensitive in detecting associated findings.¹⁵ Foreign bodies were detected in all 42 patients and three patients having no foreign body airways with alternative diagnosis. Foreign bodies were confirmed on bronchoscopy. The most reliable CT finding of an aspirated foreign body is its presence within the lumen of the tracheobronchial tree.^{16,17} Associated features are usually secondary parenchymal changes in the affected lobe. Our study showed that both the foreign body in the airway and secondary parenchymal changes such as hyperaeration, atelectasis, infiltration, and bronchiectasis are found in patients with foreign body aspiration.

Although Multi-detector CT scan is a promising tool for the evaluation of lung parenchyma, it is important to identify its shortcomings due to artifacts when interpreting images at the window width and level settings for lung parenchyma and to apply the appropriate methods for eliminating such artifacts.¹⁸

Also, Multi-detector CT scan data acquisition time depends upon well-trained technicians, state-of-the-art workstations and fast networking which are important factors to improve workflow.^{19,20}

CONCLUSION

In conclusion, chest X-Ray is not specific for diagnosis of foreign body aspiration, and a normal chest X-Ray does not always rule out the diagnosis of foreign body aspiration in patients with a positive clinical examination. Multi-detector CT chest with multi-planner reformatting and virtual bronchoscopy should be considered in all cases of clinically suspected foreign body aspiration.

REFERENCES

1. Applegate KE, Dardinger JT, Lieber ML, Herts BR, Davros WJ, Obuchowski NA, *et al.* Spiral CT scanning technique in the detection of aspiration of LEGO foreign bodies. *Pediatr Radiol* 2001;31:836–40.
2. Salvolini L, Bichi SE, Costarelli L, De Nicola M. Clinical applications of 2D and 3D CT imaging of the airways—a review. *Eur J Radiol* 2000;34(1):9–25.
3. Metrangolo S, Monetti C, Meneghini L, Zadra N, Giusti F. Eight years' experience with foreign-body aspiration in children: what is really important for a timely diagnosis? *J Pediatr Surg* 1999;34:1229–31.
4. Khan MF, Herzog C, Ackermann H, Wagner TO, Maataoui A, Harth M, *et al.* Virtual endoscopy of the tracheo-bronchial system: sub-millimeter collimation with the 16-row multidetector scanner. *Eur Radiol* 2004;14:1400–5.
5. Tan HKK, Brown K, McGill T, Kenna MA, Lund DP, Healy GB. Airway foreign bodies (FB): a 10-year review. *Int J Pediatr Otorhinolaryngol* 2000;56(2):91–9.
6. Finkelstein SE, Schrupp DS, Nguyen DM, Hewitt SM, Kunst TF, Summers RM. Comparative evaluation of super high-resolution CT scan and virtual bronchoscopy for the detection of tracheobronchial malignancies. *Chest* 2003;124:1834–40.
7. Black RE, Johnson DG, Matlak ME. Bronchoscopic removal of aspirated foreign bodies in children. *J Pediatr Surg* 1994;29:682–4.
8. Zerella JT, Dimler M, McGill LC, Pippus KJ. Foreign body aspiration in children: value of radiography and complications of bronchoscopy. *J Pediatr Surg* 1998;33:1651–4.
9. Kosucu P, Ahmetoglu A, Koramaz I, Orhan F, Ozdemir O, Dinç H, *et al.* Low-dose MDCT and virtual bronchoscopy in pediatric patients with foreign body aspiration. *AJR Am J Roentgenol* 2004;183:1771–7.
10. Konen E, Katz M, Rozenman J, Ben-Shlush A, Itzhak Y, Szeinberg A. Virtual bronchoscopy in children: early clinical experience. *AJR Am J Roentgenol* 1998;171:1699–702.
11. Lam WW, Tam PK, Chan FL, Chan KL, Cheng W. Esophageal atresia and tracheal stenosis: use of three-dimensional CT and virtual bronchoscopy in neonates, infants, and children. *AJR Am J Roentgenol* 2000;174:1009–12.
12. Rogalla P, Stöver B, Scheer I, Juran R, Gaedicke G, Hamm B. Low-dose spiral CT: applicability to pediatric chest imaging. *Pediatr Radiol* 1998;28:365–9.
13. Naidich DP, Marshall CH, Gribbin C, Arams RS, McCauley DI. Low-dose CT of the lungs: preliminary observations. *Radiology* 1990;175:729–31.
14. Zwirwich CV, Mayo JR, Muller NL. Low-dose high-resolution CT of lung parenchyma. *Radiology* 1991;180:413–7.
15. Choi YW, McAdams HP, Jeon SC, Park CK, Lee SJ, Kim BS, *et al.* Low-dose spiral CT: application to surface-rendered three-dimensional imaging of central airways. *J Comput Assist Tomogr* 2002;26:335–41.
16. Prasad SR, Wittram C, Shepard J, McLoud T, Rhea J. Standard-dose and 50% reduced-dose chest CT: comparing the effect on image quality. *AJR Am J Roentgenol* 2002;179:461–5.
17. Zissin R, Shapiro-Feinberg M, Rozenman J, Smorjik J, Hertz M. CT findings of the chest in adults with aspirated foreign bodies. *Eur Radiol* 2001;11:602–11.
18. Kelly SM, Marsh BR. Airway foreign bodies. *Chest Surg Clin North Am* 1996;6:253–76.
19. Mu L, Sun D, He P. Radiologic diagnosis of aspirated foreign bodies in children: review of 343 cases. *J Laryngol Otol* 1990;104:778–82.
20. Burton EM, Brick WG, Hall JD, Riggs W Jr, Houston CS. Tracheobronchial foreign body aspiration in children. *South Med J* 1996;89(2):195–8.

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