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Advantage of Computed Tomography (CT) Virtual Bronchoscopy in the Evaluation of Children with Suspected Foreign Body Airway

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Abstract

Background & Objectives: Foreign body aspiration (FBA) into the tracheo bronchial tree is a frequent and serious cause of respiratory distress and visit to the pediatrics emergency, principally in patients under 3 years of age. Most foreign bodies are not radio opaque and approximately one third of the children admitted will show normal chest X-ray. Virtual bronchoscopy is a relatively new and non-invasive procedure that provides a three dimensional view of the internal walls of the tracheobronchial tree through the reconstruction of axial images. The objectives of the study are, 1) to study the diagnostic accuracy and advantage of virtual bronchoscopy over rigid bronchoscopy in the evaluation of children with suspected FBA and to plan for early management as it is a non-invasive technique; 2) to study the clinical spectrum of children attending with suspected FBA. Methods: An observational study of 37 patients of age 12 yrs and below who underwent Virtual Bronchoscopy for suspected foreign body aspiration in the department of pediatrics and Otorhinolaryngology at MGM Hospital, Warangal is carried out for a period of 1.5 years during 2012-2013. Results: The common age of presentation was 1 - 3 years with male preponderance. History of foreign body was obtained in 64.86% of cases. Normal X-ray was found in 27.02% of cases. In 75.67% FB detected on rigid bronchoscopy was also revealed on virtual bronchoscopy. False positive percentage was 5.40% and false negative was 2.70%. Sensitivity and specificity was 96.5% and 75% respectively. Ground nuts were the commonest foreign bodies aspirated. Conclusion: Virtual bronchoscopy should be considered in cases with suspected foreign body aspiration, when chest X-ray is normal, to avoid needless rigid bronchoscopy. Virtual bronchoscopy is useful in screening cases of occult foreign body as it has sensitivity, specificity, and validity.

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Keywords

Virtual Bronchoscopy, Tracheobroncial Foreign Body, Radiological Findings of Foreign Body Aspiration

1. Introduction

Foreign body aspiration (FBA) into the tracheobronchial tree is a frequent and serious cause of respiratory distress and visit to the pediatrics emergency, principally in patients under 3 years of age [1]. Sudden onset of cyanosis, cough and wheezing are the principal symptoms described for this condition [2]. The radiological manifestations depend upon the size, location, and nature of the foreign body aspirated. Chest X-ray can show an non-specific infiltrate, atelectasis, areas of unilateral or bilateral hyperinflation or even patchy consolidation and bronchiectasis [3]. Most foreign bodies are not radio opaque and approximately one third of the children admitted present normal chest X-ray result [4] [5]. Virtual bronchoscopy is a relatively new, non-invasive procedure that provides a three dimensional view of the internal walls of the tracheo bronchial tree through the reconstruction of axial images. It is non-invasive and easily obtained by post processing of a routinely acquired high resolution CT data set [6]. Serious respiratory sequelae, such as recurrent pulmonary infections, bronchiectasis and destruction of the previously healthy lung parenchyma can result from foreign body aspiration. Therefore, early diagnosis and intervention are fundamental for the better management of this condition [7]. The objectives of the study are, 1) to study the diagnostic accuracy and advantage of virtual bronchoscopy over rigid bronchoscopy in the evaluation of children with suspected FBA and to plan for early management as it is a non-invasive technique; 2) to study the clinical spectrum of children attending with suspected FBA.

2. Review of Literature

Naidich and Harkin recently concluded that 3D image processing with visualization in particular the advent of virtual bronchoscopy could greatly increase the possible synergy between CT and bronchoscopy [8]. Ferritti *et al* stated that virtual bronchoscopy (intraluminal navigation through the airways) is superior to static 3D reconstruction images in evaluation of tracheobronchial stenosis and could be used as a road map for later bronchoscopy [9]. McLennan *et al*. demonstrated that prior 3D image processing and visualization can help direct subsequent bronchoscopic procedures such as balloon dilation stent design and laser ablation of tumors [10].

A study concluded that in 89.2% of cases studied history of foreign body aspiration was confirmed by bronchoscopy and with no definite history of foreign body aspiration it was detected in around 3.2% [11]. Therefore detailed history taking played a vital role in diagnosis of foreign body aspiration. In a comparison study of virtual bronchoscopy with rigid bronchoscopy in 40 children the following results are obtained: sensitivity 92.3%, specificity 85.7% concluding that CT virtual bronchoscopy is particularly useful in screening cases of occult foreign body aspiration as it has high sensitivity specificity and validity [12].

In India Dr. V. Subramaniam and Dr. Satayanarayana pioneers in the field of ENT introduced the technique of rigid bronchoscopy for foreign body removal. Tandon in his work concluded that the most common age group involved was below 6 years with the highest occurrence amongst children below 2 years [13]. Banerjee in his study stated that 52% of the cases presented within 24 hours of the accident [14]. Rothman in his work recorded that most patients gave a history of choking episodes followed by coughing [15]. A study conducted in 2013 to asses the role of virtual bronchoscopy in diagnosis of foreign body aspiration performed in 105 patients revealed sensitivity 97.6%, specificity 92.1% and accuracy 96.5%. In a study conducted by K. Lakshmanan and B. R. Santhanakrishna over a period of 7 years in 296 children, 77% were in the age group 1 - 5 yrs. 80.8% children had obvious clinical symptoms while positive history is recorded in only 33.8% cases. The frequently observed foreign bodies were ground nuts (38.2%).

3. Methodology

Source of data: Data for this study was collected from the patients who underwent Virtual Bronchoscopy for suspected foreign body aspiration in the department of pediatrics and Otorhinolaryngology at MGM Hospital,

Warangal is carried out for a period of 1.5 Yrs during 2012-2013. Approval has been obtained from the ethical committee of our institute.

Type of study: An observational Study of 37 patients of age 12 yrs and below who underwent Virtual Bronchoscopy for suspected foreign body aspiration.

Inclusion criteria: inclusion criteria was all patients aged 12 yrs and below with a history suggestive of foreign body in the tracheobroncial tree, such as sudden onset of cough, difficulty in breathing, wheezing and decreased air entry into the lungs.

Exclusion criteria: Exclusion criteria was patients aged 13 yrs and above and patients presenting with features of cerebral hypoxia secondary to foreign body aspiration.

Method of data collection: 37 patients of age 12 yrs and below who underwent Virtual Bronchoscopy for suspected foreign body aspiration in the department of pediatrics and Otorhinolaryngology were selected. Diagnosis was made by detailed history presenting as sudden onset of cough, difficulty in breathing without any history of significant fever prior, choking episode during food intake, history of foreign body aspiration and thorough clinical examination revealing stridor or wheezing more particularly a localized wheeze, tachypnoea and dyspnoea with decreased air entry into the lungs. Investigations done were CBP, HIV, HBSAG, Blood urea, sr. creatinine, CT, BT, Chest X-ray PA & Lateral view and CT Virtual bronchoscopy. Chest X-ray revealing hyperinflation of one side of lung. The patients who presented to Emergency department of Paediatrics and ENT OP with suspected foreign body aspiration were taken detailed history, examined and sent for Virtual Bronchoscopy. The data was recorded in the case sheet and used for study.

4. Results

The common age of presentation was 1 - 3 yrs of age (70.28%) with male preponderance. History of foreign body was obtained in 64.86% of cases. The commonest symptom of presentation was coughing (67.56%) followed by breathlessness (54%) (**Table 1**). Majority of the cases presented with decreased air entry (75.67%) (**Table 2**). Atelectasis was the commonest radiological finding that made up to 35.13% of cases. Normal X-ray was found in 27.02% of cases (**Table 3**). In 75.67% FB detected on rigid bronchoscopy was also revealed on virtual bronchoscopy. False positive percentage was 5.40% and false negative was 2.70%. A true positive was 75.67% and true negative was 16.21% (**Table 4**, **Figure 1**). Sensitivity and specificity was 96.5% and 75% respectively. Emergency bronchoscopy was done in 63.16% cases and elective in 35.13% of cases. Tracheostomy with bronchoscopy was done in 2.7% of cases (**Table 5**). Among the aspirated foreign bodies, vegetative matter constituted the majority (73%). Ground nuts were the commonest among vegetative matters (25%) (**Figure 2**).

Table 1. Showing various clinical symptoms of suspected FBA.

Symptoms	No of cases	Percentage%
History of Foreign Body Aspiration	21	64.86%
Cough	25	67.56%
Breathlessness	20	54.00%
Choking	11	29.70%
Excessive cry	02	5.40%
Fever	14	37.00%
ULRTI	03	8.10%

Table 2. Showing various clinical signs of suspected FBA.

Signs	No of cases	Percentage%
Decreased Air Entry	28	75.67%
Tachypnoea	27	72.97%
Respiratory Distress	16	43.24%
Added sounds	23	62.16%
Stridor	05	13.51%
Cyanosis	01	2.70%

Table 3. Showing X-ray findings of suspected FBA.

X-ray	No of cases	Percentage%
Atelectasis	13	35.13%
Normal	10	27.02%
Emphysema	09	24.32%
No xray	05	13.51%

Table 4. Showing the variables on VB and RB.

Foreign Body	Present on RB	Percentage%	Absent on RB	Percentage%	Total
Present on Virtual Bronchoscopy	28 (True positive)	75.67%	2 (false positive)	5.40%	30
ABSENT ON Virtual Bronchoscopy	1 (false negative)	2.70%	6 (true negative)	16.21%	7
TOTAL	29		8		37

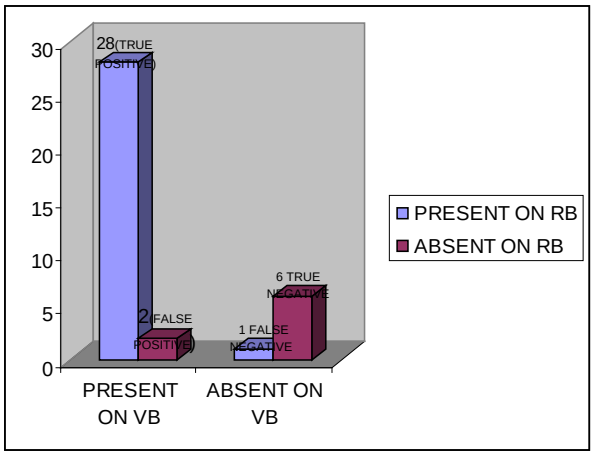

Figure 1. Bar diagram reflecting the variables in **Table 4**.

Table 5. Showing the management of FBA.

Management	Number of cases	Percentage%
Bronchoscopy		
a. emergency	23	62.16%
b. elective	13	35.13%
Tracheostomy with bronchoscopy	01	2.70%

5. Discussion

The aspiration of a foreign object into the airway may result in acute respiratory distress, chronic pulmonary infection, atelectasis and even death. Our review confirmed the earlier findings of Banarjee *et al.* [14] and Rothman *et al.* [15] that highest incidence is in children below 3 yrs. Since these children lack molar teeth, edibles placed in the mouth are usually broken up but not chewed which they easily aspirate, especially if the child is running, playing or talking. This age group may also be involved due to immature coordination in the swallowing mechanism. There was a male preponderance in our study which was similar to results reported by other authors [16] [17]. This may be attributed to the more adventurous nature of the male children. In our series 64.86% gave a positive history of foreign body aspiration, compared to 80% in a study by Sinha [18]. Atelectasis was the most frequent radiological finding in our study which concurred with study done by Kaur *et al.* [19]. Normal

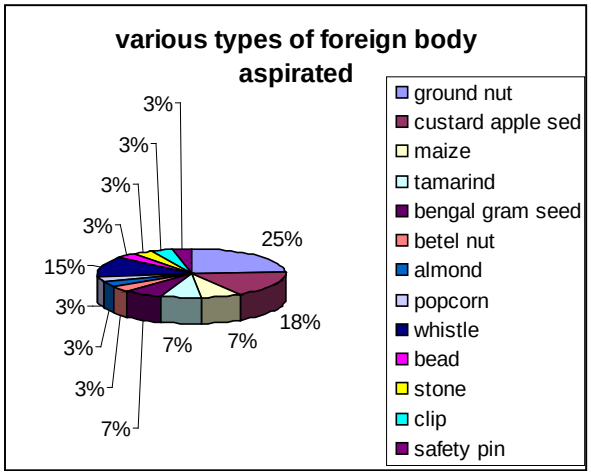

Figure 2. Pie diagram showing the percentage of various types of FBA.

chest X-ray was seen in 27.02% of our cases, while Svedstorm E *et al.* (3) reported to be 30%. Therefore a normal X-ray does not rule out foreign body aspiration in cases with strong history. It was observed in our study that the sensitivity and specificity of virtual bronchoscopy were 96.5% and 75% respectively, where as Hililogu [2], Kosucu *et al.* [1] reported the sensitivity and specificity was 100%. False positive percentage was 5.40% and false negative was 2.70%. A true positive was 75.67% and true negative was 16.21%. False positive is foreign body present on VB but absent on RB. It is due to Intraluminal mucus plug, Bronchial Vegetations, external compressions due to Neurocentric cyst, Lymph nodes [2]. False Negative foreign body absent on VB but present on RB. This cannot be explained but may be because of misinterpretation. One group of authors investigated the use of virtual bronchoscopy in pediatric patients with suspected foreign body concluded that it can correctly identify the position of FB and when the VB is normal without the evidence of endobronchial obstruction, the use of conventional bronchoscopy was not superior in providing relevant additional information and also it is associated with complications like hemorrhage, pneumothorax, air embolism, mediastinal emphysema, arrhythmias and pulmonary infiltrates. Complications of rigid Bronchoscopy are un common but even in experienced hand they do occur. In suspected foreign body aspiration Virtual Bronchoscopy is advantageous. It identifies the foreign body and also localizes the foreign body in the Bronchial lumen. This will shorten the operative time for rigid Bronchoscopy. Virtual Bronchoscopy avoids unnecessary invasive procedure of rigid Bronchoscopy [20].

Limitations of the study are, VB is costly investigation and not available in all centers. It is available only in Teaching Hospitals and big cities. VB can be done in suspected foreign body aspiration. In definite foreign body aspiration rigid Bronchoscopy is diagnostic as well as therapeutic.

6. Conclusion

Tracheobronchial foreign body aspiration is a serious and potentially fatal condition occurring with higher incidence in younger children aged 1 - 3 years. Virtual bronchoscopy should be considered in cases with suspected foreign body aspiration, when chest X-ray is normal to avoid needless rigid bronchoscopy. Virtual bronchoscopy is useful in screening cases of occult foreign body as it has sensitivity, specificity, and validity. The correct location of foreign body, the possibility of visualizing the lung parenchyma and the possibility of conducting the examination without anaesthesia makes this method viable for different evolution.

References

[1] Kosucu, P., Ahmetoglu, A., Koramaz, I., Orhan, F., Ozdemir, O., Dinc, H., *et al*. (2004) Low Dose MDCT and Virtual Bronchoscopy in Pediatric Patients with Foreign Body Aspiration. *American Journal of Roentgenology*, **183**, 1771-1777. http://dx.doi.org/10.2214/ajr.183.6.01831771

[2] Halilogu, M.C., Iftci, A.O., Oto, A., Gumus, B., Tanyel, F.C., Senocak, M.E., *et al*. (2003) CT Virtual Bronchoscopy in the Evaluation of Children with Suspected Foreign Body Aspiration. *European Journal of Radiology*, **48**, 188-192. http://dx.doi.org/10.1016/S0720-048X(02)00295-4

[3] Svedstrom, E., Puhakka, H. and Kero, P. (1989) How Accurate Is Chest Radiography in the Diagnosis of Tracheobronchial Foreign Bodies in Children? *Pediatric Radiology*, **19**, 520-522. http://dx.doi.org/10.1007/BF02389562

[4] Sodhi, K.S., Saxena, A.K., Singh, M., Rao, K.L. and Khandelwal, N. (2008) CT Virtual Bronchoscopy: New Non Invasive Tool in Pediatric Patients with Foreign Body Aspiration. *The Indian Journal of Pediatrics*, **75**, 511-513. http://dx.doi.org/10.1007/s12098-008-0080-z

[5] Fraga Ade, M., Reis, M.C., Zambon, M.P., Toro, I.C., Ribeiro, J.D. and Baracat, E.C. (2008) Foreign Body Aspiration in Children: Clinical Aspects, Radiological Aspects and Bronchoscopic Treatment. *Jornal Brasileiro de Pneumologia*, **34**, 74-82.

[6] Horton, K.M., Horton, M.R. and Fishman, E.K. (2007) Pictorial Essay. Advanced Visualization of Airways with 64-MDCT:3D Mapping and Virtual Bronchoscopy. *American Journal of Roentgenology*, **189**, 1387-1396. http://dx.doi.org/10.2214/AJR.07.2824

[7] Burke, A.J., Vining, D.J., Mc Guirt Jr., W.F., Postma, G. and Browne, J.D. (2000) Evaluation of Airway Obstruction Using Virtual Endoscopy. *Laryngoscope*, **110**, 23-29. http://dx.doi.org/10.1097/00005537-200001000-00005

[8] Naidich, D.P. and Harkin, T.J. (1995) Airways and Lung. Correlation of CT with Fiberoptic Bronchoscopy. *Radiology*, **197**, 1-12.

[9] Ferretti, G.R., Vining, D.J., Knoplioch, J. and Coulomb, M. (1996) Tracheobroncheal Tree: 3D Spiral CT with Bronchoscopic Perspective. *Journal of Computer Assisted Tomography*, **20**, 777-781. http://dx.doi.org/10.1097/00004728-199609000-00018

[10] McLennan, G., Shansolkottabi, S. and Hoffman, E.A. (1996) Assessment of Major Air Way Obstruction Using Image Analysis of Digital CT Information. *Proceedings of SPIE*, **2709**, 197-208. http://dx.doi.org/10.1117/12.237861

[11] Atyac, A., Yurdakul, Y., Ikizler, C., Olga, R. and Saylam, A. (1977) Inhalation of Foreign Bodies in Children—A Report of 500 Cases. *The Journal of Thoracic and Cardiovascular Surgery*, **74**, 145-151.

[12] Bhat, K.V., Hegde, J.S., Nagalohmath, U.S. and Patil, G.C. (2010) Evaluation of Computed Tomography Virtual Bronchoscopy in Pediatric Tracheobronchial Foreign Body Aspiration. *Journal of Otology and Laryngology*, **124**, 875-879. http://dx.doi.org/10.1017/S0022215110000769

[13] Tandan, R.K., Pantney, N.L., Srinivastava, V.K. and Wadhawan, V.P. (1976) Foreign Body in Tracheobronchial Tree in Infancy and Childhood. *The Indian Journal of Chest Diseases*, **15**, 214-218.

[14] Banerjee, A., Subba Rao, K.S.V.K., Khanna, S.K., *et al*. (1988) Laryngo-Trachheo-Bronchial Foreign Bodies in Children. *The Journal of Laryngology & Otology*, **102**, 1029-1032. http://dx.doi.org/10.1017/S0022215100107170

[15] Rothman, B.F. and Boeckmann, C.R. (1980) Foreign Bodies in the Larynx and Trachea Bronchial Tree in Children—A Review of 225 Cases. *Annals of Otology, Rhinology & Laryngology*, **89**, 434-436. http://dx.doi.org/10.1177/000348948008900512

[16] Hughes, C.A., Baroody, F.M. and Bernard, R.M. (1996) Pediatric Tracheobronchial Foreign Bodies: Historical Review from the John Hopkins Hospital. *Annals of Otology, Rhinology & Laryngology*, **105**, 555-561. http://dx.doi.org/10.1177/000348949610500712

[17] Steen, K.H. and Zimmerman, T. (1990) Tracheobronchial Aspiration of Foreign Bodies in Children: A Study of 94 Cases. *Laryngoscope*, **100**, 525-530.

[18] Bauer, T.L. and Steiner, K.V. (2007) Virtual Bronchoscopy: Clinical Applications and Limitations. *Surgical Oncology Clinics*, **16**, 323-328. http://dx.doi.org/10.1016/j.soc.2007.03.005

[19] Kaur, K., Sonkhya, N. and Bapna, A.S. (2002) Foreign Bodies in the Tracheobronchial Tree: A Prospective Study of Fifty Cases. *Indian Journal of Otolaryngology and Head & Neck Surgery*, **54**, 30-34.

[20] Cevizci, N., Dokucu, A.I., Baskin, D. and Karadag, C.A. (2008) Virtual Bronchoscopy as a Dynamic Modality in the Diagnosis and Treatment of Suspected Foreign Body Aspiration. *European Journal of Pediatric Surgery*, **8**, 398-401. http://dx.doi.org/10.1055/s-2008-1038972