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Radio-Diagnosis

COMPARISON OF CT VIRTUAL BRONCHOSCOPY WITH FIBRE OPTIC BRONCHOSCOPY IN THE EVALUATION OF ENDO-BRONCHIAL LESIONS

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ABSTRACT **Background:** Virtual bronchoscopy is a noninvasive tool for assessing the airway. It can be used along with multiplanar CT scan for better assessment of endobronchial tree. A lot of researches has been conducted in various parts of the world weather CT bronchoscopy can replace actual flexible fiberoptic bronchoscopy. We aimed to explore the utility of virtual bronchoscopy (VB) for evaluation of tracheobronchial lesions and weather this can be helpful for pulmonologist for better assessment of airway while using real time flexible bronchoscopy. **Results :** Our age group comprised of patients from 21 years to a maximum age of 80 years with a mean age of 52.6 years. VB was better in detecting external compression with a Kappa value of 0.68. VB had a moderate agreement with FOB to detect endoluminal lesions with kappa value of 0.70. None of the mucosal changes detected by FOB was detected by VB. In detecting obstructive lesions VB substantially agreed with FOB with a kappa value of 0.8. Moderate agreement was seen by VB in detecting both malignant and non-malignant lesions vompared to FOB. **Conclusion:** Virtual bronchoscopy when used in conjunction with axial CT images can enhance diagnostic accuracy of bronchial pathologies. VB cannot replace conventional bronchoscopy due to associated disadvantages such as the inability to perform a biopsy, the inability to detect mucosal infiltration, the relatively low specificity rate when compared to high sensitivity rates, and the inability to offer real-time evaluation.

KEYWORDS : Virtual bronchoscopy, Fiberoptic bronchoscopy, Bronchoscopy, Endobronchial lesions.

BACKGROUND

Bronchoscopy is a procedure to look directly at the airways in the lungs using a thin, lighted tube. Bronchoscopy can be performed with flexible or rigid fiberoptic bronchoscopes (FOB). It remains the best modality for the evaluation of endoluminal and mucosal lesions of the respiratory tract. Virtual bronchoscopy (VB) is a new technique with computed tomography (CT) based images, which allows three-dimensional image (3D) evaluation of the respiratory tract.

Endobronchial lesions includes tumour and tumour like conditions of the tracheobronchial tree. A variety of tumours, including primary malignant tumours, secondary malignant tumours, and benign tumours, can occur in the tracheobronchial tree. Primary malignant tumours commonly originate from the surface epithelium or the salivary glands, whereas most benign tumours arise from the mesenchymal tissue(1)

FOB has some important limitations. It cannot view structures outside the bronchial wall, such as the mediastinal lymph nodes and vascular structures. Additionally, FOB frequently provides little information about the extent of the extra luminal diseases or airway patency distal to high grade bronchial stenosis. In view of these limitations, some authors have suggested that virtual bronchoscopy (VB) may replace FOB. Virtual bronchoscopy can be useful to visualize external compressions on the bronchial wall not involving the mucosa. These compressions can be caused by normal anatomical structures (i.e., aortic arch, esophagus) or can be caused by pathological structures (i.e., extra luminal tumour, enlarged lymph nodes, and fibrotic masses). Correlating the position of the virtual bronchoscope with the axial CT images as well as multiplanar reformatted images (sagittal & coronal) usually allows the definition of the exact localization and cause of the external compression(2)

METHODS

Study population:

It was a hospital-based cross sectional study over a period of 1 year in Gauhati Medical College, Guwahati, Assam. A purposive sample of 100 patients were included in the study. In two patients the fiberoptic bronchoscopy procedure could not be completed because of severe bronchospasm. This made an effective sample size of 98 patients. The population contained both males and females.

Virtual bronchoscopy

The study was performed using "Phillips Brilliance iCT" 256 slice CT scanner with a Slice thickness & increment of 1 mm & 0.5mm respectively. HRCT thorax were done. The volumetric data from the spiral CT scan was supplied via local area network to the "Phillips IntelliSpace Portal V.10.1" programme, which was used to reconstruct 2D and 3D pictures of the airway using the endoscopic reconstruction tool. Virtual bronchoscopy was done by the "fly through navigation technique" and findings were recorded. The virtual bronchoscopy was done by two experienced radiologists (having 20 years and 6 years of experience respectively).

Fiberoptic bronchoscopy:

Fiber optic bronchoscopy was done under local anesthesia with Video-bronchoscope (Olympus Cv 170). The study was done by an experienced pulmonologist (6 years of clinical and bronchoscopy experience). Endobronchial biopsy were taken wherever feasible. CT guided transthoracic biopsy was then taken in cases in which FOB could not yield a sample or in those cases where endobronchial biopsy was not possible.

Interpretation & Data analysis:

FOB was considered as the gold standard of reference and the VB findings were correlated with the gold standard. Master chart was prepared in Microsoft Office Excel 2013 and statistical analysis was performed using IBM SPSS 20.0 software. Continuous variables were described using mean and SD and categorical values were described using frequency and percentage. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy were obtained. The degree of correlation between VB and FOB for various parameters was calculated using Cohen's Kappa value. The kappa value was interpreted as follows : 0– 0.20 = slight agreement ,0.21 – 0.40 = fair agreement, 0.41 – 0.60 = moderate agreement,0.61 – 0.80 = substantial agreement, 0.81 – 1.00 = almost perfect or perfect agreement

The lesions were classified according to FOB & VB into Endoluminal lesions (those lesions which caused less than 50% of stenosis of the airway), obstructive lesions (those which cause more than 50% of luminal stenosis), Mucosal changes (which included hyperemia, friability etc.) and external compression (those lesions causing compression of the airway from outside).(3) In two cases the

negotiation of fiber optic bronchoscope was not successful due to luminal obstruction. In that cases Virtual bronchoscopy became successful as it can view the airway beyond the stenosis.

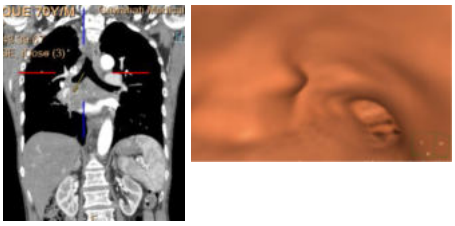


Figure 1: Endoluminal Lesion In Right Upper Lobar Bronchus

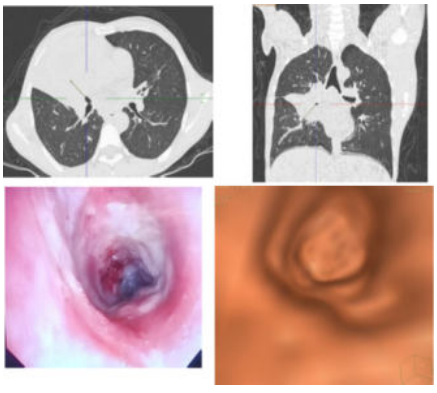


Figure 2: Infiltratng lesion in right middle lobe causing complete luminal obstruction of the medial segmental bronchus

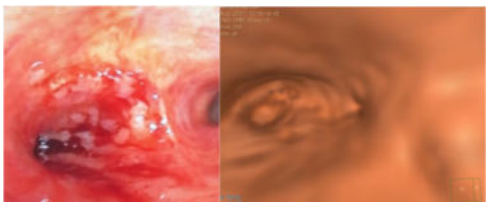


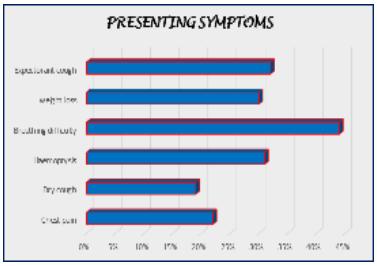
Figure 3 :Hyperemia Of The Mucosa In Fob; Not Detected In Vb

RESULTS:

The age group of patients in our study ranged from a minimum age of 21 years to a maximum age of 80 years with a mean age of 52.6 years and standard deviation of 12.23 years. The maximum number of patients were in the age group of 51 to 60 years (32.7%). Our study included a total of 59 (60.2%) male patients and 39 (39.7%) female patients with a male predominance (Male: Female ratio 1.51: 1).

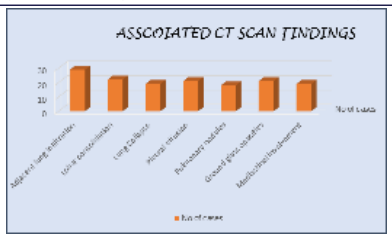
The most common presenting symptom in our study was breathing difficulty (44.8%) followed by expectorant cough (32.6%) and haemoptysis (31.6%). The least common presenting symptom was dry cough (19.3%). There was no significant difference in presenting symptoms between males and females.

Figure 4: Bar chart showing the presenting symptoms of the study population



The most common associated chest CT finding was adjacent lung parenchymal infiltration (29.6%) followed by lobar consolidation (22.4%). (21 cases, 21.4%). Other findings included pleural effusion, ground glass opacities, lung collapse and mediastinal involvement.

Figure 5: Bar diagram shows the distribution of associated findings in the chest CT



The sensitivity, specificity, PPV (positive predictive value), Negative predictive value (NPV) of VB in detecting external compression was 85%, 90%, 68% and 96 % respectively with diagnostic accuracy of 89% and Kappa value of 0.68.

VB had a sensitivity of 77%, specificity of 93%, PPV of 80% , NPV of 92% and accuracy of 89% to detect endoluminal lesions. The kappa value was 0.70.

The sensitivity, specificity, PPV, NPV and accuracy to detect obstructive lesions were 96%, 92% , 79% , 99% , 93% respectively. VB detected no mucosal changes. Hence the sensitivity & PPV were zero. The kappa value could not be calculated. However the specificity and accuracy were 90%.

Table 1: showing analysis of concordance between fiber-optic and virtual bronchoscopy findings on the basis of type of lesions

Type of lesions according to FOB	Type of lesions according to VB					Total
	Lesion type	External Compression	Endoluminal lesion	Obstructive lesion	No lesion	
	External Compression	17	1	0	2	20
	Endoluminal lesion	1	20	1	4	26
	Mucosal change	3	1	2	4	10
	Obstructive lesion	0	1	22	0	23
	No lesion	3	1	3	10	17
	Scope non-negotiable	1	1	0	0	2
	Total	25	25	28	20	98

In our study there were 55 malignant lesions (56.1%) and 29 non-malignant lesions (29.6%). Among the non- malignant lesions the most common lesions were mucus plugs (8 cases, 27.6%). Among the malignant lesions, the most common was adenocarcinoma of lung (19 cases, 34.5%), followed by squamous cell carcinoma (16 cases, 29.1%). There were some cases in which HPE showed undifferentiated neoplasm (6 cases, 10.9%)

Table 2: showing histopathological and fiberoptic bronchoscopy results categorized in to malignant and non-malignant lesions

Class of lesions	Sensitivity(%)	Specificity (%)	PPV (%)	NPV(%)	Accuracy (%)	Kappa value
Malignant	90.2	66.6	90.2	66.67	84.85	0.561
Non-Malignant	81.48	46.21	88	66.67	80	0.568

Table 3: Correlation between VB and FOB in detecting malignant & non-malignant lesions

FOB results and/or histopathology findings		No. Of cases
Non-malignant lesions	Diffuse narrowing with wall thickening	7
	Foreign body	4
	Infective	3
	Granulomatous	2
	Mucus plug	8
	Polyp	3
	Squamous papilloma	2
Malignant lesions	Adenocarcinoma	19
	Carcinoid	4
	Large cell lung cancer	4
	Small cell lung cancer	6

	Squamous cell carcinoma	16
	Undifferentiated neoplasm	6

DISCUSSION:

Patients in our study ranged from a minimum age of 21 years to a maximum age of 80 years with a mean age of 52.6 years and standard deviation of 12.23 years. Male: Female ratio was 1.51: 1.

Overall comparison of detecting of an endobronchial lesion by VB and FOB shows a fair agreement with a kappa value of 0.39. This is because VB could not pick up any of the mucosal lesions detected by FOB. The main limitation of VB pertains to the inability to evaluate the mucosal surface of the tracheobronchial tree. The mucosal changes like colour, irregularity, or friability, which gives an important clue to reach at a diagnosis cannot be assessed by VB. There was concordance in detection of the location of lesion in our study in trachea, main stem and lobar bronchi. This data indicates that a better concordance is seen in detecting lesions in the central airways which have a wider diameter and better aeration. Aeration is an important factor in detecting lesions in VB as the virtual reconstruction of airways depends upon the attenuation difference of the interfaces. In detection of lesions in segmental airways VB and FOB had less agreement than those lesions in central airways. Both VB and FOB could detect benign and malignant lesions with moderate agreement. VB had an advantage of passing beyond the stenotic airway, in those cases where FOB could not reach beyond stenosis. This is more useful in case of complete luminal obstruction by an endobronchial lesion or an external compression.

A prerequisite for conducting VB is a helical CT scan of thorax. Since features like multiplanar reconstruction can be used as an adjunct to VB in confirming the findings, there is an added advantage over FOB. Also other associated findings such as infiltration of adjacent lung parenchyma, mediastinal nodal involvement, metastases etc. can be well visualized. The etiology of various extrinsic compressions could not be clarified on FOB whereas VB, with the help of multiplanar reformats, provided comprehensive information. In most cases the cause of extrinsic compression over airways was either a huge tumour mass or lymphadenopathy. Since VB is based on surface rendering and volume rendering technology, it cannot distinguish between a mass lesion, blood clots, mucus, tumours and foreign bodies, being coded by the same colour tone. This significantly reduce the selectivity of VB. FOB was better in this regard. In terms of complications, VB is more advantageous than FOB. Though rare in occurrence, chances of minor complications like haemorrhage, bronchospasm, pneumonia etc. area associated with FOB. No such complications occur in case of VB

VB is unable to observe the response of airways to respiratory movements and cough reflexes. A clinician can clearly observe the enlargement and narrowing of airways which is useful in assessing various conditions. Since it is a real-time investigation, abnormalities like bronchomalacia, vocal cord spasm/palsy etc. can be identified in FOB.

Although it is invasive modality, FOB is always better than VB as it is a real-time examination technique. The main advantage of FOB is that it can take tissue samples like biopsy and bronchoalveolar lavage in the same examination.

CONCLUSION:

In conclusion, VB is a non-invasive, uncomplicated and reproducible examination method and it may be performed without the additional risk of radiation. Virtual bronchoscopy when used in conjunction with axial CT images can enhance diagnostic accuracy of bronchial pathologies. At the present time, we believe that VB cannot replace conventional bronchoscopy due to associated disadvantages such as the inability to perform a biopsy, the inability to detect mucosal infiltration, the relatively low specificity rate when compared to high sensitivity rates, and the inability to offer real-time evaluation. But it can certainly be an effective screening technique to identify those patients who would actually benefit from conventional bronchoscopy, thus limiting the number of invasive bronchoscopies and potential complications associated with it. We believe that VB will find a place in routine use in time with the continued development of CT detector technologies and advancement in software. (4–9)

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