

INVESTIGATIONS AND PROCEDURES IN PULMONOLOGY

BAL AND TBLB

Elective and ICU

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History

- Originated in 1897: Gustav Kilian of Germany used rigid bronchoscope
- Chevalier Jackson refined rigid bronchoscope
- 1970: Shigeta Ikeda → flexible bronchoscope

INDICATIONS of BRONCHOSCOPY

- Bronchoscopy is one of the most common invasive diagnostic & therapeutic procedure in pulmonology.
- Diagnosis of lung cancer
- Occult CA (Positive sputum cytology)
- Diagnosis of diffuse lung disease: TBLB
- Diagnosis of pulmonary infections
- **Surveillance bronchoscopy** & TBLB: obliterative bronchioitis in lung transplant patients

Procedures for FOB

- Apart from visual inspection of bronchial tree FOB is accompanied by other diagnostic tests
- BAL
- Bronchial brushing
- TBLB
- TBNA
- Endobronchial biopsy

Procedure for BAL

- FOB acts as a suitable conduit for injection & aspiration of saline
- The earliest indication of BAL were therapeutic in the form of removing inspissated secretions in severe asthma
- Later this technique was modified and smaller volumes were used
- When 60 ml or more fluid is used technically the procedure becomes BAL rather than simple bronchial washing

BAL procedure

- For obtaining BAL the tip of bronchoscope is wedged in a peripheral small bronchus; either middle lobe/lingula or lower lobe bronchus

Segment is usually selected on the basis of CXR

- 20-60 ml of warm buffered saline is injected and gently aspirated.
- A return of 50-60% is expected in normal persons and lesser in diseased lung
- BAL fluid obtained and subjected for: TC/DC, special appearance of cells, supernatant analysis, culture

Precautions

- Coughing & trauma are kept to minimum to avoid contamination with blood & mucus
- Pre-warmed saline helps in ↓ cough
- Lowering aspiration pressure ↓ trauma
- Large introduction volume >300 ml ↑ risk of post lavage pyrexia

Standardization of BAL

- To reduce the problem of variability a standard procedure for BAL is recommended
- Standard introduction volume > 100 ml (240 ml recommended) for adults
- Standard no. of input aliquots (4)
- Standard site of lavage middle lobe of R lung
- Discarding first 20 ml is not a standard procedure to ↓ bronchial contamination
- If the numbers of ciliated bronchial epithelial cells and squamous epithelial cells present in the BAL samples exceed 5% of the total BAL cells, the lavage sample may be unsatisfactory as a representation of alveoli

European Respiratory Society Recommendation

SPECIAL APPEARANCE OF CELLS IN BAL

- **Haemosiderosis/Haemorrhage:** Large no. hemosiderin laden macrophages
- **PAP:** amorphous proteinaceous material
- **Asbestosis:** asbestos disease
- **Hard metal disease:** multinucleated macrophages
- **CMV:** inclusion bodies
- ***Pneumocystis carinii*:** silver stain
- **Histiocytosis:** >5% CD1a-positive cells is highly specific; Birberk granules on EM

- **Lymphocytic BAL:** granulomatous diseases, Hypersensitivity pneumonitis (very high counts, ↑ mast cells, atypical lymphocytes) drug induced ILDs
- **Neutrophils and Eosinophils:** IPF, CT-ILD, asbestosis, ARDS, smokers, contamination
- **Haemorrhagic BAL:** cytotoxic medication like Bleomycin
- **BAL CD4/CD8 ratio** can help in differentiating sarcoidosis from lymphoma: ratio lowest in lymphomas

Atypical BAL counts

- Chronic sarcoidosis: BAL lymphocytes may be normal, neutrophils may be increased (usually without Eosinophils)
- Some cases of IPF and ILD associated with S. Sc may have ↑ lymphocytes

BAL in IIP

- UIP: ↑ N occasionally E
- NSIP: ↑ L
- BOOP: ↑ TC, L, ↓ CD4/CD8
- AIP: ↑ TC, N, RBCs
- RB-ILD & DIP: ↑ alveolar pigmented macrophages, N
- LIP: ↑ L

BAL as a prognostic indicator

- IPF with increased numbers of lymphocytes in the BAL fluid, with or without granulocytes, are more likely to respond to steroids
- In a study by Haslam et al ↑ granulocytes without lymphocytes suggested a better responsiveness to cyclophosphamide than to prednisolone
- serial BAL cell counts as a monitor of disease are clinically unhelpful
- BAL neutrophilia and/or eosinophilia is associated with more extensive disease and a poor prognosis

BAL in Pneumonia

- 40-60% of CAP, HAP & VAP are without etiologic diagnosis
- BAL is used in VAP, pneumonia in immunocompromised, severe CAP & non resolving pneumonia
- Sensitivity 72-93% specificity 65-100%
- Results of BAL can help in guiding change of therapy. In studies by Fagon et al and Heyland et al found a lower mortality for pts with VAP who underwent bronchoscopy for BAL. Both groups were similar in duration of ICU stay and mechanical ventilation.

- Autopsy studies have indicated that VAP frequently involves posterior portion of right lower lobe this area should be sampled first
- BAL collects 1ml of pulmonary secretions so 10^4 bacteria in BAL represent 10^5 cfu/ml in pulmonary secretions

Variables which may affect BAL:

- Delay in performance of procedure
- Presence of antibiotics may affect growth of fastidious organism

BAL in HIV

Study by Taylor et al (1956 newly diagnosed HIV patients):

- 30% underwent bronchoscopy
- Pneumocystis carinii was the most commonly detected organism
- Bacteria : Staphylococcus aureus, Streptococcus pneumoniae, Pseudomonas spp & Haemophilus influenzae
 - Mycobacteria in 8%. Most common: M. tuberculosis
- Viral isolates (mainly CMV): 31%
- Endobronchial Kaposi's sarcoma:15%
- detection of HHV8 DNA in BAL is sensitive and specific (pulmonary involvement of Kaposi's sarcoma).
- In a recent study bronhoscopies in HIV are ↓ing. This ↓ correlates with the start of HAART

TBLB

- Carried out for bilateral disease
- Tip of bronchoscope is wedged into laterally placed peripheral segmental bronchus of lower lobe.
- Largest possible toothed biopsy forceps are passed.
- When forceps are seen out, they are opened and advanced till resistance is felt
- Forceps are closed and withdrawn
- An elastic tug followed by a feeling of give is an indication of satisfactory biopsy. Additionally the lung tissue may be seen to coil backwards.
- Good piece: A pale fluffy specimen that floats

- Transbronchial lung biopsy in diffuse or peripherally located lung disease without endobronchial lesions is diagnostic in 72%. In the same study 3% of samples were inadequate for diagnosis.
- UIP, DIP, BOOP, pulmonary angiitis and granulomatosis may not be diagnosed

Role of FOB in Immunocompromised

Indications of FOB & BAL in neutropenic patients:

Patients with extensive pneumonia even after addition of Vancomycin & Amphotericin

Non resolving pneumonia even after recovery of counts

Yield in immunocompromised of various samples

- Sputum: 14%
- Brochial lavage: 30%
- Bronchial brushing: 38%
- TBLB: 73%
- antigen detection in BAL: for *Aspergillus* spp, *Cryptococcus neoformans*, or *Histoplasma capsulatum*

Kiwor et al; Thorax 2001

Role of FOB in Immunocompromised

- BAL has a definite role in diagnosis of invasive aspergillosis. A single positive BAL culture should be regarded as an indication to start amphotericin
- MOTT in BAL are not regarded as contaminant in BAL
- Pathogens cultured from BAL are resistant to standard broad spectrum antibiotics in 43% of cases and change of treatment is required in 18% of cases

Bronchoscopy in critically ill

- Bronchoscopy is a valuable invasive procedure in critically ill patients who present with a predominantly pulmonary problem and uncertain diagnosis.
- TBLB adds to additional risk but significantly increases diagnostic yield (60%).
- The benefit are stopping unnecessary and potentially toxic empirical therapies

BRONCHOSCOPY IN ICU

- Bronchoscopy in ICU commonly involves intubated patients who are on mechanical ventilation.
- Internal diameter of endotracheal tube restricts the size of bronchoscope while a larger bronchoscope with wider channel is required for proper suctioning. Bronchoscope in non intubated patients occupy 10-15% of cross-sectional area of trachea. A 5.7 mm bronchoscope occupies 40% of cross-sectional area of 9mm and 60% of 7mm endotracheal tube.
- Tracheostomy tubes are more prone to damage the bronchoscopes especially during withdrawal

- Bronchoscopy is indicated most commonly in diagnosis and treatment of collapse due to retained secretions. In Mayo clinic ICUs 50% bronhoscpies were performed for atelectasis
- Locally directed suctioning combined with local instillation of saline and acetyl-choline is very effective in removing these secretions.
- Bronchoscopy may also be used for obtaining microbiologic specimens for diagnosis of pneumonia

- TBLB in mechanically ventilated: more risk of pneumothorax (10%) and hge (5%). Yield of histologic diagnosis is only in one-third
- Pre-oxygenation should be achieved by giving 100%. 100% O₂ should be given throughout bronchoscopy

Mode: mandatory (other modes are not reliable)

TV: to be ↑

Rate: may be ↑

ARDS: a special perforated diaphragm is required for maintenance of PEEP

Sarcoidosis & TBLB

- Sarcoidosis with diffuse infiltrates on CXR: 75-89%
- Diagnosis less likely when parenchymal disease not visible on CXR: 44-66%
- Endobronchial biopsy: 45-75%. Any additional advantage over TBLB is not clear
- In sarcoidosis granuloma are usually diffuse, so 4 bx are sufficient. Endobronchial biopsies should be obtained if the lesion is visible
- Stage II & III sarcoidosis: 75%
- Stage I sarcoidosis: 58%

TUBERCULOSIS

- Andersen et al (101 pts with positive active TB): 77% were culture positive on induced sputum sample and 95% on BAL
- In a study done in Kuwait by Balkrishnan et al: AFB was identified in BAL, either by smear or culture, in 73.3% patients with suspected pulmonary TB and in 54.5% patients with miliary shadows.
- In a Turkish study done in suspected TB patients who were smear negative FOB provided diagnosis of TB in 50%. HPE provided diagnosis in 40%
- Culture of BAL (34%) is better than gastric washing (21%) in diagnosis of smear negative TB
- Bronchoscopy is an important tool in the diagnosis & assessment of response to ENDOBRONCHIAL TB

- Pulmonary alveolar proteinosis is usually diagnosed by BAL & TBLB (characteristic PAS +ve material in most)
- IPF: Histology of these ds is sufficiently variable that the larger sampling capability of OLB is required. Bronchoscopy is not definitive; yield varies upto 27%
- For diffuse lung disease 4-6 TBLB specimens should be obtained from one lung (for localized lung ds 7-8)

LUNG CANCER

- 80% of malignancies can be judged from bronchoscopic appearance

In a visible tumor yield of EBB is >90%

- If bronchial biopsy is combined with bronchial washing & brushing: ↑
- TBNA is more sensitive if submucosal infiltration is present. Otherwise yield is similar to forceps biopsy
 - helpful in friable masses which tend to bleed
 - TBNA can be used to sample hilar glands if they are adjacent to airways (yield: 38% if radiological e/o gland enlargement)
- BAL in CA Lung: sensitivity 27-90%; not an exclusive tool for diagnosis

PERIPHERAL LESION

- Visible on CXR but not on bronchoscopy
- For diagnosis of peripheral lesions a thin bronchoscope is required. But thinner bronchoscope cannot accommodate biopsy forceps so brushing has to be used
- Lowest yield with lesions <2 cm
- Mayo Clinic Lung Project Protocol for diagnosis of occult CA: repeated, selective segmental brushings until the tumor is detected.

Solitary pulmonary nodule

- For lesions ≤ 2 cm outer 1/3: 14%
- For lesions ≤ 2 cm outer 1/3: 31%
- Thus routine biopsy of lesions < 2 cm is not always justifiable
- HRCT can help in assessing the need of bronchoscopy in diagnosing peripheral lung lesions.

Bronchus sign: bronchus transiting the lesion

Calcification: better delineated on HRCT

- BAL is beneficial in adding to diagnostic yield

METASTASIS

Metastatic masses present in 3 ways-

- Endobronchial masses: breast & RCC

Yield is similar to lung CA by EBB

- Lymphangitis carcinomatosa:
bronchoscopy with TBLB is the diagnostic procedure of choice yield 66%
- Hematogenous: same as solitary pulmonary nodule

PRE PROCEDURE WORKUP

- Suspected COPD: spirometry
- Severe COPD FEV1 < 40%: ABG
- Prophylactic antibiotics: asplenic, heart valve prosthesis, or a previous H/O endocarditis
- Avoid bronchoscopy within 6 wks of MI
- Asthmatic patients should be given bronchodilator prior to the procedure
- Clear fluids may be allowed 2 hrs prior
- NPO for 4 hrs after bronchoscopy

Complications

- Recent retrospective study 4000 procedures: no death major complication:0.5%, minor complication: 0.8%
- **Major complications:** respiratory depression, pneumonia, pneumothorax, cardiorespiratory arrest, arrhythmias, pulmonary edema
- **Minor complication:** vasovagal, fever, haemorrhage, airway obstruction,
- **Complication following Transbronchial biopsy:** pneumothorax 1-5%, haemorrhage 9%(uremic and immunosuppressed patients).Hospitalization is not required for TBLB

- Complications of lidocaine: seizures & cardiac depression; caution in patients with malignancies involving liver. Recommended maximum dose 8.2 mg/kg
- Arrhythmia: occurs commonly in patients who develop hypoxia(40% in pts with hypoxia)
- ECG monitoring is recommended in patients who have abnormal preoperative ECG (in patients with severe cardiac disease) and if hypoxia is refractory to O₂

PNEUMOTHORAX

- Pneumothorax requiring drainage: 3.5% after TBLB. 50% of pneumothorax after TBLB require drainage. The risk is higher if mechanically ventilated(14%)
- Pneumothorax most commonly develops within 1 hr.
- Role of fluroscopy in preventing pneumothorax is not very clear

BLEEDING

- Routine checkup of platelet count and PTI and aPTT is required in patients with impaired liver function test. Routine checkup of these is required before TBLB
- If TBLB is planned oral anticoagulants should be stopped 3 days prior or they should be reversed with low dose warfarin
- Anticoagulation can be continued in form of heparin if very necessary

INFECTION/FEVER

- Fever may occur in bronchoscopy without lavage in 1.2%; with lavage (10-30%); after TBLB 15%; TBNA 10%

fever is caused by release of proinflammatory cytokines from alveolar macrophages

- Bacteremia is rare
- Prophylactic antibiotics are not required routinely

HYPOXEMIA

- Hypoxia is more common if BAL is done
- Monitoring by oximetry should be done in all patients
- O₂ supplementation is beneficial in patients with impaired lung function

Oxygen should be given through nasal cannulae @ atleast 2 lpm

In high risk hypoxemic patients requiring bronchoscopy & lavage noninvasive ventilation via face mask can be used

SPECIFIC SITUATIONS

- **ISCHEMIA**: more common in pts > 60 yrs

Continuous ECG monitoring, prevention of hypoxia and adequate sedation should be used if ongoing ischemia is present

- **ASTHMA**: asthmatic undergoing bronchoscopy → 8% develop bronchospasm
Lignocaine exacerbates bronchospasm

Preoperative bronchodilator beneficial and should be used routinely

- **COPD**: Complication rate increases to 5% (cf to normal 0.6%) when $FEV_1/FVC < 50\%$ or $FEV_1 < 1L$ & $FEV_1/FVC < 69\%$

THANK YOU