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Role of Abram's Punch Needle Biopsy of Pleural Tissue among Patients of undiagnosed Exudative Pleural Effusion

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Abstract

Background: Sometimes etiological diagnosis of pleural effusion is difficult despite cytological, biochemical and microbiological tests and labeled as undiagnosed exudative pleural effusions. Aim of present study was to make an etiological diagnosis of pleural effusion. **Methods**: Study group included patients of exudative pleural effusion where etiological diagnosis could not be yielded by conventional cytological, biochemical and microbiological investigations Pleural tissue was obtained by Abram's pleural biopsy needle. Pleural biopsy was subjected to histopathology, ZN staining to find the mycobacterium tuberculosis. **Results:** Out of 50 patients, 34 (68%) and 16 (32%) were male and female, respectively. Age ranged from 18 to 81 years (mean 46.50). Histopathology of 18(36%) showed epitheloid granuloma with caseation necrosis. In other 18 (36%) patients, epitheloid granulomas (with or without giant cells) was reported. In 10 (20%) patients, histopathology report was of nonspecific chronic inflammation. Histopathology was reported as normal in 2 cases. In 4 (8%) patients, pleural tissue obtained was inadequate for opinions. Ziehl Neelsen (ZN) stain was positive for AFB in 4 patients. **Conclusions:** The role of Abram's punch needle biopsy of pleura among patients of undiagnosed exudative pleural effusion is still accepted as a diagnostic tool, as this may lead to a specific diagnosis among 76% of cases. This is of particular importance in a developing country like Bangladesh where the facilities of thoracoscopy and imaging guided cutting needle biopsies are not easily available.

Keywords:- Abram's Punch Needle Pleural Biopsy, Pleural Biopsy, Undiagnosed Pleural Effusion, Exudative Pleural Effusion.

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INTRODUCTION

The condition of pleural effusion was known to Hippocrates. Pleural effusion is the collection of fluid in the pleural space as a result of excessive transudation or exudation from the pleural surface.[1] The etiological diagnosis of exudative effusion is essential. As many as 15% to 20% of all pleural effusions remain undiagnosed despite intensive efforts.[2] In this subcontinent, infections particularly tuberculosis is still the predominant cause.[3,4] More than 40% of patients with an undiagnosed pleural effusion that were followed without treatment developed tuberculosis within 7 years; this study suggested that tuberculosis should be a strong consideration in the diagnosis of undiagnosed exudative pleural effusion.[5] In majority of patients, the diagnosis is apparent by history, physical examination and investigations of pleural fluid. In those, where reaching the diagnosis has falled, the help of invasive diagnostic modalities is required. One of these modalities is percutaneous needle biopsy of parietal pleura. By closed pleural biopsy, 49.1% of undiagnosed exudative pleural effusions could be diagnosed.[6] Closed pleural biopsy provides the highest diagnostic yield in cases of pleural tuberculosis and malignancy, the two most important causes of exudative pleural effusion.[7] The Abram's punch needle is the instrument used most widely in tertiary hospitals of Bangladesh for pleural biopsy.[1] A blunter instrument, such as a Cope needle,[8] may be more suitable when little or no pleural fluid is present but this instrument is rarely found in general medical wards in tertiary hospitals of Bangladesh. Closed pleural biopsy using Abrams punch offers a diagnosis in 57-80% of tuberculous effusions and in 48-70% of cases of neoplasia.[9,10] The general consensus is that cytological examination of the fluid greatly increases the diagnostic yield in malignant diseases,[11] but that a pleural biopsy with tissue culture remains the optimal means of diagnosing a tuberculous and malignant effusion. Percutaneous closed Abrams punch needle pleural biopsy among patients of undiagnosed exudative pleural effusion is safe, definitive and easy procedure and the patient can go home immediately after procedure.[1] Specific diagnosis of exudative pleural effusion which persist after non-invasive investigation; tissue diagnosis is required. Abrams punch needle pleural biopsy of the visceral pleura as a diagnostic tool is in disputed. Multiple specimens can be obtained for achieving tissue diagnosis which increase the sensitivity for the diagnosis of exudative pleural effusion.

Objectives

General objectives

- To evaluate the diagnostic efficacy of Abram's punch needle pleural biopsy.

Specific objectives

- To make etiological diagnosis of exudative pleural effusion.
- To study the causes of exudative pleural effusion in a tertiary level hospital.

MATERIAL AND METHODS

The present study was a hospital based prospective study. The Place of study was Dhaka Medical College Hospital, Dhaka during the period of time January 1, 2011 to June 30, 2012. Patients admitted with exudative pleural effution in Medicine units and Respiratory Medicine unit of Dhaka Medical

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College Hospital, Dhaka. 50 cases of undiagnosed exudative pleural effusion was included. All consecutive patients fulfilled the inclusion and exclusion criteria attending in Medicine units and Respiratory Medicine unit of Dhaka Medical College Hospital, Dhaka.

Inclusion criteria:

- Clinically, radiologically & biochemically diagnosed patient with pleural effution.
- Patient having exudative pleural effusion confirmed by pleural study (by classical LIGHT's Criteria-pleural fluid protein / serum protein>0.5)
- Patient who accepts to be included in the study and provide informed consent.

Exclusion criteria:

- Patient having transudative pleural effusion.
- Pregnancy.
- Proven case of empyema was excluded.

A standard proforma and questionnaire was designed and filled up for each patient. Pleural biopsy findings was recorded in specific proforma. All data was collected by the principle investigator himself. Informed written consent of the patient was taken. Detailed history of the patient and thorough medical examination was done. Patients suspected of having exudative pleural effusion on the basis of history, physical examination, chest X-ray and pleural fluid study were primarily selected. Final selection of the patients was done on the basis of inclusion and exclusion criteria. After that selection of the patient Abrams punch needle biopsy of pleural tissue was done in all patients as per standard procedure. Data was analyzed in computer using software (SPSS) and mean ± SD was applied. Eligibility of each patient was assessed and they were informed about the procedure and the study objectives and that there was no chance of any harm to the patient by inclusion in the study. Patient was also informed that they were free to refuse to participate or to withdraw at any time without compromising their medical care.

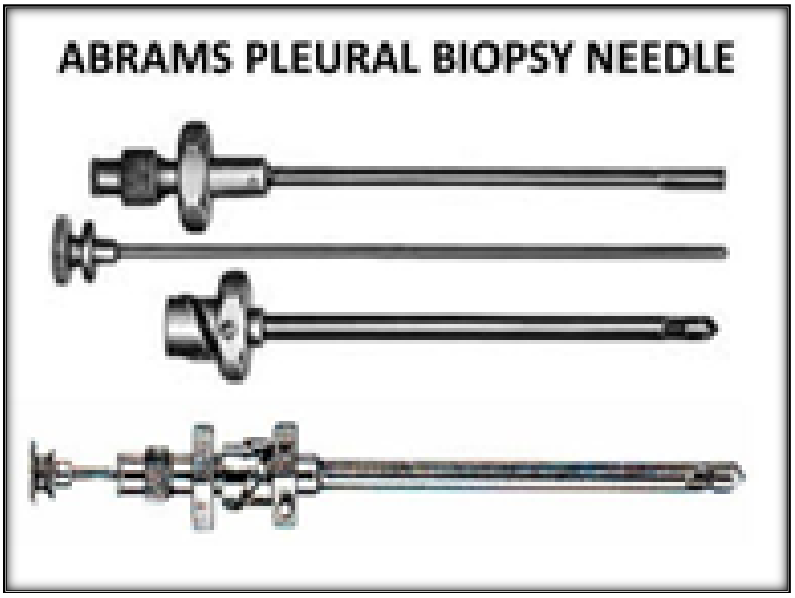

Figure 1: Abram's pleural biopsy needle

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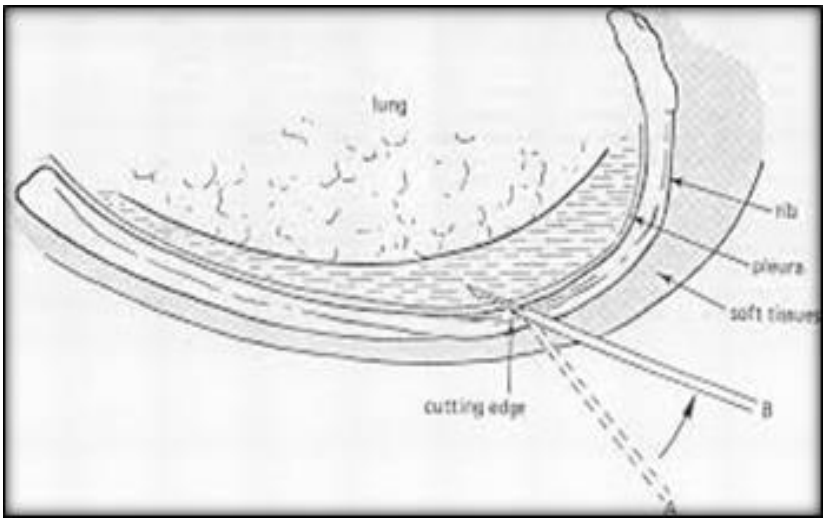

Figure 2: Performing pleural biopsy using Abram's punch needle.

Pleural biopsy:

Needle biopsy of pleura was first described in 1955 using Vim Silverman needle and later Abram Cope and Raja introduced different types of needle and were known by the inventors name,[10] Needle-like Tru-cut have been used occasionally.[1,7,8,11] Biopsy from visceral pleura had also been taken successfully and shown higher yield in diagnosis most popular needles are:[12]

1. Abram's pleural biopsy punch
2. Cope pleural biopsy needle
3. Moghissi pleural biopsy needle
4. Vim silverman needle

Now a days Abram's needle is widely used, its main advantage is that biopsy specimen can be obtain simultaneously with the aspiration of fluid without the risk of damaging the lung as its distal end is blunt. More over the instrument is large enough to take a satisfactory specimen without causing more discomfort.

The procedure of pleural biopsy was done in sitting posture of patients as described elsewhere.[13,14,15] The affected side of chest was determined and the site for biopsy was selected. This area was cleaned thoroughly with antiseptics and then infiltrated with local anesthetic (1% lignocaine). Confirmation of free fluid was acknowledged with aspiration with same syringe. For the free access, small incision of size of 0.5 cm was made just above the upper border of the rib of selected site. The Abram's needle was introduced through it. After biopsy, skin incision was sutured with a single stitch. Post blopsy chest X-ray was taken to rule out the entry of air. Pleural tissue obtained was placed in vial with formalin for histopathological examination and AFB smear staining.

RESULTS

The study included 50 patients of exudative pleural effusion in whom the diagnosis was not yielded by cytological, biochemical and microbiological investigations. They were 34 (68%) male and 16 (32 %) female. Incidence of tuberculosis & malignancy as the causes of pleural effusion is much more common in male (70%) than female (30%). Age of them ranged

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from 18 to 81 years (Mean 46.50) major incidence of tubercular effusion was in between 18-33 years and of malignant effusion were 34-41 years and 66-73 years. Low grade fever, cough was found as common symptoms of tubercular effusion. Cough, chest pain and shortness of breath were common in malignant pleural effusion Anaemia is common in both tubercular and malignant effusion. Patient of malignant effusion also show clubbing, lymphadenopathy 60% of pleural effusions were on left side. Most of the tubercular effusion was straw colored and most of the malignant effusions were hemorrhagic in nature. Effusions were predominantly lymphocytic. Mean value of polymorph and lymphocyte count was 6.84% and 92.84%, respectively. In 40 out of 50 patients there were no RBCs in pleural fluid. In 4 patients fluid was frankly hemorrhagic 6 of 50 patients were found to have mesothelial cells in their pleural fluid and their count was 1%, 2%, and 5%. Mean level of glucose was 64.44 mg/dl with lowest being nil: and highest level was 108 mg/dl. Mean level of protein in fluid was 5.56 gm/dl (range 3.6 to 7.20 gm/di). Tuberculin test was positive only in 3 patients, who were diagnosed as tubercular pleural effusion afterwards. Histopathology showed epitheloid granuloma with caseation necrosis [fig 3] in 11 patients. The epitheloid granuloma with or without giant cells were reported in another 10 cases. All of them were considered as suffering from tuberculosis. In 10(20%) patients histopathology report was of nonspecific chronic inflammation Pleural biopsy of 2 patients (4%) showed inclusion bodies in mesothelial cells. Another 2 patient's histopathology was reported as normal pleura. In 4 (8%) patients pleural Tissue obtained was inadequate for any opinion. Thus out of 50 patient's histopathology of pleural biopsy revealed tuberculosis among 21, metastasis to pleura in 11. Pleuritis (acute inflammation) in 2 and chronic inflammation in 8. Pleural tissue was also submitted for Ziehl-Neelsen (ZN) staining for presence of mycobacterium tuberculosis. It was positive in 2 of 21 patients. In most of the cases, ESR was above 50 mm in 1 hour and tuberculin test shows low efficacy. In case of tubercular pleural effusion 4 patients out of 50 patients developed hydropneumothorax and required intercostal tube drainage. 2 patient developed subcutaneous emphysema at biopsy site which resolved within next two days.

Table 1: Sex distribution of study

Sex	**No. of patients**	**Percentage %**
Male	34	68
Female	16	32
Total	50	100

Table 2: Distribution of diseases

Diseases	**No. of patents**	**Male (%)**	**Female (%)**
Tubercular	21	15	6
Malignant	11	8	3

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Table 3: Age distribution of Patients

Age of the Patients (In Years)	No. of Patients	Percentage
18-25	10	20
26-33	5	10
34-41	8	16
42-49	2	4
50-57	8	16
58-65	5	10
66-73	10	20
74-81	2	4
Total	50	100

Table 4: Age distribution according to causes of pleural Effusion

Age of the Patients (In Years)	No. of Tubercular Effusion (N-21=100%)	No. of Malignant Effusion (N-11=100%)
18-25	7 (34%)	0 (0%)
26-33	5 (24%)	0 (0%)
34-41	3 (15%)	4 (36%)
42-49	2 (10%)	0 (0%)
50-57	1 (5%)	1 (9%)
58-65	0 (0%)	1 (9%)
66-73	3 (15%)	4 (36%)
74-81	0 (0%)	1 (9%)
Total	21 (100%)	11 (100%)

Table 5: Symptoms of patients

Symptoms	Tubercular (N-21=100%)	Malignant (N-11=100%)
Chest pain	14 (68%)	8(70%)
Fever	19 (93%)	5 (44%)
Shortness of breath	6 (32%)	8 (65%)
Cough	17 (85%)	10 (87%)
Weight loss	5 (24%)	6 (52%)
Hemoptysis	1 (5%)	2 (13%)
Voice change	0 (0%)	1 (9%)

Table 6: Clinical findings of patients

Sing	Tubercular (N-21=100%)	Malignant (N-11=100%)
Anaemia	4(20%)	5(44%)
Clubbing	0	2(17%)
Iymphadonopathy	0	1(9%)
Rib tenderness/met lesion	0	1(9%)

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Table 7: Color of pleural fluid

Color of fluid	Tubercular (N-21=100%)	Malignant (N-11=100%)
Straw	18 (95%)	3 (30%)
Hemorrhagic	2 (5%)	8 (70%)

Table 8: Value of ESR

ESR mm in 1st hour	Tubercular (N-21=100%)	Malignant (N-11=100%)
<50	4 (17%)	3 (26%)
50-100	17 (83%)	7 (61%)
>100	0	1 (9%)

Table 9: Value of tubercular test

Tubercular test	No. of patient	Percentage %
0-10 mm	26	72.33%
>10mm	10	27.77%

Table 10: Important radiological finding with site of effusion

Diseases	Effusion: rt. Side	Effusion: It. Side	Effusion: bilateral
Tubercular (N-21=100%)	10 (40%)	11 (60%)	0 (0%)
Malignant (N-11=100%)	5 (40%)	6 (60%)	0 (0%)

Table 11: Specific histological type of pleural effusion

Result of pleural biopsy	No. of patient (%)			
Positive	32 (64%)			
	Tuberculosis		Malignancy	
	21 (41%)		11(23%)	
Negative	18 (36%)			
	Nonspecific findings	Different inclusions	Inadequate sample	Normal pleura
	10 (20%)	2 (4%)	4 (8%)	2 (4%)
Total	50 (100%)			

Table 12: Complications of pleural biopsy

Complications	No. of patient	Percentage %
Hydro pneumothorax	2	5%
Subcutaneous emphysema	1	2%
Bleeding	0	0%
Transient fever	0	0%
Vasovagal attack	1	2%
Seedling of tumor	0	0%
Total	4	8%

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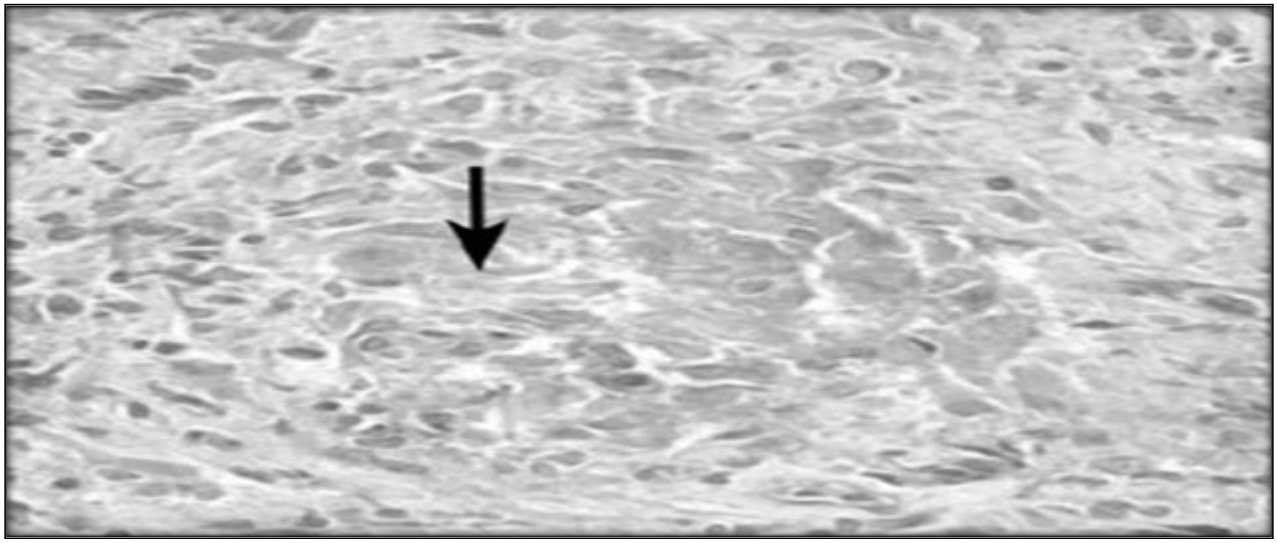

Figure 3: Section from pleura biopsy (arrow) showing epithelioid cell granuloma

DISCUSSION

The etiology of pleural effusion remained distant despite all conventional and specific investigations. In this study an effort was made to reach an etiological diagnosis in undiagnosed exudative pleural effusion by performing percutaneous parietal pleural biopsy using Abram's needle. Male (88%) gender predominated in the study population. The mean age of patients was 46.50 years and 68% were younger than 34 years. The mean age of patients with tuberculous pleural effusion was 28.71 years a little below than those reported earlier.[16,17,18] Tuberculin test was positive in 10 (25%) patients of proved tubercular effusion in the present study. Tuberculin test was negative among 30% of patients with tuberculous pleural effusion, this test may be non-reactive initially but after 6 to 8 weeks of observation may convert to reactive.[19,20,21] Adequate pleura was obtained in 46(92%) of cases in this study almost similar to others.[3] 38 (76%) of 46 patients (in whom adequate pleura was obtained) were diagnosed as a definite disease by histopathology. Thus the diagnostic yield of Abram's needle was midway between earlier reports.[17,22,23] The diagnosis of tuberculosis based on histopathology reports as epithelioid granuloma with or without giant cells and necrosis was made among 21 patients. Almost same results have been reported previously.[17] In 4 patients, AFBs were seen in histological section of pleura stained by Ziehl-Neelsen staining. Diagnostic yields of pleural biopsies in tuberculosis had been 20%.[24] Other factors like bulk of pleural tissue obtained and the number of times biopsy performed also determined the success rate.[15,24] In 8 patients the histopathology report was chronic inflammation, and in 2 patients it was normal pleura Nonspecific inflammation with varying degrees of fibrosis or normal pleura was found in 68% of patients in one study 2 patient's histopathology showed inclusion bodies inside the mesothelial cells.[25] Viruses are presumed to be one of the common causes of undiagnosed exudative pleural effusion but histological documentation is not always there.[26] Unlike this patient, in most of the

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reports patients were immunocompromised.[27,28] Significance of needle blopsy in malignant pleural effusion cannot be accurately estimated from this study as only 11 patients were with malignant effusion. Most of the patients ultimately turned out to be having carcinoma in different organ like stomach, kidney etc. with metastasis to pleura.

Limitations of the study

Classical lights criteria used in this study can miss diagnosed 5% cases of exudative pleural effusion. Some usual procedures for diagnosis of exudative pleural effusion could not use in this study, e.g pleural fluid &pleural fluid culture for AFB, Bronscopy etc. Value of repeat biopsy could not evaluate, because repeat biopsy was not done. Pleural fluid cytology for evaluation of malignant pleural effusion was much low sensitive.

CONCLUSIONS

The role of percutaneous Abram's punch needle biopsy of pleura in cases of undiagnosed exudative pleural effusion is still pivotal as it reached a specific diagnosis in majority of cases. This is of particular importance in a developing country like Bangladesh where the facilities of thoracoscopy and imaging guided cutting needle biopsies are not easily available. In addition, needie biopsy causes little morbidity and no mortality. This can be performed with little instrumental and manpower support. Abram's punch needie blopsy of pleural tissue can be safely perform for the histological diagnosis of tubercular & malignant pleural effusion. In early age group with exudative pleural effusion by the exclusion of other causes we can give ant TB therapy on trial basis where facility of pleural biopsy is not available.

REFERENCES

1. Karkhanis VS, Joshi JM. Pleural effusion: diagnosis, treatment, and management. Open Access Emerg Med. 2012;4:31-52. doi:10.2147/OAEM.S29942
2. Hirsch A, Ruffie P, Nebut M, Bignon J, Chrétien J. Pleural effusion: laboratory tests in 300 cases. Thorax. 1979;34(1):106-12. doi: 10.1136/thx.34.1.106.
3. Christopher DJ, Peter JV, Cherian AM. Blind pleural biopsy using a Tru-cut needle in moderate to large pleural effusion--an experience. Singapore Med J. 1998;39(5):196-9.
4. Jain NK, Guhan AR, Joshi N, Dixit R, Singh V, Meena RP. Comparative study of visceral and parietal pleural biopsy in the etiological diagnosis of pleural diseases. J Assoc Physicians India. 2000;48(8):776-80.
5. Patiala J. Initial tuberculous pleuritis in the Finnish armed forces in 1939-1945 with special reference to eventual postpleuritic tuberculosis. Acta Tuberc Scand Suppl. 1954;36:1-57.
6. Al-Shimemeri AA, Al-Ghadeer HM, Giridhar HR. Diagnostic yield of closed pleural biopsy in exudative pleural effusion. Saudi Med J. 2003;24(3):282-6.
7. James P, Gupta R, Christopher DJ, Balamugesh T. Evaluation of the diagnostic yield and safety of closed pleural biopsy in the diagnosis of pleural effusion. Indian J Tuberc. 2010;57(1):19-24.
8. COPE C. New pleural biopsy needle; preliminary study. J Am Med Assoc. 1958 28;167(9):1107-8. doi: 10.1001/jama.1958.72990260005011a.
9. Scharer L, McClement JH. Isolation of tubercle bacilli from needle biopsy specimens of parietal pleura. Am Rev Respir Dis. 1968;97(3):466-8. doi: 10.1164/arrd.1968.97.3.466.
10. Von Hoff DD, LiVolsi V. Diagnostic reliability of needle biopsy of the parietal pleura. A review of 272

biopsies. Am J Clin Pathol. 1975;64(2):200-3. doi: 10.1093/ajcp/64.2.200.
11. Frist B, Kahan AV, Koss LG. Comparison of the diagnostic values of biopsies of the pleura and cytologic evaluation of pleural fluids. Am J Clin Pathol. 1979;72(1):48-51. doi: 10.1093/ajcp/72.1.48.
12. Prabhudesai PP, Mahashur AA, Murudkar SN, Ajay R. Percutaneous visceral pleural biopsy with fenestrated cup biopsy forceps. Thorax. 1992;47(9):753-4. doi: 10.1136/thx.47.9.753.
13. Yokoyama T, Toda R, Tomioka R, Aizawa H. Medical Thoracoscopy Performed Using a Flexible Bronchoscope Inserted through a Chest Tube under Local Anesthesia. Diagn Ther Endosc. 2009;2009:394817. doi: 10.1155/2009/394817.
14. Uthaman B, Behbehani N, Abal A, Madda J, Khan S. Percutaneous multiple-site parietal pleural biopsy: description and evaluation of a new and safe technique. Chest. 2004;125(5):1776-82. doi: 10.1378/chest.125.5.1776.
15. Light RW. Diagnostic principles in pleural disease. Eur Respir J. 1997;10(2):476-81. doi: 10.1183/09031936.97.10020476.
16. Verma SK, Dubey AL, Singh PA, Tewerson SL, Sharma D. Adenosine Deaminase (ADA) Level in Tubercular Pleural Effusion. Lung India. 2008;25(3):109-10. doi: 10.4103/0970-2113.44121.
17. Valdés L, Alvarez D, San José E, Penela P, Valle JM, García-Pazos JM, et al. Tuberculous pleurisy: a study of 254 patients. Arch Intern Med. 1998;158(18):2017-21. doi: 10.1001/archinte.158.18.2017.
18. Burgess LJ, Maritz FJ, Le Roux I, Taljaard JJ. Use of adenosine deaminase as a diagnostic tool for tuberculous pleurisy. Thorax. 1995;50(6):672-4. doi: 10.1136/thx.50.6.672.
19. Sharma SK, Suresh V, Mohan A, Kaur P, Saha P, Kumar A, et al. A prospective study of sensitivity and specificity of adenosine deaminase estimation in the diagnosis of tuberculosis pleural effusion. Indian J Chest Dis Allied Sci. 2001;43(3):149-55.
20. Jadhav AA, Bardapurkar JS, Jain A. Alkaline phosphatase: Distinguishing between tuberculous and nontuberculous pleural effusion. Lung India. 2009;26(3):77-80. doi: 10.4103/0970-2113.53230.
21. Berger HW, Mejia E. Tuberculous pleurisy. Chest. 1973;63(1):88-92. doi: 10.1378/chest.63.1.88.
22. Escudero Bueno C, García Clemente M, Cuesta Castro B, Molinos Martín L, Rodríguez Ramos S, González Panizo A, et al. Cytologic and bacteriologic analysis of fluid and pleural biopsy specimens with Cope's needle. Study of 414 patients. Arch Intern Med. 1990;150(6):1190-4. doi: 10.1001/archinte.150.6.1190.
23. Levine H, Metzger W, Lacera D, Kay L. Diagnosis of tuberculous pleurisy by culture of pleural biopsy specimen. Arch Intern Med. 1970;126(2):269-71.
24. Chang DB, Yang PC, Luh KT, Kuo SH, Yu CJ. Ultrasound-guided pleural biopsy with Tru-Cut needle. Chest. 1991;100(5):1328-33. doi: 10.1378/chest.100.5.1328.
25. Kirsch CM, Kroe DM, Azzi RL, Jensen WA, Kagawa FT, Wehner JH. The optimal number of pleural biopsy specimens for a diagnosis of tuberculous pleurisy. Chest. 1997;112(3):702-6. doi: 10.1378/chest.112.3.702.
26. Hirose Y, Takeshita S, Konda S, Takiguchi T. Detection of human cytomegalovirus in pleural fluid of lymphoblastic lymphoma T-cell type. Int J Hematol. 1994;59(3):181-9.
27. Poe RH, Israel RH, Utell MJ, Hall WJ, Greenblatt DW, Kallay MC. Sensitivity, specificity, and predictive values of closed pleural biopsy. Arch Intern Med. 1984;144(2):325-8.
28. Delfs-Jegge S, Dalquen P, Hurwitz N. Cytomegalovirus-infected cells in a pleural effusion from an acquired immunodeficiency syndrome patient. A case report. Acta Cytol. 1994;38(1):70-2.

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