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ORIGINAL

Cytomorphological diagnosis of sarcoidosis using EBUS-TBNA in a tuberculosis-endemic region

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KEYWORDS
EBUS-TBNA;
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Abstract
Background: Sarcoidosis, a granulomatous inflammatory disease, exhibits diverse clinical manifestations, often affecting multiple organs. Diagnostic challenges arise due to its similarities with tuberculosis, particularly in high-burden areas. Differentiating between the two relies on clinical judgment, laboratory tests, imaging, and invasive procedures. Endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) has emerged as a valuable diagnostic tool, enhancing both accuracy and patient care.
Material and methods: This study enrolled 279 suspected sarcoidosis cases, evaluated via EBUS-TBNA between November 2022 and August 2023. The inclusion criteria comprised intrathoracic lymphadenopathy on CT, with subsequent diagnoses of either sarcoidosis or tuberculosis. Clinical, radiological, and laboratory assessments, along with EBUS-TBNA, were conducted. Cytopathological analysis focused on the presence of granulomas, histiocytic clusters, lymphocyte depletion, and necrosis, which aided in diagnosis. Statistical analysis was conducted using SPSS software to evaluate sensitivity, specificity, and predictive values.
Results: Out of 279 patients, 178 were diagnosed with sarcoidosis and 90 with tuberculosis. Adequate TBNA samples were obtained in 240 cases, predominantly from male patients. Negative tuberculin skin tests and negative culture studies were significant findings in the sarcoidosis cases ($p < 0.0001$). Echotexture and necrosis were distinguishing features of tuberculosis, while granulomas and histiocyte patterns varied. The sensitivity and specificity for diagnosing sarcoidosis via cytomorphology were notable, particularly when combined with negative microbiological findings.

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Conclusion: Cytomorphological analysis via EBUS-TBNA significantly aids in the diagnosis of sarcoidosis, despite overlapping features with tuberculosis. The absence of necrosis and distinctive granuloma characteristics contribute to its high sensitivity and specificity. Radiological correlations and microbiological findings further enhance diagnostic accuracy. This study underscores the importance of comprehensive evaluation in intrathoracic lymphadenopathies, highlighting the pivotal role of EBUS-TBNA in tuberculosis-endemic regions.

PALABRAS CLAVE
EBUS-TBNA;
Sarcoidosis;
Linfadenopatía;
Tuberculosis;
Granuloma

Diagnóstico citomorfológico de sarcoidosis mediante EBUS-TBNA en una región endémica de tuberculosis

Resumen
Antecedentes: La sarcoidosis, una enfermedad inflamatoria granulomatosa, presenta diversas manifestaciones clínicas y a menudo afecta a múltiples órganos. Los desafíos diagnósticos surgen debido a las similitudes con la tuberculosis, especialmente en zonas de alta prevalencia. Las características distintivas requieren juicio clínico, pruebas de laboratorio, estudios de imágenes y procedimientos invasivos. La aspiración con aguja transbronquial guiada por ultrasonido endobronquial (EBUS-TBNA) ha surgido como una herramienta diagnóstica valiosa, mejorando la precisión y la atención al paciente.
Material y métodos: Este estudio incluyó 279 casos sospechosos de sarcoidosis evaluados mediante EBUS-TBNA entre noviembre de 2022 y agosto de 2023. Los criterios de inclusión incluían linfadenopatía intratorácica en la tomografía computarizada (TC), con diagnósticos subsiguientes de sarcoidosis o tuberculosis. Se llevaron a cabo evaluaciones clínicas, radiológicas y de laboratorio, junto con EBUS-TBNA. El análisis citopatológico se centró en la presencia de granulomas, conglomerados de histiocitos, depleción de linfocitos y necrosis, lo que facilitó el diagnóstico. El análisis estadístico se realizó utilizando el software SPSS para evaluar la sensibilidad, la especificidad y los valores predictivos.
Resultados: De los 279 pacientes, 178 recibieron el diagnóstico de sarcoidosis y 90 el de tuberculosis. Se obtuvieron muestras adecuadas de TBNA en 240 casos, predominantemente de pacientes varones. Los resultados negativos en las pruebas de tuberculina y en los estudios de cultivo fueron hallazgos significativos en los casos de sarcoidosis ($p < 0,0001$). La ecotextura y la necrosis distinguieron la tuberculosis, mientras que los granulomas y los patrones histiocíticos presentaron variaciones. La sensibilidad y la especificidad para el diagnóstico de sarcoidosis mediante citomorfología fueron notables, particularmente cuando se combinaron con hallazgos microbiológicos negativos.
Conclusión: El análisis citomorfológico mediante EBUS-TBNA ayuda significativamente en el diagnóstico de sarcoidosis, a pesar de las características superpuestas con la tuberculosis. La ausencia de necrosis y las características distintivas de los granulomas contribuyen a una alta sensibilidad y especificidad. Las correlaciones radiológicas y los hallazgos microbiológicos refinan aún más la precisión diagnóstica. Este estudio subraya la importancia de una evaluación integral en las linfadenopatías intratorácicas, destacando el papel crucial de EBUS-TBNA en regiones endémicas de tuberculosis.

Introduction

Sarcoidosis is a chronic, multisystemic granulomatous inflammatory disease. Granulomas can develop in various organs and tissues throughout the body, most commonly affecting the lungs and lymph nodes. Other less frequently involved sites include the eyes, skin, salivary glands, heart, spleen, liver, and nervous system. Sarcoidosis can have a wide range of clinical manifestations, from asymptomatic to severe symptoms, depending on the organs involved. Common symptoms include persistent cough, shortness of breath, fatigue, fever, weight loss, skin rash, and joint pain. Depending on the predominant site of involvement, patients may seek evaluation from different specialties.[1]

Previously, sarcoidosis was primarily associated with developed countries. However, recent years have seen an increase in reports of sarcoidosis from countries such as India, Singapore, Malaysia, and other developing countries. This rise in the incidence of sarcoidosis is attributed to a decline in infectious diseases, particularly tuberculosis, as a result of the implementation of tuberculosis control programmes.[2]

The diagnostic challenge arises from the significant clinical similarities between sarcoidosis and tuberculosis, particularly in countries with a high burden of tuberculosis. Both thoracic sarcoidosis and tuberculosis may involve mediastinal lymph nodes (LNs), pulmonary parenchyma, and the pleura. Enlarged mediastinal lymph nodes are common in sarcoidosis, making it challenging to differentiate between them based solely on clinical presentation in many cases. Although the tuberculin skin test (TST) is useful for distinguishing sarcoidosis from tuberculosis, the demonstration of *Mycobacterium tuberculosis* through smear, culture, or molecular method provides the most definite evidence of tuberculosis. Radiologically, both sarcoidosis and tuberculosis can present with similarities, complicating their differentiation. Sarcoidosis typically exhibits discrete, bilateral, and symmetrical lymph node enlargement. While fibrosis and a miliary distribution are common in tuberculosis, they can also be observed in sarcoidosis. Additionally, both diseases exhibit granulomatous inflammation on histopathology. However, caseation, a feature specific to tuberculosis, is absent in sarcoidosis. Clinicians must rely on a combination of clinical judgment, laboratory tests, imaging studies, and sometimes invasive procedures, such as biopsy, to establish a definitive diagnosis.

Various invasive modalities, namely mediastinoscopy, TBB, TBLB, EBUS-TBNA, and EUS, are available today to help differentiate these conditions. Recently, endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) has been widely used for diagnosing sarcoidosis due to its high success rate in detecting granulomas. However, its advantages extend beyond this, optimizing sample quality, reducing complications, refining differential diagnoses, and predicting lymph node fibrosis. These benefits highlight the potential of EBUS-TBNA to enhance diagnostic accuracy and improve patient care in sarcoidosis and related conditions.[3,4]

This study illustrates the role of cytomorphological analysis of intrathoracic lymphadenopathy using EBUS-TBNA in clinically and radiologically suspicious cases of sarcoidosis in a tuberculosis-endemic region at a tertiary care centre.

Method

A total of 279 clinically suspicious cases of sarcoidosis were included in this study, which was carried out from November 2022 to August 2023. Patients who underwent EBUS-TBNA were selected based on inclusion criteria, which consisted of enlarged intrathoracic lymph nodes on CT and a final diagnosis of either sarcoidosis or tuberculosis. Rapid on-site evaluation (ROSE) was performed by a cytopathologist. The location, symmetry, and endosonographic appearance of the nodes were recorded. A detailed history, blood tests, serum ACE levels, tuberculin skin test (TST), and chest radiography were routinely carried out for these patients. Cases showing radiological suspicion of sarcoidosis on CT scans were further evaluated using EBUS-TBNA. Both air-dried (Giemsa-stained smears) and alcohol-fixed smears (95% alcohol) were prepared from the aspirated material. The aspirated material was also used for AFB staining (Ziehl-Neelsen), and samples were transferred in 0.9% sterile normal saline for mycobacterial culture and Xpert MTB/RIF testing. A cell block was prepared using the tissue coagulum clot method in all cases. A single cytopathologist, blinded to the clinical data, biopsies (endobronchial biopsy), mycobacterial culture results, Xpert MTB/RIF results, and final diagnosis, reported the cytomorphological features of the slides.

The following features were assessed while evaluating the cytology smears: adequacy of the EBUS-TBNA, presence or absence of necrosis, number and type of granulomas, number and type of histiocytic clusters, lymphocyte richness or depletion, staining for AFB in cytology slides, and the final impression of the cytologist in TBNA smears where granulomas could be identified (favouring sarcoidosis, favouring tuberculosis, or indeterminate, i.e. both given as differentials).

The adequacy of the smear was determined by the presence of lymphocytes and lympho-glandular bodies (Sydney criteria). The presence or absence of necrosis was documented in every case. Granulomas were further classified into caseating and non-caseating types, with the former favouring tuberculosis. Fewer non-caseating granulomas, whether with lymphocytes or featuring occasional or singly scattered histiocytes, favoured tuberculosis. In contrast, a large number of non-caseating lymphocyte-depleted granulomas, characterised by abundant tightly packed histiocytes, favoured a diagnosis of sarcoidosis.

Patients with consistent clinico-radiological findings and cytomorphology of sarcoidosis (non-necrotising epithelioid cell granuloma), along with negative microbiological or molecular studies and a positive response to treatment after a 6-month follow-up, were diagnosed with sarcoidosis. In contrast, cases with a positive AFB stain, culture or molecular test, as well as clinical, radiological and cytomorphological suspicion of tuberculosis, were diagnosed as tuberculosis.[5]

The objective of this study was to evaluate the cytological findings in confirmed cases of sarcoidosis and assess the diagnostic accuracy of EBUS-TBNA samples. Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software, IBM manufacture, Chicago, USA, version 25.0. Fischer's exact and Chi-square test were used to compare clinico-radiological variables, with p values <0.05 considered statistically significant. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated based on the confirmed diagnosis of sarcoidosis.

Results

A total of 279 patients who underwent EBUS-TBNA were included in this study. The median age at presentation was 45 years, ranging from 19 to 73 years. Out of the 279 cases, 178 patients were confirmed to have sarcoidosis and 90 to have tuberculosis. Among the TBNA samples, 240 were found to be adequate, including 175 males and 65 females. Addi-

Table 1 Clinical and endosonographic characteristics of patients who underwent endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) for intrathoracic lymphadenopathy.

Parameters	Total (240)	Sarcoidosis (160)	Tuberculosis (76)	*p*-Value
Age (median)	45			
Male	175	112	63	0.034*
Female	65	48	13	
TST test negative	171	155	16	<0.0001*
Lymph node station sampled				
4R	227	155	72	0.474†
7	234	159	75	0.541†
10R	132	87	45	0.862*
10L	8	5	3	0.715†
11R	25	18	7	0.634*
11L	87	64	23	0.147*
Ultrasonographic findings				
Heterogenous echotexture	58	20	38	<0.0001*
Coagulation necrosis sign	30	13	27	<0.0001*
Central intranodal vessel	78	61	17	0.016*
Culture studies negative	235	156	20	<0.0001†

* Chi-square test.
† Fischer's exact test.

tionally, 171 patients tested negative for TST, which included cases of sarcoidosis and accounted for 21% of the tuberculosis cases. Culture studies were negative in 97% of the cases of sarcoidosis and 26% of the cases of tuberculosis. The *p*-value for both TST and culture study was <0.0001. On ultrasonography, a central intranodal vessel was a common finding in cases of sarcoidosis (38%), while a heterogenous echotexture (50% vs 12.5%; *p*-value <0.0001) and coagulation necrosis sign (35.5% vs 8.1%; *p*-value <0.0001) were more commonly seen in tuberculosis. The most commonly sampled stations were 7 and 4R (97.5% and 94.5% respectively), followed by stations 10R and 11L (55% and 36.25%, respectively). There were no significant differences among the various mediastinal lymph node stations between sarcoidosis and tuberculosis, with *p* values >0.05 for all stations. The clinico-radiological parameters are summarised in Table 1.

Out of the 240 cases deemed adequate based on cytomorphology, granulomas were identified in 200 cases (79.2% in sarcoidosis and 62.2% in tuberculosis). More than 70% of cases of both sarcoidosis and tuberculosis showed fewer than 5 granulomas per smear. Singly scattered or occasional histiocytes were more commonly observed in sarcoidosis (70.7% vs 6.6%; *p*-value <0.0001) (Fig. 1). Another feature commonly seen in sarcoidosis was lymphocyte-depleted granulomas (66%) and granulomas with fibrillary stroma (54%) ($p < 0.0001$ for each) (Figs. 1 and 2). Most cases of sarcoidosis showed a lack of necrosis, while necrosis was seen in 44.4% of tuberculosis cases (Fig. 3). Table 2 summarizes the cytomorphological details of the study subjects. The findings from the cell block of EBUS-TBNA samples are shown in Fig. 4.

When considering the cytomorphology of granulomas (singly scattered histiocytes, fibrillary stroma and microgranulomas) alone, the sensitivity and specificity for diagnosing sarcoidosis were observed to be 72.37% and 68.18%, respectively (Table 3). However, when the absence of necrosis was combined with these cytomorphological features, the sensitivity and specificity increased to 88.19% and 70.83%, respectively. A sensitivity of 100% was achieved when cytological features were combined with microbiological findings, including negative cultures and GeneXpert for MTB/RIF.

Based on clinical, radiological, microbiological and cytological findings, 178 cases were diagnosed with sarcoidosis and 90 with tuberculosis. Sarcoidosis was ultimately confirmed in 79% of the cases based on cytomorphological features, while 28 cases presented both sarcoidosis and tuberculosis as differential diagnoses (Table 4).

Discussion

Our study highlights the role of cytomorphology using EBUS-TBNA in supporting the clinico-radiological diagnosis of sarcoidosis. Overlapping cytomorphological features between sarcoidosis and tuberculosis, particularly granulomas, are not uncommon. In our study, the presence and number of granulomas per smear were almost equally distributed between cases of sarcoidosis and tuberculosis. However, differences in the types of granulomas were noted. A distinguishing feature in our study was the absence of lymphocytes and the presence of fibrillary stroma in sarcoidosis, both with a *p*-value of <0.001. Tuberculous granulomas were primarily composed of tightly clustered histiocytes, while sarcoid granulomas exhibited both tightly clustered histiocytes and singly scattered histiocytes.

Another striking finding in our study was the absence of necrosis in sarcoidosis, with only two cases showing necrosis, whereas 52% of tuberculosis cases showed necrosis. Similar findings were reported in a study by Kaur et al., where none of the cases of sarcoidosis showed caseation or necrosis, while approximately 55% of cases of tuberculosis showed caseating necrosis.[6] The results of our study show that granulomas without necrosis have a sensitivity of

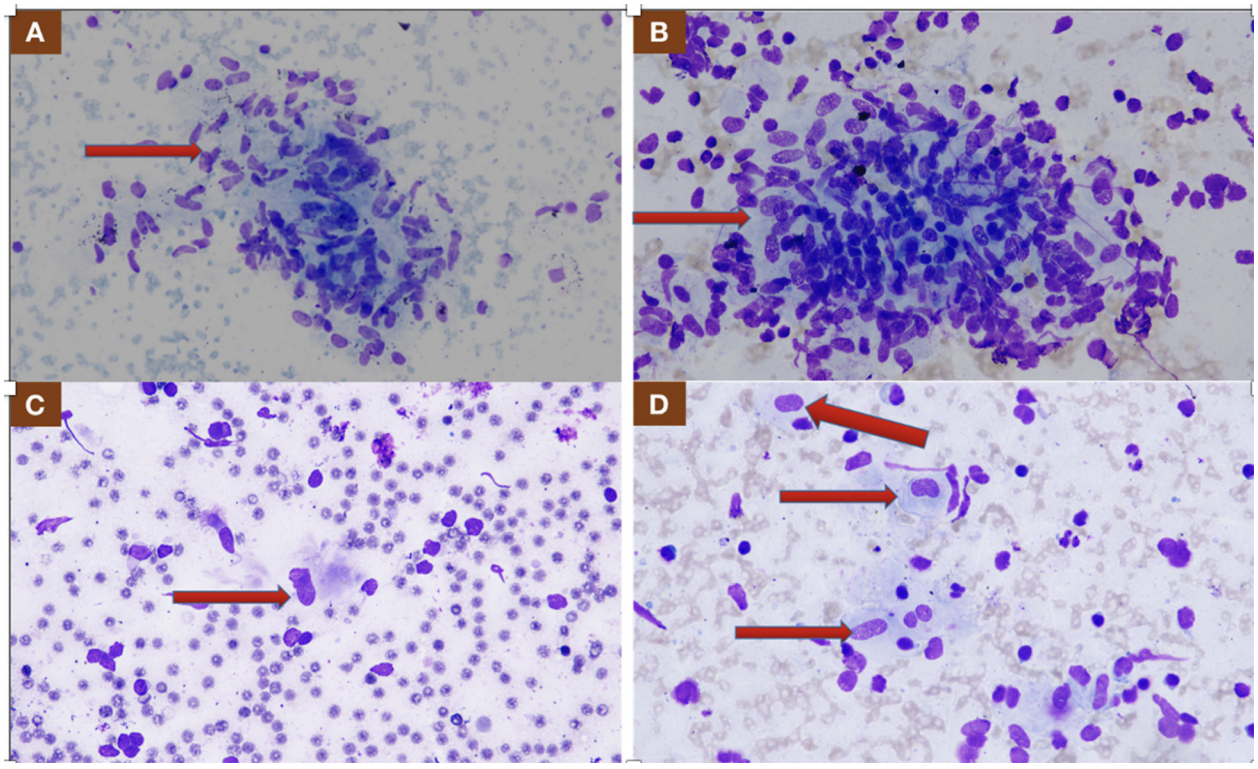

Figure 1 (A) Giemsa-stained slide (200× magnification) of EBUS-TBNA shows tight histiocytic clusters forming well-defined granulomas (red arrow). (B) Well-formed granuloma with no lymphoid cells within it (200× magnification). However, peri-granulomatous lymphoid cells are present (red arrow – granuloma, red arrowhead – peri-granulomatous lymphoid cells). (C and D) Singly lying histiocytic cells with abundant cytoplasm (400x magnification). Many singly lying histiocytes, and the background shows lymphoid cells (red arrow – singly lying histiocytic cells).

Table 2 Cytomorphological characteristics of patients who underwent endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) for intrathoracic lymphadenopathy.

Cytomorphological parameters	Total EBUS-TBNA ($n=279$)	Sarcoidosis ($n=178$)	TB ($n=90$)	*p*-Value	Others ($n=11$)
Adequacy	240	160	76	0.194*	4
Granuloma identified	200	141	56	0.003*	3
Granulomas per smear					
<5	147	104	42	0.068*	1
>5	53	37	14	0.303*	2
Singly scattered/occasional histiocytes	132	126	6	<0.0001*	–
Tight histiocytic clusters	166	121	45	0.004*	–
Naked granuloma (lymphocyte depleted)	119	107	12	<0.0001*	–
Granuloma with fibrillary stroma	93	87	6	<0.0001*	–
Necrosis	42	2	40	<0.0001†	
In one low power field	32	2	30	<0.0001†	–
More than one low power field	10	0	10	<0.0001†	

* Chi-square test.
† Fischer's exact test.

88.19% and PPV of 89.14% in diagnosing sarcoidosis. Muthu et al. concluded that the absence of necrosis had a high sensitivity of 94% for diagnosing sarcoidosis.[5] This correlation between necrosis and tuberculosis is further supported by the study carried out by Schmitt et al.[7] They categorised tuberculosis and sarcoidosis as high and low macrophage turnover granuloma respectively. Tubercle bacilli leads to high turnover due to increased monocyte consumption and macrophage death leading to necrosis. Similarly, Masilamani et al. in their study found that the highest percentage

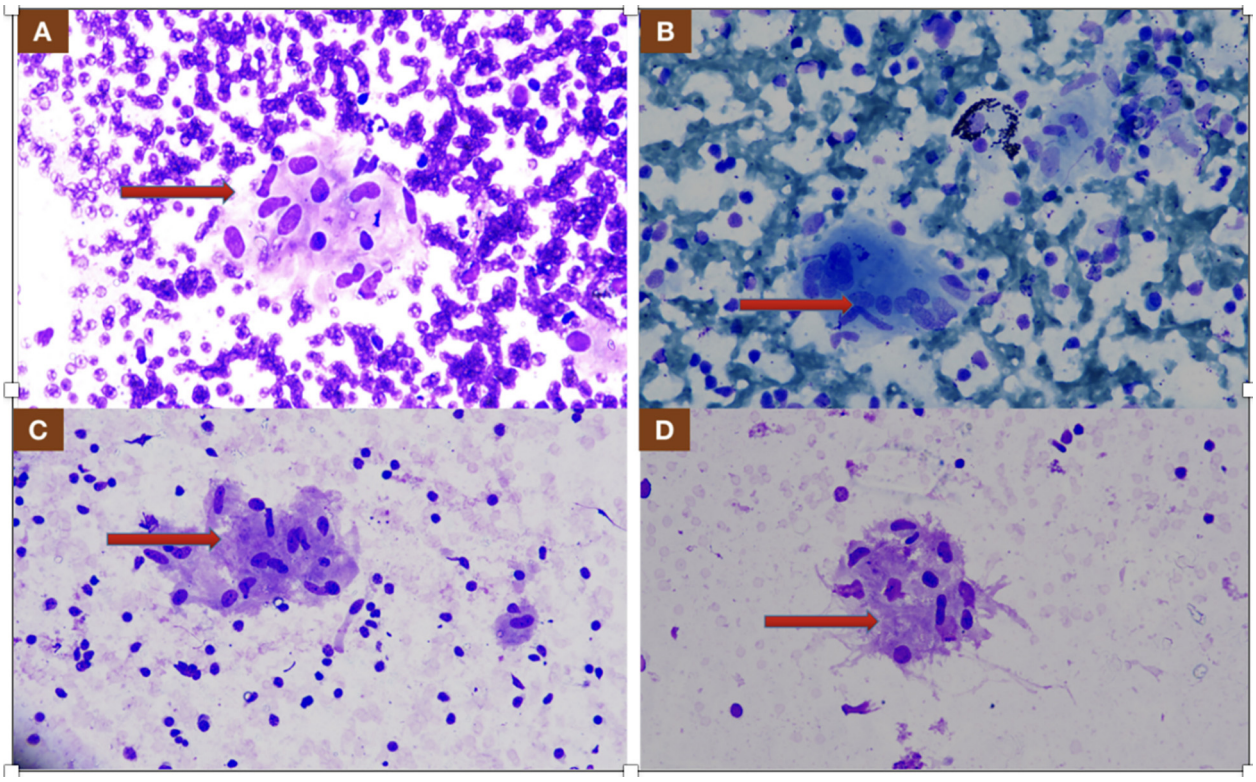

Figure 2 (A) Giemsa-stained smear (400× magnification) shows microgranulomas formed by a few histiocytes (red arrow – microgranuloma). (B) Langhans giant cells with peripherally placed nuclei (400× magnification) (red arrow – peripherally placed nuclei in Langhans giant cell). (C and D) Granuloma with a fibrillary background (400× magnification) (red arrow – fibrillary background).

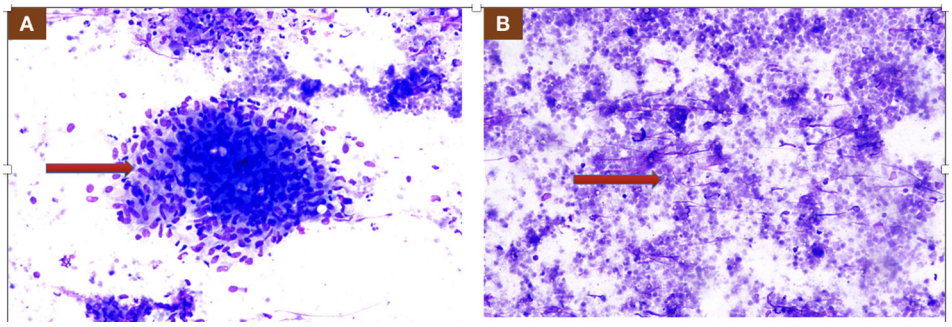

Figure 3 (A) Giemsa-stained smear shows large epithelioid cell granuloma with lymphocytes in a case of tuberculosis (200× magnification) (red arrow – granuloma). (B) Areas of necrosis were noted (200× magnification) (red arrow – necrosis).

of AFB positivity was seen in aspirates showing extensive necrosis.[8]

Nakajima et al. compared the diagnostic accuracy of three methods – bronchoalveolar lavage fluid analysis (BAL), transbronchial lung biopsy (TBLB), and endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) – in suspected cases of sarcoidosis. Their results showed that EBUS-TBNA had significantly higher diagnostic accuracy for sarcoidosis (91.4%) compared to BAL and TBLB.[9] In our study, EBUS-TBNA achieved a diagnostic accuracy of 75% for sarcoidosis, with a *p*-value of 0.001.

According to the radiological findings in our study, a heterogeneous echotexture and coagulation necrosis sign were observed in 50% and 35.5% of tuberculosis cases, respectively, with a *p*-value <0.001. These findings are in line with those reported by Dhooria et al., where heterogeneous echotexture was seen in 53.4% and coagulation necrosis was present in 26.1% of lymph nodes in tuberculosis.[10] They concluded that a positive tuberculin skin test (TST), along with either a heterogeneous echotexture or coagulation necrosis sign, had a specificity of 98% and a PPV of 91% for diagnosing tuberculosis. In contrast, our study found the presence of granuloma with a central hilar sign and an absent heterogenous echotexture had a sensitivity of 70% and a PPV of 79.4% in diagnosing sarcoidosis. Similar to our finding of a heterogenous echotexture in only 12% of sarcoidosis cases, Imai et al. reported that a homogeneous echotexture was observed in a majority of sarcoidosis cases.[11]

Mediastinal lymphadenopathy is the predominant presentation of sarcoidosis. Currently, the diagnosis of pulmonary

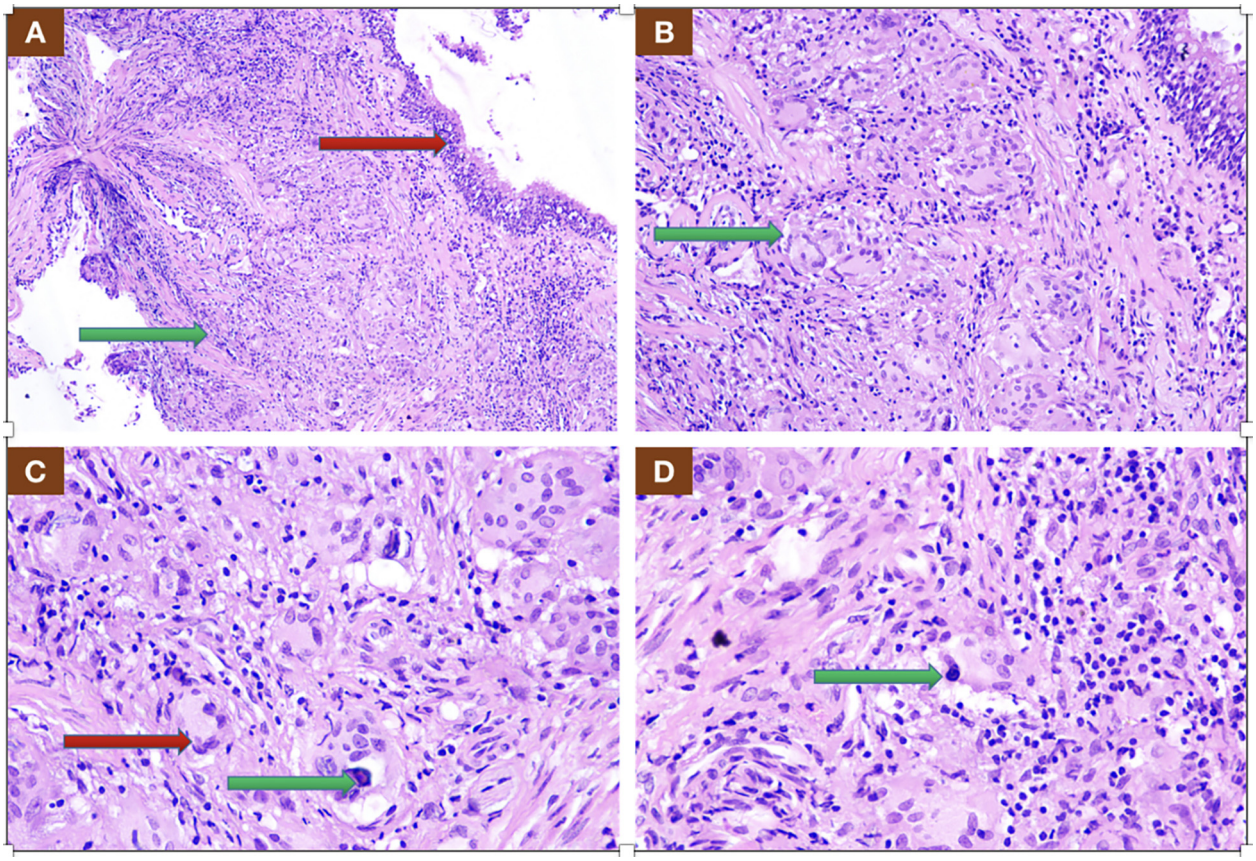

Figure 4 (A) 40× magnification and (B) 100× magnification – cell block prepared from TBNA material shows respiratory lining epithelium with underlying non-necrotizing epithelioid cell granulomas (red arrow – respiratory lining epithelium, green arrow – non-necrotizing epithelioid cell granuloma). (C and D) Langhan's giant cells with Schaumann bodies (lamellated calcifications) are seen (200× magnification) (red arrow – Langhans giant cell, green arrow – Schaumann bodies).

Table 3 Diagnostic accuracies of parameters considered in diagnosing sarcoidosis among study subjects.

Parameters	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
Cytomorphology of granuloma	72.37% (64.54–79.30)	68.18% (57.39–77.71)	79.71% (74.02–84.42)	58.82% (51.56–65.72)
Granuloma with absence of necrosis	88.19% (81.77–92.97)	70.83% (60.67–79.67)	81.94% (76.76–86.17)	80.00% (71.54–86.42)
Granuloma with endosonographic findings	70.13% (62.24–77.23)	67.44% (56.48–77.16)	79.41% (73.67–84.17)	55.77% (48.72–62.59)
Granuloma with negative microbiological culture	100.00% (97.32–100.00)	46.15% (36.33–56.20)	70.83% (67.03–74.37)	100.00% (92.60–100.00)
Granuloma with negative Xpert MTB/RIF	100.00% (97.32–100.00)	46.15% (36.33–56.20)	70.83% (67.03–74.37)	100.00% (92.60–100.00)

sarcoidosis often involves various procedures, including bronchoscopy with TBLB, conventional TBNA, endobronchial biopsy, BAL, and mediastinoscopy. Mediastinoscopy is considered the ''gold standard'', with a diagnostic yield of 82–97% for undiagnosed mediastinal adenopathy. However, it carries significant risks, including major morbidity (ranging from 1.4 to 2.3%), high cost, and the need for general anaesthesia.

Table 4 Final impression from EBUS cytology of the study subjects.

Impression on cytomorphology	EBUS-TBNA cases ($n = 279$) Adequate 240	Sarcoidosis ($n = 178$) Adequate 160	TB ($n = 90$) Adequate 76	Others ($n = 11$)
Correct diagnosis on cytomorphology	184	132	48	4
Suggested both sarcoidosis and tuberculosis as differentials on cytomorphology	56	28	28	–

The cytological feature of granulomas alone demonstrated a sensitivity and a PPV of 72.3% and 79.7%, respectively, in diagnosing sarcoidosis. However, when combined with the absence of necrosis, the sensitivity and PPV increased to 88.1% and 89.14%. In our study, the presence of granuloma alongside negative microbiology findings provided the highest sensitivity of 100%. Similarly, in the study carried out by Muthu et al.[5] the presence of a granuloma had a poor specificity of 35%. When granuloma was combined with a negative TST and the absence of endosonographic findings suggestive of tuberculosis, the specificity improved to 97% with a PPV of 99%. In conclusion, granulomatous disease of the lymph nodes can be diagnosed on the basis of cytomorphological features, but diagnostic accuracy can be significantly improved when combined with additional findings, such as culture results, tuberculin tests and radiological features. Specific features, such as the absence of necrosis and cytological characteristic of granulomas – including microgranulomas, fibrillary cytoplasmic processes in histiocytes, depleted lymphocytes, and abundant singly scattered histocytes – should be carefully evaluated in cases of intrathoracic lymphadenopathies. The study highlights the key cytological features of granuloma in cases of sarcoidosis and emphasizes the role of EBUS-TBNA in diagnosing intrathoracic lymphadenopathies in tuberculosis-endemic regions.

The study is limited to 279 patients, represents a moderate sample size, and was conducted at a single tertiary care centre. Although the study references other diagnostic techniques, such as mediastinoscopy, it does not directly compare EBUS-TBNA with these methods in terms of diagnostic accuracy.

CRediT authorship contribution statement

Conceptualisation: AAK, SD
Methodology: AAK, SD
Formal analysis: AAK, AJ
Resources: SD
Data curation: SD
Writing original draft: AJ, AAK
Writing – review and editing: AAK, SD
Supervision: SD

Informed consent

The study was conducted after obtaining informed consent from the patients and was approved by Ethics Committee.

Ethical statement

All procedures were performed in compliance with relevant laws and Institutional guidelines. Informed consent was obtained from all patients. No experimentation on human subjects was done.

Declaration of generative AI and AI-assisted technologies in the writing process

None declared.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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