



Research Article

Diagnostic yield and efficacy of Endoscopic Ultrasound-Guided Fine-Needle Aspiration in Mediastinal and Abdominal Lymphadenopathy: An exploratory descriptive study

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ABSTRACT

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Background: Mediastinal and abdominal lymphadenopathy encompass a broad spectrum of benign and malignant conditions, including reactive lymphadenitis, granulomatous diseases such as tuberculosis and sarcoidosis, as well as lymphoproliferative or metastatic malignancies. Establishing a definitive tissue diagnosis is critical for guiding management; however, conventional surgical biopsy techniques are invasive and associated with higher morbidity. Endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA), with or without fine-needle biopsy (EUS-FNB), provides a minimally invasive alternative for sampling deep-seated lymph nodes.

Objectives: To evaluate the procedure-based diagnostic yield and pathological spectrum of mediastinal and abdominal lymphadenopathy assessed using EUS-guided lymph node sampling, and to examine the incremental diagnostic contribution of adjunctive EUS-FNB.

Methods: This retrospective single-center cross sectional study included 71 patients who underwent 92 EUS-guided lymph node sampling procedures between January 2023 and December 2025. Demographic, clinical, imaging, procedural, and pathological data were analyzed. Diagnostic yield was defined on a procedure basis as the proportion of procedures providing a definitive or clinically actionable diagnosis. Comparative analysis between EUS-FNA alone and combined EUS-FNA with EUS-FNB was performed.

Results: A definitive or clinically actionable diagnosis was established in 80 of 92 procedures, resulting in an overall procedure-based diagnostic yield of 87.0%. The diagnostic yield of EUS-FNA alone was 80.4%, which increased to 87.0% with the adjunctive use of EUS-FNB. Granulomatous lymphadenitis was the most frequent diagnosis, with tuberculosis and sarcoidosis constituting the majority of cases. Malignant etiologies included adenocarcinoma, non-Hodgkin lymphoma, neuroendocrine neoplasms, and other metastatic malignancies. The incremental benefit of EUS-FNB was particularly evident in cases requiring preservation of tissue architecture, such as lymphoproliferative disorders. No major procedure-related complications were observed.

Conclusion: EUS-guided lymph node sampling is a safe and highly effective minimally invasive diagnostic modality for mediastinal and abdominal lymphadenopathy. The selective incorporation of EUS-FNB enhances diagnostic yield, particularly in conditions requiring histoarchitectural assessment, and may reduce the need for more invasive surgical procedures.

Keywords: Endoscopic ultrasound; EUS-FNA; EUS-FNB; Lymphadenopathy; Mediastinal lymph nodes; Abdominal lymph nodes; Granulomatous lymphadenitis; Tuberculosis; Sarcoidosis; Lymphoma.

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INTRODUCTION

Lymphadenopathy involving mediastinal and abdominal lymph nodes constitutes a significant diagnostic challenge due to the wide spectrum of underlying etiologies, ranging from benign reactive hyperplasia and granulomatous diseases such as tuberculosis and sarcoidosis to malignant conditions including lymphoma and carcinomas. Establishing an accurate tissue diagnosis is essential, as treatment strategies and prognostic implications differ substantially across these conditions. While cross-sectional imaging modalities such as ultrasonography, computed tomography (CT), and magnetic resonance imaging (MRI) are valuable for detecting and characterizing lymph node enlargement, they are limited in their ability to reliably differentiate benign from malignant causes or provide definitive pathological diagnosis [1].

Traditionally, tissue acquisition from mediastinal and deep abdominal lymph nodes required invasive surgical procedures such as mediastinoscopy, laparoscopy, or open biopsy. Although these methods offer diagnostic accuracy, they are associated with higher morbidity, increased healthcare costs, and limited applicability in patients with significant comorbidities. Consequently, there has been a growing demand for minimally invasive techniques that can provide reliable tissue diagnosis with lower procedural risk [2].

Endoscopic ultrasound (EUS) has emerged as a pivotal tool in the evaluation of lesions adjacent to the gastrointestinal tract. Since its introduction in the early 1990s, EUS-guided fine-needle aspiration (EUS-FNA) has revolutionized diagnostic strategies by allowing real-time ultrasound-guided sampling of deep-seated lymph nodes and masses through the esophageal or gastric wall [3]. This technique enables cytological evaluation and, when combined with ancillary methods such as cell block preparation, immunohistochemistry, and molecular studies, provides valuable diagnostic information across a wide range of pathological entities.

EUS-FNA has been extensively studied in the evaluation of mediastinal lymphadenopathy, particularly in the context of lung cancer staging and unexplained lymph node enlargement. Multiple studies have demonstrated that EUS-FNA offers high diagnostic accuracy for mediastinal lymph nodes, especially those located in the subcarinal, paraesophageal, and posterior mediastinal regions, often obviating the need for surgical staging procedures [4]. In addition to malignancy, EUS-FNA has proven effective in diagnosing granulomatous disorders, with several studies reporting high yields for the detection of non-caseating granulomas in patients with suspected sarcoidosis and necrotizing granulomas in tuberculosis-endemic regions [5].

The utility of EUS-FNA extends beyond the mediastinum to include abdominal and peripancreatic lymphadenopathy. Studies focusing on intra-abdominal lymph nodes have shown that EUS-FNA is a safe and effective modality for differentiating malignant from benign lymphadenopathy, with reported sensitivities and specificities exceeding 85–90% in many series [6]. Furthermore, meta-analyses have confirmed the high pooled diagnostic performance of EUS-FNA in abdominal lymphadenopathy, reinforcing its role as a first-line diagnostic approach in appropriate clinical settings [7].

Despite these advantages, limitations remain, particularly in the evaluation of lymphoproliferative disorders where architectural preservation is often required for definitive classification. The introduction of EUS-guided fine-needle biopsy (EUS-FNB) has partially addressed this limitation by providing core tissue suitable for histopathological and immunophenotypic analysis. Nevertheless, EUS-FNA continues to play a central role in the diagnostic algorithm of lymphadenopathy due to its safety, accessibility, and high diagnostic yield. In this retrospective study, we aimed to evaluate the diagnostic yield of EUS-guided fine-needle aspiration in mediastinal and abdominal lymphadenopathy over a three-year period.

MATERIALS AND METHODS

Study Design and Setting

This retrospective single-center cross-sectional study was conducted at the Department of Pathology, Believers Church Medical College Hospital, a tertiary care referral center. The study included patients who underwent endoscopic ultrasound-guided lymph node sampling for mediastinal or abdominal lymphadenopathy between January 2023 and December 2025.

Study Population

All consecutive patients with radiologically detected mediastinal or abdominal lymphadenopathy who underwent EUS-guided sampling during the study period were included. Patients were referred for EUS-FNA/FNB based on clinical suspicion of malignancy, granulomatous disease, lymphoma, or unexplained lymph node enlargement.

Inclusion Criteria

- Patients of all age groups and both sexes
- Presence of mediastinal and/or abdominal lymphadenopathy on imaging
- Underwent EUS-FNA with or without EUS-FNB

Exclusion Criteria

- Patients with incomplete clinical or pathological data
- Post treatment in an already known case.
- Poorly preserved or inadequate aspirate samples

- No material even after repeat procedures on the same lymph node during the study period

Data Collection

Clinical data were retrieved from hospital electronic medical records and pathology databases. The following parameters were collected:

- Demographic details (age, sex)
- Relevant clinical history and indications for EUS
- Imaging findings (site, size, and number of lymph nodes on EUS/USG)
- Procedural details (EUS-FNA alone or EUS-FNA with FNB)
- Cytopathological and histopathological diagnoses
- Procedure-related complications, if any

EUS-Guided Sampling Technique

All procedures were performed by experienced Gastroenterologists using a linear-array echoendoscope under conscious sedation. Mediastinal lymph nodes were accessed via the esophagus, while abdominal lymph nodes were sampled transgastrically or transduodenally depending on their anatomical location.

Fine-needle aspiration was performed using standard EUS-FNA needles, and multiple passes were made at the discretion of the endoscopist to ensure adequate sampling. In selected cases, EUS-guided fine-needle biopsy (FNB) was performed using core biopsy needles, particularly when lymphoma, granulomatous disease, or fibrotic lesions were suspected.

Cytopathological and Histopathological Evaluation

Aspirated material was smeared onto glass slides and stained using standard cytological stains. Cell block preparation was performed wherever feasible. Core biopsy specimens obtained by EUS-FNB were fixed in formalin and processed for histopathological examination.

Ancillary studies, such as immunohistochemistry (IHC), was performed when indicated, particularly in cases suspicious for lymphoma, metastatic malignancy, or IgG4-related disease. Cytological diagnoses were categorized as:

- Granulomatous lymphadenitis
- Reactive lymphadenitis
- Malignancy (carcinoma or sarcoma)
- Lymphoproliferative disorder/lymphoma
- Non-diagnostic

Where available, cytological findings were correlated with histopathology or clinical follow-up to assess diagnostic concordance.

Outcome Measures

The primary outcome was procedure-based diagnostic yield, defined as the proportion of EUS-guided sampling procedures that resulted in a definitive or clinically actionable diagnosis.

The secondary outcome was patient-based diagnostic yield, defined as the proportion of patients in whom EUS-guided sampling established a definitive or clinically actionable diagnosis during the diagnostic workup.

Statistical Analysis

Data were analyzed using descriptive statistical methods. Categorical variables were expressed as frequencies and percentages. Diagnostic yield was calculated as the proportion of diagnostic or clinically actionable cases relative to the total number of procedures performed. Both patient-based and procedure-based analyses were conducted. A separate comparison of diagnostic yield between EUS-FNA alone and EUS-FNA combined with FNB was performed, including year-wise evaluation from 2023 to 2025 to assess the incremental diagnostic benefit associated with the addition of FNB. Data analysis was done in IBM SPSS Statistics (V21.0).

Ethical Considerations

Approval was obtained from the Institutional Ethics Committee.

RESULTS

Study Population

Over the three-year study period, a total of 71 patients with suspected mediastinal or intra-abdominal lymphadenopathy underwent endoscopic ultrasound-guided tissue acquisition. A total of 92 EUS-guided sampling procedures (EUS-FNA with or without EUS-FNB) were performed during this period, as some patients required sampling of multiple nodal stations or repeat procedures. Patients were evaluated for clinical suspicion of granulomatous disease, malignancy, lymphoma, or unexplained lymph node enlargement.

Demographic Characteristics

The age of the study population ranged from 14 to 83 years, with a mean \pm SD of 58.99 ± 15.02 years. The majority of patients were concentrated in the sixth to eighth decades of life, indicating a predominance of the disease among older adults. The largest proportion of patients belonged to the 61–80 years age group ($n = 36$), followed by those aged 41–60 years ($n = 22$). There was a slight male predominance overall, with 35 females (49.3%) and 36 males (50.7%). Female representation was particularly notable in the older age groups, whereas males were more evenly distributed across age categories. The detailed age- and sex-wise distribution is summarized in Table 1.

Age Group (years)	Total Patients n (%)	Male n (%)	Female n (%)
≤ 20	1 (1.4%)	0 (0.0%)	1 (100%)
21–40	9 (12.7%)	5 (55.6%)	4 (44.4%)
41–60	22 (31.0%)	10 (45.5%)	12 (54.5%)
61–80	36 (50.7%)	18 (50.0%)	18 (50.0%)
>80	3 (4.2%)	3 (100%)	0 (0.0%)
Total	71 (100%)	36 (50.7%)	35 (49.3%)

Table 1: Gender Distribution across the study samples

Distribution of Lymph Node Sites

A total of 92 lymph nodes were sampled, comprising 46 intra-abdominal lymph nodes and 46 intrathoracic (mediastinal) lymph nodes. Mediastinal lymph nodes included subcarinal, paratracheal, and paraesophageal stations, while abdominal lymph nodes included periportal, peripancreatic, perigastric, para-aortic, and celiac axis nodes. EUS allowed safe and effective access to all nodal stations. The table 2 listed out the site of lymph nodes.

Lymph Node Location	Specific Stations	Number of Nodes (n)
Intrathoracic (Mediastinal)	Subcarinal, Paratracheal, Paraesophageal	46
Intra-abdominal	Periportal, Peripancreatic, Perigastric, Para-aortic, Celiac axis	46

Table 2: Anatomical distribution of mediastinal and intra-abdominal lymph nodes sampled using endoscopic ultrasound-guided techniques.

Diagnostic Adequacy

Among 71 patients who underwent EUS-guided lymph node sampling, a definitive or clinically actionable diagnosis was established in 64 patients, corresponding to a patient-based diagnostic yield of 90.1%. Non-diagnostic results occurred in 7 (9.85%) patients.

Diagnostic Yield

A total of 92 EUS-guided sampling procedures were performed. Of these, 80 procedures yielded a definitive or clinically actionable diagnosis, corresponding to a procedure-based diagnostic yield of 87.0%. Year-wise analysis demonstrated progressive improvement in diagnostic yield with the adjunctive use of EUS-FNB. The highest yield was observed in 2025 (93.5%), compared to 76.1% with FNA alone during the same period.

Parameter	FNA Alone	FNA + FNB
Total Procedures	92	92
Diagnosed Cases	74	80
Non-diagnostic	18	12
Diagnostic Yield (%)	80.4%	87.0%

Table 3: Diagnostic Performance of EUS-FNA Alone Versus EUS-FNA Combined with EUS-FNB

The overall diagnostic yield of EUS-FNA alone was 80.4%, whereas the combined use of EUS-FNA with EUS-FNB demonstrated a higher diagnostic yield of 87.0%.

Spectrum of Diagnoses

Granulomatous pathology constituted a substantial proportion of diagnoses obtained by EUS-guided lymph node sampling. Granulomatous lymphadenitis was identified in 36 cases (50.7%), with tuberculosis diagnosed in 16 cases (22.5%) and sarcoidosis in 18 cases (25.4%). Tuberculous lymphadenitis was characterized by necrotizing or suppurative granulomas, whereas sarcoidosis was diagnosed based on the presence of non-necrotizing granulomas in conjunction with compatible clinical, serological and radiological findings. In addition, ill-formed or non-specific granulomatous inflammation was observed in a small subset of cases and categorized separately when a definitive etiological diagnosis could not be established.

Malignancy accounted for 21 cases (29.6%), representing the second most common diagnostic category. Among malignant lesions, adenocarcinoma (primary or metastatic) was the most frequent subtype (n = 8), followed by non-Hodgkin lymphoma (n = 7), which included both low-grade and high-grade B-cell lymphomas. Neuroendocrine neoplasms were identified in 4 cases, while other rare malignancies, including plasma cell neoplasm and carcinosarcoma, were diagnosed in 2 cases. In cases of lymphoma and selected malignancies, the diagnosis was supported by immunohistochemistry, wherever available.

Reactive or benign lymphadenitis was reported in 5 cases (7.0%), in which cytological and histopathological features were non-neoplastic and showed concordance with clinical and imaging findings. IgG4-related disease or autoimmune pancreatitis was diagnosed in 2 cases (2.8%), based on characteristic histopathological features along with appropriate clinical correlation. Despite adequate sampling, 7 cases (9.9%) remained non-diagnostic or indeterminate, primarily due to insufficient tissue yield or non-specific morphological findings, which precluded definitive pathological classification.

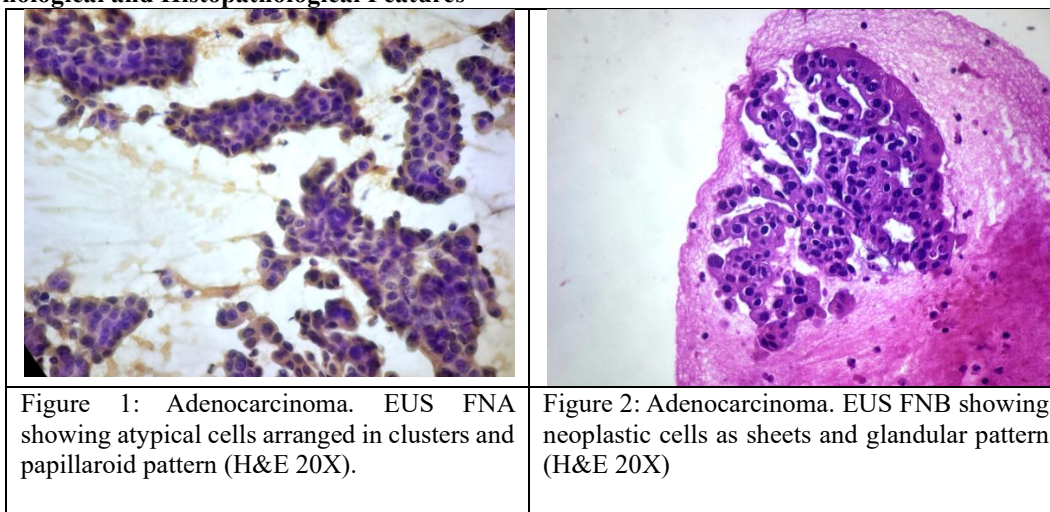
Diagnosis Category	2023 n	2024 n	2025 n	Total n (%)
Tuberculosis	2	6	8	16 (22.5%)
Sarcoidosis	5	6	7	18 (25.4%)
Others**	0	0	2	2 (2.8%)
Malignancy – Total	1	6	14	21 (29.6%)
• Adenocarcinoma	1	3	4	8 (11.3%)
• Non-Hodgkin lymphoma	0	2	5	7 (9.9%)
• Neuroendocrine neoplasm	0	0	4	4 (5.6%)
• Other malignancies*	0	1	1	2 (2.8%)
Reactive / Benign lymphadenitis	0	4	1	5 (7.0%)
IgG4-related disease / Autoimmune pancreatitis	0	0	2	2 (2.8%)
Non-diagnostic / Indeterminate	3	1	3	7 (9.9%)
Total	11	23	37	71 (100%)

**Others are granulomas which could not be categorized

*Other malignancies include plasma cell neoplasm and carcinosarcoma.

Table 4: Distribution of the pathological diagnosis obtained by the endoscopic ultrasound guided lymph node sampling.

Cytomorphological and Histopathological Features



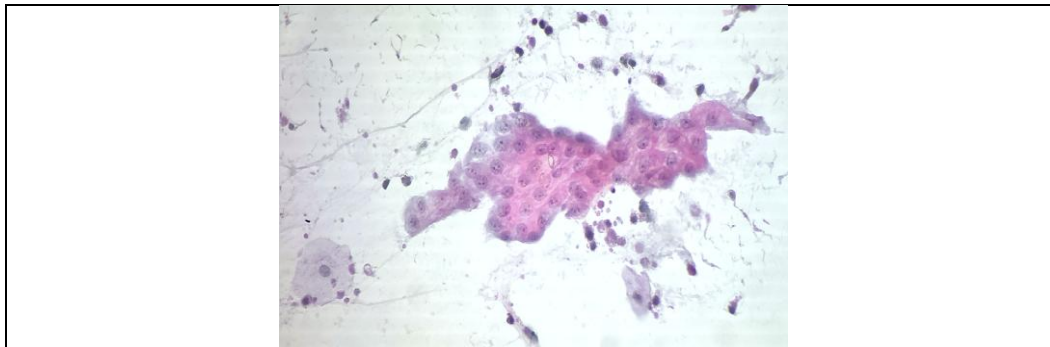


Figure 3: EUS FNA of Neuroendocrine carcinoma - Shows clusters of atypical cells with stippled chromatin (H&E 20X).

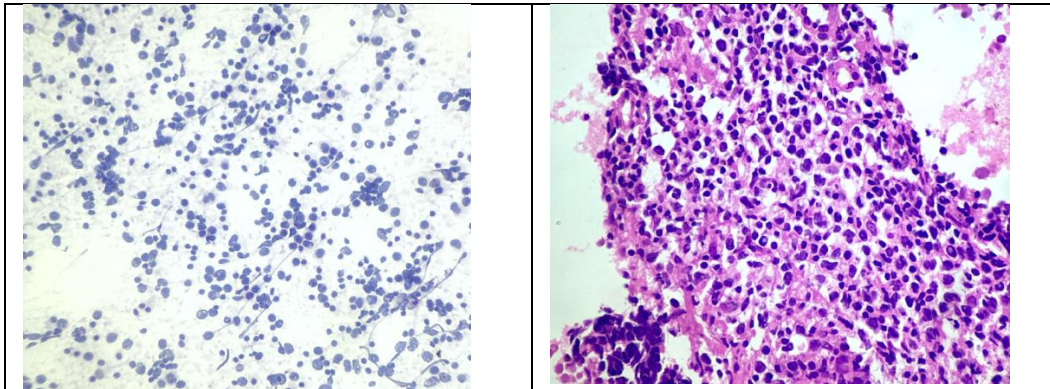


Figure 4: EUS FNA (Left) & FNB (Right) – Lymphoproliferative disorder Shows sheets of atypical lymphoid cells (H&E 20X).

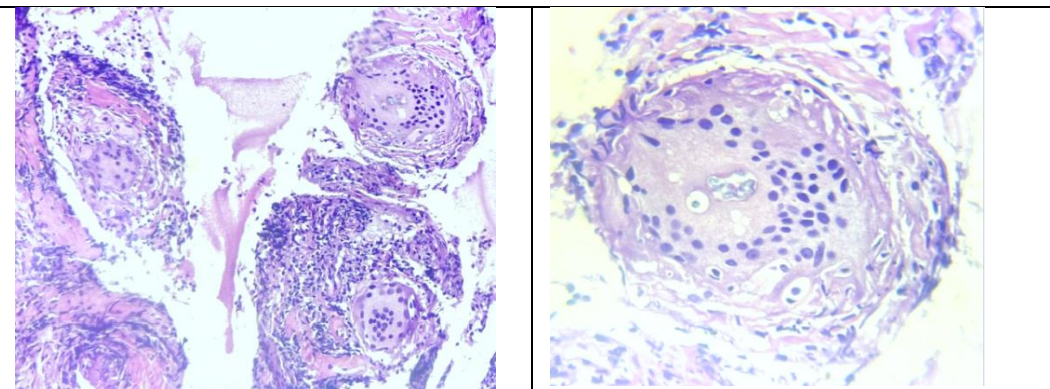
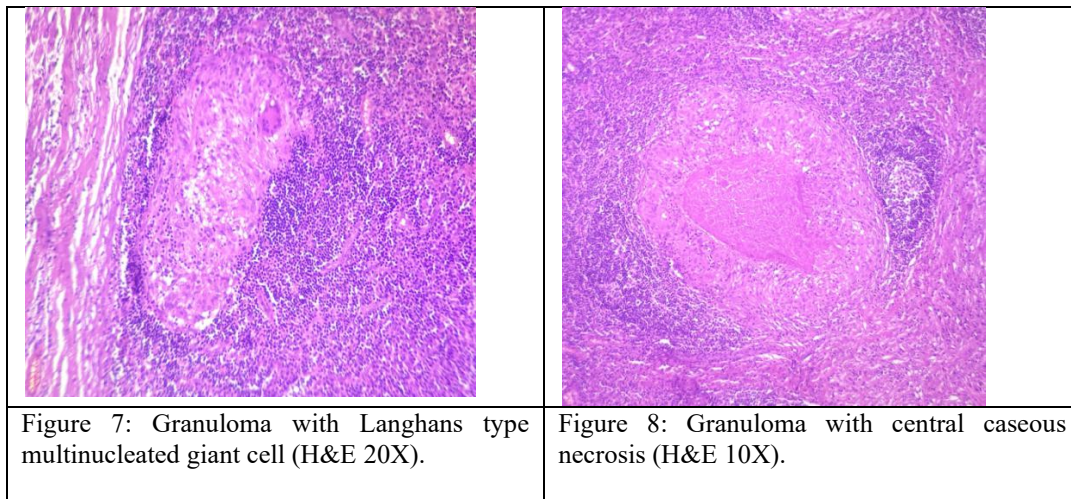


Figure 5: EUS FNB showing granulomas with multinucleated giant cells (H&E 20X).

Figure 6: Multinucleated giant cell with Schaumann bodies in case of Sarcoidosis, (H&E 40X).



Representative cytological and histopathological images obtained from EUS-guided lymph node sampling are illustrated in Figure 1-8.

Adenocarcinoma cases demonstrated cohesive clusters and papillary arrangements of atypical epithelial cells on EUS-FNA, while corresponding EUS-FNB specimens showed glandular architecture with improved preservation of tissue structure. Neuroendocrine neoplasms exhibited characteristic cytological features including loosely cohesive clusters of atypical cells with stippled chromatin.

Lymphoproliferative disorders were characterized by sheets of atypical lymphoid cells, with FNB specimens providing better architectural preservation. Granulomatous lymphadenitis showed aggregates of epithelioid histiocytes on cytology, while core biopsy specimens demonstrated well-formed granulomas with multinucleated giant cells. Cases of sarcoidosis showed non-caseating granulomas with Schaumann bodies, whereas tuberculous lymphadenitis demonstrated caseating granulomas with Langhans-type giant cells.

Safety Outcomes

No major procedure-related complications such as bleeding, perforation, or infection were documented. All procedures were well tolerated, underscoring the safety of EUS-guided lymph node sampling.

Summary of Findings

In this study, EUS-guided lymph node sampling demonstrated a high overall procedure-based diagnostic yield of 87.0% in the evaluation of mediastinal and abdominal lymphadenopathy. The technique was particularly effective in diagnosing granulomatous diseases and malignant conditions, reflecting its utility in both infectious and neoplastic etiologies. Comparative analysis showed that the addition of EUS-FNB improved diagnostic performance over FNA alone (87.0% vs 80.4%), with the greatest incremental benefit observed in later years of the study. These findings support the adjunctive role of FNB in cases requiring preservation of tissue architecture, especially lymphomas and fibrotic or complex granulomatous lesions.

DISCUSSION

In this retrospective study, EUS-guided lymph node sampling demonstrated a patient-based diagnostic yield of 90.14%, with particularly high utility in the diagnosis of granulomatous and malignant lymphadenopathy. Overall, EUS-FNA with or without FNB demonstrated a high diagnostic yield with minimal procedural risk, reinforcing its role as a first-line, minimally invasive diagnostic modality for mediastinal and intra-abdominal lymphadenopathy.

The predominance of granulomatous lymphadenitis in our cohort, particularly tuberculosis and sarcoidosis, is consistent with observations from TB-endemic regions. Similar findings have been reported by Junare et al. [8], who demonstrated that granulomatous disease constituted the majority of mediastinal lymphadenopathy cases evaluated by EUS-guided sampling in the Indian subcontinent. In contrast, studies from Western populations have reported a relatively higher proportion of malignant etiologies, underscoring the influence of geographic and epidemiological factors on disease prevalence and diagnostic yield.

The diagnostic performance of EUS-FNA observed in our study aligns well with prior large series and meta-analyses. Wang W et al. [9], in a comprehensive meta-analysis, reported pooled sensitivities exceeding 90% for EUS in evaluating lymphadenopathy, with high specificity for distinguishing malignant from benign nodes. Similarly, Annema et al. [10] demonstrated that EUS-FNA provides excellent diagnostic accuracy for mediastinal lymph nodes, significantly reducing the need for invasive surgical staging procedures such as mediastinoscopy. The present study further evaluated procedure-based diagnostic performance and demonstrated an overall 6.6% absolute improvement in diagnostic yield with the addition of FNB (87.0%) compared to FNA alone (80.4%). Although year-wise variability was observed, the cumulative trend

supports the adjunctive value of FNB, particularly in complex or architecturally dependent diagnoses such as lymphoma and fibrotic granulomatous lesions.

EUS-FNA has also been well validated in the diagnosis of sarcoidosis. VonBartheld et al. [11] showed that EUS-FNA reliably identifies non-caseating granulomas in patients with suspected sarcoidosis, particularly following non-diagnostic bronchoscopy. Our findings corroborate these results, with sarcoidosis being consistently diagnosed across the study period, highlighting the value of EUS-guided sampling in granulomatous disorders.

Lymphoproliferative disorders remain a diagnostic challenge when using cytology alone due to the need for architectural preservation and immunophenotypic characterization. In our series, lymphoma accounted for a notable proportion of malignant diagnoses, with EUS-FNB improving diagnostic confidence through the acquisition of core tissue. This observation is supported by Swerdlow et al. [12], who emphasized the importance of histological architecture and immunohistochemistry for accurate lymphoma classification in the WHO classification of lymphoid neoplasms.

Recent comparative studies have highlighted the incremental benefit of EUS-FNB over FNA in lymph node sampling. Facciorusso et al. [13], in a systematic review and meta-analysis, reported superior specimen adequacy and diagnostic accuracy with FNB, particularly for lymphoma and benign fibrotic or granulomatous lesions. Our observation of fewer non-diagnostic samples with EUS-FNB compared to EUS-FNA mirrors these findings and supports the selective use of FNB in cases where cytology alone may be insufficient.

Regarding safety, our study reported no major procedure-related complications, consistent with previously published literature. Vilmann et al. [14] and subsequent large series have demonstrated that EUS-guided tissue acquisition is associated with a low complication rate, further supporting its routine use in the evaluation of deep-seated lymphadenopathy.

The principal strengths of this study include its real-world clinical setting, inclusion of both mediastinal and abdominal lymph nodes, and evaluation of both EUS-FNA and EUS-FNB techniques over an extended period. However, limitations include its retrospective design, lack of histopathological confirmation for all cases, and potential referral bias inherent to tertiary care centers.

Our findings are consistent with and complementary to previously published studies, confirming that EUS-guided lymph node sampling is a highly effective, safe, and minimally invasive diagnostic tool. The addition of EUS-FNB enhances diagnostic yield in selected cases, particularly for lymphoproliferative and fibrotic granulomatous disorders, and should be considered when architectural assessment is required.

CONCLUSION

This study demonstrates that EUS-guided fine-needle aspiration provides a high patient-based diagnostic yield of 90.14% in mediastinal and abdominal lymphadenopathy, with an excellent safety profile. The procedure yielded a high proportion of definitive or clinically actionable diagnoses, thereby substantially reducing the need for more invasive surgical interventions. Granulomatous lymphadenitis, particularly tuberculosis and sarcoidosis, was the most frequent pathological finding, reflecting regional epidemiological trends, while a significant proportion of cases were attributable to malignant etiologies, including primary and metastatic carcinomas as well as lymphoproliferative disorders.

In addition, procedure-based analysis demonstrated that the adjunctive use of EUS-FNB improved overall diagnostic yield from 80.4% with FNA alone to 87.0% with combined FNA+FNB, with the greatest benefit observed in later years of the study. These findings highlight the complementary role of FNB, particularly in conditions requiring preservation of tissue architecture, such as lymphoma and fibrotic or complex granulomatous lesions.

Importantly, EUS-guided sampling was associated with an excellent safety profile, with no major complications observed, supporting its routine clinical application. Despite limitations related to its retrospective design and selective use of FNB, the findings are consistent with existing literature and reinforce the role of EUS-guided tissue acquisition as a first-line diagnostic modality for unexplained mediastinal and abdominal lymphadenopathy. Selective incorporation of FNB may further optimize diagnostic performance where histological architecture is required.

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