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Original Article

Pulmonologist-performed Ultrasound-guided Transthoracic Biopsy of Pleural-based Lung Masses: Diagnostic Yield and Safety, a Retrospective Study

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ABSTRACT

OBJECTIVE: Ultrasound-guided transthoracic lung biopsy is a well-established, minimally invasive technique for evaluating peripheral and pleural-based lung lesions. Its use by trained pulmonologists has expanded in recent years; however, evidence from tuberculosis-endemic regions remains limited. This study aimed to assess the diagnostic yield and safety profile of pulmonologist-performed ultrasound-guided transthoracic biopsy of pleural-based lung masses.

MATERIAL AND METHODS: This retrospective study included patients who underwent ultrasound-guided transthoracic biopsy of pleural-based lung lesions. Of 129 eligible patients, 6 did not undergo the procedure, and 7 were excluded because histopathology was unavailable, resulting in 116 patients included in the final analysis. All biopsies were performed by pulmonologists who had formal interventional pulmonology training or who were under direct supervision. Diagnostic yield, histopathological findings, and procedure-related complications were evaluated.

RESULTS: The overall diagnostic yield was 97.4% (113/116). Malignancy was identified in 72.4% of patients, with adenocarcinoma (39.7%) as the most frequent subtype, followed by squamous cell carcinoma (15.5%). Tuberculosis was diagnosed in 9.5% of cases, while 2.6% remained inconclusive. Notably, 29.3% of patients were already receiving anti-tuberculosis therapy at presentation. The overall complication rate was 10.3%. Pneumothorax occurred in 3.4% of patients, and minor hemoptysis occurred in 2.6%; all events were managed conservatively. No procedure-related mortality was recorded.

CONCLUSION: Pulmonologist-performed ultrasound-guided transthoracic biopsy of pleural-based lung lesions yields high diagnostic yield with a low complication rate when conducted by formally trained operators. In tuberculosis-endemic settings, histopathological confirmation is critical to differentiate malignancy from infectious etiologies. Structured interventional pulmonology training may further optimize procedural outcomes and enhance patient safety.

KEYWORDS: Ultrasound-guided biopsy, transthoracic lung biopsy, interventional pulmonology, pleural-based lung mass, diagnostic yield, pneumothorax, lung cancer, tuberculosis, safety

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INTRODUCTION

Pleural-based lung masses are commonly encountered in clinical practice and may represent primary malignancy, metastatic disease, tuberculosis, or benign inflammatory conditions. Establishing an accurate tissue diagnosis is crucial to guide appropriate therapeutic decision-making.[1,2]

Computed tomography (CT)-guided transthoracic biopsy has traditionally been the preferred technique for sampling peripheral lung lesions because of its high diagnostic accuracy. However, this approach is associated with radiation exposure, higher costs, and reliance on radiology infrastructure and personnel.[3] In contrast, ultrasound-guided transthoracic biopsy offers a real-time, radiation-free, and cost-effective alternative, particularly for pleural-based lesions that abut the chest wall.[4]

Previous studies have reported diagnostic yields ranging from 80% to 95%, with low complication rates, most commonly pneumothorax and hemoptysis.[4,5] Although the majority of published data pertain to procedures performed by radiologists, emerging evidence suggests that pulmonologists can achieve comparable diagnostic performance and safety outcomes.[6,7]

Given the expanding scope of interventional pulmonology, further evaluation of the effectiveness and safety of pulmonologist-performed ultrasound-guided transthoracic lung biopsy is warranted. Accordingly, we conducted this retrospective study to assess the diagnostic yield and complication profile of ultrasound-guided biopsy, performed by pulmonologists, of pleural-based lung masses at a tertiary care center.

MATERIAL AND METHODS

Study Design and Setting

This retrospective observational study was conducted in the Department of Pulmonary Medicine at a tertiary care teaching hospital in North India. All consecutive patients who underwent ultrasound-guided transthoracic biopsy for pleural-based lung masses between 1 January 2024 and 31 December 2025 were included in the study.

The study was approved by the Dr. Ram Manohar Lohia Institute of Medical Sciences Ethics Committee (IEC no: 168/25 dated 30.01.2026).

Main Points

- Ultrasound-guided transthoracic biopsy is a highly effective and safe method for diagnosing pleural-based lung masses when performed by trained pulmonologists.
- Early histopathological confirmation is crucial, particularly in tuberculosis-endemic regions, to avoid misdiagnosis and inappropriate empirical treatment.
- Proper training in interventional pulmonology and real-time ultrasound guidance significantly enhance diagnostic accuracy and minimize complications.
- As this was a retrospective analysis of anonymized data, the requirement for informed consent for study participation was waived. However, written procedural consent had been obtained from the patients or their legally authorized representatives at the time of the procedure.

Study Population (Table 1)

Inclusion criteria

- Adult patients (≥18 years).
- Presence of a pleural-based lung mass abutting the chest wall on imaging.
- Cases in which a definitive diagnosis could not be established by non-invasive methods.
- All consecutive patients with peripheral lung masses who underwent ultrasound-guided transthoracic lung biopsy during the study period.

Exclusion criteria

- Lesions not accessible by ultrasound guidance.
- Uncorrected coagulopathy (international normalized ratio >3 or platelet count <50,000/mm^3).
- Incomplete medical records.
- Cases in which biopsy samples could not be submitted for histopathological or microbiological evaluation.
- Reports that were unavailable or uninterpretable due to reasons such as inadequate sample, specimen loss, or processing errors.
- Patients who did not provide informed consent for procedure.

Procedure Technique

All procedures were performed by pulmonologists with formal training in interventional pulmonology (Doctorate of Medicine Pulmonary Medicine) or with documented prior experience in ultrasound-guided thoracic interventions. The biopsy was either performed directly by these trained pulmonologists or conducted under their strict real-time supervision.

Pre-procedure imaging, including chest radiography and CT of the thorax, was reviewed to confirm pleural contact with the lesion and to determine the optimal entry site (Figure 1).

Ultrasound-guided transthoracic lung biopsies were performed as part of routine clinical care in a dedicated procedure room. Written informed consent was obtained from the patient or their legal guardian prior to the procedure. Intravenous access was secured, and continuous monitoring of vital parameters—including pulse rate, blood pressure, and oxygen saturation—was maintained throughout the procedure.

Thoracic ultrasound was performed using a high-frequency linear or curvilinear transducer. The lesion was localized, and its size, depth, and vascularity were assessed (Figure 2). The biopsy site was marked and prepared under strict aseptic precautions. Local anesthesia was administered by infiltrating 10–15 mL of 1% lidocaine to the level of the parietal pleura. A 16-gauge tru-cut biopsy needle was used to obtain multiple core tissue samples under real-time ultrasound guidance (Figures 3 and 4).

Table 1. STROBE flow diagram of patient inclusion and exclusion

Stage	n	Details
Total patients eligible for USG-guided lung biopsy	129	
Biopsy not performed	6	No consent (n = 2) for procedure TB confirmed on sputum (n = 1) Lidocaine hypersensitivity (n = 1) Lesion not visualized due to scapular shadow (n = 2)
Patients who underwent USG-guided biopsy	123	
Excluded after biopsy	7	Histopathology reports not traceable despite best efforts
Patients included in final analysis	**116**	

USG: Ultrasonography

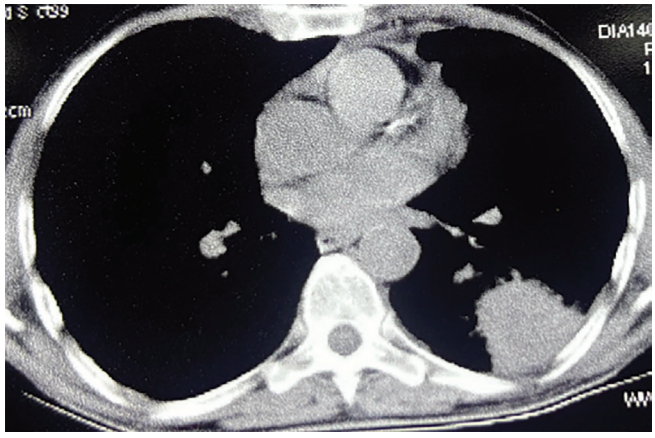

Figure 1. Computed tomography thorax showing pleural-based lung mass in left lower lobe

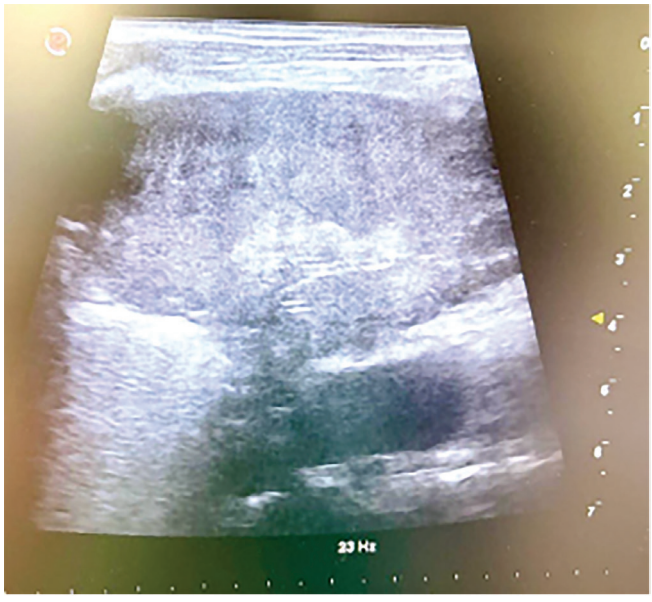

Figure 2. Ultrasound showing pleural-based hyperechoic shadow suggestive of a lung mass

Biopsy specimens were preserved in formalin for histopathological examination, and in normal saline for GeneXpert testing and for acid-fast bacilli mycobacterial growth indicator tube culture. A chest radiograph was obtained 2 hours after the procedure, or earlier if clinically indicated, to evaluate for pneumothorax or other complications.

Figure 3. 16-gauge biopsy gun with needle

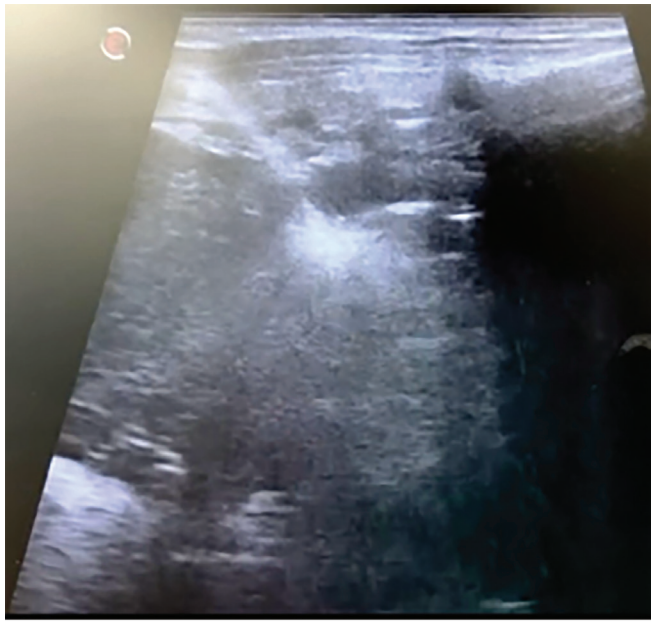

Figure 4. Needle tracking inside lung mass while performing ultrasound guided biopsyguided biopsy

Outcome Measures

Primary outcome

- **Diagnostic yield:** Defined as the proportion of biopsies that provided a definitive pathological diagnosis.

Secondary outcomes

- **Complication rate:** Including pneumothorax, hemoptysis, chest pain, vasovagal episodes, and requirement for any medical or interventional management.
- **Tissue adequacy:** Assessment of whether the biopsy specimen was sufficient for histopathological examination.

Data Collection

Demographic data, radiological characteristics (including lesion size and location), number of biopsy passes, histopathological findings, and procedure-related complications were extracted from medical records using a structured data collection form.

Statistical Analysis

Data were analyzed using SPSS version 25 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation or median (interquartile range), as appropriate, while categorical variables were presented as frequencies and percentages.

RESULTS

A total of 129 patients were screened during the study period; biopsy was not performed in six. Of the 123 patients who underwent ultrasound-guided transthoracic biopsy, seven were excluded due to unavailable histopathology reports. Ultimately, 116 patients were included in the analysis (Table 1).

The mean age of the study population was 55.15 ± 5.6 years (range 18–85 years), and the majority were male (78.4%). Tobacco exposure was common, with 58.6% reporting tobacco chewing, 24.1% reporting current smoking, and 20.7% reporting former smoking. Alcohol consumption was noted in 27.6% of patients.

Hypertension (23.3%) and diabetes mellitus (18.1%) were the most frequent comorbidities. A prior history of anti-tuberculosis therapy (ATT) was present in 17.2% of patients, while 29.3% of patients were on ATT for the same lesion at presentation. A small proportion had underlying extrapulmonary malignancies (Table 2).

Lesions were more frequently located in the right lung (48.3%) than in the left lung (41.4%); 10.3% involved the mediastinum (Table 1). On ultrasonography, 54.3% of lesions were located at a depth greater than 4 cm from the skin surface. Pleural contact exceeding 3 cm was observed in a substantial proportion of lesions. The majority (70.7%) exhibited heterogeneous echotexture, including areas of necrosis (Table 3).

Histopathological examination revealed malignancy in 84 patients (72.4%). Adenocarcinoma was the most common subtype (39.7%), followed by squamous cell carcinoma (15.5%) and small cell carcinoma (5.2%). Other malignant diagnoses included lymphomas and sarcomas. Non-malignant lesions were identified in 29 patients (27.6%), with tuberculosis accounting for 9.5% and organizing pneumonia for 7.8%. Three cases (2.6%) were inconclusive (Table 4). In the three cases that remained inconclusive (2.6%), a repeat ultrasound-guided lung biopsy was performed. However, the repeat histopathology was again non-diagnostic, showing either fibrosis or normal lung tissue with fibrotic bands. These patients were subsequently kept under clinical and radiological observation without further invasive investigation. At three-month follow-up imaging, the lesions remained stable or showed slight regression, and no clinical progression was noted.

Table 2. Baseline epidemiological and clinical profile of patients

Parameters	n = 116 n (%)
Age	
Mean ± SD	55.15±5.6
Range (years)	18–85
Sex	
Male	91 (78.4%)
Female	25 (21.6%)
Addiction	
Ex smoker	24 (20.7%)
Current smoker	28 (24.1%)
Tobacco chewer	68 (58.6%)
Alcoholic	32 (27.6%)
Comorbidity	
Diabetes	21 (18.1%)
Hypertension	27 (23.3%)
Coronary artery disease	12 (10.3%)
Chronic kidney disease	8 (6.9%)
Chronic liver disease	3 (2.6%)
Anti-tuberculosis therapy (ATT) status	
Past history of ATT	20 (17.2%)
Currently on ATT for same lesion	34 (29.3%)
Underlying malignancy	
Lung carcinoma	8 (6.9%)
Breast carcinoma	3 (2.6%)
Gastrointestinal tract malignancy	2 (1.7%)
Buccal mucosa carcinoma	2 (1.7%)
Genitourinary carcinoma	1 (0.9%)
Location of mass	
Left lung	48 (41.4%)
Right lung	56 (48.3%)
Mediastinum	12 (10.3%)
Peripheral <1/3rd area	35 (30.2%)
Peripheral <2/3rd area	28 (24.1%)
Peripheral >2/3rd area	25 (21.6%)
Extends from hilum to peripheral	16 (13.8%)

SD: Standard deviation

The overall diagnostic yield of ultrasound-guided biopsy was 97.4% (113/116). Procedure-related complications occurred in 12 patients (10.3%). Pneumothorax was observed in four patients (3.4%), one of whom required intercostal tube drainage and a 48-hour hospitalization. Minor hemoptysis occurred in three patients (2.6%) and did not require intervention. Bleeding at the biopsy site and post-procedure pain were each observed in 1.7% of patients. One patient developed a vasovagal episode requiring intensive care unit observation for 24 hours. No procedure-related mortality was reported (Table 5).

Table 3. Ultrasound characteristics of lung masses

	n (%)
Depth of mass	
<2 cm	10 (8.6%)
2–3 cm	19 (16.4%)
3–4 cm	24 (20.7%)
>4 cm	63 (54.3%)
Contact with pleura	
<2 cm	14 (12.1%)
2–3 cm	23 (19.8%)
3–4 cm	44 (37.9%)
>4 cm	35 (30.2%)
Architecture of mass	
Homogeneous	34 (29.3%)
Heterogeneous	82 (70.7%)

Table 4. Histopathological diagnosis in lung biopsy

Histopathological examination		n (%)
Malignancy (84)	**Adenocarcinoma**	46 (39.7%)
	Squamous cell carcinoma	18 (15.5%)
	Small cell carcinoma	06 (5.2%)
	Non-Hodgkin lymphoma	4 (3.4%)
	Pleomorphic sarcoma	2 (1.7%)
	Malignant phylloid tumor	1 (0.9%)
	Spindle cell tumor likely neural tumor	2 (1.7%)
	Seminoma	1 (0.9%)
	Schwannoma	1 (0.9%)
	Undifferentiated carcinoma	1 (0.9%)
	Plasmacytoma-lambda restricted	1 (0.9%)
	Osteosarcoma	1 (0.9%)
Non-malignancy (29)	Tuberculosis	11 (9.5%)
	Organizing pneumonia	9 (7.8%)
	Coagulative necrosis	1 (0.9%)
	Fibrosing pleuritis	1 (0.9%)
	Non-tubercular mycobacteria, *Mycobacterium abscessus*	1 (0.9%)
	Non-specific inflammation	6 (5.2%)
Inconclusive		3 (2.6%)
Total		116

Table 5. Complications of USG-guided lung biopsy

SN	Complications	n
1	Post procedure pneumothorax required observation	3 (2.6%)
2	Pneumothorax required admission and ICTD	1 (0.9%)
3	Post procedure hemoptysis	3 (2.6%)
4	Bleeding from biopsy site	2 (1.7%)
5	Post procedure pain at biopsy site	2 (1.7%)
6	Vasovagal shock required ICU	1 (0.9%)
7	Death	0 (0%)
	Total	12 (10.3%)

USG: Ultrasonography, SN: Serial number, ICTD: Intercostal tube drainage, ICU: Intensive care unit

DISCUSSION

In this retrospective study of 116 patients undergoing pulmonologist-performed ultrasound-guided transthoracic biopsy of pleural-based lung masses, we observed a high diagnostic yield of 97.4%, an overall complication rate of 10.3%, and no procedure-related mortality. These findings underscore the effectiveness and safety of thoracic ultrasound-guided biopsy when performed by trained interventional pulmonologists.

The diagnostic yield in our cohort is comparable to or higher than previously reported yields of 80–93% in PubMed-indexed series evaluating ultrasound-guided transthoracic biopsies (Table 6).[4-8] For instance, Portela-Oliveira et al.[4] reported a diagnostic accuracy of 90.5% in thoracic ultrasound-guided biopsies of pleural and peripheral lung lesions, while Khan et al.[5] demonstrated a yield of 88.3% for peripheral pulmonary lesions using ultrasound-guided tru-cut biopsy. In a series involving respiratory physicians, Laursen et al.[6] documented a diagnostic rate of 76.9% for malignant lesions. More recent pulmonologist-led studies have reported yields approaching 88–93% with low complication rates.[7] The higher yield observed in our study may reflect careful patient selection, inclusion of only pleural-based lesions with adequate pleural contact, and the use of real-time imaging guidance.

A key strength of our study is the standardized operator criteria. All procedures were performed or directly supervised by pulmonologists with formal training in interventional pulmonology (Doctorate of Medicine Pulmonary Medicine) or structured prior experience in ultrasound-guided thoracic interventions. Operator expertise is known to significantly influence procedural success and safety outcomes.[6,7] Unlike earlier studies where operator experience varied, our structured approach likely minimized the procedural learning curve, contributing to both the high tissue adequacy rate (97.4%) and the relatively low pneumothorax rate (3.4%). The absence of procedure-related mortality further supports the safety of performing this intervention within a specialized pulmonology unit.

Malignancy accounted for 72.4% of diagnoses, consistent with previous thoracic ultrasound biopsy series in which malignant etiologies predominate.[4,5] Adenocarcinoma was the most common histological subtype (39.7%), followed by squamous cell carcinoma (15.5%), reflecting contemporary trends in lung cancer epidemiology.[9] An important contextual factor is the tuberculosis-endemic setting of India: 29.3% of patients were already receiving ATT for the same lesion at presentation. In endemic regions, peripheral lung opacities are often treated empirically for tuberculosis before tissue confirmation is obtained, and patients who fail to respond are referred to tertiary centers for definitive diagnosis. This referral pattern likely enriched our cohort with malignant cases, contributing to a higher proportion of malignant diagnoses compared with some international series.

Table 6. Comparative analysis of USG-guided transthoracic lung biopsy

Parameter	Present study (2025)	Portela-Oliveira et al.[4] 2021	Khan et al.[5] 2019	Laursen et al.[6] 2016	Kumar et al.[7] 2025	Li and Kong[11] 2023 (meta-analysis)
Operator	**Pulmonologist**	**Radiologist**	**Radiologist**	**Respiratory physician**	**Pulmonologist**	**Mixed**
Sample size (n)	116	89	85	215	88	1200+
Diagnostic yield (%)	97.4	90.5	88.3	76.9	88.5	92 (pooled)
Adenocarcinoma (%)	39.7	35	32	34	38	NA
Squamous cell carcinoma (%)	15.5	18	20	16	14	NA
Tuberculosis (%)	9.5	NA	6	NA	5	NA
Inconclusive (%)	2.6	8	7	9	6	5–10
Pneumothorax (%)	3.4	5.6	1.5	2.5	2.3	4.5 (pooled)
Overall complications (%)	10.3	9	6	8	7	8–12

USG: Ultrasonography, NA: Not available

Tuberculosis was diagnosed in 9.5% of cases, aligning with reports from other Indian and tuberculosis-endemic settings.[5,10] The low inconclusive rate (2.6%) compares favorably with previously reported rates of 5–12%,[4,6] likely reflecting the use of a 16-gauge tru-cut needle and multiple core sampling under real-time visualization.

The overall complication rate of 10.3% is consistent with prior studies reporting complication rates between 5% and 15% for ultrasound-guided transthoracic biopsy.[4-8] Pneumothorax occurred in 3.4% of patients, with only one patient (0.9%) requiring intercostal tube drainage. These rates are substantially lower than those commonly reported for CT-guided transthoracic biopsy, where pneumothorax may occur in 15–25% of cases.[3] Minor hemoptysis and local bleeding were self-limiting and required no major intervention. A recent meta-analysis comparing ultrasound- and CT-guided biopsies confirmed lower pneumothorax rates with ultrasound guidance, supporting its favorable safety profile.[11]

Study Limitations

This study has several limitations. The retrospective design introduces potential selection bias, and the single-center experience may limit generalizability. A direct comparison with CT-guided biopsy was not performed. Nevertheless, the relatively large sample size, the standardized procedural protocol, and procedures performed exclusively by trained interventional pulmonologists strengthen the validity of our findings.

Our results support the expanding role of pulmonologists in performing ultrasound-guided transthoracic biopsy of pleural-based lung masses by demonstrating high diagnostic accuracy and acceptable safety, particularly in tuberculosis-endemic and resource-constrained settings.

CONCLUSION

Pulmonologist-performed ultrasound-guided transthoracic biopsy of pleural-based lung masses demonstrates a high diagnostic yield and an acceptable safety profile. Structured interventional training and adherence to strict operator criteria appear to enhance both tissue adequacy and procedural safety. In regions endemic for tuberculosis, this modality is especially valuable for patients who do not respond to empirical therapy. Thoracic ultrasound-guided biopsy should therefore be considered an essential component of contemporary interventional pulmonology practice.

Ethics

Ethics Committee Approval: The study was approved by the Dr. Ram Manohar Lohia Institute of Medical Sciences Ethics Committee (IEC no: 168/25 dated 30.01.2026).

Informed Consent: As this was a retrospective analysis of anonymized data, the requirement for informed consent for study participation was waived. However, written procedural consent had been obtained from the patients or their legally authorized representatives at the time of the procedure.

Footnotes

Authorship Contributions

Surgical and Medical Practices: H.K., P.G., S.G., S.J., S.S., V.M., Concept: H.K., P.G., S.G., R.S.H., S.J., S.Sh., V.M., A.K.V., Design: H.K., P.G., S.G., R.S.H., S.S., A.K.V., Data Collection or Processing: H.K., P.G., S.G., R.S.H., S.J., S.Sh., S.S., M.S., V.M., A.K.V., Analysis or Interpretation: H.K., P.G., S.G., S.J., S.S., M.S., V.M., Literature Search: H.K., P.G., S.G., S.J., S.Sh., S.S., M.S., V.M., Writing: H.K., P.G., S.G., R.S.H., S.S., M.S.

Conflict of Interest: No conflict of interest was declared by the authors.

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