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Radiologic Patterns of Thickened Pleura in Infective vs. Non-Infective Causes

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ABSTRACT

Background: Pleural thickening is a radiologic finding with various infectious and non-infectious origins. It is important to tell these conditions apart for an accurate diagnosis. This helps ensure proper treatment, especially in areas with high tuberculosis and asbestos exposure.

Objective: This study aims to analyze CT imaging characteristics of infective and non-infective pleural thickening and evaluate their diagnostic utility.

Methodology: A retrospective study was conducted at Lady Reading Hospital, Peshawar, involving 200 patients diagnosed with pleural thickening over a one-year period. CT scans were assessed for pleural thickness, distribution, enhancement characteristics, and associated findings.

Results: Among infective cases (n=97), unilateral involvement was seen in 85.6%, with smooth enhancement (74.2%) and pleural effusion (71.1%). Non-infective cases (n=103) more frequently displayed bilateral thickening (37.9%), nodular enhancement (54.4%), and calcifications (31.1%). Multivariate analysis identified nodular enhancement and subpleural nodularity as key indicators of non-infective causes.

Conclusion: CT imaging provides critical insights for differentiating between infective and non-infective pleural thickening. Identifying characteristic imaging features enhances diagnostic accuracy and facilitates early intervention for better patient outcomes.

Keywords: Pleural Thickening; Infective Pleural Disease; Non-Infective Pleural Disease; Computed Tomography (CT)

Introduction

Pleural thickening is often seen in imaging. It can happen due to infections or other diseases. These diseases fall into two types: infective and non-infective. Infective causes include tuberculosis, empyema, and bacterial or fungal infections. These conditions lead to inflammation, pleural effusion, and lung consolidation.[1,2] Non-infective causes include mesothelioma, asbestos-related pleural disease, post-inflammatory fibrosis, and autoimmune disorders. These conditions show different patterns on imaging. Identifying the cause is important for diagnosis and treatment.[3,4]

CT imaging is the best way to study pleural thickening. It provides clear and detailed images of the pleura. Important CT features include pleural thickness, whether it affects one side or both, and the type of enhancement (smooth or nodular). Other signs, such as calcifications, subpleural nodules, and lymph node swelling, help with diagnosis. These details help doctors tell apart different conditions.[5,6]

Diagnosing pleural thickening is difficult in areas with high tuberculosis and asbestos exposure. Tuberculous pleuritis may look like a cancerous disease. Asbestos-related pleural thickening may look like inflammation. Finding these differences is important for the right diagnosis.[7] Pleural thickening can cause discomfort and breathing problems. Some patients may feel chest pain or shortness of breath. These symptoms depend on the cause of thickening. Infections can lead to fever and cough. Non-infective causes, like cancer or asbestos exposure, may not show symptoms early.[8,9] Finding the exact cause is important for proper treatment.

Doctors use CT scans to check pleural thickening in detail. A CT scan gives clear images of the pleura. It helps doctors see how thick the pleura is and where it is located. The scan also shows if the thickening is smooth or nodular. These details help in telling apart infections from other causes. Early diagnosis of pleural thickening is important for better treatment. If an infection is the cause, doctors may give antibiotics. If it is cancer or asbestos-related, other treatments may be needed. CT imaging plays a key role in making the right decision. It helps doctors find the best way to treat each patient.[10]

This study looks at CT imaging features of pleural thickening. It compares infective and non-infective causes. The goal is to improve diagnosis by checking enhancement patterns, thickness, and other signs.

Objective

The objective of the present study was to identify common radiologic features of pleural thickening in infective and non-infective causes and to evaluate the diagnostic utility of CT imaging in differentiating these etiologies. By analyzing imaging characteristics, the study aimed to establish key radiologic markers that could aid in distinguishing between infectious and non-infectious origins of pleural thickening, thereby enhancing diagnostic accuracy and guiding appropriate clinical management.

Methodology

This retrospective study was conducted at Lady Reading Hospital, Peshawar, and included patients who underwent CT chest imaging for pleural thickening between July 2023 and July 2024. A total of 200 patients with radiologically confirmed pleural thickening on CT imaging were included, comprising 97 cases of infective pleural thickening and 103 cases of non-infective pleural thickening. Patients aged 14 years or older were eligible for inclusion. Exclusion criteria included cases with incomplete imaging data, patients with coexisting primary lung malignancies unrelated to pleural thickening, and cases where the etiology of pleural thickening remained indeterminate.

Imaging data were reviewed by two experienced radiologists, and various CT imaging characteristics were recorded. These included the thickness of the pleura (measured in millimeters), distribution (unilateral vs. bilateral), presence of calcifications, and associated findings such as pleural effusion, lung consolidation, and lymphadenopathy. Additionally, enhancement patterns were assessed and categorized as smooth or nodular.

For statistical analysis, descriptive statistics were used to summarize baseline characteristics. Categorical variables were compared using chi-square tests, while continuous variables were analyzed using t-tests. A p-value of less than 0.05 was considered statistically significant.

Ethical approval for the study was granted by the Institutional Review Board (IRB) of MTI Lady Reading Hospital, Peshawar, under reference number 77/LRH/MTI.

Results

The mean age of patients with non-infective causes was significantly higher than those with infective causes. Unilateral pleural thickening was more common in infective causes, while bilateral thickening and greater pleural thickness were more frequently observed in non-infective causes as shown in table 1

Table 2 depicts that smooth pleural enhancement and pleural effusion were significantly more common in infective cases, while nodular enhancement, calcifications, and lymphadenopathy were predominant in non-infective causes. Lung consolidation strongly favored infective causes.

The majority of infective cases were due to tuberculosis and empyema, while non-infective cases were primarily

Table 1. Baseline Characteristics of study cases

Characteristic	Infective Causes (n=97)	Non-Infective Causes (n=103)	p-value
Mean age (years)	52.6 ± 11.9	58.3 ± 12.1	<0.01
Male (%)	63 (65%)	72 (69.9%)	0.51
Female (%)	34 (35%)	31 (30.1%)	0.51
Smoking history (%)	29 (29.9%)	41 (39.8%)	0.11
Mean pleural thickness (mm)	8.3 ± 3.0	11.3 ± 4.4	<0.01
Unilateral thickening (%)	83 (85.6%)	64 (62.1%)	<0.01
Bilateral thickening (%)	14 (14.4%)	39 (37.9%)	<0.01

related to mesothelioma and asbestos-related pleural thickening. All these findings are summarized in table 3.

Table 4 shows Pleural thickening >10 mm, subpleural nodularity, and associated lung fibrosis were significantly more frequent in non-infective cases, highlighting their relevance in differentiating benign and malignant processes.

The statistical evaluation of the data demonstrated significant differences between infective and non-infective causes of pleural thickening. Mean pleural thickness was higher in non-infective causes (11.3 ± 4.4 mm) compared to infective causes (8.3 ± 3.0 mm), with a t-test confirming statistical significance ($p < 0.01$). Similarly, the prevalence of bilateral pleural thickening was greater in non-infective cases (37.9%) compared to infective cases (14.4%), as validated by chi-square analysis ($p < 0.01$).

Smooth pleural enhancement was predominantly observed in infective cases (74.2%), whereas nodular enhancement was more frequently associated with non-infective cases (54.4%), both showing statistically significant differences ($p < 0.01$). Calcifications, which were rare in infective cases (6.2%), were significantly more common in non-infective cases (31.1%). Pleural effusion and lung consolidation were strongly associated with infective causes, with 71.1% and 60.8% prevalence, respectively.

Multivariate logistic regression analysis identified nodular enhancement as a strong predictor of non-infective causes, yielding an odds ratio (OR) of 3.25 (95% CI: 1.87–5.64). Subpleural nodularity and associated lung fibrosis were significant markers for non-infective etiologies, further emphasizing their diagnostic relevance.

Discussion

This study highlights significant radiologic differences between infective and non-infective pleural thickening. It also underscores the diagnostic value of CT imaging. By analyzing imaging patterns the key distinguishing

Table 2. Distribution and Findings of study cases

Characteristic	Infective Causes (n=97)	Non-Infective Causes (n=103)	p-value
Smooth enhancement (%)	72 (74.2%)	47 (45.6%)	<0.01
Nodular enhancement (%)	25 (25.8%)	56 (54.4%)	<0.01
Calcifications (%)	6 (6.2%)	32 (31.1%)	<0.01
Pleural effusion (%)	69 (71.1%)	46 (44.7%)	<0.01
Lung consolidation (%)	59 (60.8%)	11 (10.7%)	<0.01
Lymphadenopathy (%)	39 (40.2%)	27 (26.2%)	0.04

Table 3. Selected Causes for Analysis

Cause	Cases (n)
Infective Causes	
Tuberculosis	45
Empyema	32
Bacterial pneumonia	15
Fungal infections	5
Non-Infective Causes	
Malignant pleural mesothelioma	40
Asbestos-related pleural thickening	35
Post-inflammatory fibrosis	20
Systemic autoimmune diseases	8

features were identified that enhances diagnostic accuracy in complex cases.

Infective pleural thickening mostly happens on one side. It is thinner than non-infective thickening. This is common in tuberculosis and empyema. These diseases cause inflammation in certain areas[11] Non-infective cases are different. They often affect both sides and are thicker. This happens in mesothelioma and asbestos-related disease.[12] A study by Kim et al. (2018) found similar results.[13]

CT contrast helps in diagnosis. In infections, the pleura looks smooth. This means active inflammation is present. This is common in tuberculosis and empyema. In cancers, the pleura looks nodular[3, 14] This is often seen in mesothelioma. A study by Zhou et al. (2020) also found this pattern. These differences help doctors decide if a biopsy is needed.[15]

Pleural effusion and lung consolidation are more common in infections. These signs show the presence of inflammation. Meanwhile, non-infective cases were more likely to present with calcifications, subpleural nodularity, and lung fibrosis.[16] These features are particularly relevant in asbestos-related diseases.[17] Lymphadenopathy was observed more frequently in non-infective cases. It aids in differentiating malignant from benign conditions[18].

Diagnosing pleural thickening in regions with high tuberculosis prevalence and asbestos exposure like Pakistan is challenging. Tuberculous pleuritis often mimics malignancies which makes its differentiation difficult. Occupational asbestos exposure contributes to the pleural disease burden [19]. This study highlights the need for region-specific diagnostic approaches that incorporate local disease patterns.

A key limitation of this study is its retrospective nature, which restricts causal analysis. Additionally, as a single-center study, the findings may not be broadly applicable.[20] Future multicenter research with prospective study designs will be valuable for validating these results and exploring pleural thickening patterns in greater depth [21]. Advances in imaging, including artificial intelligence and functional imaging, may further improve diagnostic capabilities.

Table 4. Additional CT Findings

Characteristic	Infective Causes (n=97)	Non-Infective Causes (n=103)	p-value
Pleural thickening >10 mm (%)	35 (36.1%)	64 (62.1%)	<0.01
Subpleural nodularity (%)	21 (21.6%)	59 (57.3%)	<0.01
Associated lung fibrosis (%)	17 (17.5%)	44 (42.7%)	<0.01

While this study offers valuable insights, certain limitations must be acknowledged. The retrospective design restricts the ability to establish causal relationships. Additionally, as a single-center study, findings may not be generalizable to broader populations. Future research should focus on multicenter, prospective studies to validate these results and further refine diagnostic criteria. Advances in imaging modalities, including artificial intelligence and functional imaging, have the potential to further enhance the diagnostic accuracy of pleural diseases.

Conclusion

This study demonstrates that ct imaging is a valuable tool in differentiating infective from non-infective pleural thickening by identifying characteristic radiologic features. Infective causes are predominantly unilateral, associated with smooth pleural enhancement, pleural effusion, and lung consolidation, whereas non-infective causes exhibit bilateral thickening, greater pleural thickness, nodular enhancement, calcifications, and subpleural nodularity. These findings enhance diagnostic accuracy and aid in guiding appropriate clinical management.

Given the high prevalence of tuberculosis and asbestos-related diseases in certain regions, radiologists must be aware of these distinguishing imaging patterns. Recognizing key ct characteristics allows for earlier diagnosis, targeted investigations, and optimized treatment strategies, reducing the need for invasive procedures such as biopsy in select cases.

While this study provides valuable insights, further multicenter, prospective research is required to validate these findings across broader populations. Advancements in imaging techniques, including artificial intelligence and functional imaging, may further refine diagnostic capabilities and improve patient outcomes. By integrating imaging findings with clinical history and risk factors, clinicians can achieve a more precise and timely diagnosis, leading to better patient management and prognosis.

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