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Article

Chronic pulmonary aspergillosis: Diagnostic accuracy of serum galactomannan and CT findings

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Name of Author:
Sarah Akram[1], Sarmad Abdul Rehman Khan[2], Syed Haris Ali Shah[3], Shahid Hamid[4], Amjad Yayat[5], Faisal Hassan Zahid Chaudery[6], Mbakwe Favour Kosisochukwu[7]

Affiliation:
[1] Senior Registrar Pulmonology Department, Aziz Fatima Medical and Dental College Faisalabad
[2] Consultant Pulmonologist Department of Pulmonology Nishtar Medical university and hospital Multan
[3] Senior Registrar Department of Pulmonology Rai Foundation Medical College ,Sargodha .
[4] Assistant Professor of Medicine University of Sharja and DAHC Medical Specialist Dubai
[5] Assistant professor Department of internal medicine Sahara medical college Narowal
[6]Assistant Professor Department of Pulmonology Gulab Devi hospital/ Al Aleem medical college Lahore
[7] Registrar Department of Internal Medicine Obafemi Awolowo University Ile Ife, Osun, Nigeria

Corresponding Author:
Sarah Akram
sdoc707@gmail.com

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Abstract: *Background: Chronic pulmonary aspergillosis is a progressive fungal lung disease that is difficult to diagnose due to nonspecific clinical features, and accurate diagnosis requires reliable imaging and serological tools. Objective: To evaluate the diagnostic accuracy of serum galactomannan and CT chest findings in patients with suspected chronic pulmonary aspergillosis. Methods: This was a diagnostic accuracy study conducted at Aziz Fatima Medical and Dental College Faisalabad from June 2024 to June 2025 including 190 patients with suspected CPA. Serum galactomannan testing and CT chest imaging were performed, and diagnostic performance was assessed using a composite reference standard. Results: The mean age was 47.1 ± 13.4 years. CT findings such as cavitary lesions (84.3%) and fungal balls (51.0%) were significantly more common in CPA (p <0.001). Serum galactomannan levels were higher in CPA (0.82 ± 0.31 vs 0.46 ± 0.22; p <0.001), with 74.5% positivity. CT showed higher sensitivity (82.4%) compared to galactomannan (74.5%). The combined diagnostic approach demonstrated improved performance with sensitivity of 88.2%, specificity of 82.9%, and accuracy of 85.8%. Conclusion: CT chest remains the primary diagnostic modality for CPA, while serum galactomannan enhances diagnostic accuracy when used in combination.*

Keywords: Chronic pulmonary aspergillosis; Galactomannan; CT chest; Diagnostic accuracy; Fungal infections.

INTRODUCTION

Chronic pulmonary aspergillosis (CPA) is a slow progressive fungi infection of the lungs that is usually caused by Aspergillus fumigatus, and therefore, it usually occurs in those individuals who already have a structural lung disease like previous tuberculosis, chronic obstructive pulmonary disease, or bronchiectasis [1]. It is a major health burden in the world especially in areas where pulmonary infections are high and is accompanied with high morbidity and mortality when untreated [2]. Although CPA has clinical significance, it is usually underdiagnosed as it has an indolent progression and uncharacteristic symptoms [3]. COPD Patients with CPA normally appear with a chronic cough, hemoptysis, loss of weight, fatigue and breathlessness, which also often overlap with other chronic respiratory diseases [4]. Such overlap frequently results in the delay of diagnosis and wrong management, which also adds to the development of the disease and complications [5]. Diagnosis of the condition at an early and accurate stage is thus important in order to initiate timely antifungal therapy and to enhance patient outcomes [6]. Radiology especially high-resolution computed tomography (CT) of the chest is at the center of assessment of suspected CPA [7]. The common CT appearances are one or more pulmonary cavities, may or may not have intracavitary fungal balls, thickening of pleura, and progressive fibrosis [8]. Nevertheless, these characteristics are not fully unique to CPA and could be observed in other disorders like tuberculosis or lung cancer, which restricts the diagnostic specificity of the imaging test used by itself [9].

In the support of the diagnosis of CPA, serological biomarkers have been actively investigated. One of the cell wall constituents of Aspergillus is called serum galactomannan, and it is commonly utilized in the diagnosis of invasive aspergillosis but its application in CPA is not well-defined [10]. Although there are studies that have indicated moderate sensitivity and specificity, there are studies that indicate limited diagnostic sensitivity in chronic manifestations of the disease [11]. This inconsistency reminds us that more assessment is necessary in other clinical contexts [12]. A combination of radiological evidence and serological markers could be beneficial in enhancing the level of accurate diagnosis and decreasing uncertainty [13]. The combination of CT imaging and serum galactomannan testing can contribute to earlier diagnosis and subsequent treatment [14]. Nevertheless, local evidence evaluating their combination value as diagnostic in the field of CPA is limited [15]. Since the underlying lung diseases are very high and the diagnosis of CPA presents a challenge, it is important to consider valid and available diagnostic tools.

Objective

To evaluate the diagnostic accuracy of serum galactomannan and CT chest findings in patients with suspected chronic pulmonary aspergillosis.

Methodology

This was a diagnostic accuracy study conducted at Aziz Fatima Medical and Dental College Faisalabad from June 2024 to June 2025, including 190 patients with suspected chronic pulmonary aspergillosis presenting with chronic respiratory symptoms.

Inclusion Criteria

- Patients aged ≥18 years with chronic respiratory symptoms (>3 months) such as cough, hemoptysis, or weight loss
- Patients with underlying structural lung disease (e.g., previous tuberculosis, COPD, bronchiectasis)
- Patients with radiological suspicion of CPA on initial imaging
- Patients willing to undergo diagnostic testing and provide consent

Exclusion Criteria

- Patients with invasive aspergillosis or acute fungal infections
- Patients receiving antifungal therapy prior to evaluation
- Immunocompromised patients (e.g., HIV/AIDS, chemotherapy) where invasive disease is suspected
- Patients with incomplete diagnostic data

Data Collection

After ethical approval, demographic and clinical data were collected using a structured proforma. All patients underwent serum galactomannan testing, and results were recorded as positive or negative based on established cut-off values. High-resolution CT scans of the chest were performed, and findings such as cavitary lesions, fungal balls, pleural thickening, and fibrosis were documented. Final diagnosis of CPA was established using a composite reference standard including clinical

presentation, imaging findings, and microbiological evidence (such as sputum culture or histopathology where available). Patients were categorized as CPA or non-CPA accordingly.

Statistical Analysis

Data were analyzed using SPSS version 24.0. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequency and percentage. Diagnostic accuracy measures including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated for serum galactomannan and CT findings. Receiver operating characteristic (ROC) curve analysis was performed to assess diagnostic performance. A p-value of ≤0.05 was considered statistically significant.

Results

Patients with CPA were older, with a mean age of 49.6 ± 13.8 years compared to 44.2 ± 12.5 years in non-CPA (p = 0.006), and a higher proportion >50 years (54.9% vs 40.9%). Gender distribution was similar. Previous tuberculosis was significantly more common in CPA (70.6% vs 43.2%; p <0.001), as was bronchiectasis (35.3% vs 20.5%; p = 0.023). Hemoptysis was markedly higher in CPA (56.9% vs 27.3%; p <0.001), and symptom duration was longer (8.6 ± 3.2 vs 5.1 ± 2.4 months; p <0.001).

Table 1. Baseline Demographic and Clinical Characteristics (N = 190)

Variable	Category	CPA (n=102)	Non-CPA (n=88)	Total (N=190)	p-value
Age (years)	Mean ± SD	49.6 ± 13.8	44.2 ± 12.5	47.1 ± 13.4	0.006
Age Group	≤50 years	46 (45.1%)	52 (59.1%)	98 (51.6%)	0.048
	>50 years	56 (54.9%)	36 (40.9%)	92 (48.4%)	0.048
Gender	Male	64 (62.7%)	50 (56.8%)	114 (60.0%)	0.394
	Female	38 (37.3%)	38 (43.2%)	76 (40.0%)	0.394
Previous TB	Present	72 (70.6%)	38 (43.2%)	110 (57.9%)	<0.001
COPD	Present	41 (40.2%)	28 (31.8%)	69 (36.3%)	0.228
Bronchiectasis	Present	36 (35.3%)	18 (20.5%)	54 (28.4%)	0.023
Hemoptysis	Present	58 (56.9%)	24 (27.3%)	82 (43.2%)	<0.001
Duration of Symptoms (months)	Mean ± SD	8.6 ± 3.2	5.1 ± 2.4	7.0 ± 3.4	<0.001

CT findings were significantly more frequent in CPA. Cavitary lesions were present in 84.3% vs 36.4% (p <0.001), fungal balls in 51.0% vs 11.4% (p <0.001), and pleural thickening in 66.7% vs 29.5% (p <0.001). Fibrosis was also higher in CPA (43.1% vs 25.0%; p = 0.009). Multiple cavities were more common (47.1% vs 15.9%; p <0.001), while nodules showed no significant difference (27.5% vs 34.1%; p = 0.321).

Table 2. CT Chest Findings in CPA vs Non-CPA Patients

CT Finding	CPA (n=102)	Non-CPA (n=88)	Total (N=190)	p-value
Cavitary Lesions	86 (84.3%)	32 (36.4%)	118 (62.1%)	<0.001
Fungal Ball (Aspergilloma)	52 (51.0%)	10 (11.4%)	62 (32.6%)	<0.001
Pleural Thickening	68 (66.7%)	26 (29.5%)	94 (49.5%)	<0.001
Fibrosis	44 (43.1%)	22 (25.0%)	66 (34.7%)	0.009
Nodules	28 (27.5%)	30 (34.1%)	58 (30.5%)	0.321
Multiple Cavities	48 (47.1%)	14 (15.9%)	62 (32.6%)	<0.001

Serum galactomannan levels were significantly higher in CPA (0.82 ± 0.31 vs 0.46 ± 0.22; p <0.001). A positive test (≥0.5) was observed in 74.5% of CPA patients compared to 31.8% of non-CPA (p <0.001), indicating a strong association with disease presence.

Table 3. Serum Galactomannan Results

Parameter	CPA (n=102)	Non-CPA (n=88)	Total (N=190)	p-value
Galactomannan Level (OD index)	0.82 ± 0.31	0.46 ± 0.22	0.65 ± 0.33	<0.001
Positive (≥0.5)	76 (74.5%)	28 (31.8%)	104 (54.7%)	<0.001
Negative (<0.5)	26 (25.5%)	60 (68.2%)	86 (45.3%)	<0.001

CT findings demonstrated higher sensitivity (82.4%) than serum galactomannan (74.5%), while specificity was comparable

(70.5% vs 68.2%). Fungal ball showed high specificity (88.6%) but lower sensitivity (51.0%). Overall diagnostic accuracy was higher for CT (77.4%) compared to galactomannan (71.6%).

Table 4. Diagnostic Accuracy of Serum Galactomannan and CT Findings

Diagnostic Test	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Serum Galactomannan	74.5	68.2	73.1	69.8	71.6
CT Findings (Combined)	82.4	70.5	76.6	77.3	77.4
Cavitary Lesions Alone	84.3	63.6	72.9	77.4	74.2
Fungal Ball	51.0	88.6	83.9	61.1	68.4

Combining both tests improved diagnostic performance. Using either test positive increased sensitivity to 91.2% but reduced specificity to 60.2%. Using both tests positive improved specificity to 90.9% with moderate sensitivity (68.6%). The combined model showed the best balance, with sensitivity 88.2%, specificity 82.9%, and overall accuracy 85.8%, indicating superior diagnostic performance.

Table 5. Combined Diagnostic Performance (CT + Galactomannan)

Combination Strategy	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Either Test Positive	91.2	60.2	75.4	83.3	77.4
Both Tests Positive	68.6	90.9	87.3	75.0	79.5
CT + Galactomannan Model (Combined)	88.2	82.9	85.7	85.8	85.8

Discussion

The present study has shown that serum galactomannan as well as CT chest results have significant roles in diagnosis of chronic pulmonary aspergillosis, and CT has a higher sensitivity and general diagnostic performance. CPA patients were aged (49.6 ± 13.8 years) and more inclined to have a history of tuberculosis (70.6%), bronchiectasia (35.3%), and hemoptysis (56.9%), which points to the close relationship between underlying structural lung disease and CPA. The chronicity of the diagnosis and the delayed diagnosis time is also evident by the longer duration of the symptoms (8.6 ± 3.2 months) in CPA. The same trends have been observed in other studies, in which previous pulmonary infections especially tuberculosis have been reported as some of the significant predisposing factors to CPA [16]. Radiologically, finding of CT was more common in CPA with more frequent finding of cavitary lesions (84.3%), fungal balls (51.0%), pleural thickening (66.7%), and multiple cavities (47.1%). These results support the key usage of CT imaging to detect typical structural abnormalities. The sensitivity of CT (82.4) as witnessed in this study is in line with the other studies that have revealed that CT is highly sensitive in identifying the morphological characteristics of CPA but not as specific because it is similar to other chronic lung diseases [17]. CPA patients had very high levels of serum galactomannan (0.82 ± 0.31 vs 0.46 ± 0.22) with the positivity rate of 74.5%. It also exhibited significant diagnostic value despite having a lower sensitivity (74.5) and specificity (68.2) as compared to CT. The findings are consistent with the prior studies where serum galactomannan performed averagely as a diagnostic test and was regarded as an adjunctive, rather than a diagnostic, test [18].

The complementary aspect of the two modalities is pointed out in the diagnostic accuracy analysis. Although CT was more sensitive, some of the findings like fungal ball were highly specific (88.6%) which means that it can be strongly diagnosed when it is present. This was further enhanced by the addition of serum galactomannan that helped in the detection of cases that may not have standard imaging appearances. Similar studies in the past have also highlighted the fact that a combination of the radiological and serological instruments enhances the reliability of the diagnosis [19]. Notably, the combined diagnostic method produced the best results with the sensitivity of 88.2, specificity of 82.9, and the overall accuracy of 85.8. This implies that combining CT results with serum galactomannan would greatly improve the diagnostic accuracy and minimize chances of wrong diagnoses. A multimodal approach has also been supported in the prior studies especially in situations where there is scarcity of resources and where overreliance on one diagnostic modality can result in underdiagnosis [20][21]. On the whole, the results of the current study prove that CT is the foundation of CPA diagnosis, and serum galactomannan is an effective biomarker that can be used as a supplement. The fact that these results are consistent with those of past studies further gives the argument of embracing a combined diagnostic approach. This method can potentially help make diagnosis of the condition earlier, more precise in its distinction of other lung diseases and begin antifungal treatment promptly to eventually achieve better patient outcomes.

Conclusion

It is concluded that CT chest findings demonstrate higher sensitivity and overall diagnostic utility in identifying chronic pulmonary aspergillosis, while serum galactomannan serves as a valuable supportive tool. Characteristic CT features such as cavitary lesions, fungal balls, and pleural thickening are strongly associated with CPA. Although serum galactomannan alone

shows moderate diagnostic performance, its combination with CT significantly improves sensitivity, specificity, and overall accuracy. Therefore, a combined diagnostic approach using both radiological and serological methods provides the most reliable strategy for early and accurate diagnosis of CPA, particularly in patients with underlying lung disease..

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