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Computed Tomography Features of Pulmonary Emphysema at the Bouaké Centre for Medical Imaging and Analysis: A Series of 105 Cases

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Abstract

Introduction: Emphysema is one of the two major pathological components of chronic obstructive pulmonary disease (COPD), and its characterisation relies on chest computed tomography (CT). As existing guidelines are based on cohorts of smokers from high-income countries, data from sub-Saharan Africa remain limited. The aim was to describe the CT features of pulmonary emphysema and their associations with clinical presentations and associated lesions. **Methods:** A retrospective, descriptive study with an exploratory design was conducted at the Bouaké Centre for Medical Imaging and Analysis (Côte d'Ivoire) from January 2020 to December 2024. The 986 chest CT reports from this period were reviewed. The types of emphysema were defined according to the Fleischner Society classification, with paracicatricial emphysema reported separately. Associations were analysed using the chi-squared test or Fisher's exact test, with crude, unadjusted odds ratios (OR). **Results:** Emphysema was reported in 139 of 986 examinations (14.1%); 105 patients met the analysis criteria: 93 men and 12 women (sex ratio 7.75), with a median age of 72 years (interquartile range 68 - 78). Respiratory symptoms were the primary presenting complaint (45.7%). Centrilobular emphysema was the most common type (41.0%), followed by paraseptal (31.4%), paracicatricial (20.0%) and panlobular (13.3%). At least one associated lesion was present in 83.8% of patients: interstitial syndrome (54.3%), bronchiectasis (29.5%) and pulmonary fibrosis (24.8%). Centrilobular emphysema was associated with referral for COPD assessment (OR = 11.61; 95% CI: 2.44 - 55.18; $p < 0.001$), whilst paracicatricial emphysema was associated with bronchiectasis (OR = 3.52; 1.30 - 9.50; $p = 0.010$) and fibrosis (OR = 2.96; 1.07 - 8.16; $p = 0.032$).

Conclusion: Emphysema was found approximately one in seven chest scans and was rarely isolated. The role of paracicatricial emphysema, a recognised entity defined by its relationship to scarred areas rather than by acinar topography, suggests a lesion profile specific to this context and justifies the adoption of a structured chest scan report.

Keywords

Pulmonary Emphysema, Computed Tomography, Chronic Obstructive Pulmonary Disease, Pulmonary Tuberculosis, Côte d'Ivoire

1. Introduction

Pulmonary emphysema is defined, from a pathological perspective, as an abnormal and permanent enlargement of the air spaces beyond the terminal bronchioles, associated with destruction of the alveolar walls [1]. In the field of imaging, the Fleischner Society's glossary has updated this definition, notably by no longer considering the absence of fibrosis as a necessary condition for the definition of emphysema [2]. Emphysema, together with airway damage, constitutes one of the two major pathological components of chronic obstructive pulmonary disease (COPD) [3], one of the most widespread chronic respiratory conditions worldwide [4].

In 2019, the global prevalence of COPD was estimated at 10.3% among adults aged 30 to 79, with over 80% of cases occurring in low- and middle-income countries [4]. In Africa, epidemiological data remain limited and are based on a small number of studies, with significant heterogeneity in the methods used [5]. A recent multicentre community-based study conducted in Cameroon found a prevalence of 2.9% (95% CI: 2.4 - 3.3) among 5055 adults assessed by spirometry [6]. In Côte d'Ivoire, hospital data also remain limited; at Bouaké University Hospital, COPD accounted for 2.47% of admissions to the respiratory medicine department [7]. Medical imaging, and in particular chest computed tomography (CT), allows for a precise morphological characterisation of emphysema and the identification of associated pulmonary and extrapulmonary abnormalities. CT characterisation of emphysema distinguishes, in particular, between centrilobular, panlobular and paraseptal forms, according to the criteria proposed by the Fleischner Society [8], whose terminology was updated in the 2024 glossary [2].

In sub-Saharan Africa, the profile of risk factors differs from that observed in high-income countries, with a significant contribution from non-tobacco exposures, particularly to biomass smoke [9]. Furthermore, emphysema is among the CT-detectable sequelae described following pulmonary tuberculosis, with emphysematous changes reported in 15% to 45% of post-tuberculous lungs [10]. However, the available data on the distribution of the different types of emphysema in sub-Saharan populations remain very limited. To our knowledge, data from Côte d'Ivoire specifically focusing on the CT characteristics of the different types of

pulmonary emphysema remain limited. It is against this background that we conducted this study, the aim of which was to describe the CT features of pulmonary emphysema observed at the Centre for Medical Imaging and Analysis in Bouaké (CIMAB) and to explore the associations between types of emphysema, reasons for the examination and associated lesions, in order to formulate hypotheses regarding their determinants in our context.

2. Materials and Methods

2.1. Type, Setting and Period of the Study

This was a retrospective, descriptive and analytical study with an exploratory aim, conducted at CIMAB (Côte d'Ivoire) over a five-year period, from January 2020 to December 2024. During this period, 986 chest computed tomography (CT) scans were performed at the centre.

2.2. Study Population

The target population consisted of all patients who had undergone a chest CT scan at the CIMAB during the study period. The study population comprised patients whose chest CT scans revealed signs of pulmonary emphysema.

The 986 chest CT scan reports produced during the period were reviewed. The identification of relevant examinations was based on a search for the terms "emphysema", "emphysematous", "bulla", and "distension", followed by a full reading of each report identified to confirm the explicit mention of pulmonary emphysema. One hundred and thirty-nine reports mentioned pulmonary emphysema. Three corresponded to repeat scans in patients already included in the study; only the first scan confirming emphysema was retained, meaning each patient was counted only once, leaving 136 distinct patients. Of these, 31 were excluded because the type of emphysema was not specified or because not all the variables under study had been recorded. The sampling was exhaustive non-probability sampling, with consecutive recruitment of all patients meeting the eligibility criteria. The final sample comprised 105 patients.

2.3. Acquisition Technique

The scans were performed on a 16-slice computed tomography (CT) scanner. Helical acquisition was performed during inspiratory breath-hold, from the lung apices to the pleural recesses. The images were reconstructed as contiguous 3 mm-thick axial slices, with a 3 mm reconstruction interval and no overlap, using parenchymal and mediastinal algorithms, and were then analysed on parenchymal and mediastinal windows. The scans were performed without contrast medium injection or, depending on the clinical indication, after injection of iodinated contrast medium. The technical facilities did not allow for either a dedicated high-resolution acquisition protocol or supplementary acquisition during exhalation. No densitometric quantification software was available.

2.4. Definitions and Diagnostic Criteria

Pulmonary emphysema was defined as an abnormal and permanent enlargement of the air spaces beyond the terminal bronchioles, associated with destruction of the alveolar walls, in accordance with the Fleischner Society glossary [2].

Three types of emphysema were distinguished according to the CT criteria set out in this guideline [2] [8]. Centrilobular emphysema corresponded to small hypodense areas without an identifiable wall, surrounded by normal parenchyma, situated in the centre of the secondary pulmonary lobule, at a distance from the interlobular septa and the pleura. Panlobular emphysema corresponded to extensive hypodense areas within which the architecture of the secondary lobule was no longer recognisable. Paraseptal emphysema was characterised by hypodense foci located subpleurally, peri-fissural or juxta-mediastinal, separated by intact interlobular septa, with no architectural distortion.

Irregular peri-scar air space enlargement, referred to in this study as paracicatricial emphysema, was also recorded when observed within or in contact with an area of architectural distortion or retractile sequelae. As this presentation did not constitute a distinct category amongst the three main types of emphysema described by the Fleischner Society [8], it was reported separately and was not arbitrarily assigned to a centrilobular, panlobular or paraseptal type. These categories were not mutually exclusive, as several types could coexist in the same patient; each type was therefore coded separately. The topography was described in terms of the laterality of each type, whether unilateral or bilateral. Generalised bilateral involvement was defined as the presence of at least one type of emphysema in both lungs. The severity and extent of the lesions were not recorded in most reports and were therefore not analysed.

Among the associated lesions, three variables warrant clarification, as their definition determines the interpretation of the reported associations.

Interstitial syndrome was recorded when the report mentioned reticulation, thickening of the interlobular septa or ground-glass opacities, as defined in the Fleischner Society glossary [2]. This was a descriptive category, without prejudging whether the condition was acute or chronic, or its aetiology. Pulmonary fibrosis was recorded when the report described signs of established fibrosis, namely architectural distortion, traction bronchiectasis or a honeycomb appearance [2]. bronchiectasis was recorded when the report mentioned bronchiectasis meeting the usual criteria, namely a bronchial diameter greater than that of the satellite artery, an absence of peripheral narrowing, or the visibility of bronchi within one centimetre of the pleura [2].

These three variables were assessed independently of one another and were not mutually exclusive. In particular, pulmonary fibrosis was not included within the interstitial syndrome. However, as certain signs of interstitial syndrome may nevertheless fall within the clinical spectrum of fibrosis, a single patient could present with both variables; the number of patients concerned is reported in the results.

2.5. Data Collection and Quality Control

All data were retrospectively extracted from the reports and the department's records. The reports, routinely produced by three radiologists depending on the shift, were used as the source of radiological data. Each examination had been interpreted by a single reader at the time it was performed. The examinations were not subject to double reading or standardised retrospective re-reading according to the study criteria.

2.6. Variables Studied

The variables studied were: age and age groups; gender; the reason for the examination as stated on the referral form, categorised into fourteen categories and then grouped into five classes (respiratory symptoms, parenchymal assessment, assessment for chronic obstructive pulmonary disease, pleural disease, referral for follow-up of declared tuberculosis); the type of emphysema; the lateralisation of each type and overall bilateral involvement; and associated lesions. Referral for follow-up of previous pulmonary tuberculosis was derived from the indication stated on the request form only. It therefore reflected self-reported information rather than a history documented in a medical record. Smoking status was not included on the examination request forms and could therefore not be recorded.

2.7. Statistical Analysis

The data were entered into Microsoft Excel and analysed using SPSS software (IBM, version 30). Qualitative variables were expressed as frequencies and percentages. The normality of the distribution of quantitative variables was assessed using the Shapiro-Wilk test; variables that did not follow a normal distribution were expressed as the median, accompanied by the interquartile range and the extreme values, with the mean and standard deviation reported as supplementary information. Associations between qualitative variables were explored using Pearson's chi-squared test when all expected frequencies were greater than or equal to 5, and using Fisher's exact test otherwise; this condition was verified for each cross-tabulation before the test was selected. The strength of the associations was estimated using the odds ratio (OR) and its 95% confidence interval. The significance level was set at 0.05. These exploratory analyses did not include correction for multiple comparisons, and their results should be interpreted as generating hypotheses. Missing data were not imputed, and the analyses were carried out on the available observations for each variable.

The odds ratios reported are crude estimates derived from bivariate analyses, without adjustment for potential confounding factors. No multivariate analysis was carried out, as the sample size and the number of available variables did not allow for this.

2.8. Ethical Considerations

The study was approved by the Medical and Scientific Directorate of the CIMAB.

Owing to the retrospective nature of the study and the complete anonymisation of the data, individual patient consent was not obtained.

3. Results

3.1. Frequency and General Characteristics

Of the 986 chest CT scans performed during the study period, 139 revealed pulmonary emphysema, representing a prevalence of 14.1% across the scans. After excluding 3 repeat scans and 31 patients whose reports did not provide information on all the variables under investigation, 105 patients were analysed, representing 10.6% of the scans performed. The cohort comprised 93 men (88.6%) and 12 women (11.4%), giving a sex ratio of 7.75. The median age was 72 years (interquartile range: 68 to 78 years; range: 18 and 87 years), with a mean age of 70.0 ± 13.0 years. The 60 - 79 age group was the most common, comprising 64 patients (61.0%), followed by the 80 and over age group with 23 patients (21.9%). Four patients (3.8%) were under 40 years of age.

3.2. Indications for the Examination

The indications are detailed in Table 1. Respiratory symptoms were the primary reason for referral (48 patients; 45.7%), dominated by dyspnoea (25 patients; 23.8%) and chronic cough (11 patients; 10.5%). These were followed by assessment of a known or suspected parenchymal abnormality (22 patients; 21.0%), assessment of chronic obstructive pulmonary disease (COPD) (14 patients; 13.3%), investigation of a pleural condition (12 patients; 11.4%) and referral for follow-up of declared tuberculosis (9 patients; 8.6%).

Table 1. Indications for chest CT (n = 105).

Indications	Frequency	%
Respiratory symptoms	**48**	**45.7**
Dyspnoea	25	23.8
Chronic cough	11	10.5
Chest pain	8	7.6
Haemoptysis	4	3.8
Parenchymal assessment	**22**	**21.0**
Pulmonary fibrosis	6	5.7
Atelectasis	4	3.8
Interstitial lung disease	4	3.8
Pulmonary mass	4	3.8
Suspected pulmonary embolism	3	2.9
Cannonball metastases	1	1.0
COPD assessment	**14**	**13.3**
Pleural conditions	**12**	**11.4**

Continued

Pneumothorax	8	7.6
Pleural effusion	4	3.8
Follow-up of declared tuberculosis	**9**	**8.6**
Total	**105**	**100.0**

COPD: chronic obstructive pulmonary disease.

3.3. Types of Emphysema and Topography

The type of emphysema was specified for all 105 patients (Table 2). Centrilobular emphysema was the most common type (43 patients; 41.0%), followed by paraseptal emphysema (33 patients; 31.4%), paracicatricial emphysema (21 patients; 20.0%), and panlobular emphysema (14 patients; 13.3%). These categories were not mutually exclusive: six patients (5.7%) had two types, the most common combination being entrilobular and Paraseptal (3 cases).

Involvement was bilateral in 72 patients (68.6%). This bilateral involvement was predominant in panlobular emphysema (12 out of 14 cases; 85.7%), paraseptal emphysema (24 out of 33 cases; 72.7%) and centrilobular emphysema (30 out of 43 cases; 69.8%). Paracicatricial emphysema was characterised by an almost equal distribution between unilateral (11 out of 21 cases; 52.4%) and bilateral (10 out of 21 cases; 47.6%) forms.

Table 2. Types of emphysema and laterality (n = 105).

Type of emphysema	Frequency (%)*	Unilateral, n (%)	Bilateral, n (%)
Centrilobular	43 (41.0)	13 (30.2)	30 (69.8)
Paraseptal	33 (31.4)	9 (27.3)	24 (72.7)
Paracicatricial	21 (20.0)	11 (52.4)	10 (47.6)
Panlobular	14 (13.3)	2 (14.3)	12 (85.7)

* Non-exclusive categories; six patients (5.7%) presented with two types (centrilobular and paraseptal: 3; paraseptal and paracicatricial: 2; centrilobular and paracicatricial: 1); the total number of patients exceeds 105. The percentages for laterality are reported in relation to the number of cases of each type.

3.4. Associated Lesions

At least one associated lesion was present in 88 patients (83.8%) (Table 3). Interstitial syndrome was the most common (57 patients; 54.3%), followed by bronchiectasis (31 patients; 29.5%) and pulmonary fibrosis (26 patients; 24.8%). Other lesions were less common: pleural effusion (12 patients; 11.4%), pulmonary nodules (9 patients; 8.6%), mediastinal lymphadenopathy and pneumothorax (5 patients each; 4.8%), aspergilloma (3 patients; 2.9%), rib destruction (2 patients; 1.9%) and airspace consolidation (1 patient; 1.0%).

Interstitial syndrome and pulmonary fibrosis co-occurred in 20 patients (19.0%); 37 patients (35.2%) had interstitial syndrome without documented fibrosis, and 6

(5.7%) had fibrosis without associated interstitial syndrome.

Table 3. Associated lesions (n = 105).

Associated lesion	**Frequency**	**%**
Interstitial syndrome	57	54.3
Bronchiectasis	31	29.5
Pulmonary fibrosis	26	24.8
Pleural effusion	12	11.4
Pulmonary nodule	9	8.6
Mediastinal lymphadenopathy	5	4.8
Pneumothorax	5	4.8
Aspergilloma	3	2.9
Rib destruction	2	1.9
Airspace consolidation	1	1.0
At least one associated lesion	**88**	**83.8**

These categories are not mutually exclusive; a single patient could have several associated lesions.

3.5. Exploratory Analysis of Associations

The results of the exploratory analysis are shown in Table 4. Centrilobular emphysema was significantly associated with the indication for a COPD assessment, which was found in 12 of the 43 patients with this condition, compared with 2 of the 62 patients without it (OR = 11.61; 95% CI: 2.44 to 55.18; Pearson's chi-squared test, $p < 0.001$), as well as with the indication for follow-up of declared tuberculosis (7/43 versus 2/62; OR = 5.83; 95% CI: 1.15 to 29.62; Fisher's exact test, $p = 0.030$).

Paracicatricial emphysema was significantly associated with the presence of bronchiectasis (11/21 versus 20/84; OR = 3.52; 95% CI: 1.30 to 9.50; Pearson's chi-squared test, $p = 0.010$) and to pulmonary fibrosis (9/21 versus 17/84; OR = 2.96; 95% CI: 1.07 to 8.16; Pearson's chi-squared, $p = 0.032$). However, it was not associated with the indication of follow-up for declared tuberculosis (Fisher's exact test, $p = 1.000$). Paraseptal emphysema was significantly less common in men (26 of the 33 patients with this condition were men, compared with 67 of the 72 patients without it; OR = 0.28; 95% CI: 0.08 to 0.95; Fisher's exact test, $p = 0.047$). None of the 33 patients with paraseptal emphysema had been referred for follow-up as a declared tuberculosis, compared with 9 of the 72 patients without this condition; however, this difference did not reach the threshold of statistical significance (Fisher's exact test, $p = 0.054$).

The association between centrilobular emphysema and interstitial syndrome approached but did not reach the significance threshold (Pearson's chi-squared test, $p = 0.064$). The other associations explored, notably those between types of emphysema and age, and between bilateral involvement and age, were not signif-

icant (Table 4).

Table 4. Exploratory analysis of associations between types of emphysema, indications and associated lesions (n = 105).

Association	Presence	Absence	OR [95% CI]	p
Centrilobular × COPD assessment	12/43	2/62	11.61 [2.44 to 55.18]	<0.001
Centrilobular × declared TB	7/43	2/62	5.83 [1.15 to 29.62]	0.030†
Paracicatricial emphysema × associated bronchiectasis	11/21	20/84	3.52 [1.30 to 9.50]	0.010
Paracicatricial emphysema × pulmonary fibrosis	9/21	17/84	2.96 [1.07 to 8.16]	0.032
Paracicatricial emphysema × declared TB	2/21	7/84	1.16 [0.22 to 6.03]	1.000†
Paraseptal × declared TB	0/33	9/72	0.10 [0.01 to 1.77]‡	0.054†
Paraseptal × male	26/33	67/72	0.28 [0.08 to 0.95]	0.047†
Centrilobular × interstitial syndrome	28/43	29/62	2.12 [0.95 to 4.73]	0.064
Panlobular × bilateral involvement	12/14	60/91	3.10 [0.65 to 14.73]	0.216†
Bilateral involvement × age ≥ 70 years	50/72	19/33	1.67 [0.71 to 3.93]	0.234

†Fisher's exact test (Pearson's chi-squared test for other comparisons). ‡ Odds ratio calculated after Haldane-Anscombe correction due to a null cell. OR: odds ratio; CI: confidence interval; TB: tuberculosis (declared on the request form). Presence and absence: proportion of patients exhibiting the characteristic shown in the column amongst carriers and non-carriers of the type of emphysema under consideration. Exploratory analyses, without correction for multiple comparisons.

4. Discussion

4.1. Frequency and Demographic Profile

In our series, pulmonary emphysema was reported in 14.1% of chest CT examinations performed during the study period. This proportion cannot be equated with prevalence in the general population, as the denominator consists of patients referred for a chest CT scan; however, it reflects the significant role played by emphysema in our practice. The median age of 72 years (interquartile range: 68 - 78 years) is comparable to that reported in Western CT series; Wilgus *et al.* reported an identical median (interquartile range: 68 - 75 years) in 83 patients with COPD confirmed by spirometry [11]. Our population, however, was overwhelmingly male, with 88.6% men and a sex ratio of 7.75, whereas women accounted for 41% of that cohort [11]. This predominance is consistent with data from Ivorian hospitals, where men accounted for 93.9% of patients treated for COPD at Bouaké University Hospital [7]. Several factors may contribute to this. Exposure to biomass smoke is a significant risk factor for chronic respiratory disease in African populations, particularly among those who have never smoked [9], and the forms of COPD associated with it tend to involve damage to the small airways rather

than marked emphysematous destruction [12]. Differences in access to imaging depending on gender may also play a role. However, the lack of data on smoking status and occupational or domestic exposures means it is not possible to distinguish between these hypotheses.

4.2. Distribution of Types of Emphysema

Centrilobular emphysema was the most frequently observed type (41.0%), which is consistent with its well-established association with smoking [8] [13], but its predominance was less pronounced than in some Western series: in the study by Wilgus *et al.*, the dominant subtype was centrilobular in 68% of patients, panlobular in 26% and paraseptal in 6% [11]. These proportions are not directly comparable with ours, as that cohort comprised patients with COPD confirmed by spirometry and a documented history of smoking, and identified a single dominant subtype, whereas our series included all cases of emphysema identified by CT scan and allowed for multiple subtypes in the same patient. Paraseptal emphysema, identified in 31.4% of patients, was also more common than in that cohort [11]. It is classically associated with smoking and is characterised by areas of hyperlucency located predominantly in contact with the interlobular septa and the pleura [8] [13], but the lack of data on smoking status prevents us from exploring this relationship in our series. Part of this discrepancy may also be due to the difficulty in distinguishing paraseptal abnormalities from paracicatricial emphysema, both of which are subpleural in location. Panlobular emphysema was present in 13.3% of patients. Defined by a relatively homogeneous involvement of the acinus, with a loss of distinction between its various subdivisions [2] [8], it becomes difficult to distinguish visually from confluent centrilobular destruction when the lobular architecture is significantly altered. In the absence of a standardised severity scoring system, our data do not allow a definitive conclusion to be drawn for the 14 cases in question, which highlights the value of a standardised description of severity and distribution.

Finally, paracicatricial emphysema was present in 20.0% of patients. This proportion cannot be directly compared with studies that report only the three acinar subtypes of the CT classification, as paracicatricial emphysema is a recognised entity but is defined by its relationship to the scar rather than by its acinar topography [2] [8]. It was identified as a separate category to avoid artificially classifying it as one of the other subtypes when its appearance did not permit such classification.

4.3. Characteristics of Paracicatricial Emphysema

The frequency of paracicatricial emphysema is one of the key findings of our study. Found in one in five patients, it was significantly associated with bronchiectasis (OR = 3.52; 95% CI: 1.30 - 9.50) and pulmonary fibrosis (OR = 2.96; 95% CI: 1.07 - 8.16). This profile, combining emphysematous destruction and chronic parenchymal changes, is consistent with parenchymal remodelling in the vicinity

of scarred areas. In our context, post-tuberculous sequelae constitute an important aetiological hypothesis, as studies on post-tuberculous lung disease report a high prevalence of bronchiectasis, fibrosis and emphysematous abnormalities [10] [14]. However, our study does not allow us to attribute these lesions to tuberculosis. The lack of association with the indication for follow-up of a declared tuberculosis ($p = 1.000$) is likely due to the self-reported nature of this variable, which is derived from the referral form and may be missing in patients who nevertheless have such a history. The radiological identification of post-infectious sequelae can therefore provide guidance when the available clinical information is incomplete. Similarly, the absence of paraseptal emphysema amongst the nine patients referred for follow-up as declared tuberculosis ($p = 0.054$) could reflect a difficulty in distinguishing between paraseptal subpleural hypodensities and paracicatricial emphysema; however, the small sample size involved means this is merely a hypothesis generated by the data.

These associations should therefore be regarded as a radiological finding requiring confirmation rather than as evidence of an aetiological mechanism. A prospective study involving standardised re-reading of images, systematic collection of infectious history and precise characterisation of tuberculous sequelae would be necessary.

4.4. Other Types of Emphysema and Associated Factors

Centrilobular emphysema was strongly associated with the indication for a COPD assessment (OR = 11.61; 95% CI: 2.44 - 55.18; $p < 0.001$), which is consistent with its recognised role in the CT phenotype of COPD, particularly in subjects exposed to smoking [8] [13]. As no spirometry data were available, this indication did not constitute a functional diagnosis: the association links a reason for referral to a type of emphysema, rather than COPD to centrilobular emphysema. Its association with the indication for follow-up of a declared tuberculosis (OR = 5.83; 95% CI: 1.15 - 29.62; $p = 0.030$) remains difficult to interpret aetiologically, as this variable is self-reported and the medical history is not documented. It may reflect the coexistence of risk factors or multiple pulmonary lesions rather than a direct link paraseptal emphysema was observed less frequently in men (OR = 0.28; 95% CI: 0.08 - 0.95; $p = 0.047$). This association should be interpreted with the utmost caution: it is based on only twelve women and contradicts the findings of the MESA COPD study, in which the paraseptal subtype was more prevalent in men [13], whilst Wilgus *et al.* reported no significant difference by sex [11]. Sampling variation is likely, and verification in a larger population would be necessary.

Finally, the association between centrilobular emphysema and interstitial syndrome did not reach the threshold of statistical significance (OR = 2.12; 95% CI: 0.95 - 4.73; $p = 0.064$). As "interstitial syndrome" encompasses a broader descriptive category than pulmonary fibrosis alone, this trend does not allow us to conclude that a combined emphysema-fibrosis syndrome is present, this being a CT-defined entity characterised by the association of emphysema predominantly at

the apices and fibrosis predominantly at the bases [15].

4.5. Associated Lesions and Implications for Clinical Practice

Emphysema was rarely isolated: 88 patients (83.8%) presented with at least one associated lesion, predominantly interstitial syndrome (54.3%), bronchiectasis (29.5%) and pulmonary fibrosis (24.8%). These changes may form part of post-infectious sequelae or complex interactions between airway damage, emphysematous destruction and pulmonary remodelling [10] [14]. The presence of nodules in 8.6% of patients is worth noting, as emphysema identified on CT is associated with an increased risk of bronchopulmonary cancer [16], although our data do not allow for its characterisation. In practical terms, most reports did not include a formalised severity score, with the description being limited to the type and lateralisation. A structured report incorporating the subtype, its distribution and its severity grade would improve standardisation and comparability; the Fleischner Society's visual classifications, in particular, allow for a more reproducible description [2] [17]. This limitation extends beyond the report itself. None of the 105 referral forms in our series mentioned smoking history in pack-years or exposure to open fires or firewood, although such exposures are among the main documented determinants of chronic respiratory disease in African populations [9]. Standardising the referral form, with at least these two fields, therefore appears as necessary as standardising the report, since the quality of one determines the interpretation the other allows.

4.6. Strengths and Limitations

This study is based on comprehensive, consecutive recruitment over five years and provides data on the distribution of emphysema types in an African population where such data remain limited. The systematic identification of paracicatricial emphysema constitutes its main originality. Several limitations should be highlighted. The retrospective nature of the study means the analysis is based on routine clinical reports; each scan was interpreted by just one of the three readers, without double-reading or standardised re-reading, which leaves the study open to particularly marked inter-observer variability in distinguishing between subtypes [18]. Technical constraints also limited morphological characterisation: 3 mm slices, and the absence of a high-resolution protocol, of expiratory acquisition and of densitometric quantification. Mild or limited forms may have gone undetected; expiratory trapping could not be assessed; and the emphysematous burden could not be quantified, particularly as severity was not rated in the reports. However, the agreement between visual reading and densitometric quantification remains modest itself, at around 61% (kappa 0.22), with the two approaches being complementary rather than interchangeable [19]. Key clinical and functional data were lacking: smoking status, exposure to biomass, occupational history, spirometry and documented tuberculosis status. The study therefore does not allow CT-detected emphysema to be equated with COPD, nor does it enable the determina-

tion of its aetiological factors.

Finally, the frequency reported does not represent a population prevalence, as the single-centre recruitment and reliance on prescription indications introduce selection bias. The analyses were exploratory, without correction for multiple comparisons, and some sample sizes were small, particularly among women and for panlobular emphysema; significant associations should therefore be regarded as hypothesis-generating.

5. Conclusion

In this routine CT series, emphysema was reported in approximately one in seven chest examinations, predominantly in elderly men, and was rarely isolated, with more than eight in ten patients (83.8%) presenting at least one associated lesion. The distribution of subtypes differed from that seen in Western cohorts of smokers: centrilobular emphysema, although the most common, was only moderately predominant, whilst paraseptal emphysema and, in particular, paracicatricial emphysema were prominent. The latter, found in one in five patients and associated with bronchiectasis and fibrosis, is a recognised entity that does not correspond to any of the three acinar subtypes of the CT classification. These exploratory findings, derived from routine radiological reports and based on unadjusted associations, call for prospective studies involving standardised re-evaluation, the collection of data on smoking status, exposure to biomass and a history of tuberculosis, as well as respiratory function testing. They already justify the adoption of a structured chest imaging report specifying the type, distribution and severity of emphysema, which is a prerequisite for the comparability of data produced in our departments.

Author Contributions

All authors contributed to, read and approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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