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Radiologic patterns of distant organ metastasis in advanced breast cancer patients: A report of 114 computed tomography cases in private and public medical practice in Kinshasa

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ABSTRACT

Introduction
Distant metastases from breast cancer represent a major determinant of prognosis and therapeutic decision-making. Computed tomography (CT) plays a central role in staging advanced disease, particularly in resource-limited settings where local epidemiological data remain scarce.

Purpose
To describe the radiological patterns of distant metastases detected on CT scans in patients with advanced breast cancer in Kinshasa.

Methods
A retrospective descriptive study was conducted over a five-year period (January 2020–January 2025) across four medical imaging centres in Kinshasa. Thoracoabdominopelvic CT scan reports from 114 patients diagnosed with stage IIIB and IV breast cancer were analysed. Metastases were identified according to predefined radiological criteria, and data were analysed using descriptive statistics.

Results
The mean age of patients was 52.9 years (range: 19–96 years). Thoracic metastases were observed in 98 patients (85.9%), abdominopelvic metastases in 67 patients (58.3%), and bone metastases in 40 patients (35.0%). The lungs were the most frequently affected site (75 cases), followed by the liver (46 cases). Bone metastases predominantly involved the spine (32 cases) and were mainly osteolytic in nature. Lymph node involvement was identified in 26 patients, primarily within the thoracic region. Multisite metastases were present in 74 patients (64.9%).

Conclusion
Advanced breast cancer in Kinshasa is characterised by a high prevalence of metastases, frequently multisystemic, with predominant involvement of the lungs and liver. CT imaging remains an essential tool for disease staging and treatment guidance in this setting.

INTRODUCTION

Breast cancer remains the leading cause of cancer-related mortality among women worldwide. Despite advances in screening and treatment, a substantial proportion of patients continue to present with advanced disease characterised by distant metastases (Brookes et al., 2007; Pesapane et al., 2020; Troc et al., 2014). These secondary sites constitute the principal determinant of survival and play a decisive role in guiding therapeutic strategies (Chanté et al., 2021).

Metastatic dissemination of breast cancer follows preferential patterns, most commonly involving the lungs, liver, skeletal system, and lymph nodes (Brookes et al., 2007; Eo et al., 2008; Or et al., 2014). Medical imaging—and particularly computed tomography (CT)—plays a central role in initial staging, assessment of tumour extension, and patient follow-up (Itani et al., 2021; Michaels et al., 2016).

Multidetector CT enables comprehensive, rapid, and reproducible evaluation of major metastatic sites, making it a reference imaging modality (Moy et al., 2016), especially in resource-limited settings. However, most existing knowledge regarding the radiological patterns of breast cancer metastases is derived from studies conducted in high-income countries.

In sub-Saharan Africa, and particularly in the Democratic Republic of the Congo, systematically collected scientific data describing the radiological characteristics of metastatic dissemination remain scarce. This lack of local evidence represents a significant challenge in a context where diagnosis is frequently delayed and clinical decision-making relies heavily on imaging findings.

The central problem therefore lies in the absence of structured characterisation of metastatic patterns of advanced breast cancer encountered in routine radiological practice within this setting. Without robust local data, optimisation of diagnostic strategies and treatment planning remains limited.

Accordingly, the present study aims to address this gap by providing a systematic and analytical description of the radiological patterns of distant metastases in advanced breast cancer detected on CT scans in Kinshasa, thereby contributing to improved local understanding of disease behaviour and enhanced patient management.

METHODS

Study Design

This descriptive, retrospective, multicentre study was conducted over a five-year period from January 2020 to January 2025 across four public and private medical imaging facilities in Kinshasa: the Kokolo Medical Imaging Centre, Renaissance University Hospital Centre, Diamant Medical Centre, and Tshatshi Military Hospital. Ethical approval was obtained prior to study initiation (ESP/CE/63B/2025).

The study involved analysis of thoracoabdominopelvic computed tomography (CT) reports performed in patients diagnosed with advanced breast cancer.

A total of 114 Congolese women with metastatic breast cancer (stages IIIB and IV), who were treatment-naïve and had undergone thoracoabdominopelvic CT examination, were included. Patients with incomplete medical records or non-interpretable imaging examinations were excluded.

Diagnostic Imaging Criteria for Metastases

Diagnostic imaging criteria for metastatic involvement were established based on previously published radiological studies (Hamaoka et al., 2004; Holling et al., 2002; Houssami et al., 2012).

Lung Metastases

Pulmonary lesions were considered metastatic when at least one of the following CT features was present:

1. Solitary or multiple pulmonary nodules of varying size
2. Endobronchial lesions
3. Airspace consolidation
4. Focal pulmonary opacities in a patient with known breast cancer
5. Lymphangitic carcinomatosis
6. Ipsilateral pleural effusion corresponding to tumour laterality

Liver Metastases

Liver metastases were diagnosed when CT imaging demonstrated one or more of the following characteristics:

1. Solitary or multiple hepatic nodules of varying size

2. Irregular hypodense nodules with peripheral enhancement
3. Tumour infiltration with spread along hepatic sinusoids

Bone Metastases

Bone metastases were defined by CT evidence of bone tissue destruction presenting as:

- Osteolytic lesions,
- Osteosclerotic lesions, or
- Mixed lytic–sclerotic changes.

Lymph Node Metastases

Lymph nodes were considered metastatic when at least one of the following CT criteria was identified:

1. Rounded or oval morphology
2. Contrast enhancement
3. Loss of the fatty hilum

Data Analysis

Data were entered and analysed using **IBM SPSS Statistics version 24**. Quantitative variables were summarised using means, standard deviations, and ranges, whereas qualitative variables were expressed as frequencies and percentages.

Associations between metastatic sites and selected clinical variables were evaluated using Pearson's chi-square test or Fisher's exact test when expected cell counts were fewer than five. Statistical significance was defined at $p < 0.05$.

RESULTS

General Characteristics of the Study Population

The study included 114 patients diagnosed with advanced breast cancer (stages IIIB and IV). Patient ages ranged from 19 to 96 years, with a mean age of 52.9 years. All patients were treatment-naïve at the time of CT examination **(Figure 1)**.

Distribution of Metastatic Sites

Thoracic metastases represented the most frequent site of metastatic involvement, observed in 98 patients (85.9%). Abdominopelvic metastases were identified in 67 patients (58.3%), whereas bone metastases were present in 40 patients (35.0%).

Within the thoracic region, the lungs were the predominant metastatic site (75 cases), followed by pleural involvement (10 cases) and thoracic lymph node involvement (22 cases). Pulmonary metastases most commonly presented as multiple nodular lesions.

In the abdominopelvic region, the liver was the most frequently affected organ (46 cases), followed by peritoneal metastases (14 cases) and ovarian involvement (6 cases).

Bone metastases predominantly involved the vertebral column (32 cases), followed by the ribs (8 cases) and the ischial bone (3 cases). Osteolytic lesions constituted the predominant radiological pattern.

Analysis of Statistical Associations

Inferential analysis was conducted to evaluate associations between lymph node involvement and metastatic dissemination.

Thoracic lymph node metastasis showed a statistically significant association with thoracic metastatic involvement (Fisher's exact test, $p < .05$). Conversely, no statistically significant association was observed between abdominopelvic lymph node involvement and metastases within this region ($p > .05$).

No statistically significant relationship was identified between patient age and the number of metastatic sites ($p > .05$).

Patterns of Metastatic Dissemination

Multisite metastatic disease was observed in 74 patients (64.9%), whereas 40 patients (35.1%) presented with single-site metastasis.

The most frequent metastatic combinations were:

- Thoracic and abdominopelvic metastases (28.9%)
- Combined thoracic, abdominopelvic, and bone metastases (19.2%)

Figures 1 and **2** illustrate the overall metastatic distribution and overlap between metastatic sites.

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Figure 1:
Diagram illustrating the metastatic distribution identified on CT imaging in patients with advanced breast cancer

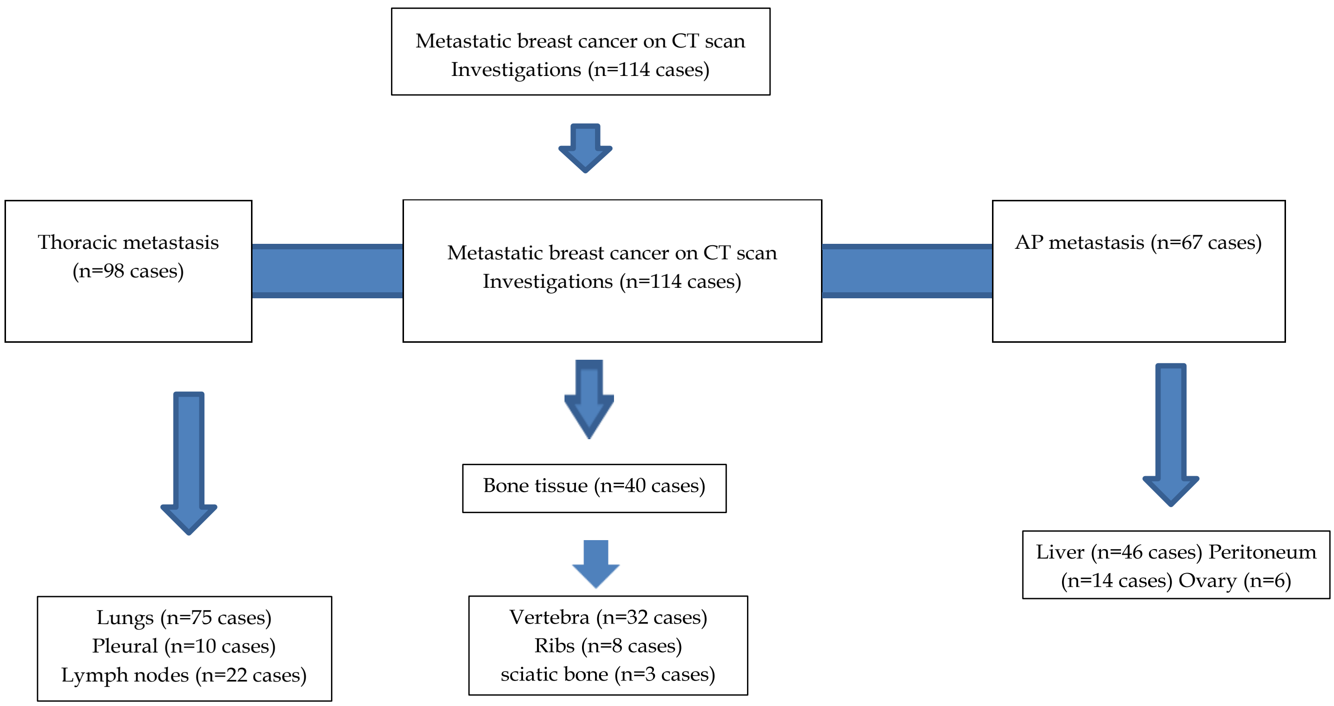


Figure 2:
Venn diagram showing patterns of multisite metastases (AP = abdomen and pelvis; B = bone; C = thorax)

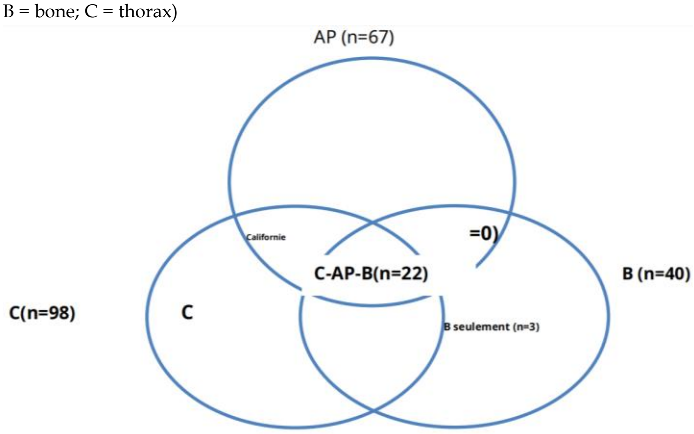


Figure 3:
Axial CT scan of the chest, mediastinal window showing amassive right pleural effusion, pleural thickening and a left nodule, strongly suggestive of metastatic disease

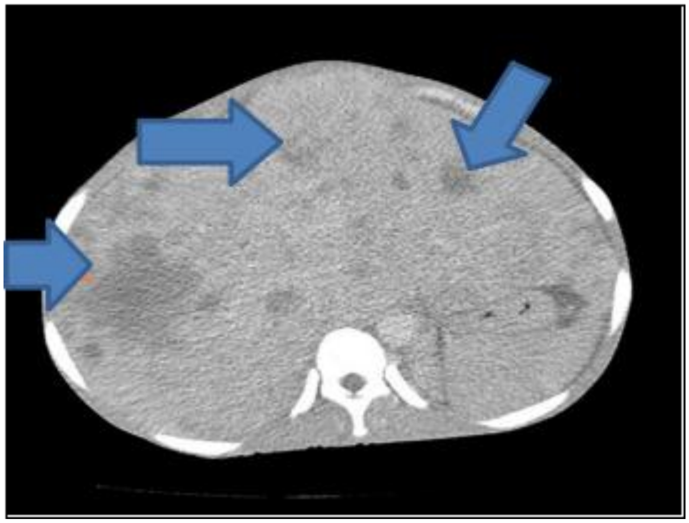
Table 1
Morphological Characteristics of Pulmonary Metastases (n = 75)

Characteristic	Frequency	Percentage (%)
Morphology of lesions		
Nodules	45	60.0
Consolidation	9	12.0
Lymphangitic carcinomatosis	20	28.0

Characteristic	Frequency	Percentage (%)
Number of nodules (n = 45)		
Solitary	28	62.2
Multiple	17	37.8

Note: Percentages calculated within subgroup totals.

Figure 2:
Axial CT scan images of the abdomen, at the level of the liver



The image shows countless hypodense lesions at minimal elevation (arrows), compatible with metastases.

Figure 3:
Sagittal (A) and axial (B) CT scan images of the spine and thorax, in bone window, showing a lesion lytic at the level of the body of the T10 vertebra and the left rib

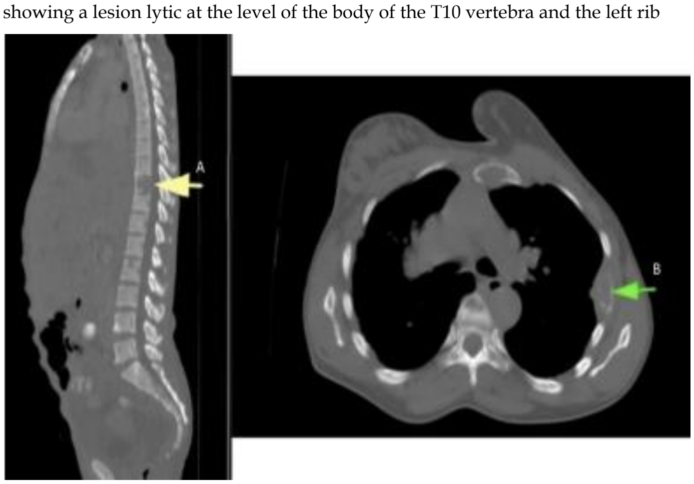


Table 2:
Radiological Characteristics of Liver Metastases in Patients With Advanced Breast Cancer (n = 46)

Characteristic	Frequency	Percentage (%)
Lesion morphology		
Hypodense	16	34.7
Heterogeneous	30	65.3
Distribution		
Diffuse	23	50.0
Focal	23	50.0
Lesion margins		
Ill-defined	9	19.5
Well defined	29	63.2
Mixed	8	17.3
Contrast enhancement		
Heterogeneous	32	69.5
Homogeneous	14	30.5
Necrosis		
Absent	14	30.5
Present	32	69.5
Liver hypertrophy		
No	14	30.5
Yes	32	69.5
Pleomorphism		
No	32	69.5
Yes	14	30.5

Figure 4:
The axial CT scan of the abdomen and thorax shows enlarged round/oval lymph nodes in the armpit (A) and the portal liver (B)

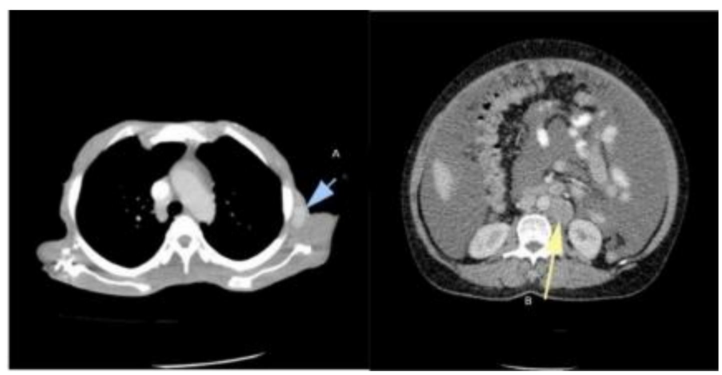


Table 3:
Radiological Appearance of Bone Metastases (n = 40)

Feature	*Frequency*	*Percentage (%)*
Type of lesion		
Osteolytic	*37*	*92.5*
Osteosclerotic	*3*	*7.5*
Zone of transition		
Narrow	*26*	*65.0*
Wide	*8*	*20.0*
Mixed	*6*	*15.0*
Margins		
Ill-defined	*13*	*32.5*
Well defined	*17*	*42.5*
Mixed	*10*	*25.0*

Feature	*Frequency*	*Percentage (%)*
Number of lesions		
Solitary	*6*	*15.0*
Multiple	*34*	*85.0*
Bones affected		
Vertebrae	*32*	*80.0*
Ribs	*8*	*20.0*
Ischium	*3*	*7.5*

Note: Some patients presented with involvement of multiple skeletal sites

DISCUSSION

This study demonstrates a high prevalence of distant metastases among patients with advanced breast cancer in Kinshasa, with predominant thoracic involvement—particularly pulmonary metastases—followed by hepatic and bone involvement. These findings confirm the multisystemic nature of advanced breast cancer and emphasise the essential role of computed tomography (CT) in evaluating tumour extension, as consistently reported in international literature (Goldhirsch et al., 2013; Sung et al., 2021).

The high frequency of thoracic metastases observed in this series (85.9%) is comparable to findings from previous studies identifying the lungs as one of the most common metastatic sites, with reported prevalence ranging from 60% to 80% (Brookes et al., 2007; Houssami et al., 2012). The predominance of multiple pulmonary nodules corresponds to classical radiological patterns reflecting haematogenous dissemination of breast cancer cells (Michaels et al., 2016).

This pulmonary predilection may be explained by the extensive pulmonary capillary network, which favours trapping, adhesion, and proliferation of circulating tumour cells (Pesapane et al., 2020).

Liver metastases, identified in 40.4% of patients, represented the second most frequent metastatic site. This observation aligns with previously reported prevalence rates ranging between 30% and 50% (Goldhirsch et al., 2013; Moy et al., 2016). The predominance of heterogeneous and frequently necrotic hypodense lesions observed in this study corresponds to recognised radiological characteristics of hepatic metastases from breast cancer and is often associated with poorer clinical outcomes (Hamaoka et al., 2004). The relatively elevated frequency observed may reflect delayed diagnosis and substantial tumour burden at the time of imaging.

Bone metastases were present in 35.0% of patients, with marked predominance of vertebral involvement and mainly osteolytic lesions. These findings are consistent with established evidence identifying the axial skeleton as the preferential site of breast cancer bone metastases (Itani et al., 2021; Marie et al., 2022). From a pathophysiological perspective, this distribution is attributed to the bone marrow microenvironment, which provides growth factors that promote tumour cell survival and proliferation. The statistically significant association between thoracic lymph node involvement and thoracic metastases suggests continuity between regional lymphatic spread and distant metastatic dissemination. This finding supports the hypothesis that lymph node involvement functions not only as an indicator of tumour progression but also as a facilitator of systemic spread (Houssami et al., 2012).

Furthermore, the high proportion of multisite metastases observed in this study (64.9%) exceeds that reported in several cohorts from high-income countries (Brookes et al., 2007; Edge et al., 2010; Moy et al., 2016). This disparity may be explained by delayed diagnosis, limited access to specialised oncology services, and the absence of organised screening programmes within the local healthcare context (Cardoso et al., 2018; Sung et al., 2021).

Overall, these findings reaffirm CT imaging as a central modality for staging advanced breast cancer and highlight the need for standardised diagnostic pathways to optimise patient management in resource-limited settings.

CONCLUSION

The most frequent metastatic sites identified in this study were the thoracic region, abdominopelvic organs, and bone structures, in decreasing order of occurrence. The majority of patients presented with multisite metastatic disease.

The predominant CT patterns observed included nodular pulmonary metastases, pleural effusion, heterogeneous hepatic masses, and predominantly osteolytic bone lesions. These findings reinforce the importance of systematic CT evaluation for accurate staging and therapeutic planning in patients with advanced breast cancer.

Authors' Contributions

- **Study conception and design:** L. K. Makwanza, G. M. Luyeye, F. T. Tshibasu, J. T. Mukaya
- **Data acquisition:** S. T. Yanda, D. M. Iyoto, C. O. Ndesazim
- **Manuscript drafting:** L. K. Makwanza, A. A. Molua
- **Data analysis and interpretation:** S. T. Yanda, F. T. Tshibasu, L. K. Makwanza
- **Final revision and approval:** G. M. Luyeye, J. T. Mukaya, D. K. Mashinda

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Use of generative AI: The authors declare that no generative artificial intelligence or AI-assisted technologies were used in the writing or preparation of this research manuscript.

Data Availability: Because participant consent did not include unrestricted data sharing, anonymised datasets may be made available to qualified investigators upon reasonable request to the corresponding author.

Ethical Approval: This study was reviewed and approved by the Ethics Committee of the School of Public Health, University of Kinshasa, acting as the National Ethics Committee (Approval No. ESP/CE/63B/2025). All procedures complied with ethical standards and the principles of the Declaration of Helsinki (1964) and its subsequent amendments..

Conflicts of Interest: None declared.

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