ISSN: 2164-5388 Volume 13, Number 1, January 2023

Scientific Research Publishing

Open Journal of Biophysics

ISSN: 2164-5388

https://www.scirp.org/journal/ojbiphy

Scientific Research Publishing

Open Journal of Biophysics, 2023, 13, 1-13
https://www.scirp.org/journal/ojbiphy
ISSN Online: 2164-5396
ISSN Print: 2164-5388

Contribution of Scintigraphy in the Assessment of Extension of Osteophilic Cancers in Senegal from 2018 to 2021

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How to cite this paper: Fachinan, O.H., Bathily, E.H.L., Djigo, M.S., Houndétoungan, G.D., Issoufou, D.M., Ndong, B., Amoussou-Guénou, K.M. and Mbodj, M. (2023) Contribution of Scintigraphy in the Assessment of Extension of Osteophilic Cancers in Senegal from 2018 to 2021. *Open Journal of Biophysics*, **13**, 1-13.
https://doi.org/10.4236/ojbiphy.2023.131001

Received: September 16, 2022
Accepted: November 1, 2022
Published: November 4, 2022

Abstract

The aim of this study was to highlight the contribution of bone scintigraphy in the assessment of extension of osteophilic cancers in Senegal. This was a retrospective study, with a descriptive and analytical purpose, carried out over a period of four (04) years between January 01, 2018 and December 31, 2021. It focused on the files of patients who underwent bone scintigraphy for extension assessment of an osteophilic cancer during the study period. According to the study, prostate cancer was by far the most representative primary cancer (86.9%). Scintigraphy contributed in 75% of cases (362 cases) with 35% positive scintigraphy and 40% negative scintigraphy. The result was doubtful in 25% of cases (120 cases). The metastatic lesions were located preferentially at the level of the axial skeleton and only one case was of an exclusive appendicular site. More than half of patients with metastases (70%) had a poor prognosis with the SOLOWAY score greater than or equal to II. With the improvement of the nuclear imaging technical platform in Senegal (performance of SPECT/CT examinations), doubtful cases in our sample could be better explored with the advantage of adequate patient care.

Keywords

Bone Scintigraphy, Osteophilic Cancers, Bone Metastases

1. Introduction

Cancer is one of the most common causes of morbidity and mortality worldwide [1]. In Senegal, with an annual incidence of nearly eight thousand cases, cancer is one of the major public health problems because diagnosis is often late and treatment is difficult and costly [2].

The natural evolution of the disease is most often with a spread of cancer cells outside the primary site [3]. Metastatic proliferation follows specific sequential steps from the primary tumor. It is associated with a very reduced survival with an alteration of the quality of life.

Bone is the third most common site of metastatic disease, after the liver and lungs [4]. The cancers most responsible for bone metastases are those of the prostate, breast, thyroid, lungs, kidneys and digestive system [3].

To search for these bone metastases, four medical imaging modalities are commonly used, namely: standard radiography, computed tomography (CT), scintigraphy and magnetic resonance imaging (MRI) [5].

Bone scan remains the most widely used, practical and cost-effective diagnostic technique to assess the whole skeleton for bone metastases since it is more sensitive than other imaging modalities [6].

The aim of the study was to analyze the different scintigraphic aspects in the context of the extension assessment of osteophilic cancers in the nuclear medicine department of the Idrissa Pouye General Hospital in Dakar.

2. Methodology

2.1. Study Method

This was a descriptive and analytical retrospective study. It focused on the files of patients who underwent bone scintigraphy for the assessment of extension of osteophilic cancer in the nuclear medicine department of the Idrissa Pouye General Hospital in Dakar from January 2018 to December 2021. All the studies were performed in the only one functional nuclear medicine service in Senegal.

To collect and exploit the data, we used the patient bone scintigraphy files from the software database (InterViewXP/Médiso), the physical files (clinical observation sheets) of each patient included in the study.

The sampling was exhaustive. For each patient file, the data collected were related to socio-clinical, biological and scintigraphic data. These data were transcribed on a data processing from designed for the study.

2.2. Technique for Performing the Scintigraphic Examination

Bone scintigraphy was done according to the classic protocol on the whole body: anterior and posterior surfaces in order to obtain images of the entire skeleton. For exploration, a diphosphonate derivate, hydroxymethylene diphosphonate (HMDP) labeled with technetium 99 m (^{99m}Tc) was injected intravenously with an activity of 8 to 10 MBq/kg, without exceeding 1200 MBq. The acquisition was carried out in patients in supine position on the examination table, three hours

later, thanks to a scan of the whole body by a SPECT Médiso gamma camera with a high-resolution low-energy collimator at a speed of 15 cm per minute.

3. Results

A total of 482 bone scans were performed as part of an extension assessment from 2018 to 2021 at General Idrissa Pouye Hospital in Dakar.

3.1. General Data

3.1.1. Years of Achievement

The number of bone scans for staging of osteophilic cancer in Senegal has been constantly increasing during the study period, ranging from 70 patients received in 2018 to 174 patients received in 2021.

On average, 120 patients have undergone bone scintigraphy each year to search for secondary bone locations.

3.1.2. Primary Cancers Concerned

Table 1 presents the organ site of the primary cancer of the patients seen for research of secondary bone localizations.

The other primary cancers were as follows: four (4) cases of osteosarcoma, two (2) cases of bladder tumours, one (1) case of tongue tumour, one (1) case of ovarian cancer, one (1) case of cervical cancer and one (1) case of kidney cancer.

It should be noted that according to the D'Amico classification, scintigraphy was justified (intermediate risk and high risk of bone metastases) in almost all patients with prostate cancer (96.2%).

3.1.3. Ages of Patients

The mean age of the patients was 65.69 years and extremes of 17 and 88 years. Table 2 reports the age of the patients according to the primary cancer developed.

3.2. Scintigraphic Data

3.2.1. Indications for Bone Scan

Indications for bone scintigraphy were largely represented by the completion of extension workup (94.8% of cases). There were 19 cases (3.9%) of control scintigraphy and only 6 (1.2%) cases of biochemical recurrence.

Table 1. Distribution of patients according to the organ site of the primary cancer.

Primitive Cancer	Frequency	Percentage (%)
Prostate	**419**	**86.9**
Breast	29	6.0
Thyroïde	24	5.0
Other	10	2.1
Total	482	100.0

Table 2. Age distribution of patients according to the primary cancer developed.

Primary cancer	Ages				
	Mean	Median	Standard deviation	Minimum	Maximum
Prostate	68.22	68.00	7.299	49	88
Breast	49.41	48.00	12.037	28	72
Thyroid	46.54	46.50	13.565	17	68
Other	53.10	57.00	12.600	26	65
Total	65.69	67.00	10.470	17	88

3.2.2. Contribution of Scintigraphy

The scintigraphy was contributory in 75.1% (362 patients) of the cases, with 169 patients (35.1%) presenting bone metastases (positive scintigraphy) against 193 patients (40.0%) with no bone metastases (negative scintigraphy).

The result was doubtful (inconclusive) in 120 patients (24.9%).

- **Primary cancer and scintigraphic results**

Figure 1 shows the distribution of the primary cancer site organ according to the presence of bone metastases.

- **PSA level and presence of metastases**

Figure 2 shows the relationship between the PSA level in ng/ml and the presence or an absence of bone metastases.

Of the 419 patients with prostate cancer, those with bone metastases on scintigraphy had a mean PSA level of 171.35 ng/ml, a median of 106.5 ng/ml and extremes of 10.5 and 850 ng/ml.

Patients without metastases had a mean PSA level of 35.1 ng/ml, a median of 28 ng/ml and extremes of 4.9 and 100 ng/ml.

For those with a dubious scintigraphy, the average PSA level was 60.1 ng/ml, the median level 54 ng/ml and extremes of 6.59 and 180 ng/ml.

- **Histology of prostate cancer and presence of metastases**

In our study, 133 out of 137 (97.1%) patients with metastases had a Gleason score greater than or equal to 7. Of the 53 patients with a Gleason score of 7, 47 had a Gleason score of (4 + 3) versus (3 + 4) for 6 of the patients.

- **Histology of breast cancer and presence of metastases**

Of the 17 patients with bone metastases, 14 (82.4%) had infiltrating carcinoma and 3 (17.6%) had ductal carcinoma in situ.

- **Histology of thyroid cancer and presence of metastases**

Among the 9 patients with thyroid cancer and bone metastases, 8 (88.9%) had papillary carcinoma and only one (11.1%) had vesicular carcinoma.

3.2.3. Topography of Metastatic Bone Lesions

In the study, of the patients who presented with bone metastases, 147 (87.5%) presented with multiple metastatic lesions and 21 (12.5%) presented with a solitary lesion.

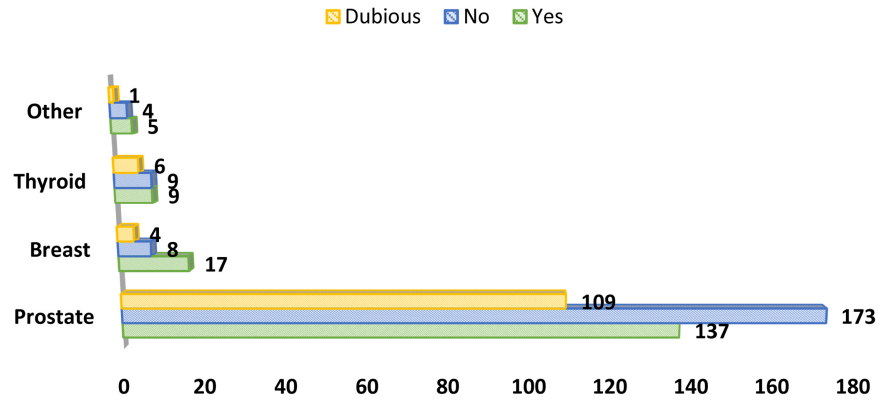

Figure 1. Primary cancer and scintigraphic results.

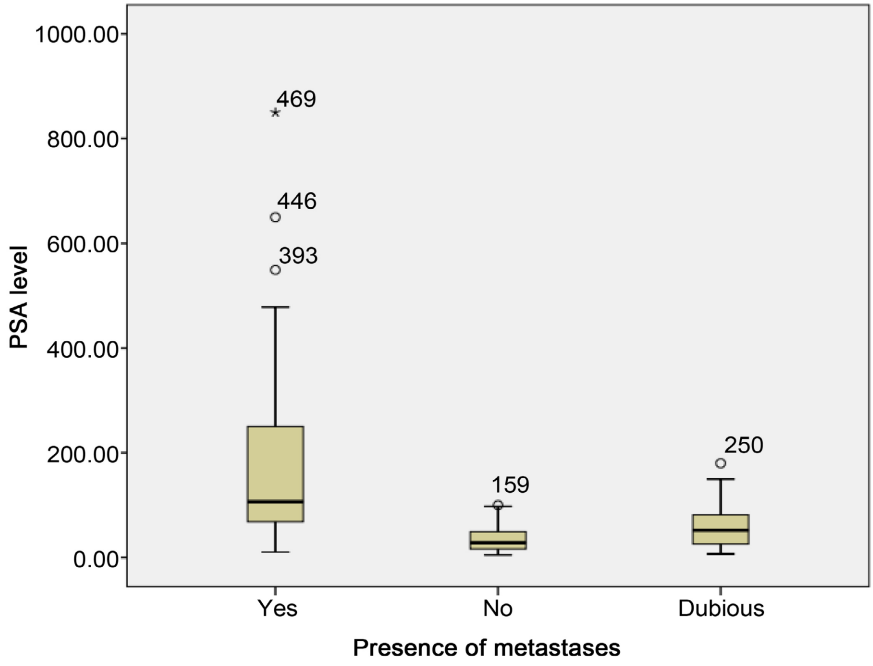

Figure 2. PSA level in ng/ml and presence of metastases.

➢ **topography of lesions**

Figure 3 reports the sites of bone metastases.

NB: the case of an exclusive localization in the appendicular skeleton from a patient that had a prostate cancer.

➢ **Precision of the topography at the level of the axial skeleton**

For patients with bone metastases, our study showed in decreasing order that 124 patients out of 168 (73.8%) had a spinal location, 117 patients out of 168 (69.6%) at the costal grill, 99 patients out of 168 (58.9%) at the pelvic girdle, 88 out of 168 patients (52.4%) at the sternum and 48 out of 168 patients (28.6%) at the chest girdle.

3.2.4. Types of Bone Lesions

The bone metastatic lesions found were raising of uptake in 154 cases (91.7%);

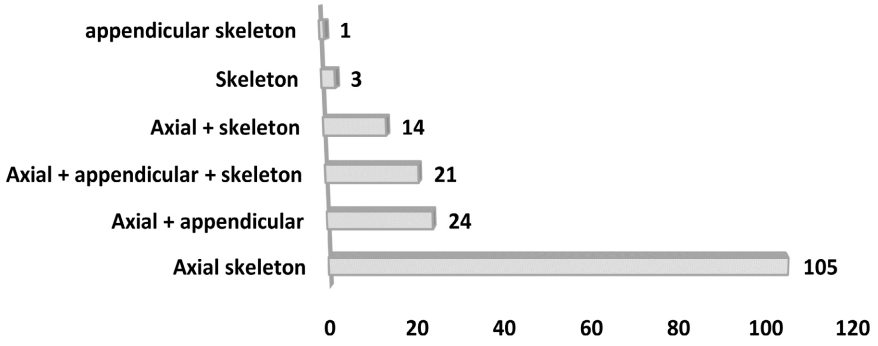

Figure 3. Sites of bone metastases.

mixed (association of high uptake and lytic lesions) in 12 cases (7.1%) and lytic lesions in 2 cases (1.2%). Both cases of lytic lesions were found in patients with thyroid cancer.

3.2.5. Quantification of Bone Involvement

The SOLOWAY score was used to quantify metastatic bone lesions.

51 of 169 patients (30%) had grade I (less than six bone metastases); 57 of 169 patients (34%) had grade II (between six and 20 bone metastases); 42 patients out of 169 (25%) had grade III (more than 20 bone metastases but less than a Superscan) and 19 patients out of 169 (11%) had grade IV (Superscan).

3.3. Some Images of Different Bone Scan Models

Figures 4-6 show some images of different bone scan models from our study.

4. Discussion

4.1. General Data

4.1.1. Years of Achievement

The number of bone scans for extension assessment of osteophilic cancer in Senegal has been steadily increasing from 2018 to 2021. On average, 120 patients have benefited from bone scans each year to search for secondary bone locations. This testifies not only to the increasing evolution of the incidence of cancers in Senegal [1], but also to the increasing visibility of the nuclear medicine department of the Idrissa Pouye General Hospital in Dakar.

4.1.2. Primary Cancers Concerned

Despite being the fourth most common cancer in Senegal after cancer of the cervix, breast and liver [2], prostate cancer, according to our study, was the most representative primary cancer. This cancer is by far the most common primary cancer in our sample because of the proximity (location) of the department that provides the most bone scans for bone metastases. This is the urology department of the Idrissa Pouye General Hospital in Dakar. The physicians of this department are well informed about the services offered by our nuclear medicine department.

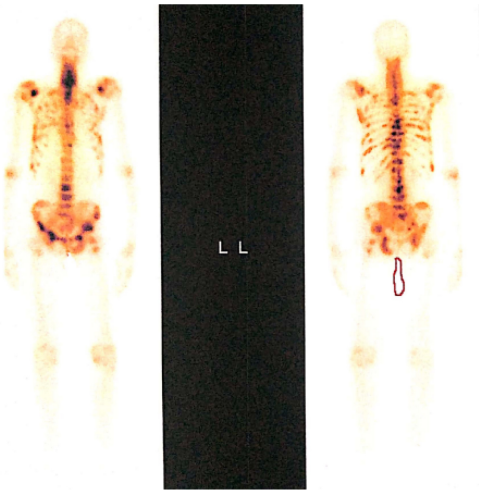

Figure 4. Whole body Bone scan performed in an 81-year-old with prostate adenocarcinoma. Description of **Figure 4**: Whole body Bone scan performed in an 81-year-old with prostate adenocarcinoma. There are multiple focal and intense hyperfixations in the cervical and thoracolumbar spin, anterior and posterior costal arches, sternum and pelvis (sacrum, iliac wings, pubic symphysis, ilio and ischi-pubic branches) compatible with metastases bones. We conclude with a scintigraphic picture of metastatic super bone scan.

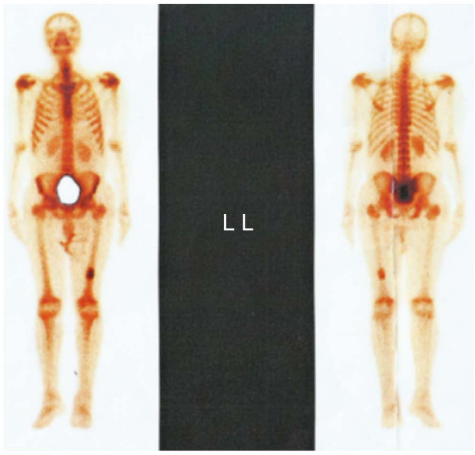

Figure 5. Whole body bone scan performed in an 81-year-old with prostate adenocarcinoma. Description of **Figure 5**: Whole body bone scan performed in an 81-year-old with prostate adenocarcinoma. There are focal hyperfixation in the distal diaphyseal of the left femur suggestive of solitary secondary bone localization (or osteosarcoma?). We therefore conclude that there is a scintigraphic aspect of solitary secondary left femoral bone localization, without ruling out osteosarcoma of the left femur.

It will be necessary to extend and strengthen information to other health structures in order to serve the whole country for the well-being of patients.

4.1.3. Ages of the Patients

The average age of the patients with prostate cancer in our study was 68.22 years and extremes of 49 and 88 years. The mean age of the patients is comparable to those reported in the literature, in particular those observed by Ndong and al (66.71 years) [7], Jalloh and al (65.61 years) [8]. For these authors, prostate cancer

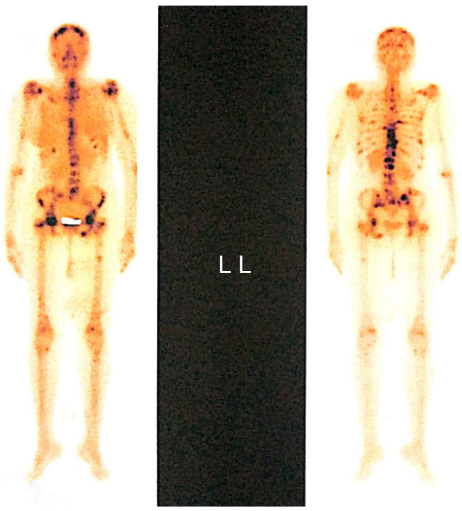

Figure 6. Whole body bone scan performed in 45-year-old patient with left breast carcinoma. Description of **Figure 6**: Whole body bone scan performed in 45-year-old patient with left breast carcinoma. There are multiple focal and intense hyperfixations localized in the skull, cervical and thoraco-lumbar spine, sternum, anterior and posterior costal arches, pelvis (iliac wings, sacrum, ilio and ischio-pubic branch) and left femur, compatible with bone metastases. We conclude that there is a scintigraphic appearance of multiple secondary bone localisations realizing diffuse malignant osteosis.

is a disease of the elderly.

Regarding patients with breast cancer, their mean age in our study was 49.41 years and extremes of 28 and 72 years. Some authors have found similar results, notably El Ajmi *et al.* (51.59 years) [9], Diop *et al.* (46.9 years) [10], Mayi-Tsonga *et al.* (48 years) [11].

As for thyroid cancer, the mean age in our series was 46.54 years and extremes of 17 and 68 years. Williams et al had noted in their study that the incidence of thyroid cancer increases in early adulthood and decreases in people over 75 years [12]. The same findings have also been made by some authors [13] [14].

4.2. Scan Results

4.2.1. Indications and Contribution of Scintigraphy

Indications for bone scintigraphy of patients were largely represented by the completion of extension work-up (94.8% of cases). There were 19 cases (3.9%) of control scintigraphy and only 6 cases (1.2%) of biochemical recurrence. Punnen & Al have noted that several indications require medical imaging in the management of cancerous pathologies [15]. Among the indications, they found nearly 30% biochemical recurrence in their sample [15].

In principle, nuclear imaging in the management of cancerous pathologies is not only performed for the purpose of extension assessment. The lack of an adequate technical platform in Senegal would justify these results. Several authors have argued that the use of 18F-FCholine PET/CT is currently recommended for the search and localization of recurrences in patients with biochemical relapse [16] [17]. Others have gone further by demonstrating the importance

of identifying, by 68Ga-PSMA-11 PET/CT imaging, the locations of recurrence in order to propose optimal locoregional or systematic treatment. They found a higher positivity rate than 18F-Fcholine PET/CT imaging [18] [19].

Scintigraphy contributed in 75% of cases (362 cases). The result was doubtful in 25% of cases (120 cases). It revealed 35% positive scintigraphy and 40% negative scintigraphy.

For patients with prostate cancer, scintigraphy was positive in 32.7% of cases. Ndong and collaborators found a similar result (33.33% positive scintigraphy) in their study [7].

Regarding patients with breast cancer, scintigraphy was positive in 58.6% of cases. Diop and colleagues found 30% positive scintigraphy [10]; a result lower than ours.

As for patients with thyroid cancer, scintigraphy was positive in 37.5% of cases. Similar results have been found in the literature [20].

With the improvement of the nuclear imaging technical platform in Senegal (realization of SPECT/CT and PET/CT examinations), doubtful cases could be better explored with the advantage of adequate patient care.

4.2.2. PSA Blood Level and Positive Scintigraphy

Of the 419 patients with prostate cancer, those with bone metastases on scintigraphy had a mean PSA level of 171.35 ng/ml, a median of 106.5 ng/ml and extremes of 10.5 and 850 ng/ml. Patients without metastases had a mean PSA level of 35.1 ng/ml, a median of 28 ng/ml and extremes of 4.9 and 100 ng/ml.

Already described in the literature, the blood level of PSA is correlated with the presence of metastases [7] [21]. Thus, Jemal and collaborators had shown that a PSA level above 10 ng/ml was indicative of localized prostate cancer; a level greater than 50 ng/ml indicated extra-prostatic involvement in 80% of cases and finally a level greater than 100 ng/ml proved systematic extra-prostatic involvement [21].

4.2.3. Primary Cancer Histology and Positive Scintigraphy

The Gleason score is a histo-prognostic score characterizing the degree of tumor differentiation, and an essential prognostic factor in the management of prostate cancer. It is obtained by adding the two histological grades ranging from 1 to 5, of the most represented cancers [22]. In our study, 133 out of 137 patients (97.1%) with metastases had a Gleason score greater than or equal to 7. Ndong and collaborators in Senegal found in 2011 results slightly lower than ours. In fact, 80% of the patients in their series with a positive scintigraphy had a Gleason score greater than or equal to 7 [7].

For the 53 patients with a Gleason score equal to 7, there were 47 (82.6%) who presented a score (4 + 3) and therefore a poorer prognosis. This subdivision is widely integrated into the therapeutic decision in the case of localized prostate cancer [23].

The histology of the breast cancer of the patients in the study is represented by

infiltrating carcinoma in 58.6% of cases and by ductal carcinoma in situ in 41.4% of cases. However, of the 17 breast cancer patients with bone metastases, 14 (82.4%) had infiltrating carcinoma and only 3 (17.6%) had ductal carcinoma in situ. The analytical study revealed that there is a statistically significant link between the histological type and the presence or absence of metastases ($P = 0.00 < 0.05$). In infiltrating breast carcinomas, malignant cells spread to nearby tissues which may promote distant spread [9].

Among the 9 patients with thyroid cancer and bone metastases, 8 (88.9%) had papillary carcinoma and only one (11.1%) had vesicular carcinoma. In the literature, papillary carcinoma appears to be the most representative cancer of thyroid cancers [24]. However, a correlation between histological types and the presence or absence of bone metastases has not been demonstrated.

4.2.4. Topography of Metastatic Bone Lesions

Multiple metastatic lesions are mainly represented (87.5% of cases of metastases) in our sample. Some authors have also found the predominance of multiple lesions in their respective study [7] [10]. In our study, the metastatic lesions were preferentially located in the axial skeleton and only one case was exclusively appendicular. Our results are comparable to those of the literature [7] [10]. Indeed, tumor cells are localized secondarily by preference to the most richly vascularized parts of the skeleton such as the hematopoietic bone marrow of the axial skeleton, the upper extremities of the humeri, femurs and tibiae [25].

Furthermore, our study showed in decreasing order that 124 patients out of 168 (73.8%) had a spinal localization, 117 patients out of 168 (69.6%) at the level of the costal grill, 99 patients out of 168 (58.9%) at the pelvic girdle, 88 patients out of 168 (52.4%) at the level of the sternum and 48 patients out of 168 (28.6%) at the thoracic girdle. These results are almost identical to those found by some authors in the literature [7] [10].

4.2.5. Types of Bone Lesions

Bone metastases in our study were largely represented by hyperfixing lesions. The results are comparable to those found by Diop and colleagues [10]. Bone hyperfixation is suggestive of metastasis, but unequivocal because of its non-specificity [10]. Indeed, there was a differential diagnosis between metastases and benign pathologies which are linked to significant bone remodeling, especially when these foci of osteoblastic hyperfixation were unique and/or were located at the level of particular anatomical regions (for example near joints) [10].

Only two patients in our study presented osteolytic lesions. Lytic lesions are exceptional, linked to increased osteoclast activity and are often found in cases of thyroid or breast cancer [3].

4.2.6. Quantification of Bone Involvement

The SOLOWAY score was used to quantify metastatic bone lesions. This quantification technique revealed that more than half of patients with metastases (70%) had a poor prognosis with a grade greater than or equal to II. This meant that

these patients consulted late or were poorly monitored on an outpatient basis, as we mentioned above. The same observation has been made in the literature [7] [9].

For patients with prostate cancer, the mean and median of the PSA level increased with the grades of the SOLOWAY score. Already described in the literature, there is an increasing relationship between SOLOWAY grades and PSA level [7] [26].

5. Conclusions

Bone scintigraphy occupies a place of choice in the detection of bone metastases, due to its high sensitivity. It can determine the prognosis by taking into account the number of locations, the topography and the metastatic bone tumor volume which are predictive factors of the patient's survival time.

Its low specificity raises the indication of an improvement of the technical platform of nuclear imaging in Senegal (performance of SPECT/CT, PET/CT examinations). Thus, the doubtful cases of our sample could be better explored with the advantage of adequate patient management.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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