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Review Article

^{99m}Tc-Mibi Parathyroid Scintigraphy in the Exploration of Hyperparathyroidism in Senegal: A Study of 66 Cases in the Idrissa Pouye General Hospital, Dakar

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Abstract: Hyperparathyroidism is a common endocrinopathy, and parathyroid scintigraphy is part of the preoperative work-up. A prerequisite for adenoma surgery is precise localization of the pathological gland(s) concerned. Our aim was to review the parathyroid scans performed for hyperparathyroidism in Senegal. We carried out a retrospective study over a period of 2.5 years, including patients with hyperparathyroidism who underwent parathyroid scintigraphy with ^{99m}Tc-MIBI, in the nuclear medicine department of the Idrissa Pouye General Hospital in Dakar. A total of 66 patients were included. The mean age was 52 years, with a sex ratio (M/F) of 0.34. The majority of patients were from the capital, Dakar (93%). Primary hyperparathyroidism was the predominant indication (70%). Most patients were symptomatic. Mean parathyroid hormone (PTH) and Calcemia were 464 pg/ml and 98 mg/l respectively. Ultrasound revealed a thyroid nodule in 35% of cases. The scintigraphy was in favour of parathyroid adenoma (30%) with a predominant right upper location (right P4) (35%) and poor concordance between cervical ultrasound and parathyroid scintigraphy was observed with a kappa coefficient k=0.04. Parathyroid scintigraphy with ^{99m}Tc-MIBI allows precise localization of hyper functioning glands, enabling unilateral or minimally invasive cervical surgery to be adopted and reducing the therapeutic failure rate.

Keywords: Hyperparathyroidism, Scintigraphy, ^{99m}Tc-MIBI, Senegal

1. Introduction

Hyperparathyroidism is the excessive and inappropriate secretion of parathyroid hormone (PTH) by one or more parathyroid glands. It is the most frequent cause of hyper-calcemia in ambulatory patients [1]. There are three types of hyperparathyroidism: primary, secondary and Primary hyperparathyroidism is an autonomous secretion of PTH. Its incidence worldwide has been rising steadily since the introduction of routine Calcemia testing, making primary hyperparathyroidism the third most frequent endocrinopathy after diabetes and hyperthyroidism [2]. In Western Europe, the incidence of unspecified hyperparathyroidism has risen steadily to 40.3 per 100,000 female years and 13.7 per 100,000 male years [3]. In Senegal, the incidence and prevalence of hyperparathyroidism are poorly understood. It is a disease with a female predilection [3]. With systematic screening of calcium levels, the diagnosis is made at the asymptomatic stage, and the etiology is dominated by parathyroid adenoma. Para-thyroidectomy is the treatment of

choice for primary hyperparathyroidism when clinical criteria are met. Ultrasound and parathyroid scintigraphy remain indispensable tests for the preoperative localization of parathyroid adenoma. Dual-isotope scintigraphy using ^{99m}Tc-Mibi (Metastable Technetium-99 – Methoxyisobutylisonitrile) (thyroid and parathyroid fixation) combined with iodine-123 or ^{99m}Tc (thyroid fixation only) remains the examination of choice today in an attempt to localize the hype-functioning gland(s). Through a retrospective study from January 2020 to July 2023 of patients who underwent parathyroid scintigraphy with ^{99m}Tc-Mibi in the nuclear medicine department of the Idrissa Pouye General Hospital (HOGIP), and updated documentation, this study aims to determine the precise role of this investigation in the accurate localization of parathyroid adenoma.

2. Patients and Method

This was a retrospective, descriptive and analytical study of all the records of patients who underwent parathyroid scintigraphy with ^{99m}Tc-Mibi, during the period from January 1, 2020 to July 31, 2023.

All patients underwent parathyroid scintigraphy using the double isotope subtraction technique (^{99m}Tc and ^{99m}Tc-Mibi) with a dual-head SPECT gamma camera (Mediso Nucline TM Spirit DH-V type) (Figure 1).

Figure 1. *Gamma camera SPECT, double head brand MEDISO NUCLINE TM SPIRIT DH-V, with acquisition console on right (HOGIP).*

The examination protocol was always as follows:

1) Preparing the patient and drawing up the observation sheet
   a. Identification and validation of the scintigraphy prescription and the documents required at the time of the examination;
   b. Obtain results of previous examinations: biology (parathormone, blood calcium, vitamin D, etc.), imaging (ultrasound, scintigraphy, and other examinations);
   c. Look for a history of: cervical surgery, particularly thyroid or parathyroid surgery
   d. Ensure there is no iodine overload (X-ray examination with iodine contrast injection: 4 weeks to 3 months; iodine-containing medication).
   e. Avoid possible drug interference
   f. Search for possible pregnancy (date of last menstrual period, β CGH assay) (β Chorionic Gonadotrophic Hormone);
   g. Suspension of breastfeeding for at least 12 hours in the case of a nursing mother;
   h. Patient information was given on arrival in the department (examination objectives, expected benefits, examination conditions and various stages, time between injection and image acquisition);
   i. Physical examination of the patient, with emphasis on anterior cervical examination.
2) Radiopharmaceutical injection and image acquisition (Figure 2)
   a) Pertechnetate injection and thyroid acquisition:
      a. The radiotracer injected by the DIV (Direct intravenous) route is free technetium in the form of pertechnetate.
      b. Injected dose: 111 MBq (3 mCi) on average (75 to 150 MBq) in adults.
      c. Images were taken an average of 20 min after radiopharmaceutical injection using a front centred gamma camera;
      d. The patient was in dorsal decubitus position, neck in discreet hyper-extension, under the camera;
   b) 99mTc-sestamibi injection and cervicothoracic acquisitions:
      a. IV injection of approximately 600 MBq ^{99m}Tc-sestamibi (400 to 740MBq),
      b. Wait 5 to 10 minutes, then acquire the cervicothoracic image with the parallel collimator.
      c. Cervicothoracic acquisitions at 20, 30, 40 and 1 hour 30 minutes;
      d. If no focus identifiable on early acquisitions, thyroid/parathyroid images late time (~90-120 minutes after 99mTc-sestamibi injection).

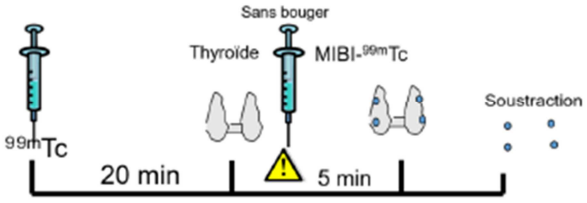


Figure 2. *Protocol for subtraction parathyroid scintigraphy.*

   c) Image processing
      a. Quantitative analysis of thyroid scintigraphy was determined using the region of interest (ROI)

technique;

b. Visual image analysis (qualitative scintigraphy)

c. Digital subtraction of the images collected with the two isotopes, with registration images before subtraction if necessary (patient motion correction).

d) Image interpretation:

It is carried out by an experienced nuclear physician and then certified by a senior nuclear physician.

In the thyroid area: Any residual focus after image subtraction will be considered as possibly corresponding to an abnormal parathyroid gland (Figure 3).

Outside the thyroid area: Any focalized image located in the neck or mediastinum (in possible parathyroid gland sites), independent of physiological fixation sites (salivary glands, myocardium, etc.), will be considered as a possible abnormal parathyroid gland (ectopic).

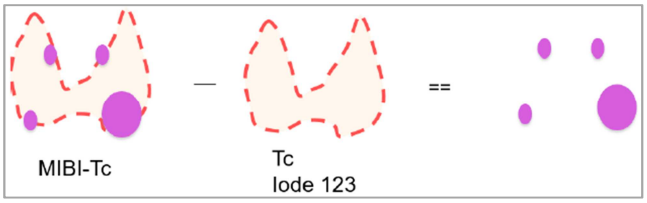


Figure 3. *Illustration of the interpretation of subtraction parathyroid scintigraphy.*

Statistical analysis

Using the kappa coefficient, we measured the agreement between cervical ultrasonography and parathyroid scintigraphy in the diagnosis of parathyroid adenomas. We obtained a numerical agreement between these two diagnostic techniques, the judgment of which is qualitative (presence or absence of parathyroid adenoma). This agreement is defined as the conformity of two pieces of diagnostic information (ultrasound and parathyroid scintigraphy) relating to the same object (adenoma).

The kappa coefficient was calculated as follows:

$$k = \frac{Pr\,(a) - Pr\,(e)}{1 - Pr\,(e)}$$

Pr (a) is the relative agreement between two techniques.

Pr (e) is the probability of a random or expected agreement

The kappa coefficient is expressed as a number between -1 and 1.

< 0 complete mismatch

0.01-0.20 poor match

0.21- 0.40 poor agreement

0.41-0.60 moderate agreement

0.61-0.80 good agreement

0.81-0.99 excellent agreement

Data processing and analysis, i.e. tables and figures, was carried out using Excel software.

Quantitative variables are expressed as averages, while qualitative variables are expressed as percentages.

Ethical considerations

Patient consent was not mandatory for this retrospective study.

However, all other ethical requirements relating to health research were respected. Patient data were treated confidentially and in strict compliance with medical secrecy.

3. Results

3.1. Age and Gender

Over a period of 2 years 6 months, 66 patients were collated, including 49 women and 17 men, with a sex ratio of 0.34.

The mean age was 52 years, with a standard deviation of 13.10. The most common age group was over 60, accounting for 36% of patients (Figure 4).

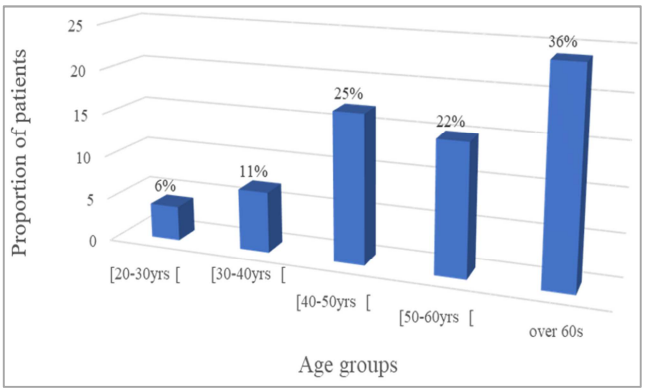


Figure 4. *Proportion of patients by age range.*

3.2. Patient Distribution by Geographic Origin

Most of our patients were from the capital, Dakar (93%); the remaining 7% came from other regions (Figure 5).

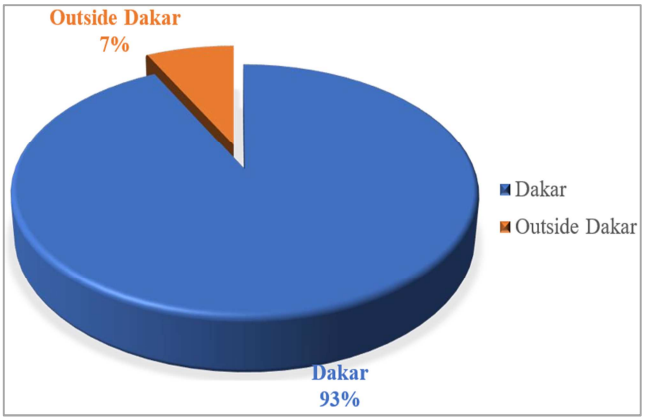


Figure 5. *Patients distribution by geographical origin.*

3.3. Breakdown by Prescribing Department

The bulk of parathyroid scintigraphy prescription bulletins came from Endocrinology departments, with 35% of prescriptions, followed otorhinolaryngology (ORL) (20%) and Nephrology (20%). Internal medicine ranked fourth with 16% of prescriptions, followed by rheumatology with 3%, haematology, oncology, hepato-gastrology and one unspecified department (Figure 6).

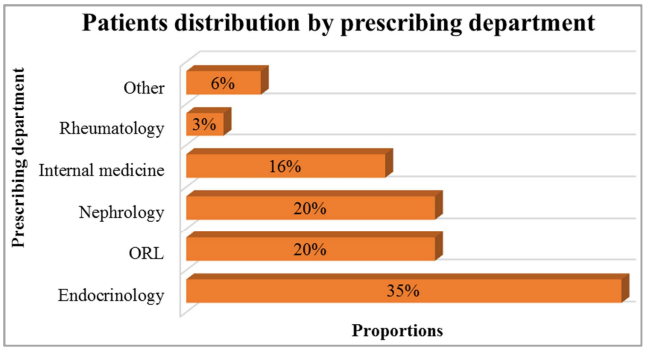


Figure 6. *Patients distribution by prescribing department.*

3.4. Breakdown by Indication

Primary hyperparathyroidism was the most predominant indication, accounting for 70% of cases. A few rare indications of secondary hyperparathyroidism (7%) and tertiary hyperparathyroidism (3%) were noted. However, 12 cases of imprecise indications were noted (hyperparathyroidism only). Figure 7 illustrates the indications.

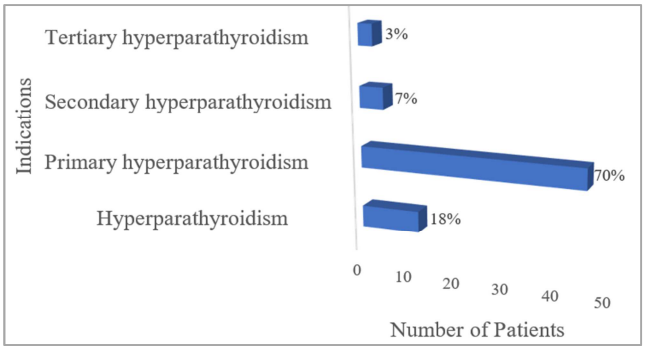


Figure 7. *Distribution of patients by indication.*

3.5. Distribution by History

Over the majority of the cohort were hypertensive (56%), 10% had undergone thyroidectomy, and 19% para-thyroidectomy. Chronic renal failure and diabetes accounted for 16% of cases. A history of gout (6%) and renal lithiasis (6%) was also noted.

3.6. Clinical Aspect

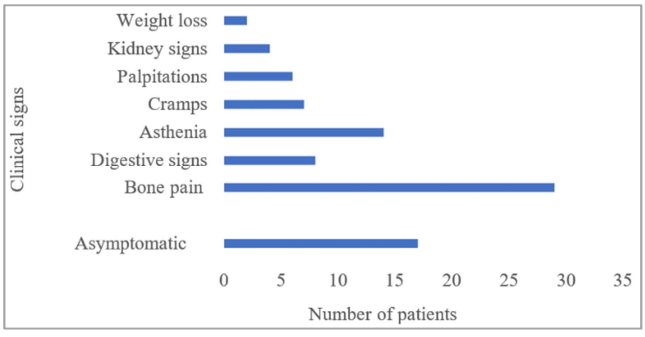


Figure 8. *Distribution of patients by clinical signs.*

Of the 66 patients surveyed, 26% were asymptomatic, 29 had bone pain (43%) as their main clinical sign, 14 had asthenia (21%), and 6 patients had vomiting as their main sign (9%). Other signs included muscle cramps (7 cases), palpitations (5 cases) and renal manifestations (4 cases). Figure 8 illustrates the presentation of clinical signs.

3.7. Para-Clinical Aspects

Biology:

PTH was available in 44 patients, 97% were biologically hyper-parathyroid (PTH greater than 60 pg/ml) with a mean PTH equal to 464 pg/ml and extremes of 47.6 and 2900 pg/ml.

Hyper-calcemia (blood calcium greater than 106 mg/l) was found in 28 patients. Mean calcemia was 98mg/l.

Mean phosphorus level was 37.5mg/l.

A drop in Vitamin D was found in 11 patients, with a mean vitamin D level of 24.6ng/ml. Table 1 shows the biological results.

Table 1. *Breakdown of biological results.*

Biological parameters	Average	Standard deviation
PTH	464 pg/ml	686,9
Calcemia	98 mg/l	18,7
Phosphoremia	37,5 mg/l	7,12
Vitamin D	24,6 ng/ml	13,3

Ultrasound:

Cervical ultrasound findings were available in 20 patients, 35% of whom were found to have a parathyroid adenoma (6 nodules and one parathyroid hyperplasia). One case of cervical sub maxillitis was noted, 1 case of thyroid nodules. Ultrasound scans were normal in 55% of cases (Figure 9).

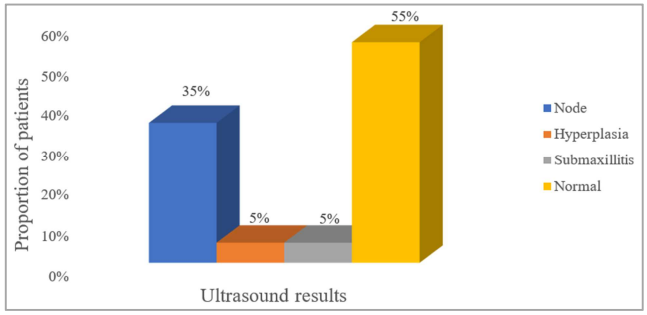


Figure 9. *Patient distribution according to cervical ultrasound findings.*

Scintigraphy results

The scintigraphy showed parathyroid adenoma in 20 patients (30%).

Two results were inconclusive (doubtful) hampered by thyroidectomy.

The adenoma was single in 81% of cases, and multiple in 4 cases (double in 3 and triple in 1) (Figure 10).

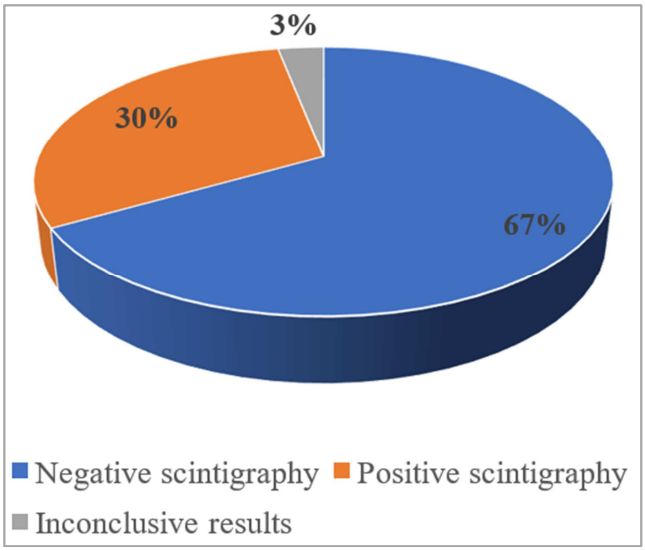


Figure 10. *Distribution of patient according to scintigraphy results.*

Patient distribution by adenoma location (Figure 11)

Upper right (P4 right) was predominant (35%), with 20% of adenomas in upper left, 15% in lower right (P3 right) and 25% in lower left, and ectopic in the 15% (mediastinum, left sub-lobar). One case of double adenoma with ectopic and inferior localization was also noted.

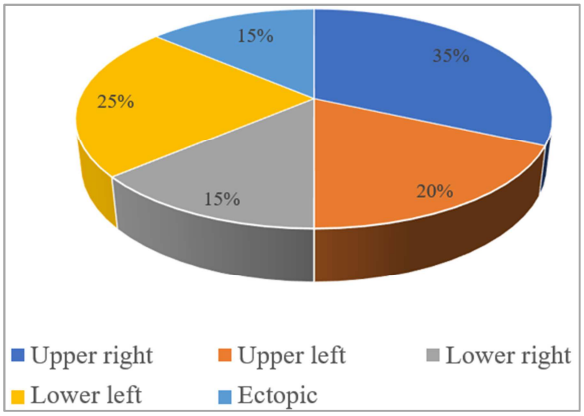


Figure 11. *Distribution of patient according to adenoma location on scintigraphy.*

The concordance between scintigraphy and ultrasonography is shown in table 2.

Table 2. *Concordance table between scintigraphy and ultrasonography.*

Ultrasound				
		Positive	**Negative**	**Total**
Scintigraphy	Positive	7	20	27
	Negative	12	44	56
	Total	19	64	83

Calculation of the concordance coefficient Cc

$$Cc = \frac{\text{Sum of matching results}}{\text{Total number of examinations}} = \frac{7+44}{83}\ 0.61(61\%)$$

We obtained a concordance of 61%

Let's calculate the expected match Ca

$$Ca = \frac{(19x27) + (64x56)}{83x83} = 0.59 \text{ or } 59\%$$

We obtained a Ca random agreement of 59%.

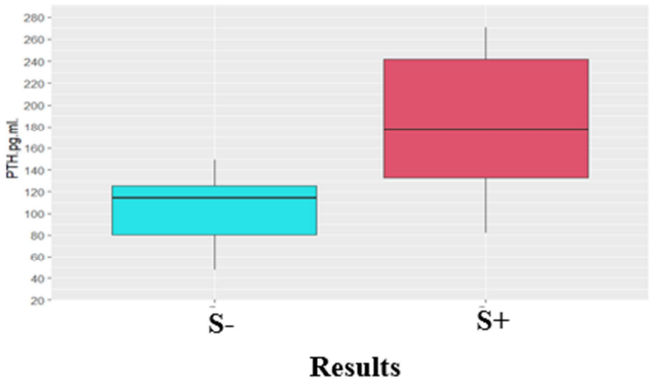
Correlation between adenoma and PTH

In patients with a positive scintigraphy, the minimum PTH level was 82 pg/ml and 50% had a PTH of over 177 pg/ml.

In patients with a negative scintigraphy, the minimum PTH value was 47.6 pg/ml, and 50% of them had a PTH of less than 114 pg/ml.

There was a significant difference between the two medians.

We could then conclude that there was a correlation between PTH levels and the presence of adenoma on scintigraphy (Figure 12).



S-: Negative scintigraphy; S+: Positive scintigraphy

Figure 12. *Correlation between adenoma and PTH.*

4. Discussion

Age and gender:

In our series, the mean age was 52 years, with extremes of 21 and 76 years.

The sex ratio was 0.34 (M/F) in favour of women. These results corroborate the data in the literature.

In Senegal, A. Dia et al [4] found a mean age of 47.3 years, with extremes ranging from 29 to 66 years, and a M/F sex ratio of 2/8.

Niass [5] found a mean age of 51.35 at diagnosis (extremes 19 and 69) in 18 women and 4 men.

Foufouo [6] had a mean age of 51.36 years, with extremes between 19 and 69 years, and a female predominance (81%) in his series.

Ahmed [7] found a mean age of 47.16 years, with extremes of 7 and 81 years.

In Europe, a study carried out in Denmark showed an average age of 50 for primary hyperparathyroidism, with a predominance of women [8].

In Morocco, A. Kerekou obtained 34 patients meeting the criteria for hyperparathyroidism. The mean age was 42.4 years, with a sex ratio of 0.09 [9]. In developed countries, however, these data differ: the average age at diagnosis was older.

In South Africa, a single-center hospital study reported an average age of 60, with 78.6% of women [10].

In North America, hyperparathyroidism appears at a much later age, with an average of 60.4 and a higher susceptibility in women (77%) [11].

In China, Xiaoyun Lin had a mean age and age of onset of 58.44 ± 14.11 and 56.16 ± 14.60 years respectively. The study group comprised 457 patients: 352 (77.0%) were women, 105 (23.0%) were men (female: male ratio 3.4:1) [12].

In Saudi Arabia, a retrospective multi-center study showed a mean age of 59.8 ± 15.5 years, with more women than men (3/1) [13].

Geographical origin

Almost all our patients (93%) were from the Dakar region. This may be explained by the availability of parathyroid scintigraphy in Dakar, where Senegal's only functional nuclear medicine department is located.

The prescribing department

In our series, the majority of parathyroid scintigraphy prescriptions came from Endocrinology departments (35%), which can be explained by the association of primary hyperparathyroidism (endocrine pathology) with multiple endocrine neoplasia type 1 (NEM 1), NEM2A and NEM 4 [14], which are pathologies of the endocrinology specialty. Secondary hyperparathyroidism, mainly of renal etiology, accounts for 20% of prescriptions from nephrology. Finally, the management of parathyroid adenomas, particularly surgery, is the responsibility of the ENT specialty, which accounts for 20% of prescriptions.

Indications: [2,15]

Parathyroid scintigraphy is specifically indicated to locate parathyroid adenomas or parathyroid hyperplasia, in patients with hyperparathyroidism, which is determined on the basis of elevated parathyroid hormone levels and in the establishment of elevated serum calcium.

Localization of hyper-functioning parathyroid tissue (adenomas or hyperplasia) in primary hyperparathyroidism is useful before surgery to help the surgeon locate the lesion, thus shortening the procedure time. In the past, when surgery involved bilateral exploration of the neck, parathyroid scintigraphy was controversial. However, with today's minimally invasive para-thyroidectomy, preoperative parathyroid scintigraphy can be extremely useful in reducing the duration or extent of surgical exploration. Parathyroid scintigraphy may also be indicated for the localization of hyper-functional parathyroid tissue in patients with persistent or recurrent disease. Many of these patients will already have undergone one or more surgical procedures, making re-exploration more technically challenging. In addition, ectopic tissue is more prevalent in this population, and preoperative localization is likely to enhance surgical success, in part by helping to guide the surgical approach.

Background:

Our study showed that 56% of our patients were hypertensive (hypertension), which correlates with the study by DIA et al [4], who found that 40% of their patients were hypertensive.

However, it is difficult to attribute hypertension to hyperparathyroidism, especially as hypertension was diagnosed long before hyperparathyroidism. We know that hyperparathyroidism has adverse effects on the heart and cardiac cells, such as cardiac hypertrophy, remodelling and arrhythmias [16]. Seven cases of thyroidectomy were reported in our series; in the literature, rare cases of hyperparathyroidism secondary to thyroid surgery have been reported [17-18]. This may be related to auto-transplantation of the parathyroid gland during thyroidectomy or a history of cervical irradiation [18].

Thirteen patients, or 19%, had undergone para-thyroidectomy; recurrence of sporadic primary hyperparathyroidism after initial surgical cure in the minimally invasive para-thyroidectomy era is 2.5% [19].

Reema Mallick et al [20], of these 261 patients, 28 (10.7%) had a recurrence. The mean time to recurrence was 77 months (range 13-170). Identifying those at risk of recurrence using studies of serum calcium ≥6.9 mg/dl, parathyroid hormone ≥8 pg/ml and/or potentially conflicting localization studies can inform surveillance strategies. Surgical failure (defined as persistent hyper-calcemia and hyperparathyroidism) occurred in five cases (1.7%) according to the study by Enrico Battistella et al [21]. Uncertain preoperative localization of the adenoma may be responsible for these recurrences.

Clinical aspects:

In our cohort, 26% were asymptomatic; our series corroborates the study by DIA et al [4] which found 90% of patients to be symptomatic, as well as that of A. KEREKOU et al in Morocco with 100% symptomatic patients [22]. At the same time, these results differ from those of Shonni J et al [23], who found only 20 patients (17%) out of 221 with symptoms of hyperparathyroidism, and Enrico Battistella et al [21], with over 85% of patients asymptomatic.

Houra et al [24] in Senegal found that 66% of patients were asymptomatic. Asymptomatic hyperparathyroidism has been the dominant clinical phenotype of primary hyperparathyroidism in the USA and Western Europe for the past 4 years [25].

Skeletal manifestations (43%), asthenia and digestive manifestations dominated the clinical picture of symptomatic patients, corroborating the studies by DIA et al and FOUFOUO et al in Senegal [6, 4], as well as that by A. KEREKOU et al [22].

Para-clinical aspects:

Biology

Of the patients for whom PTH was available, it was high in almost all (97%) with a mean PTH of 464 pg/ml, a mean similar to that of HOURA et al [24] but higher than that of DIA et al; FOUFOUO et al [4, 6].

Hyper-calcemia was found in 42% of cases, with a mean calcemia of 98mg/l, similar to other studies carried out in Senegal [4-6, 24]. A mean phosphoremia of 37.5 mg/l was observed in our study, similar to that of DIA [4].

Table 3. *Comparison of biological results with those of other studies.*

Authors	Average PTH pg/ml	Average Calcemia mg/l	Average Phosphoremia mg/l	Average Vitamin D ng/ml
Our study	464	98	37,5	13,3
DIA [4]	267,29	117,29	30,44	--
AHMED [7]	427,46	119,25	--	--
FOUFOUO [6]	248,2	117,7	30,1	--

Ultrasound results

Ultrasound is the first-line examination for the diagnosis of parathyroid adenomas, with a sensitivity of 68% to 95% [26]. It allows the diagnosis of parathyroid adenoma by objectifying the adenoma in the form of a nodule. In our series, ultrasound was suggestive of parathyroid adenoma in 35% of cases. This is linked to the conditions in which the examination was carried out (equipment, experience of the sonographer). The advantage of ultrasound is that it can identify any associated thyroid pathology, which was also found in our cohort.

Scintigraphy results

Sestamibi parathyroid scintigraphy plays a crucial role in the topographical diagnosis of hyperparathyroidism. When carried out preoperatively, it can diagnose an ectopic adenoma, thereby guiding the surgical procedure and limiting the risk of re-intervention. In our study, image acquisition was carried out using the dual tracer method: dual isotope image acquisition (99mTc and 99mTc-sesta- MIBI) with subtraction images followed by late image acquisition, early and late mediastina image acquisition in search of ectopic. The sensitivity of parathyroid scintigraphy is 67.1%, with a specificity of 92.3% [27].

N. Fujimoto et al had a sensitivity of 84.6% [28] and depends on gland size and secretory activity.

The majority of our patients at the time of the study had not yet undergone surgery, making it impossible to make a comparative study with the anatomopathological results. Seventeen positive examinations showing a right or left sub-lobar focus selectively capturing MIBI were found, and 3 positive examinations showed an ectopic focus (one left sub-lobar and one mediastina), thus corroborating the series by I.. Essongue Ozouaki et al in Casablanca [29], as well as that of I. Ghfir in Rabat [30].

Location of adenoma

Scintigraphy localized the adenoma with a right upper and left lower predominance similar to the results of Leblanc's study [31] and Hamidi's [32].

Table 4. *Comparison of adenoma location with another study.*

Authors	Upper right	Upper left	Lower right	Lower left
Our Study	35%	20%	15%	25%
Leblanc [31]	28%	26%	36%	39%

Correlation between PTH and parathyroid adenoma

A correlation between PTH level and parathyroid adenoma on scintigraphy was observed in our series corroborating the K. Limam [33] and Marios [34] series.

Furthermore, different studies have demonstrated varying degrees of relationship between several preoperative serum PTH levels with respect to adenoma volume and weight.

Rutledge et al [35] have shown a relationship between preoperative serum PTH and calcium levels with gland weight or volume.

In a retrospective study, Mozes et al [36] concluded that extreme PTH values in patients with parathyroid disease alert the surgeon to the size of the adenoma.

In Senegal, a case of a giant adenoma weighing 15kg was observed, and the laboratory results had found an elevated PTH of more than 50 time's normal [37].

Concordance between cervical ultrasound and scintigraphy

A poor correlation was found in our series, with a kappa coefficient of 0.04. There was no correlation between ultrasound and parathyroid scintigraphy in our series. This may be related to the insufficient number of cervical ultrasounds available compared with the number of scans.

Tublin [38] found that the sensitivity and positive predictive value of ultrasound for identifying abnormal parathyroid glands were 74% and 90%, respectively.

The two techniques are complementary in adenoma localization, and their combination gives better results in terms of sensitivity and specificity [39]. The overall sensitivity of ultrasound combined with ^{99m}Tc-MIBI scintigraphy in primary hyperparathyroidism is 81% [40].

However, Sestamibi scintigraphy is significantly more sensitive for ectopic parathyroid adenomas, providing correct localization in 8/8 cases [41].

In parallel, the diagnostic performance of Fluorocholine PET/CT (^{18} F-Choline) is superior to that of MIBI scintigraphy and ultrasound [42].

A retrospective study carried out in a university hospital, including 157 patients with primary hyperparathyroidism, found the sensitivity of Fluorocholine PET/CT to be 99.3% higher than that of ultrasound (75.2%), MIBI scintigraphy (65.1%) and ultrasound-coupled scintigraphy (89.9%) [42].

^{18} F-Choline PET/CT has high diagnostic power in primary hyperparathyroidism and can be used for further evaluation of patients with inconclusive cervical ultrasound and ^{99m}Tc-MIBI scintigraphy [43].

5. Conclusion

The most common endocrinopathy after diabetes and hyperthyroidism, it is diagnosed biologically and often at an asymptomatic stage. The etiology is dominated by parathyroid adenoma. Parathyroid scintigraphy with ^{99m}Tc-MIBI remains an indispensable examination for the preoperative localization of parathyroid adenoma. It allows precise localization of hyper-functioning glands, enabling unilateral or minimally invasive cervical surgery to be performed and reducing the rate of therapeutic failure.

MIBI scintigraphy is more sensitive than ultrasonography

in localizing a hyper-functioning parathyroid in the usual or ectopic position. The use of new tracers and new technologies will enhance the performance of this examination. Gamma-cameras coupled with CT scans (SPECT/CT) improve the sensitivity and accuracy of localization. 18F-choline PET/CT is particularly useful in cases where SPECT (or SPECT/CT) is negative or inconclusive.

Abbreviations

PTH: Parathyroid Hormone
HOGIP: Idrissa Pouye General Hospital
^{99m}Tc: Metastable Technetium-99
MIBI: Methoxyisobutylisonitrile
β CGH: β Chorionic Gonadotrophic Hormone
DIV: Direct Intravenous
SPECT: Single-Photon Emission Computer Tomography
ROI: Region of Interest
ORL: Otorhinolaryngology

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Conflict of Interest

The authors declare no conflicts of interest.

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