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Neuroblastoma Revealed by ^{99m}Tc - HMDP Bone Scan

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Abstract **Case Report**

Neuroblastoma is the second most common solid tumor in children, after central nervous system tumors. However, it is the most common malignant neoplasm in infants arising from neural tissue. Bone scintigraphy is typically performed for staging. We report the case of a 2.5-year-old child admitted for exploration of bone pain with deterioration of general condition, and a biological inflammatory syndrome. Bone scintigraphy, performed as part of his assessment 2 hours after injection of HMDP labeled with 99mTc, objectified the presence of heterogeneous uptake in the right hypochondrium, pushing back the homolateral kidney with extension to the vertebral plane, initially suggesting a retroperitoneal mass in contact with the upper pole of the kidney. It is associated with hyperfixations of the left orbital floor, the left humerus and the femurs. Metastatic neuroblastoma to the bone was then suspected. Computed tomography (CT) scans revealed the presence of a large intra- and retroperitoneal tumor invading the right renal hilum. 131I-MIBG scintigraphy confirmed the diagnosis suggested by the bone scan. Neuroblastoma is a difficult tumor to diagnose, given its rarity and the age of the children affected. 99mTc-HMDP bone scans can reveal indirect signs that can point toward the diagnosis of neuroblastoma.

Keywords: Neuroblastoma, bone scan.

INTRODUCTION

Neuroblastoma (NB) is a poorly differentiated malignant tumor originating from neural crest cells and developing within the sympathetic nervous system. It is the most common extracerebral solid tumor in children, accounting for approximately 8 to 10% of pediatric cancers [1]. The annual incidence of neuroblastoma decreases exponentially with age at diagnosis. In 75% of cases, the tumor originates in the abdominal region, with a predilection for the adrenal gland in approximately 32% of cases, and in the thorax in 15% of cases [2]. The clinical course is closely linked to several prognostic factors, including the child's age at diagnosis (less than or more than one year), the extent of the tumor, and the possible presence of N-myc gene amplification within the tumor [3,4]. His positive diagnosis is based on the combination of imaging data, urinary catecholamine dosage, meta-iodobenzylguanidine (MIBG) scintigraphy and tumor samples. To assess the bone extent of the disease, a bone scan is usually performed [5,6]. Through this case, we illustrate the need to be attentive to small scintigraphic anomalies, particularly in pediatric pathology.

OBSERVATION

Our case is a 3-year-old patient from a non-consanguineous marriage, with no particular medical history. He was admitted for investigation of bone pain with impaired general condition and a biological inflammatory syndrome. The clinical examination revealed:

- Bilateral peri-orbital ecchymosis
- Hutchinson syndrome, consisting of exophthalmos and macrocrania at 55 cm

A bone scan was performed as part of his assessment 2 hours after an IV injection of 3.5 mCi of 99mTc-labeled HMDP, using static images of the entire skeleton.

The results showed:

- Focus of hyperfixation in the left orbital floor (Figure 1)
- Reinforcement of moderate fixations affecting the left humeral shaft (Figure 1), and the femoral shafts bilaterally, more marked on the right (Figure 2) and the right calcaneus (Figure 3).

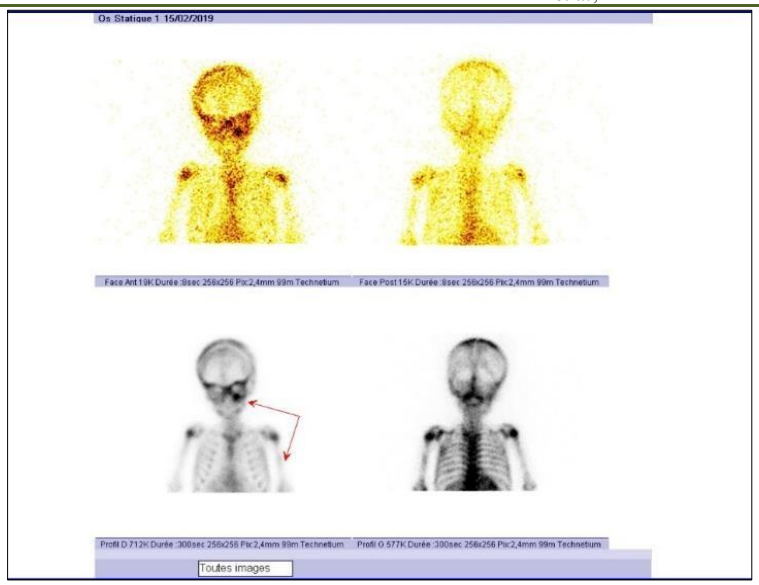

Figure 1

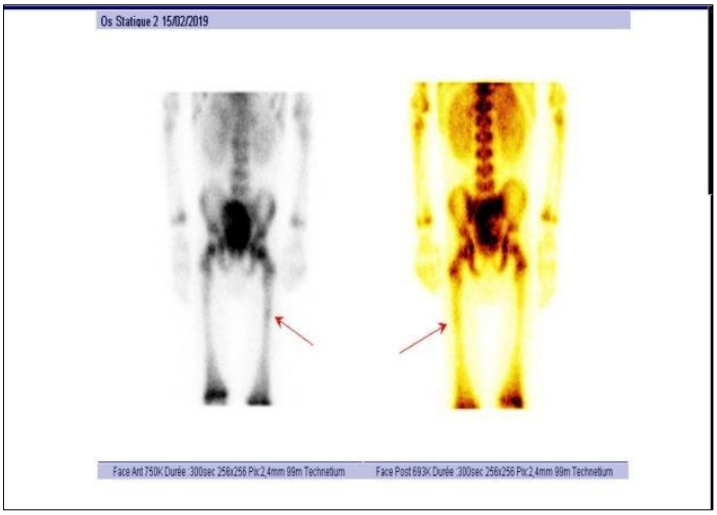

Figure 2

- Heterogeneous uptake by a calcified abdominal mass, with extension to the opposite vertebral plane (Figure 4).

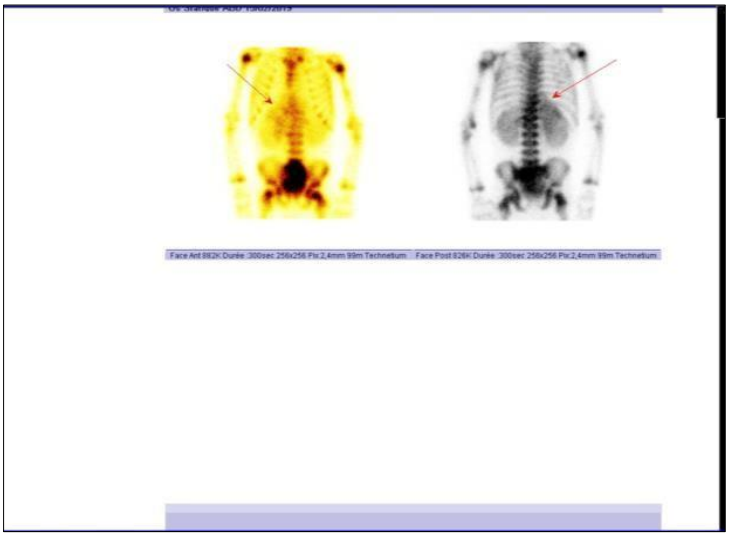

Figure 3

- Following this heterogeneous hyperfixation at the abdominal level, described on the bone scan, a thoraco-abdomino-pelvic CT scan was requested, which showed a large intra- and retroperitoneal tumor process invading the right renal hilum with endo-ductal extension at the level of D11-D12, with magma of ADP above and below the diaphragm. Then a myelogram was requested which concluded a bone marrow invasion suggesting metastatic cells.

An MIBG (metaiodobenzylguanidine) scintigraphy (Planar scanning and computed tomography (SPECT/CT) images of the abdominopelvic region) showed an intense hyperfixation of the mass of the right hypochondrium, consistent with a metastatic adrenal neuroblastoma at the bone level (Figures 4, 5 and 6):

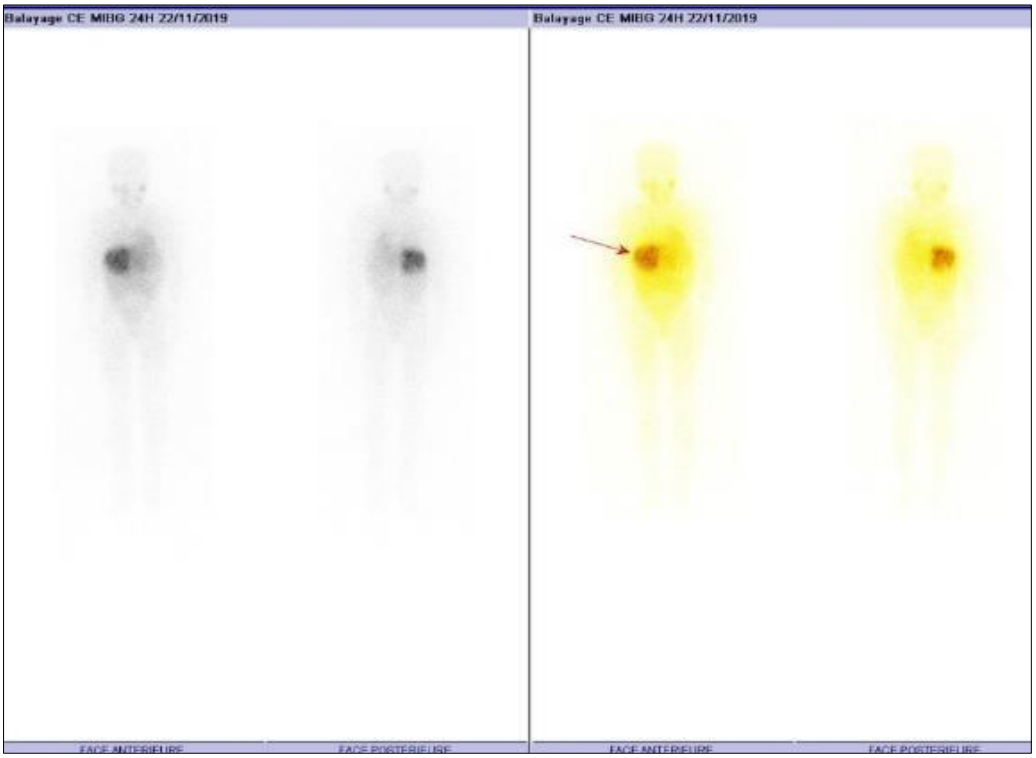

Figure 4: 24-hour full body scan

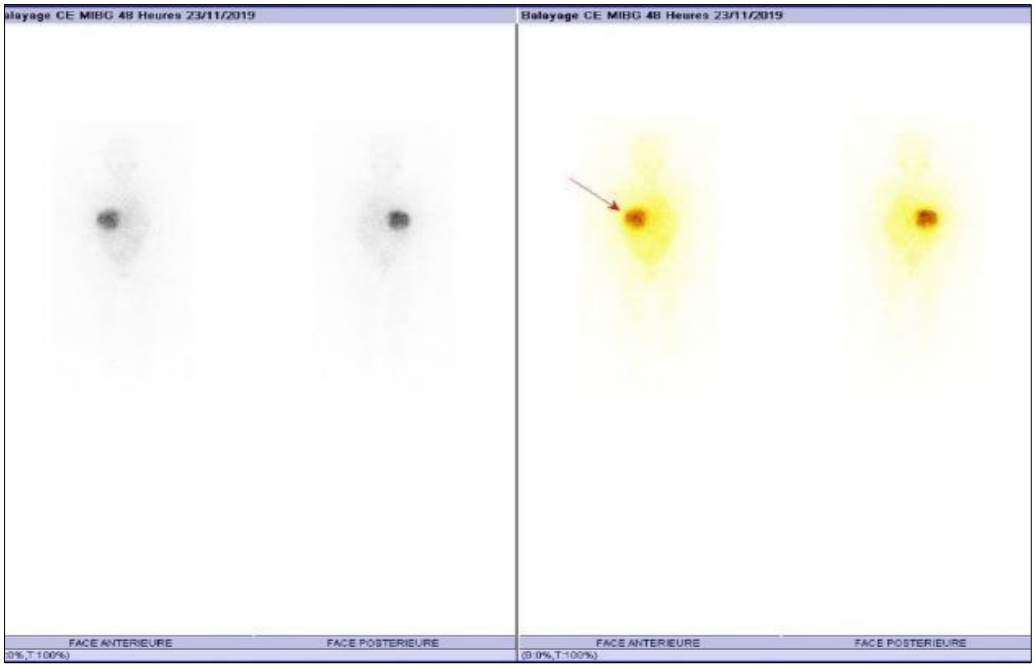

Figure 5: 48-hour full-body scan

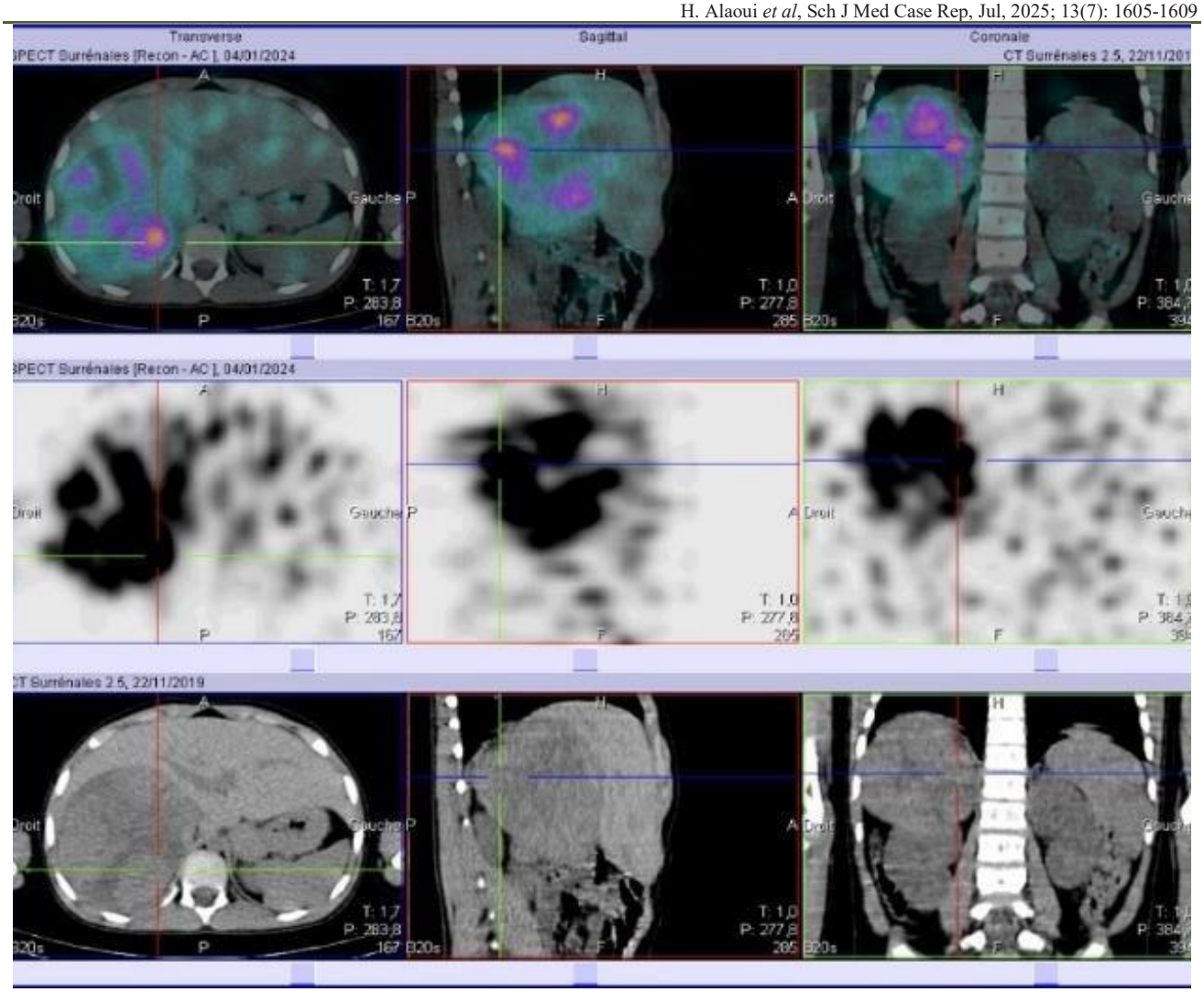

Figure 6: CT-combined tomoscintigraphic sections of the abdominopelvic regions

- The patient underwent surgical resection, with anatomopathological study which confirmed the diagnosis of adrenal neuroblastoma. It was decided following chemotherapy

DISCUSSION

Neuroblastoma accounts for approximately 10% of all pediatric malignant cancers and is responsible for approximately 15% of childhood oncology-related deaths [7]. It is a typical early childhood cancer, with the majority of cases diagnosed before the age of five [7]. Its exact origin remains unclear. However, some familial forms suggest a genetic susceptibility, as indicated by the study conducted by Shojaei in 2004 [8]. Diagnosis is based on an integrated approach, combining clinical data, imaging, and laboratory analyses.

Metaiodobenzylguanidine (MIBG) imaging plays a key role in the initial assessment and follow-up of patients with neuroblastoma, being considered the first-line functional imaging [9]. However, in approximately 10% of cases, the tumor does not show affinity for MIBG. In this context, fluorine-18 positron emission tomography (18F-FDG PET) or bone scintigraphy using technetium-99mmethylene diphosphonate (99mTc-MDP) is recommended to complete the assessment [10]. Bone scintigraphy offers high diagnostic sensitivity [11]. Its specificity, although lower than that of MIBG, can be optimized by considering the topography, number and appearance of the lesions observed, as well as the tracer distribution pattern. Several mechanisms have been proposed to explain the binding of technetium-labeled bisphosphonates [11]:

- Affinity for the organic phase of bone, particularly immature collagen; - Binding to hydroxyapatite crystals, which constitute the mineral phase;
- Cellular internalization by osteoblasts or osteoclasts.

Extraosseous uptake, although rare, can occur, particularly in organs such as the liver, heart, kidneys, lungs, or stomach. These deposits, of a phosphocalcic nature comparable to bone matrix, reflect a similar mineral tropism and exhibit similar scintigraphic profiles

[11]. Muscle uptake can also be observed, for example in the context of myositis ossificans or in pleural effusion. Although sometimes incidental, these images can provide useful diagnostic information. However, uptake in soft tissues can also generate artifacts that may compromise the quality of the images obtained [12]. Furthermore, 99mTc-HMDP bone scintigraphy can reveal indirect signs suggesting neuroblastoma, such as renal asymmetry, potentially reflecting a retroperitoneal tumor process [13].

In summary, 99mTc-HMDP scintigraphy can highlight calcified extraosseous lesions, reflecting active calcium metabolism, thus contributing to the diagnosis of pediatric solid tumors. However, MIBG imaging remains the gold standard for both the initial diagnosis and therapeutic monitoring of localized or metastatic neuroblastomas. A better understanding of bisphosphonate binding mechanisms could not only refine the diagnosis, but also open up prospects for the therapeutic use of these molecules in the treatment of bone tumors.

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