# Additional dosimetry while using techniques of hybrid SPECT-CT acquisition during a bone scan

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## Background

Nuclear medicine has experienced real success over the past and has brought new perspectives, mainly in the treatment of cancers. )

In bone disease, Single photon computed tomography associated to computed tomography (SPECT-CT) combined with conventional scintigraphy makes possible, in a single examination, a whole body exam and CT scan centered on a suspicious bone foci, thereby improving the diagnostic accuracy of planar scintigraphy. However, the additional radiation dose from X-ray CT, is now the subject of numerous public and technical discussions.

We proposed to evaluate for patients and workers, doses of radiation delivered during a SPECT-CT bone scan.

## Methods

On our nuclear medicine department, equipped with 02 SPECT-CT (Fig 1), additional SPECT-CT was performed for 200 patients with indeterminate foci on bone scintigraphy. For these patients, we estimated effective doses received and analyzed the parameters involved in the variation of doses. The estimated total effective dose following a bone scan, was calculated by multiplying the average activity administered (between 555 and 740MBq) for each patient by the "effective dose per unit activity administered" conversion factors listed in the International Commission on Radiological Protection (ICRP) publication 53 and 80. The effective dose for a CT scan was appreciated from the product of the dose length (DLP) and a conversion factor specific body region, k (mSv mGy-1 cm-1), which take into account the change in biological sensitivities of different organs.

Concerning the workers under radiation (technicians and physicians), we compared for the same persons values of doses (mSv) recorded by the TLD dosimeters before the installation of the SPECT-CT machines with those recorded after the arrival of the 02 machines in the department.

## *Results*

In fused imaging (SPECT-CT), we noted a significant increase in dose delivered to the patient. Effective dose was estimated on mSv between 3,16 and 4,22 (Table 1). It was depended on the administered activity and patient age; while for CT scan, it depends on: tube current, tube potential, the speed of rotation of the cutting thickness, patient weight. The additional radiation induced by the CT ranged from 9 for Head and Neck region to 116,8% for pelvis (Table 1). Regarding radiation workers (technicians and physicians) Ionizing radiation exposure was estimated between 0,54 and 3,3mSv befor acquisition of the hybrid machines and between 0,6 and 3,9mSv with an average value of 1,68 mSv after installation of SPECT-CTs. These values varies from 0,78 to 3,9 with an average value of 2,34 mSv for technicians and from 0,6 to 1,62 with an average value of 1.08mSv for physicians.

Figure 1: Our nuclear medicine department equipped with Gamma Cameras integrated SPECT and CT System

Table 1: Effective dose for The CT ($E_{CT}$) and percentage contribution of the additional radiation of the CT (%$E_{CT}$) by region explored.

| *Explored Area* | *Effective dose $E_{CT}$* | *Percentage contribution of the additional radiation of the CT (% $E_{CT}$)* |
|---|---|---|
| Head and Neck | 0,37 ± 0,25 | 9 |
| Thorax | 3,93 ± 0,22 | 96,92 |
| Abdomen | 4,09 ± 1,86 | 109,24 |
| Pelvis | 4,22 ± 1,15 | 116,82 |

## Discussion

The addition of computed tomography (CT) to a gamma-camera has revolutionized nuclear medicine. CT acquisition improves the sensitivity, specificity and accuracy of the examination. Despite the fact that the hybrid camera uses a low-dose non-diagnostic scanner, it increases the overall radiation dose. The effective dose is an important parameter for comparing the doses and the risks of ionizing radiation due to various diagnostic examinations. In our study, the effective dose induced by bone scintigraphy ranged from 3,16 to 4,22 mSv. This value is very close to that found by other studies [1,2]. The additional radiation induced by the CT to the total dose delivered by the hybrid imaging ranged from 9 to 116,8%, with an average of 85%. This fairly large value depends on the examination carried out: region, and length explored by the CT, but also and mainly CT scan aquisition parameters: tube current, kVp, slice thickness and pitch. These parameters have to be optimized and standardized to ensures that the likelihood of incurring exposure, the numbers of people exposed and the magnitude of their individual doses will be kept as low as reasonably achievable. Workers occupational exposure in our study is comparable with that before the introduction of SPECT-CT and far below the maximum dose inherent to their professional categorization.

## *Conclusion*

Keeping radiation dose as low as reasonably achievable (ALARA) is the guiding principle for a medically indicated CT examination. Many techniques and strategies are available for radiation dose reduction. During a SPECT-CT examination following an inconclusive bone scan, the additional dose delivered by a CT scan is justified because of the direct benefit to the patient.

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***References***
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