^{177}Lu-DOTATATE Quantification for Patient Personalised Dosimetry in Therapy of Neuroendocrine Tumours

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Introduction

Recently, remarkable improvements have been made in the field of radionuclide therapies, particularly their usage for cancer treatments. Peptide Radionuclide Radiotherapy (PRRT) with ^{177}Lu-DOTATATE is a nuclear medicine therapeutic option with increasing interest over the last few years due to its efficacy in the treatment of metastatic and/or inoperable neuroendocrine tumors overexpressing somatostatin receptors.

^{177}Lu

$T_{1/2}$	**6.67 dias**
$E_{\beta max}$	**498 keV**
$\overline{E_\beta}$	**147 keV**
E_γ	**113 keV e 208 keV**
$R_{\beta max}$	**~ 0,67 mm**

Theranostic Properties

PRRT with ^{177}Lu-DOTATATE

- **Tumor Regression**
- **Symptom Relief**

Toxicity may represent a major limitation. The European Council Directive 2013/59/EURATOM states that all treatment plans must be optimized to each patient, to consider the dose received by critical organs and tumor lesions.

Critical Organs: kidneys and red bone marrow.

Aim

Our aim in this retrospective study was to quantify the mean absorbed dose by the liver, kidneys, spleen and bone marrow, in patients undergoing this PRRT with ^{177}Lu-DOTATATE, for further customization of future treatments.

Methods

From August 2017 to March 2019, four patients were treated with 7.4±0.3 GBq of ^{177}Lu-DOTATATE/cycle (four cycles per patient). Images acquired in each treatment cycle (Fig.1), post injection (PI):

- Whole-body planar images @ 1h, 4h, 24h e 120h PI
- SPECT @ 24h e 120h PI and CT @ 24h PI

Methods (cont.)

The radiopharmaceutical kinetic distribution was analysed, the voxel-wise absorbed dose distribution was determined, and critical organ's toxicity was assessed (Fig. 2.).

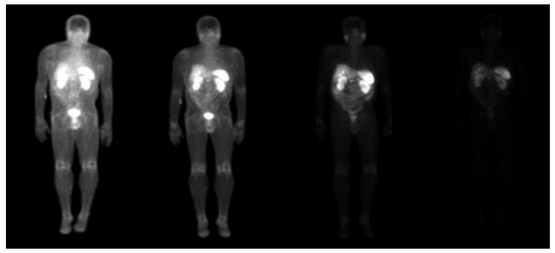

Figure 1. WB planar images in counts, acquired at 1h, 4h, 24h and 120h PI, from the first patient and treatment cycle. Significant uptake in the liver, spleen, kidneys and metastases, in agreement with the ^{177}Lu-DOTATATE biokinetic models [1].

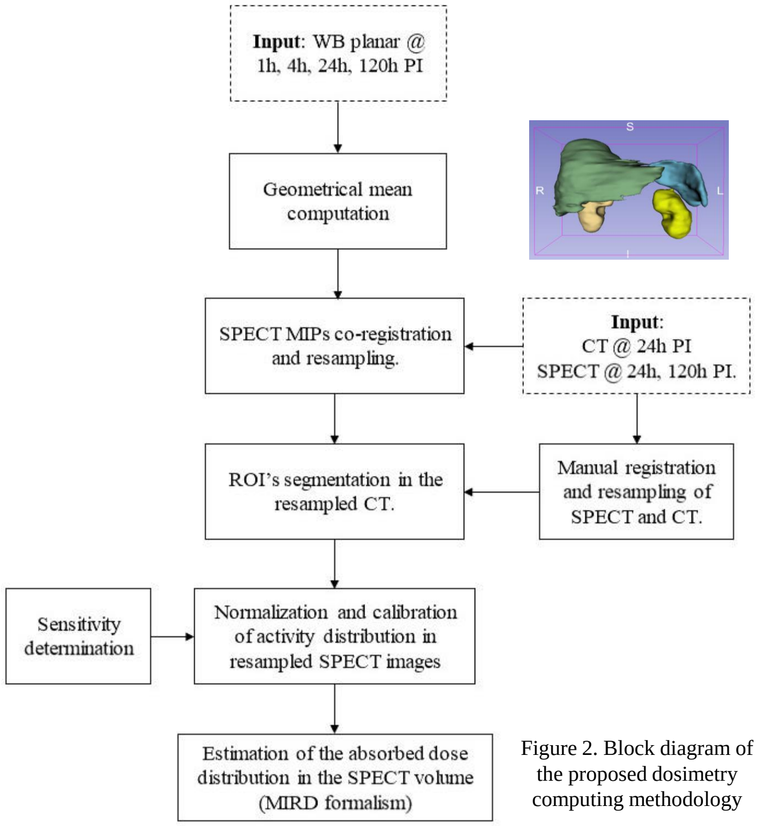

Figure 2. Block diagram of the proposed dosimetry computing methodology

Results

After the four treatment cycles, it was found that:

- mean absorbed dose values in the liver and kidneys differ significantly between patients (Fig. 3).
- ~ half of the average absorbed dose on each cycle has occurred within the first 5 days PI.

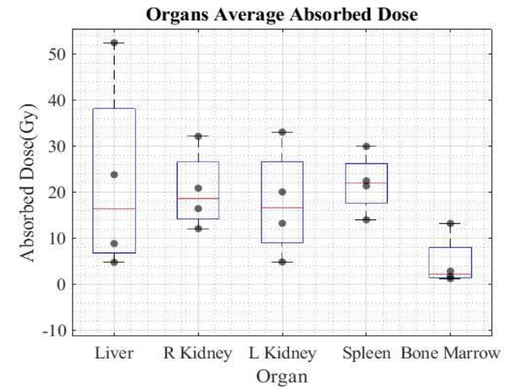

Figure 3. For the 4 patients, absorbed dose for each organ of interest, after completion of 4 treatment cycles. The red line represents the median. No outlier was identified.

- Mean absorbed doses by the kidneys were **below** the established limits.
- Mean absorbed dose by the bone marrow was **higher** than expected [2].

Conclusions

Administered activity could have been altered, not to optimize treatment effectiveness, but to improve bone marrow toxicity.

Ongoing work is designed to measure the absorbed dose by tumour lesions, and to optimize a protocol to implement personalized therapy in patients with metastatic NET.

1. Brolin *et al.* (2015). Pharmacokinetic digital phantoms for accuracy assessment of image-based dosimetry in ^{177}Lu-DOTATATE peptide receptor radionuclide therapy. *Phys Med Biol*.
2. Sandström *et al.* (2013). Individualized dosimetry of kidney and bone marrow in patients undergoing 177Lu-DOTA-octreotate treatment. *Journal of nuclear medicine, Society of Nuclear Medicine*, *54*(1), 33–41.