

## Assessment of Internal Absorbed Dose in the Human Abdominal Organs from Two Renal Radiopharmaceuticals Based on Experimental Mouse Data

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### Abstract

Radiopharmaceuticals are applied in nuclear medicine for therapy and diagnosis of disease and organ function. The radiopharmaceuticals can enter the human body as radioisotopes alone or radioisotopes connected to different chemical compounds. Some radiopharmaceuticals are used for renal function and anatomy. The radiopharmaceuticals for investigation of renal function and structure can be divided into three categories: first, the radiopharmaceuticals filtered by the glomerulus, second, the radiopharmaceuticals retained in the renal tubules via proximal tubule receptor-mediated endocytosis from the glomerular filtrate, and third, the radiopharmaceuticals primarily secreted by the renal tubules via the organic anion transporter. <sup>131</sup>I-Hippuran and <sup>99m</sup>Tc-MAG3 are two important radiopharmaceuticals in renal scintigraphy. <sup>99m</sup>Tc-MAG3 is a renal tubular agent which was introduced in 1986 as an alternative for the use of <sup>131</sup>I-Hippuran with similar pharmacokinetic and human renogram pattern. <sup>99m</sup>Tc-MAG3 is highly protein-bound and is removed from the plasma primarily by the organic anion transporter 1. <sup>99m</sup>Tc-MAG3 is used more than <sup>99m</sup>Tc-DTPA for patients with suspected obstruction and impaired renal function (IRF) and is applied in almost 70% of the renal scans performed in the US.

<sup>131</sup>I-iodohippurane is a radiopharmaceutical used in diagnostics of kidneys malfunction and renal tract obstructions. After injection, <sup>131</sup>I-iodohippurane is excreted by the renal system rapidly. The maximum uptake in renal system occurs almost within 2 to 5 minutes of injection. The peak of uptake often depends on the nature of the kidneys diseases, the patient hydration and extent of renal impairment. More than 60% of the mentioned radiopharmaceutical binds reversibly with plasma proteins. The renal excretion for this compound is mainly by tubular secretion (80%) and glomerular filtration (20%). The clearances

of these renal radiopharmaceuticals are often characterized as the effective renal plasma flow. <sup>131</sup>I-Hippuran is cleared from plasma by tubular secretion. However, <sup>131</sup>I is far from optimal with regard to physical properties and hence to image quality and radiation burden. Preliminary studies of <sup>99m</sup>Tc-MAG3 in normal volunteers indicated that plasma clearance was less than that of <sup>131</sup>I-Hippuran. <sup>131</sup>I-Hippuran has the poor imaging characteristics and deliver a high radiation dose. The study by Erbslöh-Möller et al demonstrated a better sensitivity of <sup>131</sup>I-hippuran renography than <sup>99m</sup>Tc-DTPA scintigraphy to diagnose renovascular hypertension (RVH). Although the clearance of <sup>99m</sup>Tc-MAG3 is only 50%–60% that of OIH (<sup>131</sup>I-Hippuran), the <sup>99m</sup>Tc-MAG3 clearance is highly correlated with the clearance of OIH, and the <sup>99m</sup>Tc-MAG3 clearance can be used as an independent measure of renal function.

The body receives radiation dose from the radiopharmaceuticals. Appraising the internal radiation dosimetry of radiopharmaceuticals is an essential part of the usage and development of novel radiopharmaceuticals. Many studies have been completed for calculation of the internal absorbed dose after injection of radiopharmaceuticals in body. In 2004, Angela Keleher et al. calculated the dose of 92.5MBq of <sup>99m</sup>Tc - sulfur colloid on pregnant women, the highest dose calculated to the fetus was 7.74E-2mGy. In 2012, Shahbazi et al. determined the absorbed dose of different organs resulting from <sup>99m</sup>Tc-dioxide phosphene where the highest dose of 38.73 E-4mGy/MBq was delivered to the kidney. In 2014, the authors have recently calculated and compared effective dose of different organs of body resulting from injection of two radiopharmaceuticals of <sup>99m</sup>Tc-Bombesin and <sup>67</sup>Ga-Bombesin.

There are several methods to calculate the internal absorbed dose of radiopharmaceuticals. One of the methods is "Medical internal radiation dose (MIRD)". MIRD has offered a method for calculation of gamma beam energy on organs and tissues. This method is based on absorbed fraction; it means that a fraction of emitted energy from source organs is absorbed on target organs. MCNP code is a second method for calculating internal dose of body. MCNP is a generalpurpose Monte Carlo N-Particle code that can be used for some particles transport. Specific areas of application include, but are not limited to, radiation

***Keywords***

MCNPX simulation code; MIRD method; 99mTc- MAG3; 131I-Hippuran; Effective dose.

protection and dosimetry, radiation shielding, radiography, medical physics etc. The code treats an arbitrary three-dimensional configuration of materials in geometric cells bounded by first-and seconddegree surfaces and fourth-degree elliptical tori.

The purpose of this research is the calculation and comparison of human internal absorbed dose of two renal radiopharmaceuticals (99mTc- MAG3 and 131I-Hippuran) resulting from 1 MBq after intravenous injection to mice.