
Contents

Preface	ix
Chapter 1. Radiological Imaging	1
1.1. Radiological imaging and nuclear medicine imaging.	3
1.1.1. Medical imaging methods	3
1.1.2. Absorption coefficients and Hounsfield number	4
1.1.3. Treatment planning system (TPS)	7
1.2. X-ray imaging	9
1.2.1. Principle of X-ray production	9
1.2.2. Principle of X-ray imaging	10
1.2.3. Principle of computed tomography or scanner	14
1.3. Nuclear magnetic resonance (NMR)	18
1.3.1. Definition and principle of NMR	18
1.3.2. Nuclear magnetic moment	19
1.3.3. Physical model of NMR in biological tissues	20
1.3.4. Quantum model of Larmor precession	26
1.3.5. Excitation and magnetic resonance phenomenon	31
1.3.6. Quantum model of the magnetic resonance phenomenon	33
1.4. Magnetic resonance imaging (MRI)	35
1.4.1. Nuclear magnetic resonance and medical imaging.	35
1.4.2. Magnetic resonance imaging techniques	35
1.4.3. T_1 relaxation time and spin–lattice relaxation	38
1.4.4. T_2 relaxation time and spin–spin relaxation	43
1.4.5. Relaxation time T_2^* and free induction decay (FID).	45
1.4.6. Spin echo sequence	49
1.4.7. Gradient echo sequence	56
1.4.8. The slice plane and the slice selection gradient	57
1.4.9. Frequency-encoding gradient and phase-encoding gradient.	59

1.4.10. Fourier plane and MRI signal decoding	64
1.4.11. Image reconstruction	66
1.5. Ultrasound imaging	71
1.5.1. Ultrasound principle	71
1.5.2. Different elements of an ultrasound scan	73
1.5.3. The principle of Doppler ultrasound	74
Chapter 2. Technetized Radiopharmaceuticals and Radiothallium-201 used in Nuclear Medicine	77
2.1. Metastable technetium-99 and thallium-201 radiotracers	79
2.1.1. Overview	79
2.1.2. Dosimetry and gamma cameras	80
2.1.3. Advantages of technetated tracers over thallium-201	85
2.1.4. Uses of metastable technetium-99 in brain, bone and kidney scintigraphy	85
2.2. Metastable technetium-99 radiotracers.	87
2.2.1. Metastable technetium-99 production line	87
2.2.2. Preparation of metastable radiotechnetium-99	88
2.2.3. Effective half-life, biological half-life, physical half-life	90
2.3. Technetium-labeled radiopharmaceuticals used in myocardial scintigraphy	91
2.3.1. ^{99m}Tc technetized radiopharmaceuticals	91
2.3.2. Principle of ^{99m}Tc -MIBI scintigraphy and dosimetry	92
2.3.3. Elimination of ^{99m}Tc -MIBI from the body	95
2.3.4. ^{99m}Tc -labeled tetrofosmin scintigraphy and dosimetry	95
2.4. Radiopharmaceuticals labeled with metastable technetium-99 used in lung scintigraphy.	97
2.4.1. Technegas [^{99m}Tc] ventilation scintigraphy, dosimetry	97
2.4.2. [^{99m}Tc]-DTPA ventilation scintigraphy and dosimetry	99
2.4.3. ^{99m}Tc -MAA lung perfusion scintigraphy and dosimetry.	100
2.5. Radiopharmaceuticals used in brain scintigraphy.	101
2.5.1. ^{99m}Tc -HMPAO and ^{99m}Tc -ECD radiopharmaceutical structures and dosimetry.	101
2.5.2. Characteristics of ^{99m}Tc -HMPAO and ^{99m}Tc -ECD radiopharmaceuticals.	104
2.5.3. Principle of the brain scan	105
2.5.4. Preparing and carrying out the cerebral perfusion scintigraphy examination	106
2.6. Production, use and dosimetry of radiothallium-201	107
2.6.1. Radiothallium-201 production process	107
2.6.2. Use of ^{201}Tl radiotracer and dosimetry	108
2.6.3. Excretion of thallium-201 from the body	109

2.7. Myocardial scintigraphy	112
2.7.1. Definition and uses	112
2.7.2. Procedure	113
2.7.3. Ergometric bicycle and treadmill	114
2.7.4. Performing the stress test	115
2.7.5. Arm exercise test and exercise intensity	117
2.7.6. Examination at rest	118
2.7.7. Myocardial scintigraphy coupled with pharmacological stimulation	118
2.7.8. General information on myocardial infarction	119
2.8. Radiopharmaceuticals used in bone scintigraphy	122
2.8.1. Structure of the MDP radiopharmaceutical labeled with metastable technetium-99	122
2.8.2. Principle of bone scintigraphy	122
2.9. Radiopharmaceuticals used in renal scintigraphy	127
2.9.1. Structures of DMSA and MAG ₃ radiopharmaceuticals labeled with metastable technetium-99	127
2.9.2. Characteristics and properties of DMSA and dosimetry	128
2.9.3. ^{99m} Tc-DMSA static scintigraphy procedure	131
2.9.4. MAG ₃ characteristics and properties and dosimetry	132
2.9.5. Characteristics and properties of DTPA and dosimetry	133
2.9.6. ^{99m} Tc-TDPA and ^{99m} Tc-MAG ₃ dynamic scintigraphy procedure	135
2.10. Radiopharmaceuticals used in digestive scintigraphy	137
2.10.1. Definition	137
2.10.2. Standardized consensus meal labeled with metastable technetium-99	137
2.10.3. Digestive scintigraphy procedure	138
Chapter 3. Radioisotopes Fluorine-18, Metastable Krypton-81 and Iodine-123, 125 and 131 used in Nuclear Medicine	139
3.1. Properties and uses of the radiotracer ¹⁸ FDG	140
3.1.1. Choice of radiofluorine-18 in positron emission tomography	141
3.1.2. Obtaining radiofluorine-18	141
3.1.3. Synthesis of the radiopharmaceutical ¹⁸ FDG	144
3.1.4. Principle of PET Scan, dosimetry	147
3.1.5. Excretion of fluorine-18 from the body	152
3.2. Properties of the ^{81m} Kr radiotracer, dosimetry	154
3.2.1. Production of the ^{81m} Kr tracer by the ⁸¹ Rb- ^{81m} Kr generator	154
3.2.2. ^{81m} Kr tracer ventilation scintigraphy: dosimetry	155
3.3. Lung scintigraphy examination	157
3.3.1. Procedure for the ventilation test	157
3.3.2. Perfusion examination procedure	159
3.3.3. Elimination of ^{99m} Tc and ^{81m} Kr in the body	160

3.4. Radiopharmaceuticals used in thyroid scintigraphy	161
3.4.1. Benefits of iodine	161
3.4.2. ^{123}I radiotracer production chain	162
3.4.3. Main emissions of the ^{123}I radiotracer	164
3.4.4. Properties of $[^{123}\text{I}]$ MIBG and $[^{123}\text{I}]$ ioflupane radiopharmaceuticals	165
3.4.5. Principle of iodine-123 scintigraphy, dosimetry	166
3.4.6. Excretion of iodine-123 from the body	169
3.4.7. ^{131}I radiotracer production chain	171
3.4.8. Main emissions of iodine-131	172
3.4.9. Principle of iodine-131 scintigraphy: dosimetry	174
3.4.10. Excretion of iodine-131 from the body	176
3.5. General information on aerosols	177
3.5.1. Aerosol therapy: the concept of aerosol	178
3.5.2. Nebulization system: aerosol generators	178
3.5.3. Notion of median mass aerodynamic diameter (MMAD)	179
3.5.4. Particle deposition phenomena	179
3.5.5. Aerosol deposition sites and methods	181
3.6. Prostate disorders	183
3.6.1. The prostate in the urinary tract	183
3.6.2. Benign prostatic adenoma or enlargement	184
3.6.3. Prostatitis	187
3.6.4. Prostate cancer	191
3.6.5. Symptoms and diagnosis of prostate cancer	193
3.6.6. Treatment methods for prostate cancer	194
3.7. Principle of prostate brachytherapy using an iodine-125 implant	195
3.7.1. Decay diagram for radioiodine-125	195
3.7.2. Definition of brachytherapy: LDR, HDR and PDR brachytherapy modes	197
3.7.3. Principle of implantation of prostate brachytherapy equipment	199
3.7.4. Prostatic chemotherapy	201
3.8. Appendices	203
3.8.1. Stroke	203
3.8.2. Thyroid and parathyroid scans	215
References	231
Index	255