

CONT

CHAPTER 1

From Protons to Images	1
<i>Spinning Protons</i>	<i>1</i>
<i>Magnetic Fields</i>	<i>1</i>
<i>Radio Pulses and Transverse Magnetization</i>	<i>3</i>
<i>Spatial Localization</i>	<i>4</i>
<i>MRI Instrument Overview</i>	<i>6</i>

CHAPTER 2

Proton Environments and Relaxation	9
<i>Water Structure</i>	<i>9</i>
<i>T1 Relaxation (Recovery)</i>	<i>9</i>
<i>Magnetic Field Strength</i>	<i>12</i>
<i>T2 Relaxation (Decay)</i>	<i>13</i>
<i>Local Magnetic Effects</i>	<i>14</i>
<i>Chemical Shifts</i>	<i>17</i>

CHAPTER 3

Longitudinal Magnetization and T1 Contrast	21
<i>Repetition Time</i>	<i>21</i>
<i>Flip Angle</i>	<i>22</i>

CHAPTER 4

Transverse Magnetization and T2 Contrast	29
<i>Echo Time</i>	<i>29</i>
<i>Non-T2 Causes of Transverse Magnetization Decay</i>	<i>29</i>
<i>Refocusing Radio Pulses and the Spin Echo</i>	<i>33</i>

CHAPTER 5

Spatial Localization: Magnetic Field Gradients	39
<i>Basic Pulse Sequence</i>	<i>39</i>
<i>Annotation</i>	<i>39</i>

ENTS

<i>Section Selection</i>	40
<i>Frequency Encoding</i>	40
<i>Gradient Dephasing</i> <i>and Rephasing</i>	46
<i>Gradient Echoes</i> <i>and Spin Echoes</i>	49
<i>Phase Encoding</i>	51
<i>Pulse Sequence Basics</i>	53

CHAPTER 6

K-Space: A Graphic Guide	57
<i>Basics of K-Space</i>	57
<i>K-Space Representation of</i> <i>Image Resolution and Field</i> <i>of View</i>	58

CHAPTER 7

Creating MR Images	65
<i>Single-Section Acquisitions</i>	65
<i>Two-Dimensional</i> <i>Multisection Acquisitions</i>	65
<i>Two- and Three-Dimensional</i> <i>Fourier Techniques</i>	71

CHAPTER 8

Signal-to-Noise Ratio, Spatial Resolution, and Acquisition Time	77
<i>Signal-to-Noise Ratio</i>	77
<i>Spatial Resolution</i> <i>(Pixel and Voxel Size)</i>	77
<i>Acquisition Time</i>	79

CHAPTER 9

Additional Determinants of Signal-to-Noise Ratio	93
<i>Magnetic Field Strength</i>	93
<i>Sampling Bandwidth</i> <i>of the Receiver</i>	94
<i>Local Receiver Coils</i>	98

C H A P T E R 10

Motion-Induced Artifacts	109
<i>Gradient-Induced (Within-View)</i>	
<i>Phase Changes</i>	<i>109</i>
<i>View-to-View Intensity Errors</i>	<i>116</i>
<i>Strategies for Reducing Motion-Induced Artifacts</i>	<i>117</i>

C H A P T E R 11

Pulse Sequences:	
Gradient Echo and Spin Echo	131
<i>Unspoiled Gradient Echo Techniques</i>	<i>131</i>
<i>Spoiled Gradient Echo Techniques</i>	<i>135</i>
<i>Repetition Time and Flip Angle: Effects on Tissue Contrast ...</i>	<i>138</i>
<i>Echo Time: Effects on Tissue Contrast</i>	<i>138</i>
<i>Steady-State Free Precession</i>	<i>139</i>
<i>Spin Echo Techniques</i>	<i>139</i>

C H A P T E R 12

Preparatory Pulses	143
<i>Inversion Recovery</i>	<i>143</i>
<i>Spatially Selective Saturation</i>	<i>149</i>
<i>Chemically Selective Saturation</i>	<i>149</i>
<i>Magnetization Transfer</i>	<i>152</i>
<i>Magnetization-Prepared Rapid Gradient Echo Techniques</i>	<i>154</i>

C H A P T E R 13

Multiecho Techniques	159
<i>Images with Multiple Image Contrast</i>	<i>159</i>
<i>Multiecho Conjugate Techniques</i>	<i>159</i>
<i>Echo Planar Techniques</i>	<i>161</i>
<i>Fast Spin Echo (Rapid Acquisition with Relaxation Enhancement, Turbo Spin Echo) ...</i>	<i>165</i>
<i>Gradient Recalled and Spin Echo Techniques</i>	<i>178</i>

C H A P T E R 14

T1-Weighted Pulse Sequences	181
<i>Spin Echo</i>	<i>181</i>
<i>Inversion Recovery</i>	<i>183</i>
<i>Multisection Spoiled Gradient Echo</i>	<i>183</i>

<i>Single-Section Spoiled</i>	
<i>Gradient Echo</i>	184
<i>Magnetization-Prepared</i>	
<i>Gradient Echo</i>	186
<i>T1-Weighted Chemical Shift</i>	
<i>Pulse Sequences</i>	186

CHAPTER 15

T2-Weighted Pulse Sequences	191
<i>Spin Echo Techniques</i>	191
<i>Gradient Echo Techniques</i>	191
<i>Steady-State Free Precession</i>	191
<i>Multishot Fast Spin Echo</i>	
<i>Techniques</i>	193
<i>Fast Spin Echo-Inversion Recovery</i>	198
<i>Single-Shot Fast Spin Echo (Haste) Techniques</i>	199
<i>Echo Planar and Gradient Echo and Spin Echo</i>	199

CHAPTER 16

Intermediate-Weighted Pulse Sequences	205
<i>Definition</i>	205
<i>Attributes for Clinical Use</i>	205
<i>Spin Echo Techniques</i>	206
<i>Fast Spin Echo versus Spin Echo Techniques</i>	207
<i>Optimizing Independent Acquisition of Intermediate-Weighted Images</i>	208
<i>Gradient Echo Techniques</i>	210

CHAPTER 17

Contrast Agents	213
<i>Extracellular Paramagnetic Agents</i>	213
<i>Tissue-Directed Paramagnetic Agents</i>	224
<i>Particulate Agents</i>	228
<i>Oral Agents</i>	232
<i>Contrast Agent Nomenclature</i>	233

CHAPTER 18

Vascular Techniques	237
<i>Dark Blood Mechanisms</i>	237
<i>Paramagnetic Enhancement</i>	238
<i>Time-of-Flight Techniques</i>	239
<i>Phase-Contrast Technique</i>	246

<i>Perfusion and Diffusion Techniques</i>	249
-----------------------------------------------------	-----

C H A P T E R 19

Artifacts	257
<i>Wrap-Around</i>	257

<i>Edge Artifacts</i>	262
<i>Ghost Artifacts</i>	264
<i>Stripes</i>	265
<i>Altered Signal Intensity</i>	266
<i>Image Distortion</i>	272
Index	273