Contents

Foreword by Vincent W. S. Chan ........................................................ vii
Preface ................................................................................................ ix
Acknowledgments ............................................................................. xi
Contributors ....................................................................................... xxv

I Imaging in Interventional Pain Management
and Basics of Ultrasonography

1 Imaging in Interventional Pain Management ............................................................... 3
Marc A. Huntoon
   Introduction 3
   C-Arm FDCT 5
   Ultrasound 7
      Intra-Articular Injections 8
      Trigger Point and Muscular Injections 8
      Zygaphyseal and Medial Branch Blocks 8
      Epidural Blocks 9
      Sympathetic Blocks 9
      Combined US and CT/Fluoroscopy 10
   Conclusion 10
   References 11

2 Basics of Ultrasound Imaging ................................................................. 13
Vincent Chan and Anahi Perlas
   Introduction 13
   Basic Principles of B-Mode US 14
   Generation of Ultrasound Pulses 14
   Ultrasound Wavelength and Frequency 14
   Ultrasound–Tissue Interaction 15
   Recent Innovations in B-Mode Ultrasound 18
   Conclusion 19
   References 19
## 3 Essential Knobology for Ultrasound-Guided Regional Anesthesia and Interventional Pain Management

*Alan J.R. Macfarlane, Cyrus C.H. Tse, and Richard Brull*

- Introduction 22
- Frequency and Probe Selection 22
- Depth 23
- Gain 25
- Time Gain Compensation 26
- Focus 26
- Presets 28
- Color Doppler 29
- Power Doppler 30
- Compound Imaging 31
- Tissue Harmonic Imaging 32
- Optimization Button 32
- Freeze Button and Image Acquisition 33
- References 33

## 4 How to Improve Needle Visibility

*Dmitri Souzdalnitski, Imanuel Lerman, and Thomas M. Halaszynski*

- Introduction 35
- Training and Phantom Simulation 36
  - Training with Adequate Mentorship 36
  - Phantoms 36
  - High-Fidelity Simulation 37
- Combined Ultrasound and Flouroscopic Phantom Simulators 38
- Procedural Needle-Related Visibility Factors 40
  - Basic Sonography and Needle Image Interpretation 40
  - Acoustic Impedance as the Basis for Procedure Needle Visualization 42
  - Size (Gauge) of the Procedure Needle and Its Echogenicity 43
  - The Skin Insertion Site Selected and Angle of Procedure Needle Passage 44
  - Echogenic Procedure Needles 46
  - Procedure Needle Tip 49
- The Ultrasound Device and Procedure Needle Visibility 51
  - Ultrasound Imaging Artifacts and Procedure Needle Visibility 51
  - Impact of Various Sonographic Modes on Procedure Needle Visibility 52
  - Recent Advances in Ultrasound Imaging and Procedure Needle Visibility 57
- Needle-Probe Alignment 58
  - Need for Procedure Needle and Ultrasound Probe Alignment 58
  - “In-Plane” and “Out-of-Plane” Needle Approach: Classical Probe-Needle Interpositions 58
  - Oblique Plane Needle Approach for Ultrasound-Guided Pain Management 60
- Biplane Needle Imaging Approach for Ultrasound-Guided Pain Management 61
- Mechanical and Optical Procedure Needle Guides 61
- Advanced Procedure Needle Positioning Systems 62
- The “ART” of Scanning for Better Procedure Needle Visualization 64
- Ergonomics for Better Procedure Needle Visibility 65
- Enhancement and Techniques to Improve Procedure Needle Localization 66
  - Basic Sonographic Effect of Enhancement 66
II  Spine Sonoanatomy and Ultrasound-Guided Spine Injections

5  Spine Anatomy and Sonoanatomy for Pain Physicians

Bernhard Moriggl

Introduction  79
Basic Spine Anatomy  80
Cervical Spine  80
Thoracic Spine  83
Lumbar Spine  84
Sacrum  87
Sonoanatomy of the Cervical Spine  90
Superficial  90
Deep  92
Sonoanatomy of the Thoracic Spine  96
Superficial  96
Deep  97
Sonoanatomy of the Lumbar Spine  98
Superficial  98
Deep  101
Sonoanatomy of the Sacrum and Sacroiliac Joint  103
Superficial  103
Deep  104

6  Ultrasound-Guided Third Occipital Nerve and Cervical Medial Branch Nerve Blocks

Andreas Siegenthaler and Urs Eichenberger

Anatomy  107
Indications for Cervical Medial Branch Block  108
Why Ultrasound-Guided Facet Nerve Block? The Literature and Our Experience  109
Possible Advantages of Ultrasound for Cervical Facet Nerve Blocks  110
Limitations of Ultrasound  110
Ultrasound-Guided Technique for TON and Cervical Medial Branch Block  110
Scanning Before Injection  110
Identifying the Correct Level: Method 1  110
Identifying the correct Level: Method 2  114
Practical Performance of Block  114
Conclusion  116
References  116
7 Ultrasound-Guided Cervical Zygapophyseal
(Facet) Intra-Articular Injection ........................................ 119
Samer N. Narouze

- Anatomy of the Cervical Facet Joints 119
- Indications for Cervical Zygapophyseal Joint Intra-Articular Injection 120
- Literature Review of Ultrasound-Guided Cervical Facet Injections 120
- Ultrasound-Guided Technique for Cervical Facet Intra-Articular Injection 120
  - Lateral Approach 120
  - Posterior Approach 120
- References 122

8 Ultrasound-Guided Cervical
Nerve Root Block ............................................................... 125
Samer N. Narouze

- Anatomy of Cervical Nerve Root 125
- Indications 126
- Limitations of the Fluoroscopy-Guided Techniques 126
- Literature Review of Ultrasound-Guided Cervical Nerve Root Block 126
- Sonoanatomy of the Cervical Spine and Identification of the Cervical Level 127
- Ultrasound-Guided Technique for Cervical Selective Nerve Root Block 128
- References 130

9 Ultrasound-Guided Thoracic
Paravertebral Block ............................................................. 133
Manoj Kumar Karmakar

- Introduction 133
- Anatomy 134
- Mechanism of Blockade 135
- Techniques of TPVB 136
- Ultrasound-Guided TPVB 136
- Sonoanatomy Relevant for TPVB 138
  - Basic Considerations 138
  - Transverse Scan of the Thoracic Paravertebral Region 139
  - Sagittal Scan of the Thoracic Paravertebral Region 141
- Techniques of USG TPVB 144
  - Transverse Scan with Short-Axis Needle Insertion (Technique 1) 144
  - Paramedian Oblique Sagittal Scan with In-Plane Needle Insertion (Technique 2) 144
  - Transverse Scan with In-Plane Needle Insertion or the Intercostal Approach to the TPVS (Technique 3) 145
- Conclusion 146
- Acknowledgment 147
- References 147
CONTENTS

10 Ultrasound-Guided Lumbar
Zygapophyssial (Facet) Nerve Block.............................. 149
David M. Irwin and Michael Gofeld

- Introduction 149
- Anatomy 150
- Literature Review 150
- Scanning Technique 151
- Injection Technique 154
  - Lumbar (L1–L4) Zygapophysial Medial Branch and L5 Dorsal Ramus Nerve Block 154
  - Limitations of Ultrasound-Guided Zygapophysial Nerve and Joint Injection 156
- References 156

11 Ultrasound-Guided Lumbar
Nerve Root (Periradicular) Injections.......................... 157
Klaus Galiano and Hannes Gruber

- Introduction 157
- Ultrasound-Guided Technique 158
- Limitations of the Ultrasound-Guided Technique 158
- References 159

12 Ultrasound-Guided Central
Neuraxial Blocks.................................................... 161
Manoj Kumar Karmakar

- Introduction 161
- History 162
- Ultrasound Imaging of the Spine 163
  - Basic Considerations 163
  - Axis of Scan 163
  - Spinal Sonoanatomy 164
  - The Water-Based Spine Phantom 165
  - Ultrasound Imaging of the Sacrum 166
  - Ultrasound Imaging of the Lumbar Spine 168
  - Ultrasound Imaging of the Thoracic Spine 170
- Ultrasound-Guided CNB 171
  - Caudal Epidural Injection 172
  - Lumbar Epidural Injection 173
  - Thoracic Epidural Injection 174
  - Spinal Injection 175
- The Evidence 175
- Education and Training 175
- Conclusion 176
  - Acknowledgment 176
- References 177
13 Ultrasound-Guided Caudal, Ganglion Impar, and Sacroiliac Joint Injections .......... 179
Amaresh Vydyanathan and Samer N. Narouze

- Ultrasound-Guided Caudal Epidural Injections 180
  - Anatomy 180
  - Indications for Caudal Epidural Injection 180
  - Limitations of the Landmark “Blind” Technique 180
  - Literature Review of Ultrasound-Guided Caudal Epidural Injections 180
  - Ultrasound-Guided Caudal Injection Is Better than the “Blind” Technique 181
  - Ultrasound-Guided Technique for Caudal Epidural Injection 181
  - Limitations of the Ultrasound-Guided Technique 182

- Ultrasound-Guided Ganglion Impar Block 183
  - Anatomy 183
  - Indications 183
  - Limitations of the Current Technique 184
  - Literature Review on Ultrasound-Guided Ganglion Impar Block 184
  - Technique of Ultrasound-Guided Ganglion Impar Block 184
  - Limitations of the Ultrasound-Guided Technique 184

- Ultrasound-Guided Sacroiliac Joint Injection 184
  - Anatomy 184
  - Indications for SIJ Injection 186
  - Literature Review on Ultrasound-Guided SIJ Injection 186
  - Technique of Ultrasound-Guided SIJ Injection 186
  - Limitations of Ultrasound-Guided SIJ Injection 186

References 188

III Ultrasound-Guided Abdominal and Pelvic Blocks

14 Ultrasound-Guided Transversus Abdominis Plane (TAP) Block ......................... 193
Samer N. Narouze

- Introduction 193
- Anatomy 194
- The Classic Approach 194
- Ultrasound-Guided Technique 195
- Summary 196
- References 197

15 Ultrasound-Guided Celiac Plexus Block and Neurolysis ................................. 199
Samer N. Narouze and Hannes Gruber

- Introduction 199
- Anatomy of the Celiac Plexus 200
- Current Techniques for Celiac Plexus Block 200
- The Anterior Percutaneous Approach 201
- Advantages of US-Guided Anterior Approach 202
- Limitations of US-Guided Anterior Approach 202
- Sonoanatomy of the Epigastrium and Relevant Structures 202
- Percutaneous Ultrasound-Guided Celiac Plexus Block Technique 203
- References 206
16 Ultrasound-Guided Blocks for Pelvic Pain

Chin-Wern Chan and Philip W.H. Peng

Introduction 207
Ilioinguinal, Iliohypogastric, and Genitofemoral Nerves 208
Anatomy 208
Literature Review on the Injection Techniques for Ilioinguinal, Iliohypogastric, and Genitofemoral Nerve Block 210
Ultrasound-Guided Technique of Ilioinguinal, Iliohypogastric, and Genitofemoral Nerve 211

Piriformis Syndrome 214
Anatomy 215
Literature Review on Piriformis Muscle Injections 216
Ultrasound-Guided Technique for Piriformis Muscle Injection 216

Pudendal Neuralgia 218
Anatomy 218
Literature Review on the Pudendal Nerve Injections 219
Ultrasound-Guided Technique for Pudendal Nerve Injection 219

Conclusion 220
References 221

IV Ultrasound-Guided Peripheral Nerve Blocks and Continuous Catheters

17 Ultrasound-Guided Nerve Blocks of the Upper Extremity

Anahi Perlas, Sheila Riazi, and Cyrus C.H. Tse

Introduction 227
Brachial Plexus Anatomy 228
Intercalene Block 229
Anatomy 229
Indication 229
Procedure 229
Supraclavicular Block 230
Anatomy 230
Indication 230
Procedure 230
Infraclavicular Block 232
Anatomy 232
Indication 232
Procedure 232
Axillary Block 233
Anatomy 233
Indication 233
Procedure 234
Distal Peripheral Nerves in the Upper Extremity 234
Summary 236
References 236
18 Ultrasound-Guided Nerve Blocks of the Lower Limb

Haresh Mulchandani, Imad T. Awad, and Colin J.L. McCartney

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Considerations</td>
<td>239</td>
</tr>
<tr>
<td>Femoral Nerve Block</td>
<td>240</td>
</tr>
<tr>
<td>Clinical Application</td>
<td>240</td>
</tr>
<tr>
<td>Anatomy (Figures 18.3 and 18.4)</td>
<td>240</td>
</tr>
<tr>
<td>Preparation and Positioning</td>
<td>241</td>
</tr>
<tr>
<td>Ultrasound Technique</td>
<td>241</td>
</tr>
<tr>
<td>Sciatic Nerve Block</td>
<td>243</td>
</tr>
<tr>
<td>Clinical Application</td>
<td>243</td>
</tr>
<tr>
<td>Anatomy</td>
<td>244</td>
</tr>
<tr>
<td>Preparation and Positioning</td>
<td>244</td>
</tr>
<tr>
<td>Ultrasound Technique</td>
<td>244</td>
</tr>
<tr>
<td>Sciatic Nerve Blockade in the Popliteal Fossa</td>
<td>246</td>
</tr>
<tr>
<td>Clinical Application</td>
<td>246</td>
</tr>
<tr>
<td>Anatomy</td>
<td>246</td>
</tr>
<tr>
<td>Preparation and Positioning</td>
<td>246</td>
</tr>
<tr>
<td>Ultrasound Technique</td>
<td>246</td>
</tr>
<tr>
<td>Lumbar Plexus Block</td>
<td>248</td>
</tr>
<tr>
<td>Clinical Application</td>
<td>248</td>
</tr>
<tr>
<td>Anatomy</td>
<td>248</td>
</tr>
<tr>
<td>Preparation and Positioning</td>
<td>248</td>
</tr>
<tr>
<td>Ultrasound Technique</td>
<td>249</td>
</tr>
<tr>
<td>Obturator Nerve Block</td>
<td>250</td>
</tr>
<tr>
<td>Clinical Application</td>
<td>250</td>
</tr>
<tr>
<td>Anatomy</td>
<td>250</td>
</tr>
<tr>
<td>Preparation and Positioning</td>
<td>250</td>
</tr>
<tr>
<td>Ultrasound Technique</td>
<td>250</td>
</tr>
<tr>
<td>Lateral Femoral Cutaneous Nerve Block</td>
<td>251</td>
</tr>
<tr>
<td>Clinical Application</td>
<td>251</td>
</tr>
<tr>
<td>Anatomy</td>
<td>251</td>
</tr>
<tr>
<td>Preparation and Positioning</td>
<td>251</td>
</tr>
<tr>
<td>Ultrasound Technique</td>
<td>252</td>
</tr>
<tr>
<td>Saphenous Nerve Block</td>
<td>252</td>
</tr>
<tr>
<td>Clinical Application</td>
<td>252</td>
</tr>
<tr>
<td>Anatomy</td>
<td>252</td>
</tr>
<tr>
<td>Preparation and Positioning</td>
<td>253</td>
</tr>
<tr>
<td>Ultrasound Technique</td>
<td>253</td>
</tr>
<tr>
<td>Ankle Block</td>
<td>254</td>
</tr>
<tr>
<td>Clinical Application</td>
<td>254</td>
</tr>
<tr>
<td>Anatomy</td>
<td>254</td>
</tr>
<tr>
<td>Preparation and Positioning</td>
<td>256</td>
</tr>
<tr>
<td>Ultrasound Technique</td>
<td>256</td>
</tr>
<tr>
<td>References</td>
<td>257</td>
</tr>
</tbody>
</table>
V Musculoskeletal (MSK) Ultrasound

22 Ultrasound-Guided Shoulder Joint and Bursa Injections ........................................................... 293

Michael P. Schaefer and Kermit Fox

Introduction 293
Subacromial/Subdeltoid Bursa 294
Anatomy 295
Clinical Presentation 295
Limitations of the Blind Approach 295
Ultrasound-Guided Technique 295
Biceps Tendon Sheath (Biceps – Long Head) 296
Anatomy 296
Clinical Presentation 297
Ultrasound-Guided Technique 297
Acromio-Clavicular Joint 298
Anatomy 298
Clinical Presentation 299
Ultrasound-Guided Technique 299
Glenohumeral Joint 300
Anatomy 300
Clinical Presentation 300
Limitations of the Blind Approach 301
Ultrasound-Guided Technique 301
The Rotator Interval Approach 302
Subscapularis Tendon/Subscapularis Bursa 303
Anatomy 303
Clinical Presentation 303
Ultrasound-Guided Technique 303
Sternoclavicular Joint 304
Anatomy 304
Clinical Presentation 304
Ultrasound-Guided Technique 305
Conclusion 305
References 306

23 Ultrasound-Guided Hand, Wrist, and Elbow Injections ................................................................. 307

Marko Bodor, John M. Lesher, and Sean Colio

Introduction 307
Ultrasound-Guided Carpal Tunnel Injections 308
Anatomy 308
Literature Review on Ultrasound-Guided Carpal Tunnel Injections 309
Ultrasound-Guided Technique for Carpal Tunnel Injection 309
Ultrasound-Guided Trigger Finger Injections 311
Anatomy 311
Literature Review on Ultrasound-Guided Trigger Finger Injections 311
Ultrasound-Guided Trigger Finger Injection Technique 311
Ultrasound-Guided Wrist Injections 312
Anatomy 312
CONTENTS

Literature Review on Ultrasound-Guided Wrist Injections 313
Ultrasound-Guided Technique for Wrist Injections 313
Ultrasound-Guided Injections for Tendon Dysfunction 316
Anatomy 316
Ultrasound-Guided Technique for Tendon Dysfunction 317
Ultrasound-Guided Elbow Injections 319
Anatomy 319
Literature Review on Ultrasound-Guided Elbow Injections 319
Ultrasound-Guided Elbow Injection Technique 320
References 321

24 Ultrasound-Guided Hip Injections................................. 325
Hariharan Shankar and Swetha Simhan
Introduction 325
Anatomy of the Hip Joint 326
Intra-Articular Hip Injections 326
Limitations of the Blind Technique 326
Evidence for Ultrasound-Guided Hip Injections 327
Technique of Ultrasound-Guided Hip Injections 327
Conclusion 329
References 329

25 Ultrasound-Guided Knee Injections ......................... 331
Mark-Friedrich B. Hurdle
Introduction 331
Limitations of the Current Surface Landmarks Technique 331
Technique for Ultrasound-Guided Knee Joint Injection 332
Conclusion 334
References 334

VI Advanced and New Applications
of Ultrasound in Pain Management

26 Ultrasound-Guided Peripheral
Nerve Stimulation .................................................. 337
Marc A. Huntoon
Introduction 337
Current Evidence 338
Patient Selection and Role of Neurolysis 339
Anatomical Considerations 339
Radial Nerve Stimulation 339
Ulnar Nerve 340
Median Nerve 340
Sciatic Nerve at Popliteal Bifurcation 341
Posterior Tibial Nerve 343
Conclusion 343
References 343
27 Ultrasound-Guided Occipital Stimulation ........................................................................ 345
Samer N. Narouze

   Introduction 345
   Limitations of the Current ONS Technique 346
   Anatomy of the GON 346
   Occipital Field Stimulation vs. Peripheral Nerve Stimulation 347
   Technique of US-Guided ONS Lead Implant 347
   References 348

28 Ultrasound-Guided Groin Stimulation .............................................. 349
Samer N. Narouze

   Introduction 349
   Limitations of the Current Technique 350
   Anatomy of the Ilioinguinal and Iliohypogastric Nerves 350
   Groin Field Stimulation vs. Peripheral Nerve Stimulation 350
   Technique of Ultrasound-Guided IL/IH PNS Lead Implant 350
   Reference 352

29 Ultrasound-Guided Atlanto-Axial and Atlanto-Occipital Joint Injections .............................. 353
Samer N. Narouze

   Introduction 353
   Anatomy of the Atlanto-Axial and Atlanto-Occipital Joints 354
   Ultrasound-Guided Atlanto-Axial and Atlanto-Occipital Joint Injection Technique 354
   References 357

30 Ultrasound-Assisted Cervical Diskography and Intradiskal Procedures ............................ 359
Samer N. Narouze

   Introduction 359
   Limitations of the Fluoroscopically Guided Cervical Diskography 360
   Technique of Ultrasound-Assisted Cervical Diskography 360
   References 362

Index ................................................................................................................. 363
Atlas of Ultrasound-Guided Procedures in Interventional Pain Management
Narouze, S.N. (Ed.)
2011, XXVIII, 372 p. 465 illus., 350 illus. in color., Hardcover