

Contents

Foreword	xviii
Preface	xix
Acknowledgments	xx
Contributors	xxi
Abbreviations	xxiii
General Aspects of Interventional Ultrasound	
1 Interventional Ultrasound: Introduction and Historical Background	2
<i>H. Lutz</i>	
1.1 The Vienna Congress	2
1.2 The Introduction of Ultrasound into Routine Clinical Use	3
1.2.1 The Evolution of Ultrasound Imaging Techniques	3
1.2.2 Technical Evolution of Ultrasound-Guided Biopsies	4
1.2.3 Clinical Application	7
1.2.4 Risks of Interventional Ultrasound	9
1.3 Later Developments: Ultrasound-Guided Therapeutic Interventional Procedures	10
1.4 Outlook	10
References	11
2 Interventional Materials and Equipment	13
2.1 General Considerations on Interventional Procedures	13
<i>U. Gottschalk, C. F. Dietrich</i>	
2.1.1 Brief Historical Introduction	13
2.1.2 Biopsy Principles and Techniques	13
2.1.3 Needle Systems	15
2.2 Therapeutic Interventions	20
2.2.1 Introduction	20
2.2.2 Brief Historical Review	20
2.2.3 Patient Preparation	21
2.2.4 Access Routes	21
2.2.5 Indications and Contraindications	21
2.2.6 Complications	22
2.2.7 Needle Techniques	23
2.2.8 Special Needle Types	23
2.2.9 Trocar Technique	23
2.2.10 Seldinger Technique	24
2.2.11 Peel-Away Sheath	24
2.2.12 Anchor Systems, Suture Techniques	25
2.2.13 Guidewires	26
2.2.14 Dilators	27
2.2.15 Drainage Catheters	27
2.2.16 Other Drainage Systems	29
2.2.17 Accessories	29
References	31
3 Informed Consent	32
<i>D. Nuernberg, A. Jung</i>	
3.1 What Should Be Disclosed?	32
3.1.1 Indication	32
3.1.2 Explaining the Procedure	32
3.1.3 Risks and Complications	32
3.2 Means of Disclosure	32
3.2.1 Consent Form	32
3.2.2 Informed Consent Discussion	32
3.2.3 Delegating Informed Consent	33

3.3	Documentation	33	3.5.2	Patients Lacking the Capacity to Consent	33
3.4	Timing of the Consent Process	33	3.5.3	Minors	33
3.5	Special Situations	33	3.5.4	Language Barriers	34
3.5.1	Implied Consent	33	3.5.5	Waiving of Informed Consent	34
				References	34
4	Medications, Equipment, and Setup Requirements	35			
	<i>D. Nuernberg, A. Jung</i>				
4.1	Medications	35	4.2.3	Positioning, Preprocedure Examination, and Marking	37
4.1.1	Premedication	35	4.2.4	Monitoring During the Procedure	37
4.1.2	Analgesia	35	4.2.5	Postprocedure Monitoring	37
4.1.3	Coagulation	36	4.2.6	Facilities (Procedure Room)	37
4.1.4	Local Anesthesia	36	4.2.7	Functional and Design Requirements	38
4.2	Equipment and Setup Requirements ..	37	4.2.8	Operational and Organizational Requirements	38
4.2.1	Biopsy Equipment	37		References	38
4.2.2	Interventional Materials	37			
5	Pathology and Cytology	40			
	<i>A. Tannapfel, C. F. Dietrich</i>				
5.1	Pathology	40	5.4.2	Grading	43
5.2	Biopsies	40	5.5	Specific Analysis	43
5.2.1	Types of Biopsy Procedure	40	5.5.1	Lymph Nodes	43
5.3	Histology or Cytology?	40	5.5.2	Lymphomas	45
5.3.1	Sources of Error	41	5.6	Hormone Growth Factor Receptor Analysis	47
5.4	Typing, Grading, and Staging	41		References	48
5.4.1	Classification (Typing)	41			
6	Fine Needle Aspiration Cytology	49			
	<i>C. Jenssen, T. Beyer</i>				
6.1	Specimen Collection	49	6.3.1	Basic Principles	55
6.1.1	Ultrasound-Guided Biopsy	49	6.3.2	Air Drying and Romanowsky Stains	55
6.1.2	Needle Movement and Aspiration	49	6.3.3	Wet Fixation and Papanicolaou Staining ..	55
6.2	Specimen Preparation	49	6.3.4	Ancillary Tests	56
6.2.1	Fluid Aspirates	49	6.4	Cytomorphologic Evaluation	58
6.2.2	Centrifuging Effusions	49	6.4.1	Rapid On-Site Evaluation	58
6.2.3	Aspirates from Solid Lesions	50	6.4.2	Final Cytologic Diagnosis	63
6.3	Fixation and Staining	55	6.5	Conclusions	64
				References	64

7	Infections and Diagnostic Microbiology	68		
	<i>T. Glueck, H. J. Linde, C. F. Dietrich</i>			
7.1	General Principles of Microbiological Testing	68	7.2.6	Limitations of Microbiological Methods ..
			7.2.7	Specimen Receipt during Off-hours (Nights, Weekends, Holidays)
				72
7.1.1	Microbiological Specimens	68		
7.1.2	Prerequisites for Microbiological Testing. .	68	7.3	Specific Guidelines for Microbiological Testing and Differential Diagnosis by Organ Systems and Syndromes
7.2	Microbiological Techniques	69		73
7.2.1	Stains.	69	7.3.1	Investigation of Enlarged Lymph Nodes. . .
7.2.2	Culture Techniques	71	7.3.2	Microbiological Testing and Antimicrobial Therapy for Suspected Tuberculosis
7.2.3	Nucleic Acid Amplification Techniques . .	71	7.3.3	Liver Mass Suspicious for an Abscess (Including Amebic Abscess)
7.2.4	Serology	71		77
7.2.5	When Are Microbiological Test Results Available?	72		References
				81
8	Hygiene Management	82		
	<i>H. Martiny, D. Nuernberg</i>			
8.1	General Hygienic Requirements	82	8.3	Ultrasound Probe and Accessories.
				84
8.1.1	Personal Protective Equipment and Coverings	82	8.3.1	Decontamination of the Ultrasound Probe
8.1.2	Disposable Probe Covers	83	8.3.2	Decontamination of Ultrasound Accessories
8.1.3	Ultrasound Gel.	83		85
8.2	Hand Antisepsis and Skin Preparation	83		References
				85
9	Contraindications, Complications, and Complication Management	86		
	<i>C. Jenssen, C. F. Dietrich</i>			
9.1	Interventional Risk	86	9.3.5	Prevention of Infection
			9.3.6	Optimal Approach and Alternatives
9.1.1	Complication Rates and Mortality	86		93
9.1.2	Factors that Influence Interventional Risk	86	9.4	Contraindications
9.2	Frequent Complications and Their Risk Factors	86		93
9.2.1	Pain and Vasovagal Reactions	86	9.4.1	Coagulopathies
9.2.2	Bleeding Complications	87	9.4.2	Procoagulant Therapy and Antiplatelet Drugs
9.2.3	Needle Tract Seeding	88	9.4.3	"Risky" Lesions and Access Routes
9.2.4	Specific Complications	89		94
9.3	Prevention of Complications	89	9.5	Management of Complications
				95
9.3.1	Risk Assessment and Patient Selection	89	9.5.1	Postinterventional Care and Detection of Complications
9.3.2	Modification of Risk Factors	90	9.5.2	Treatment of Complications
9.3.3	Risk Reduction Techniques	92		95
9.3.4	Local Anesthesia and Intravenous Sedation	92	9.6	Specific Biopsy Sites
				95
			9.6.1	Liver Biopsy
			9.6.2	Renal Biopsy
			9.6.3	Pancreatic Biopsy
			9.6.4	Splenic Biopsy
				100

9.6.5	Biopsy of Gastrointestinal Hollow Organs and Mesenteric Masses.	100	9.7.3	Transrectal Prostatic Biopsy.	102
9.6.6	Adrenal Biopsy.	100	9.7.4	Ultrasound-Guided Drainage (of Cysts, Pseudocysts, Abscesses, Cholecystitis).	102
9.6.7	Lungs, Pleura, and Mediastinum.	101	9.7.5	Ultrasound-Guided PTCD and Cholecystotomy.	103
9.7	Specific Interventions.	101	9.7.6	Ultrasound-guided Tumor Ablation Therapy.	103
9.7.1	EUS-FNA, EUS-TCB, EBUS-TBNA.	101		References.	104
9.7.2	EUS-Guided Therapeutic Interventions. ...	101			
10	Assistance in Ultrasound Interventions.	109			
	<i>U. Gottschalk, C. F. Dietrich</i>				
10.1	Basic Principles.	109	10.6	Sedation.	111
10.2	Duties of Assisting Personnel.	109	10.7	Drain Placement.	111
10.3	Diagnostic Ultrasound.	110	10.8	Endosonography.	113
10.4	Diagnostic Interventions.	110		References.	113
10.5	Therapeutic Interventions.	111			
11	Sedation in Interventions.	114			
	<i>U. Gottschalk, C. F. Dietrich</i>				
11.1	Introduction.	114	11.6	Complications.	115
11.2	Medications.	114	11.7	Summary.	115
11.3	Personnel Requirements.	114		References.	115
11.4	Monitoring Requirements.	115			
11.5	Postprocedure Care.	115			
Specific Ultrasound-Guided Procedures: Abdomen					
12	Indications for Diagnostic Interventions in the Abdomen and Thorax (Liver, Pancreas, Spleen, Kidneys, Lung, Other Sites).	120			
	<i>H. Kinkel, D. Nuernberg</i>				
12.1	Liver.	120	12.5	Lung.	125
12.1.1	Diffuse Liver Diseases.	120	12.6	Adrenal Gland.	125
12.1.2	Focal Liver Lesions.	121	12.7	Lymph Nodes.	125
12.2	Pancreas.	123	12.8	Other Lesions.	126
12.3	Spleen.	123		References.	126
12.4	Kidneys.	124			

13	Diagnostic and Therapeutic Paracentesis of Free Abdominal Fluid	128		
	<i>D. Nuernberg</i>			
13.1	Peritoneal Cavity	128	13.7	Diagnostic Paracentesis: Laboratory Tests
13.2	Sites of Predilection for Intra-abdominal Fluid	128	13.8	Indications for Therapeutic Paracentesis
13.3	Pathogenesis and Differential Diagnosis of Ascites	129	13.8.1	Treatment of Ascites in Hepatic Cirrhosis: Paracentesis for Symptom Relief in Hepatic Cirrhosis (and Pancreatitis).....
13.4	Specific Indications	129	13.8.2	Palliative Paracentesis for Peritoneal Carcinomatosis.....
13.4.1	Transudate.....	129	13.8.3	Cytostatic Therapy of Peritoneal Carcinomatosis (Intraperitoneal Chemotherapy).....
13.4.2	Exudate.....	129	13.8.4	Drainage (with Irrigation) for Bile Leakage (For Example in a Palliative Setting).....
13.4.3	Cirrhosis.....	130	13.9	Materials
13.4.4	Heart Failure.....	130	13.10	Contraindications, Complications, and Postprocedure Care
13.4.5	Hypoalbuminemia.....	130		References.....
13.4.6	Peritonitis.....	130		
13.4.7	Peritoneal Carcinomatosis.....	130		
13.4.8	Hemoperitoneum.....	130		
13.4.9	Pancreatitis.....	131		
13.4.10	Other Rare Abdominal Fluid Collections ..	131		
13.5	Differentiating a Localized Fluid Collection from Ascites	133		
13.6	Practical Issues: How and Where to Aspirate?	133		
14	Fine Needle Aspiration Biopsy and Core Needle Biopsy	138		
	<i>J.-C. Kaemmer, D. Nuernberg</i>			
14.1	Historical Background	138	14.3.2	Cutting Biopsy with an Otto or Franseen Needle.....
14.2	Description of Biopsy Techniques	138	14.3.3	Autovac and BioPince Biopsy Systems
14.2.1	What Type of Needle Should Be Used?	138	14.3.4	Biomol Biopsy System.....
14.3	Biopsy Technique for Specific Needle Types	141	14.3.5	Trucut Needles.....
14.3.1	Biopsy with the Chiba Needle.....	142	14.4	Summary
				References.....
15	Abscess Drainage	144		
	<i>C. F. Dietrich, A. Ignee, U. Gottschalk</i>			
15.1	Historical Considerations	144	15.3.4	Magnetic Resonance Imaging.....
15.2	Preliminary Remarks, Etiology	144	15.4	Devices
15.3	Selection of Imaging Modality	144	15.4.1	Drainage Catheters.....
15.3.1	Ultrasound.....	144	15.5	Indications
15.3.2	Conventional Radiographic Drainage.....	146	15.6	Contraindications
15.3.3	Computed Tomography.....	146		

15.7	Patient Preparation	147	15.11.3	Liver Abscess in Biliary Disease	155
15.8	Treatment Options	148	15.11.4	Abscess in Pancreatitis	156
15.8.1	General	148	15.11.5	Liver Abscess in Amebiasis	156
15.8.2	Medical Treatment Options	148	15.11.6	Protozoan Infections with Liver Involvement	157
15.8.3	Surgical Treatment Options	148	15.11.7	Septic (Pyogenic) Abscess with Associated Diseases (Sepsis, Coagulopathies, Ascites)	157
15.9	Technique of Percutaneous Abscess Drainage	148	15.11.8	Infection of Necrotic Tumor Components	158
15.9.1	Preparation	148	15.11.9	Liver Abscess after Liver Transplantation	158
15.9.2	Initial Needle Insertion	149	15.12	Complications	158
15.9.3	Trocar Technique	151	15.13	Irrigation	159
15.9.4	Irrigation	154	15.14	Sequelae	159
15.9.5	Drain Removal	154	15.15	Ultrasound-Guided Gallbladder Drainage and Other Indications	159
15.9.6	Specimen Processing	154		References	160
15.10	Postprocedure Care	154			
15.11	Specific Diseases	154			
15.11.1	Pyogenic Liver Abscess	154			
15.11.2	Abscesses in Appendicitis, Peridiverticulitis	155			
16	Percutaneous Sclerotherapy of Cysts	163			
	<i>C. F. Dietrich, B. Braden</i>				
16.1	Percutaneous Sclerotherapy of Liver Cysts	163	16.3	Percutaneous Sclerotherapy of Renal Cysts	164
16.1.1	Epidemiology and Etiology	163	16.3.1	Summary of the Literature	164
16.1.2	Symptoms	163	16.3.2	Epidemiology, Differential Diagnosis, and Classification	165
16.1.3	Indications	163	16.3.3	Technique	166
16.1.4	Contraindications	163	16.3.4	Sclerosing Agents	166
16.1.5	Interventional Materials and Equipment	163	16.4	Alternative Procedures	167
16.1.6	Sclerosing Agents	163	16.5	Special Issues Relating to Splenic Cysts	167
16.1.7	Treatment Options	163	16.6	Special Issues Relating to Pancreatic Cysts	167
16.1.8	Technique for Percutaneous Sclerotherapy of a Liver Cyst	163		References	167
16.2	Sclerotherapy Technique	164			
16.2.1	Follow-up Care	164			
16.2.2	Prognosis	164			
17	Interventional Treatment of Echinococcosis	168			
	<i>C. F. Dietrich, M. Hocke</i>				
17.1	Echinococci: Types and Epidemiology ..	168	17.2	Clinical Manifestations	169
17.1.1	<i>Echinococcus granulosus</i>	168	17.3	Diagnosis	169
17.1.2	<i>Echinococcus multilocularis</i>	169	17.3.1	Three Main Diagnostic Criteria	169

17.3.2	Laboratory Parameters	169	17.5	Treatment	173
17.3.3	Serologic and Molecular Biologic Tests ...	169	17.5.1	Surgical Treatment Options	174
17.4	Imaging Studies, Staging of Disease ...	169	17.5.2	Drug Treatment Options	174
17.4.1	Historical Background	169	17.5.3	Local Ablative Procedures: PAIR	175
17.4.2	Morphologic and Functional Classification Systems	171	17.5.4	Endoscopic Retrograde Cholangiography	177
17.4.3	WHO Classification	171		References	177
18	Local Ablative Procedures; Percutaneous Ethanol and Acetic Acid Injection	179			
	<i>C. F. Dietrich, B. Braden, M. Hocke</i>				
18.1	Basic Considerations	179	18.4.1	Materials and Equipment	180
18.1.1	What Tumors Are Suitable for Local Ablative Procedures?	179	18.4.2	Preparations	180
18.1.2	Radiofrequency Ablation or Percutaneous Ethanol Injection?	179	18.4.3	Technique	180
18.1.3	Ethanol or Acetic Acid Injection?	179	18.5	Follow-up Care, Complications, and Prognosis	182
18.1.4	Single or Multiple Sessions?	179	18.5.1	Follow-up Care	182
18.2	Indications	179	18.5.2	Complications	182
18.2.1	Considerations on Hepatocellular Carcinoma	180	18.5.3	Monitoring of Treatment Response	182
18.3	Contraindications	180	18.5.4	Factors That Determine Prognosis	183
18.4	Practical Aspects	180	18.6	Summary	183
				References	183
19	Local Ablative Procedures for Liver Tumors, Radiofrequency Ablation	185			
	<i>C. F. Dietrich, T. Albrecht, T. Bernatik, A. Ignee</i>				
19.1	Concepts (Curative, Palliative, Multimodal)	185	19.5.2	Local Anesthesia, Sedation, Sedation/Analgesia, and General Anesthesia	187
19.1.1	Hepatocellular Carcinoma	185	19.5.3	Treatment Planning	187
19.1.2	Colorectal Carcinoma	185	19.6	Materials	187
19.2	Selection of imaging Modality (Ultrasound, CT, MRI)	186	19.6.1	Standard Materials	187
19.3	Indications	186	19.6.2	Basic Principle	188
19.3.1	Number of Tumors	186	19.6.3	Monopolar versus Bipolar and Multipolar Systems	188
19.3.2	Tumor Size	186	19.6.4	Needle Applicators	189
19.3.3	Tumor Location	186	19.6.5	Control and Temperature Measurement	189
19.4	Contraindications	187	19.6.6	Flow Rate of Needle Perfusion	189
19.5	Preparations	187	19.7	Technique	189
19.5.1	Antibiotic Prophylaxis	187	19.7.1	Patient Positioning	189
			19.7.2	(Local) Anesthesia	190
			19.7.3	Probe Insertion	190
			19.7.4	Techniques for Specific Systems	191

19.8	Assessing the Efficacy of Treatment . . .	192	19.9.2	Postinterventional Care	196
19.9	Complications and Aftercare	193	19.9.3	Clinical Aftercare and Follow-up	196
19.9.1	Complications	193		References	196
20	Percutaneous Transhepatic Cholangiodrainage	198			
	<i>C. F. Dietrich, B. Braden, X. W. Cui, A. Ignee</i>				
20.1	Basic Principles	198	20.6.1	Results with Plastic Endoprotheses	207
20.2	Indications	198	20.6.2	Results with Metal Endoprotheses	208
20.2.1	Endoscopic Retrograde or Percutaneous Approach	199	20.7	Complications	208
20.2.2	Rendezvous Technique	199	20.7.1	Incidence	208
20.3	Contraindications	199	20.7.2	Management of Complications	208
20.4	Materials and Equipment	200	20.8	Aftercare	208
20.4.1	Description of Materials	200	20.9	Use of Intracavitary Ultrasound Contrast Agents	209
20.5	Technique	201	20.10	Analysis of the Literature	210
20.5.1	Patient Positioning	202	20.10.1	Present Authors' Data	210
20.5.2	Needle Insertion and Drainage	202	20.10.2	Comparison of Endoprotheses	210
20.5.3	Procedure Time	207		References	212
20.6	Success Rate	207			
21	Percutaneous Gastrostomy	215			
	<i>A. Ignee, G. Schuessler, C. F. Dietrich</i>				
21.1	Indications	215	21.8	Role of Ultrasonography	217
21.2	Contraindications	215	21.8.1	General	217
21.3	Materials and Equipment	215	21.8.2	Ultrasound-Assisted PEG	218
21.4	Types of Gastrostomy	215	21.8.3	Technique of Percutaneous Sonographic Gastrostomy	219
21.4.1	Percutaneous Endoscopic Gastrostomy	215	21.9	Questions Relevant to Percutaneous Sonographic Gastrostomy	220
21.4.2	Percutaneous Sonographic Gastrostomy	216	21.9.1	Use of a Spasmolytic Agent	220
21.5	Advantages and Disadvantages of Different Methods	216	21.9.2	Prophylactic Antibiotics	220
21.6	Success Rates of Different Gastrostomy Techniques	216	21.9.3	Use of a Guidewire	220
21.7	Complication Rates of Different Gastrostomy Techniques	216	21.9.4	Need for Gastropexy	220
			21.9.5	Type of Drainage	221
			21.10	Summary	222
				References	223

22	Interventional Endosonography	224
	<i>C. F. Dietrich, M. Hocke, C. Jenssen</i>	
22.1	Cost–Benefit Analysis	224
22.2	Historical Introduction	224
22.3	Materials and Equipment	224
22.3.1	Requirements of the Endoscopy Unit	224
22.3.2	Which Endosonography Systems Have Become Established?	225
22.3.3	Which Biopsy Needles and Techniques Have Become Established?	225
22.3.4	Guidewires	227
22.3.5	Fixed-Diameter Dilators	228
22.3.6	Balloon Dilators	229
22.3.7	Plastic Stents (Pigtail)	230
22.3.8	Metal Stents	231
22.3.9	Diathermy Devices, Cystotome	232
22.3.10	Retrievers	233
22.3.11	Supplementary Techniques in EUS-guided Biopsy	234
22.4	Procedure	234
22.4.1	Sedation	234
22.4.2	Other Medications	234
22.4.3	Orientation	234
22.4.4	General Rules for Needle Insertion	234
22.4.5	Biopsy Technique	235
22.4.6	Suction	235
22.4.7	Specimen Processing	235
22.5	Diagnostic Interventions	236
22.5.1	Indications	236
22.5.2	Risk of Complications	237
22.5.3	Contraindications	238
22.6	Therapeutic Interventions, General Aspects	238
22.6.1	Therapeutic EUS-Guided Interventions	238
22.6.2	Endoscopes and Needle Types	238
22.6.3	General Rules for Needle and Wire Handling	239
22.6.4	Indications	239
22.6.5	Contraindications	239
22.7	Drainage of Peripancreatic Fluid Collections	239
22.7.1	History	239
22.7.2	Basic Anatomical Considerations	239
22.7.3	Pathophysiologic Considerations	239
22.7.4	Diagnostic Workup	239
22.7.5	Indications	240
22.7.6	Timing of the EUS Intervention	240
22.7.7	Selection of Procedure	240
22.7.8	Technique	240
22.7.9	One-Step Systems	240
22.7.10	Treatment of Nonpancreatic Fluid Collections	242
22.7.11	Surgical Options	243
22.8	EUS-Guided Cholangiodrainage	243
22.8.1	Introduction	243
22.8.2	Indications and Treatment Goals	244
22.8.3	Equipment	244
22.8.4	Preparatory Measures	244
22.8.5	Technique	244
22.8.6	Assessing the Result, Postinterventional Care, Complications	246
22.9	EUS-Guided Pancreatic Duct Drainage	246
22.9.1	Indications and Treatment Goals	246
22.9.2	Technique	246
22.9.3	Assessing the Result, Postinterventional Care, Complications	246
22.10	Celiac Plexus Neurolysis and Celiac Plexus Blockade	246
22.10.1	Indications and Treatment Goals	246
22.10.2	Materials	247
22.10.3	Technique	247
22.10.4	Assessing the Result, Postinterventional Care, Complications	247
22.11	Tumor Ablation with Alcohol	247
22.12	EUS-Guided Vascular Interventions	248
22.12.1	Indications and Treatment Goals	248
22.12.2	Materials	248
22.12.3	Technique	248
22.12.4	Assessing the Result, Postinterventional Care, Complications	248
22.13	Complications	249
22.14	Postinterventional Care	250
	References	251

23	Special Issues Regarding Interventions in the Spleen	254
	<i>C. F. Dietrich</i>	
23.1	Diffuse Splenic Changes	254
23.2	Specific Disorders	254
23.2.1	Splenic Rupture	254
23.2.2	Splenic Infarction	254
23.2.3	Focal Splenic Changes	255
23.3	Procedures	255
23.3.1	Clinical Scenarios	255
23.3.2	Anatomical Considerations in Splenic Interventions	255
23.3.3	Procedures for Specific Applications	256
23.4	Abscess Drainage	256
23.5	Indications	256
23.6	Contraindications	256
23.7	Indications for Splenic Biopsy Drawn from Case Data	256
23.8	Postinterventional Care	257
23.9	Complications	257
23.10	Preinterventional Vaccinations	257
	References	257

Specific Ultrasound-Guided Procedures: Thorax

24	Thoracic Interventions	260
	<i>W. Blank, A. Heinzmann</i>	
24.1	Advantages of Ultrasound-Guided Interventions	260
24.2	Indications	261
24.3	Contraindications	261
24.4	Selection of Materials	261
24.4.1	Ultrasound Technology	261
24.4.2	Biopsy Devices	262
24.5	Preparations	263
24.6	Technique	264
24.6.1	Chest Wall Lesions	264
24.6.2	Pleural Space	264
24.6.3	Subpleural Lung Lesions	265
24.6.4	Pulmonary Abscesses	268
24.6.5	Mediastinum	268
24.7	Steps in the Procedure	269
24.7.1	Preparations	269
24.7.2	Technique	269
24.7.3	Postprocedure Care	269
24.8	Problems and Complications	269
24.8.1	Postbiopsy Pneumothorax	269
24.9	Postprocedure Care and Follow-Up	270
	References	271

Specific Ultrasound-Guided Procedures: Urogenital System

25	Percutaneous Renal Biopsy	274
	<i>U. Goettmann, B. K. Kraemer</i>	
25.1	Indications	274
25.2	Contraindications	274
25.3	Materials and Equipment	275
25.4	Preparations	275
25.5	Procedure	276
25.5.1	Native Renal Biopsy	276
25.5.2	Review of the Procedure Steps	277
25.5.3	Biopsy of a Renal Allograft	277
25.6	Complications	277

25.7	Postbiopsy Care	278	References	278
25.8	List of Materials and Equipment	278		
26	Interventional Urology	280		
	<i>D. Brix, A. Ignee, C. F. Dietrich</i>			
26.1	Transrectal Ultrasonography of the Prostate	280	26.3.5	Transperineal Biopsy
				282
26.1.1	Introduction	280	26.4	Percutaneous Nephrostomy
26.1.2	Equipment Requirements	280		282
26.2	Diseases of the Prostate	280	26.4.1	Introduction
				282
26.2.1	Prostate Cancer	280	26.4.2	Indications
26.2.2	Prostatic Abscess	281		282
26.3	Prostate Biopsy	281	26.4.3	Relative Contraindications
				282
26.3.1	Introduction	281	26.4.4	Complications
26.3.2	Indications	281		282
26.3.3	Informed Consent and Preparation	281	26.4.5	Preparations
26.3.4	Complications and Their Management ...	281		282
			26.4.6	Materials and Equipment
				282
			26.4.7	Technique
				282
			26.4.8	Anesthesia
				283
			26.4.9	Procedure
				283
			26.4.10	Postoperative Care
				284
			References	285

Specific Ultrasound-Guided Procedures: Other Organ Systems

27	Interventional Thyroid Ultrasound	288		
	<i>B. Braun, T. Mueller</i>			
27.1	Diagnostic Interventions	288	27.1.8	Problems
				293
27.1.1	Indications	288	27.1.9	Pitfalls in Thyroid Biopsy
27.1.2	Contraindications	288		294
27.1.3	Methods	288	27.2	Therapeutic Interventions
27.1.4	Complications	290		295
27.1.5	Materials and Equipment	290	27.2.1	Evacuation Procedures
27.1.6	Preparation	291		296
27.1.7	Procedure	292	27.2.2	Ablative Procedures
				296
			References	301
28	Musculoskeletal Interventions	304		
	<i>W. Hartung, T. Weigand</i>			
28.1	Indications and Contraindications	304	28.3.2	Overview of Technique
				306
28.1.1	Indications	304	28.3.3	Details of Technique
28.1.2	Contraindications	304		306
28.2	Materials and Equipment	304	28.3.4	Rotator Cuff (Supraspinatus Muscle)
				309
28.3	Procedure	305	28.4	Pitfalls and Complications
				312
28.3.1	Preparations	305	28.5	Postprocedure Care
				313
			References	313

29	Neurologic Interventions, Ultrasound-Guided Regional Anesthesia	315
	<i>H. H. Wilckens, A. Ignee, M. Kaeppler, H. Boehrer, C. F. Dietrich</i>	
29.1	History and Development	315
29.2	Indications	315
29.3	Contraindications	315
29.3.1	Patient Refusal	315
29.3.2	Clinically Overt Coagulopathy and Anticoagulant Medication	315
29.3.3	Infections at the Puncture Site	316
29.3.4	Neurologic Deficit	316
29.4	Needle Insertion Techniques	316
29.4.1	Out-of-Plane versus In-Plane Technique	316
29.5	Ultrasound Imaging of Nerves and Muscles	316
29.5.1	Nerves	316
29.5.2	Muscles	317
29.6	Materials and Equipment	317
29.6.1	Ultrasound Machines	317
29.6.2	Anesthesia Needles and Catheters	317
29.7	Regional Anesthesia at Specific Sites: Upper Limb	318
29.7.1	Brachial Plexus	318
29.7.2	Infraclavicular Brachial Plexus Block	320
29.7.3	Axillary Brachial Plexus Block	321
29.8	Regional Anesthesia at Specific Sites: Lower Limb	322
29.8.1	Lumbosacral Plexus	322
29.8.2	Femoral Nerve Block	323
29.8.3	Obturator Nerve Block	323
29.8.4	Sciatic Nerve Block	325
29.8.5	Saphenous Nerve Block	326
29.8.6	Lateral Femoral Cutaneous Nerve Block	326
29.9	Summary	327
	References	328
30	Ultrasound-Guided Emergency and Vascular Interventions	330
	<i>T. Mueller, C. Jenssen</i>	
30.1	Emergency Interventions	330
30.1.1	Indications	330
30.1.2	Contraindications	331
30.1.3	Materials and Equipment	331
30.1.4	Antisepsis	332
30.1.5	Problems and Complications	332
30.1.6	Intra-abdominal Free Fluid	332
30.1.7	Intrathoracic Free Fluid	333
30.1.8	Pneumothorax	333
30.1.9	Pericardial Fluid	334
30.2	Percutaneous Vascular Interventions	335
30.2.1	Vascular Access	335
30.2.2	Ultrasound-Guided Treatment of Pseudoaneurysms	341
30.3	Endosonographically Guided Vascular Interventions	345
30.3.1	Indications and Treatment Goals	345
	References	348
Specific Ultrasound-Guided Procedures: Other Applications of Interventional Ultrasound		
31	Extravascular Use of Ultrasound Contrast Agents	354
	<i>A. Ignee, G. Schuessler, C. F. Dietrich</i>	
31.1	Approved Indications	354
31.2	Contraindications and Complications	354

31.3	Technique	354	31.5	Use of Ultrasound Contrast Agents in Nonphysiologic Body Cavities	356
31.4	Use of Ultrasound Contrast Agents in Physiologic Body Cavities	355	31.5.1	Ultrasound Fistulography	356
31.4.1	Voiding Sonography for the Detection of Vesicoureteral Reflux	355	31.5.2	Percutaneous Injection of UCAs for Abscess Imaging	357
31.4.2	Contrast-Enhanced Ultrasound for Evaluating Tubal Patency	355	31.5.3	UCAs for Demonstrating Pancreatitis-Associated Cystic Lesions after EUS-Guided Biopsy	357
31.4.3	Imaging the Peritoneal Cavity with UCAs (for Detection of Ascites)	355	31.6	Summary	357
31.4.4	Biliary Tract	356		References	358
31.4.5	UCAs in Enterography	356			
31.4.6	CEUS Gastrography—Percutaneous Injection of UCA into the Stomach to Assess Gastrostomy Placement	356			
32	Volume Navigation	359			
	<i>C. F Dietrich, A. Ignee, M. Hoepfner</i>				
32.1	How Tracking Works	359	32.5	Magnetic Field–Assisted Needle Tracking and Guidance	362
32.2	Position Marking	359	32.6	Illustrative Images and Case Reports	362
32.3	Fusion with CT, MRI, or PET Volume Data Sets	359	32.6.1	Case Report 1	362
32.4	Fusion with Archived Ultrasound Volume Data	362	32.6.2	Case Report 2	362
				References	363
33	Palliative Interventions and the Role of Ultrasonography in Palliative Care	364			
	<i>D. Nuernberg</i>				
33.1	Content and Goals of Palliative Care ...	364	33.4	Portable Ultrasound in Specialized Ambulatory Palliative Care	367
33.2	Ultrasound in Palliative Staging, Follow-Up, and Palliative Treatment Monitoring	364	33.5	Palliative Ultrasound in Caring Medicine	367
33.3	Ultrasound-Guided Palliative Interventions	365	33.6	Conclusions	368
33.3.1	Palliative Diagnostic Interventions	365		References	368
33.3.2	Specific Palliative Therapeutic Interventions	366			
	Index	369			