

Contents

Foreword					xiii
Preface					xv
Acknowledgments					xvii
Contributors					xix
1 History of Endonasal Tumor Surgery					2
<i>Wolfgang Draf^f, Philip Michael, Amir Minovi</i>					
1.1 Introduction	2	1.5 Powered Instrumentation and Navigation in Sinus Surgery			4
1.2 The Origins of Sinus Surgery	2	1.6 Functional Endonasal Sinus Surgery ...			4
1.3 Development of Visual Tools in Sinus Surgery	3	1.7 The Development of Endonasal Oncologic and Skull Base Surgery			5
1.4 Diagnostic and Radiological Tools	4	1.8 Conclusions			6
2 Anatomy of Anterior, Central, and Posterior Skull Base					10
2.1 The Osseous Anatomy of the Skull Base and Related Regions	10	2.2.2 Vessels.....			28
<i>Andreas Prescher</i>					
2.1.1 Introduction and General Aspects	10	2.2.3 Nerves.....			33
2.1.2 Anterior Cranial Fossa	11	2.3 Endoscopic Glance at the Skull Base			38
2.1.3 Middle Cranial Fossa	12	<i>Manfred Tschabitscher, Jacopo Dallan</i>			
2.1.4 Posterior Cranial Fossa	15	2.3.1 Introduction.....			38
2.1.5 Paranasal Sinuses	18	2.3.2 Anterior Ethmoid Cells.....			39
2.1.6 Pterygopalatine Fossa (s. Sphenomaxillary Fossa)	25	2.3.3 Frontal Sinus.....			39
2.1.7 Craniocervical Junction	27	2.3.4 Maxillary Sinus.....			39
2.2 Vessels and Nerves	28	2.3.5 Posterior Ethmoid.....			40
<i>Leo F. S. Ditzel Filho, Danielle de Lara, Daniel M. Prevedello, Domenico Solari, Bradley A. Otto, Amin B. Kassam, Ricardo L. Carrau</i>					
2.2.1 Introduction	28	2.3.6 Sphenoid Sinus.....			40
		2.3.7 Vascularization.....			41
		2.3.8 Cribriform Plate Window.....			41
		2.3.9 Sphenoidal Window.....			42
		2.3.10 Orbital Window.....			48
		2.3.11 Maxillary Window to the Infratemporal Fossa and the Upper Parapharyngeal Space.....			48
3 Etiology, Biology, and Pathology of Skull Base Tumors					56
<i>Gerhard Franz Walter</i>					
3.1 Introduction	56	3.2.2 Classification.....			56
3.2 Definitions	56	3.2.3 Prognosis.....			57
3.2.1 Etiology	56	3.2.4 Prediction.....			57
		3.3 Meningeal Tumors			58

Contents

3.3.1	Meningiomas	58	3.7.2	Pituitary Carcinoma	72
3.3.2	Hemangiopericytoma	62	3.7.3	Spindle Cell Oncocytoma of the Adenohypophysis	72
3.3.3	Hemangioblastoma	63	3.7.4	Pituicytoma	72
3.3.4	Leptomeningeal Melanocytic Lesions	64	3.7.5	Granular Cell Tumor of the Neurohypophysis	72
3.4	Tumors of the Peripheral, Autonomous, and Central Nervous Systems	65	3.7.6	Craniopharyngioma	72
3.4.1	Schwannomas	65	3.8	Tumors of the Nasal Cavity and Paranasal Sinuses	72
3.4.2	Malignant Peripheral Nerve Sheath Tumors	65	3.8.1	Schneiderian Papilloma	72
3.4.3	Jugulotympanic Paraganglioma	65	3.8.2	Sinonasal Squamous Cell Carcinoma	75
3.4.4	Pilocytic Astrocytoma	67	3.8.3	Nasopharyngeal Angiofibroma (Juvenile Nasopharyngeal Angiofibroma)	75
3.4.5	Pilomyxoid Astrocytoma	67	3.8.4	Nasal Glioma	75
3.4.6	Ependymoma	67	3.8.5	Esthesioneuroblastoma (Olfactory Neuroblastoma)	76
3.5	Tumors of the Hematopoietic System	69	3.9	Tumors of the Osseous Skull Base	76
3.5.1	Primary Central Nervous System Lymphomas	69	3.9.1	Plasma Cell Myeloma	76
3.5.2	Langerhans Cell Histiocytosis	69	3.9.2	Fibrous Dysplasia	77
3.5.3	Non-Langerhans Cell Histiocytosis	70	3.9.3	Ossifying Fibromyxoid Tumor	78
3.6	Germ Cell Tumors and Dysontogenetic Tumorlike Cysts	70	3.9.4	Osteoblastoma	78
3.6.1	Germ Cell Tumors	70	3.9.5	Osteosarcoma	78
3.6.2	Teratoma and Tumorlike Dysontogenetic Cysts	70	3.9.6	Chondroblastoma	78
3.7	Tumors of the Sellar Region	72	3.9.7	Chondrosarcoma	78
3.7.1	Pituitary Adenoma	72	3.9.8	Chordoma	78
4	Imaging Assessment and Endovascular Treatment	86	3.10	Tumors of Orbit and Eye	79
4.1	Advanced Diagnostic Imaging of Skull Base Tumors	86	3.10.1	Tumors of the Orbit	79
	<i>Bernhard Schuknecht, Erich Hofmann</i>		3.10.2	Tumors of the Eye	81
4.1.1	Introduction	86	3.10.3	Metastatic Tumors	81
4.1.2	Goals of Imaging	86	4.1.14	Sinonasal Malignant Tumors	101
4.1.3	Inverted Papilloma	87	4.1.15	Squamous Cell Carcinoma	101
4.1.4	Osteoma	88	4.1.16	Adenocarcinomas	101
4.1.5	Fibrous Dysplasia	89	4.1.17	Adenoid Cystic Carcinoma	104
4.1.6	Ossifying Fibroma	90	4.1.18	Sinonasal Undifferentiated Carcinoma	104
4.1.7	Schwannomas	90	4.1.19	Neuroendocrine Carcinoma	104
4.1.8	Angiofibroma	92	4.1.20	Sinonasal Malignant Melanoma	105
4.1.9	Pituitary Adenoma	93	4.1.21	Lymphoma	107
4.1.10	Craniopharyngioma	94	4.1.22	Metastases	108
4.1.11	Meningioma	96	4.2	Endovascular Interventional Procedures of Skull Base Pathologies	109
4.1.12	Esthesioneuroblastoma	97		<i>Ralf Siekmann, Erich Hofmann</i>	
4.1.13	Chordoma	99	4.2.1	Introduction	109
			4.2.2	Basic Principles of Embolization and Techniques	110

4.2.3	Embolization Materials.....	111	4.2.5	Applications of Endovascular Therapy.....	116
4.2.4	Test Occlusion of Vessels—Applications, Principles, and Indications.....	114			
5	Management of the Internal Carotid Artery in Skull Base Tumor Surgery				134
	<i>Dietmar Frey, Peter Vajkoczy</i>				
5.1	Introduction.....	134	5.3.4	Excimer Laser-Assisted Nonocclusive Anastomosis.....	144
5.2	Patient Selection.....	134	5.3.5	Intraoperative Assessment of Bypass Function.....	145
5.2.1	Tumors Involving the Internal Carotid Artery.....	134	5.3.6	Antiaggregation and Anticoagulation Regimes.....	147
5.2.2	Preoperative Diagnostic Procedures.....	137	5.4	Management of Internal Carotid Artery	147
5.2.3	Patient Selection for Bypass Surgery.....	140	5.5	Management of Tumor	147
5.3	Technique of Extracranial–Intracranial Bypass Surgery	141	5.6	Combined Endovascular and Surgical Approach as an Alternative for Bypass Surgery	148
5.3.1	Superficial Temporal Artery to Middle Cerebral Artery Bypass.....	141	5.6.1	Cerebral Perfusion and Hemodynamics...	149
5.3.2	Intermediate-Flow Bypass with Radial Artery Graft Interposition.....	142			
5.3.3	High-Flow Bypass with Saphenous Vein Graft Interposition.....	142			
6	Multidisciplinary Endoscopic Skull Base Centers: Delivering Integrated Care				152
	<i>Nancy McLaughlin, Ricardo L. Carrau, Amin B. Kassam, Daniel M. Prevedello, Wolfgang Deinsberger, Ulrike Bockmühl</i>				
6.1	Introduction.....	152	6.3.1	Preoperative Care.....	154
6.2	Key Features of the Multidisciplinary Team Approach.....	152	6.3.2	Intraoperative Care.....	155
6.2.1	Formats of Teamwork.....	152	6.3.3	Postoperative Care.....	155
6.2.2	Concepts of Teamwork.....	152	6.3.4	Long-term Follow-up.....	155
6.3	Implementation of a Multidisciplinary Approach to Sinonasal and Skull Base Pathologies	154	6.4	Trends for a Multidisciplinary Team at Endoscopic Skull Base Centers	156
			6.5	Conclusion	156
7	360° Access to the Skull Base				160
	<i>Nancy McLaughlin, Daniel M. Prevedello, Juan C. Fernandez-Miranda, Ricardo L. Carrau, Amin B. Kassam</i>				
7.1	Introduction.....	160	7.3.2	Overview of Approaches to the Anterior Cranial Fossa.....	162
7.2	Skull Base Surgery: An Evolving Discipline.....	160	7.3.3	Overview of Approaches to the Middle Cranial Fossa.....	163
7.3	The 360° Vision.....	161	7.3.4	Overview of Approaches to the Posterior Cranial Fossa.....	166
7.3.1	Overview of Skull Base Approaches.....	162	7.4	Principles of the 360° Philosophy	171

8	The Sinonasal Corridor	174			
	<i>Ulrike Bockmühl, Ricardo L. Carrau, Bradley A. Otto, Daniel M. Prevedello, Amin B. Kassam</i>				
8.1	Introduction	174	8.5.1	Minor Complications	184
8.2	Preoperative Planning	174	8.5.2	Major Complications	184
8.3	Intraoperative Preparation and Other General Considerations	174	8.5.3	Immediate Complications	185
8.4	Surgical Technique	177	8.5.4	Delayed Complications	185
8.4.1	Basic Sinonasal Corridor	177	8.6	Postoperative Care	185
8.4.2	Expanded Sinonasal Corridor	180	8.6.1	Kassel Hospital (Germany)	185
8.5	Complications	182	8.6.2	Ohio State University	186
9	Expanded Endoscopic Endonasal Approaches	190	8.7	Conclusion	186
	<i>Nancy McLaughlin, Daniel M. Prevedello, Daniel F. Kelly, Ricardo L. Carrau, Amin B. Kassam</i>				
9.1	Introduction	190	9.3.3	Expanded Endonasal Approaches: Anatomical Modules	192
9.2	Indications and Preoperative Work-up	190	9.4	Complications	204
9.3	Surgical Technique	191	9.5	Sequential Learning and Training for Expanded Endonasal Approaches	204
9.3.1	General Concepts for Endoscopic Endonasal Skull Base Surgery	191	9.6	Postoperative Care and Outcome	206
9.3.2	Transsellar Approach to Complement an Expanded Endonasal Approach	192	9.7	Conclusion	206
10	Transpterygoid Approaches	210			
	<i>Carlos Diogenes Pinheiro-Neto, Pornthep Kasemsiri, Ricardo L. Carrau, Daniel M. Prevedello, Amin B. Kassam</i>				
10.1	Introduction	210	10.3.1	Perioperative Preparation	212
10.2	Preoperative Work-up and Indications	211	10.3.2	Surgical Exposure	213
10.3	Surgical Technique	212	10.3.3	Postoperative Care and Outcome	214
11	Endoscopic Transsphenoidal Pituitary Surgery: Endoneurosurgery	218	10.4	Complications	215
	<i>Giorgio Frank, Ernesto Pasquini, Matteo Zoli, Diego Mazzatenta, Vittorio Sciarretta, Marco Faustini Fustini</i>				
11.1	Introduction	218	11.4.1	Preoperative and Postoperative Evaluation	222
11.2	Indications	218	11.4.2	Pituitary Adenoma Outcome Analysis	224
11.3	Surgical Technique	218	11.4.3	Results	225
11.3.1	Standard Technique	218	11.5	Complications	229
11.3.2	Extended Approaches	221	11.5.1	Rhinosinusal Complications	230
11.4	Materials and Methods	222	11.5.2	Intrasellar Complications	230
			11.5.3	Suprasellar and Parasellar Complications	230

11.5.4	Medical Complications	231	11.6.2	Good Tolerance	231
11.5.5	Discussion	231	11.6.3	Effectiveness	232
11.6.1	Expediency	231	11.6.4	Complications	232
			11.6.5	Final Remarks	233
12	Tumor-Specific Strategies				236
12.1	Inverted Papilloma	236	12.3.6	Expanded Endoscopic Endonasal Approach to the Anterior Skull Base: Surgical Technique	255
	<i>Paolo Castelnuovo, Apostolos Karligkiotis, Paolo Battaglia, Federica Sberze, Davide Lombardi, Piero Nicolai</i>		12.3.7	Outcomes	257
12.1.1	Introduction	236	12.3.8	Discussion	258
12.1.2	Technical Considerations	236	12.4	Meningiomas	259
12.1.3	Surgical Technique	237		<i>Nancy McLaughlin, Daniel M. Prevedello, Daniel Kelly, Juan Fernandez-Miranda, Ricardo L. Carrau, Amin B. Kassam</i>	
12.1.4	Postoperative Care and Follow-up	245	12.4.1	Introduction	259
12.1.5	Complications	245	12.4.2	General Surgical Strategy	260
12.1.6	Conclusions	246	12.4.3	Anatomical Considerations and Limitations	263
12.2	Juvenile Angiofibroma	246	12.4.4	Preoperative Evaluation	267
	<i>Piero Nicolai, Alberto Schreiber, Andrea Bolzoni Villaret, Davide Farina</i>		12.4.5	Surgical Technique: General Considerations Specific to Meningiomas Approached via an Expanded Endonasal Approach	267
12.2.1	Introduction	246	12.4.6	Complications	269
12.2.2	Site of Origin and Patterns of Spread	246	12.4.7	Postoperative Care and Outcome	269
12.2.3	Diagnostic Work-up	247	12.4.8	Conclusion	270
12.2.4	Staging Systems	249	12.5	Chordoma	271
12.2.5	Surgical Strategies and Perioperative Management	251		<i>Eng H. Ooi, Ian J. Witterick, Fred Gentili</i>	
12.2.6	Postoperative Surveillance	251	12.5.1	Introduction	271
12.2.7	Outcome	252	12.5.2	Clinical Features	271
12.2.8	Is There Any Role for Nonsurgical Treatments?	252	12.5.3	Pathology	271
12.3	Esthesioneuroblastoma	253	12.5.4	Imaging	271
	<i>Matteo de Notaris, Isam Alobid, Joaquim Enseñat, Manuel Bernal-Sprekelsen</i>		12.5.5	Prognostic Factors	271
12.3.1	Introduction	253	12.5.6	Anatomy of the Clivus	272
12.3.2	Imaging Features	254	12.5.7	Classification System	272
12.3.3	Histologic Findings	255	12.5.8	Management	272
12.3.4	Surgery	255	12.5.9	Adjuvant Treatment	274
12.3.5	Principles	255	12.5.10	The Endoscopic Approach for Clival Chordoma Resection	274
			12.5.11	Conclusion	277
13	Dural Reconstruction				284
	<i>Paolo Castelnuovo, Andrea Pistochini, Stefania Gallo</i>				
13.1	Introduction	284	13.2	Skull Base Reconstruction	285
13.1.1	The "Pre-endoscopic" Era	284	13.2.1	Available Materials (Grafts and Flaps)	285
13.1.2	The "Endoscopic" Era	284	13.2.2	Indications and Duraplasty Techniques	289
13.1.3	Skull Base Reconstruction	284			

13.3	Postoperative Care and Follow-up	293	13.5	Conclusions	294
13.4	Results	293			
14	Prevention and Management of Complications	298			
	<i>Ernesto Pasquini, Giorgio Frank</i>				
14.1	Introduction	298	14.3	Other Complications	304
14.2	Vascular Complications	298	14.3.1	Neurological Complications.....	304
14.2.1	Vascular Complications in the Approach Phase.....	298	14.3.2	Endocrine Complications.....	305
14.2.2	Vascular Complications in the Dissecting Phase.....	302	14.3.3	Cerebrospinal Fluid Leak	306
			14.3.4	Infections	307
			14.4	Final Remarks	308
15	Surgical Results	312			
15.1	Long-term Outcome of Endonasal Resection of Sinonasal and Skull Base Malignancies (Fulda, Kassel School)	312	15.2	Endoscopic Resection of Sinonasal and Skull Base Tumors (Varese, Brescia School)	318
	<i>Ulrike Bockmühl, Wolfgang Draf</i>				
15.1.1	Introduction.....	312	15.2.1	Introduction.....	318
15.1.2	Surgical and Oncological Principles of Endonasal Tumor Surgery	312	15.2.2	Fibro-osseous Lesions.....	319
15.1.3	Results of Endonasal Surgery for Malignancies	313	15.2.3	Inverted Papilloma	321
			15.2.4	Juvenile Nasopharyngeal Angiofibroma ..	323
			15.2.5	Malignant Tumors of the Sinonasal Tract and Adjacent Skull Base	325
	Index				332