

Contents

Foreword	vi
<i>Paolo Castelnovo</i>	
Foreword	vii
<i>James N. Palmer</i>	
Preface	viii
Acknowledgments	ix
Contributors	x
Videos	xxx
Section I Anatomy of the Frontal Sinus and Frontal Recess	1
1. Developmental Bases of the Anatomy of the Frontal Sinus	2
<i>Roger Jankowski</i>	
1.1 Introduction	2
1.2 Frontal Sinuses and Ethmoid Lateral Masses have Different Evolutionary and Developmental Origins	2
1.2.1 The Ethmoid Develops from the Olfactory Cartilaginous Capsule	2
1.2.2 The Frontal Sinuses Pneumatize after Erythropoietic Bone Marrow Conversion into Fatty Marrow	3
1.3 The Nitric Oxide “Story” of the Paranasal Sinuses Makes them Play a Role in Blood Oxygenation on Demand	3
1.4 Pneumosinus Dilatans and Arrested Pneumatization Could Bear Witness to Sinus Development	5
1.4.1 Pneumosinus Dilatans	5
1.4.2 Arrested Pneumatization	6
1.5 Conclusion	7
2. Radiological Anatomy	9
<i>Claudia Kirsch</i>	
2.1 Introduction	9
2.2 Lamina Papyracea	12
2.3 Uncinate Process	12
2.4 Floor of Olfactory Recess	13
2.5 Agger Nasi Air Cell	13
2.6 Accessory Air Cells	14
2.7 Anterior Ethmoidal Artery	14
2.8 Bulla Ethmoidalis	15
2.9 Middle Turbinate	15
2.10 Conclusion	15
3. Applied Surgical Anatomy	18
<i>Iacopo Dallan, Lodovica Cristofani Mencacci, and Veronica Seccia</i>	
3.1 General Considerations	18
3.2 Applied Anatomy for Endonasal Approaches	18
3.3 Applied Anatomy for External Approaches ..	21
3.3.1 Coronal Approach	21
3.3.2 Transpalpebral Approach	22

3.4 Blood Supply	22	3.6 Anatomical Variations and Surgical Considerations	23
3.5 Innervation	22	3.7 Conclusions	23
Section II Endoscopic Surgical Approaches to Frontal Sinus Disease		25	
4. Draf Frontal Sinusotomy I and IIa	26		
<i>Andreas Leunig and Hans Rudolf Briner</i>			
4.1 Indications	26	4.4 Case Examples	28
4.2 Surgical Steps	26	4.5 Complications Management	47
4.3 Tips and Tricks	28	4.6 Conclusion	50
5. Draf Frontal Sinusotomy IIb	52		
<i>Kevin Kulendra, Ahmed Youssef, and Shahzada Ahmed</i>			
5.1 Indications	52	5.3.2 Median Approach	52
5.2 Anatomy	52	5.4 Tips and Tricks	53
5.3 Surgical Steps	52	5.5 Complications	53
5.3.1 Lateral Approach	52		
6. Extended Draf IIb and Other Modifications of the Lothrop Procedure	54		
<i>Vivek V. Kanumuri, Qasim Husain, Suat Kilic, Michael J. Pfisterer, Osama Tarabichi, and Jean Anderson Eloy</i>			
6.1 Introduction	54	6.5 Tips and Tricks	57
6.2 Indications	54	6.6 Case Examples	57
6.3 Surgical Steps	54	6.6.1 Example 1	57
6.3.1 Overview of Standard Draf IIb	54	6.6.2 Example 2	57
6.4 Modifications of the Standard Draf IIb Procedure	55	6.6.3 Example 3	57
6.4.1 Modified Hemi-Lothrop Procedure (Eloy IIC)	55	6.7 Complications	57
6.4.2 Modified Mini-Lothrop Procedure (Eloy IID)	55	6.7.1 Recurrence and Chronic Scarring	57
6.4.3 Modified Subtotal-Lothrop Procedure (Eloy IIE)	55	6.7.2 Cerebrospinal Fluid Leak	57
6.4.4 Modified Central-Lothrop Procedure (Eloy IIF)	56	6.7.3 Orbital Injury	58
		6.7.4 Anterior Ethmoid Artery Injury	58
7. The Frontal Sinus Rescue Procedure	59		
<i>Fahad Alasousi, Anali Dadgostar, and Amin Javer</i>			
7.1 Indications	59	7.3 Reverse Frontal Rescue Procedure	60
7.2 Surgical Steps	59	7.4 Complications	60
7.2.1 Step 1	60	7.5 Tips and Tricks	62
7.2.2 Step 2	60	7.6 Conclusion	62
7.2.3 Step 3	60		
7.2.4 Step 4	60		

8.	Draf III (Endoscopic Modified Lothrop)— Inside-Out and Outside-In Approaches	64		
	<i>Christos Georgalas, Vasileios Chatzinakis, Klementina Avdeeva, Georgiy A. Polev, and Anshul Sama</i>			
8.1	Indications	64	8.6.2	A Case of Chronic Frontal Sinusitis with a High Posterior Frontal (Type 3) Cell
8.1.1	Relative Contraindications	64	8.6.3	A Case of Chronic Frontal Sinusitis—Riedel's Procedure Reversal
8.2	Surgical Steps	64	8.7	Postoperative Management
8.3	Lateral-to-Medial/Inside-Out Technique	64	8.8	Complications and their Management
8.4	Outside-In/Medial-to-Lateral Technique	66	8.8.1	Skull Base Injury and Cerebrospinal Fluid Leak ..
8.5	Tips and Tricks	70	8.8.2	Hemorrhage
8.6	Case Examples	70	8.8.3	Orbital Injury
8.6.1	A Case of Allergic Fungal Rhinosinusitis with Fronto-orbital Mucocele	70	8.8.4	Skin Injury
			8.8.5	Stenosis of the Frontal Sinus Neo-ostium
9.	Transseptal Approach	76		
	<i>Bobby A. Tajudeen and Pete S. Batra</i>			
9.1	Background and CT Review	76	9.5	Surgical Steps
9.2	Indications and Contraindications	76	9.6	Tips and Tricks
9.3	Advantages	77	9.6.1	Case Example
9.4	Disadvantages	77	9.7	Complications
10.	Endoscopic Endonasal Orbital Transposition for Lateral Frontal Sinus Lesions	81		
	<i>Paolo Castelnuovo, Mario Turri-Zanoni, Enrico Fazio, Paolo Battaglia, and Apostolos Karligkiotis</i>			
10.1	Indications	81	10.4	Case Example
10.2	Surgical Steps	82	10.5	Complications
10.3	Tips and Tricks	83		
11.	The Role of Frontal Sinus in Anterior Skull Base Surgery and the Transcribriform Approach	87		
	<i>E. Ritter Sansoni, Raymond Sacks, and Richard J. Harvey</i>			
11.1	Indications	87	11.3	Tips and Tricks
11.2	Surgical Steps	89	11.4	Complications
12.	Extended Endonasal Anterior Skull Base Approaches	93		
	<i>Soma Subramaniam, Guillermo Maza, Daniel M. Prevedello, and Ricardo L. Carrau</i>			
12.1	Indications	93	12.3	Tips and Tricks
12.2	Surgical Steps	93	12.4	Case Examples
12.2.1	Principles	93	12.4.1	Esthesioneuroblastoma (Transcribriform Approach)
12.2.2	Operative Setup	94	12.4.2	Tuberculum Sellae Meningioma: Endoscopic Transtuberculum/Transplanum Approach
12.2.3	Surgical Technique	94		
12.2.4	Reconstruction	95		
12.2.5	Postoperative Considerations	95		

12.5 Complications and Management	96	12.5.3 Cerebrospinal Fluid Fistulas.....	99
12.5.1 Vascular Complications.....	96	12.5.4 Postoperative Infection	99
12.5.2 Cranial Nerve Injury.....	99	12.5.5 Other Complications	99
13. Revision Endoscopic Frontal Sinus Surgery	101		
<i>Salil Nair and Peter John Wormald</i>			
13.1 Introduction	101	13.7 Specific Scenarios	107
13.2 Indications	101	13.7.1 Retained Cells in the Frontal Recess or Extending into the Frontal Sinus (Draf I or International Classification of Extent of Endoscopic Frontal Sinus Surgery Grades 1–3)... ..	107
13.2.1 Ongoing Mucosal Disease	102	13.7.2 A Narrow Frontal Ostium and/or Extensive Supra Agger/Bulla Frontal Cells, or Ongoing Significant Burden of Disease (CRSwNP, Aspirin-Sensitive Asthma, Allergic Fungal Disease [Draf III/EFSS 6]).	107
13.2.2 Incomplete Dissection.....	102	13.8 Tips and Tricks	109
13.2.3 Lateralization of the Middle Turbinate	102	13.9 Case Example	109
13.2.4 Scarring and Synechiae	103	13.10 Complications: Management	111
13.2.5 Neo-Osteogenesis.....	103	13.10.1 Scarring and Restenosis.....	111
13.3 Patient Selection	103	13.10.2 Anterior Ethmoid Artery	111
13.4 Preoperative Planning	104	13.10.3 Orbital Injury	112
13.4.1 Analyzing the Computed Tomography Imaging.	104	13.10.4 Cerebrospinal Fluid Leak.....	112
13.4.2 Computer-Assisted Navigation during Surgery	104		
13.4.3 Endoscopes and Equipment.....	104		
13.5 Choice of Procedure	104		
13.6 Surgical Steps	105		
13.6.1 The Axillary Flap Technique.....	105		
13.6.2 Frontal Sinus Mini-Trephine	106		
14. Complications of Frontal Sinus Surgery	113		
<i>David Morrissey and Alkis J. Psaltis</i>			
14.1 Introduction	113	14.3.5 Scar/Stenosis	117
14.2 Epidemiology and Etiology	113	14.3.6 Mucocele Formation	117
14.3 Specific Complications of Endoscopic Approaches to the Frontal Sinus	113	14.3.7 Anterior Skull Base Injury/Cerebrospinal Fluid Leak	118
14.3.1 Failure to Accomplish the Specific Aim of the Procedure	113	14.3.8 Orbital Injury	119
14.3.2 Pain.....	115	14.4 Prevention of Complications	119
14.3.3 Bleeding.....	115	14.4.1 Preoperative Planning	120
14.3.4 Infection	116	14.4.2 Perioperative Technique.....	120
15. Delivery of Topical Therapy to the Frontal Sinus	122	14.4.3 Postoperative Care	120
<i>John R. Craig and Nithin D. Adappa</i>			
15.1 Introduction	122	15.3 Clinical Research on Topical Distribution to the Sinuses	124
15.2 Basic Science Research on Topical Distribution to the Sinuses	122	15.3.1 Tips and Tricks.....	125
		15.4 Conclusion	125

16. Postoperative Management: Dressings and Toilet	126
<i>Neil Cheng-Wen Tan and Peter John Wormald</i>	
16.1 Natural History of Sinus Ostia after Surgery	126
16.2 Intranasal Packing	126
16.2.1 Nonabsorbable Packs.....	126
16.2.2 Absorbable Packings	127
16.3 To Pack or Not to Pack	128
16.4 Inert Stents	129
17. Office-Based Frontal Sinus Procedures	133
<i>Joshua M. Levy and John M. DelGaudio</i>	
17.1 Indications	133
17.1.1 Anatomic Considerations	133
17.1.2 Patient Selection	133
17.1.3 Frontal Sinusitis.....	134
17.1.4 Frontal Mucoceles.....	134
17.1.5 Nasal Polyps.....	134
17.2 Surgical Steps/Anesthesia	135
17.3 Postoperative Management and Procedures	135
17.4 Tips and Tricks	136
17.4.1 Case Examples	136
17.5 Controversies	138
17.5.1 Balloon Catheter Dilation	138
17.6 Emerging Technologies	139
17.7 Conclusion	139
17.3.1 Nasal Irrigations and Topical Therapies	136
Section III Open Surgical Approaches to Frontal Sinus Disease	141
18. Mini- and Maxi-Trephines	142
<i>David A. Gudis, Charles F. Palmer, and Rodney J. Schlosser</i>	
18.1 Indications	142
18.2 Surgical Steps	142
18.3 Tips and Tricks	144
18.4 Case Example	144
18.5 Complications	144
19. Osteoplastic Flap Approach with and without Obliteration	146
<i>Arjun K. Parasher and James N. Palmer</i>	
19.1 Indications	146
19.2 Surgical Steps	146
19.2.1 Osteoplastic Flap without Obliteration.....	146
19.2.2 Osteoplastic Flap with Obliteration	148
19.3 Tips and Tricks	149
19.4 Complications: Management	149
19.5 Conclusion	149
20. Riedel's Procedure and Cranialization of the Frontal Sinus	150
<i>Kato Speleman and Anshul Sama</i>	
20.1 Riedel's Procedure	150
20.1.1 Historic Perspective	150
20.1.2 Indications	151
20.1.3 Technique	151
20.2 Cranialization of the Frontal Sinus	151
20.2.1 Historic Perspective	151
20.2.2 Indications	152
20.2.3 Technique	153

Section IV Management of Specific Frontal Sinus Conditions	155
21. Frontal Sinus Barosinusitis	156
<i>Ioannis I. Diamantopoulos</i>	
21.1 Epidemiology and Etiology	156
21.2 Clinical Presentation and Investigations ...	156
21.3 Management	157
22. Frontal Sinus in Patients with Cystic Fibrosis	161
<i>Kiranya E. Tipirneni, Hari Jeyarajan, and Bradford A. Woodworth</i>	
22.1 Epidemiology and Etiology	161
22.2 Clinical Presentation and Investigations ...	161
22.2.1 Radiographic Abnormalities in Cystic Fibrosis and the Frontal Sinus.....	162
22.3 Management	163
22.3.1 Medical Therapy	163
22.3.2 Nasal Saline Irrigations	163
22.3.3 Corticosteroids	163
22.3.4 Topical Antibiotics	163
22.3.5 Oral Antibiotics	164
22.3.6 Dornase Alfa.....	164
22.3.7 Cystic Fibrosis Transmembrane Conductance Regulator modulators	164
22.3.8 Surgical Therapy	164
22.3.9 Endoscopic Approaches	165
22.4 Complications: Management	169
23. Pneumosinus Dilatans	173
<i>Ing Ping Tang, Yves Brand, and Prepageran Narayanan</i>	
23.1 Introduction	173
23.2 Epidemiology and Etiology	173
23.3 Clinical Presentation and Investigations ...	173
23.4 Diagnosis	173
23.5 Management	174
23.6 Complications	174
23.7 Conclusion	174
24. Frontal Sinusitis in Chronic Rhinosinusitis without Nasal Polyposis	176
<i>Kristine A. Smith, Jeremiah A. Alt, and Richard R. Orlandi</i>	
24.1 Introduction	176
24.2 Epidemiology	176
24.3 Pathophysiology	177
24.3.1 Anatomic Factors.....	177
24.3.2 Physiological Factors	178
24.4 Management	178
24.4.1 Medical Management	178
24.4.2 Surgical Management	179
24.5 Conclusion	180
25. Frontal Sinus Surgery in CRSwNP, AFRS, and ASA Triad	182
<i>Nsangou Ghogomu and Robert C. Kern</i>	
25.1 Epidemiology and Etiology	182
25.1.1 Chronic Rhinosinusitis with Nasal Polyps	182
25.1.2 Aspirin-Exacerbated Respiratory Disease	182
25.1.3 Allergic Fungal Sinusitis	182
25.2 Clinical Presentation and Investigations ...	182
25.2.1 Chronic Rhinosinusitis with Nasal Polyps	182
25.2.2 Aspirin-Exacerbated Respiratory Disease	182
25.2.3 Allergic Fungal Sinusitis	183
25.3 Management Overview	183
25.3.1 Chronic Rhinosinusitis with Nasal Polyps	183
25.3.2 Aspirin-Exacerbated Respiratory Disease	183
25.3.3 Allergic Fungal Sinusitis	183

25.4 Extent of Surgery and Outcomes	183	25.5.1 Samter's Triad Successfully Managed with Draf IIa	185
25.4.1 Goals of Surgery	183	25.5.2 Samter's Triad Only Controlled after Draf III	185
25.4.2 Effect of Extent of Surgery on Outcomes for Maxillary and Ethmoid Sinuses	184	25.5.3 Nasal Polyp Recurrence in Frontal Ostium Managed in the Office	185
25.4.3 Effect of Extent of Surgery on Outcomes for the Frontal Sinus	184	25.5.4 Allergic Fungal Sinusitis Presenting with Proptosis	186
25.5 Case Examples	185	25.6 Complications	186
26. Frontal Sinus Mucocoeles	188		
<i>James Constable and Anshul Sama</i>			
26.1 Terminology	188	26.6 Classification	189
26.2 Epidemiology	188	26.7 Management	190
26.3 Pathology	188	26.8 Outcomes	193
26.4 Clinical Presentation	188	26.9 Conclusion	193
26.5 Investigations	189		
27. Frontoethmoidal Osteomas	195		
<i>Christos Georgalas and Edward Hadjihannas</i>			
27.1 Epidemiology and Etiology	195	27.5.1 External Approaches	197
27.2 Histology	196	27.5.2 Endoscopic Approaches	197
27.3 Clinical Presentation and Investigations ...	196	27.6 Summary	199
27.4 Management	196	27.7 Case Examples	200
27.5 Approaches for Frontoethmoidal Osteomas	197	27.7.1 Case 1	200
		27.7.2 Case 2	201
		27.7.3 Case 3	202
		27.7.4 Case 4	202
28. Frontal Inverted Papilloma	205		
<i>Paolo Battaglia, Apostolos Karligkiotis, Giacomo Pietrobon, Paolo Castelnovo, and Mario Turri-Zanoni</i>			
28.1 Epidemiology and Etiology	205	28.4.1 Case 1	211
28.2 Clinical Presentation and Investigations ...	207	28.4.2 Case 2	211
28.3 Management	208	28.4.3 Case 3	211
28.4 Case Examples	211	28.5 Complications: Management	212
29. The Frontal Sinus: Fibro-Osseous Lesions	217		
<i>Catherine Banks and Raymond Sacks</i>			
29.1 Fibrous Dysplasia	217	29.2.2 Clinical Presentation and Investigations	221
29.1.1 Epidemiology and Etiology	217	29.2.3 Management	222
29.1.2 Clinical Presentation and Investigations	218	29.2.4 Surgical Steps	222
29.1.3 Management	219	29.2.5 Consent	222
29.2 Ossifying Fibroma	220	29.3 Summary	223
29.2.1 Epidemiology and Etiology	220		

30. Malignant Disease Involving the Frontal Sinus	226		
<i>Dennis Tang, Christopher Roxbury, Kelsey McHugh, Deborah Chute, and Raj Sindwani</i>			
30.1 Epidemiology and Etiology	226	30.5 Case Example	231
30.2 Clinical Presentation and Investigation	229	30.6 Complications: Management	231
30.3 Staging	230	30.7 Tips and Tricks	232
30.4 Management	230		
31. Acute Frontal Osteomyelitis: Intracranial and Orbital Complications	233		
<i>Ashok Rokade and Dimitris Ioannidis</i>			
31.1 Epidemiology and Etiology	233	31.3.4 Management of Osseous Complications	241
31.1.1 Epidemiology	233	31.4 Case Examples	241
31.1.2 Etiology	234	31.4.1 Case 1: Subperiosteal Abscess (Contrast-Enhanced CT)	241
31.2 Clinical Presentation and Investigations ...	234	31.4.2 Case 2: Orbital Abscess (Magnetic Resonance Imaging)	241
31.2.1 Orbital Complications	234	31.4.3 Case 3: Cerebral Abscess (Magnetic Resonance Imaging)	241
31.2.2 Intracranial Complications	235	31.4.4 Case 4: Epidural Abscess (Contrast-Enhanced CT)	241
31.2.3 Osseous Complications	236	31.4.5 Case 5: Subdural Abscess (Contrast-Enhanced CT)	241
31.2.4 Investigations	236	31.4.6 Case 6: Pott's Puffy Tumor	241
31.3 Management	238		
31.3.1 Frontal Sinus Drainage Techniques	238		
31.3.2 Management of Orbital Complications	240		
31.3.3 Management of Intracranial Complications	240		
32. Fungal Frontal Sinusitis: Allergic and Nonallergic	244		
<i>Fahad Alasousi, Anali Dadgostar, Amin Javer, and Carl M. Philpott</i>			
32.1 Introduction	244	32.3.3 Special Considerations in Frontal Sinus Fungal Disease	246
32.2 Epidemiology and Etiology	244	32.4 Management	247
32.2.1 Invasive	244	32.4.1 Medical Management	247
32.2.2 Noninvasive	244	32.4.2 Surgical and Postoperative Management in the Frontal Sinus	247
32.3 Clinical Presentation and Investigations ...	245	32.4.3 Complications: Management	247
32.3.1 Invasive	245	32.5 Conclusion	248
32.3.2 Noninvasive	245		
33. Frontal Sinus Trauma and Its Management	250		
<i>Ulrik A. Felding and Christian von Buchwald</i>			
33.1 Epidemiology and Etiology	250	33.3 Management	251
33.1.1 Anatomy	250	33.3.1 Surgical Techniques	251
33.1.2 Trauma Mechanism	250	33.3.2 Surgical Decision-Making	252
33.2 Clinical Presentation and Investigations ...	251	33.4 Case Example	253
33.2.1 Initial Examination of the Patient	251	33.5 Complications: Management	253
33.2.2 Imaging and Paraclinical Investigations	251		

34. Cerebrospinal Fluid Leak in the Frontal Sinus: Endoscopic Management	256		
<i>Hari Jeyarajan, Benjamin K. Walters, and Bradford A. Woodworth</i>			
34.1 Epidemiology and Etiology	256	34.3.3 Postprocedural Care	259
34.1.1 Etiologies	256	34.3.4 Postprocedural Adjuvants	259
		34.3.5 Outcomes	260
34.2 Clinical Presentation and Investigations ...	257	34.4 Case Examples	260
34.3 Management	258	34.5 Complications: Management	260
34.3.1 Surgical Management	258	34.6 Conclusion	263
34.3.2 Endoscopic versus Open Repair	259		
Section V Controversial Topics in Current Practice			
267			
35. The Use of Flaps in Frontal Sinus Surgery	268		
<i>Nadim Khoueir and Philippe Herman</i>			
35.1 Published Evidence	268	35.2.2 Recommendation for Future Studies	270
35.1.1 Background	268	35.2.3 Flaps Feasibility	271
35.1.2 Rationale for Flaps	268	35.2.4 Illustrative Cases	271
35.1.3 Literature Review and Surgical Techniques	269	35.3 Surgical Tips	273
35.2 Controversies and Opinions	270	35.4 Unanswered Questions	273
35.2.1 Promising Outcome for Flaps	270		
36. Osteitis and the Frontal Sinus	275		
<i>Christos Georgalas</i>			
36.1 Introduction	275	36.3.1 Radiological Features	277
		36.3.2 Clinical Implications	278
36.2 Epidemiology and Etiology	275	36.3.3 Prognostic Factor	278
36.2.1 Definitions	275	36.4 Management	278
36.2.2 Histology: Pathophysiology	275	36.5 Case Example	279
36.2.3 Allergy	276	36.6 Summary	280
36.2.4 Bacteriology	276	36.7 Key Points	280
36.2.5 Biofilms	277		
36.2.6 Incidence	277		
36.3 Clinical Presentation and Investigations ...	277		
37. Extreme Lateral Lesions: What Is the Limit of Endoscopic Surgery?	282		
<i>Cem Meco, Suha Beton, and Hazan Basak</i>			
37.1 Published Evidence	282	37.1.3 Evolution of Far Lateral Frontal Sinus Surgery: Exploring Limits of ESS	285
37.1.1 Traditional External Approaches for Far Lateral Lesions	282	37.2 Controversies and Opinions	287
37.1.2 Endonasal Endoscopic Surgery and Evolution of Lateral Disease Management	283	37.3 Unanswered Questions	294
38. Use of Image Guidance Technology: Mandatory or Not	299		
<i>Judd H. Fastenberg, Marvin P. Fried, and Waleed M. Abuzeid</i>			
38.1 Introduction	299	38.1.2 Applications	300
38.1.1 Indications	299		

38.2 Published Evidence	300	38.3 Controversies and Opinions	301
38.2.1 Complications	300	38.3.1 Indications	301
38.2.2 Revision Rate	300	38.3.2 Surgical Training	301
38.2.3 Clinical and Quality-of-Life Outcomes	301	38.3.3 Future Use	301
38.2.4 Medicolegal Concerns	301	38.4 Unanswered Questions	301
38.2.5 Cost	301		
39. Balloon Technology in the Frontal Sinus: Useful or Gimmick	304		
<i>Claire Hopkins and Roland Hettige</i>			
39.1 Published Evidence	304	39.2.4 Contraindications	309
39.1.1 Level 1 Evidence	304	39.2.5 Preoperative Preparation	309
39.1.2 Nonrandomized Studies	307	39.2.6 Training Requirements	310
39.2 Controversies and Opinions	307	39.2.7 Complications	310
39.2.1 Diffuse versus Localized CRS	308	39.3 Unanswered Questions	311
39.2.2 Polyp Disease	309	39.3.1 Cost-Effectiveness	311
39.2.3 Miscellaneous Uses	309	39.3.2 Extrapolation to Wider Patient Cohort	312
40. Minimum versus Maximal Surgical Sinusotomy	314		
<i>Anne E. Getz and Todd T. Kingdom</i>			
40.1 Published Evidence	314	40.3 Case Studies	316
40.1.1 Balloon Dilation	314	40.3.1 Case 1	316
40.1.2 Draf I	315	40.3.2 Case 2	317
40.1.3 Draf IIa	315	40.3.3 Case 3	317
40.1.4 Draf IIb	315	40.4 Unanswered Questions	317
40.1.5 Draf III	316		
40.2 Controversies and Opinions	316		
41. Patient-Reported Outcome Measures and Outcomes in Frontal Sinus Surgery: Do They Make a Difference?	320		
<i>Yujay Ramakrishnan, M. Reda El Badawey, and Sean Carrie</i>			
41.1 Published Evidence	320	41.2 Controversies and Opinions	321
41.1.1 Patient-Reported Outcome Measures in Rhinology	320	41.3 Unanswered Questions	324
41.1.2 Patient-Reported Outcome Measures in Frontal Sinus Treatment	321		
42. Symptoms of Frontal Sinus Disease: Where Is the Evidence?	325		
<i>Zara M. Patel</i>			
42.1 Published Evidence	325	42.3.2 Case 2	328
42.2 Controversies and Opinions	326	42.3.3 Case 3	328
42.3 Case Examples	327	42.3.4 Case 4	330
42.3.1 Case 1	327	42.3.5 Case 5	330
		42.4 Unanswered Questions	331

43. Anatomy and Classification of Frontoethmoidal Cells	333		
<i>Tomasz Gotlib, Anshul Sama, and Christos Georgalas</i>			
43.1 Introduction	333	43.3 Controversies and Opinions	336
43.2 Published Evidence	333		
44. To Drill or Not to Drill			340
<i>Alfonso Santamaría-Gadea, Isam Alobid, and Manuel Bernal-Sprekelsen</i>			
44.1 Published Evidence	340	44.4 Complications	342
44.2 Indications for Drilling Approaches of the Frontal Sinus	340	44.5 Controversies and Opinions	342
44.3 Results of Drilling Approaches of the Frontal Sinus	341	44.6 Unanswered Questions	342
45. Indications for Operating the Frontal Sinus: Primary Surgery or Always Second Line?	344		
<i>Nsangou Ghogomu and David B. Conley</i>			
45.1 Introduction	344	45.3 Case Studies	348
45.2 Controversies and Opinions	344	45.3.1 Case 1: Mild Diffuse CRSwNP Involving the Frontal Sinus.....	348
45.2.1 Does OMC/Frontal Recess Obstruction Cause Frontal CRS?.....	344	45.3.2 Case 2: Failed Draf I Procedure Requiring at least Draf IIa—Ciliary Dysfunction?	348
45.2.2 Is Anterior Ethmoidectomy (Draf I) Optimal as First-Line Surgery for Frontal CRS?	346	45.3.3 Case 3: Severe CRSwNP Requiring EMLP as Initial Surgical Intervention.....	348
45.2.3 What Are the Clinical Characteristics of Patients Who Fail Draf I?	346	45.3.4 Case 4: Odontogenic Frontal CRS	348
45.2.4 Why Is Draf I not Successful in Some Patients with Frontal CRS?	347	45.4 Unanswered Questions	349
45.2.5 Is Primary Draf IIa Effective as an Initial Surgical Intervention for Frontal CRS?	347		
46. Economic and Quality-of-Life Evaluation of Surgery and Medical Treatment for Chronic Rhinosinusitis	351		
<i>Caroline S. Clarke, Carl M. Philpott, and Steve Morris</i>			
46.1 Published Evidence	351	46.2 Controversies Surrounding the Cost-Effectiveness of Treatment for CRS	354
46.1.1 What is Known about the Economic Burden of Chronic Rhinosinusitis?.....	351	46.3 Unanswered Questions and Future Research	355
46.1.2 What Are the Wider Costs of CRS?.....	352		
46.1.3 What Is the Impact of CRS on QOL?.....	352		
46.1.4 Cost and Cost-Effectiveness of Treatment for CRS	353		
47. Training Models and Techniques in Frontal Sinus Surgery	358		
<i>Abdulaziz Al-Rasheed, Philip A. Chen, and Marc A. Tewfik</i>			
47.1 Introduction	358	47.3 Controversies and Opinions	360
47.2 Published Evidence	358	47.4 Unanswered Questions	361

48. Augmented Reality in Frontal Sinus Surgery	363
<i>Pavol Šurda and Martyn Barnes</i>	
48.1 Role of Augmented Reality in Preoperative Planning	363
48.2 Role of Augmented Reality during Surgery	363
49. Robotic Surgery: Beyond DaVinci	366
<i>Paul Breedveld</i>	
49.1 Published Evidence	366
49.1.1 Shortcomings of DaVinci	366
49.2 Steering at Greater Simplicity	366
49.3 Steering at Reduced Dimensions	367
49.4 Controversies and Opinions	367
49.4.1 Maneuvering beyond DaVinci	367
49.5 Maneuvering Like a Snake	368
49.6 Future Steps toward Clinical Practice	369
49.7 Unanswered Questions	369
50. Pathophysiology of the Failed Frontal Sinus and Its Implications for Medical Management	371
<i>Li-Xing Man, Zeina Korban, and Samer Fakhri</i>	
50.1 Introduction	371
50.2 Failure due to Errors in Patient Selection ..	371
50.3 Local Causes of Recalcitrant Frontal Sinus Disease	371
50.4 Systemic Causes of Recalcitrant Frontal Sinus Disease	374
50.5 Conclusion	376
Index	378