# Contents

List of Contributors xxxiii
Preface xxxviii

## Part 1  Basic Principles

**Section Editor: Tony Pogrel**

### 1  Patient Evaluation

*Alan S. Herford and Wayne K. Tanaka*

- Obtaining a patient history 3
- Physical examination 5
- Comorbidities/systemic diseases 6
  - Cardiovascular system 6
  - Pulmonary system 9
  - Endocrine system 10
  - Obesity 11
  - Other organ systems 11
- Imaging 12
- Laboratory studies 12
- Arriving at a diagnosis 14
- Assessing anesthetic/surgical risk 14
  - Office vs inpatient 14
- Summary 15
- References 15

### 2  Radiographic Imaging in Oral and Maxillofacial Surgery

*Arne Petersson*

- Introduction 17
  - Computed tomography (CT) 17
  - Cone-beam computed tomography (cone-beam CT) 18
  - Magnetic resonance imaging (MRI) 18
- Impacted teeth 18
- Pathological conditions – inflammatory lesions, cysts, benign and malignant tumors 18
  - Inflammatory lesions 18
  - Cysts and benign tumors 21
  - Malignant tumors 22
- Temporomandibular joint (TMJ) 24
- Implant treatment 25
- References 27

### 3  Medical Aspects – High-risk Patients

*Earl G. Freymiller*

- Cardiovascular system 29
  - Ischemic heart disease 29
  - Valvular heart disease 30
  - Congestive heart failure 31
- Respiratory system 31
  - Asthma 31
  - Chronic obstructive pulmonary disease 32
- Renal system 32
  - Renal failure 32
- Endocrine system 32
  - Diabetes mellitus 32
4 Medical Emergency Care

Zachary S. Peacock and M. Anthony Pogrel

Syncope
Management
Chest pain
Pathogenesis
Diagnosis and history
Management
Cardiac arrest
The automated external defibrillator
General approach to the collapsed patient
Considerations in transfer of the patient
Asthma
Pathophysiology
Prevention
Clinical presentation
Management
Hypoglycemia
Normal physiological response to hypoglycemia
Signs and symptoms of hypoglycemia
Management
Anaphylaxis
Presentation
Differential diagnosis
Management
Seizures
Management
Status epilepticus
References

5 Local Anesthesia

John Gerard Meechan

Introduction
Mode of action of local anesthetics
Techniques of local anesthesia for oral and maxillofacial surgery
Topical anesthesia
Infiltration anesthesia
Regional block anesthesia
Supplementary intraoral techniques of local anesthesia
Local anesthetic drugs
Lidocaine
Mepivacaine
Prilocaine
Articaine
Etidocaine
# Contents

Bupivacaine 58  
Levobupivacaine 58  
Ropivacaine 58  
Complications of local anesthesia in the orofacial region 58  
Localized complications 58  
Systemic complications 59  
References 60  

6a Sedation and General Anesthesia in Oral and Maxillofacial Surgery:  
A UK Perspective 61  
C. Michael Hill

- History 61  
- The role and scope of sedation 63  
- Inhalational sedation 64  
- Oral sedation 65  
- Intravenous sedation 65  
- General anesthesia 67  
- Conclusion 68  
- References 68  

6b Sedation and General Anesthesia in Oral and Maxillofacial Surgery:  
A US Perspective 69  
Richard C. Robert

- Historical perspective 70  
  - The 19th century after Wells and Morton 70  
  - The 20th century 72  
  - The 21st century 75  
  - Training, professional organizations, and standards 75  
- Goals and objectives in the administration of anesthesia 76  
  - The initial intuitively derived concepts 76  
  - The initial approach 77  
  - Requisites for the ideal anesthetic in the modern era 77  
  - The essential role of the basic sciences in the advancement of anesthesia 77  
  - Areas of the brain affected by anesthetic agents 77  
  - The critical realization that on a molecular basis all anesthetic drugs share a common mechanism of action 81  
  - Multiple sites of action and receptors in the CNS dictate a balanced approach 86  
- The current status of office anesthesia in the oral and maxillofacial surgery practice 87  
  - Primary anesthetic agents 87  
  - Ancillary agents 92  
- Balanced anesthetic approaches currently used in oral and maxillofacial surgery practices 96  
  - Method of delivery 97  
  - Total intravenous anesthesia (TIVA) 97  
  - The author’s office-based anesthesia technique 98  
  - Intravenous sedation 98  
  - Local anesthesia 98  
- Perioperative management 101  
  - Preoperative preparation 101  
  - Delivery system 103  
  - Airway management 104  
  - Monitoring 105  
  - Awareness during anesthesia 108  
  - Intraoperative fluid management 108  
  - Recovery and discharge 109  
  - Special patient populations 109  
  - Future trends and advancements – on the horizon 113  
- Conclusion 114  
- References 114
7 Dentofacial Infection

Ashraf Ayoub

Introduction
Dentoalveolar abscess
Radiographic appearance
Site and spread of infection
Microbiology of dental infections
Management of patients with orofacial infection
Ludwig’s angina
Osteomyelitis
Chronic sclerosing non-suppurative osteomyelitis (Garre’s osteomyelitis)
Diffuse sclerosing osteomyelitis of the mandible
Osteoradionecrosis
Osteonecrosis secondary to bisphosphonate therapy
Cavernous sinus thrombosis
Necrotizing fasciitis
Actinomycosis
Mycobacterium infection of the oral mucosa and jawbones
Syphilis
References

8 Armamentarium for Basic Procedures

Ala Al-Musawi

Basic instrumentation for soft tissue procedures
Basic hard tissue instrumentation
Drills
Dental elevators
Dental forceps
Ancillary instrumentation
Sterilization of instruments
Suture materials and needles
Resorbable and non-resorbable
Braided and solid
Naturally occurring materials or synthetic
Uses for the various suture materials
Suture needles
New innovations in surgical instrumentation
References

9 Basic Surgical Principles

M. Anthony Pogrel and Fabio Kricheldorf

Aseptic technique
Principles of surgical incisions
Types of intraoral incisions
Principles of soft tissue biopsy
Biopsy of the mucosal surface of the lip
Principles of suturing
Types of sutures
Types of needles
Suturing techniques
References

10 Complications Associated with Dentoalveolar Surgery

Srinivas M. Susarla, Ryan J. Smart, and Thomas B. Dodson

Side-effects of dentoalveolar procedures
Bleeding
Pain
Swelling
### Postoperative complications

- Surgical site infection 158
- Alveolar osteitis 158
- Fractures 159
- Root fracture 160
- Root or tooth displacement 161
- Oroantral communication 162

### References

- 163

<table>
<thead>
<tr>
<th>11a Normal Wound Healing</th>
<th>165</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anh Le and Vivek Shetty</td>
<td></td>
</tr>
</tbody>
</table>

**Physiology**

- Inflammatory phase 165
- Proliferation phase 165
- Maturation/remodeling phase 166

**Specialized healing**

- Skin and oral mucosa (including grafts) 166
- Bone/extraction wounds 168
- Implant healing 168

**Wound healing adjuncts**

- Growth factors 168
- Hyperbaric oxygen therapy 169
- Skin substitutes 169

### References

- 169

<table>
<thead>
<tr>
<th>11b Compromised Wound Healing</th>
<th>171</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gösta Granström</td>
<td></td>
</tr>
</tbody>
</table>

**Introduction**

- Compromised wounds 171
- Microbiology of compromised wounds 171
- Proteolytic enzymes 172
- Growth factors and extracellular matrix 172

**Treatment possibilities**

- Prevention of infections 172
- Oxygen tension of tissues 172
- Debridement (removal of necrotic tissue) 172
- Regulation of proteolytic activity 173
- Topical antimicrobial agents 173
- Dressings 173

**Specific compromised wounds**

- Non-healing wounds in irradiated tissue 173
- Osteoradionecrosis 174
- Osseointegration in irradiated tissues 174
- Compromised skin grafts and flaps 175
- Old age – osteoporosis 175
- Diabetes mellitus 175
- Drugs – bisphosphonates 175

### References

- 176

<table>
<thead>
<tr>
<th>Part 2 Dentoalveolar Surgery</th>
<th>179</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Editor: Lars Andersson</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12 Extraction of Teeth</th>
<th>181</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adel Al-Asfour and Sanjiv Kanagaraja</td>
<td></td>
</tr>
</tbody>
</table>

**Medical evaluation**

- 181

**Indications for extraction**

- Caries 181
<table>
<thead>
<tr>
<th>Consent</th>
<th>231</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient information</td>
<td>231</td>
</tr>
<tr>
<td>The medically compromised patient</td>
<td>232</td>
</tr>
<tr>
<td>Medications commonly used in oral surgery</td>
<td>232</td>
</tr>
<tr>
<td>Anxiety and pain relief</td>
<td>232</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>234</td>
</tr>
<tr>
<td>Analgesia</td>
<td>234</td>
</tr>
<tr>
<td>Steroids</td>
<td>234</td>
</tr>
<tr>
<td>Chlorhexidine</td>
<td>234</td>
</tr>
<tr>
<td>Surgical procedure</td>
<td>234</td>
</tr>
<tr>
<td>Principles of exodontia of third molars without using a flap</td>
<td>234</td>
</tr>
<tr>
<td>Surgical extraction of third molars</td>
<td>237</td>
</tr>
<tr>
<td>Alternative procedures</td>
<td>245</td>
</tr>
<tr>
<td>Coronectomy</td>
<td>245</td>
</tr>
<tr>
<td>Eruption of third molar</td>
<td>245</td>
</tr>
<tr>
<td>Orthodontic traction</td>
<td>245</td>
</tr>
<tr>
<td>Autotransplant</td>
<td>250</td>
</tr>
<tr>
<td>Germectomy or lateral trepanation</td>
<td>250</td>
</tr>
<tr>
<td>Restoration of adjacent tooth</td>
<td>250</td>
</tr>
<tr>
<td>Obliteration of third molar tooth bud</td>
<td>250</td>
</tr>
<tr>
<td>Periodontal therapy</td>
<td>250</td>
</tr>
<tr>
<td>Other techniques</td>
<td>250</td>
</tr>
<tr>
<td>Outcomes of third molar surgery</td>
<td>250</td>
</tr>
<tr>
<td>Successful outcome</td>
<td>250</td>
</tr>
<tr>
<td>Complications associated with treatment</td>
<td>252</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>254</td>
</tr>
<tr>
<td>References</td>
<td>254</td>
</tr>
</tbody>
</table>

15 Surgical Treatment of Impacted Teeth other than Third Molars

Mehran Hossaini

Introduction | 259
Definitions | 259
Incidence | 260
Theories why teeth become impacted | 260
Evaluation | 260
Radiographic evaluation | 261
Treatment planning | 262
Orthodontic considerations and prognostic markers | 263
Surgical considerations and prognostic markers | 264
Surgical management | 264
Surgical removal | 264
Exposure and bonding for guided eruption | 265
Postoperative management and complications | 266
References | 266

16 Nerve Involvement in Oral and Maxillofacial Surgery

M. Anthony Pogrel

Trigeminal nerve | 269
Inferior alveolar nerve block | 269
Inferior alveolar nerve damage from root canal treatment | 269
Nerve damage from dental implants | 270
Periodontal surgery | 271
Nerve damage from dentoalveolar surgery | 271
Lingual nerve | 272
Long buccal nerve | 274
Mylohyoid nerve | 274
Evaluation of trigeminal nerve damage | 274
Facial nerve | 275
Microneurosurgery | 277
References | 278
17  Autotransplantation of Teeth  281  
Lars Andersson, Mitsuhiro Tsukiboshi, and Jens O. Andreasen

Introduction  281  
Donor teeth  281  
Indications  282  
  Congenitally missing teeth  282  
  Unrestorable teeth  282  
  Crown-root and root fractures  282  
  Lost teeth in young growing patients  283  
  Lost teeth in adults  283  
  Autotransplants vs implants  283  
Principles of healing after autotransplantation  283  
  Pulp  284  
  Periodontal ligament  286  
Principles of surgery  287  
Surgical techniques  288  
Postoperative care  288  
Long-term prognosis  289  
Summary  290  
References  290

18  Endodontic Surgery  293  
Peter Carrotte and Colin Murray

Introduction  293  
  Periradicular surgery procedures  293  
  Historical perspective of surgical endodontics  294  
  Initial clinical assessment  294  
  Why periapical surgery?  294  
  Root canal infections  295  
  Orthograde root canal treatment  295  
  Non-surgical root canal treatment outcomes  295  
  Periradicular disease lesions and outcomes  296  
  Microflora of the PRD lesion  296  
Apicectomy procedures  296  
  Local anatomic considerations  297  
  Preoperative imaging  298  
  Equipment and materials  299  
  Surgical procedures  301  
  Guided tissue regeneration  306  
  Wound closure  306  
  Postsurgical management  307  
  Periradicular surgery outcomes  307  
Other surgical endodontic procedures  308  
  Hemisection or root resection  308  
  Perforation repair  308  
  Intentional replantation  309  
Informed consent  309  
Endodontic surgery vs endosseous implants  310  
References  310

19  Preprosthetic and Oral Soft Tissue Surgery  313  
Selçuk Basa, Sina Uğur, and Reha Kışnüşçü

Overview  313  
  Background  313  
History  314  
Oral soft tissue anatomy and histology  315  
  Lips  315
Part 3  Implant Surgery

Section Editor: Karl-Erik Kahnberg

20  Implantology

Lars Rasmusson and Lars Sennerby

Biological principles behind osseointegration 341
Implant stability and loading considerations 341
Bone tissue responses to implants 345
The marginal tissues 348
Implant components 349
Indications for implant treatment 349
Contraindications 349
Medical contraindications 349
Systemic risk factors 349
Local contraindications 350
Treatment of children and adolescents with oral implants 350
Treatment planning 350
Clinical examination 350
Radiographic examination 351
Model analyses 351
Surgical procedure 352
Maintenance 352
Computer-guided implant treatment 353
References 354
21 Optimal Implant Placement in the Esthetic Zone by the Use of Guided Bone Regeneration 357
Christer Dahlin

- Biological factors influencing the reconstruction of alveolar bone
- The biological principles of guided bone regeneration
- Tissue integration
- Membrane design criteria and material selection
- Biocompatibility
- Non-resorbable membranes
- Biodegradable barrier membranes
- Indications for GBR treatment
- Basic surgical technique of GBR
- Preoperative antibiotics
- Flap design
- Site preparation
- Graft material
- Membrane selection and positioning
- Suturing
- Follow-up
- Membrane removal
- Clinical results of GBR
- References

22 Implant Placement in the Posterior Mandible 367
Bo Rosenquist

- Anatomy of the posterior edentulous mandible
- Normal topography
- The mandibular canal
- The mandibular neurovascular bundle
- Resorption patterns of the alveolar ridge
- General considerations
- Implant placement superior to the mandibular canal
- The use of wider implants
- Placement of implants lingual to the neurovascular bundle
- Crestal split
  - Surgical technique
- Onlay augmentation in the posterior mandible
  - Vertical onlay
  - Lateral onlay
- Distraction osteogenesis in the posterior mandible
  - Surgical technique
- Nerve transposition
  - Surgical technique
- Nerve lateralization
  - Surgical technique
- Nerve repair
- Ethical considerations
- References

23 Autogenous Bone Harvesting Techniques 383
George K.B. Sándor, David K. Lam, Leena P. Ylikontiola, Vesa T. Kainulainen, Kyösti S. Oikarinen, and Cameron M.L. Clokie

- Introduction
  - The need for bone
  - Choosing a harvest site based upon anticipated volumetric and structural needs
  - Cortical or cancellous graft?
- Intraoral harvesting sites
  - Mandibular symphysis
Mandibular ramus and retromolar area 387
Maxillary tuberosity 388
Coronoid process 389
Mandibular and maxillary tori 389
Zygomatic bone 389
Extraoral harvesting sites 390
Ilium 390
Costochondral grafts 395
Calvarium 396
Proximal tibia 398
Proximal ulna 399
Vascularized fibula 399
References 401

24 Treatment of Bone-deficient Ridges in Implant Rehabilitation 405
Karl-Erik Kahnberg

Introduction 405
Background 405
Aspects of bone graft behavior 406
Block or particulated bone 406
Onlay grafting 406
Inlay grafting 409
Bone graft reconstruction of the jaws before implant placement 410
Use of platelet-rich plasma 411
Staging of grafting procedures 411
Split crest surgery 411
Complications 412
References 412

25 Implant Rehabilitation in the Posterior Maxilla Using Autogenous Bone Material 415
Karl-Erik Kahnberg

Introduction 415
Background 415
Morphologic aspects 416
Surgical technique 416
Literature review 419
Complications associated with sinus lift procedures 421
References 422

26 Biomaterials for Bone Replacement in Implant Surgery 425
Carlo Maiorana

Introduction 425
Biomaterials 425
Biomaterials currently used in osseointegration 426
Anorganic bovine bone 426
Calcium phosphate 426
Calcium sulfate 427
Calcium carbonate 427
Bioactive glass 427
Deminerlized freeze-dried bone allograft 427
Surgical techniques 427
Postextraction sites 427
Horizontal defects 428
Vertical defects 429
Sinus elevation 429
Biomaterials in major advanced osseointegration 433
Developments: growth factors and BMP 435
References 435
27 The Zygoma Implant for the Totally Atrophied Maxilla 439
Chantal Malevez

Introduction 439
The zygoma 440
Features of the zygoma bone 441
The zygoma implant 441
Description 442
Indications and aims 442
Radiological examination 442
Surgery 443
Complications 444
Functional rehabilitation 446
Guided and minimally invasive surgery 447
Conclusions 447
References 449

28 The Role of Implants in Maxillofacial Reconstruction 451
Arun B. Sharma and John Beumer III

Maxillary defects 451
Prosthodontic treatment 452
Definitive soft palate prosthesis 454
Tongue–mandible defects 455
Free bone grafts 456
Free vascularized flaps 456
Definitive prosthetic restoration 457
Implant-assisted overlay dentures 457
Facial defects 458
Surgical reconstruction vs prosthetic restoration 458
Alterations at surgery to enhance the prosthetic prognosis 459
Prosthetic facial restorations 459
Implants in irradiated tissues 461
Predictability of implants in irradiated bone 462
Irradiation of existing implants 463
References 463

Part 4: Infections 465

Section Editor: Lars Andersson

29 Infections of the Oral and Maxillofacial Region 467
Tomoari Kuriyama, Michael A.O. Lewis, and David W. Williams

Biomedical sciences 468
Anatomy 468
Microbiology 470
Immunity and inflammation 472
Pharmacology 477
Principles of diagnosis of oral and maxillofacial infections 484
Assessment of emergency level 484
Recording of medical history 484
Assessment of the patient’s present status 485
Imaging studies 486
Blood and urine tests 486
Microbiologic examination 487
Principles of management of bacterial infections 488
Surgical treatment 489
Antimicrobial therapy 492
Medical supportive care 495
Patient monitoring and evaluation of response to treatment 496
Odontogenic infections 497
  Types of odontogenic infections 497
  Bacteriology of odontogenic infections 503
  Pathology of odontogenic infections 504
  The natural history of progression and clinical features 504
  Management 507
Fascial space infections 507
  Etiology and microbiology 508
  Principles of diagnosis and management 508
  Specific fascial space infections 510
  Gas gangrene and necrotizing fasciitis 518
Osteomyelitis of the jaw 519
  Suppurative osteomyelitis of the jaw 519
  Infantile osteomyelitis 525
  Chronic diffuse sclerosing osteomyelitis 525
  Garré’s sclerosing osteomyelitis 526
  Osteoradionecrosis 526
  Bisphosphonate-related osteonecrosis of the jaw (BRONJ) 527
Dental fistulae 529
  Pathogenesis and clinical findings 529
  Diagnosis 530
  Treatment 530
Acute necrotizing ulcerative gingivitis 531
  Etiology and pathogenesis 532
  Clinical features 532
  Diagnosis 533
  Management 533
Peri-implantitis 533
  Etiology and pathogenesis 533
  Microbiology 534
  Clinical features 534
  Diagnosis 534
  Treatment 535
Infection of the maxillary sinus 535
  Maxillary sinusitis of odontogenic origin 535
  Influence of non-odontogenic maxillary sinusitis on the teeth 540
  Fungal sinusitis (Aspergillus mycetoma of the maxillary sinus) 540
Oroantral communication and fistula 542
  Clinical findings and diagnosis 542
  Management of oroantral communication 542
  Management of oroantral fistulae 543
  Postoperative care and possible major complications 546
  Consideration for antibiotic prophylaxis and its regimen 546
Peritonsillar abscess 546
  Etiology and pathogenesis 546
  Microbiology 547
  Clinical features 547
  Diagnosis 547
  Treatment 548
Suppurative arthritis of the temporomandibular joint 548
  Etiology, pathogenesis, and microbiology 548
  Clinical signs and symptoms 548
  Diagnosis 548
  Treatment 549
Actinomycosis, tuberculosis, and syphilis 549
  Actinomycosis 549
  Tuberculosis 550
  Syphilis 551
Complications of maxillofacial infections 552
  Airway obstruction 552
Part 5: Oral Pathologic Lesions

Section Editor: Tony Pogrel

30  Initial Evaluation and Management of the Oral and Maxillofacial Pathology Patient

Allen Cheng and Brian L. Schmidt

Approaching the oral and maxillofacial pathology patient  586
  Obtaining the history  586
  The focused physical examination  586
  Imaging studies  593
  Obtaining a tissue diagnosis  596
  Fine-needle aspiration biopsy  599
  Open biopsy for lymphadenopathy  602
  Summary of the approach to the oral and maxillofacial pathology patient  602

Adjunctive diagnostic tools  603
  Toluidine blue  604
  Tissue fluorescence  604
  Tissue reflectance  606
  Brush cytology  606

Management of premalignant disease  607
Contents

Natural history of pre-malignant disease 608
Genetic progression to oral cancer 609
Surgical management of dysplasia 609
Medical management of dysplasia 610
Summary of management of dysplasia 610
Margin assessment 610
Frozen section analysis 610
Tissue shrinkage in margin analysis 611
Molecular techniques in margin analysis 611
Summary 611
Case presentations 612
The case of the inappropriate use of a technique 612
The case of the inadequate specimen 613
The case that benefited from an oral pathology consult 615
References 616

31  **Cystic Lesions of the Jaws**

*Nicholas M. Goodger and Christopher W. Hendy*

**Odontogenic cysts** 621
  - Apical or radicular cysts 621
  - Residual cysts 622
  - Lateral periodontal cysts 622
  - Dentigerous cysts 623
  - Eruption cyst 623
  - Gingival cysts 624
  - Odontogenic keratocyst (primordial cyst, keratocystic odontogenic tumor) 624
  - Calcifying epithelial odontogenic cyst 624
  - Malignancy within odontogenic cysts 624
**Non-odontogenic cysts** 624
  - Fissural cysts 624
  - Globulomaxillary cysts 624
  - Median mandibular cyst 624
  - Nasopalatine cysts 624
**Non-epithelially lined cysts** 625
  - Stafne/static bone cyst 625
  - Aneurysmal bone cysts 625
  - Solitary bone cyst 625
**Soft tissue cysts** 625
  - Nasolabial cysts 625
  - Sublingual dermoid and dermoid cysts 625
  - Branchial lymphoepithelial cysts 625
  - Thyroglossal cysts 626
**Suggested reading list** 626

32  **Odontogenic and Non-odontogenic Tumors of the Jaws**

*R. Bryan Bell*

Introduction 629
Odontogenic tumors 630
  - Classification 630
  - Molecular biology 632
Treatment options for benign tumors of the jaws 633
  - Enucleation and curettage 633
  - Enucleation and peripheral ostectomy 634
  - Marsupialization 634
  - Intralesional adjunctive therapy: chemical fixation 635
  - Intralesional adjunctive therapy: cryotherapy 635
  - Resection 638
  - Reconstruction 638
Surgical treatment of malignant tumors of the jaws 640
Benign tumors
  Odontogenic epithelium with mature, fibrous stroma without odontogenic ectomesenchyme 640
  Odontogenic epithelium with odontogenic ectomesenchyme with or without hard tissue formation 654
  Mesenchyme and/or odontogenic ectomesenchyme with or without odontogenic epithelium 656
Non-odontogenic benign tumors
  Ossifying fibroma 658
  Fibrous dysplasia 658
  Osseous dysplasias 660
  Central giant cell lesion 661
  Cherubism 663
  Aneurysmal bone cyst 663
  Simple bone cyst 664
Odontogenic carcinomas
  Ameloblastic carcinoma 664
  Primary intraosseous squamous cell carcinoma 665
  Clear cell odontogenic carcinoma 666
  Ghost cell odontogenic carcinoma 666
  Odontogenic sarcomas 666
Non-odontogenic malignant jaw tumors
  Osteosarcoma 667
  Chondrosarcoma 669
  Ewing sarcoma 669
  Malignant peripheral nerve sheath tumor 672
  Metastatic carcinoma 674
Summary 675
References 675

33 Mucosal Lesions (Potentially Malignant Disorders of the Oral Mucosa) 687
Takashi Fujibayashi

Concept and histology of potentially malignant disorders of the oral mucosa 687
  General concept of potentially malignant disorders of the oral mucosa 687
  Histology (grading of dysplasia) 688
Potentially malignant disorders of the oral mucosa 690
  Leukoplakia 690
  Erythroplakia 693
  Palatal lesions in reverse smokers 694
  Oral submucous fibrosis 694
  Oral lichen planus 694
  Others 697
Early detection and management of potentially malignant disorders of the oral mucosa 697
  Early detection and diagnosis 697
  Management 699
References 701

34 Principles of Oral Cancer Management 705
Brian L. Schmidt

Epidemiology and risk factors 705
Histologic grading, tumor staging, and clinical behavior 706
  Tumor differentiation 706
  Tumor thickness 706
  Tumor size and staging 707
  Tumor invasive pattern 707
  Perineural invasion 707
  Proliferative verrucous leukoplakia 708
Preoperative assessment, staging, and work-up 708
Surgical treatment of oral cancer based on subsite 712
Tongue 713
Maxillary gingiva 714
Mandibular gingiva 716
Buccal mucosa 716
Floor of the mouth 718
Lip 719
Management of the neck 719
  Managing the N0 neck 719
  Elective neck dissection versus “wait and see” for the N0 patient 721
  Quality of life for patients having a neck dissection 722
  Radiation therapy should not be used to treat the N0 neck 722
  Extent of neck dissection for the N0 neck 723
  Sentinel node biopsy 724
  Managing the N+ neck 725
Postsurgical management 725
  Histopathologic evaluation of the specimen 725
  Postoperative complications 726
  Surgery and postoperative radiation 726
  Chemotherapy and radiation therapy 727
  Follow-up 727
Non-resectable SCC or poor surgical candidates 727
Summary 727
References 728

35 Management of Patients Undergoing Radiation and Chemotherapy 735
Göran Kjeller
Radiotherapy 736
Brachytherapy 737
Chemotherapy 737
Side-effects 737
  Radiotherapy 737
  Chemotherapy 738
Management of oral health during radiation 739
Management of oral health during chemotherapy 739
Emotional well-being 740
Follow-up 740
Management of postradiation conditions 740
References 741

36 Salivary Gland Disorders 743
Mark McGurk and Jeremy Sherman
Differential diagnosis 743
  Introduction 743
  Investigations 744
The discrete salivary mass 745
  Granulomas and chronic infections 745
  Inflammatory conditions 746
  Cystic lesions 746
The intermittently swollen gland 747
  The obstructed gland 747
The diffusely enlarged gland 747
  Infection (bacterial and viral) 747
  Autoimmune salivary disease 749
  Non-autoimmune salivary gland disease 750
  Metabolic salivary gland disease 751
  Miscellaneous 751
Obstructive salivary gland disease 751
  Introduction 751
  Investigation 751
37 Outcomes of Management of Oral Pathologic Lesions
Simon N. Rogers and Kalyan Voruganti

Introduction 775
Survival 776
Tumor recurrence rates 777
Complications 777
Adult respiratory distress syndrome (ARDS) 777
Deep vein thrombosis (DVT) 777
Donor site morbidity 777
Free flap loss and flap salvage 778
Length of stay (LOS) 778
Plate infection and removal 778
Readmission 778
Wound infection rates 778
Patient-reported outcomes 778
Function 779
Access 780
Bone flaps 780
Mandibular resection 780
Maxillectomy 780
Neck dissection 780
Oral rehabilitation 780
Percutaneous endoscopic gastroscopy (PEG) 780
Postoperative radiotherapy 781
Soft palate resection 781
Tumor resection 781
Conclusion 781
Acknowledgments 781
References 781

Part 6 Trauma 785

Section Editor: Lars Andersson

38 Assessment of the Injured Patient
Brian Bast

Development of the ATLS concept of trauma care 787
Trauma centers and trauma systems 788
Initial treatment of the trauma patient 788
Triage 788
Primary survey and resuscitation 789
Secondary survey 795
Conclusion 796
References 797
Contents

39  Traumatic Dental Injuries 799
Lars Andersson and Jens O. Andreasen

Epidemiology of traumatic dental injuries and relation to oral and somatic injuries 799
Examination and diagnosis of dental injuries 799
Radiographic examination of TDI 803
Classification and clinical findings 803
Injuries to the hard dental tissues and the pulp 803
Injuries to the periodontal tissues 805
Treatment 805
Infraction 805
Crown fracture 805
Crown–root fracture 808
Root fracture 808
Concussion 808
Subluxation 808
Lateral luxation 808
Extrusive luxation (extrusion) 808
Intrusive luxation (intrusion) 808
Avulsion 810
Splinting of TDI 813
TDI in the primary dentition 813
Complications 814
Pulpal complications 814
Periodontal complications 815
Summary 816
References 816

40  Midfacial Fractures 817
Petr Schütz and Lars Andersson

Midfacial skeleton as a three-dimensional structure 817
Classification 818
Epidemiology 820
Assessment of patients with midface injuries 821
Open or closed reduction 821
Surgical approaches to midfacial skeleton 821
Intraoral incisions 821
Midfacial degloving by intraoral incision 822
Periorbital incisions 822
Coronal incision 827
Limited transcutaneous approaches 830
Use of traumatic wounds 831
Endoscopic approaches 831
Treatment at the site of fracture 832
Fractures of the maxillary alveolar process 832
Fractures of the maxillary sinus walls 832
Le Fort I fracture (Guérin fracture, suborbital maxillary fracture) 833
Fractures of the hard palate 835
Fractures of nasal bones and related structures 835
Fractures of the zygomatic bone 839
Fractures of the orbit 845
Subfrontal fractures 845
Fractures of the frontal bone 848
Biodegradable screws and plates in management of midfacial fractures 853
Surgical technique 853
Strategy of management of complex midfacial fractures 854
Timing of repair 854
Anesthesia and airway management 855
References 857
41 Orbital Reconstruction and Panfacial Fractures 861
Marc Christian Metzger, Nils Weyer, Ralf Schön, and Rainer Schmelzeisen

Orbital reconstruction 861
Introduction 861
Surgical anatomy 861
Surgical approaches to the orbital cavity 862
Investigation of orbital trauma 863
Complications of orbital trauma 863
Preparation for orbital surgery 864
Material for orbital reconstruction 866
Intraoperative imaging and postoperative control 868
Conclusion 869
Planning and sequencing of the treatment of panfacial fractures 869
Diagnostics 869
Airway 870
Approaches 871
Timing 871
Therapy 873
Summary 874
References 874

42 Mandibular Trauma – Principles of Treatment 877
William Chung and Bernard J. Costello

Historical background 877
Etiology and epidemiology 878
Classification of mandibular fractures 878
Patient evaluation 879
Imaging 880
Goals of mandibular fracture treatment 882
Treatment options 883
Closed reduction 883
Open reduction 885
Surgical approaches 886
Basic principles of internal fixation 888
Complications of mandibular fracture repair 890
Infection 890
Malunion 891
Non-union 891
Nerve injury 892
Temporomandibular joint dysfunction and ankylosis 892
Growth disturbances 892
Facial widening 892
Special considerations 893
Teeth in the line of fracture 893
Condylar fractures 893
Comminuted fractures 896
Edentulous mandible fractures 896
Pediatric mandible fractures 897
Conclusions 897
References 898

43 Transoral Endoscope-assisted Treatment of Displaced Condylar Mandible Fractures 901
Ralf Schön and Rainer Schmelzeisen

Indications 901
Contraindications 902
Pre-, intra-, and postoperative evaluations 902
Surgical technique 903
Postoperative course and long-term results 907
Surgical vs non-surgical treatment of mandibular condyle fractures 908
The role of endoscope-assisted transoral techniques 909
Training 909
Summary 909
References 909

44 Soft Tissue Trauma 911
Bethany Serafin, Paul Koshgerian, and Richard H. Haug

Introduction 911
General principles of management 912
Assessment 912
Timing of repair 912
Antibiotic and tetanus prophylaxis 913
Tissue handling 914
Instrumentation 914
Postoperative care 915
Dressing management 915
Suture and staple removal 915
Healing adjuncts 916
Considerations for the extremes of age 918

Specific wounds 919
Abrasion 919
Laceration 919
Hematoma 920
Avulsion 921
Mucosa 921
Tongue 921
Nose 923
Ear 925
Eyelid injury 926
Canaliculi and lacrimal apparatus 927
Parotid duct and capsule 930
Facial nerve 933
Neck 933
Scalp 935

Postoperative untoward results 935
Delayed healing 935
Infection 935
Chronic inflammation 937
Over-repair 937

References 939

Part 7 Dentofacial Deformities 943

Section Editor: Karl-Erik Kahnberg

45 Cleft Lip and Palate: An Overview 945
Radhika Chigurupati, Andrew Heggie, and Krishnamurthy Bonanthaya

Global burden of birth defects: cleft lip and palate 945
Epidemiology 946
Etiology and genetics 946
Embryology 947
Classification 948
Interdisciplinary management of the cleft individual 948
Prenatal diagnosis 949
General assessment 950
Feeding and nutrition 950
Ear, nose, and throat evaluation 950
### Contents

Presurgical orthopedics 950
Cleft lip repair 951
  - Unilateral cleft lip 952
  - Bilateral cleft lip 953
Repair of cleft palate 955
  - Timing of palate repair 955
  - Surgical anatomy 956
  - Principles and techniques of palate repair 956
Speech and velopharyngeal dysfunction 957
Correction of oronasal fistulae 958
Orthodontic management of the cleft individual 959
Alveolar cleft repair 959
Replacement of absent teeth in the line of the cleft 961
Surgical correction of maxillary hypoplasia 961
  - Technical considerations for cleft orthognathic surgery 962
  - Conventional orthognathic surgery vs distraction osteogenesis 965
Surgical correction of secondary lip and nose deformities 966
  - Secondary lip deformities 966
  - Cleft nasal deformity 966
  - Cleft septorhinoplasty 967
Summary 969
References 969

46  Diagnosis and Treatment Planning for Orthognathic Surgery 973

*Johan P. Reyneke and Carlo Ferretti*

Introducing the patient to orthognathic treatment concepts 975
Systematic patient evaluation 975
  - Facial evaluation 976
  - Intraoral examination 984
  - Temporomandibular joint evaluation 984
  - The nose 985
  - Radiographic evaluation 986
Diagnosis and treatment planning 986
  - Lateral cephalometric analysis 986
  - Skeletal antero-posterior relationships 987
  - Vertical skeletal relations 988
  - Analysis of dental relations 988
  - Postero-anterior cephalometric analysis 989
  - Transverse planes 990
  - Vertical cephalometric midline 990
  - Triangular analysis 990
Dental model analysis 990
Orthodontic principles in orthognathic surgery 991
Postsurgical orthodontics 993
Orthodontics without prior surgical consideration 993
Esthetic objectives and surgical solutions 993
Treatment principles for various surgical treatment scenarios 994
  - Single jaw surgery: mandibular repositioning 994
  - Single jaw surgery: maxillary surgery 995
  - Double jaw surgery: repositioning the maxilla and the mandible 997
  - Double jaw surgery: rotation of the maxillomandibular complex 998
Chin surgery 1000
Treatment priorities and sequencing the treatment 1004
Visual treatment objective 1004
Model surgery 1004
Surgical technique 1005
  - Bilateral sagittal split ramus osteotomy 1005
  - Genioplasty 1008
  - Le Fort I maxillary osteotomy 1009
  - Simultaneous orthognathic surgery and rhinoplasty 1012
References 1012
47 Orthognathic Surgery in Obstructive Sleep Apnea

Scott B. Boyd

Introduction

Obstructive sleep apnea
  Epidemiology and pathophysiology
  Diagnosis and definitions of OSA
  Principles of treatment

Patient evaluation
  Symptoms and history
  Polysomnography
  Physical examination
  Imaging
  Indications for maxillomandibular advancement
  Presurgical treatment planning

Surgical treatment
  Anesthetic and medical management considerations
  Surgical technique and sequencing of care
  Postoperative care and monitoring
  Pediatric considerations

Acknowledgment

References

48 Distraction Osteogenesis

Lim K. Cheung, Hannah Daile P. Chua, Firdaus Hariri, John Lo, Andrew Ow, and Li-wu Zheng

Introduction

History and development
  Development of distraction applications on cranio-maxillofacial skeleton

Biological process of distraction osteogenesis

Mandibular distraction
  Indications for mandibular distraction osteogenesis
  Extraoral mandibular distraction
  Intraoral mandibular distraction

Craniofacial distraction osteogenesis
  Indications for craniofacial distraction osteogenesis
  External maxillary and midface distraction
  Internal maxillary and midface distraction
  Zygomatic distraction
  Cranial distraction
  Maxillary palatal distraction

Alveolar distraction osteogenesis
  Indications for alveolar distraction osteogenesis
  Vertical alveolar distraction
  Transverse alveolar distraction

Temporomandibular joint distraction
  Bone transport distraction
  Extraoral devices for mandibular bone transport
  Intraoral distractor for mandibular bone transport
  Maxillary transport distraction

Complications

Research and development in maxillofacial distraction
  Administration of growth factors to enhance bone healing
  Resorbable distractor
  Continuous distraction osteogenesis

References
49a Craniofacial Syndrome Patients – Reconstructive Surgery 1061

Peter Tarnow

Introduction 1061
Craniosynostosis 1062
Sagittal synostosis 1062
Metopic synostosis 1062
Unicoronal synostosis 1062
Bicoronal synostosis 1064
Lambdoid synostosis 1064
Positional plagiocephaly 1064
Craniofacial dysostosis syndromes 1064
Treatment in infancy 1065
Crouzon syndrome 1065
Pfeiffer syndrome 1067
Apert syndrome 1068
Saethre–Chotzen syndrome 1069
Carpenter syndrome 1070
Muenke syndrome 1070
Treacher Collins syndrome 1070

References 1071

49b Craniofacial Syndrome Patients – Orthognathic Surgery 1073

Karl-Erik Kahnberg

Crouzon syndrome 1073
Maxillofacial characteristics 1073
Orthodontic treatment 1073
Orthognathic surgery 1074
Apert syndrome 1075
Maxillofacial characteristics 1077
Orthodontic treatment 1077
Orthognathic surgery 1077
Pfeiffer syndrome 1078
Saetre–Chotzen syndrome 1078
Treacher Collins syndrome 1078
Maxillofacial characteristics 1078
Orthodontic treatment 1079
Orthognathic surgery 1079
Other syndromes 1080
Hemifacial microsomia 1082
Introduction 1082
Maxillofacial characteristics 1082
Orthodontic treatment 1082
Orthognathic surgery 1082

References 1084

50 Reconstruction of Maxillary Defects 1085

Nagi Demian, Joann Marruffo, James McCaul, and Mark Eu-Kien Wong

Introduction 1085
Classification and treatment approaches for maxillary defects 1086
Classification of maxillary defects 1086
Okay classification 1086
Brown classification 1087
Maxillary defect reconstruction 1087
Prosthetic obturation of maxillary defects 1088
Staging of obturator fabrication 1088
Facilitating obturator retention and stability 1090
Soft tissue coverage of defects 1090
Implant support 1091
51 **Mandibular Reconstruction**

*M. Anthony Pogrel and Brian L. Schmidt*

Marginal resection 1109
Segmental resection 1110
Non-vascularized bone grafting for mandibular reconstruction 1113
Ribs 1113
Iliac crest 1115
Tibia 1118
Bone-containing microvascular free flaps 1119
Reconstruction involving the mandibular condyle 1120
Rib grafting 1120
Alloplastic condyle 1120
Replacement with a metatarsal 1121
Sternoclavicular joint 1121
Microvascular reconstruction of the condyle 1121
Staged techniques 1121
Radiation therapy 1121
Bisphosphonate therapy 1123
References 1123

52 **Tissue Engineering and Reconstruction**

*Henning Schliephake*

Introduction 1125
Basic principles of tissue engineering 1126
Biomaterials 1127
Biomaterial tissue interaction 1127
Scaffolds 1128
Biofunctionalization 1129
Application of growth factors 1131
Growth factors 1131
Delivery vehicles and controlled release 1135
Cell-based approaches 1137
Cell sources 1137
Recombinant cells 1140
*In vitro* technology 1141
Future perspectives 1143
References 1144

53 **Cosmetic Facial Surgery**

*Joe Niamtu*

Minimally invasive cosmetic facial surgery procedures 1149
Botox (botulinum toxin A) 1149
Injectable facial fillers 1152
Cervicofacial liposuction 1153
Contents

Midface implants 1155
Cheek implant technique 1156
Cosmetic blepharoplasty 1157
Evaluation of the blepharoplasty patient 1157
Blepharoplasty anesthesia 1159
Blepharoplasty procedure 1159
Postoperative care 1169
Acknowledgment 1172
References 1172

Part 8 Temporomandibular Joint Disorders 1173
Section Editor: Tony Pogrel

54 Diagnosis and Non-surgical Management of Orofacial Pain 1175
Charles McNeill and Patricia A. Rudd

Introduction 1175
Head, neck, and orofacial pain classifications 1176
Medical conditions masquerading as orofacial pain 1177
Intracranial disorders 1177
Neurovascular headache disorders 1177
Neuropathic pain disorders 1178
Headache attributed to associated extracranial pain disorders 1178
Intraoral pain disorders 1179
Musculoskeletal cervical and temporomandibular disorders 1180
Cervical spine disorders 1180
Temporomandibular disorders 1181
Classification of articular disorders 1182
Developmental and acquired disorders 1182
Disc derangements 1182
Condylar dislocation 1183
Inflammatory and non-inflammatory disorders 1183
Ankylosis and fracture 1184
Muscular disorders 1184
Local myalgia 1184
Myofascial pain 1184
Centrally mediated myalgia 1185
Myospasm 1185
Myositis and tendonitis 1185
Muscle contracture 1185
Muscle neoplasia 1185
Assessment of musculoskeletal disorders 1186
Screening history and examination 1186
Comprehensive history and examination 1186
Behavioral and psychosocial assessment 1186
Imaging 1186
Additional diagnostic tests 1187
Adjunctive diagnostic devices 1188
Dental casts 1188
Management of musculoskeletal disorders 1188
Patient education and self-care 1189
Cognitive behavioral intervention 1189
Pharmacologic therapy 1189
Physical therapy 1190
Orthopedic appliance therapy 1191
Conclusion 1192
References 1192
55 Arthroscopy and Arthroscopic Surgery

Anders Holmlund

Development of temporomandibular joint arthroscopy 1197
Anatomic considerations 1197
Diagnostic arthroscopy 1198
Contraindications 1198
Arthroscopy equipment 1199
Arthroscopic procedure 1201
Anesthesia 1201
Puncture 1201
Arthroscopic examination 1202
Arthroscopic surgery 1202
Technical aspects 1202
Synovial biopsy 1202
Lavage (arthrocentesis) 1203
Lysis 1203
Disc repositioning 1203
Synovectomy 1203
Debridement and abrasion 1205
Restriction 1205
Intra-articular pharmacotherapy 1205
Postoperative care 1205
Complications 1206
Vascular injury 1206
Extravasation 1206
Scuffing 1206
Broken instruments 1206
Otologic complications 1206
Intracranial damage 1207
Infection 1207
Nerve injury 1207
Concluding remarks 1207
References 1207

56 Temporomandibular Joint Surgery

Anders Holmlund

Development of temporomandibular joint surgery 1209
Classification of surgical TMJ disease 1210
Reciprocal clicking and chronic closed lock 1210
Surgical approaches to the TMJ 1211
Preparation of the surgical site 1211
Incision 1211
Dissection of the joint 1211
Reciprocal clicking 1213
Clinical diagnosis 1213
Surgical treatment 1213
Mandibular dislocation 1216
Clinical diagnosis 1216
Surgical treatment 1216
Chronic closed lock and osteoarthritis 1218
Clinical diagnosis 1218
Surgical treatment 1219
Osteoarthritis (degenerative joint disease) 1220
Chronic polyarthritis with TMJ involvement 1220
Clinical diagnosis 1221
Surgical treatment 1221