

Maxillofacial Rehabilitation

Prosthodontic and Surgical Management of
Cancer-Related, Acquired, and Congenital Defects
of the Head and Neck, *Third Edition*

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Table of Contents

Dedication vii

Preface to the Third Edition viii

Preface to the Second Edition x

Contributors xi

1 Oral Management of Patients Treated with Radiation Therapy and/or Chemoradiation 1

John Beumer III / Eric C. Sung / Robert Kagan / Karl M. Lyons / Harold J. Gulbransen / Bhavani Venkatachalam / Niki Ghaem-Maghani

2 Rehabilitation of Tongue and Mandibular Defects 61

John Beumer III / Mark T. Marunick / Sol Silverman, Jr / Neal Garrett / Jana Rieger / Elliot Abemayor / Renee Penn / Vishad Nabili / Rod Rezaee / Donald A. Curtis / Alan Hannam / Richard Nelson / Eleni Roumanas / Earl Freymiller / Bernard Markowitz

3 Rehabilitation of Maxillary Defects 155

John Beumer III / Mark T. Marunick / Neal Garrett / Dennis Rohner / Harry Reintsema / Elliot Abemayor / Renee Penn / Vishad Nabili / Peter Bucher

4 Rehabilitation of Soft Palate Defects 213

Salvatore J. Esposito / Jana Rieger / John Beumer III

5 Rehabilitation of Facial Defects 255

John Beumer III / David J. Reisberg / Mark T. Marunick / John Powers / Sudarat Kiat-amnuay / Robert van Oort / Yi-min Zhao / Guofeng Wu / Lewis R. Eversole / Henry M. Cherrick / Eleni Roumanas / Don Pedroche / Tomomi Baba / Jan de Cubber / Peter K. Moy / W. D. Noorda / G. van Dijk

6 Rehabilitation of Cleft Lip and Palate and Other Craniofacial Anomalies *315*

Arun B. Sharma / Ting Ling Chang / Lawrence E. Brecht / Leonard B. Kaban / Karen Vargervik

7 Digital Technology in Maxillofacial Rehabilitation *355*

John Wolfaardt / Ben King / Richard Bibb / Henk Verdonck / Jan de Cubber / Christoph W. Sensen / Jung Soh

8 Tissue Engineering of Maxillofacial Tissues *375*

Min Lee / Benjamin M. Wu

9 Psychosocial Perspectives on the Care of Head and Neck Cancer Patients *403*

David A. Rapkin / Neal Garrett

10 Oral Management of Chemotherapy Patients *425*

Evelyn M. Chung / Eric C. Sung

Index 441

Dedication

This textbook represents the culmination of 40 years of patient care, teaching, and research and is dedicated to my father, John Beumer Jr, my mother, Elizabeth Ruth Beumer, and my wife, Janet Lauritsen Beumer, for their continued and devoted support of my work in maxillofacial prosthetics over the span of my professional career.

—*John Beumer III*

It is with profound gratitude and appreciation that I dedicate this textbook to my parents, Otto and Jean Marunick; to my siblings, John and Kathryn; and to my wife, Robin Edwards Marunick. Their unwavering support in my career development and ongoing encouragement over the years has fostered my dedication in the field of maxillofacial prosthetics. I thank my children, Mark, Piper, and Joel, for their forbearance and understanding during the completion of this project. I also recognize all of my mentors at the various stages of my career.

—*Mark T. Marunick*

My contribution to this comprehensive textbook must be dedicated to several people. First and foremost, to my wife and partner, Kathleen, the love of my life, for her never-ending support; to our very supportive children, Lisa, Jennifer, and Scott; to my mentors, S. Howard Payne, Ed Mehringer, and Norman Schaaf; and to my parents, Louis and Katherine Esposito, all of whom have been instrumental in making me the person I am. Last but certainly not least, to my good friend John Beumer, who allowed me to affix my name to this book. Clearly, he has been its driving force and without his energy it would never have happened. Thanks, John; you have brought our specialty to new levels with your commitment to patient care, research, education, and again with this outstanding textbook.

—*Salvatore J. Esposito*

Preface to the Third Edition

Rehabilitation of patients with disabilities of the head and neck secondary to acquired and congenital defects continues to be a challenging endeavor, requiring close interaction between many health care disciplines. Not so long ago, it was difficult to rehabilitate these patients on a consistent basis. Today, however, it is possible to restore the majority of them to near normal form and function, enabling them to lead useful and productive lives. How has this come to happen? What has changed? In the 1980s, two key technical advances—the introduction of osseointegrated implants and free vascularized flaps—were made, but in recent times the most significant changes are the result of improved collaboration between prosthodontic and medical researchers and clinicians. Many challenges remain; for instance, we have yet to find an effective means of minimizing the very significant long-term side effects of chemoradiation therapy. Yet, for the most part, we have made great strides in the last 15 years.

Nevertheless, the pace of change in the rehabilitation of oral and facial defects, given the technical advances made in reconstructive surgery, maxillofacial prosthetics, and dental care of the irradiated patient, has been far too slow. Changes in the quality of care would occur much more rapidly if cancer therapists would employ a truly multidisciplinary approach to clinical care and research. For example, free tissue transfers have been used throughout the world for the last 20 years to restore bony defects of the mandible, but still far too many surgeons fail to understand that it is equally important to restore the bulk and contour of the tongue if the oral functions of speech, mastication, and control of saliva are to be restored. Hence, we appeal to our readers to work with their colleagues toward a multidisciplinary approach to cancer care and to encourage and participate in multidisciplinary research efforts. Surgeons, radiation oncologists, and medical oncologists must be made to appreciate the advantages of making their dental colleagues equal members of the cancer therapy, rehabilitation, and research team. Treatment strategies developed for head and neck cancer patients must always consider the need to maintain or re-

store oral functions and oral health. No longer should we hear the cliché so often echoed in the past, and even today, in reference to one of our patients: “The cure was worse than the disease.”

The prosthodontist is the undisputed expert on oral function and the person most capable of restoring it when it is lost, but to be an effective member of this multidisciplinary effort he or she must not just understand the prosthodontist’s role but those of the other team members as well. The prosthodontist must understand the issues important to the cancer surgeon, the reconstructive surgeon, the radiation oncologist, and the medical oncologist in order to make intelligent and practical contributions to the care of these patients. Indeed, all members of the treatment and rehabilitation team must be familiar with the expertise of the other team members so that treatment can be smoothly integrated. And so, in keeping with the multidisciplinary nature of this field, we have attempted to provide insights into the etiologies and procedures for treating defects associated with the maxilla, mandible, and facial structures, and related disabilities, as well as the procedures for rehabilitation.

Readers familiar with the second edition will note that three chapters, “Maxillofacial Trauma,” “Cranial Implants,” and “Miscellaneous Prostheses,” have been deleted, although pertinent portions of these chapters have been incorporated into existing chapters. Two new chapters—“Digital Technology in Maxillofacial Rehabilitation” and “Tissue Engineering of Maxillofacial Tissues”—have been added, reflecting the impact that computer-aided design/computer-assisted manufacturing and molecular biology will have on our discipline. In addition, the psychosocial portion of the book (formerly Chapters 1 and 2) has been completely reconceived and condensed into a single chapter (Chapter 9). We are especially pleased by the efforts made by David A. Rapkin and Neal Garrett for this chapter, which represents a very significant contribution. All chapters devoted to the prosthetic restoration of acquired oral and facial defects have undergone significant revision, reflecting the knowledge and

sophistication we have gained over the last few years in the use of osseointegrated implants, free vascularized flaps, and CAD/CAM. A new section devoted to the use of implants in growing children has been added to Chapter 6, “Rehabilitation of Cleft Lip and Palate and Other Craniofacial Anomalies.” Chapter 1, “Oral Management of Patients Treated with Radiation Therapy and/or Chemoradiation,” has been completely rewritten and reflects the knowledge gained in the last 15 years regarding the dental management of the irradiated patient.

Acknowledgments

We would like to thank our many contributors. At their institutions they have embraced and through their contributions helped us to expand our vision of multidisciplinary care. We would also like to take this opportunity to pay tribute to the contributions made to this discipline and to this text by Professor Thomas A. Curtis. Many of his ideas, treatment philosophies, and words of wisdom remain. He has had a profound influence on the lives and the careers of many colleagues and mentored several who have made major contributions to this book.

The principal editor would like to take this opportunity to personally thank his mentors—Dr Sol Silverman Jr, Professor of Oral Medicine, University of California, San Francisco; Dr Thomas A. Curtis, Professor of Prosthodontics, University of California, San Francisco; and Dr F. J. Kratochvil, Professor of Prosthodontics, UCLA. These individuals are rightly considered giants in their respective disciplines. Their commitment to and enthusiasm for their work and their pursuit of excellence have been inspiring to me and many others. They gave me the basic tools that have permitted me to build bridges across professional barriers and forge the close professional relationships necessary for true progress in this complex and fascinating field.

The authors of Chapter 7, “Digital Technology in Maxillofacial Rehabilitation,” wish to dedicate it to Dr Henk Verdonck of the Netherlands. Dr Verdonck was one of the pioneers of the application of digital technologies to maxillofacial prosthetics and made a major contribution to the chapter. His untimely death has deprived our specialty of an immensely creative and innovative professional, and we will miss his contributions to our discipline.

Finally, we would like to thank Brian Lozano, senior artist, UCLA School of Dentistry. He has meticulously redrawn all of the previous illustrations and added several new ones.

Preface to the Second Edition

Rehabilitation of patients with disabilities of the head and neck secondary to acquired and congenital defects is a difficult task, requiring a close interaction among a number of health science disciplines. This book seeks to place the various disciplines in proper perspective in the rehabilitation process. Since the dentist is the primary person involved in many facets of care, much of this book is directed toward the profession of dentistry. However, because of the multidisciplinary nature of this topic, we believe the material will also have relevance for surgeons, radiation therapists, social workers, and other health science professionals.

The disabilities range from minor cosmetic discrepancies to a major functional disability combined with cosmetic disfigurement. The deliverer of therapy must understand posttreatment sequelae and be cognizant of the variations in therapy that significantly improve the process of rehabilitation. In addition to being experts in their respective fields of responsibility, all members of the treatment and rehabilitation team must be familiar with the expertise of the other members of the team so that therapy and rehabilitation may be smoothly integrated. In keeping with the multidisciplinary nature of this topic, we have attempted to give the reader insights into the etiologies and treatment procedures for defects associated with the mandible, maxilla, soft palate, and facial structures, as well as the associated disabilities and the procedures for rehabilitation.

Writing a text which attempts to define a diverse subspecialty, such as maxillofacial prosthetics, is a daunting task. One feels as if a first edition is never really completed. One simply exhausts his or her allotted time and energy, concluding the effort with the hope that a second edition will correct the known limitations. For these reasons, an old adage in literary parlance states that a first edition should never be published. However, a subsequent edition provides another opportunity to define the subject. Readers familiar with the original edition will note that 2 chapters, "Prosthetic Implications of Oral and Maxillofacial Surgery" and "Reconstructive Preprosthetic Surgery," have been deleted, but portions

of these chapters survive in new or existing chapters. Two new chapters, "Behavioral and Psychosocial Issues in Head and Neck Cancer" and "Maxillofacial Trauma," have been added, broadening the scope of the text. Moreover, the chapter, "Cleft Lip and Palate," has been completely rewritten, while others (eg, "Acquired Defects of the Mandible" and "Restoration of Facial Defects") have received major revisions, reflecting the changes in care resulting from the use of free vascularized flaps and osseointegrated implants. The remaining chapters have all been revised and updated to include newer techniques, such as the use of osseointegrated dental implants, 3-D image processing and stereolithography, and so on.

We would like to thank all of our many contributors. They helped us to expand our multidisciplinary vision and understand our role in the rehabilitation of our mutual patients. Without them, this book would certainly not have been possible. Also, we would like to acknowledge the contribution of David Firtell, who chose not to participate as a third editor for this edition, but whose words and thoughts remain from past contributions. By the same token, we welcome Mark Marunick as the third editor and contributor.

Writing this book required the efforts of many dedicated individuals, and it is indeed difficult to identify them all. Several persons stand out, however, and the principal editor would like to take this opportunity to thank those individuals whose counsel and aid during his professional development eventually enabled him to undertake this endeavor: Thomas A. Curtis, Sol Silverman, Jr, and F. J. Kratochvil.

We all wish to thank Mickey Stern for the enormous task of typing the final manuscript, Irene Petravicius for her wonderful illustrations, and Walter Livengood for his superb editorial effort.

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Rehabilitation of Tongue and Mandibular Defects

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The management of malignant tumors associated with the tongue, floor of the mouth, mandible, and adjacent structures represents a difficult challenge for the surgeon, radiation oncologist, and prosthodontist in terms of both control of the primary disease and rehabilitation following treatment. The most common intraoral sites for squamous cell carcinoma (SCC) are the lateral margin of the tongue and the floor of the mouth. Both locations predispose the mandible to tumor invasion, often necessitating its resection in conjunction with large portions of the tongue, the floor of the mouth, and the regional lymphatic system.

Disabilities resulting from such resections may include impaired speech articulation, difficulty in swallowing, problems with mastication, altered mandibular movements, compromised control of salivary secretions, and severe cosmetic disfigurement. In the past 20 years, free tissue transfers and dental implants have resulted in considerable improvement in the form and function of these patients. The impact of free tissue transfers in reconstruction of the tongue and mandible and osseointegrated implants for retaining prostheses has been particularly notable. With these new surgical and prosthodontic methods, more patients with defects of the tongue and mandible can have their appearance and function restored to levels that approach their presurgical condition. These rehabilitative efforts are more complex and require the efforts of a sophisticated, well-trained, multidisciplinary team of oncologic surgeons, maxillofacial prosthodontists, reconstructive surgeons, speech therapists, social workers, and others.

Although available, osseous and soft tissue free flaps and osseointegrated implants for various reasons may not always be indicated or possible. In such instances, rehabilitation efforts will be challenged and functional outcomes are frequently diminished.

Treatment modalities for malignant neoplasms that invade or approximate the mandible or contiguous soft tissues impact the jaw, which can least afford to be compromised. Many vital and life-sustaining functions evolve around the moveable mandible, tongue, and adjacent structures. A partially resected tongue compounds the problem, because it will not function like a normal tongue. A mandible reconstructed with an osseous free flap can demonstrate relatively normal mandibular movements and appearance but altered sensory status may still result in less than optimal function. Radiation therapy also has a significant impact on mandibular structures. The functional movements and occlusal proprioception of a mandible that has lost bony continuity are entirely different from normal mandibular movements and occlusion.

It is unrealistic to discuss functional impairment without reference to the psychic and social factors that affect patients with mandibular resections. Distortions in self-image, inability to communicate, and altered family and vocational roles require the reconstruction of psychic systems to handle these new demands. Those involved in rehabilitation of these patients must be sensitive to the emotional trauma precipitated by cancer and its treatment.



Fig 2-25 Composite resection defect. The intraoral wound was closed primarily.

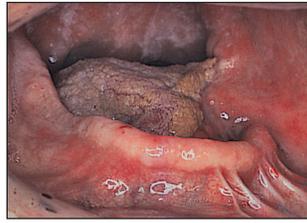


Fig 2-26 Tongue sutured to the buccal mucosa following hemiglossectomy. Tongue mobility is limited, compromising oral function.



Fig 2-27 (a) Appearance following composite resection. The lip is retracted and the corner of the mouth lowered. (b) Scarring and resection of the marginal mandibular nerve may prevent effective lip closure.

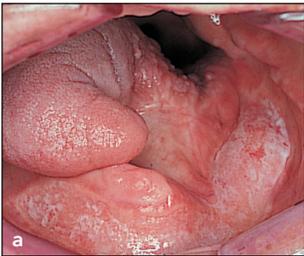


Fig 2-28 Mandibular continuity either maintained or restored after partial glossectomy. (a) Hemiglossectomy defect. The mandible has been reconstructed with a free graft. (b) Partial glossectomy defect with primary closure. Mandibular continuity is maintained. (c) Hemiglossectomy defect restored with a radial forearm flap. Mandibular continuity is maintained. Only the patient in (c) will have a chance to use a complete denture successfully for mastication.

Tongue function is dramatically compromised unless the bulk is restored with a flap (Figs 2-28a and 2-28b). Tongue function is less affected if the resected portion is restored with a free flap. Myocutaneous flaps restore lost bulk and prevent the severe mandibular deviation that occurs in patients whose defects are closed primarily. The residual tongue and flap are centered beneath the palatal structures, permitting the reconstructed tongue to articulate speech phonemes more effectively. Myocutaneous flaps, however, become scarred and immobile and thus limit the mobility of the residual tongue, and speech articulation may remain poor (see Fig 2-11).

In contrast, most patients whose tongues are reconstructed with free flaps have the potential of achieving nearly normal speech. The flap restores lost bulk, as does the myocutaneous flap, but it does not become heavily scarred and immobile. Thus, the mobility of the residual tongue is improved dramatically. With speech therapy, the patient learns to manipulate the residual tongue musculature and flap quite effectively, to the point that the quality of speech articulation approaches normal limits in many patients (Fig 2-28c).

Like speech, the degree to which deglutition is adversely affected depends on the extent of surgery and the method of closure. In normal patients the tongue, in concert with the soft palate, directs the bolus posteriorly to the oral pharynx with a synergistic squeezing action. This act is performed with far less efficiency in patients with tongue resections, although eventually most patients learn to swallow quite acceptably. Patients subjected to primary closure experience the most difficulty swallowing because they cannot elevate the tongue sufficiently to propel the food bolus posteriorly. Patients whose tongue bulk is restored with free flaps experience the least difficulty and many are able to swallow in a nearly normal fashion. (The physiology of oral function following resection will be discussed in detail later in the chapter.)

In patients whose wound is closed primarily following surgical resection, if mandibular continuity is not restored, the remaining

mandibular segment will retrude and deviate toward the surgical side at the vertical dimension of rest (Fig 2-29). When the mouth is opened, this deviation increases, leading to an angular pathway of opening and closing. It is not uncommon to note 1- to 2-cm deviation laterally and 2- to 4-mm retrusion posterior to the chin point during maximum opening. When the incisal point of the mandible is traced, this diagonal pathway of closure is obvious.²⁰⁴ During mastication, the entire envelope of motion occurs on the surgical defect side²⁰⁴ (Fig 2-30). Some patients are unable to effect lateral movements toward the nondefect side and are incapable of making protrusive movements. Patients whose resections are closed with a myocutaneous flap or a free tissue transfer demonstrate much less deviation, regardless of whether or not mandibular continuity is restored.

In patients whose mandibular continuity has not been restored, loss of the proprioceptive sense of occlusion leads to uncoordinated, imprecise movements of the mandible. In addition, the absence of the attachments of the muscles of mastication on the surgical side results in a significant rotation of the mandible on forceful closure. When viewed from the frontal plane, teeth on the surgical side of the mandible move away from the opposing maxillary teeth after initial contact on the nonsurgical side has been established. As the force of closure is increased, the remaining mandible actually rotates through the frontal plane, leading to the term *frontal plane rotation* (Fig 2-31). This factor, with the addition of impaired tongue function, may totally compromise mastication in some patients. Frontal plane rotation is observed in most patients with lateral mandibular discontinuity defects, regardless of whether the site has been closed primarily or with a myocutaneous or a free flap.

If mandibular continuity is not restored, the severity and permanence of mandibular deviation are highly variable and are dependent on a number of complex factors, such as the amount of soft and hard tissue resected, the method of closure, and so forth. Patients whose wounds are closed with a myocutaneous or free

Fig 2-29 Severe deviation of the mandible following composite resection of a lateral floor of the mouth lesion.

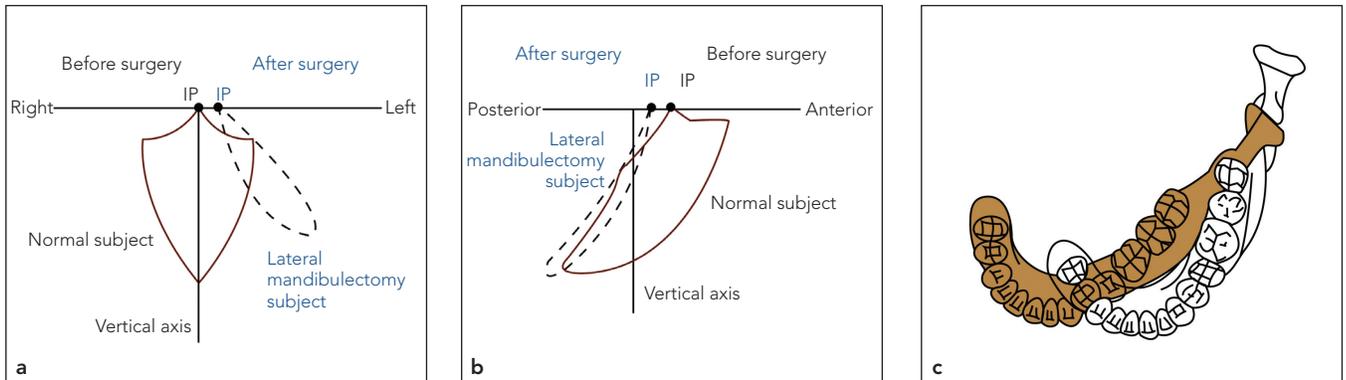


Fig 2-30 (a) Envelope of motion as viewed in the (a) frontal and (b) sagittal planes in a normal patient (solid lines) and a patient who has undergone lateral mandibular resection (broken lines). IP—Interocclusal position. (c) Position of the remaining mandible in open (shaded) and closed (white) positions. Note the character of lateral movements toward the resected side. This lateral movement is somewhat reproducible.



Fig 2-31 (a and b) Frontal plane rotation. As the force of mandibular closure is increased, the mandible rotates around occlusal contacts on the unresected side, and the remaining teeth on the resected side drop further out of occlusion. (c) Occlusal relationship on the unresected side in a patient with a lateral discontinuity defect. Note the difference before (left) and after (right) surgery.

flap soon attain an acceptable interocclusal relationship, without adjunctive therapy, although some patients whose wounds are closed primarily are never able to achieve an appropriate and stable interocclusal position.

When a usable occlusal relationship is achieved, the mandibular teeth often occlude distal to the presurgical pattern of cuspal interdigitation. On the nonsurgical side, the buccal slopes of the mandibular buccal cusps function with the central fossae of the maxillary teeth because of mandibular rotation in the frontal plane (see Fig 2-31c). Scar contracture, tight wound closure, and muscle imbalances secondary to the primary resection all contribute to mandibular deviation. Mandibular deviation is most severe following primary closure of base of the tongue lesions.

Control of saliva is profoundly affected by most resections of the tongue and mandible. These resections obliterate the lingual and buccal sulci and consequently a means of collecting and channeling secretions posteriorly no longer exists. In addition, the motor

and sensory innervation of the lower lip on the resected side is often lost, adversely affecting oral competency and preventing the patient from detecting secretions escaping from the mouth. Impaired sensory innervation and poor tongue control and mobility also contribute to poor control of saliva. Individuals with unimpaired tongue function are capable of identifying escaping secretions and to use the tongue to direct these secretions posteriorly to be swallowed. With compromised tongue function, this manipulation often is impossible.

Drooling is compounded on the defect side by the drooping of the corner of the mouth. Cracking and large fissures develop, and these may become infected with *Candida albicans* (Fig 2-32).

Most patients who submit to lateral resections of the mandible present with varying degrees of trismus following surgery. Trismus is most severe in those patients requiring preoperative or postoperative radiation therapy and is more likely if the patient receives chemoradiation. Early initiation of a well-organized mandibular

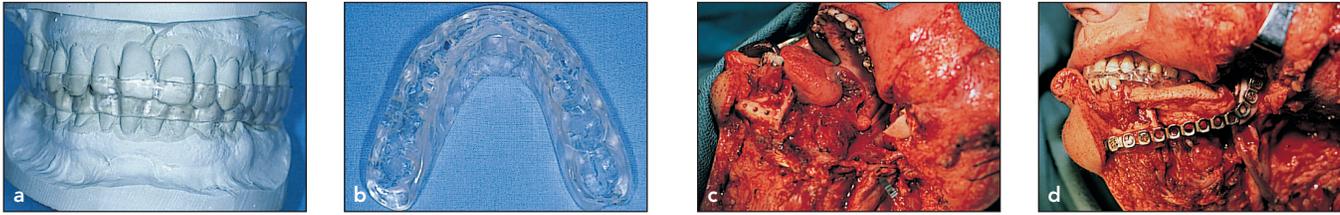


Fig 2-51 Use of surgical templates to properly position residual fragments and correctly align the graft segment. (a and b) Surgical template. Note the maxillary and mandibular occlusal indices. (c) Lateral composite resection defect. Prior to resection, the template is positioned and the mandible is placed in centric occlusion. A titanium-coated hollow screw and reconstruction plate (THORP) is adapted, and screw holes are placed. (d) THORP secured. A free flap has been inset. Note the presence of the template. Preoperative maxillomandibular relationships have been maintained.

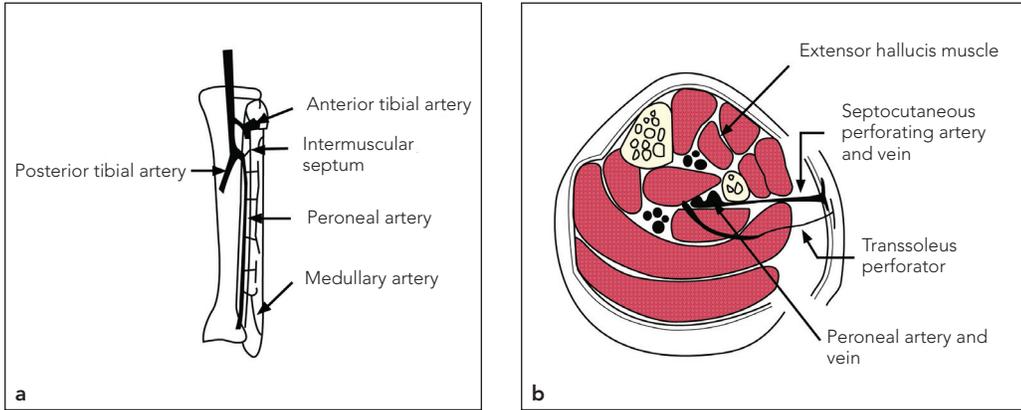


Fig 2-52 Blood supply for the composite fibular flap. (a) The principal blood supply to the fibula is the peroneal artery. Segmental periosteal vessels circle the fibula along its length. (b) Vasculature of the lateral leg. Note the perforating septocutaneous vessels. A skin island is centered over these vessels. (Adapted from Swartz and Janis²³⁴ with permission.)

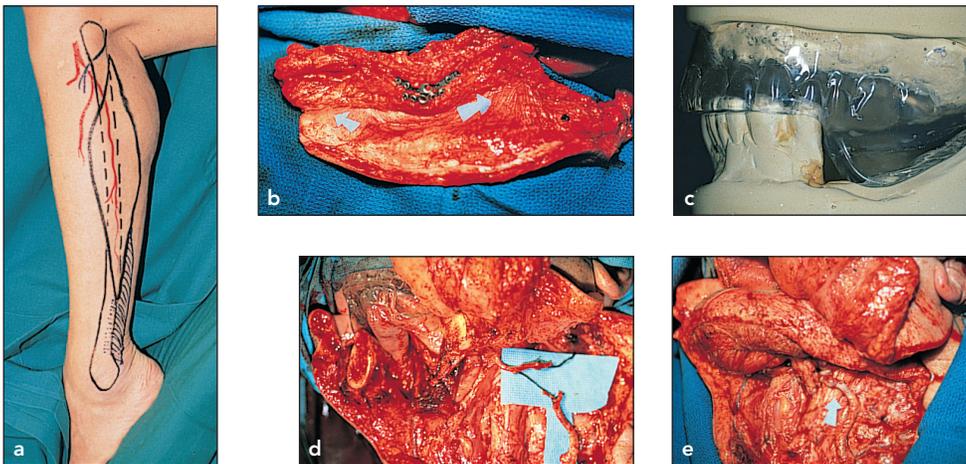


Fig 2-53 Composite fibular flap. (a) Outline of a fibula osteomyocutaneous free flap. Note the skin island and the course of the peroneal artery. (b) Flap perfused in situ. Osteotomies are performed in situ with the flap vascularized. Osteotomies are stabilized with miniplates and screws. The arrows point to vessel anastomosis. (c) Template prepared for use. (d) Composite anterior resection defect. Posterior mandibular fragments have been positioned in the template. (e) Fibular flap inset with the skin island rotated over the superior aspect of the bone component for intraoral closure. The flexor hallucis longus muscle has been used to replace resected submental musculature and separate the oral cavity from the neck, where microvascular anastomosis (arrow) has been performed.

some instances preoperative, contouring of the osseous portion of the free flap. A surgical stent is used to properly position residual mandibular fragments and correctly align the graft segment²³³ (Fig 2-51).

Fibula. The composite fibular flap is nourished by the peroneal (fibular) vessels (Fig 2-52). The flap may be transferred with bone alone or with skin and muscle (Fig 2-53). The composite flap may include up to 25 cm of bone, more than 250 cm of lateral leg skin surface, a portion of the soleus muscle, and the entire flexor hallucis longus muscle if needed for complex defects.

The bone's length and extensive periosteal blood supply allows the reconstruction of the entire mandible.²³⁵ Multiple osteotomies may be performed to replicate the contour of the resected man-

dible without risk of devascularizing the bone segments. At least 6 cm of bone is left proximally and distally to maintain respective joint stability. The fibula's cortical nature and thickness make it an excellent recipient of osseointegrated implants, and the success rates appear to be quite good.²²⁶⁻²³⁸ Either leg may be utilized as a donor site, although the choice may be determined by the vascularity of the lower extremity, the side, location, and extent of the tumor resection, and the reconstructive surgeon's preference. When the ipsilateral neck is vessel depleted, the pedicle may be lengthened by using the distal bone and dissecting the periosteum.

The skin island is based on septocutaneous perforators, emanating through the posterior crural septum from the peroneal vasculature. The cutaneous portion of the flap may be used for intraoral, external, and combined defects. The flexor hallucis longus

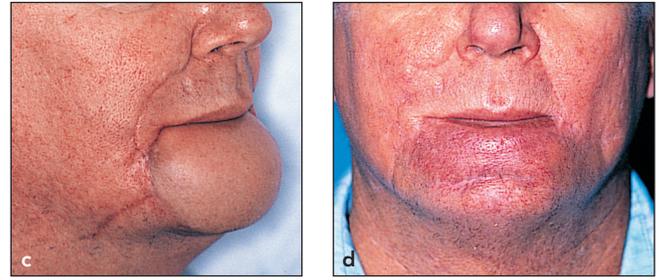
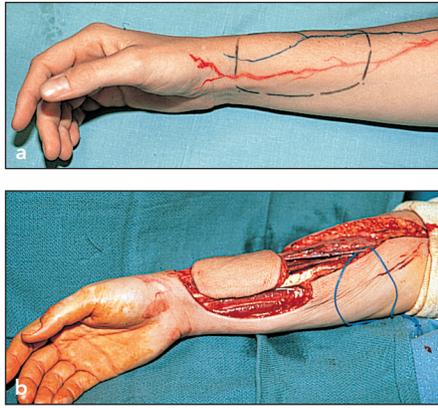


Fig 2-54 Radial forearm flap. (a) Radial forearm flap planned for reconstruction of a subtotal tongue defect. The flap is based on the radial artery, venae comitantes, and cephalic vein. (b) Flap elevated in situ. (c) Lower lip reconstructed with a radial forearm flap. (d) Final result after flap revision. (Figs 2-54c and 2-54d courtesy of Dr John Loran, Los Angeles, CA.)

muscle is routinely harvested with the flap. Its position along the inferior border of the bone make it an ideal substitute for the submental and submandibular soft tissues and it acts as an additional partition between the oral cavity and neck. Harvesting a 2-cm cuff of flexor hallucis and soleus also can enhance the vascular supply to the skin paddle by preserving musculocutaneous perforators traversing this location.

The composite fibular flap is the preferred donor site for most complex orofacial-mandibular defects. For defects of the lateral mandible that do not involve a significant amount of oral mucosa, the osseous flap may suffice, but the osteocutaneous flap is preferred. The addition of a skin island allows for absolute tension-free intraoral closure that enhances tongue mobility. It also permits monitoring of the otherwise buried flap more effectively. The donor site may be closed directly when less than 4 to 5 cm of skin are included with bone, but split-thickness skin grafting to the site must be considered in the majority of situations.

The fibula osteomyocutaneous flap is also recommended for lateral and symphyseal composite defects that include substantial amounts of intraoral mucosa, tongue, and external skin. As the mucosal defect enlarges, so do the harvested skin paddle requirements. Skin islands 10 to 12 cm wide are available for more extensive defects. A skin graft is necessary to close the donor site.

Radial forearm. The radial forearm fasciocutaneous flap is supplied by the radial artery, its venae comitantes, and superficial veins (Fig 2-54). The flap may be harvested with or without bone and may include both tendon and muscle. The composite flap may include 10 to 12 cm of bone, the entire skin of the volar and radial forearm, the palmaris longus tendon, and parts of the flexor radialis and flexor pollicis longus muscles. The medial and lateral cutaneous nerves may be included to make it a sensate flap.

Approximately one third of the circumference (radial aspect) of the radius is harvested as a monocortical graft. Several radial artery perforators traverse the flexor pollicis longus muscle in this region to supply the bone's periosteum. This maintains the viability of the bone graft, but a single osteotomy is all that is advised because of concerns about interrupting the blood supply. The bone can be folded on itself to increase its thickness, although its stock is not well suited for osseointegrated implants.

The skin island is centered between the radial artery and cephalic vein (when present) and includes volar ulnar extension

when necessary. If the cephalic vein is not available, the flap is moved toward the ulna, and a superficial volar vein as well as the venae comitantes may be used for venous outflow. The cutaneous paddle is nourished by perforators traversing the lateral intermuscular septum. The fasciocutaneous component of the flap is thinner distally where the perforators are also more numerous.

The radial forearm skin island is an ideal substitute for intraoral lining and can also be used for external and combined defects (see Figs 2-28c, 2-40b, 2-46a, 2-46c, and 2-48). The nondominant upper extremity is the preferred site for flap harvest, although either side may be used because there is minimal long-term impact on function. A nondominant harvest site also allows better communication via writing for patients in the immediately postoperative period, when they are unable to speak because of the location of the surgery and the presence of a tracheotomy in many instances.

The fasciocutaneous soft tissue–only flap with a mandibular reconstruction plate is preferred for the reconstruction of composite posterolateral defects in patients with advanced disease and finite life expectancies or those edentulous patients whose anticipated masticatory forces are less than would warrant bone replacement (see Fig 2-42). The composite flap is used (more sparingly) for straight segmental bone defects that include buccal mucosa and/or floor of the mouth.²³⁹

The thinness of the tissue is this flap's major advantage and its disadvantage. It is an excellent substitute for intraoral lining but does not have sufficient volume for the more extensive composite resections. In addition, the bone is not of sufficient thickness for implants, long segment defects, or defects requiring multiple osteotomies.

Scapula. The composite scapular or parascapular flap is supplied by the circumflex scapular artery, through its terminal deep branches, the transverse and descending cutaneous branches, and venae comitantes (Fig 2-55). Approximately 12 to 14 cm of lateral scapular bone, 400 cm of the back skin, and the latissimus dorsi and serratus anterior muscles may be included in the flap for large and complex defects. The thoracodorsal vessels must be included when the latissimus or serratus muscle is used. The pedicle may be traced to the parent subscapular artery and vein for additional pedicle length and increased vessel caliber.

The lateral border of the scapula is dependent on the terminal intramuscular (deep) branch of the circumflex scapular artery for

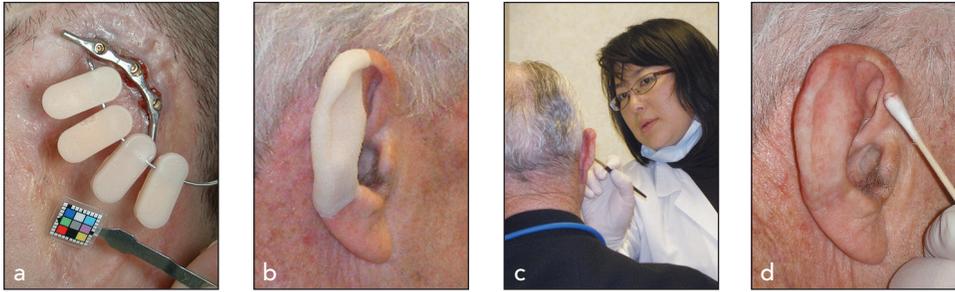


Fig 5-24 Color matching. (a) Shade guides will ensure consistency in the color and translucence of the base. (b to d) Coloration is accomplished under corrected light conditions.

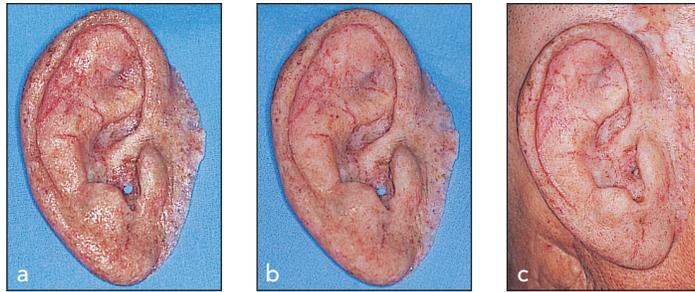


Fig 5-25 Elimination of shine after extrinsic coloration. (a) Before deglossing and after application of sealant. (b) After deglossing. (c) Prosthesis in position.

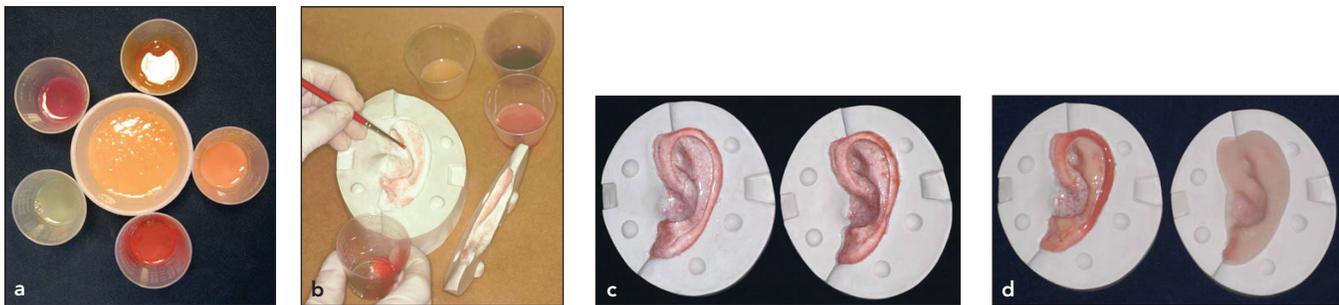


Fig 5-26 Color record for intrinsic coloration. (a) Catalyzed silicone colors. (b) Painting of initial color in mold. (c) Subsequent color layers in mold. (d) Base shade added to mold.

layer is allowed to partially catalyze before the subsequent one is placed. Then the base shade is placed, and the mold is closed and processed. A record of color samples and locations is kept for later prosthesis remakes (Fig 5-26).

Rehabilitation of Auricular Defects

Auricular defects occur secondary to congenital malformations, trauma, or surgical removal of neoplasms. Defects secondary to total resection of the auricle are easily rehabilitated prosthetically. Defects secondary to partial resection of the auricle or secondary to microtia are more difficult to rehabilitate.

Preoperative consultations are extremely valuable for patients with auricular tumors requiring resection. Besides informing the patient of the nature of the defect and the future prosthesis, preoperative impressions and photographs make construction of the postsurgical auricular prosthesis simple. After surgery, the wax duplicate of the patient's ear is easily positioned and adapted to the defect. All that remain to be completed are the placement and feathering of margins and the incorporation of appropriate surface detail.

Temporary auricular prostheses

In most patients, the tissue bed is sufficiently organized 4 to 6 weeks after surgery to allow placement of a temporary ear prosthesis. Use of heat-polymerizing acrylic resin to fabricate this temporary prosthesis will allow periodic adjustment and relining with a temporary denture reliner. Alternatively, a preoperative cast of the missing ear may be used to make a temporary prosthesis from silicone elastomer. This too may be refitted with silicone rubber as healing progresses.

Early rehabilitation of the defect is appreciated by some patients, and few complications have resulted from this practice. Retention is accomplished with medical grade skin adhesives. For most patients, 4 to 5 months is a suitable period to allow for organization and contracture of the wound before fabrication of the permanent prosthesis commences.

Definitive auricular prostheses

Impressions

Unlike orbital or nasal defects, the tissues in the auricular area are not displaceable, and significant distortions do not result from

Box 5-7 Recipe for custom sculpting wax**Ingredients**

- 1 lb beeswax (Factor II)
- Seven sticks of paraffin (canning supplies from grocery store)
- One or two sheets of pink baseplate wax (dental supply)
- Assorted crayons for custom color formula

Mixing instructions

- Melt beeswax, paraffin, and baseplate wax in a double boiler.
- After waxes have melted, remove a small quantity and add melted crayons to develop a custom color.
- Keep the individual wax formulas in an egg poacher (found at hardware stores).
- Evaluate by cooling several drops in cold water.

postural changes. Consequently, the impression can be obtained with the patient positioned upright, lying on his or her side, or in a supine position. However, condylar movements should be closely examined, for they may result in tissue bed mobility, which can affect marginal placement, tissue coverage, and ultimately the retention of the prosthesis. The working cast may have to be lightly sanded in areas of functional soft tissue mobility to prevent gapping and allow a more intimate prosthesis fit in the condylar area.

Before the impression is made, a skin-marking pen may be used to place orientation marks such as the location of the external auditory meatus and the angulation of the long axis of the ear. The defect area is isolated with drapes, cotton is placed in the ear canal, and a suitable impression material is applied. Adjacent hair should be taped or covered with a water-soluble lubricant or cold cream. Petroleum-based products may interfere with processing of some silicones.

Disposable syringes are useful for depositing impression material into areas with difficult access. Light-bodied polysulfide, polyvinyl siloxane, and irreversible hydrocolloid are appropriate impression materials. If irreversible hydrocolloid is used, the addition of 50% more water will improve its flow properties and facilitate the impression procedure.

A backing of quick-setting plaster will provide suitable support for the impression. The plaster backing must be applied in succeeding thin layers to avoid distorting the underlying tissues and the impression. Strips of gauze or wisps of cotton partially embedded within the setting impression material and painted with the appropriate adhesive are used to unite the impression material with the plaster backing.

Sculpting

If a presurgical cast of the resected ear is available, it is reproduced in wax and compared to the remaining ear (Box 5-7). Use of a skin-colored wax rather than pink denture baseplate wax may be helpful because it gives the patient and clinician a more realistic idea of the definitive prosthesis. Appropriate changes are made in the basic contours, and at the next appointment the wax ear is positioned and adapted to the defect to achieve natural symmetry in all planes with the opposite side. A water bath and flame



Fig 5-27 Dividing the normal ear into equal compartments will aid in sculpting. Note how the anterior margin is feathered.

are necessary to complete this procedure successfully. A modified facebow or a Fox occlusal plane (Dentsply Trubyte) may be useful aids to verify the position of the wax prosthesis.

If preoperative casts are not available, the prosthesis can either be sculpted from the beginning or the “donor” technique may be employed. In recent times, computer-aided design and computer-aided manufacture (CAD/CAM) techniques have become increasingly popular (see the discussion on page 299 as well as chapter 7). Sculpting an ear from the beginning is time consuming, but it may be necessary for selected patients. This task is facilitated by dividing the cast of the normal ear into equal sections so that contours are more easily verified (Fig 5-27).

The donor technique is an easier method. A person with ear contours that closely mimic those of the patient is selected. Often, this may be a family member. An impression of the appropriate ear of the donor is made and a wax cast is retrieved. The wax ear is adapted and recontoured as necessary. If the clinician makes wax duplicates of the ears of all auriclectomy patients, he or she soon will have a suitable donor supply and will not need to seek a donor.

When the position and basic contours of the wax pattern are acceptable, the patient is dismissed and the surface details are applied. The upper portion of the anterior margin will be exposed and should be carefully blended and feathered (see Fig 5-27). The middle portion should be wrapped around the tragus, if this structure is present. The inferior margin, in most patients (particularly elderly patients), should be made to look like a crease in the skin. The entire surface must be textured to match the skin textures of the adjacent skin and opposite ear. The texture should be made a little more prominent, because some detail is lost during processing and painting.

Proper texture is important for a number of reasons. First, without texture, the prosthesis can never be suitably matched to adjacent skin. Second, without texture, extrinsic tinting becomes extremely difficult inasmuch as appropriate application, control, and distribution of paint on a smooth surface is almost impossible. Care should be taken to avoid making the stipples excessively deep, because paint has a tendency to pool in deep stipples. Third, texturing provides mechanical retention for extrinsic colorants and lengthens the period of service of the prosthesis.

Page numbers followed by “f” indicate figures; those followed by “t” indicate tables; those followed by “b” indicate boxes

A

Absorbable collagen sponges, 382
 Abutment teeth, 35, 189, 189f
 Accelerated fractionation, 4, 29
 Acidosis, 388
 Acidulated phosphate fluoride, 33
 Acinar cells, 18, 21
 Acrylic resin prostheses, 262f, 267
 Actinic cheilitis, 258
 Actinomycin D, 428
 Acute candidiasis, 15, 15f, 25, 25f
 Additive-layer manufacturing, 361, 362f
 Adenoid cystic carcinoma, 158, 159f
 Adenoidectomy, 344
 Adenosine deaminase inhibitors, 426
 Adhesive dentistry, 335
 Adhesives, 267–268
 Adipose-derived adult stromal cells, 379
 Adnexal tumors, 257
 Adult stem cells, 377–379
 Aggressiveness, 414
 Alar cartilage, 322
 Alcohol, 67–68
 Alkylating agents, 426, 427t
 Altered fractionation, 4
 Alveolar cleft grafting
 description of, 331, 332f, 333, 341
 implant placement in sites of, 341–342, 342f
 Alveolar ridge
 carcinoma of
 characteristics of, 85–87, 87f
 resection of, 10, 91f, 91–92
 immediate surgical obturator attached to, 169f
 lymphatic system of, 156
 Amalgam restorations, 35
 Ameloblastoma, 85f, 85–86
 Amorphous calcium phosphate, 34
 Androgen deprivation therapy, 428
 Anodontia, 349, 349f
 Anophthalmia, 301–302
 Anterior mandible defects
 facial disfigurement caused by, 90
 implant-supported prostheses for, 127f, 127–128
 reconstruction of, 94
 removable partial denture for, 125–128
 resection of, disability secondary to, 90, 91f
 Anterior open bite, 339f
 Anterolateral thigh flap, 102
 Antifungal medications, 16

Antimetabolites, 426, 427t
 Antioxidants, 74
 Apoptosis, 388
 Articulation, 214–216, 215f
 Articulator, 181f
 Aspergillosis, 161
 Assimilation nasality, 219
 Audition, 215–216
 Auricular defects
 congenital, 286, 286f–287f
 considerations for, 276
 implants for, 286, 286f–287f
 prostheses for. *See* Auricular prostheses.
 Auricular prostheses
 coloration of, 275–276, 276f
 congenital defects reconstructed with, 286, 286f–287f
 definitive, 276–278, 277f–278f
 implant-retained, 288–290, 289f–290f
 partial auriclectomy defects restored with, 276
 surface texture of, 274, 275f
 temporary, 276
 Auriclectomy defects
 illustration of, 272f
 partial, 278f, 278–279
 prostheses for. *See* Auricular prostheses.
 Authority, in Group Relations model, 407–408
 Avulsive maxillary defects. *See* Maxillary defects, avulsive.

B

Backscatter
 definition of, 11, 11f
 from gold restorations, 14
 noble metals as cause of, 53
 Basal cell carcinoma, 256f–257f, 257–258
 Basic Assumption activities, 413–415
 Beam mixing, 6
 Beam weighting, 6
 Betel, 67
 Bifid uvula, 344
 Biologic agents, 427t, 428–429
 Biologic equivalent dose escalation, 1
 Bisphosphonates, 54
 Bone
 radiation therapy effects on, 22f–23f, 22–23
 tissue engineering of, 384–385
 Bone grafts
 alveolar cleft, 331, 332f, 333
 biology of, 96
 bone regeneration uses of, 384

 cleft lip and palate closure using, 331–332, 332f
 sites for, 96
 Bone marrow stromal cells, 379, 381
 Bone marrow transplantation, 438–439, 439f
 Bone morphogenetic proteins, 96, 380–384, 386
 Bone necrosis, 30–31, 44. *See also* Osteoradionecrosis.
 Boundaries, in Group Relations model, 406–407
 Brachytherapy
 conventional radiation therapy and, 29
 definition of, 7
 description of, 12
 osteoradionecrosis associated with, 40
 soft tissue necrosis risks, 44
 tumor site scarring secondary to, 45
 Buccal inlay technique, 169, 170f
 Buildup region, 4–5
 Buried sphere implant, 300, 301f
 Buried-integrated implant, 300–301, 301f

C

CAD/CAM. *See* Computer-aided design/computer-aided manufacture.
 Calcium phosphate remineralizing preparations, 33–34
 Calvarial bone, 96
Candida albicans, 15, 15f, 25, 89, 90f, 435, 435f
 Candidiasis, 15f, 15–16, 25, 25f, 71, 435f
 Caregivers, 416–419
 Caries
 cervical, 34–35
 radiation, 26, 26f, 122
 salivary gland dysfunction as risk factor for, 19–20
 sites of, 34
 Streptococcus mutans, 25
 Cartilage tissue engineering, 385–386
 Casein phosphopeptides, 33–34
 Catalytic innovation, 357–358
 Cell(s)
 embryonic stem, 376–377, 377f
 hematopoietic stem, 377–378, 378f
 primary autologous, 376
 Cell cycle-dependent agents, 3
 Central philtrum, 320
 Centric registration, 137, 137f
 Centric relation, 45, 180, 195
 Cerrobend alloy, 11–12
 Cervical carious lesions, 34–35

- Cheek biting, 16
- Cheek resection defect, 298f
- Chemoradiation
- oral cavity neoplasms treated with, 92
 - osteoradionecrosis associated with, 41, 92
 - preradiation extractions, 29
 - radiation therapy and, 26–27
 - spontaneous osteoradionecrosis caused by, 38f
 - tongue fibrotic changes secondary to, 18
 - trismus after, 135
- Chemotherapy
- agents used in
 - alkylating, 426, 427t
 - antimetabolites, 426, 427t
 - biologic, 427t, 428–429
 - hormones, 427t, 428
 - mechanism of action, 425–429
 - nitrosoureas, 426, 427t
 - plant alkaloids, 426–427, 427t
 - basal cell carcinoma treated with, 258
 - dental management, 436–438, 438b
 - description of, 425
 - growth and development affected by, 436
 - neurologic changes secondary to, 436
 - oral effects of
 - hemorrhage, 432–434
 - infection, 434–436, 435f
 - mucositis, 429–432, 430f–431f, 432t
 - xerostomia, 432
 - oral hygiene during, 437
- Chewing tobacco, 66, 67f
- Children
- implants in, 350–353, 351f–352f
 - single-tooth defects in, 351, 351f
- Chlorhexidine mouthrinses, 16
- Chlorinated polyether, 266
- Chronic candidiasis, 25, 25f
- Cleft lip and palate
- alveolar
 - description of, 331, 332f, 333, 341
 - implant placement in sites of, 341–342, 342f
 - anterior, 317–317
 - bilateral
 - with anterior open bite, 339f
 - bone grafting considerations in, 331
 - description of, 318
 - in edentulous patient, 341f
 - nasal deformities associated with, 322
 - nasoalveolar molding appliance for, 326–327, 327f
 - nasoalveolar molding of, 326–327, 327f
 - bone grafting of, 331–332, 332f
 - breast-feeding difficulties, 319
 - classification of, 317f–318f, 317–318
 - description of, 315
 - early treatment of, 318–320
 - in edentulous patients, 316f, 338f, 340, 340f–341f
 - etiology of, 318
 - feeding aids for, 319, 319f, 345
 - genetic evaluation, 319–320
 - growth and development, 328f, 328–329
 - incidence of, 318
 - median, 318, 318f
 - missing dentition secondary to
 - adhesive dentistry effects on, 335
 - in alveolar cleft patients, 341
 - complete dentures for, 336–338
 - definitive prosthodontic treatment for, 333f–342f, 333–342
 - early care for, 333
 - fixed partial dentures for, 334–335
 - illustration of, 332f
 - interim prostheses for, 334, 334f
 - lateral incisors, 332, 332f
 - maxillary overlay dentures for, 338–341
 - osseointegrated implants for, 339–341, 340f–341
 - overview of, 331–332
 - removable partial denture for, 334f, 334–336, 336f
 - zygoma implants for, 341, 341f
 - nasal deformities associated with, 322–323
 - nasal resistance caused by, 223
 - nasoalveolar molding of, 324–327, 325f–327f
 - nasopharyngeal area access difficulties, 330, 331f
 - obturator prosthesis for, 240, 330, 330f
 - occult submucous, 226
 - orthodontic treatment
 - maxillary expansion to correct segment position and crossbite, 329, 329f
 - tooth eruption monitoring, 329, 329f
 - parental counseling, 318–319
 - pathogenesis of, 320–321
 - pharyngeal flaps for, 330, 330f–331f
 - posterior, 317–317
 - primary dentition stage, 328
 - prosthetic treatment in, 330, 330f
 - removable partial denture for, 316f
 - speech distortions associated with, 216
 - summary of, 353
 - supernumerary teeth associated with, 332
 - surgical treatment of
 - growth and development after, 328f, 328–329
 - lip adhesion, 322
 - lip repair, 320–322
 - palatal repair, 323f, 323–324
 - revision surgery, 323
 - sequence of, 321f
 - velopharyngeal closure after, 226f
 - team evaluation, 320
 - unilateral
 - growth and development after repair of, 328f
 - illustration of, 317f
 - nasoalveolar molding appliance for, 325–326, 326f
 - nasoalveolar molding of, 324–326, 325f
 - velopharyngeal deficiencies in, 330
 - vertical dimension of occlusion
 - establishment in, 337
- Cleft uvula, 317f
- Clinical target volume, 7
- Cobalt beam, 5
- Collagen, 382
- Colony-stimulating factors, 428–429
- Colorants, of facial prostheses, 268–269
- Complete dentures. *See also* Dentures.
- cleft lip and palate-related missing dentition treated with, 336–338
 - impression taking for, 337
 - lateral mandibular discontinuity defects
 - managed with, 133–140
 - single maxillary, 338
 - speech affected by, 337
 - try-in, 337–338
- Complete-palatal coverage prosthesis, 120
- Composite resection
- oral tongue squamous cell carcinoma
 - treated with, 78f, 78–79
 - oropharyngeal squamous cell carcinoma
 - treated with, 84–85
- Composite resins, 35
- Compton effect, 2
- Computer modeling, of jaw biomechanics, 107–109
- Computer-aided design/computer-aided manufacture
- applications of, 358–359, 359f
 - description of, 95, 299
 - facial prosthesis construction using, 368
 - training in, 360–361
- Concept modelers, 362
- Congenital microphthalmia, 301–302
- Consonants, 217, 217t
- Continuous hyperfractionation accelerated radiation therapy, 4
- Conventional fractionation, 4, 9
- Conventional radiation therapy
- brachytherapy with, 29
 - denture placement after, 43
 - description of, 6
 - dosimetry, 28f
 - fields in, 19f–20f
 - necrosis rate for, 8
 - olfactory loss secondary to, 16
 - osteoradionecrosis secondary to, 38, 40
 - preradiation extraction considerations, 28
 - symphyseal region, 52
- Coronary circulation, 389
- Counterdependency, 414
- Coziness, 414
- Craniofacial anomalies
- ectodermal dysplasia, 347–350, 348f–350f, 352
 - facial defects secondary to, 256
 - hemifacial microsomia, 346, 347f
- Craniofacial implants
- auricular prostheses retained with, 286, 286f–287f, 288–290, 289f–290f
 - CAD/CAM systems for fabricating, 286

- description of, 52, 53f, 285
 failure of, 292f
 glabella application of, 288
 hygiene considerations, 291–293, 292f
 nasal prostheses retained with, 288, 288f, 290, 291f
 orbital prostheses retained with, 287, 287f
 placement stages, 286–288, 287f–288f
 results of, 292–293
 success rates for, 292
 treatment planning for, 285–286
 Critical-sized defects, 385
 Cul-de-sac resonances, 216
 Cytomegalovirus, 64
- D**
- Deglutition. *See* Swallowing.
 Delayed surgical obturation
 maxillary defects rehabilitated with, 166–170, 168f–171f
 soft palate defects rehabilitated with, 233–234, 234f
 Demonstrativeness, 415
 Denial defense, 412
 Dental care, postradiation
 dental maintenance, 32–34
 diet, 37
 endodontic therapy, 35–36
 follow-up, 34–35
 restorative, 34–35
 tooth extractions, 31–32, 35–36
 treatment approach, 37
 Dental compliance, 27–28, 31
 Dental consultation, 27
 Dental maintenance
 calcium phosphate remineralizing preparations, 33–34
 objective of, 32
 topical fluorides for, 33, 33f
 Dental radiation, 24, 74–75
 Dentures
 care after delivery of, 46
 complete. *See* Complete dentures.
 delivery of, 46
 in edentulous patients, 43
 foundation area for, 45
 implant-retained overlay, 140–141
 impressions for, 45
 morbidity associated with, 44
 occlusal forms, 45–46
 oral cancer risks, 73–74
 oral examination before, 44–45
 osteoradionecrosis risks, 42–44
 overlay, 132f, 244f, 338–341, 339f
 partial. *See* Partial denture.
 placement of, 42–44
 postretention, 140f
 preexisting bone necrosis and, 44
 removable partial. *See* Removable partial denture.
 residual ridge considerations, 43
 soft tissue necrosis risks, 44
- tissue irritation caused by, 74
 try-in, 337–338
 vertical dimension of occlusion
 assessments, 45
 Dependency, 414
 Depletion, 414
 Diet, 37
 Digital technology
 future directions in, 372–373
 maxillofacial prosthetics application of, 364–369
 overview of, 355–357
 rapid prototyping, 358–364
 significance of, 357–358
 surgical applications of, 366–369
 virtual reality, 369–372, 371f
 Direct biologic effects, 2
 Directly ionizing, 2
 Dosimetry, 4–6, 19, 20f
 Drooling, 89
 Dry mouth. *See* Xerostomia.
 Dynamic bite openers, 18, 18f, 45
 Dynamic fulcrum lines, 190–191
 Dysphagia, 109, 112–113
 Dysplasia, 68, 70t
- E**
- Ear
 hemifacial microsomia-related deformities, 346
 prosthesis for. *See* Auricular prostheses.
 Economic revolution, 356, 356f
 Ectodermal dysplasia, 347–350, 348f–350f, 352
 Ectropion, 302–303, 303f
 Edema, 16–17, 45, 158, 159f
 Edentulous patients
 cleft lip and palate in, 316f, 338f, 340, 340f–341f
 definitive obturators for, 175–186, 176f–187f
 dentures in, 43
 edema in, 17
 implants in
 anterior maxillary segment for, 162
 description of, 106, 183, 352–353
 lateral mandibular discontinuity defects in, 133–143
 oral prosthesis considerations in, 296, 296f
 positioning stents for, 10–11, 11f
 surgical obturator for, 167
 trismus in, 17
 Embryonic stem cells, 376–377, 377f
 Endodontic therapy, 35–36
 Enuclation, 300–302
 Epidermoid carcinoma, 68f, 76f, 165
 Epiglottis, 111
 Epstein-Barr virus, 64
 ERA attachment, 52, 52f, 142
 Erythema, 14, 15f
 Erythroleukoplakia, 69f, 70
 Erythroplasia, 70–72
 Evisceration, 300
- Exenteration. *See* Orbital exenteration defects.
 Exposed-integrated implant, 300–301, 301f
 External beam radiation therapy, 11
 Extractions
 in chemotherapy patients, 437
 postradiation
 description of, 31–32
 endodontic therapy as alternative to, 35–36
 preradiation. *See* Preradiation extractions.
- F**
- Facial artery, 317
 Facial defects
 auricectomy, 272f
 basal cell carcinoma as cause of, 256f
 ear. *See* Auricular defects.
 eye, 282–285, 283f–285f
 free flap reconstruction of, 273
 implants for. *See* Craniofacial implants.
 lateral, 297f–298f, 297–298
 midface. *See* Midfacial defects.
 nose, 279f–282f, 279–282
 orbital, 199–200, 200f, 273, 273f, 282–285, 283f–285f
 overview of, 255–256
 prostheses for. *See* Facial prostheses.
 rhinectomy, 272, 272f–273f
 surgical reconstruction of, 260
 Facial neoplasms
 basal cell carcinoma, 256f–257f, 257–258
 classification of, 256t, 256–257
 malignant melanoma, 257, 259f, 259–260
 squamous cell carcinoma, 258–259, 259f
 types of, 256t
 Facial prostheses
 adhesives, 267–268
 attachment systems, 289
 auricular, 276f–279f, 276–279
 color stability of, 269–271
 coloration/colorants of, 268–269, 275–276, 276f
 CAD/CAM used to construct, 368
 description of, 375
 discoloration of, 271
 extrinsic coloration of, 275, 276f
 form restorations, 274, 274f
 history of, 261–263
 lateral facial defects rehabilitated with, 297, 297f
 lines of junction between skin and, 274–275
 materials used in, 260–271, 261t, 262f, 263t
 nasal, 279f–282f, 279–282
 ocular. *See* Ocular prostheses.
 oral prosthesis connection with, 298, 298f
 orbital, 282–285, 283f–285f
 osseointegrated implants used in, 260
 patient acceptance of, 255
 polymers, 266
 polyurethanes used in, 262
 primers, 267

- principles for, 274–276
 problems associated with, 271
 silicones, 263–266
 surface texture of, 274, 275f
 surgical procedures to enhance, 271–273, 272f–273f
 surgical reconstruction versus, 260
 upper lip considerations, 272f, 272–273, 293, 293f
- Falloff region, 4–5
- Family members, 416–419
- Family Smoking Prevention and Tobacco Control Act, 67
- Fibrosis
 description of, 9, 16–17
 radiation-induced, 135
 trismus caused by, 17
- Fibular free flaps
 blood supply for, 100f
 characteristics of, 100–101
 composite, 100f, 101
 harvesting of, 207, 208f
 illustration of, 82f
 lateral mandibular discontinuity defect
 reconstructed with, 129, 130f–131f
- Fight-flight, 415
- Fixed partial dentures
 cleft lip and palate-related missing
 dentition treated with, 334–335
 illustration of, 316f
- Floor of the mouth
 carcinoma of, 81f–83f, 81–83
 reconstruction of defects of, 94
 resection of
 disabilities secondary to, 90, 91f
 speech affected by, 114
- Fluoride, 25, 33, 33f, 75
- Forehead flaps, 93, 94f
- Fractionation, 4, 29
- Free bone grafts
 biology of, 96
 grafting sites for, 96
 mandibular reconstruction using, 95–99, 99f
 technique for, 96–97
- Free flaps
 complications of, 102
 donor sites for
 anterolateral thigh, 102
 complications associated with, 102
 fibula. *See* Free flaps, fibular.
 overview of, 99–100
 radial forearm, 101, 101f, 143f, 245
 rectus abdominis, 102
 scapula, 101–102, 102f
 facial defects reconstructed with, 273
 fibular
 blood supply for, 100f
 characteristics of, 100–101
 composite, 100f, 101
 illustration of, 82f
 lateral mandibular discontinuity defect
 reconstructed with, 129, 130f–131f
 history of, 93
 implant placement with, 131–132, 132f
 maxillary defects rehabilitated with,
 205–206
 speech outcomes affected by, 114–115
 tongue defect reconstruction using, 77–78,
 78f, 88, 90f, 93, 94f, 104, 104f, 114f
- Free palatal grafts, 132, 132f
- Free radicals, 2
- Fricative sounds, 217
- Frontal plane rotation, 88, 89f, 135f
- Fulcrum lines, 190–191
- Fungal infections, 435, 435f
- Fused deposition modeling, 395f, 395–396
- G**
- Gamma rays, 2
- Gingival bleeding, 433, 434f
- Gingival carcinoma, 8, 87, 87f
- Gingivoperiosteoplasty, 326
- Glass-ionomer cements, 35
- Glossectomy
 description of, 77, 78f
 mandibular continuity after, 88f
 partial, 117f, 143f
 speech after, 114
 swallowing affected by, 113
 tissue engineering for defects caused by,
 386
- Gold copings, 339, 339f
- Gold restorations, 14
- Graft-versus-host disease, 438–439, 439f
- Granström protocol, 53
- Gross tumor volume
 description of, 6–7, 9
 intensity-modulated radiation therapy, 28
 mandibular body, 29
 osteoradionecrosis risks, 38
- Group Relations model, 404–408
- Growth and development
 after cleft lip and palate treatment, 328f,
 328–329
 chemotherapy effects on, 436
- Growth factors, 15–16, 380–384, 381f
- H**
- Hader bar segment, 52, 340
- Hairy leukoplakia, 71
- Hard palate
 blood supply to, 157, 157f
 defects of, 166
 maxillary defects bordering, definitive
 obturators for, 197, 198f
 retention of, 162, 162f
- Healing abutments, 184
- Helplessness, 414
- Hematopoietic stem cells, 377–378, 378f
- Hemifacial microsomia, 346, 347f
- Hemiglossectomy
 defects caused by
 illustration of, 88f
 myocutaneous flap reconstruction of,
 93, 94f
 prosthetic reconstruction of, 144f
 description of, 77
- Hemorrhage, oral, 432–434
- Herpes labialis, 64
- Herpes simplex viruses, 64–65, 435, 435f
- Hierarchical obsolescence, 360
- High-energy photons, 2
- High-temperature vulcanizing silicones, 264
- Hormone therapy, 427t, 428
- Hostility, 414
- Human papillomaviruses, 65
- Hyaluronic acid scaffolds, 383
- Hyperbaric oxygen
 angiogenesis promotion using, 50
 controversy regarding, 50
 osteoradionecrosis treated with, 40–41, 41f
 postradiation extractions with, 38
- Hyperfractionation, 4, 29
- Hypernasality, 216, 240, 330, 343
- Hyperplastic candidiasis, 435
- Hypofractionation, 4
- Hyponasality, 216
- Hypoxia, 388, 390
- I**
- I-bar retainers, 129, 196f
- Immediate surgical obturation
 maxillary defects rehabilitated with, 166–
 170, 168f–171f
 soft palate defects rehabilitated with, 233,
 234f
 velopharyngeal defects rehabilitated with,
 233, 234f
- Immune system, 64
- Immunosuppression, chemotherapy-induced,
 434–435, 435f
- Implant(s)
 animal studies of, 47–48
 in children, 350–353, 351f–352f
 cleft lip and palate uses of, 339–341,
 340f–341
 craniofacial. *See* Craniofacial implants.
 definitive obturator and, 174, 175f
 description of, 46–47
 in ectodermal dysplasia patients, 349–350
 in edentulous patients
 anterior maxillary segment for, 162
 description of, 106, 183, 352–353
 existing, irradiation of, 53, 53f–55
 facial prostheses retained with, 260
 failure of, 52
 free flap reconstruction with, 131–132,
 132f
 human data regarding, 48–50
 impairments of, 50
 irradiation of, 53–54, 53f

- long-term function of, 46
- in mandible, 50, 52, 52f, 183
- mandibular bone graft reconstruction
 - considerations, 95–96
- in maxilla, 49, 52–53
- navigation surgery, 367, 367f
- osteoradionecrosis risks, 43, 46–47, 49f, 51, 51f
- osteotomy site preparations, 53
- overload of, 340
- patient selection and treatment, 52–53
- predictability of, 47–50
- retention of, 244
- single-tooth defects treated with, 351, 351f
- in soft palate defects, 244
- success factors for, 46, 49
- surfaces of, 340
- survival rates for, 50, 182
- tissue bar for, 365f
- tongue function effects on, 46
- total palatotomy defects, 366, 366f
- treatment planning, 366–367
- zygoma, 184, 185f
- Implant placement**
 - digitally derived surgical guide for, 364
 - with free flaps, 131–132, 132f
 - immediate, 273, 273f
 - in irradiated bone, 53
 - simulation of, 360
 - tumor resection and, 165, 273, 273f
- Implant-retained overlay dentures**, 140–141
- Implant-retained prostheses**
 - auricular, 290f
 - craniofacial uses of, 285, 290f
 - definitive obturators and, 182–186, 183f–186f, 244–245
 - lateral mandibular discontinuity defects treated with, 131, 131f
- Implant-supported prostheses and restorations**
 - anterior mandibular defects managed with, 127f, 127–128
 - Granström protocol for, 53
 - mastication and, 106
 - in partially edentulous patients, 127, 127f
 - removal of, 54f
- Impressions**
 - auricular prosthesis, 276–277
 - cleft lip and palate, 324, 325f
 - complete dentures, 337
 - dentures, 45, 123, 123f, 136–137
 - nasal prosthesis, 279–280, 280f
 - obturators
 - definitive, 178–180, 179f–180f, 193f–195f, 193–195
 - surgical, 167, 168f, 171, 172f
 - ocular prostheses, 304, 304f
 - orbital prosthesis, 282–283, 283f
 - orbital-nasal-cheek prosthesis, 294, 295f
 - trismus effects on, 179
- Incisive foramen**, 317
- Indications of head and neck cancer**, 8–9
- Infection, chemotherapy-induced**, 434–436, 435f
- Inferior alveolar artery**, 22
- Infuse/LT-Cage device**, 383–384
- Intensity-modulated radiation therapy**
 - dose distribution of, 6, 7f
 - dosimetry, 28f, 51
 - gross tumor volume, 28
 - olfactory loss secondary to, 16
 - osteoradionecrosis secondary to, 38, 43
 - planning target volumes for, 6–7
 - preradiation extraction considerations, 28–29
 - salivary glands affected by, 19, 20f
 - symphyseal region, 52
- Interferons**, 428
- Interim obturation**
 - maxillary defects rehabilitated with, 172–173, 173f
 - soft palate defects rehabilitated with, 234, 235f
- Interim prostheses**, 334, 334f
- Interleukins**, 428
- Interstitial implantation**, 7
- Inverse square law**, 7
- Iridium 192**, 7
- Iridium implants**, 40f
- Iron-deficiency anemia**, 74
- Isodose curves**, 5, 5f
- Isoeffects modeling**, 3
- Isoelectric points**, 382
- Isotopes**, 7–8
- J**
- Jaw biomechanics**, 107–109
- K**
- Keratinocytes**, 256
- Keratoacanthomas**, 256
- Knowledge work**, 356–357
- Koilocytes**, 71
- L**
- Lactic acidosis**, 388
- Larynx**, 110
- Lateral mandibular discontinuity defects**
 - complete denture for, 133–140
 - in edentulous patients, 133–143
 - fibular free flap reconstruction of, 129, 130f–131f
 - implant-retained prostheses for, 131, 131f
 - partial denture for, 122–124
 - in partially edentulous patients, 128–131
 - removable partial denture for, 128–131
- Lateral palatine processes**, 316, 316f
- Lateral pharyngeal walls**, 230–231
- Leukopenia**, 434
- Leukoplakia**
 - Candida* spp. associated with, 71
 - definition of, 68
- diagnosis of, 70
- dysplastic characteristics of, 68, 70t
- epidemiology of, 68
- hairy, 71
- malignant transformation of, 69t, 71t, 73
- management of, 72–73
- proliferative verrucous, 70–71, 71f
- tobacco use and, 70
- Levator sling**, 343
- Levator veli palatini**, 164, 164f, 227–228, 230, 343
- Lever arm**, 187, 187f
- Lichen planus**, 73, 73f, 439
- Lingual plates**, 122, 122f
- Lingual resections**, 112–113
- Lip**
 - cleft. *See* Cleft lip and palate.
 - upper. *See* Upper lip.
 - zones of, 320
- Lip adhesions**, 322
- Lip pits**, 320, 320f
- Lip plumper**, 136, 140, 140f
- Lymph nodes**
 - neck, 79, 79f
 - oral tongue squamous cell carcinoma metastasis to, 76
 - submandibular, 79
- Lymphoma**, 8
- M**
- Magnetic resonance imaging**, 222
- Malignant melanoma**, 257, 259f, 259–260
- Mandible**
 - biomechanics of, 107–108
 - carcinoma of, 85–87, 87f
 - deviation of, 88–89
 - growth of, 345
 - implants in, 50, 52, 52f
 - mastication affected by integrity of, 105–106
 - movements during speech, 218
 - osteoradionecrosis risks in, 27
 - preradiation extractions, 27
 - in Robin sequence, 345, 345f
 - without continuity, 107–108, 108f
- Mandibular angle reconstruction**, 98–99
- Mandibular body**
 - gross tumor volume, 29
 - reconstruction of
 - fibular free flap, 92, 92f
 - free bone grafts, 98
- Mandibular condyle reconstruction**, 98–99
- Mandibular continuity**
 - after glossectomy, 88f, 113
 - defects with maintenance or reestablishment of, 125–132, 143–145
 - prosthetic treatments for, 144
 - reconstruction plate for, 93f
 - restoration of, 88, 93f
 - swallowing and, 113
 - teeth and, 93

- Mandibular defects
 anterior. *See* Anterior mandible defects.
 discontinuity
 description of, 118
 lateral. *See* Lateral mandibular discontinuity defects.
 mandibular guidance therapy for, 118–121
 mastication difficulties associated with, 133
 maxillary defects and, comparison between, 155–156
 rehabilitation of, 156
 resection of, disability secondary to, 87–90, 88f–90f
 tongue release for, 102–103
 traumatic, 145–146
 vestibuloplasty for, 102–103
- Mandibular guidance therapy
 description of, 118
 guidance restorations, 119–121
 maxillomandibular fixation, 118–119
 occlusal equilibration after, 121, 121f
 outcomes of, 121
 prostheses for, 119f, 119–120
 timing of, 119
- Mandibular ramus reconstruction, 98–99
- Mandibular reconstruction
 after tumor ablation, 92
 complications of, 98
 delayed, 97
 free bone grafts for, 95–99, 99f
 goals of, 95–96
 hemifacial microsomia treated with, 347f
 immediate, 97
 implant placement after, 106
 mandibular fragment presurgical position, 92
 timing of, 97
- Mandibular resection
 deviation caused by, 118
 disability secondary to, 87–90, 88f–90f
 mastication effects, 104–109
 occlusion affected by, 108
 saliva control affected by, 89
 trismus secondary to, 89–90
- Mandibular symphysis reconstruction, 98, 99f
- Mandibular tumors
 ameloblastoma, 85f, 85–86
 description of, 75
 floor of the mouth carcinoma, 81f–83f, 81–83
 oral tongue carcinoma. *See* Oral tongue squamous cell carcinoma.
 oropharyngeal squamous cell carcinoma, 83–85
 osteosarcoma, 86–87
 presurgical consultation for, 75
 tonsillar squamous cell carcinoma, 83–85
- Mandibular-based tongue prosthesis, 117, 117f
- Mandibulectomy
 description of, 41
 marginal, 80, 143
 speech affected by, 114
- Mandibulotomy, 80, 113
- Marginal mandibulectomy, 80, 143
- Master casts, 181f
- Mastication
 mandibular discontinuity defect effects on, 133
 mandibular resection effects on, 104–109
 occlusal force and, 106
 physiology of, 104
 radiation therapy effects on, 106–107
 tooth-to-tooth contacts and, 107
- Maxilla
 collapsed, 339f
 growth of, 350
 implants in, 49, 52–53
 osteoradionecrosis risks in, 57
 preradiation extractions, 27
- Maxillary defects
 access to, 164–165, 165f
 anterior, 197–199, 198f
 avulsive
 description of, 161
 illustration of, 200f
 osseointegrated implants for, 202f
 rehabilitation for, 200–201
 etiology of, 158t
 free flaps for, 205–206
 mandibular defects and, comparison between, 155–156
 prosthetic rehabilitation of
 defect access considerations, 164–165, 165f
 definitive obturators. *See* Obturators.
 hard palate retention, 162
 interim obturation, 172–173, 173f
 maxillary tuberosity effects on, 186
 palatal mucosa, 163–164, 164f
 phases of, 166–175
 presurgical planning, 166
 soft palate, 164
 surgical obturation. *See* Surgical obturation.
 surgical procedures to enhance, 161–165
 surgical rehabilitation versus, 165–166
 tooth retention, 162–163
 psychosocial profile of patients with, 156
 rehabilitation of, 156
 soft tissue flap reconstruction of, 164
 squamous cell carcinoma as cause of, 198f
 surgical rehabilitation of
 description of, 165–166
 prosthetic rehabilitation with, 205–210, 207f–210f
 tooth retention adjacent to, 162–163, 174f, 189
- Maxillary guidance ramp, 138f–139f
- Maxillary tuberosity, 136f, 176, 177f
- Maxillary tumors
 adenoid cystic carcinomas, 158, 159f
 behavioral characteristics of, 158–159
 debulking surgery for, 159
 diagnosis of, 157–159
 edema associated with, 158, 159f
 imaging of, 158
 presentation of, 158
 surgical resection of, 159–161
 treatment of, 159–161
- Maxillectomy
 maxillary tumors treated with, 160f, 160–161
 skin incisions for, 160f
- Maxillectomy defects
 cheek resection defect with, 298f
 definitive obturators for
 in dentulous patients, 187f–197f, 187–197
 implant-retained prostheses and, 182–186, 183f–186f
 partial defects, 182, 182f
 rapid prototyping and manufacturing application, 364–365, 365f
 fulcrum lines affected by, 190
 immediate surgical obturation for, 166, 171f
 orbital exenteration defects and, 199–200, 200f, 298f
 osteocutaneous flap reconstruction of, 165
 ovoid arch form, 190f
 partial, definitive obturators for, 182, 182f, 197, 197f
 partial denture designs for, 192, 192f
 posterior pharyngeal wall extension of, 199, 199f
 skin grafting for, 162, 163f
 soft tissue flap contraindications, 164, 165f
 tissue bar attachments for, 186, 187f
 trismus and, 191f
- Maxillofacial prosthetics
 digital technology application to, 364–369
 speech effects, 216
 speech phonemes affected by, 217–218
- Maxillomandibular fixation, 118–119
- Meaningfulness, 415–416
- Meatal obturator prostheses, 248–249, 249f
- Median cleft lip, 318, 318f
- Median palatine process, 316
- Medical models, 360
- Melanocytes, 256–257
- Melanoma, 257, 259f, 259–260
- Merkel cell carcinoma, 257
- Microcystic adenocarcinoma, 257
- Micrognathia, 345–346
- Microphthalmia, 301–302
- Microtia, 286f
- Midfacial defects
 description of, 293
 large, 294f
 lateral, 297f–298f, 297–298
 oral cavity involvement, 295, 295f
 oral prosthesis for, 295, 296f

- resection of, surgical modifications during, 293
 skin-lined undercuts for, 271
 upper lip involvement, 295, 295f
- Midfacial prostheses
 definitive, 294f–297f, 294–297
 oral prosthesis, 295, 296f
 orbital-nasal-cheek defects, 294–295, 295f
 patient tolerance of, 293
 prognosis for, 293–294
 temporary, 294, 294f
- Midline granuloma, 161
- Mixed nasality, 216
- Modified radical neck dissection, 79
- Monoclonal antibodies, 429
- Mouth
 floor of. *See* Floor of the mouth.
 reduction in opening of, 17–18
- Mucormycosis, 161, 161f, 435f
- Mucosa
 palatal, 163–164, 164f
 tissue engineering of, 387
- Mucosal atrophy, 43, 43f
- Mucositis
 chemotherapy-induced, 429–432, 430f–431f, 432t
 radiation therapy-induced, 14–15, 15f
- Multicystic ameloblastoma, 86
- Multileaf collimator, 4
- Multiple beams, 5, 5f
- Multiple-teeth defects, 351–352, 352f
- Muscle atrophy, 9, 9f
- Muscle wasting, 9, 9f
- Musculus uvulae, 226–227
- Mylohyoid ridge, 45
- Myocutaneous flaps
 hemiglossectomy defect reconstructed using, 93, 94f
 history of, 93
 pectoralis major, 78, 78f, 94
 regional, 104
 tongue reconstruction using, 88
 tonsil defect reconstruction using, 94–95
- N**
- Nasal breathing, 224
- Nasal defects
 cleft lip and palate as cause of, 322–323
 description of, 279f–282f, 279–282, 290
- Nasal endoscopy, 220–221, 221f, 231
- Nasal prostheses
 definitive, 279–282, 280f–282f
 illustration of, 262f
 implant-retained, 288, 288f, 290, 291f, 292
 partial, 282
 temporary, 279, 279f
- Nasal resistance, 223
- Nasal stent, 14f
- Nasal valve, 223–224
- Nasalance, 224
- Nasoalveolar molding
 abutments for, 189, 189f
 of cleft lip and palate, 324–327, 325f–327f
 appliance for, 326f–327f, 326–327
- Nasolabial folds, 274
- Nasometrics, 224–225
- Nasopharyngeal carcinomas, 8
- Navigation surgery, 367, 367f
- Neck dissection, 79, 79f, 84
- Neck metastases, 258
- Neediness, 414
- Nevi, 257
- Nitrosamines, 66
- Nitrosoureas, 426, 427t
- Nodular melanomas, 260
- Nutrition, 74
- O**
- Obturator
 abutments for, 189, 189f
 acrylic resin base, 185
 air leakage associated with, 202–203
 bite force effects, 202
 bolus manipulation and, 192
 buccal retention of, 192
 cleft lip and palate treated with, 240, 330, 330f
 clinical procedures for, 178–182, 192–197, 193f–197f
 definition of, 232
 delivery of, 181–182, 182f
 design of, 174–175
 double-processing method, 196–197
 in edentulous patients, 175–186, 176f–187f
 with partial maxillectomy defects, 197, 197f
 with total maxillectomy defects, 187f–197f, 187–197
 esthetics of, 196, 196f–197f
 evaluation of, 202–205
 extension of, into defect, 174, 174f
 fabrication of
 description of, 236–237, 237f
 errors in, 238, 239f
 fluid leakage associated with, 202–203, 203f
 functional limitations of, 202
 immediate
 maxillary defects rehabilitated with, 166–170, 168f–171f
 soft palate defects rehabilitated with, 233, 234f
 implant benefits for, 174, 175f
 implant-retained, 182–186, 183f–186f, 244–245
 impressions for, 178–180, 179f–180f, 192–195, 193f–194f
 interim
 maxillary defects rehabilitated with, 172–173, 173f
 soft palate defects rehabilitated with, 234, 235f
 leakage associated with, 202–203, 203f
 level of placement, 242
- lingual retention of, 192
 masticatory performance effects, 202
 maxillary defects treated with
 anterior, 197–199, 198f
 bordering hard and soft palates, 197, 198f
 partial maxillectomy, 197, 197f
 total maxillectomy, 187f–197f, 187–197
- maxillectomy defects
 in dentulous patients, 187f–197f, 187–197
 implant-retained prostheses and, 182–186, 183f–186f
 orbital exenteration defects and, 199–200, 200f
 partial, 182, 182f
 posterior pharyngeal wall extension, 199, 199f
- meatal, 248–249, 249f
 movement of, 176, 176f
 nasopharyngeal placement of, 238
 occlusal schemes, 181, 181f, 195f, 195–196
 overlay denture with, 244f
 palatal lift prostheses, 241, 246–248, 247f–248f
 planning considerations for, 173–175
 processing of, 181–182, 182f
 quality of life effects, 204–205
 rapid prototyping and manufacturing used in construction of, 364–365, 365f
 records, 180–181, 181f, 195, 195f
 relining of, 205
 retention of, 176–177, 177f
 skin grafting benefits for, 162, 163f
 soft palate defects rehabilitated with, 234–243, 235f, 237f–239f, 241f–242f
 speech effects, 203–204
 speech restoration prognosis, 243–244, 249
 speech therapy after placement of, 239–240
 stability of, 177–178
 support for, 176, 177f
 timing of construction, 173
 total palatotomy defects treated with, 198f, 199
 waxing, 181
 weight of, 174–175
- Occlusal ramp, 124, 124f
- Occlusion
 complete denture and, 137–139, 138f–139f
 dynamic modeling of, 108–109
 equilibration of
 after mandibular guidance therapy, 121, 121f
 removable partial denture design after, 130
 mandibular resection effects on, 108
 vertical dimension of, 45, 137, 180, 217, 337, 339, 347
- Occult submucous cleft palate, 226, 342–344, 343f

- Ocular prostheses. *See also* Orbital prostheses.
- anophthalmia, 301–302
 - complications that affect socket fitting of, 302–303, 303f
 - congenital micropthalmia, 301–302
 - delivery of, 308, 309f
 - fabrication of, 304f–309f, 304–309
 - goals for, 300
 - implants
 - motility of, 304
 - selection of, 300–301, 301f–302f
 - impression for, 304, 304f
 - iris, 305–308, 306f–307f
 - postoperative care, 301
 - precautions for, 308–309
 - sclera, 308, 308f
 - stock eye modifications, 309
- Olfactory impairments, 16
- Open bite, 339f
- Oral breathing, 224
- Oral cancer
- age-related factors, 62
 - chemoradiation for, 92
 - dentures and, 73–74
 - dietary factors, 74
 - epidemiology of, 62–64
 - etiology of, 64–65
 - gender and, 62
 - genetics and, 63
 - herpes viruses and, 64–65
 - human papillomaviruses and, 65
 - incidence of, 62, 62t
 - leukoplakia. *See* Leukoplakia.
 - lichen planus, 73, 73f, 439
 - nutritional factors, 74
 - palatal papillary hyperplasia, 74
 - predisposing factors
 - alcohol, 67–68
 - social customs, 67
 - tobacco, 65–67
 - psychosocial impact of, 146–148, 148f, 403–423
 - quality of life effects, 146–148, 148f
 - race and, 63
 - sites of, 62
 - stage of, 62–63
 - viral causes of, 64–65
- Oral cavity
- chemotherapy-induced infection of, 434–436, 435f
 - defects of, 295, 295f
- Oral examination, 44–45
- Oral flora, 15, 24–25, 25f
- Oral hygiene, 27–28, 32
- Oral lichen planus, 73, 73f
- Oral mucositis, 429–432, 430f–431f, 432t
- Oral Mucositis Rating Scale, 431
- Oral mucous membranes
- chemotherapy-related changes in, 430
 - erythema of, 14, 15f
 - late changes in, 16, 17f
 - radiation therapy effects on, 14–16, 15f, 17f
- Oral prosthesis
- construction of, 295, 296f
 - in edentulous patients, 296, 296f
 - facial prosthesis connection with, 298, 298f
- Oral tongue squamous cell carcinoma
- cervical metastases of, 76, 79, 79f
 - classification of, 76, 77t
 - clinicopathologic considerations, 75–76
 - composite resection of, 78f, 78–79
 - lymph node metastases of, 76
 - mandibulotomy for, 80
 - metastases of, 76
 - prognosis for, 76
 - resection of, 77–79, 78f
 - segmental mandibulectomy for, 80
 - staging of, 76, 77t
 - treatment of, 76–81
- Orbicularis oris muscle, 320–321
- Orbital exenteration defects
- description of, 199–200, 273, 300
 - illustration of, 200f, 273f
- Orbital floor defects, 200
- Orbital prostheses. *See also* Ocular prostheses.
- CAD/CAM fabrication of, 299, 299f
 - description of, 282–285, 283f–285f
 - hygiene issues, 291–292, 292f
 - implant-retained, 290–292, 291f
 - magnetic retention of, 291, 291f
- Orbital-nasal-cheek defects, 294–295, 295f
- Organogenesis, 389
- Oronasal fistula, 331, 332f
- Oropharyngeal lesions, 45
- Oropharyngeal squamous cell carcinoma, 83–85
- Orthovoltage, 5
- Osteoblasts, 22, 380
- Osteoclasts, 22
- Osteocutaneous flaps, 165
- Osteogenesis, 96
- Osteoinduction, 96
- Osteoradionecrosis
- bone necrosis caused by, 37
 - brachytherapy, 40
 - chemoradiation and, 26, 92
 - conservative treatment of, 39–40
 - contributing factors, 38–39
 - conventional radiation therapy as cause of, 38, 40
 - definition of, 37
 - dentures and, 42–44
 - gross tumor volume and, 38
 - hyperbaric oxygen therapy for, 40–41, 41f
 - incidence of, 38
 - intensity-modulated radiation therapy as cause of, 38, 43
 - mandible, 28
 - osseointegrated implants as cause of, 43, 46–47, 49f, 51, 51f
 - peri-implant tissue infection as risk for, 54
 - periodontal infection associated with, 23, 27f, 38
 - postradiation extractions and, 38
 - preradiation extraction sites, 38
 - prostheses and, 42
 - removable partial denture and, 39
 - risk factors for, 26, 28, 51
 - spontaneous, 37, 37f
 - trauma-induced, 37
 - treatment of, 39–41
 - vascularized free flaps for, 41
- Osteosarcoma, 86–87
- Outrigger, 123, 133, 134f
- Overlay dentures, 132f, 244f, 338–341, 339f
- Ovoid arch form, 190f
- Oxygenation, 2
- P**
- Pair production, 2
- Palatal defects
- causes of, 161, 161f
 - surgical rehabilitation of
 - flaps for, 166, 167f
 - prosthetic rehabilitation versus, 165–166
 - traumatic, 200
- Palatal grafts, 132, 132f
- Palatal incompetence, 218
- Palatal insufficiency, 218
- Palatal lift prostheses, 241, 246–248, 247f–248f
- Palatal mucosa, 163–164, 164f
- Palatal papillary hyperplasia, 74
- Palatal speech aid, 116, 117f
- Palate. *See also* Hard palate; Soft palate.
- anatomy of, 156–157
 - blood supply to, 157f
 - cleft. *See* Cleft lip and palate.
 - embryologic development of, 316f, 316–317
 - lymphatic drainage of, 156, 157f
 - secondary, 316f
 - squamous cell carcinoma of, 159f
- Palatotomy, 159–160
- Palatotomy defects
- description of, 159, 160f
 - osseointegrated implants for, 366, 366f
 - total, 198f, 199, 366
- Palatine shelves, 316–317
- Palatoglossus muscle, 231
- Palatopharyngeus muscle, 231
- Paranasal sinuses, 156–157, 157f
- Paré, Ambroise, 261–262
- Parotid gland, 19
- Partial auriculectomy defects, 278f, 278–279
- Partial dentures. *See also* Fixed partial dentures; Removable partial denture.
- design of
 - for avulsive maxillary defects, 201
 - considerations for, 210
 - description of, 188–189
 - for maxillectomy defects, 192, 192f

- for soft palate defects, 236
 - trismus effects on, 191, 191f
 - fabrication of, 123, 123f
 - lateral discontinuity defects managed with, 122–124
 - Partial glossectomy, 117f, 143f
 - Partial nasal prostheses, 282
 - Partially edentulous patients
 - lateral discontinuity defects in, 122–124
 - lateral mandibular discontinuity defects in, 128–131
 - Particulate radiation, 2, 5, 5f
 - Passavant ridge, 222, 228f–229f, 228–229
 - Passive-aggressiveness, 414
 - Passiveness, 414
 - Patients
 - Basic Assumption activities of, 413–415
 - biopsychosocial symptoms, morbidities, and disabilities, 412–413
 - challenges for, 410–413
 - cognitive disruptions, 412
 - followership tasks of, 410
 - leadership tasks of, 409–410
 - mortality of, 411–412
 - psychosocial rewards for, 410
 - re-scaling by, 416
 - role of, 409–416
 - self-management, 415–416
 - Pectoralis major myocutaneous flap, 78, 78f, 94
 - Penetration depth of the maximum dose, 4–5
 - Pericoronitis, 30
 - Peri-implant tissue infections, 54
 - Periodontal disease, 437
 - Periodontal infection, 23, 27f, 38
 - Periodontium, 23f, 23–24
 - Peripheral neuropathy, 436
 - Pharyngeal cancer, 62
 - Pharyngeal flaps, 330, 330f–331f
 - Pharyngeal plexus, 231
 - Pharyngopalatal resection, 111
 - Phase-measuring profilometry, 299, 299f
 - Phonation, 214
 - Photoelectric effect, 2
 - Photon beam, 5, 5f
 - Photons, 2
 - Phytochemicals, 72
 - Planning target volumes, 6
 - Plant alkaloids, 426–427, 427t
 - Plummer-Vinson syndrome, 74
 - Polyjet modeling, 363
 - Polymers, 266
 - Polyphosphazenes, 266
 - Porcelain-fused-to-metal restoration, 334
 - Positioning stents, 10f–11f, 10–11
 - Posterior pharyngeal wall
 - anatomy of, 228–230
 - maxillectomy defects extending to, 199, 199f
 - muscles of, 229–230
 - Passavant ridge, 222, 228f–229f, 228–229
 - velopharyngeal closure role of, 228–230
 - Postradiation extractions
 - description of, 31–32
 - endodontic therapy as alternative to, 35–36
 - hyperbaric oxygen after, 38
 - osteoradionecrosis secondary to, 38
 - Preradiation extractions
 - bone necrosis rates, 30
 - brachytherapy, 29
 - concomitant chemotherapy considerations, 29
 - conventional radiation therapy, 28
 - criteria for, 26–31
 - current philosophy regarding, 30
 - disadvantages of, 30
 - fractionation considerations, 29
 - intensity-modulated radiation therapy, 28–29
 - mandible versus maxilla, 27
 - mandibular body volume in gross tumor volume, 29
 - mandibular teeth, 30–31
 - osteoradionecrosis at site of, 38, 39f
 - patient-related factors, 27–28
 - radiation delivery factors, 28–29
 - surgical procedures, 30–31
 - third molars, 30, 31f
 - tumor prognosis considerations, 29
 - Primary autologous cells, 376
 - Primary caregivers, 416–419
 - Primers, 267
 - Projective identification, 405–406
 - Proliferative verrucous leukoplakia, 70–71, 71f
 - Prostheses. *See specific prostheses.*
 - Prosthodontic procedures
 - examination, 44–45
 - saliva evaluation, 45
 - vertical dimension of occlusion assessments, 45
 - Pseudomembranous mucositis, 14
 - Pseudoptosis, 302
 - Psychoeducational tasks, 419–420
 - Pterygoid hamulus, 168
 - Ptosis, 302, 303f
 - Pulp, 24, 25f
 - Purine antagonists, 426
 - Pyrimidine antagonists, 426
- Q**
- Quality of life
 - concepts associated with, 146
 - instruments for assessing, 146–147, 147b, 148f
 - mandibular defects effect on, 155
 - maxillary defects effect on, 155
 - oral cancer effects on, 146–148
- R**
- Radial forearm fasciocutaneous flap, 101, 101f, 143f, 245
 - Radiation carrier, 12f, 12–13
 - Radiation positioning stents
 - description of, 12–13
 - tissue bolus devices and, 14f
 - Radiation therapy. *See also* Chemoradiation.
 - basal cell carcinoma treated with, 258
 - biologic effects of, 2–3, 3f
 - chemoradiation and, 26–27
 - conventional. *See* Conventional radiation therapy.
 - definition of, 2
 - general tissue effects of, 9
 - heart effects of, 26
 - indications for, 8–9
 - intensity-modulated. *See* Intensity-modulated radiation therapy.
 - oral effects of
 - bone, 22f–23, 22–23
 - caries, 26, 26f
 - dental tissue, 24, 24f
 - edema, 16–17
 - mucositis, 14–15, 15f
 - olfactory impairments, 16
 - oral flora alterations, 15, 24–25, 25f
 - oral mucous membranes, 14–16, 15f, 17f
 - periodontium, 23f, 23–24
 - pulp, 24, 25f
 - root sensitivity, 24
 - salivary gland dysfunction. *See* Salivary gland(s), dysfunction.
 - taste impairments, 16
 - tooth development, 24, 25f
 - trismus, 17–18, 18f
 - velopharyngeal insufficiency, 17–18
 - peri-implant tissue infections after, 54
 - physical principles of, 2
 - postoperative, 9
 - principles of, 2–9
 - squamous cell carcinoma treated with, 259
 - tissue interactions, 2
 - tonsillar squamous cell carcinoma treated with, 84
 - Radical maxillectomy, 17
 - Radical neck dissection, 79–80, 90
 - Radiopaque shields, 12
 - Radioprotective agents, 15
 - Rapid prototyping, 358–364, 396
 - concept modelers, 362
 - description of, 361
 - extrusion-based processes, 363
 - maxillary obturator construction using, 364–365, 365f
 - powder-based processes, 363–364
 - resin-based processes, 362–363
 - Recombinant human bone morphogenetic proteins, 379, 382–383
 - Recontouring stents, 12
 - Record base, 195, 195f
 - Records, 180–181, 181f, 195, 195f
 - Rectus abdominis flap, 102
 - Remineralizing preparations, 33–34

- Removable partial dentures. *See also* Partial dentures.
 cleft lip and palate treated with, 316f, 334, 334f
 cleft lip and palate-related missing dentition treated with, 334f, 334–336, 336f
 conventional, 125
 designs of
 considerations for, 210
 description of, 129–130, 190f
 trismus effect on, 191
 framework of, 191f
 interim, 334, 334f
 lateral discontinuity defects managed with, 122, 122f
 lateral mandibular discontinuity defects managed with, 128–131
 mandibular defects treated with, 125–128
 osteoradionecrosis risks, 39
 overlay, 338, 339f
 rotational path, 126, 126f
- Reoxygenation, 3
- Repair of sublethal damage, 2
- Resection
 deglutition affected by, 109–113
 disabilities secondary to, 61, 87–92
 implant placement concurrent with, 165, 273, 273f
 mastication effects, 104–109
 maxillary tumors, 159–161
 oral function after, 103–118
 oral tongue squamous cell carcinoma treated with, 77–79, 78f
 osteosarcoma treated with, 86
 palatal mucosa used to cover, 164f
 speech affected by, 114–118
 transalveolar, 162, 163f
- Resonation, 214, 216
- Responsibility, in Group Relations model, 407–408
- Rest seats, 188, 189f
- Restorative care, 34–35
- Rhinectomy defects
 illustration of, 272, 272f–273f
 nasal prosthesis for
 description of, 279–282, 280f
 implant-retained, 290
- Rib graft, for mandibular condyle reconstruction, 98–99
- Robin sequence, 323, 344–346, 345f
- Room-temperature vulcanizing silicones, 264–266
- Root canal therapy
 after high-dose radiotherapy, 32, 35
 crown amputation and, 36f
- Rotational path removable partial denture, 126, 126f
- S**
- Sagging lower eyelid, 303, 303f
- Saliva
 buffering capacity of, 21
 functions of, 432
 mandibular resection effects on control of, 89
 production of, 19
 prosthodontic success affected by, 45
 taste acuity affected by, 16
 tongue resection effects on control of, 89
 viscosity of, after radiation therapy, 20
- Saliva stimulants, 21, 432
- Saliva substitutes, 21, 25
- Salivary gland(s)
 adenocarcinoma of, 10
 dysfunction of
 caries risk secondary to, 19–20
 chemotherapy-related, 432
 conventional radiation therapy fields and, 19, 19f–20f
 dose volume concept for, 19–20
 fibrosis, 19
 histology of, 19f
 mechanisms of, 18
 posttherapy recovery of, 20
 stem cell transplantation for, 21–22
 intensity-modulated radiation therapy effects on, 19, 20f
 parenchyma of, 21
 protective agents for, 21
 radiation therapy effects on, 19, 175
- Salpingopharyngeus muscle, 231
- Scaffolds, in tissue engineering, 379–380, 380f, 389–391, 395
- Scapular flap, 78f, 101–102, 102f
- Schwann cells, 9
- Sculpting
 of auricular prosthesis, 277, 277f
 of nasal prosthesis, 280–281, 281f
 of orbital prosthesis, 283–284, 284f
- Segmental mandibulectomy, 80
- Segmentation, 364
- Selective laser sintering, 363, 394f, 394–395
- Selective neck dissection, 79
- Self-management
 by family members, 419
 by patients, 415–416
 by primary caregivers, 419
 by providers, 421–422
- Shielding stents, 11f, 11–12
- Sibilant sounds, 217
- Silicones, 263–266
- Single beams, 5, 5f
- Single maxillary complete dentures, 338
- Single-tooth defects, 351, 351f
- Sinonasal tumors, 158
- Skin grafts/grafting
 maxillectomy defects, 162, 163f
 obturator and, 162, 163f
 vestibuloplasty and, combined use of, 103
- Skin scaling, 15f
- Skin-sparing effect, 5
- Smoking, 65–67
- Snuff dipping, 66
- Soft liners, 42
- Soft palate. *See also* Palate.
 anatomy of, 156–157, 157f, 225–228
 deglutition role of, 110
 histology of, 227
 levator veli palatini, 164, 164f, 227–228
 maxillary defects bordering, definitive obturators for, 197, 198f
 muscular diastasis of, 343f
 musculus uvulae of, 226–227
 position and movement of, 225–226
 velar eminence of, 225–226
- Soft palate defects
 acquired, 218
 cleft. *See* Cleft lip and palate.
 lateral, 170
 obturators for
 definitive, 234–243
 interim, 234, 235f
 meatal, 248–249, 249f
 palatal lift prostheses for, 241, 246–248, 247f–248f
 posterior border, 240–243, 241f–243f
 reconstruction of
 description of, 94–95
 surgical, 218, 219f
 rehabilitation of
 speech considerations. *See* Speech.
 velopharyngeal mechanism. *See* Velopharyngeal mechanism.
 resection of, disabilities secondary to, 91
 surgical issues for, 245
 surgical obturation for, 233–234, 234f
 total, 235–240
- Soft tissue dehiscence, 98
- Soft tissue necrosis
 dentures and, 44
 description of, 41–42
 oral mucous membrane, 16, 17f
- Solid freeform fabrication technologies, 391, 396
- Speech
 articulation, 214–216, 215f
 audition, 215–216
 closed-loop systems that affect, 215–216
 components of, 213–216
 definitive obturator effects on, 203–204
 denture effects on, 337
 maxillofacial prosthetics and, 216
 neural integration of, 215
 obturator effect on restoration of, 243–244, 249
 phonation, 214
 physiology of, 114
 resection effects on, 114–118
 resonance, 214, 216
 respiration and, 213–214
 submucous cleft palate effects on, 344
 tongue resection effects on, 88
 tongue's role in production of, 114, 215
- Speech aids, 115–118

- Speech phonemes, 216–218
 Speech therapy, 116–117, 239–240
 Squamous cell carcinoma
 chemoprevention of, 72
 clinical features of, 258, 259f
 clinical presentation of, 63f
 erythroleukoplakia transformation into, 69f
 facial, 258–259, 259f
 gingival, 87, 87f
 intraoral sites for, 61, 63f
 maxillary defects caused by, 198f
 oral tongue. *See* Oral tongue squamous cell carcinoma.
 oropharyngeal, 83–85
 palate, 159f
 tonsillar, 83–85
 treatment of, 259, 259f
 Stem cells
 embryonic, 376–377, 377f
 hematopoietic, 377–378, 378f
 transplantation of, for salivary gland dysfunction, 21–22
 Stents
 positioning, 10f–11f, 10–11
 radiation positioning, 12–13
 recontouring, 12
 shielding, 11f, 11–12
 Stereolithography, 362, 363f, 391, 393–394, 394f
Streptococcus mutans, 25, 34
 Stress shielding, 97
 Submandibular lymph nodes, 79
 Submucosal bleeding, 434f
 Submucous cleft palate, 342–344, 343f
 Superficial spreading malignant melanoma, 259f
 Superior labial artery, 320
 Supernumerary teeth, 332
 Support systems, 416–419
 Surgical obturation
 delayed
 maxillary defects rehabilitated with, 166–170, 168f–171f
 soft palate defects rehabilitated with, 233–234, 234f
 immediate
 maxillary defects rehabilitated with, 166–170, 168f–171f
 soft palate defects rehabilitated with, 233, 234f
 velopharyngeal defects rehabilitated with, 233, 234f
 materials used in, 166
 Surveillance Epidemiology and End Results Program, 62
 Swallow reflex, 110
 Swallowing
 aids for, 115–118
 dysphagia, 109, 112–113
 evaluation of, 111–112
 fiber-optic endoscopic evaluation of, 112
 phases of, 109f, 109–110
 specialized testing of, 112
 tongue resection effects on, 88
 tonsillar resection effects on, 91
 velopharyngeal closure during, 219
 videofluoroscopic modified barium swallow evaluation of, 112
T
 Taste impairments, 16
 Taxanes, 426
 Team functioning, 422
 Technologist group, 357
 Teeth
 missing, in cleft lip and palate patients. *See* Cleft lip and palate, missing dentition secondary to.
 radiation therapy effects on development of, 24, 25f
 Telangiectasia, 16, 17f
 Temporomandibular joint, 346, 347f
 Thermal inkjet modeling, 393
 Thermoplastic materials, 13
 Thick tissue engineering, 387–390
 Thoracoacromial flaps, 93
 Three-dimensional printing, 391–393, 392f–393f
 Throat screen, 36
 Thrombocytopenia, 432–433, 433t
 Tissue
 radiation therapy interactions with, 2
 tolerance of, 3
 turnover rates of, 9
 Tissue bar attachments, 183f, 183–186, 186f–187f, 244f, 290, 340, 365f
 Tissue bolus devices, 13–14, 14f
 Tissue engineering
 acidosis concerns, 388–389
 advanced manufacturing technologies for fused deposition modeling, 395f, 395–396
 overview of, 390–391
 selective laser sintering, 394f, 394–395
 stereolithography, 391, 393–394, 394f
 thermal inkjet modeling, 393
 three-dimensional printing, 391–393, 392f–393f
 bone, 384–385
 cartilage, 385–386
 cells used in
 spatial distribution of, 390
 types of, 376–379, 377f–378f
 growth factors in, 380–384, 381f
 hypoxia effects, 388, 390
 materials in, 379–380
 metabolic waste accumulation considerations, 388–389
 oral mucosa, 387
 overview of, 376
 pH gradient analysis, 390
 scaffolds, 379–380, 380f, 389–391, 395
 skin, 387
 stem cell applications, 379
 summary of, 396
 thick tissues, 387–390
 3D scaffolds, 389–390
 tongue, 386–387
 Titanium implants, 53, 53f
 Tobacco
 chewing, 66, 67f
 cigarettes, 65–66
 components of, 65
 leukoplakia risks, 70
 oral cancer caused by, 65–67
 statistics regarding, 65t–66t
 Tocopherol, 32, 40
 Tongue
 articulation of, 114
 defects of
 reconstruction of, 94–95
 resection of, disability secondary to, 87–90, 88f–90f
 divisions of, 75
 edema of, 16, 45
 fibrotic changes in, 18
 flap reconstruction of, 77–78, 78f
 mandibular-based prosthesis, 117, 117f
 mastication role of, 106
 prosthetic outcome affected by mobility of, 134f
 reconstruction of
 bulk restoration through, 77–78, 78f, 90f
 free flaps for, 77–78, 78f, 90f, 93, 94f, 104, 104f, 113f
 importance of, 92
 mastication affected by, 106
 resection of
 anterior, 103
 disabilities secondary to, 87–90, 88f–90f, 93, 103
 lower lip affected by, 87
 saliva control affected by, 89
 speech affected by, 114
 squamous cell carcinoma treated with, 77–79, 78f
 speech production role of, 114, 215
 squamous cell carcinoma of. *See* Oral tongue squamous cell carcinoma.
 tissue engineering applications, 386–387
 Tongue biting, 16
 Tongue release, 102–103
 Tongue-positioning devices, 10, 11f
 Tonsillar defects, 91, 91f, 94–95
 Tonsillar squamous cell carcinoma, 83–85
 Tonsillectomy, 344
 Tooth eruption monitoring, in cleft lip and palate patients, 329, 329f
 Tooth extractions. *See* Extractions.
 Topical fluorides, 33, 33f
 Topoisomerase inhibitors, 426
 Total palatotomy, 198f, 199
 Tragus, 272, 272f
 Transalveolar resections, 162, 163f

Trauma. *See also* Maxillary defects, avulsive.
 mandibular defects caused by, 145–146
 osteoradionecrosis induced by, 37
 palatal defects caused by, 200

Treatment planning
 beam characteristics included in, 4
 craniofacial implants, 285–286
 description of, 8
 implants, 366–367

Tripolyphosphate, 386

Trismus
 after chemoradiation, 135
 description of, 17–18, 18f, 37, 45
 immediate surgical obturator affected by,
 169
 impression taking affected by, 179
 mandibular resection as cause of, 89–90
 maxillary obturator prosthesis affected
 by, 180
 removable partial denture design affected
 by, 191
 vertical dimension of occlusion
 considerations, 137

Two-stage palatoplasty, 323–324

U

Unicystic ameloblastoma, 86

Upper lip
 cleft of. *See* Cleft lip and palate.
 facial prosthesis considerations, 272f,
 272–273, 293, 293f
 midfacial defects involving, 295, 295f

Urethane-lined silicone prostheses, 267

UV light absorber, 271

V

Value creation, 356–357

Van der Woude syndrome, 320f

Vascularized free flaps, 41

Velar eminence, 226–227

Velopharyngeal closure
 level of, 231
 muscles involved in, 227f
 patterns of, 218–219, 220f, 221–222, 229f,
 344
 physiology of, 226f
 sphincteric nature of, 230
 timing of, 224

Velopharyngeal deficiencies
 classification of, 218
 in cleft lip and palate patients, 330
 etiology of, 218

Velopharyngeal insufficiency
 circular closure pattern associated with,
 229
 description of, 17–18, 221

Velopharyngeal mechanism
 anatomy of, 218
 lateral pharyngeal walls, 230–231
 posterior pharyngeal wall, 228–230
 soft palate, 225–228
 considerations for, 218–219
 evaluation of, 220–225
 functioning of, 218, 233
 innervation of, 231–232
 magnetic resonance imaging evaluation
 of, 222
 nasal endoscopy evaluation of, 220–221,
 221f, 231

perceptual evaluation of, 225
 pressure-flow studies for evaluation of,
 222–225
 videofluoroscopy evaluation of, 220

Velopharyngeal orifice size, 223

Vertical dimension of occlusion, 45, 137, 180,
 217, 337, 339, 347

Vestibuloplasty, 102–103

Videofluoroscopy, 220

Vinca alkaloids, 426, 427t

Virtual reality, 369–372, 371f

Vitamin A, 72

Voiceless consonants, 217, 217t

Volume effect, 20

von Langenbeck technique, 323

Vowels, 216–217

Vulcanization, 263–264

W

Waldeyer ring, 156

Wax pattern, 367, 368f

Weber-Fergusson incision, 160, 160f, 169

X

Xerostomia
 chemotherapy-induced, 432
 radiation-induced, 33–34

X-rays, 2

Z

Zurich approach, 323–324

Zygoma implants, 184, 185f, 341, 341f