CLINICAL REVIEW of ORAL and MAXILLOFACIAL SURGERY

THIRD EDITION

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Dedication

This book is dedicated to my loving family Jana, Shaheen, Bijan, Lilianna, Parviz, Ladan, Homayoun, and all the students of oral and maxillofacial surgery across the world.

Shahrokh C. Bagheri

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Academic surgery has seen further separation from private practice oral and maxillofacial surgery. It is essential that all practitioners, young and old, recognize the dedication of academic surgeons to our profession. On a personal note, I would like to thank the several surgeons who have impacted my personal growth surgically and academically. It is through the coalescence of our mentors teachings and that we formulate our own personal style and point of reference. I would like to thank Dr. Eric J. Dierks (who has also authored the forward in this text), Dr. Roger A. Meyer, Dr. Bryce E. Potter, Dr. Robert A. Bays, Dr. Leon Assael, Dr R. Bryan Bell, and Dr. Sam E. Farish for their selfless dedication of my surgical career. I was also inspired, perhaps unknown to them, by my children Shaheen Bagheri (who assisted on several illustrations and logistics of this project), Bijan Bagheri (who has help me at work on many occasions) and my daughter Lilianna Bagheri who was miraculously born in 2024.

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Preface

It is remarkable how the specialty of oral and maxillofacial surgery has changed since the first edition of *Clinical Review of Oral and Maxillofacial Surgery* in 2007. Several changes and challenges have emerged in our specialty, all of which bear on our future. These ongoing concepts will shape the profession beyond the professional lifespan of individual surgeons. And for this reason, their impact may go unnoticed until it has perhaps positively or adversely influenced the landscape. This kind of evolution warrants thought and concern beyond one's own individual perspective.

Since 2007, we have seen changes in our scope of practice, challenges in the academic sector such as faculty shortage, innovation of new procedures, emerging diseases, the COVID-19 pandemic, the impact of politics and new laws, anesthesia guidelines and enhanced monitoring, private equity acquisitions, and stagnant insurance reimbursements. All of these further emphasize the importance of organized local and global oral and maxillofacial surgery groups and associations, which can help navigate this broad horizon. As one reflects on these changes, it is clearer than ever that we are all in the "same boat." Regardless of where we practice or what is the scope of our practice, we are all united by the commonality of our roots in oral and maxillofacial surgery.

We are unique and proud that we are the only known specialty that has to constantly adapt and maintain the earned position and respect of our specialty in three sectors, dentistry, medicine, and surgery. Among many factors, this is enhanced via the continued output of peer-reviewed literature and texts; a strong presence in private and academic hospital centers; and most important, by delivery of quality surgical care. In the United States, the recent acceptance of qualified oral and maxillofacial surgeons into fellowship in the American College of Surgeons has strengthened our bonds with our surgical colleagues in other specialties and gains well-deserved recognition and respect for our specialty among our medical colleagues.[1] This establishment of interprofessional collegiality bodes well for the future of oral and maxillofacial surgery.

A notable change and perhaps the elephant in the room is the weight of economic forces that has landed upon our profession. Stagnant and even decreasing insurance reimbursement, increasing cost of education, and the ever-increasing difficulties and challenges of working with insurance companies and governmental bureaucracies have changed the decision process, particularly of younger surgeons, toward their career choice.[2] Economic factors rather than professional patient care–driven decisions have started to play a larger role than ever before. This dichotomy has and will further adversely affect the decades-old achievements of the increased scope of practice in trauma, orthognathics, temporomandibular joint, cosmetics, oncologic surgery, and pediatric craniofacial care.[3] If unrealistically low compensation is continued by "managed care" governmental and private insurance plans, the ambitions of wide-scope surgery of our future generation may dwindle toward these more challenging and technically difficult but essential services. Such challenges are best addressed by a unified front from our professional bodies. It is also enhanced by inspiring younger surgeons about the professional fulfillment integral to providing comprehensive care for all our patients' needs in the oral and maxillofacial region. Oral and maxillofacial surgery, after all, is first and foremost a "calling" and a duty to serve the public, not a *business*.

Despite the effects of any challenges, it remains very clear that the services of oral and maxillofacial surgeons remain in heavy demand. As reflected in the highly diverse array of diseases, injuries and other conditions, and procedures that are sampled as educational case presentations in this text, our profession will need to be ready and available to serve *all* the needs of our patients. As the world's population continues to age and with medical treatments and surgical procedures that prolong a useful life span even further, there will be a sustained and consistent increase in the need for the services of modern oral and maxillofacial surgeons.

After completing my formal surgical training in 2004, the need for a text to help prepare students and younger surgeons for training, examinations, and surgical care based on real patient scenarios was clear. The purposes of this third edition of *Clinical Review on Oral and Maxillofacial Surgery* are to **inspire**, **unite,** and **educate** the younger generation of surgeons. This oral and maxillofacial surgery textbook provides its readers with a systematic approach to the surgical management of patients with the most common presentations of congenital, development, traumatic, and pathological conditions seen in this specialty. Similar to the prior editions and contrary to traditional textbooks of surgery, we emphasize a *case-based* approach to learning that is suitable for readers of oral and maxillofacial surgery at all levels of training or practice. We have elected some of the most common as well as complex cases to illustrate the presentation, physical examination findings, and laboratory and imaging studies, along with an analysis of treatment options, complications, and discussion of other relevant information. Each chapter is more than a patient scenario but rather a carefully written *teaching case* that outlines essential and fundamental information pertinent to history and physical examination, laboratory and imaging studies, differential diagnosis, surgical management, and postoperative care of the condition as the present in the practice of oral and maxillofacial surgery.

It has been my experience that learning can be enhanced by incorporating teaching around real patient scenarios. In this manner, readers are actively engaged into the cases with the intent of raising the interest and therefore maximizing the retention of information presented. Traditional textbooks of surgery present the material in a fashion not directly related to a patient but rather list all the findings, pathophysiology, and treatment modalities. Although the intent of this book is not to replace a full-scope textbook of oral and maxillofacial surgery, it can serve as a powerful

learning tool for those interested in the field. It provides a rapid, concise, and easily comprehensible approach to disorders that readers can access as they encounter patients. Predoctoral students will benefit from the basic presentation of the disorders and treatment options. More advanced readers, such as residents in training and board candidates, will benefit from the more detailed material and will get accustomed to the style of patient presentation that is reflected in the clinical teaching of students, residents, and fellows in training, which is currently emphasized across the world in many certifying examinations.

We have continued to grow scientifically and have improved in many aspects that are reflected in this book. With better care, advancing technology, cooperation, and "finger touch" availability of information, we are better and stronger. It is my great honor to have been involved in this third edition with the help and contribution of extremely talented and dedicated surgeons who have volunteered their time to put together this material. It is with great excitement that we launch this edition and hope that it continues to inspire surgeons and improve the care of patients worldwide.

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Foreword

3rd edition, Clinical Review of Oral and Maxillofacial Surgery

"Live as if you were to die tomorrow. Learn as if you were to live forever."

— MAHATMA GANDHI

As the fellowship candidate from Georgia sat down for his interview, long before the COVID pandemic would forever remove the direct, in-person interview from our toolboxes, I could tell from his body language and demeanor that Shahrokh Bagheri was very comfortable within his own skin. Intracutaneous contentment is a laudable attribute regardless of the field of one's professional endeavor. It bespeaks a level of satisfaction without complacency with one's current skill set and fund of knowledge such that the individual is comfortable moving ahead to the next step in his or her professional evolution. This proved to be but one of Shahrokh's many attributes. Upon completion of his fellowship, it was apparent that Shahrokh Bagheri had considerably expanded his body of knowledge and depth of surgical experience. One would expect this of any successful fellow, but beyond this, Shahrokh had already begun an internal taxonomy of learning to guide his further acquisition of even more knowledge. He told me later that the concept of this textbook actually came to him during his fellowship while he was engaged in conversation with Deepak Kademani in the Legacy Emanuel Hospital library.

2023 marks the 20th anniversary of the commencement of Shahrokh Bagheri's fellowship in craniomaxillofacial trauma and cosmetic surgery under Bryce Potter, Bryan Bell, and me. Deepak was Shahrokh's running mate during the 2003 to 2004 academic year in our parallel fellowship in head and neck oncologic and reconstructive surgery. The cross pollination that occurred between these two during their shared fellowship year was as extensive as it was fruitful, and both are now the authors of major textbooks. Following his fellowship in Portland, Shahrokh returned to Atlanta, where he has blossomed into the widely recognized figure that he is today, both nationally and internationally. His teachings and writings reflect a clear sense of what is existentially important. It has been my privilege to accompany Shahrokh Bagheri on several international teaching events, and perhaps his polyglot upbringing is responsible for his knack of being equally relevant in Dubai as he would be in Dallas.

First published in 2007, *Clinical Review of Oral and Maxillofacial Surgery* is now in its third edition, and the reader-learners benefit from Shahrokh's assemblage of talent among his authors and section editors. Since its inception, the format of this text has emphasized the *clinical* pertinence of the subject matter. He and his authors link their discussions of diseases, tumors, injuries, and other conditions to the real people that the authors describe. For many learners, this connection of didactic material to a human being who is experiencing the effects of this condition is a critical step in the consolidation of knowledge. As you read this book, consider the authors' patients to be your patients and their disorders to be your challenges to accurately diagnose and skillfully treat. The third edition has expanded with 14 new chapters, including timely new material on the effects of marijuana and vaping as well as the opioid epidemic. Bob Marx has contributed two new chapters on drug-induced osteonecrosis.

It is a distinct pleasure to write this Foreword for the latest textbook of my former fellow, now colleague and friend, Shahrokh Bagheri. I am confident that this third edition will be welcomed by the worldwide community of oral and maxillofacial surgeons and by learners in related disciplines.

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Contents

Video Contents

1

Multilocular Radiolucent Lesion in the Pericoronal Region (Odontogenic Keratocyst)

CLAIRE MILLS and PIYUSHKUMAR P. PATEL

CC

A 20-year-old male is referred for evaluation of a swelling on his right mandible.

Odontogenic Keratocyst

Odontogenic keratocysts (OKCs) show a slight predilection for males and are predominantly found in individuals of Northern European descent. The peak incidence is seen between 11 and 40 years of age. Patients with larger lesions may present with pain secondary to infection of the cystic cavity. Smaller lesions are usually asymptomatic and are frequently diagnosed during routine radiographic examination.

The World Health Organization (WHO) defines OKCs as an odontogenic cyst characterized by a thin, regular lining of parakeratinized stratified squamous epithelium with palisading hyperchromatic basal cells. From 2005 to 2017, the WHO recommended use of the term *keratocystic odontogenic tumor* rather than *odontogenic keratocyst* based on the suspected neoplastic nature of the lesion, including its propensity for recurrence and common genetic chromosomal abnormality of the *PTCH* gene on chromosome 9q22.3-q31. However, in 2017, the WHO changed the classification back to OKC. The WHO determined that there was insufficient evidence to justify classification as a neoplasm because not all OKCs possess *PTCH* mutations, and the mutation is also found in other types of cysts, including dentigerous cysts.

HPI

The patient complains of a 2-month history of progressive, nonpainful swelling of his right posterior mandible. (Approximately 80% of OKCs occur in the mandible, most often in the posterior body and ramus region. OKCs account for □10%–20% of all oral cystic lesions.) The patient denies any history of pain in his right lower jaw, fever, purulence, or trismus. He does not report any neurosensory changes (which are generally not seen with OKCs).

MHX/PDHX/Medications/Allergies/SH/FH

Noncontributory. There is no family history of similar presentations.

Nevoid basal cell carcinoma syndrome (NBCCS), also known as Gorlin syndrome, is an autosomal dominant inherited condition with features that can include multiple basal cell carcinomas of the skin, multiple OKCs, intracranial calcifications, and rib and vertebral anomalies. Up to 5% of OKC cases occur as part of NBCCS. Many other anomalies have been reported with this syndrome (Box 1.1). The prevalence of NBCCS is estimated to be 1 in 31,000 to 1 in 164,000 persons.

Examination

Maxillofacial. The patient has slight lower right facial swelling isolated to the lateral border of the mandible and not involving the area below the inferior border. The mass is hard, nonfluctuant, and nontender to palpation. (Large cysts may rupture and leak keratin into the surrounding tissue, provoking an intense inflammatory reaction that causes pain and swelling.) There are no facial or trigeminal nerve deficits. (Paresthesia of the inferior alveolar nerve would be more indicative of a malignant process.) The intercanthal distance is 33 mm (normal), and there is no evidence of frontal bossing. His occipitofrontal circumference is normal (an intercanthal distance [the distance between the two medial canthi of the palpebral fissures] of greater than 36 mm is indicative of hypertelorism, and an occipitofrontal circumference greater than 55 cm is indicative of frontal bossing; both can be seen with NBCCS).

Neck. There are no palpable masses and no cervical or submandibular lymphadenopathy. Positive lymph nodes would be indicative of an infectious or a neoplastic process. A careful neck examination is paramount in the evaluation of any head and neck pathology.

Intraoral. Occlusion is stable and reproducible. The right mandibular third molar appears to be distoangularly impacted. (OKCs do not typically alter the occlusion.) The interincisal opening is within normal limits. There is buccal expansion of the right mandible, extending from the right mandibular first molar

• BOX 1.1 Diagnostic Criteria for Nevoid Basal Cell Carcinoma Syndrome

Diagnosis: The diagnosis of BCNS can be established based on:
1. One major criterion and genetic confirmation
2. Two major criteria
3. One major criterion and two minor criteria

Major Criteria
1. BCCs before age 20 years or multiple BCCs
2. OKCs before age 20 years
3. Palmar or plantar pitting
4. Lamellar calcification of the falx cerebri
5. Medulloblastoma (desmoplastic variant)
6. First-degree relative with BCNS

Minor Criteria
1. Rib anomalies
2. Macrocephaly
3. Cleft lip or palate
4. Ovarian or cardiac fibroma
5. Lymphomesenteric cysts
6. Ocular abnormalities (i.e., strabismus, hypertelorism congenital cataracts, glaucoma, coloboma)
7. Other specific skeletal malformations and radiological changes (i.e., vertebral anomalies, kyphoscoliosis, short fourth metacarpals, postaxial polydactyly)

Prevalence: 1 in 31,000–164,000
Incidence: 1 in 18,976 births

Genetic test: In 50%–70% of patients with a clinical diagnosis of BCNS, an underlying *PTCH1* mutation is found, and 64% of patients have an underlying *SUFU* mutation. In case of high clinical suspicion, postzygotic mosaicism can be ascertained by finding an identical mutation in at least two BCCs.

Genetics: An autosomal dominant inheritance with 50% chance of passing on the mutated gene to offspring

In 20%–40% of patients, the disorder is caused by a de novo mutation.

BCC, Basal cell carcinoma; *BCCS*, basal cell carcinoma syndrome; *BCN*, basal cell carcinoma; *OKC*, odontogenic keratocyst.
From Verkouteren BJA, Cosgun B, Reinders MGHC, et al: A guideline for the clinical management of basal cell naevus syndrome (Gorlin–Goltz syndrome), *Br J Dermatol* 186(2):215-226, 2022.

area posteriorly toward the ascending ramus. Resorption of bone may include the cortex at the inferior border of the mandible, but this is observed at a slower rate than in intermedullary bone, which is less dense. For this reason, OKCs characteristically extend anteroposteriorly rather than buccolingually. This pattern of expansion into less dense bone explains why maxillary OKCs show more buccal than palatal expansion and often expand into the maxillary sinus. There is no palpable thrill or audible bruit, both of which are seen with arteriovenous malformations (AVMs). The oral mucosa is normal in appearance with no signs of acute inflammatory processes.

Thorax-abdomen-extremity. The patient has no findings suggestive of NBCCS (e.g., pectus excavatum, rib abnormalities, palmar or plantar pitting, skin lesions; see Box 1.1).

Imaging

A panoramic radiograph is the initial screening examination of choice for patients presenting for evaluation of intraosseous mandibular pathology (10%–20% of OKCs are incidental radiographic findings). This provides an excellent overview of the bony architecture of the maxilla, mandible, and associated structures. Computed tomography (CT) scans can be obtained when large lesions are found. CT scans are valuable in that they provide additional information, such as the proximity of adjacent structures (e.g., the mandibular canal), the integrity of cortical plates, and the presence of perforations into adjacent soft tissues. CT scans provide accurate assessment of the size of the lesion and can demonstrate additional anatomic details (or lesions) that do not appear on panoramic radiographs.

A cone-beam computed tomography (CBCT) scan is appropriate for the evaluation of this lesion. Given its higher resolution, lower radiation dose (□20% of the radiation of a conventional [helical] CT), and lower cost, a CBCT can replace helical CT for evaluation and follow up of such a lesion. The CBCT scan can also be used to create a stereolithic model of the area of interest.

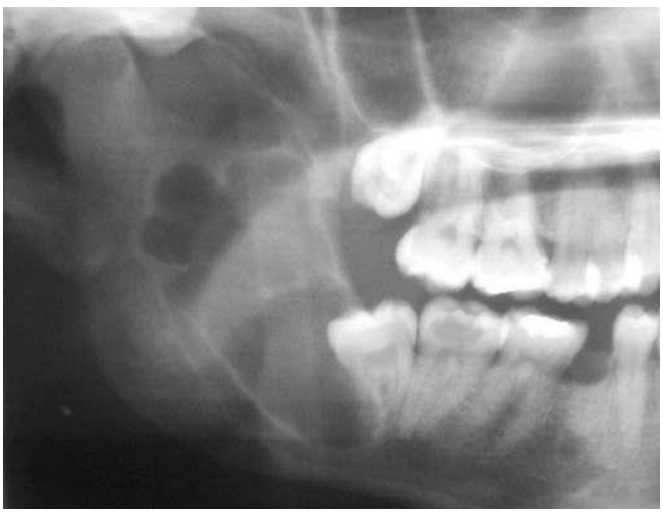
It has been demonstrated that T2-weighted magnetic resonance imaging (MRI) can detect OKCs in 85% of new cases with a readily recognizable pattern. Several studies have found that MRI signal intensity can be useful in distinguishing OKCs from ameloblastomas. However, the use of MRI for management of suspected OKCs is not routine and is mainly used as a complementary technique to CT in select cases to better visualize soft tissue involvement and internal cystic features.

In this patient, the panoramic radiograph reveals a large, well-demarcated, multilocular radiolucent lesion with a corticated margin and with possible displacement of the right mandibular third molar (Fig. 1.1). There are also several carious teeth and a retained root tip of the right mandibular second bicuspid (tooth #29). (In a patient with a radiolucent lesion of the mandible presumed to be an odontogenic cystic lesion, a multilocular appearance is associated with a 12-fold increased risk for the diagnosis of OKC; however, the majority of OKCs present as unilocular lesions [□70%].)

Labs

No laboratory tests are indicated unless dictated by the medical history.

Fine-needle aspiration (FNA) is a relatively noninvasive technique used in diagnosis of many masses but has not been used often for oral or jaw lesions because of diversity of lesion types and heterogeneity of cell populations. However, FNA biopsy and



• Fig. 1.1 Preoperative panoramic radiograph showing a large multilocular radiolucent lesion of the right mandible body and ramus associated with an impacted third molar.

cytokeratin-10 immunocytochemical staining have been shown to differentiate OKCs from dentigerous and other nonkeratinizing cysts. A study of FNA use in diagnosis of 72 oral and jaw cysts and neoplasms reported a 91.6% diagnostic accuracy rate for FNA with 1 false-positive and 6 false-negative cases. Despite their availability, these techniques are not routinely ordered because of difficulty accessing and aspirating lesions and limited experience.

Differential Diagnosis

The differential diagnosis of multilocular radiolucent lesions can be divided into lesions of cystic pathogenesis, neoplastic (benign or malignant) lesions, and vascular anomalies (least common). The differential diagnosis of multilocular radiolucent lesions is presented in Box 1.2 and can be further narrowed by the clinical presentation. Special consideration should be given to radiolucent lesions with poorly defined or ragged borders, which have a separate differential.

Biopsy

An incisional or excisional biopsy can be performed, depending on the size of the lesion. A smaller cystic lesion can be completely excised, whereas larger lesions require an incisional biopsy to

• BOX 1.2 Differential Diagnosis of Multilocular Radiolucent Lesions

- Ameloblastoma—The most frequent location is the posterior mandible, and the tumor's most common radiographic appearance is that of a multilocular radiolucent lesion. This is the most frequently diagnosed odontogenic tumor.
- Keratocystic odontogenic tumor (KCOT)—This lesion cannot be differentiated on clinical and radiographic grounds from an ameloblastoma. KCOTs generally do not cause resorption of adjacent teeth. The orthokeratin variant is usually associated with an impacted tooth.
- Dentigerous cyst—Large dentigerous cysts can have a multilocular appearance on radiographs, given the existence of bone trabeculae within the radiolucency. However, they are histologically a unilocular lesion. There is a strong association with impacted mandibular third molars. Painless bony expansion and resorption of adjacent teeth are uncommon but can occur.
- Ameloblastic fibroma—The posterior mandible is also the most common site for this lesion. It is predominantly seen in the younger population, and most lesions are diagnosed within the first 2 decades of life. Large tumors can cause bony expansion. The lesion can manifest as a unilocular or multilocular radiolucent lesion that is often associated with an impacted tooth. Ameloblastic fibro-odontomas are mixed radiopaque–radiolucent lesions.
- Central giant cell tumor—Approximately 70% of these lesions occur in the mandible, most commonly in the anterior region. The tumor's radiographic appearance can be unilocular or multilocular. These lesions can contain large vascular spaces that can lead to substantial intraoperative bleeding. The aneurysmal bone cyst has been suggested to be a variant of the central giant cell tumor. The majority of these lesions are discovered before the age of 30 years.
- Odontogenic myxoma—Although myxomas are seen in all age groups, the majority are discovered in patients who are 20 to 40 years of age. The posterior mandible is the most common location, and the tumor's radiographic appearance can be unilocular or multilocular. At times, the radiolucent defect may contain thin, wispy trabeculae of residual bone, given its "cobweb" or "soap bubble" trabecular pattern.
- Aneurysmal bone cyst—Lacking a true epithelial lining, these cysts most commonly occur in the long bones or the vertebral column. They rarely occur in the jaws, but when they do, it is mostly in young adults. They can present as a unilocular or multilocular radiolucent lesion with marked cortical expansion that usually displaces but does not resorb teeth.
- Traumatic bone cyst—This lesion lacks a true epithelial lining and frequently involves the mandibular molar and premolar region in young adults. These cysts can cause expansion and usually show a well-defined unilocular, scalloping radiolucency between the roots without resorption. The lesion always exists above the inferior alveolar canal.
- Calcifying epithelial odontogenic tumor (CEOT)—This is an uncommon tumor. The majority are found in the posterior mandible, mostly in patients aged 30 to 50 years. A multilocular radiolucent defect is seen more often than a unilocular radiolucency. Although the tumor may be entirely radiolucent, calcified structures of varying sizes and density are usually seen within the defect. CEOTs can also be associated with an impacted tooth.
- Lateral periodontal cyst (botryoid odontogenic cyst)—This is usually found in older individuals (fifth to seventh decades of life). The botryoid variant often shows a multilocular appearance. It is most commonly seen in the premolar canine areas.
- Calcifying odontogenic cyst—Most commonly found in the incisor canine region, this cyst is usually diagnosed in patients in the mid-30s. Although the unilocular presentation is most common, multilocular lesions have been reported. Radiopaque structures are usually present in approximately one-third to one-half of the lesions.
- Intraosseous mucoepidermoid carcinoma—This is the most common salivary gland tumor arising centrally within the jaws. Most commonly found in the mandible of middle-aged adults, the tumors can appear radiographically as unilocular or multilocular radiolucent lesions. Association with an impacted tooth has been reported.
- Hyperparathyroidism (brown tumor)—Parathyroid hormone (PTH) is normally produced by the parathyroid gland in response to decreased serum calcium levels. In primary hyperparathyroidism, uncontrolled production of PTH is caused by hyperplasia or carcinoma of the parathyroid glands. Secondary hyperparathyroidism develops in conditions of low serum calcium levels (e.g., renal disease), resulting in a feedback increase in PTH. Patients with hyperparathyroidism usually present with a classic triad of signs and symptoms, described as "stones, bones, and abdominal groans." Patients with primary hyperparathyroidism have a marked tendency to develop renal calculi ("stones"). "Bones" refers to the variety of osseous changes that are seen, including the brown tumor of hyperparathyroidism. These lesions can appear as unilocular or multilocular radiolucent lesions, most commonly affecting the mandible, clavicle, ribs, and pelvis. "Abdominal groans" refers to the tendency of these patients to develop duodenal ulcers and associated pain. When dealing with any giant cell lesions, the clinician must rule out the brown tumor of hyperparathyroidism by evaluating the patient's serum calcium level. (It is elevated in those with hyperparathyroidism.) Patients with brown tumor also have elevated levels of PTH (which is confirmed by radioimmunoassay of the circulating parathyroid levels).
- Cherubism—In this rare developmental inherited condition, painless bilateral expansion of the posterior mandible produces cherublike facies (plump-cheeked little angels depicted in Renaissance paintings). In addition, involvement of the orbital rims and floor produces the classic "eyes upturned toward heaven." Radiographically, the lesions are usually bilateral multilocular radiolucent lesions. Although rare, unilateral involvement has been reported.
- Intrabony vascular malformations—Arteriovenous malformations are most often detected in patients between 10 and 20 years of age and are more commonly found in the mandible. Mobility of teeth, bleeding from the gingival sulks, an audible bruit, or a palpable thrill should alert the clinician. The radiographic appearance is variable, but the malformation most commonly presents as a multilocular radiolucent lesion. The loculations may be small, giving the honeycomb appearance that produces a "soap bubble" radiographic appearance. Aspiration of all undiagnosed intrabony lesions is warranted to rule out the presence of this lesion because fatal hemorrhage can occur after an incisional biopsy.

guide final therapy. It is important to aspirate the lesion before incising into it (entering carefully through the cortical bone) to rule out a vascular lesion. The aspiration of bright red blood alerts the surgeon to the presence of a high-flow vascular lesion, such as an AVM, which could result in uncontrollable hemorrhage. In such a case, the procedure should be aborted to allow for further radiographic and angiographic studies to characterize the vasculature of the area. The aspiration of straw-colored (or clear) fluid is characteristic of a cystic lesion, and the absence of any aspirate may be seen with a solid mass (tumors).

Assessment

Expansile multilocular radiolucent mass of the posterior right mandible associated with an impacted right mandibular third molar (25%–40% of cases are associated with an unerupted tooth).

With this patient under intravenous anesthesia, an incisional biopsy was performed after aspiration of straw-colored fluid that showed the classic histopathology of the OKC. Histologic features include a thin squamous cell epithelial lining (five to eight cell layers thick). Because of the lack of rete ridges, the epithelial–connective tissue interface is flat. The epithelial surface is parakeratinized and often corrugated (wavy). The basal cell layer is hyperchromatic and composed of cuboidal cells, which show prominent palisading, giving a "tombstone" effect. The fibrous wall is usually thin and at times shows a mixed inflammatory response. Keratinization of the lumen is not a pathognomonic finding. The fibrous wall may contain epithelial islands that show central keratinization and cyst formation; these are known as *daughter-satellite cells.*

Treatment

Options that have been used to treat OKCs include the following:

- Decompression by marsupialization
- Marsupialization followed by enucleation (surgical decompression of the cyst followed by several months of daily irrigation with chlorhexidine via stents secured in the cystic cavity followed by cystectomy)
- Enucleation with curettage alone
- Enucleation followed by chemoablation or cryotherapy
- Enucleation with peripheral ostectomy
- Enucleation with peripheral ostectomy and chemoablation or cryotherapy
- En bloc resection or mandibular segmental resection

Resection is advocated only if there have been multiple recurrences after enucleation with an adjunctive procedure (e.g., cryotherapy, Carnoy's solution, or peripheral ostectomy) or for a large OKC exhibiting aggressive behavior, such as destruction of adjacent tissues. Several studies demonstrate that enucleation alone (when the diagnosis of OKC has been established) has a high recurrence rate (□28%); therefore, many surgeons advocate enucleation with a local adjunctive procedure, such as cryotherapy, Carnoy's solution, or peripheral ostectomy.

Some surgeons advocate the application of Carnoy's solution after enucleation and peripheral ostectomy with application of methylene blue. Carnoy's solution is composed of 1 g of ferric chloride dissolved in 6 mL of absolute alcohol, 3 mL of chloroform, and 1 mL of glacial acetic acid. Carnoy's solution penetrates the bone to a depth of 1.54 mm after a 5-minute application. It is difficult to obtain and needs to be mixed fresh. It does not fixate the inferior alveolar nerve, but some clinicians cover the nerve with sterile petrolatum as a caution. Synchronous bone grafting is not carried out with this technique. However, this solution is no longer recommended because of chloroform's carcinogenic potential. Instead of Carnoy's solution, some surgeons have used the non-chloroform containing modified Carnoy's solution with success. A recent study found that there were similar recurrence rates and distribution of time to recurrence in patients treated with adjuvant Carnoy's (13.9% recurrence) and modified Carnoy's (14.6% recurrence) solutions.

Cryotherapy with liquid nitrogen is also an acceptable alternative to the use of Carnoy's solution. Liquid nitrogen is sprayed within the cavity and penetrates to a depth of about 1.5 mm. Suggested protocols include spraying the cavity for 1 minute and then allowing the bone to thaw. This can be repeated two or three times.

Synchronous grafting with cancellous bone can be accomplished after cryotherapy. Patients should be cautioned because liquid nitrogen weakens the mandible, and this may result in a pathologic fracture. Sensory nerves within the field may show paresthesia; however, the majority recover within 3 to 6 months.

With both techniques, adjacent soft tissue needs to be protected. An alternate technique is used in cases of buccal or lingual plate perforation and with sinus involvement.

Topical 5-fluorouracil (5-FU) has also been suggested as an adjuvant treatment to reduce the risk of OKC recurrence. 5-FU is an antimetabolite of the pyrimidine synthesis pathway that has also been used topically to treat patients with basal cell carcinoma by inducing DNA damage that reduces cell proliferation. A systematic review including three studies of a total of 129 patients found that patients treated with adjuvant topical 5-FU in addition to enucleation and peripheral ostectomy had a recurrence rate of 0% compared with 25% in the group treated with enucleation and peripheral ostectomy alone and 19% to 66% treated with enucleation, peripheral ostectomy, and modified Carnoy's solution. These results are promising for the use of 5-FU and suggest a significant benefit of adjuvant 5-FU in OKC management, though should be followed up with larger scale studies.

Odontogenic keratocysts do not invade the epineurium; therefore, the inferior alveolar nerve can be separated and preserved. Furthermore, any perforations of the keratinized mucosa should be excised because they may contain additional epithelial rests, which can lead to recurrences. Aggressive soft tissue excision is not required because OKCs do not usually infiltrate adjacent structures. If the cyst is removed in one unit, there is no need for curettage unless the lining has been shredded or torn.

Some controversy exists regarding the optimal management (extraction vs retention) of teeth involved with an OKC. It is generally accepted that an OKC with a scalloped radiographic appearance should have the associated teeth removed because it is considered impossible to completely remove the thin-walled cystic lining. However, if the OKC is successfully removed in one unit, the teeth may be spared without compromising recurrence. In most instances, there is no need for endodontic therapy despite surgical denervation. The teeth may not become devitalized because of perfusion of the pulp via accessory canals through the periodontal ligaments.

This patient was treated under general anesthesia with enucleation of the lesion followed by the application of methylene blue to guide peripheral ostectomy. The patient was placed on a soft diet to reduce the risk of jaw fracture. The postoperative panoramic radiograph confirmed that the inferior border of the mandible remained intact.

The final pathology report confirmed the diagnosis of OKC consistent with the initial incisional biopsy specimen. The patient was placed on a strict recall schedule—every 6 months for the first 5 years and then yearly. The recurrence rate for OKCs has been reported to range from 5% to 60%. It has been reported that most recurrences are seen within 5 years, although they can develop at any time. Recurrences that arise secondary to residual cyst left in the bone may be apparent within 18 months of surgery.

Complications

Odontogenic keratocysts have been described as having clinical features that include potentially aggressive behavior and a high recurrence rate. Because recurrence is a major concern, clinicians vary in their surgical approach. Resection results in the lowest recurrence rate; however, considerable morbidity is associated with this radical treatment. The primary mechanisms for recurrence have been postulated to be incomplete removal of all the cystic lining, new primary cyst formation from additional activated rests, or the development of a new OKC in an adjacent area that is interpreted as a recurrence.

Odontogenic keratocysts have been reported to undergo transformation into ameloblastoma and squamous cell carcinoma (0.13%–3%), although this occurrence is rare. Other common postprocedural complications include inferior alveolar nerve paresthesia; postoperative infection; and with larger lesions, pathologic mandibular fracture. (The highest risk is during the first few weeks after enucleation.)

Discussion

Ever since the histologic features of the OKC were established, many investigators have recognized that two major variants exist based on microscopic findings: a cyst with a parakeratinized epithelial lining and a cyst with an orthokeratinized epithelial lining.

Crowley and colleagues (1992) undertook a comparison of the orthokeratin and parakeratinized variants. In their review, they found that the parakeratinized variant occurred more commonly than the orthokeratinized variant (frequency of 86.2% for the parakeratinized variant compared with 12.2% for the orthokeratinized variant); 1.6% of cysts had both orthokeratin and parakeratin features.

These researchers also found that the parakeratinized variant demonstrated a 42% recurrence rate compared with only 2.2% for the orthokeratinized variant. In addition, the orthokeratinized variant was more frequently associated with impacted teeth. Given the different clinical behaviors of these two entities, many authors designate them as separate pathologic lesions, with the orthokeratinized variant known as an *orthokeratinized odontogenic cyst*. A lesion with both orthokeratin and parakeratin features should be treated as a parakeratinized OKC.

Stimulation of residual epithelial cells is a common feature in the development of any cyst. In the case of the OKC, the most accepted theory of origin is from remnants of the dental lamina. There is also frequent association with mutation or inactivation of the *PTCH1* gene, which results in aberrant cell epithelial proliferation of the OKC. Collagenase activity in the cyst's epithelium, with its resorptive properties, appears to regulate the ability of the lesion to grow expansively in bone.

Identification of individuals who may have NBCCS allows the clinician to arrange appropriate referrals. NBCCS should be suspected when multiple lesions exist. The diagnosis is confirmed upon finding (1) one major criteria and genetic confirmation, (2) two of the major criteria, or (3) one major criterion plus two minor criteria (see Box 1.1). Some abnormalities are pertinent only to the diagnosis and do not require any specific therapy. Other abnormalities may pose further risk to the patient and require the input of other specialists. Patients with spina bifida or central nervous system tumors require referral to a neurosurgeon. In addition, genetic counseling for all patients with NBCCS is recommended. OKCs associated with this syndrome are treated in the same manner as an isolated OKC; however, these lesions have a higher rate of recurrence when associated with NBCCS (which may represent new lesions). OKCs are often associated with the follicle of a potentially functional tooth, so when possible, marsupialization with orthodontic guidance should be considered.

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2

Unilocular Radiolucent Lesion of the Mandible

SEPIDEH SABOOREE, MICHAEL R. MARKIEWICZ, JAMES C. MELVILLE, and KEVIN C. LEE

CC

A 68-year-old White male is referred for evaluation of "swelling of my right lower jaw."

Dentigerous Cyst

Dentigerous cysts, also known as *follicular cysts,* are typically associated with an impacted tooth, most commonly the mandibular third molar. It is more prevalent in White people, has a slight male predilection, and is usually seen in the age range of 10 to 30 years.

HPI

Approximately 2 months earlier, the patient noticed a nonpainful swelling of the right posterior mandible. (Dentigerous cysts can cause expansion but are typically not painful unless secondarily infected.) He was seen by the referring general dentist who had discovered a radiolucent lesion on a periapical radiograph. The patient denies any history of pain or sensory changes, drainage from the site, or trismus. He has not experienced any fevers, chills, night sweats, or unintentional weight loss.

PMHX/PDHX/Medications/Allergies/SH/FH

Noncontributory. There is no history of similar presentations in his family. (There is no familial predisposition.)

Examination

General. The patient is well-appearing but anxious (patients are often anxious because they fear a malignant process).

Maxillofacial. There is noticeable right lower facial swelling isolated to the lateral border of the mandible that does not extend below the inferior border. Consistent with a noninflammatory process, the mass is hard, nonfluctuant, and nontender to palpation. There are no facial or trigeminal nerve deficits. (Paresthesia of the right inferior alveolar nerve would raise the suspicion for an infiltrative or malignant process.)

Neck. The patient does not have cervical or submandibular lymphadenopathy. Lymphadenopathy would be indicative of an infectious or neoplastic etiology, so a careful neck examination is paramount in the evaluation of any head and neck pathology.

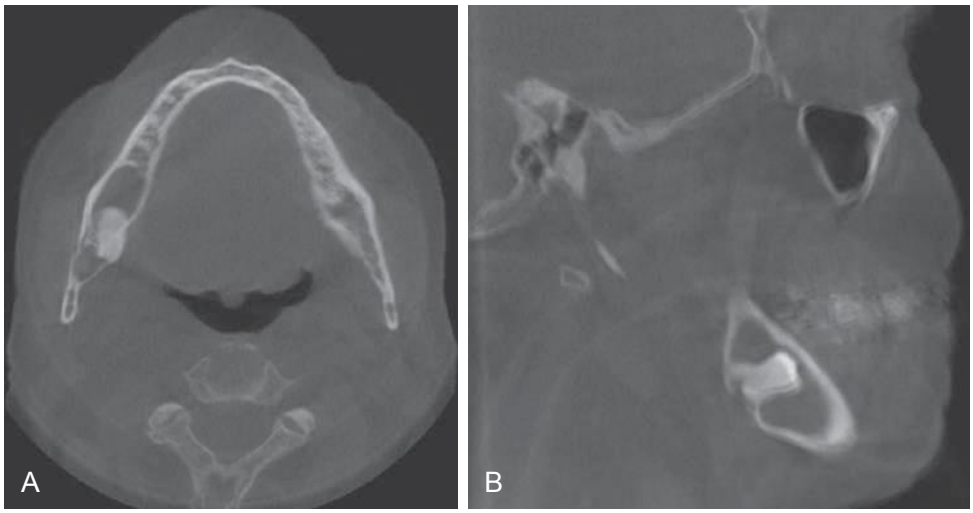
Intraoral. The occlusion is stable and reproducible. There does not appear to be displacement of the dentition in the involved area. (Dentigerous cysts do not typically alter the occlusion.) Interincisal opening is within normal limits. There is significant buccal expansion of the right mandible, extending posteriorly from the mental foramen and into the ascending ramus. (Large cysts may be associated with a painless expansion of the bone, but most are asymptomatic and do not cause expansion.) The patient does not have a palpable thrill or an audible bruit (both of which are signs of arteriovenous malformations). The oral mucosa is normal in appearance with no signs of any acute inflammatory processes.

Imaging

When evaluating intraosseous lesions of the mandible, the panoramic radiograph is an excellent initial study to assess the underlying bony and dental anatomy.

Dentigerous cysts are pericoronal lesions that attach to the cementoenamel junction of the associated tooth. However, large dentigerous cysts may radiographically encompass the roots of the impacted tooth; other pathologies may appear to be pericoronal radiolucencies on imaging. Therefore, imaging is a not a diagnostic tool for evaluation of lesions, and a histologic assessment is required for final diagnosis. When the pericoronal radiolucency of an impacted tooth is 3 mm or smaller, the tissue is deemed to be an enlarged dental follicle and can be discarded. However, when the pericoronal radiolucency of an impacted tooth is larger than 3 mm, cystic development should be considered, and tissue should be submitted for histological evaluation.

A computed tomography scan (Fig. 2.1) is not essential but helps delineate the three-dimensional extent and regional architecture, including involvement of the mandibular cortices (cortical perforation is seen with some tumors and locally aggressive cysts) and the lesion's proximity to the inferior alveolar canal.



• **Fig. 2.1** Cone-beam computed tomography demonstrating right unicystic radiolucency of posterior mandibular body without cortical perforation (A, axial view) and tooth #32 located within the lesion (B, sagittal view).

In this patient, a panoramic radiograph (Fig. 2.2A) demonstrates a well-corticated unilocular radiolucent lesion of the right posterior mandible extending from the area of tooth #31 up to the sigmoid notch and coronoid process. The right mandibular third molar (tooth #32) is displaced inferiorly, and the lesion involves the roots of tooth #31 with some resorption and superior displacement of the tooth. After aspiration and incisional biopsy, teeth #31 and #32 were extracted, and the cyst was enucleated (Fig. 2.2B–E). Six- and 16-week postoperative panoramic imaging demonstrate good progressive bony fill of the defect (Fig. 2.2F and G).

Labs

No laboratory tests are indicated unless dictated by the medical history. If a brown tumor of hyperparathyroidism is on the differential diagnosis, serum calcium, phosphate, and parathyroid hormone levels should be obtained. Brown tumors are sequalae of primary hyperparathyroidism, leading to bony lesions with abundant hemorrhage and hemosiderin deposition (giving it a brown color). Removal of the hyperplastic parathyroid tissue is the definitive treatment.

Differential Diagnosis

The differential diagnosis for a unilocular radiolucency includes odontogenic and non-odontogenic cysts, benign and malignant tumors, and (less commonly) vascular anomalies. In general, large radiolucencies with multiple septations should raise the suspicion for other more aggressive entities because most dentigerous cysts are small and unilocular. A recent study found that among pericoronal radiolucencies, lesion size 2 cm or larger was predictive of a nondentigerous cyst diagnosis on final pathology. The presence of loculations on presurgical imaging independently increases the risk for a nondentigerous cyst diagnosis by 12-fold. When considering possible diagnostic alternatives, the lesions presented in Box 2.1 should be considered with the first three being the most likely.

Biopsy

An incisional biopsy would be indicated to guide the final therapy for this lesion. This can be done under local anesthesia, intravenous (IV) sedation, or general anesthesia depending on surgeon and patient preference. It is important to aspirate the bony cavity before perforating the cortex. Bright red blood indicates the presence of a high-flow vascular lesion that has the potential for uncontrollable hemorrhage. In such a case, the biopsy procedure should be aborted to allow for further imaging studies to characterize the vasculature of the area. Straw-colored fluid is suggestive of a cystic lesion, thick white content is suggestive of an odontogenic keratocyst, and the absence of a fluid aspirate may be seen with traumatic bone cysts or jaw neoplasms.

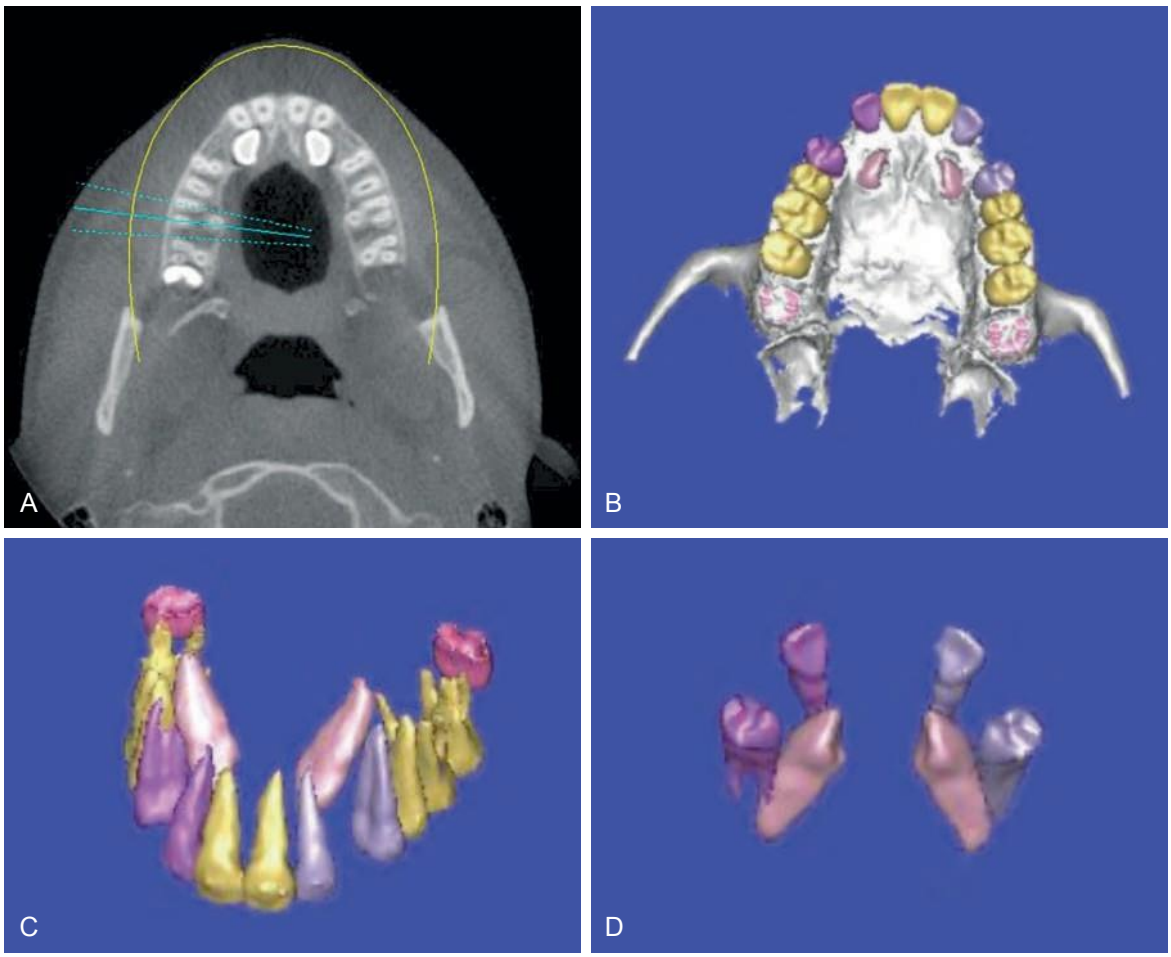
Assessment

Expansile radiolucent mass of the posterior mandible associated with impacted right mandibular second and third molars.

In this case, an incisional biopsy was performed under IV anesthesia after aspiration (straw-colored fluid), demonstrating classic dentigerous cyst histopathology (epithelial lining of nonkeratinized, stratified squamous epithelium and a loosely arranged fibrous connective tissue wall).

Treatment

Complete removal of the cyst by enucleation along with removal of the unerupted tooth is the preferred treatment for dentigerous cysts. If eruption of the involved tooth into a functional position is feasible (with or without orthodontic guidance), enucleation can be performed without extraction of the associated tooth. The inferior alveolar neurovascular bundle is commonly displaced by the cyst and should be preserved if possible. Large cysts may be treated with marsupialization when enucleation and curettage would likely result in neurosensory dysfunction or a pathologic fracture of the mandible. Postoperative maxillomandibular fixation may be prudent to permit remodeling of the bone before function.



• **Fig. 6.2** Axial view (A) and cone-beam computed tomography reconstruction (B–D) with different-colored masks assigned to the different anatomic structures in the field of view. Segmentation of the adjacent anatomy allows a better appreciation of the region of interest.

pathology (cysts, tumors, resorption of adjacent teeth), and relationship to adjacent structures (inferior alveolar nerve canal, sinus). CBCT software allows anatomic entities in the 3D image to be differentiated by assigning each a color (known as a *mask*). The masks can be turned off, allowing the clinician a better appreciation of the anatomy. This type of reconstruction can be time-consuming, but it can be referred to third-party companies.

Assessment

Impacted maxillary canines needing surgically assisted exposure and bracketing for orthodontic correction.

Treatment

The precise location of the maxillary canines was determined. No readily apparent resorption of the lateral incisors was noted. (It is possible to underestimate root resorption, owing to inadequate visualization secondary to the limitations of CBCT, such as selecting a large field of view [FOV], which diminishes the resolution of the image.) The 3D reconstruction served two important purposes. It allowed the surgeon to easily appreciate the anatomy, and it also provided a visual aid that enabled the patient to easily understand the anatomic configuration of her problem; this in turn facilitated discussion of the procedure and its risks and benefits with the patient and her parents. Subsequently, the impacted canines were exposed and bracketed without incident in a standard fashion. (See Chapter 28.)

Complications

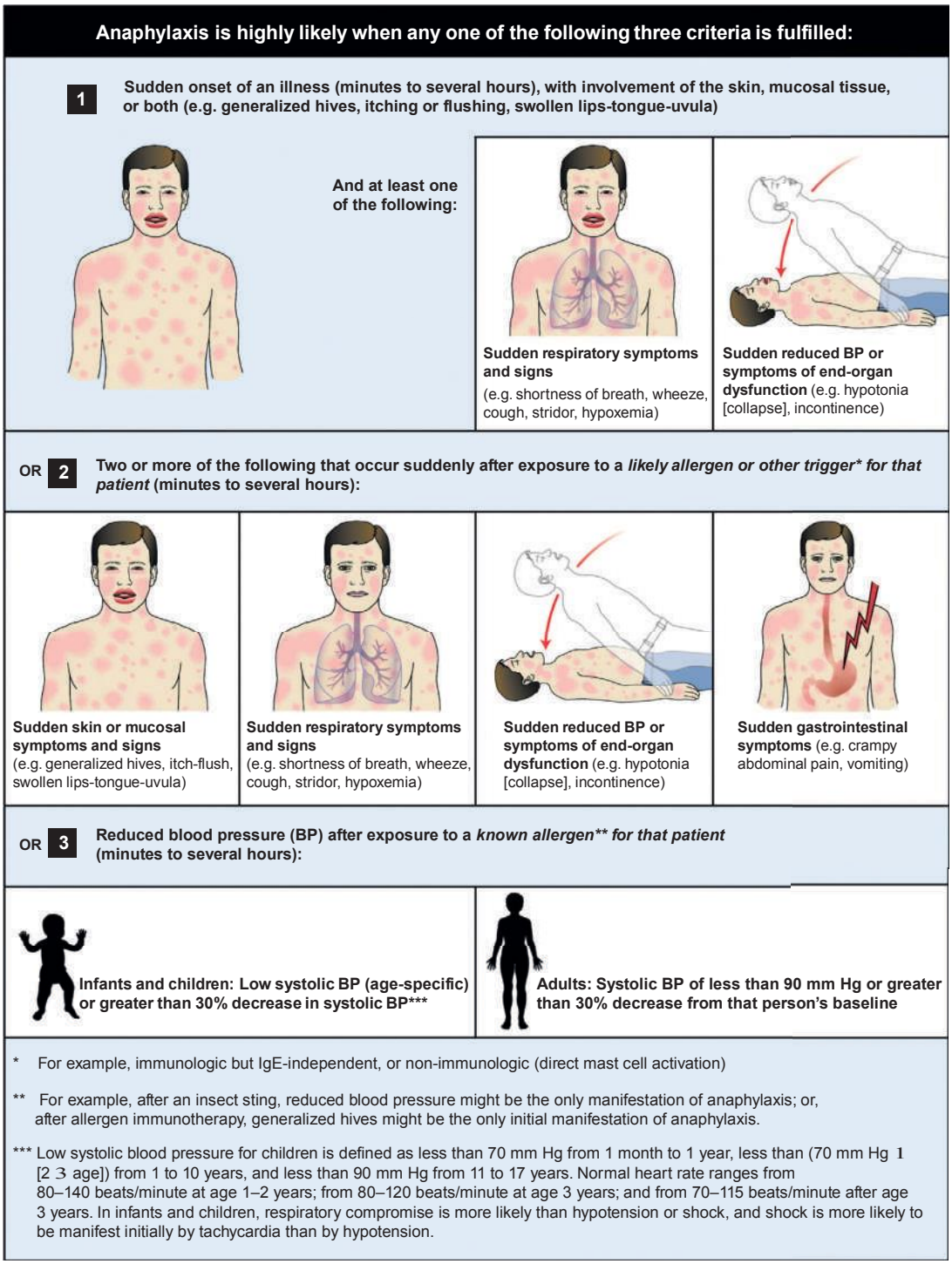
Clinicians must abide by the "as low as reasonably achievable" principle when ordering an imaging modality for a patient. Exposing the patient to the radiation must provide an image with a diagnostic value that is greater than the detriment the radiation exposure may cause. Not every patient requires CBCT because the technique does expose the patient to radiation and results in increased cost. The American Dental Association Council on Scientific Affairs suggests that CBCT use should be based on professional judgment, and clinicians must optimize technical factors, such as using the smallest FOV possible for diagnostic purposes and using appropriate personal protective shielding.

Although there was a sixfold increase in medical radiation exposure between 1980 and 2006 in the United States, radiation exposure per capita decreased 20% between 2006 and 2016. However, ionizing radiation is also found in the natural environment in the form of cosmic rays or radon, which contributes to

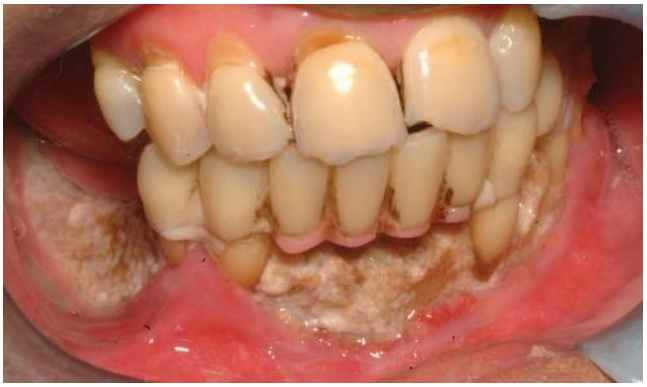
highly likely when any one of the criteria is met. It was acknowledged that no single set of criteria can provide 100% sensitivity and specificity, but it is believed that the WAO's proposed criteria are likely to capture more than 95% of cases of anaphylaxis. The majority of anaphylactic reactions include skin symptoms, which are noted in more than 80% of cases. Thus at least 80% of anaphylactic reactions should be identified by criterion 1, even when the allergic status of the patient and the potential cause of the reaction might be unknown. One significant change to the previous criteria is the presence of "severe" rather than "persistent" GI symptoms including abdominal cramping, pain, and repetitive vomiting.

Imaging

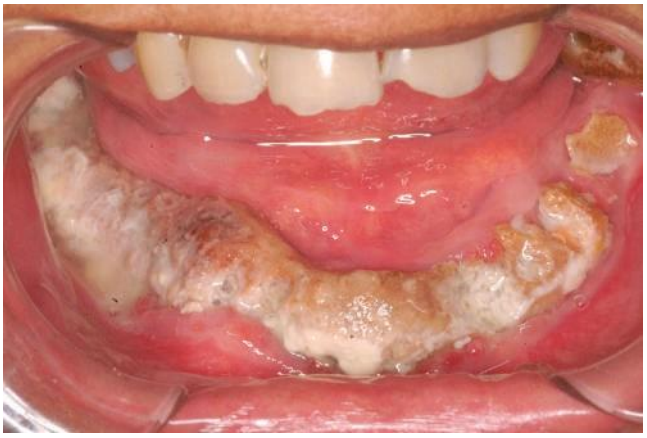
In the acute phase of anaphylaxis, no imaging studies are indicated. (Any unnecessary delay may compromise other lifesaving interventions.)



• **Fig. 7.1** A, Clinical criteria for the diagnosis of anaphylaxis.



• **Fig. 14.3** After this patient was switched from zoledronate to denosumab, the exposed bone rapidly became more extensive.



• **Fig. 14.4** The acceleration of drug–induced osteonecrosis of the jaws by denosumab caused exfoliation of her remaining mandibular teeth.

ago, exposed bone appeared in the anterior mandible (Fig. 14.1). With continued denosumab use, the exposed bone area extended to all of her remaining dentition (see Fig. 14.3). About 6 months ago, these teeth "were exfoliated," or "fell out," leaving her with the extensive alveolar bone exposure seen today (Fig. 14.4). She reports that in the past year, she has had several bouts of severe pain and swelling, one requiring a hospital admission for intravenous antibiotics.

PMHX/PDHX/Medications/Allergies/SH/FH

This patient's past medical history is significant for hypertension, osteoporosis, and insomnia. She currently takes amlodipine–benazepril, atenolol, and dapagliflozin for her hypertension and uses zolpidem for sleep each night. Her vital signs are stable with a blood pressure of 138/87 mm Hg. She is a never smoker and has a stated allergy to penicillin that she reports as "shortness of breath."

She is currently receiving lenalidomide, bortezomib, and prednisone for her multiple myeloma IGa type, which is at 2400 mg/dL (reference range, 60–400 mg/dL).

Examination

The oral examination today identifies exposed sockets and alveolar bone from the left second molar area to the right second molar area. The exposed bone is nonmobile but is tender to the touch. In the anterior area, a slight suppurative exudate came to be expressed. The maxilla is partially edentulous with moderate periodontal bone loss and 1**1** mobility of the remaining teeth.

Oral and Maxillofacial

Imaging

A cone-beam computed tomography scan shows osteolysis mainly focused on the intercortical bone area of the mandible (Fig. 14.5). There is no evidence of osteolysis to the inferior border or that of a pathologic fracture.

Labs

The accompanying laboratory results from the oncologist identifies a chronic anemia with hemoglobin of 9.7 g/dL and hematocrit of 29%, a white blood cell count of 8000 cells/mm^3, and myeloma proteins at 2400 mg/dL.

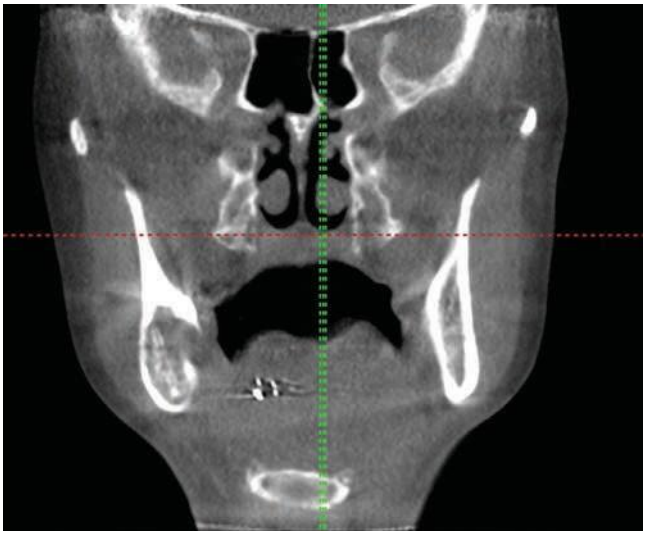
Assessment

This is a somewhat typical example of a severe and extensive DIONJ. The main causative agent in this case is denosumab, but both the previous treatment with zoledronate and the multiple myeloma itself contributed to its extensiveness.

It is now well-known that if a RANK ligand inhibitor follows a loading period of a bisphosphonate, rapid and extensive DIONJ results. Although denosumab is known to cause a more extensive DIONJ by itself, the downregulation of the osteoclast population by zoledronate contributed to the extensiveness seen here. Additionally, multiple myeloma is a malignancy of the bone marrow. Its very presence and pathophysiology also reduce the number of osteoclast precursors.

Treatment

The focus of treatment for the oral and maxillofacial surgeon is not necessarily to resolve the DIONJ but to support the oncologist's continuing treatment of the life-threatening malignancy. This, of course, requires a direct communication with the oncologists with



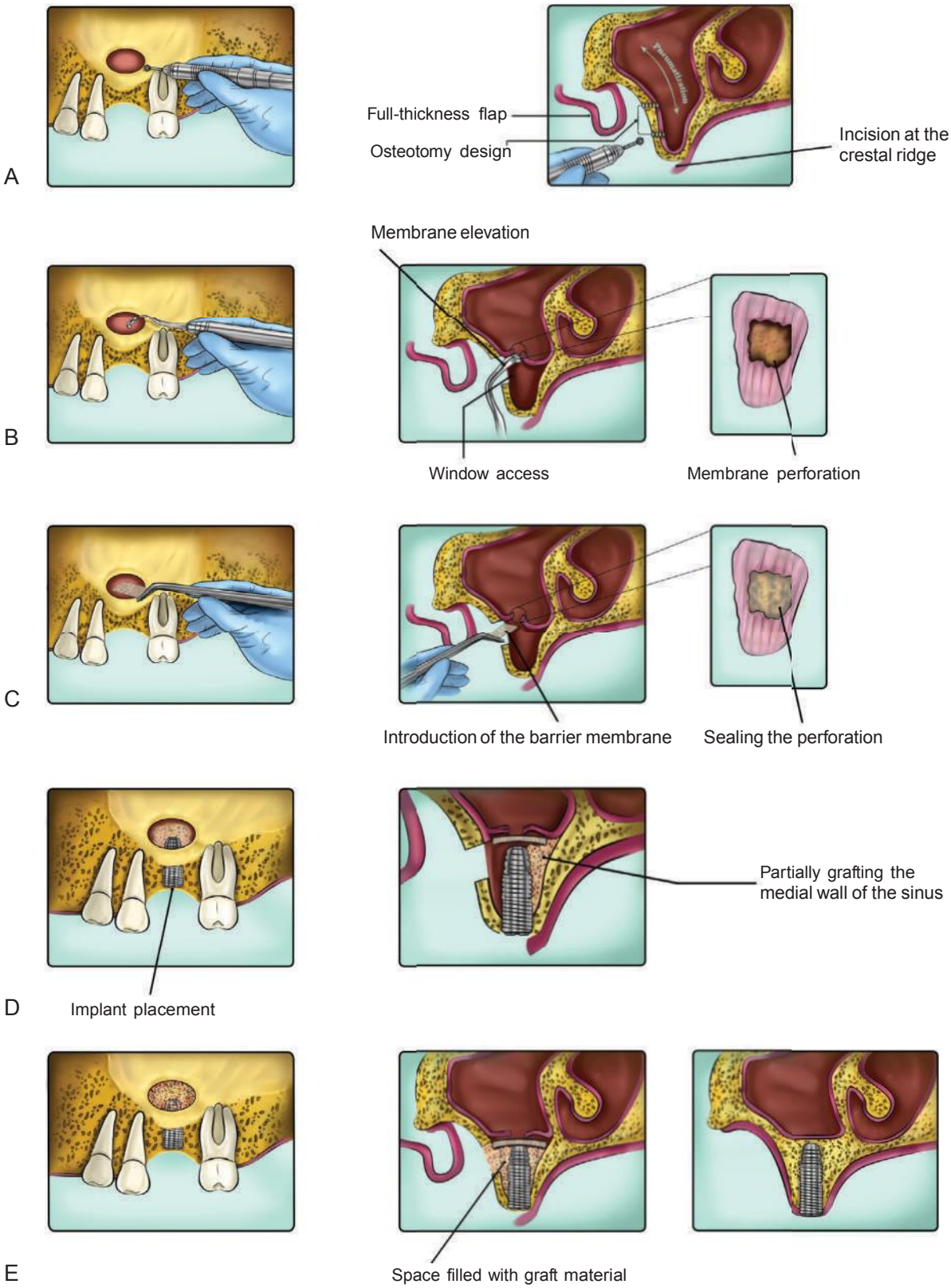
• **Fig. 14.5** Osteolysis within the marrow space in the mandible.

feeling as if glass is grinding into the face (Table 20.3). Patients may comment that attacks can be precipitated by various stimuli to the face. No neurologic deficits are present except when a secondary cause exists (e.g., tumor or MS). Pain is confined to the distribution of the trigeminal nerve and is almost always unilateral. It is estimated that in 5% to 8% of cases, TN is precipitated by trauma, most commonly an acute flexion–extension injury. The pain is more commonly located in the V3 ‒ V2 ‒ V1 nerve distribution. About 14% to 50% of patients also describe continuous pain in the same distribution. This pain may be described as dull, aching, or throbbing in nature, may last hours to days, and is less severe than the paroxysmal pain.

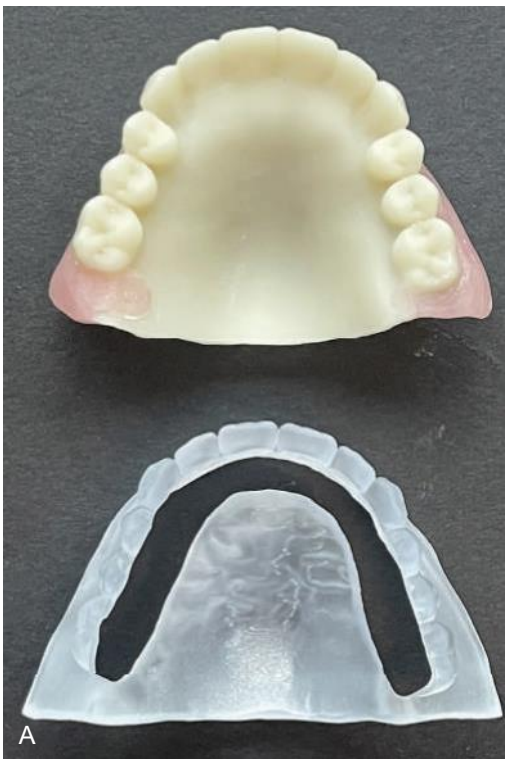
In deciding on the treatment options for a patient with TN, the clinician must take into account various clinical factors. The International Headache Society has classified TN into two categories: classic (idiopathic) and secondary (symptomatic). The two

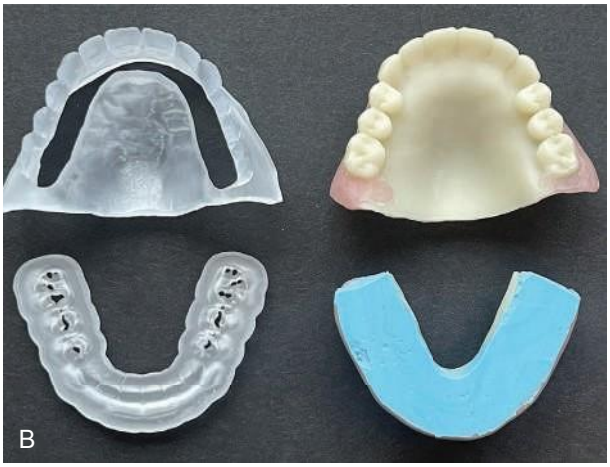
TABLE 20.3 Types of Facial Pain

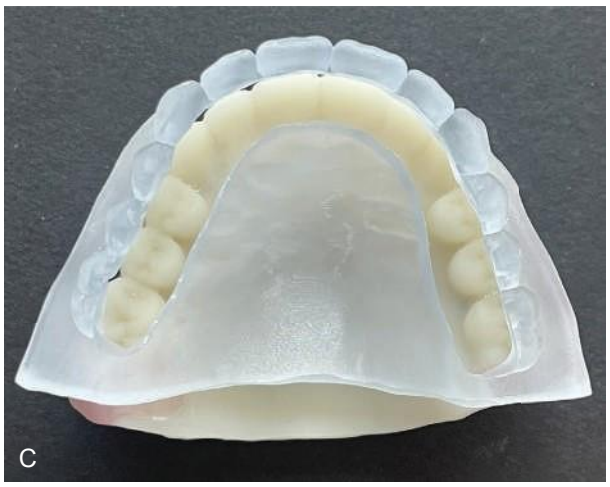
Diagnosis	Location	Quality	Intensity	Duration	Triggers	Other Characteristics
Trigeminal neuralgia	Second and third divisions of trigeminal nerve; unilateral Rarely, first division	Stabbing, sharp, shooting; electric shock–like	Severe	Seconds	Touching or washing the face, eating, chewing, smiling, talking, brushing teeth, shaving	No sensory or motor paralysis in idiopathic cases
Postherpetic neuralgia	Usually ophthalmic or maxillary branch of fifth cranial nerve; unilateral	Burning, tingling, shooting	Severe	Continuous	Touch, movement	Allodynia, hyperalgesia, altered sensation
Glossopharyngeal neuralgia	Ear, tonsils, neck, posterior tongue	Sharp, shooting, stabbing	Severe	Seconds	Swallowing, chewing, yawning, coughing, touch	Unilateral Rule out eagle syndrome because of similar pain associations
Atypical facial pain	One side of face, nasolabial fold or side, chin, jaw, neck; poorly localized	Aching, burning, often stabbing	Mild to severe	Constant		Depressive and anxiety states
TMD	Jaw, mandible, preauricular region, masticatory muscles	Dull, aching, throbbing, sharp, stabbing	Mild to moderate	Minutes to hours	Prolonged chewing, talking, opening wide	Clicking, crepitus, limited opening, deviation of mandible on opening, ear pain or fullness, tinnitus
Tolosa-Hunt syndrome	Mainly retro-orbital; unilateral	Aching	Severe	Constant		Ophthalmoplegia, sensory loss over forehead, ptosis
Carotidynia	Face, ear, jaws, teeth, upper neck; unilateral	Throbbing	Moderate	Constant	Compression of common carotid artery	Compression of common carotid at or below bifurcation reproduces pain in some
Temporal arteritis	Temporal region; unilateral or bilateral	Throbbing, dull, aching, tender	Moderate to severe	Constant	Pressure over temporal artery	Jaw claudication Usually seen in older adults Elevated ESR and CRP Temporal artery biopsy (4- to 6-cm segment) to confirm diagnosis
Alveolar osteitis (dry socket)	Affected bone	Sharp, aching, throbbing	Moderate to severe	Continuous 4–5 days postextraction	Open socket	Loss of clot, exposed bone, halitosis
Mucosal pathology	Affected mucosa	Sharp, burning, tingling	Mild to severe	Intermittent	Touch	Erosive or ulcerative lesions, redness
Pulpitis	Teeth	Intermittent, throbbing	Mild to severe	Minutes to hours	Mechanical, cold, heat, lying supine	Deep caries, extensive restoration
Maxillary sinusitis	Over affected sinus; unilateral or bilateral	Dull, aching	Mild to moderate	Constant	Touch, bending	History of URTI, nasal discharge, fullness over cheek with or without erythema over cheek



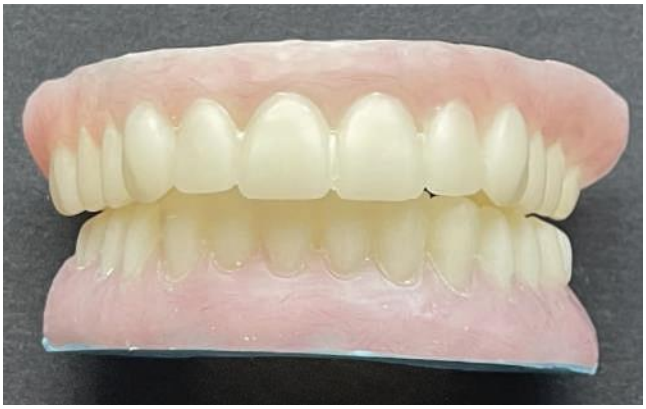
• **Fig. 34.1** A graphical abstract demonstrating the entire procedure. A, The design of the window outline and window osteotomy. B, Elevation of the Schneiderian membrane and the concurred membrane perforation. C, The introduction of the collagen membrane into the antral cavity to cover and seal the perforation. D, Partially grafting the medial wall of the antral cavity with simultaneous implant placement. E, Grafting the entire cavity after implant insertion, closure, and the healed view of the operative site.



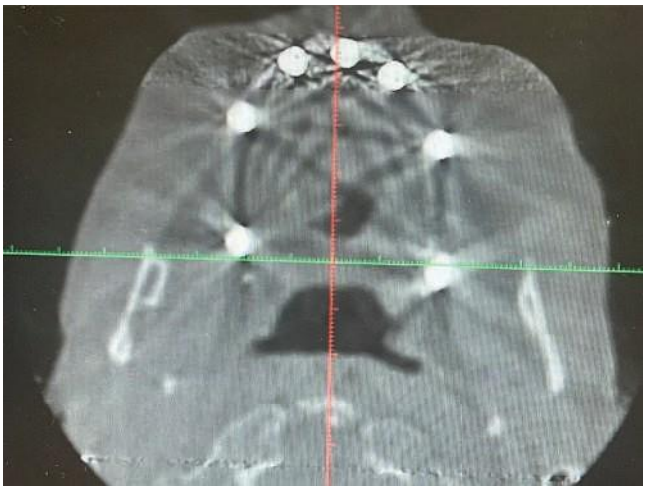




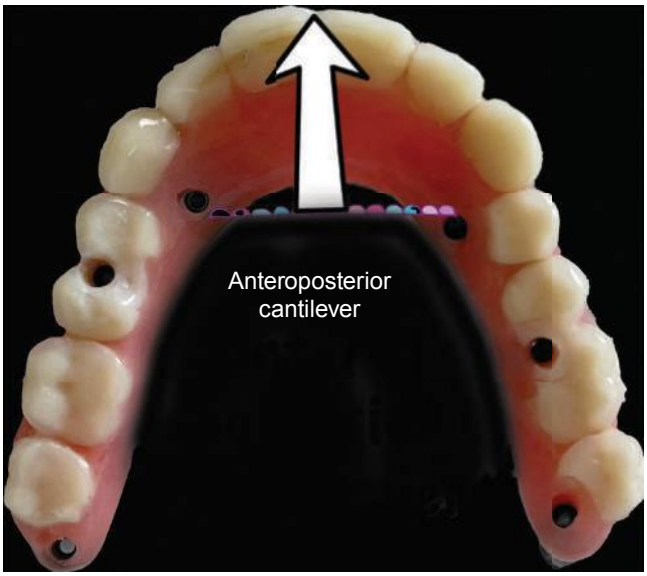
• **eFig. 35.14** Printed unrestricted surgical guide and maxillary denture to guide the surgeon during the implant placement, especially to keep the implants from being too lateral or too palatal.



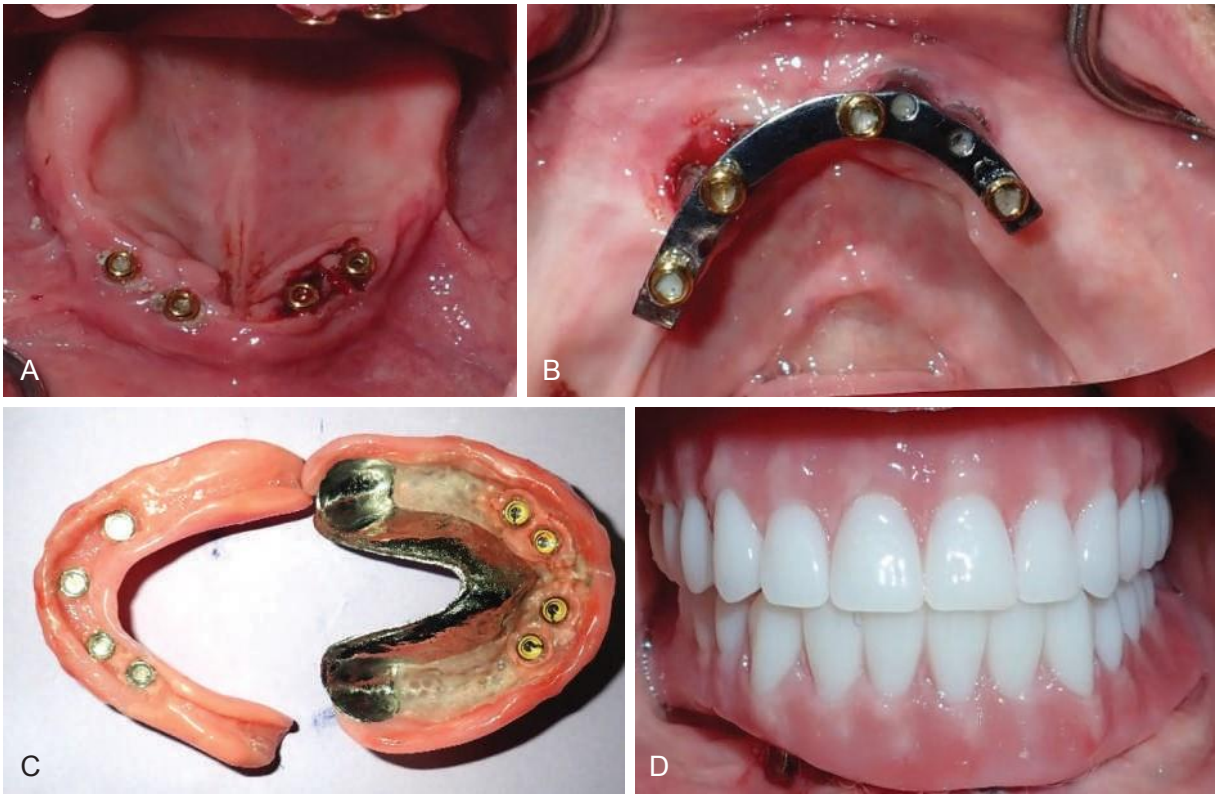
• **eFig. 35.15** Printed denture from the scanner and printer without the need for conventional impression from the mouth.



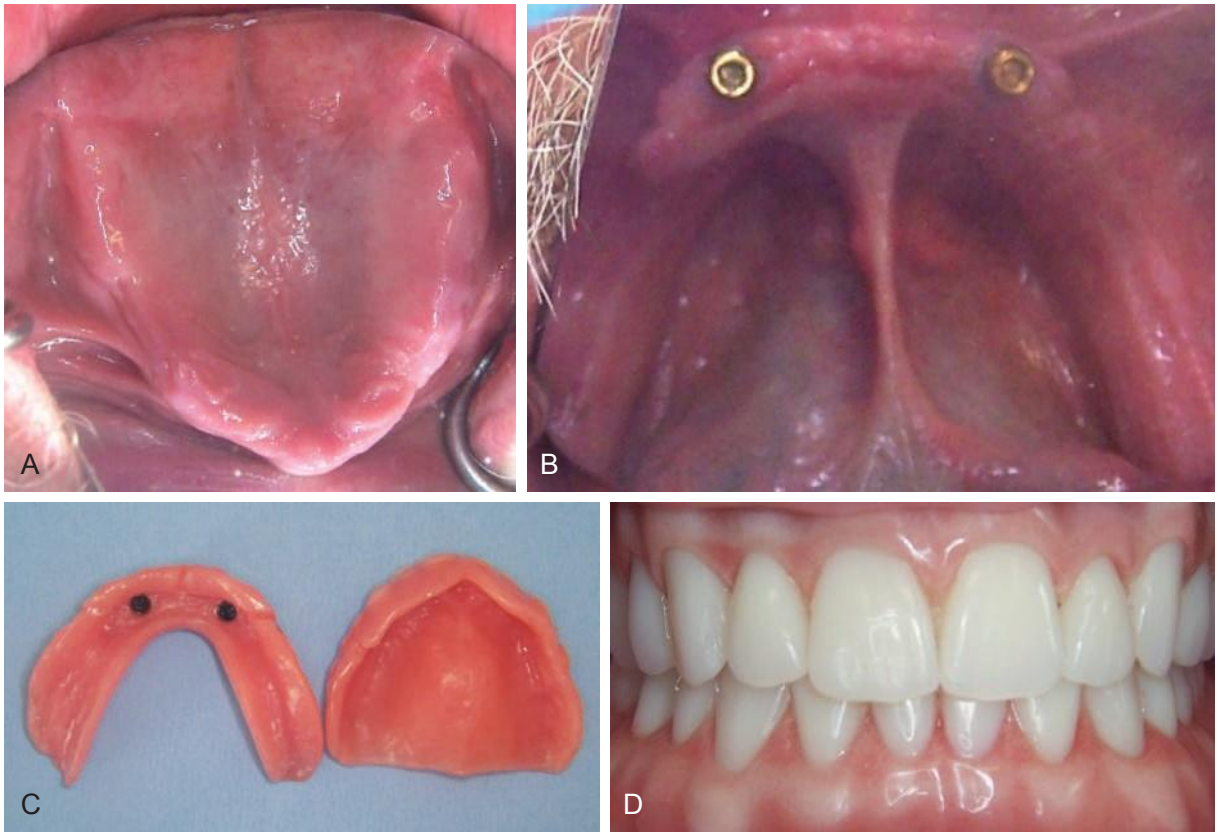
• **eFig. 35.17** Axial view of all seven implants on this atrophic maxilla. The implant in the midline is to avoid an anterior cantilever.



• **eFig. 35.20** Maxillary prosthesis showing a large anteroposterior cantilever that will create prosthetic failures and ultimately implant failures.



• **Figure 36.4** A, Postoperative maxilla. B, Postoperative mandibular bar. C and D, The final prosthesis.



• **Fig. 36.5** A–D, Conventional maxillary dentures and implant-retained mandibular denture.

39

Implants in the Esthetic Zone

EDWARD R. SCHLISSEL

CASE 1

CC

A 42-year-old female presents to the dental office complaining of a fractured maxillary incisor. She states that she suffered the injury in an automobile accident 2 days earlier and that she is not in pain.

Fracture of an anterior tooth in an otherwise intact dentition is a traumatic event for any person. In addition to acute pain and the possibility of infection, there are always concerns about cosmetic replacement and problems in the future. Immediate replacement with a provisional restoration and the fabrication of a final restoration that has an excellent long-term prognosis should be the goals of the dentist.

HPI

The maxillary left central incisor was fractured during an automobile accident. The patient was a passenger in the vehicle. She was drinking from a travel mug when the impact with the inflated airbag occurred. The tooth had endodontic treatment 3 years before the accident and was restored with a ceramic crown. A fiber-reinforced resin endodontic post had been placed.

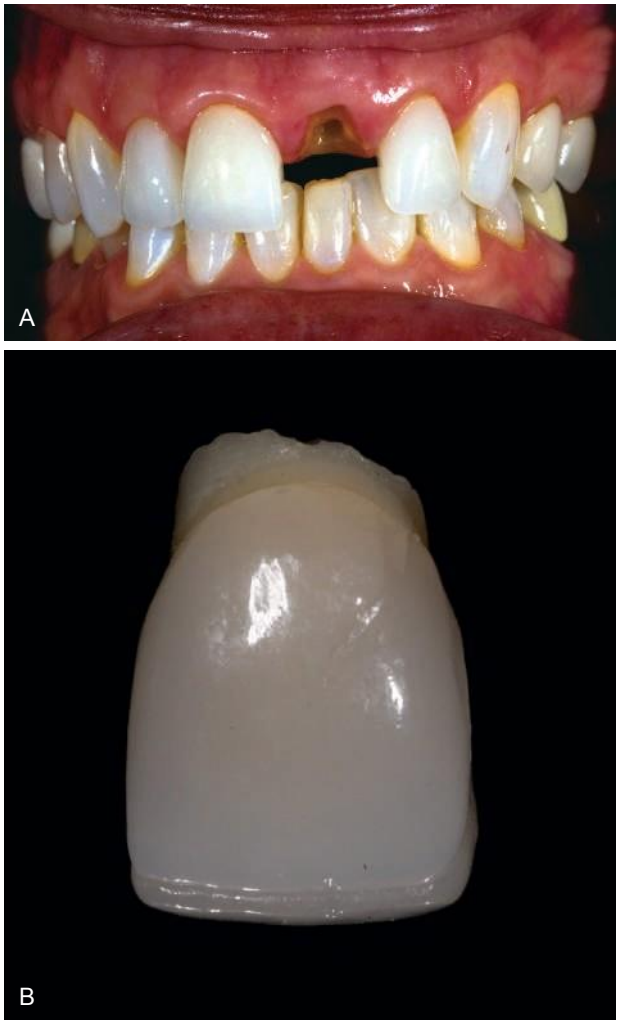
PMHX/PDHX/Medications/Allergies/SH/FH

The patient has an unremarkable medical history. She has no known allergies and takes no medications that would have an impact on her dental treatment. She has had regular dental care and has several restorations in the area of the injury, including full crowns and porcelain veneers.

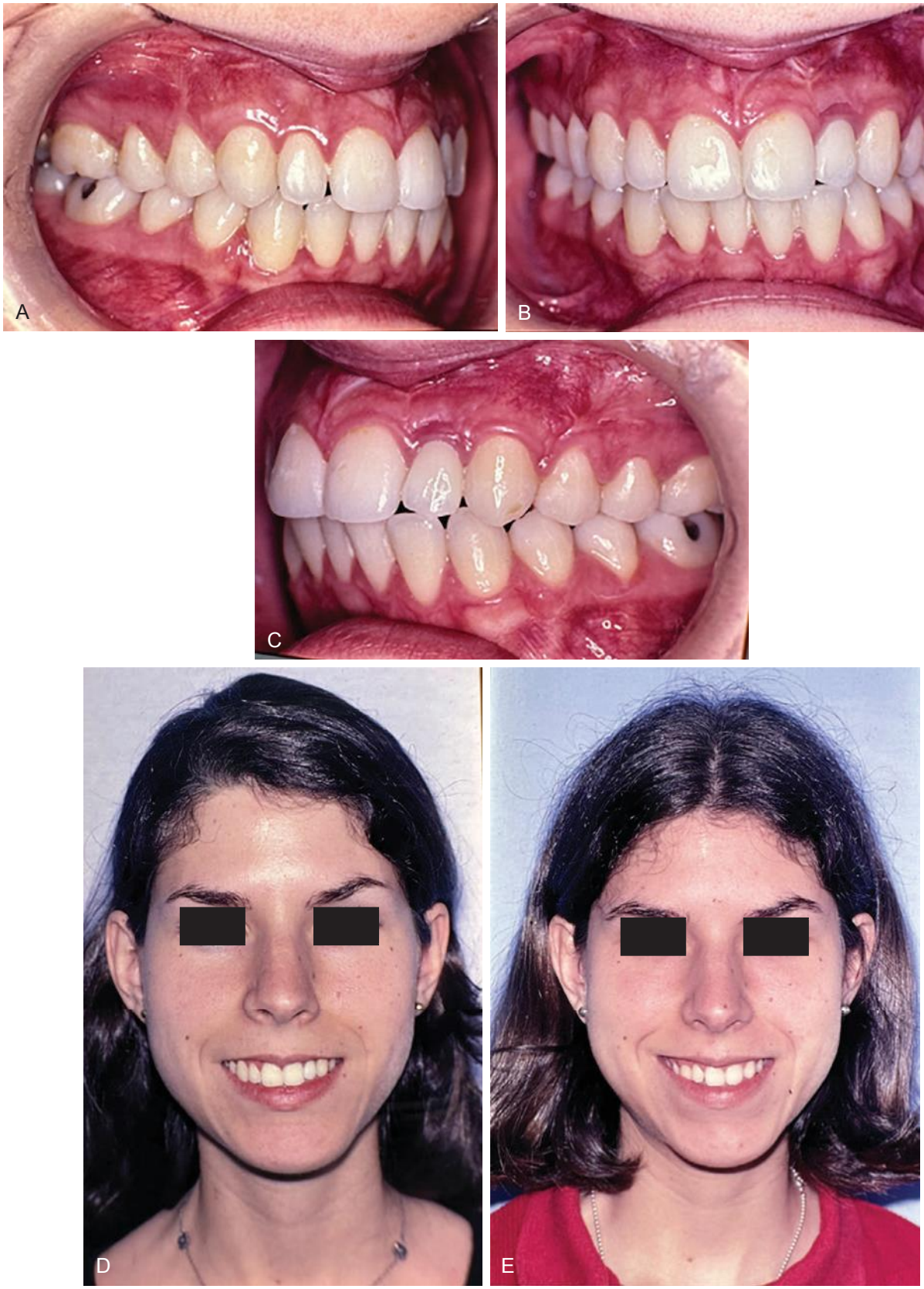
It is imperative to obtain a complete medical history when evaluating alternative treatment options for the replacement of a tooth. Systemic medications, including bisphosphonates and antineoplastic agents, and medical conditions such as uncontrolled diabetes are known to have deleterious effects on wound healing and bone metabolism, and may be contraindications to implant placement.

Examination

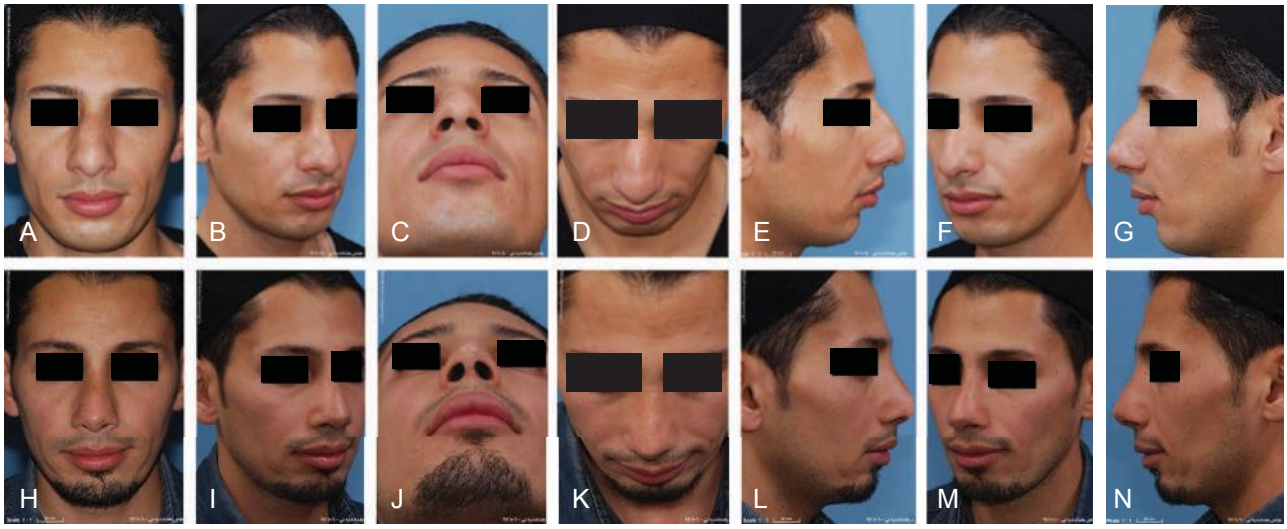
The left maxillary central incisor was fractured slightly above the level of the alveolar crest of bone and was out of the mouth (Fig. 39.1). The patient had no pain and had not taken any analgesic medications. She was upset about her injury and the prospects for replacement of the fractured tooth. There was no radiographic evidence of injury to adjacent teeth or bone. Intraoral and extraoral examination revealed no other injuries in either arch. There was no injury to the lips or other soft tissue. The anterior teeth were normal in appearance and showed neither discomfort on percussion nor abnormal mobility. Periodontal pocket depths were 3 mm or less, and there was no bleeding on



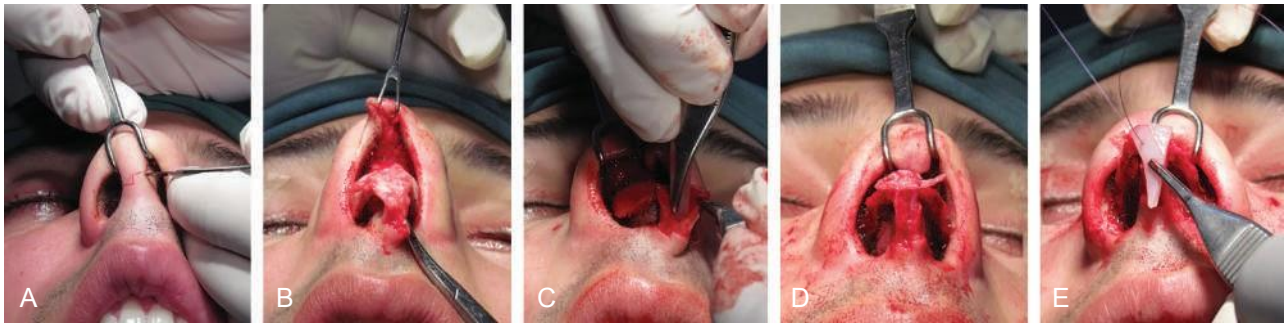
• **Fig. 39.1** A, Intraoral, retracted view of the fractured incisor. B, Fractured incisor, out of the mouth.



• **eFig. 63.10** A–G, Removal of braces and final crown fabrication and installment.



• **Fig. 85.4** A–G, Standard preoperative photo imaging. H–N, The same photos repeated postoperatively.



• **Fig. 85.5** A, Stair-step incision. B, Subperichondrial dissection. C, Strut placement. D, Cap graft. E, shield graft.

TABLE 85.1 Adverse Events Listed in the American Society of Plastic Surgeons' Consent for Rhinoplasty and the Associated Rate Range Found During This Systematic Review of the Literature

Adverse Event	Event Rate (%)
Nasal septal perforation	0–2.6
Infection	0–4
Bleeding	0–23.4
Nasal airway obstruction	0–23.7
Hypertrophic scarring	0.55–9.1
Delayed healing	—
Dehiscence	5
Skin discoloration	1.7–21.8
Firmness	2–2.5
Need for revision surgery	0–10.9
Numbness or paresthesia	4.0–49.1
Seroma	7.4
Fat necrosis	—

by cleaning, gentle pressure, and dressing in a small gauze. Continuous and serious bleeding is extremely rare, and the author has never encountered it in more than 5000 rhinoplasty surgeries. However, a rhinoplasty surgeon should be ready for rare possibilities.

Necrosis

Necrosis is a relatively rare but devastating complication in rhinoplasty. The best practice is to remember risk factors and plan the surgery based on those risk factors (Table 85.2).

Irregularities

Irregularities are the most common reason for revision rhinoplasty. Sharp edges of grafts are to be feathered or shaved. Intraoperative irregularities are best corrected by crushed cartilage grafts.

Cerebrospinal Fluid Leakage

Cerebrospinal fluid (CSF) leakage is an excessively rare rhinoplasty complication. Manipulation and damage to the cribriform plate during osteotomies or aggressive manipulation of the bony septum may lead to CSF leakage.

Clear rhinorrhea and positional headaches need special attention diagnosis and management.

To prevent CSF rhinorrhea, it is suggested not to extend osteotomies beyond the internal canthus and not to manipulate the bony septum aggressively during septoplasties.