Edited by
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IMPLANT THERAPY

Clinical Approaches and Evidence of Success

SECOND EDITION

QUINTESSENCE PUBLISHING

Implant Therapy: Clinical Approaches and Evidence of Success, Second Edition

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Clinical Approaches and Evidence of Success

SECOND EDITION

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Dedications

I dedicate this effort to my wife, Marcy. She has remained the wind beneath my wings, even when I was preoccupied with the editing process. She is my best friend and soulmate and encourages my commitment to education.

—Myron Nevins

I dedicate this book to my lovely family, my research collaborators, my friends, my former and current students, my chairs, and the University of Michigan for their continued support of my career. Without their sacrifices and support, this journey would be impossible.

—Hom-Lay Wang

Foreword

Oral implant therapy is recognized as one of the most significant innovations of dentistry in the 20th century. The reconstruction of edentulous or partially edentulous patients with osseointegrated dental implants has been revolutionary to improve esthetics, phonetics, and function for our patients. In this comprehensive book, Drs Myron Nevins and Hom-Lay Wang—leaders in regenerative and reconstructive dentistry—have assembled a text that will be a tremendous benefit to students, clinical scholars, and practicing clinicians alike. Given the strong adoption of dental implant therapy into clinical practice, it has become increasingly important for clinicians to have the proper guidance in both the identification of suitable patients and the clinical scenarios for the placement of dental implants for oral rehabilitation. No longer is it sufficient for a dental implant simply to survive: To be successful, implants must be placed optimally to provide the proper esthetics and function that last predictably over time. Thus, the appropriate training and treatment planning is critical to implant success to avoid biologic and/or technical complications that have increasingly plagued implant therapeutic outcomes over the years.

In this text, Drs Nevins and Wang have brought together chapters from leaders in implant dentistry. First, they work to improve the understanding about clinical decision making over the dilemma of tooth preservation versus extraction. However, if extraction of a hopeless tooth is required, how do we appropriately treatment plan? The plan must be designed for the good of the patient to facilitate the coordination of the team of surgeons, restorative dentists, and auxiliaries needed to deliver functional implant reconstructions for the lifetime of the patient. The first several chapters of the book focus significantly on treatment planning, including the use of 3D imaging and patient and implant-site risk assessment to determine the potential for implant installation and clinical success. If there are insufficient soft and hard tissues present, how does a surgeon augment deficient alveolar bone ridges for single or multi-implant placements? The book provides expert step-by-step guidance on local bone augmentation situations by region (anterior, posterior, mandibular, and maxillary areas) and the unique clinical challenges posed by each area. The cases and illustrations wonderfully depict the clinical scenarios and treatment protocols to emphasize the principles so well portrayed in the book. There are valuable chapters on managing the maxillary sinus or when insufficient vertical and/or lateral alveolar bone is available. Treatment alternatives using sinus floor augmentation, vertical bone augmentation, or the use of short dental implants play into these alternatives prepared by leaders in the field. The use of cutting edge therapies for hard and soft tissue reconstruction using tissue engineering methodologies (growth factor biologics, novel scaffolding technologies, or bone graft substitutes) have improved the repertoire of regenerative options for rehabilitation for the partially or fully edentulous patient.

Drs Nevins and Wang also bring together critical aspects in interdisciplinary clinical care in highly complex clinical situations, when tooth preservation is often coupled with implant therapy as well as with orthodontics and/or orthognathic surgery. Loading protocols for immediate- or delayed-implant placement are presented to consider the most appropriate applications of these treatment guidelines. How these reconstructions are planned, delivered, and maintained both provisionally and long-term are presented in fine detail.

With the long-term maintenance of dental implants, a key biologic complication following therapy is the initiation and progression of peri-implantitis. This difficult-to-manage clinical situation is addressed using a variety of approaches, ranging from nonsurgical care to resection, regenerative therapy, or implant removal and augmentation of the residual bony defect. Finally, specific protocols are presented for appropriate dental implant maintenance therapy in collaboration with restorative dentists, surgeons, and dental hygienists to promote the long-term preservation, stability, and clinical success of osseointegrated dental implants.

In summary, I anticipate that this text will be a valuable asset to the student and clinician who have the highest standards of clinical care. Please enjoy the book and implement the principles presented here for the optimal rehabilitation of the dental implant patient.

William V. Giannobile, DDS, MS, DMedSc

Preface

Every text is a reflection of its era. We saw the need in this era for an extraordinary textbook that would present to contemporary readers the long-term patient benefits of implant therapy. It was immediately evident that it would cover the scope from diagnosis and treatment planning through various treatment modalities and conclude with the maintenance of the result, because we are very mindful of the many complications in implant treatment that require thoughtful management. It was necessary for us to seek contributions from leaders and role models for each phase and modality. The response from contributors was positive, and the excellence of their chapters reveals their enthusiasm for the topic.

For many years, osseointegrated implants have demonstrated successful tooth replacement, much to the satisfaction of the dental profession. The initial research results emerging from P-I Brånemark and associates captured the attention of dentistry. It is worth noting that their research took place over a considerable period of time, without marketing a product until many unknowns were resolved. The dental community was intrigued with the scientific studies that were brought to their attention, and research and innovation continued.

The early emphasis was centered on the edentulous patient, but implant treatment is routinely used today as an alternative to fixed restorative dentistry. The periodontist or surgeon was a prisoner of the size and form of the jaw, but changes in treatment planning were initiated in 1989 with the first reports of simultaneous delivery of an implant into an extraction wound. Then came recovery of implant fenestrations or dehiscences with regenerative protocols as well as the development of guided tissue regeneration, which expanded the population of implant candidates with the regeneration of bone surface deformities. Reports of implant treatment in the maxillary and mandibular posterior regions surfaced as a result. Three-dimensional radiography provided information to help avoid or alter anatomical obstacles. Grafting of the floor of the maxillary sinus, bone augmentation, and eventually, vertical growth of bone all provided corrections that were previously thought impossible. To quote Sir Anthony Eden, "Every succeeding scientific discovery makes greater nonsense of oldtime conceptions of sovereignty."

All educational institutions include osseointegrated implants in their curricula. This is because of the overwhelming improvement in treatment demonstrated by the leaders of surgical innovation, and the prosthetic community has participated in a similar fashion to produce excellent results through implant treatment. Dentistry not only offers a remarkable base of evidence that supports many well-established concepts but also continues to push for intellectual advancements. We must continue our investigation of new therapies to improve dentistry. An old Chinese proverb states, "Learning without thought is deceptive; thought without learning is perilous."

Unfortunately, the challenge of peri-implantitis has threatened long-term implant survival. This has awakened the profession to the need for strict oversight with well-constructed maintenance programs to provide early diagnosis and appropriate correction. Our patients are not immune to biologic complications, with or without implants. The main issue today is the fundamental clinical question: Can we or should we preserve the remaining natural dentition, or do implants offer a more predictable prognosis?

This text addresses the challenge of decision making with specific solutions for each area of the dentition. It uses the evidence that is now available for both paths of treatment and directs the well-informed clinician toward resolution. We expect to affect the thinking process of the discriminating dentist who is willing to invest time in the decision-making process to arrive at the optimal result for the patient's benefit.

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1

MYRON NEVINS • RICHARD HERMAN • YOSHI ONO

A Clinical Decision: Save the Tooth or Place an Implant?

Treatment Planning Considerations

Treating Periodontally Compromised Teeth

The Endodontic Treatment Option

Treating Patients with Sound Periodontium and a Localized Problem

Periodontal Regeneration

Decision Making for Saving the Natural Dentition

Esthetic Considerations

The contemporary hallmark of a superior clinician is the ability to select therapies that are predictable and have long-lasting results. The question of whether to save a tooth or replace it with a dental implant is multifaceted, and the assessment requires a multidisciplinary approach to dental care. Giannobile and Lang have reported a trend over the past two decades toward a reduced emphasis in clinical practice to save compromised teeth.[1] They suggest that clinicians should revisit the long and successful history of tooth maintenance, preserving the natural dentition without the rush to extract teeth and replace them with implants. Dental practitioners do a disservice to their patients and themselves when they fail to carefully weigh the advantages and disadvantages of such options in providing optimal oral health care delivery to patients.

TREATMENT PLANNING CONSIDERATIONS

Decisions made in treatment planning often determine the value of the result for the patient. Contemporary dentistry has benefited from the predictability of osseointegration,[2–10] periodontal regeneration,[11–29] successful endodontics,[30] and prosthodontics, four compelling areas in which the clinician must be knowledgeable in order to make an informed decision regarding when to save the tooth or place an implant.

Nearly every patient asks the same questions during consultations. They are the following:

- How much discomfort will I endure?
- How many visits will be required?
- What will be the total treatment time?
- How will this affect my appearance?
- What is the financial commitment?
- What is the expected longevity of the treatment outcome?

There is minimal information available in evidence-based dentistry to assist in making many clinical decisions because of the number of variables that challenge the recruitment of populations for randomized controlled trials. As a result, when considering the prospect of replacing a maxillary first premolar with two roots, for example, clinicians eventually resort to their own clinical experience or case report publications. Considerations that must be made include the following:

- What is the distance from the apex of the tooth to an anatomical obstacle, and will it be necessary to augment the bone in the floor of the sinus (Figs 1-1a and 1-1b)?
- What is the position of the roots of the tooth relative to each other and to the neighboring teeth?
- Is the tooth vital, and how intact is the tooth structure and the occlusal level of bone (Figs 1-1c and 1-1d)?
- What type of lip line and dental display does the patient have, and how will it affect the esthetics?
- Could the tooth be treated endodontically? (A 2009 report by Morris et al[31] concluded that implants require more postoperative treatment than endodontically treated teeth, possibly a result of contemporary advancements. In addition, many endodontic complications, with the exception of fractured teeth, are resolvable.)

Implant patients fall into two general categories. The first includes individuals with teeth that are congenitally missing or damaged by trauma or root resorption (Fig 1-2). The second group has demonstrated susceptibility to inflammation that is evidenced by radiographic bone loss (Fig 1-3). Those in the first category require only tooth structure correction or replacement, whereas the second group presents the additional challenge of preventing or minimizing recurrent inflammation. The primary factor dictating decision making becomes the length of the clinical root, ie, that portion of the tooth that resides in the alveolar process (see Figs 1-1c and 1-1d). With a susceptible patient, it is advisable to eliminate the periodontal disease and provide a carefully constructed periodic maintenance program to reduce the risk of active inflammatory disease.[32] The therapeutic result has to provide an environment that the patient and dental hygienist can maintain (see Fig 1-3).

It is of paramount importance to recognize at the outset that it is possible, and in some instances preferable, to use the time-honored therapeutic approaches of conventional restorative dentistry. Although there is a lack of controlled studies in the discipline of periodontal prostheses, there is a paucity of significant randomized controlled human studies to support the clinical application of many periodontal and prosthetic approaches. There is, however, overwhelmingly positive clinical evidence gathered through the observation of treated patients to be considered. Periodontally compromised patients with mobile, drifting, or missing teeth have been successfully rehabilitated with or without implants (Figs 1-3 to 1-5). Such patients require a treatment plan that provides predictability over an extended time frame.

In patients with few missing teeth or those with obvious periodontal disease, total extraction of the dentition and replacement with implants is frequently unnecessary (Figs 1-6 and 1-7). There are many examples of positive long-term results with maintenance of the dentition, while at the same time there are increasing complications with implants. It is unfortunate that the dental profession frequently is unaware of the positive results of traditional periodontal, endodontic, and prosthetic care.[10,33,34]

Fig 1-1 *(a and b)* It is impossible to have just one protocol for a maxillary first premolar. There is ample bone on the left side to accept an osseointegrated implant; however, if the maxillary first premolar were extracted on the right side it probably would be necessary to augment bone to receive an implant. *(c and d)* Cadaver material demonstrating the difference in bone levels between a patient with a healthy dentition and a patient who is severely compromised periodontally. The prime dictating factor relates to the length of the clinical root rather than the length of the anatomical root.

Fig 1-2 *(a to c)* A young woman with root resorption on the distal surface of the right central incisor. An esthetic dental display is very important to the patient. *(d to f)* The clinical and radiographic postoperative result after replacing the damaged tooth with an osseointegrated implant.

Fig 1-3 *(a)* The patient presented for a periodontal regeneration procedure. The radiographic examination demonstrated intrabony defects that were not contained, therefore eliminating the possibility of periodontal regeneration. The two premolars were removed, the alveolar process underwent reconstruction, and two dental implants were placed. *(b)* A 3-year posttreatment radiograph illustrates significant recovery and no evidence of bone loss. *(c)* The bone-implant contact remains steady after 14 years. This demonstrates that patients susceptible to disease can accept osseointegrated implants successfully.

Fig 1-4 *(a)* The patient presented with generalized advanced periodontitis. *(b)* A radiographic survey 1 year after the placement of many dental implants. *Red circles* indicate post and core risk. *(c and d)* Radiographic and clinical observation after 7 years. The maxillary left canine suffered a vertical root fracture and was replaced by a third 18-mm implant. The molar was removed and replaced with a cantilever. *(e and f)* Clinical presentation after 17 years. *(g)* A radiographic survey after 25 years. Once again, this demonstrates that people susceptible to periodontal disease can be treated successfully with osseointegrated implants.

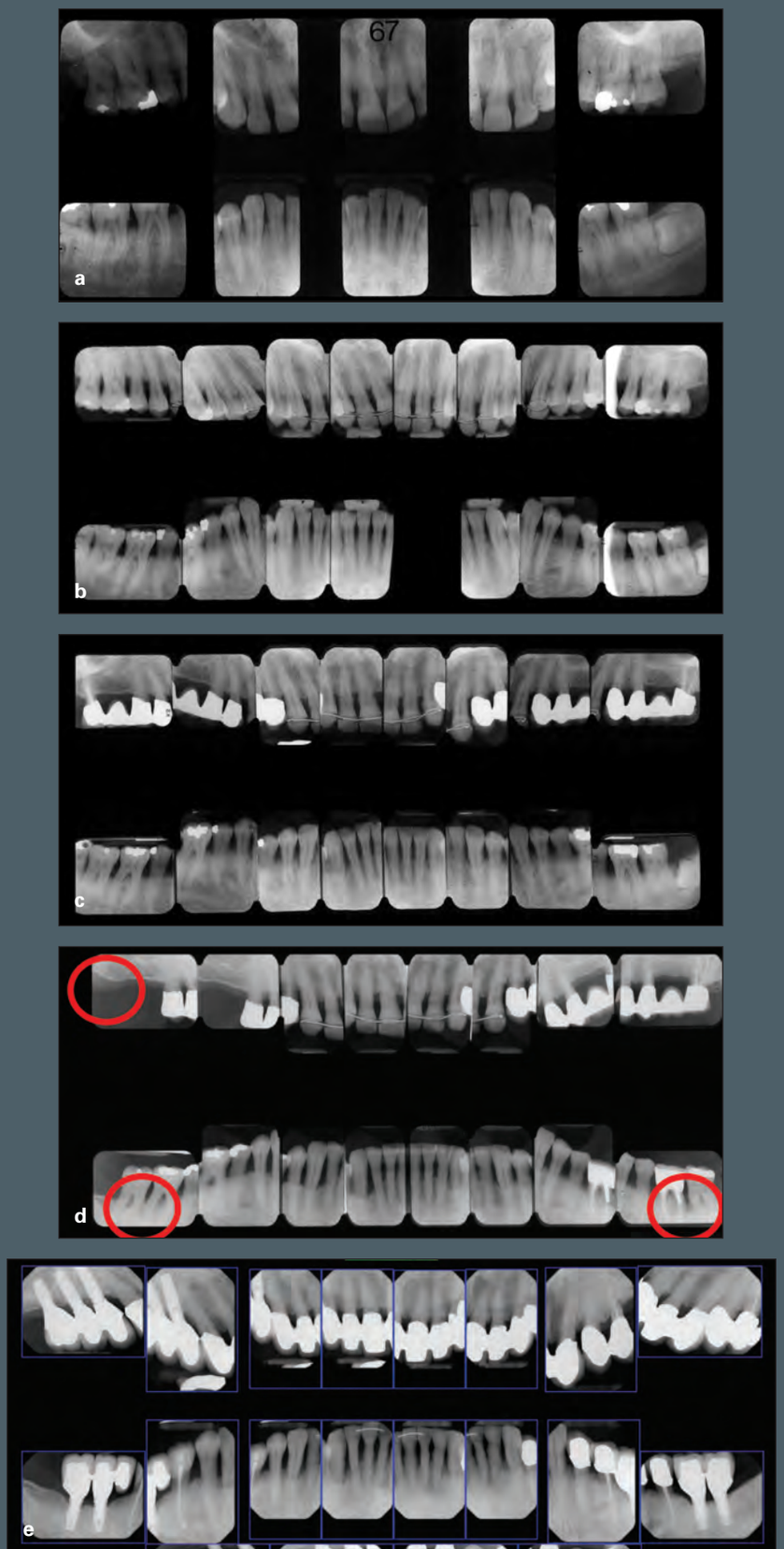

Fig 1-5 *(a and b)* Before and after radiographic surveys of a patient clearly susceptible to inflammatory periodontal disease. *(c)* A 13-year radiographic survey demonstrating the replacement of the maxillary first molars with fixed restorative dentistry. *(d)* The radiographic survey after 34 years. *Red circles* indicate loss of supporting bone. *(e)* A 50-year posttreatment radiographic survey. Treatment has been provided in an incremental fashion as additional areas required treatment.

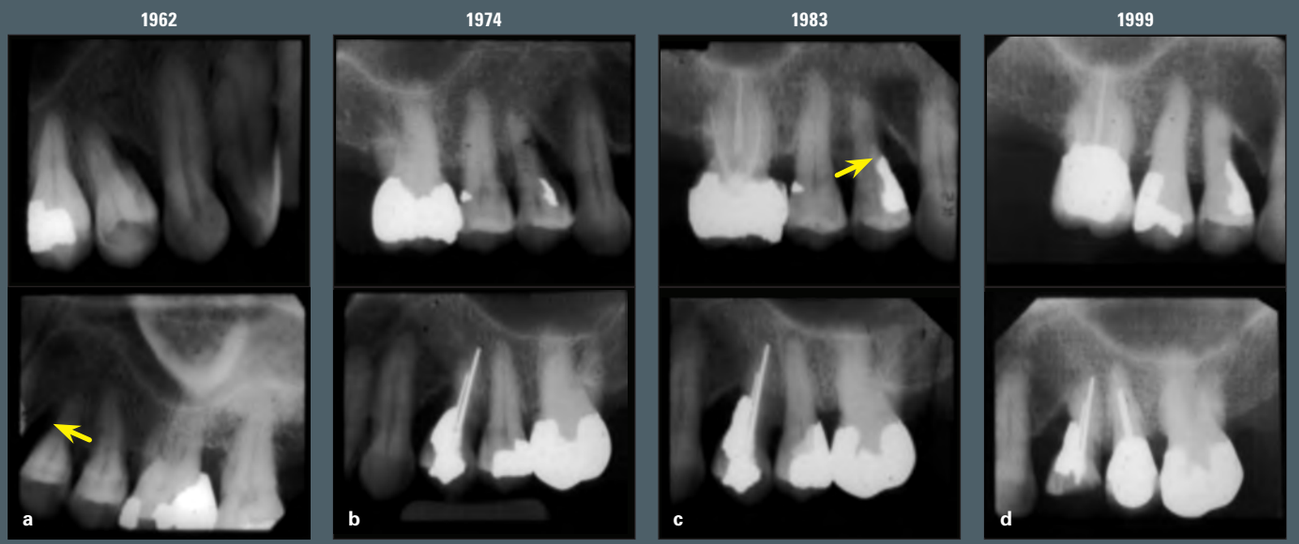

Fig 1-6 This patient first presented in the year 1962 *(a)*. Finances prevented the extraction of the maxillary first premolars and the construction of fixed partial dentures. These radiographs taken at 12 *(b)*, 21 *(c)*, and 37 *(d)* years show that the first premolars remained in the patient's mouth for 37 years with no corrective therapy. The recall interval was 3 months, and the patient continued to be punctual until her death. This is an example that must be looked at as an outlier.

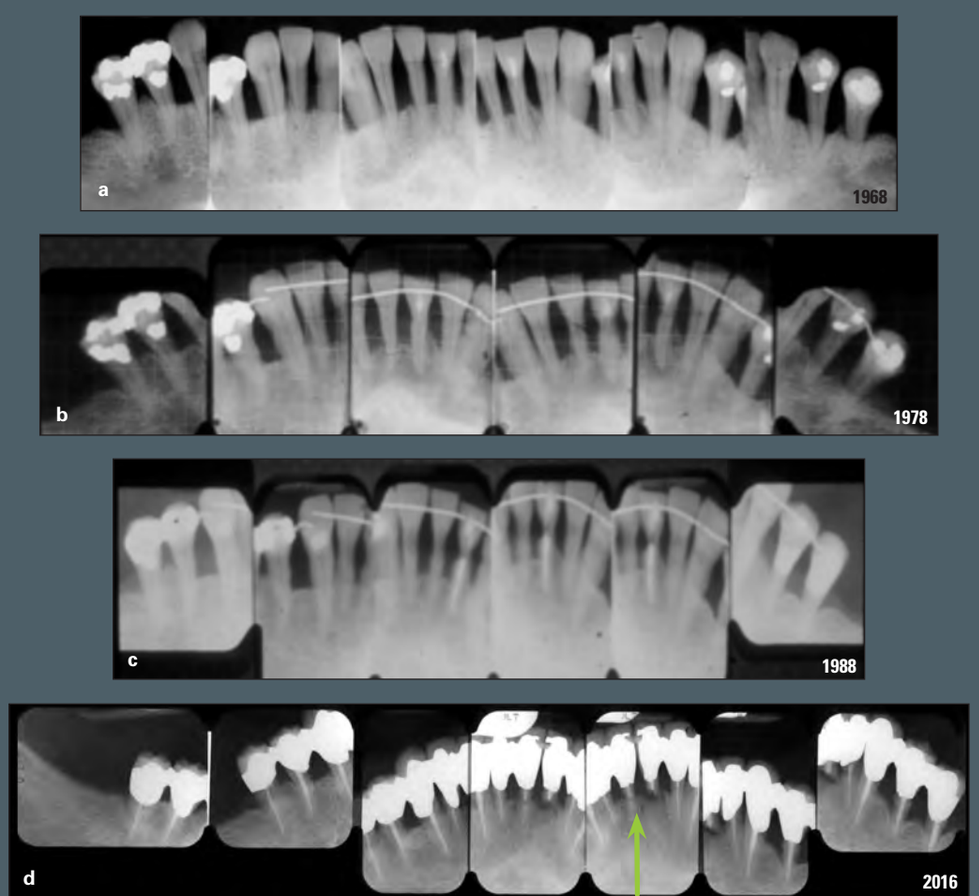

Fig 1-7 *(a)* This patient presented with significant loss of the periodontium in 1968. Her chief complaint was that the teeth were too mobile to masticate food. The initial therapy included nonsurgical treatment and splinting of the teeth. After this was successful, bone was harvested from the edentulous maxilla to regain periodontium where possible. *(b)* The patient retained all 10 teeth for 10 years. *(c)* Radiographs at 20 years. Her restorative dentist restored all of the teeth with fixed crowns in 1997. *(d)* The 2016 radiographic survey demonstrates 9 of the 10 teeth still functioning. The original endodontic treatment for the left central incisor was questionable and became problematic *(green arrow)*.

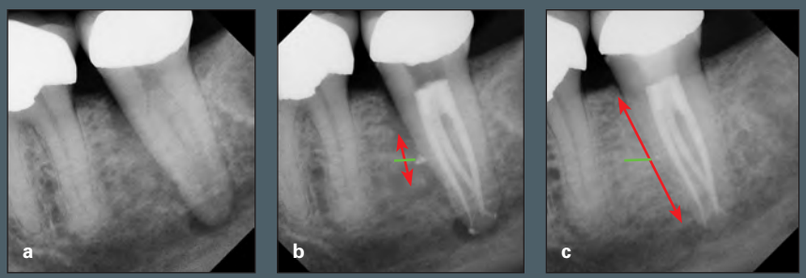

Fig 1-8 *(a)* A preoperative apical pathosis accompanied by lateral periodontal breakdown. *(b)* After treatment with bioceramic sealer and a lateral canal adjacent to the cervical periodontal bone loss. The *red arrow* designates loss of bone on the mesial surface of the molar. *(c)* Postoperative radiograph showing healing periapically and periodontally. The *green line* indicates the lateral canal. The *red arrow* designates loss of bone on the mesial surface of the molar. *(c)* Postoperative radiograph showing healing periapically and periodontally. The *green line* indicates the lateral canal. The *red arrow* shows the regeneration of bone adjacent to the root.

TREATING PERIODONTALLY COMPROMISED TEETH

Favorable results can be accomplished when implants are placed in patients with a chronic history of periodontal disease. There are many publications that have demonstrated long-term healthy and functional implants in place after the loss of periodontally compromised teeth.[9,10,35–39] It has been recognized that two very important factors are the elimination of periodontal disease before implants are placed and the availability of oral hygiene programs.[32,40]

Implants have provided an opportunity to greatly reduce the necessity for periodontal heroics by taking advantage of osseointegration. However, there is overwhelming evidence that periodontally compromised teeth can survive indefinitely.[41–43] Esthetics and masticatory function may become compromised over time for some patients, but this is not usually the case. Osseointegrated implants have been one of the most significant improvements of the 20th century, and when appropriate, provide solutions heretofore unavailable. It is important that the dentist weigh the success of saving a tooth using the capabilities of contemporary periodontal regeneration and/or endodontics against the success of an implant. This presents a significant conflict for the knowledgeable dentist, while practitioners with minimal knowledge of the success of periodontics and endodontics generally find it easier to place an implant. The most important question for the dentist is, "What would I do if this problem were in the mouth of a friend or loved one?"

Before peri-implantitis was encountered, it was believed that implant success would exceed 90%.[2–4,11] Several studies have demonstrated the error of thinking that implants always have a better long-term prognosis than teeth with treatable problems.[44] Recent studies show that peri-implantitis and mucositis are frequent complications that challenge the future health of an implant.[45,46] Therefore, the decision has to be carefully considered before treatable teeth are removed.

Conversely, there are routine treatment plan objectives for which tooth replacement with implants offers a better prognosis. When teeth are mobile because of significant loss of bone, esthetics may be greatly affected, even in a posterior quadrant. If there is horizontal bone loss beyond 50%, the bone level of adjacent teeth will contribute to vertical bone reconstruction, allowing implant placement to be favorable and providing a more acceptable result than resorting to pocket elimination surgery (see Fig 1-3).

THE ENDODONTIC TREATMENT OPTION

Recent literature demonstrates that endodontics and single-tooth implant therapy have similar success rates. Hannahan and Eleazer found that 95% to 97% of teeth with treated root canals were retained after a period of 8 years compared with implant retention rates of 85% to 90% over a similar time span.[47] Postoperative intervention, an indication of treatment failure, was noted for 12.4% of implants compared with 1.3% of endodontically treated teeth. A more recent report studied the 10-year success rate of 1,175 endodontically treated teeth.[48] The life-table analysis demonstrated that 93% of the teeth survived 10 years after endodontic treatment. However, it is critical to determine the criteria for success used when discussing implants.

Endodontic procedures are best performed under the surgical operating microscope, as it enhances the clinician's ability to locate and navigate canals.[49] It has been shown that with the microscope the ability to locate second mesiobuccal canals has increased from 53% to 93%.[50,51] The success rates of periapical surgery have also demonstrated significant improvement (Figs 1-8 to 1-10). In such procedures, it is imperative to prepare the crypt and the canals as well as place the retroseal.[52]

The introduction of nickel titanium instrumentation allows the clinician to shape the canal, which increases the ability of the irrigation protocol to clean the complex anatomy of the root canal system. In addition, new advancements in material science related to obturation have developed. It is now possible to have a biocompatible sealer that bonds to dentin, as well as gutta-percha, which provides a fluid yet impermeable and tight seal.[52]

Fig 1-9 *(a)* Preoperative radiograph of a nonvital mandibular molar with periapical pathosis. *(b)* Following obturation with biocompatible bioceramics. *(c)* Healed periapical pathosis at 6 months.

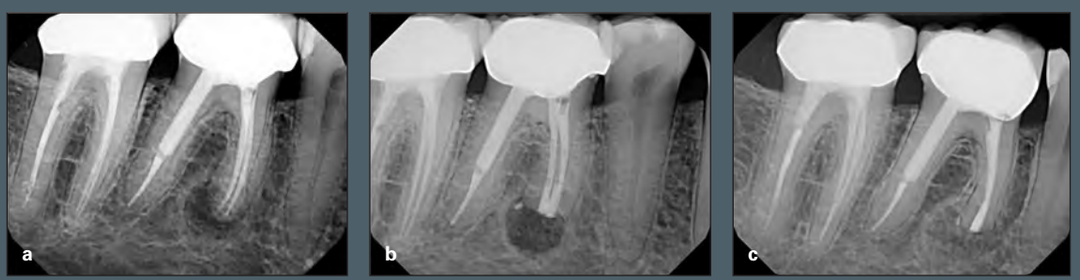

Fig 1-10 *(a)* Preoperative periapical lesion with a post present in the distal canal. *(b)* Following microsurgery using compatible bioceramics with an ultrasonic retrograde preparation. *(c)* Complete resolution of periapical pathosis at 6-month recall.

Fig 1-11 *(a and b)* A fistula *(yellow arrows)* remains at the maxillary right central incisor root after apical surgery. *(c)* The tooth was extracted, and the area was grafted to repair the osseous damage. *(d)* Six months later, a dental implant was placed. *(e)* The result satisfied the patient. *(f)* There is scar evidence of the previous endodontic surgery.

However, this should not be perceived as a competition between endodontics and implant treatment; rather, they should complement each other. On the basis of survival rates, it appears more than 95% of single-tooth implants and teeth that have undergone endodontic treatment remain functional over time[50] (see Figs 1-8 to 1-10).

TREATING PATIENTS WITH SOUND PERIODONTIUM AND A LOCALIZED PROBLEM

There are frequently situations in which a tooth in the esthetic region can be saved, but the patient would benefit from its

Fig 1-12 *(a)* Presurgical evaluation demonstrates a probing depth of 9 mm with no bleeding and pink gingiva. *(b)* The intrabony defect is almost completely devoid of a buccal wall. *(c)* The radiograph demonstrates severe loss of osseous support, although the tooth is stable. *(d)* The graft material and recombinant human platelet-derived growth factor are placed into the osseous defect. *(e)* The clinical appearance after 3 days demonstrates initial healing. *(f)* The flap is reflected after 1 year and demonstrates regeneration of the osseous defect. *(g)* A 1-year radiograph demonstrates the premolar in contact with the canine and significant bone response. *(h)* A 6-year postoperative radiograph. *(i)* A 10-year postoperative radiograph. *(j)* The 10-year postoperative clinical appearance.

replacement with an implant. When both conventional and surgical endodontics have failed, extraction and site reconstruction allow the clinician to place an implant or a three-unit fixed partial denture. It is then possible to consider the length of the restoration and predict the likelihood of interproximal black triangles. It is also an advantage to replace one tooth without altering adjacent teeth (Fig 1-11).

PERIODONTAL REGENERATION

Not every tooth with reduced alveolar support is a candidate for extraction, especially if it would result in loss of continuity of the natural dental arch.[53–56] These defects may be identified in patients with either a localized problem or advanced generalized periodontal disease. Variables such as age, medical history, esthetic expectations, and finances may influence the selection of treatment, but it is appropriate for practitioners to consider what they would do if this was their own mouth.

Treatment may include barrier membranes, autografts, allografts, xenografts, and alloplasts[17–23] (Fig 1-12). The introduction of recombinant human platelet-derived growth factor BB (rhPDGF-BB) together with any of the previously mentioned materials has significantly improved the ability to achieve a successful outcome.[23–29] Once again, it is necessary to consider the stability of the tooth and the morphology of the defect. The containment of the defect provided by remaining osseous structure provides the protection of the blood clot while it becomes organized and provides space maintenance for regeneration to

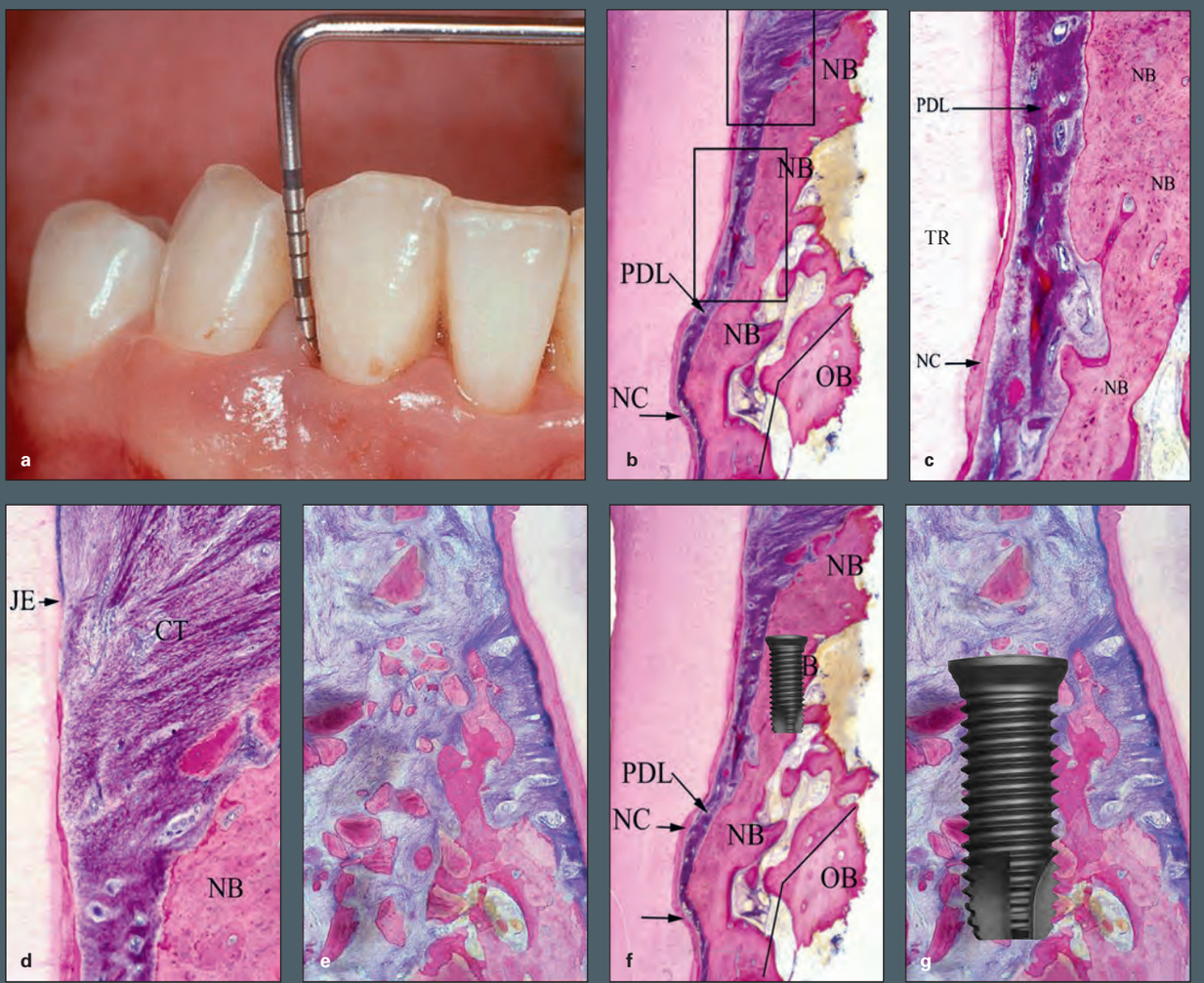

Fig 1-13 *(a)* An 8-mm probing depth with pink, non-bleeding tissue. *(b)* The histologic block section after 8 months. *(c)* Note the new cementum (NC), new periodontal ligament (PDL), and the new bone (NB). Very little graft material remains. Clinical enlargement of the middle block is observed. *(d)* The apical position of the junctional epithelium (JE) was prohibited by the connective tissue (CT) attachment. Note two small pink pieces occlusal to the new bone. This is the only evidence of the biologic after healing. *(e)* This is the result of conventional periodontal regeneration without rhPDGF. *(f)* This implant demonstrates osseointegration. *(g)* This regenerative result demonstrates new cementum and a strong periodontal ligament. However, the bone-to-implant contact is limited. OB, old bone; TR, trunk.

occur. It is generally impossible to achieve periodontal regeneration when the defect morphology is completely horizontal, but it is possible for vertical osseous defects. The stability of the tooth is critical to accomplishing regeneration; therefore, stabilization of the tooth may be required before regeneration. It is necessary to consider the type of defect and identify the source of the progenitor cells and vascularity. Since almost every defect is a combination of one, two, and three walls, *contained* versus *noncontained* seems to be more meaningful terminology. What is important is to recognize the possibility of regenerating the lost periodontium rather than removing the tooth to place an implant when this is not necessary.[22–28]

Since the definition of *periodontal regeneration* is a histologic demonstration of new cementum and bone as well as a periodontal ligament connecting them, it is important to select the appropriate grafting materials (Figs 1-13 and 1-14), whose predictability should be supported by clinical studies.[26,28,29] There is abundant evidence to suggest long-term success with and without surgical treatment.

The bone morphology will frequently dictate decision making in esthetic areas. Unfortunately, experience is required to make the decision, and even then it may be a compromise. The availability and efficacy of methods and materials available have expanded the possibilities of both successful implant placement and periodontal regeneration, which can complicate decision making. Results are achievable today that were unlikely to be seen in the past.

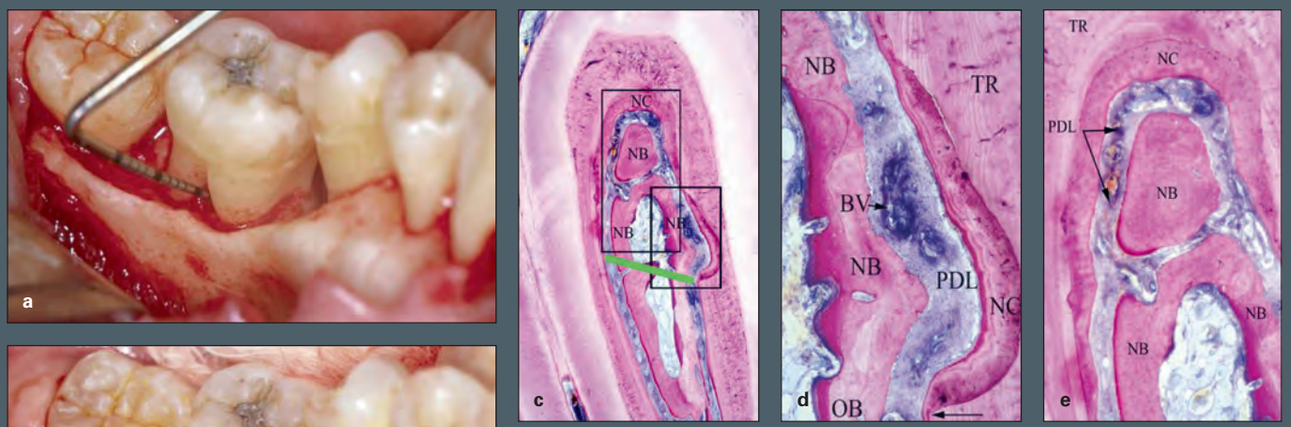

Fig 1-14 *(a)* There is a lingual Class II furcation involvement of the mandibular molar. *(b)* This is grafted with a bone allograft combined with rhPDGF-BB. *(c)* An overall histologic section of the molar following treatment of the Class II furcation. The *green line* demonstrates the difference between the very thin eruption cementum and the regenerative cellular cementum, which is broader. *(d)* A magnified view of the notch made at the level of bone. Once again, it is obvious that there is new cementum (NC), new periodontal ligament (PDL), and new bone (NB). The *arrow* demonstrates the thin, eruptive cementum and the thick, new cellular cementum to show periodontal regeneration. TR, trunk. *(e)* A magnified view focusing on the furcation regeneration.

DECISION MAKING FOR SAVING THE NATURAL DENTITION

In the posterior dentition in which there is damage to tooth structure, periodontal disease associated with significant loss of alveolar structure, and/or the need for endodontic therapy, the most frequent clinical decisions are to treat and retain the natural dentition or place osseointegrated implants. Let us first consider the loss of bone support for multirooted teeth with furcation involvement. A Class I furcation should be addressed with the mindset of stopping the progress before it becomes a Class II furcation. This can be confidently achieved with reduction of the sulcus and perhaps minor osseous surgery. There is human histologic evidence to demonstrate periodontal regeneration in Class II furcations[21–24] (see Fig 1-14). However, these were proof-of-principle studies and do not guarantee the goal will be achieved 100% of the time.

There is no clear human histologic evidence that the regeneration of Class III furcations can be expected using any current treatment regimens. Therefore, the next consideration is whether the tooth can be preserved with root resections over an extended period of time. The prognosis of root resection has been clearly demonstrated in previous publications.[57–60] The dictating factors for this decision are the length of the clinical root and the size of the edentulous span. When there is a combination of a long root and a small edentulous distance, the likelihood for success is high (Figs 1-15 and 1-16). Conversely, short roots and long edentulous spans will have a much worse prognosis. The stopgap decision is crown-lengthening surgery to address the loss of tooth structure. However, the distance from the cementoenamel junction to the furcation is frequently no more than 4 to 5 mm. It is not wise to open the furcation by removing bone for crown lengthening, and extraction and replacement with an implant is logical.[61,62] Of course, the saving grace is the rare instance when the roots are fused (Figs 1-17 and 1-18). Essentially, root resection converts furcated molars to single-rooted teeth with a favorable environment for oral hygiene.

Decisions for anterior single-rooted teeth are greatly influenced by esthetics. Mandibular intrabony defects can be successfully managed over a long period of time without encountering esthetic disappointment from the patient.[63,64]

There is significant evidence that teeth with reduced periodontium can provide successful mastication and patient satisfaction for many decades. As previously mentioned, the uninvited problem of peri-implantitis challenges earlier beliefs that implant success was expected to be in the 95th percentile.[44,46,65–67] It is of utmost importance for the clinician to be cognizant of all therapeutic opportunities to arrive at the best solution for the patient.

Similar decisions are involved in endodontic treatment of single-rooted mandibular teeth or defects in tooth structure that require crown lengthening. It is necessary to become knowledgeable about contemporary endodontic therapy supported by evidence-based dentistry in order to be successful when compromised teeth are saved and remain part of the natural dentition (Figs 1-19 and 1-20).

Some of the technologic advancements that enable us to save teeth include the surgical operating microscope, nickel-titanium instrumentation, apex locators, ultrasonics, mineral trioxide aggregate, hydrodynamic irrigation, bioceramics, and cone beam computed tomography.

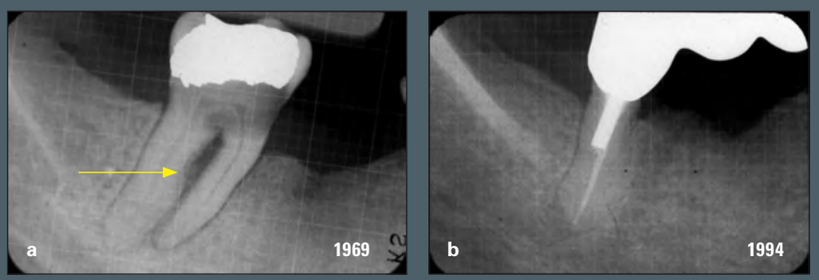

Fig 1-15 *(a)* This mandibular molar had significant mesial caries and furcation involvement *(arrow)* in 1969. *(b)* The result after 25 years demonstrates the success of root resection of a multirooted tooth. Note the bone level *(arrow)*.

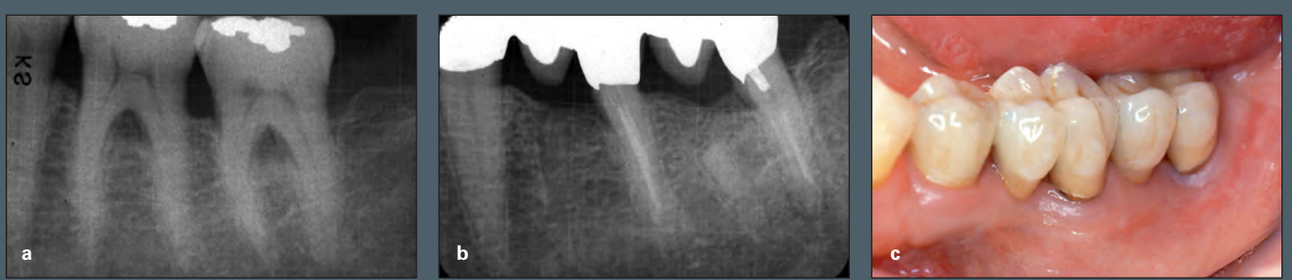

Fig 1-16 *(a)* Both mandibular molars have Class III furcation invasion. *(b)* The finished prosthetic restoration. The retention of the apical portion of the mesial roots remains after 21 years. *(c)* Definitive restoration.

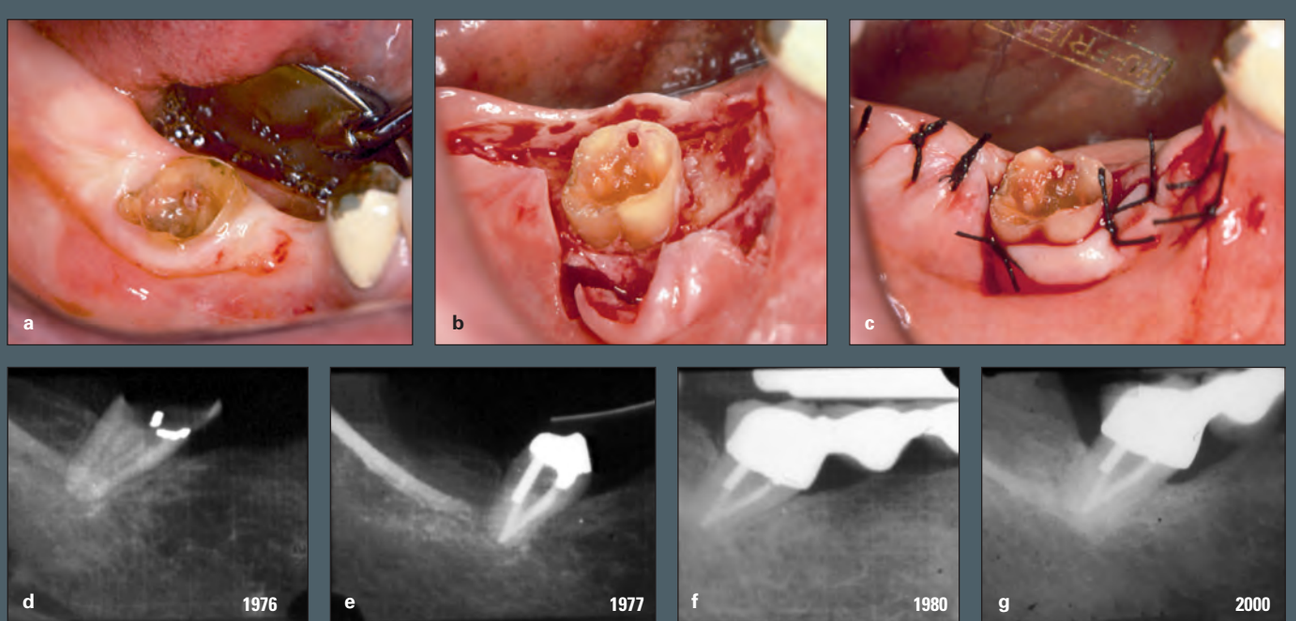

Fig 1-17 *(a and b)* This case predates osseointegration, and crown lengthening was necessary to construct a restoration with margins on healthy tooth structure. *(c)* The sutured position of the flaps. *(d to g)* Radiographs from 1976, 1977, 1980, and 2000, respectively. The tooth has served the patient's masticatory needs for 24 years.

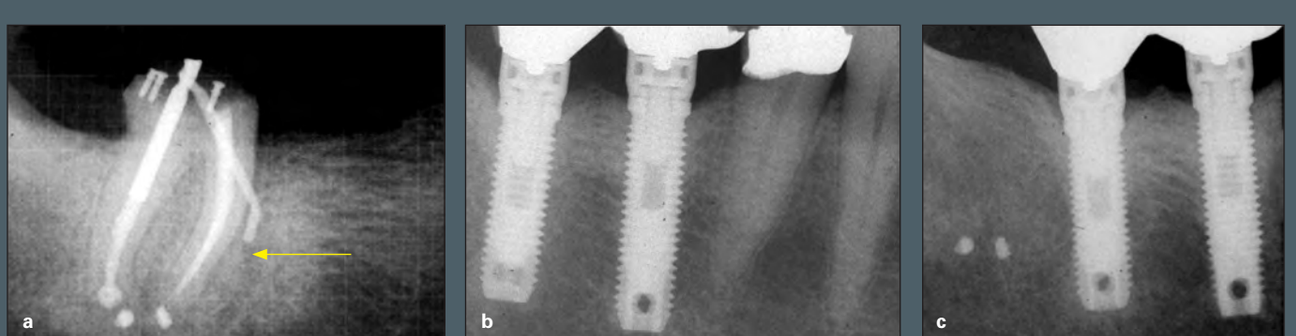

Fig 1-18 *(a)* Crown lengthening was performed with screws and composite. The gutta-percha cone *(yellow arrow)* demonstrates that the lingual cusps of the tooth fractured. It was decided that no further therapy should be performed for this tooth, and it would be replaced by dental implants. *(b)* The restored implants in 1992. *(c)* An updated radiograph in 2017, after 25 years.

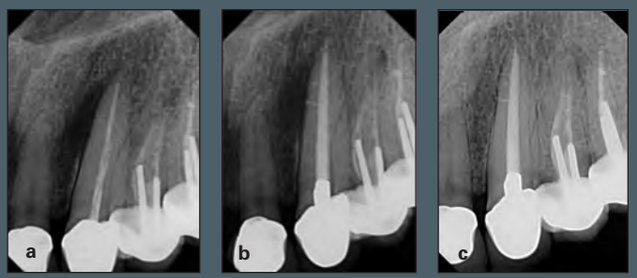

Fig 1-19 *(a)* Preoperative view showing previous endodontic treatment failure accompanied by a lateral periodontal lesion. *(b)* Following retreatment with biocompatible bioceramics. Notice the lateral canals. *(c)* Complete resolution of the lesion.

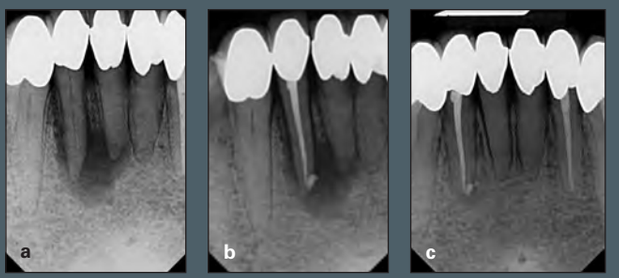

Fig 1-20 *(a)* Preoperative view of periapical pathosis. *(b)* Following endodontic treatment with biocompatible bioceramics. *(c)* Postoperative view of complete resolution of periapical pathosis.

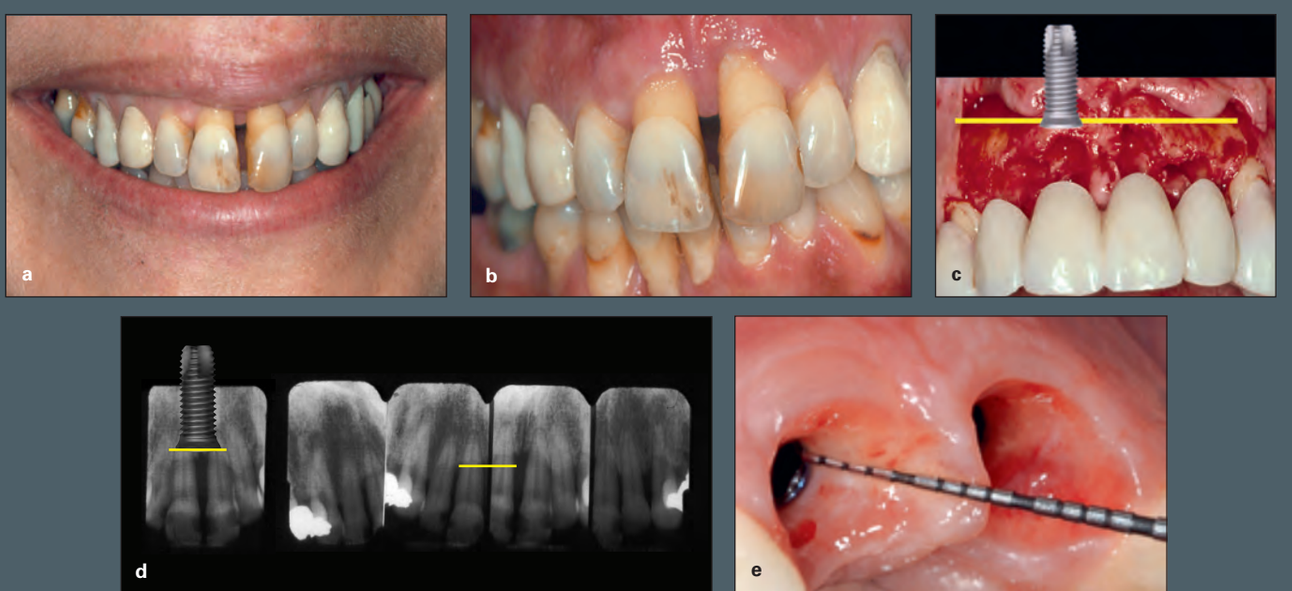

Fig 1-21 *(a)* The patient's chief complaint centers on esthetics, but she is unaware of her advanced loss of periodontium. *(b)* It is evident that there has been a significant loss of supporting bone for these teeth. *(c)* If implants are placed without significant successful regenerative therapy, the implant-abutment junction will be too apical to allowing cleaning by the patient or the hygienist. The decision was made to remove the teeth and place a provisional partial denture. *(d)* Radiographs showing the loss of bone. *(e)* If a patient is susceptible to inflammation, it is important to have structures in a position where the hygienist and patient can decontaminate the components of the restoration, such as the implant abutment and prosthetic restoration.

ESTHETIC CONSIDERATIONS

Many contemporary patients identify esthetic improvement as their motivating factor to seek dental care. Although the esthetic region includes the maxillary and mandibular anterior teeth, most individuals' display area focuses on the maxillary region. It is important for the dentist to be cognizant of the patient's wishes and whether or not they are realistic and to explain the difficulty of the procedure and the need to satisfy both esthetic and biologic goals for long-term success, as this may be the discerning factor. Every effort should be made to provide clinical and radiographic documentation that will enhance the diagnosis and planning of an optimal result.

The esthetic restoration of a single tooth is identified by the patient as one that matches the shade and size of the adjacent teeth (see Figs 1-2 and 1-11). Patients are generally dissatisfied with interproximal black triangles, which may be present with a single tooth- or implant-supported restoration. Esthetic restoration is a realistic goal when a tooth is lost to fracture from trauma or endodontic failure. A fractured tooth may require a crown-lengthening procedure to provide sound tooth structure for the cervical margin of a new crown. This may be accomplished with soft tissue excision but usually requires some removal of bone. In these instances, esthetics may be optimized by preserving the bone, extracting the damaged tooth, and replacing it with an implant (see Fig 1-2).

All patients would prefer the restoration to re-create their natural, younger appearance, and all dentists would like to accommodate this request. Therefore, it can be helpful to ask the patient to provide a photograph from the past to help in planning the restoration.

The conflict between the desire for longevity and the desire for esthetics can complicate treatment. Perhaps the most difficult treatment plan involves the patient with a large dental display and a significant loss of supporting structure for the remaining teeth (Fig 1-21). However, esthetic goals can be real-