Chapter 1 Introduction to Implant Dentistry

INTRODUCTION

The successful long-term clinical use of dental endosseous implants requires some type of biologic attachment of implants to bone. In 1969, Brånemark et al. defined this process as osseointegration (Branemark et al. 1977). This process has been subsequently studied by numerous researchers around the world and has come to identify the functional stability of the endosseous implant/bone connection (Davies 1998). The histology and biomechanics of osseointegration are beyond the scope of this text; the reader is referred to other sources for further information and increased understanding relative to osseointegration.

Treatment of edentulous or partially edentulous patients with endosseous implants requires a multidisciplinary team approach. This team generally consists of an implant surgeon, a restorative dentist, and a dental laboratory technician. Implant dentistry is a restorative-driven service, and the ultimate success of implant treatment will be measured, at least in part, by the aesthetic and functional results as perceived by patients. Prosthesis design, whether a single implant-retained crown or full-arch prosthesis, will have a major impact on the number, size, and position of the implant(s) that will be used in a particular treatment plan. Treatment planning for implant dentistry must therefore begin with the restorative phase prior to considering the surgical phases of treatment.

Brånemark and coworkers introduced a two-stage surgical protocol into North America in 1982 (Zarb 1993). Numerous, long-term clinical studies have proven the efficacy of titanium endosseous implants (Adell 1981; Friberg et al. 1991; Sullivan et al. 2002; Testori et al. 2002; Ostman et al. 2012). Most clinicians consider osseointegration of dental implants to be predictable and highly effective in solving clinical problems associated with missing teeth (Davarpanah et al. 2002).

PURPOSE OF TEXTBOOK

The purpose of this textbook is to provide clinicians and dental laboratory technicians with a step-by-step approach to the treatment of certain types of edentulous and partially edentulous patients with dental implants. Eight types of patient treatments will be featured. The treatments will be illustrated with emphasis on diagnosis and treatment planning, restorative dentist/implant surgeon communication, and restorative treatments, on an appointment-by-appointment basis. The requisite implant components (restorative and laboratory) will be identified for each specific appointment. Laboratory procedures and work orders will also be included. Implant loading protocols will be discussed for each particular case presentation.

The biologic and theoretical aspects of osseointegration will not be reviewed. Osseointegration will be defined as clinically immobile implants, absence of peri-implant radiolucencies as assessed by an undistorted radiograph, mean vertical bone loss less than 0.2 mm annually after the first year of occlusal function, and absence of pain, discomfort, and infection (Smith & Zarb 1989). Clinical verification of osseointegration can sometimes be difficult. Some implants that have been considered successful at the second surgical or impression appointments have subsequently failed prior to or after completion of the prosthetic portion of treatment. Zarb and Schmitt (1990) reported that *late failures* occurred 3.3% of the time in patients with mostly edentulous mandibles. Naert et al. (1992) published a report that contained data from partially edentulous patients' maxillae and mandibles. They reported that late failures occurred in 2.5% of the cases studied. Late failures are important to clinicians and patients because of the additional expenses and treatments that patients may elect to undergo in replacing prostheses on failed implants.

This text will concentrate on how clinicians may successfully incorporate implant restorative dentistry into their practices. A team approach will be emphasized among members of the implant team: restorative dentists, implant surgeons, dental laboratory technicians, dental assistants, office staff, and treatment coordinators. Appointment sequencing, laboratory work orders, and fee determination for restorative dentists will also be discussed including the identification of costs associated with fixed overhead, implant components, laboratory services, and profit margins.

Clinicians have multiple implant systems to choose from. There are similarities and differences among systems including but not limited to macroscopic surface morphology, implant/

abutment connections, diameters, thread pitch, and screw hex/morphology. The author and coauthors purchased all of the components that were used in this textbook. The principles described in this textbook should be applicable to multiple implant manufacturers.

Economics of Implant Dentistry

One of the major reasons cited by general dentists relative to including or excluding implant dentistry in their practices is the costs involved in dental implant treatment. Levin reported that more than 35% of patients referred from general dentists to oral surgeons or periodontists for implant dentistry never actually make the appointment (Levin 2004). He has recommended that financing should be offered to every implant patient because it is not known which patients will require financing for treatment and which ones will not. Levin considered that financing was no longer an option; it should be considered a necessity. He reported that clients of the Levin Group significantly increased their levels of case acceptance by making financing options available to patients.

Levin (2005) described a comprehensive approach to dentistry that included four significant parts:

1. Comprehensive examination

2. Tooth-by-tooth exam

3. Cosmetic exam

4. Implant exam

Levin identified implant dentistry for his general practitioner clients as an enormous growth opportunity and also stated that more than half of general dentists do not restore a single implant in any given year. Implant dentistry not only improves the lives of patients, it also can be a significant profit center for dental practices. Since implant dentistry generally is not covered by dental insurance, Levin stated that implants should be viewed as an opportunity to increase the elective portions of dental practices.

Implant treatment may be divided into treatment of partially edentulous and edentulous patients. Partially edentulous patients may warrant treatment involving the replacement of one tooth, or they may require replacement of multiple teeth. Periodontal disease may also factor into dental implant treatment planning. It has been the author's personal experience that patients will frequently call for *comparison shopping*. A common question is, "How much will implants cost?" Patients may also request the costs of a single crown for comparison purposes. It is the responsibility of the dental staff to make sure patients know that in order to make fair

Table 1.1 Costs/fees/profits associated with a 3-unit porcelain-fused-to-metal (PFM) FPD.

Chair time	Fixed overhead	Laboratory expenses	Fees ($)
Preparations		Casts	50
Impression		Dies	50
Provisional restoration		Articulation	50
FPD			1000
1.75 hours	$400/hour = $700	**Sub Total**	1150
FPD insertion			
0.75 hours	$400/hour = $300		
Total	$1000		1150
Professional fee			4500
Costs (fixed overhead and laboratory expenses)			2150
Profit (fees less costs)			1350
Profit per hour ($1350/2.5 hours)			540

comparisons, patients must compare the costs associated with a 3-unit fixed partial denture (FPD) or similar prosthesis to the costs of an implant-retained restoration replacing one tooth. This may sometimes be difficult to explain/inquire of patients during the initial phone conversation (Tables 1.1–1.3).

Implant dentistry should also be profitable for clinicians and dental laboratory technicians. Initially, as with other new technologies that require the acquisition of learned, skilled behaviors, implant restorative dentistry may not be as profitable as other aspects of restorative dentistry. Restorative dentists should expect a learning curve relative to diagnosing, treatment planning, and treatment in implant restorative dentistry. With practice and reasonable efforts on behalf of the dentist and staff, implant dentistry may become one of the most profitable aspects of general practice.

Predictability of Fixed Prosthodontics

There are numerous goals of prosthodontic treatment, among them are to provide aesthetic and functional replacements for missing teeth on a long-term basis. Clinicians would like to attain these goals with restorations that have a predictable prognosis, minimal biologic trauma, and reasonable cost. For a significant number of restorative dentists, there are multiple advantages associated with conventional fixed prosthodontic therapy: familiarity with protocols, techniques, and materials. There are also multiple limitations associated with conventional fixed prosthodontics: tooth preparation and soft tissue retraction, potential pulpal involvement, recurrent caries, and periodontal disease.

Table 1.2 Costs/fees/profits associated with an implant-retained crown (premachined abutment/PFM crown).

Chair time	Fixed overhead	Laboratory expenses	Fees ($)
		Casts	50
		Articulation	25
		PFM crown	300
		Mill abutment	75
0.5 hours	$400/hour = $200	Sub total	450
		Implant components	
		Healing abutment	60
		Impression coping	51
		Analog	26
		Premachined abutment	125
		Lab screw	14
		Abutment screw	54
		Sub total	330
Crown insertion			
0.5 hours	$400/hour = $200		
Total	$400		1085
Professional fee			2000
Costs (fixed overhead and laboratory expenses)			1485
Profit (fees less costs)			515
Profit per hour ($515/hour)			515

Note: Healing abutments, impression copings, and lab screws may be used multiple times; therefore, costs will be decreased for each succeeding case, and profits will be increased. Analogs should not be reused.

Table 1.3 Comparisons of costs, fees, and profits per hour for 3-unit FPD versus single-unit implant-retained crown.

	Fixed overhead ($)	Laboratory and implant components cost ($)	Fees ($)	Profit/ hour ($)
3-unit FPD	1000	1050	3600	540
Implant restoration	400	1085	2000	515

Note: Implant-retained crown needs to be compared to the costs for a 3-unit FPD in order to accurately compare the costs associated with replacing a single missing tooth.

Missing teeth have been predictably replaced with FPDs for many years. However, there are increased stresses and demands placed on the abutment teeth, as well as limitations associated with ectopic tooth positions.

In 1990, more than four million FPDs were placed in the United States (ADA Survey 1994). It may be surprising to note that there is little long-term research on the longevity of these restorations; comparisons between studies cannot be easily accomplished due to the lack of established parameters (Mazurat 1992). The authors have reported on the failure rates of FPDs over time, but the definitions of failures have been inconsistent: recurrent caries, fractured porcelain, broken rigid connectors, and loss of periodontal attachment (Schwartz et al. 1970; Reuter & Brose 1984; Randow et al. 1986; Walton et al. 1986; Foster 1990).

FPDs have documented long-term success. Scurria et al. (1998) performed a meta-analysis of multiple published studies and documented success rates as high as 92% at 10 years and 75% at 15 years. Other authors have recorded failure rates of 30% or more for FPDs at 15–20 years (Lindquist & Karlsson 1998). Cenci et al. (2010) reported the results of a clinical study with 8 years of follow-up that posterior fiber-reinforced FPDs exhibited acceptable clinical performances after a period of up to 8 years. The cumulative survival rate (CSR) was 81.8%. A key point that should be recognized from these reports is that it is important for clinicians to realize that for younger patients, FPDs may need to be replaced two to three times during their lifetimes.

Ioannidis et al. (2010) investigated the possible influence patients' ages may have on the longevity of tooth supported fixed prosthetic restorations. Assessment and selection of studies were conducted in a two-phase procedure by two independent reviewers utilizing specific inclusion and exclusion criteria. The minimum mean follow-up time was set at 5 years. The results of the review demonstrated that increased age of patients should not be considered as a risk factor relative to the survival of fixed prostheses. Although the majority of studies showed no effect of age on survival of fixed prostheses, the authors concluded that there was some evidence that middle-aged patients may present with higher failure rates.

Miyamoto et al. (2007) reported the results of a long-term clinical study where data were collected from 3071 restored teeth from 1448 compliant patients from a single private practice in Yamagata, Japan. Follow-up times ranged from 15 to 23 years, with a mean follow-up of 19.2 years. Every tooth and restoration placed during this time frame was evaluated by one of the authors at each recare visit. Miyamoto and others reported that during this clinical study, multisurface restorations had the highest incidence of failures ($P < 0.001$) Abutment teeth for removable partial dentures (RPDs) had the highest individual failure rates that resulted in extractions. They concluded that restored teeth experienced a higher incidence of failure compared with unrestored teeth. Full crowns and abutments for fixed partial dental prostheses had fewer restorative failures when

compared with teeth with complex multisurface restorations. RPD abutments experienced the highest failure rate.

In a literature review, Priest (1996) reviewed multiple papers to compare the efficacy of implant-retained crowns and conventional FPDs over time. He found that although FPDs were assumed to demonstrate predictable longevity, failure rates have been reported from 3% failure rates over 23 years to 20% failure rates over 3 years. Implant longevity, on the other hand, appears to be more promising and generally displays narrower ranges of failures: 9% over 3 years to 0% over 6.6 years. Priest cautioned that failure rates for FPDs and implant-retained crowns cannot be easily compared among studies since parameters had not been established and that replacing missing teeth is a complex issue. There are sufficient data for single-tooth implant-retained restorations to be used as functional and biologic methods for long-term tooth replacement.

DEVELOPMENT OF PROGNOSIS FOR TEETH: EXTRACT OR MAINTAIN

A question often asked by clinicians and patients relates to the viability and prognosis of maintaining compromised teeth. Even with the advances in implant dentistry since the 1970s, the predictability of implants is still not 100%. Therefore, it may still be difficult to recommend the extraction of a tooth with a compromised prognosis and replace it with a dental implant. The American Academy of Periodontology's position paper on dental implants stated that all patients should be informed as to the risks and benefits of implant and alternative treatment prior to implant placement and restoration (American Academy of Periodontology 2000).

O'Neal and Butler (2002) discussed the clinical and economic factors that clinicians should consider in making decisions relative to extraction and implant placement versus retention of compromised teeth (O'Neal & Butler 2002). They divided the clinical issues into four basic categories:

1. The heavily restored tooth

2. The furcation-involved tooth

3. The periodontal-prosthesis patient

4. Difficult aesthetic cases

The Heavily Restored Tooth

This type of tooth may have been damaged as a result of blunt trauma, dental caries, or multiple dental restorations (Figure 1.1). In Figure 1.1, this mandibular molar had been treated endodontically and had moderate horizontal bone loss and recurrent dental caries. The author considered the
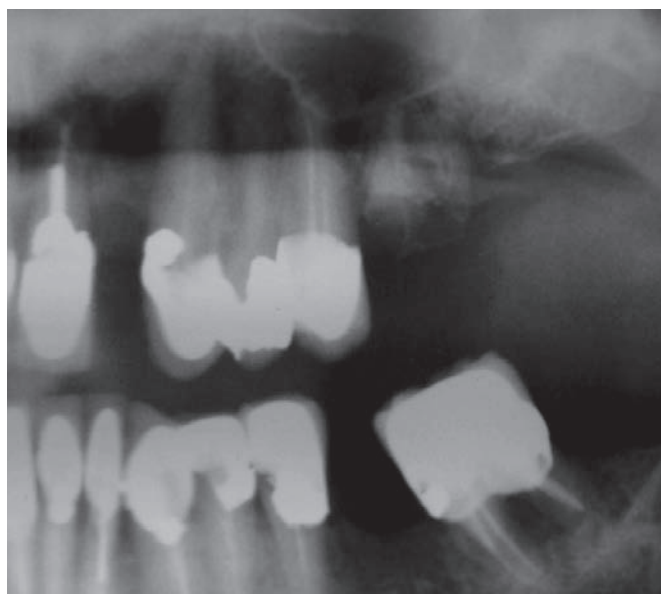

Figure 1.1 Radiograph of mandibular molar that may be considered for use as the distal abutment for a 3-unit FPD. It had been treated endodontically and restored with a crown. There are recurrent caries beneath the mesial margin.

Figure 1.2 Clinical view of implant-retained crowns that replaced the mandibular right second premolar and first molar.

long-term prognosis for this tooth to be poor if used as the distal abutment for a new 3-unit FPD. The treatment choices for this patient included hemisection and mesial root amputation, osseous surgery, and a new 3-unit FPD. Or, the tooth could be extracted, the socket grafted with bone or a bone substitute, and the extraction site allowed to heal prior to placing an implant and implant restoration (Figure 1.2).
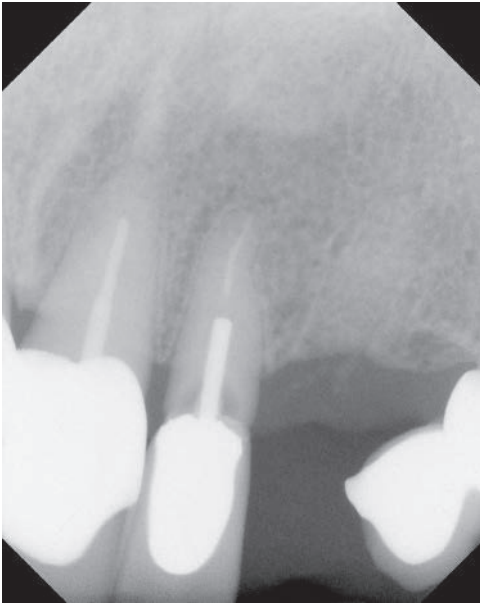
Figure 1.3 Radiograph of a maxillary lateral incisor with previous endodontic therapy. There was an incomplete horizontal root fracture; the post retained the crown.

Based on the reports of Miyamoto and Priest, the prognosis for the latter choice is much better and may be more conservative long term than the first treatment option.

The clinical condition exemplified by Figure 1.3 is also frequently encountered in clinical practice: an incompletely fractured tooth with previous endodontic therapy where the crown was held in place by a post. Numerous authors have suggested that the axial walls of tooth preparations for endodontically treated teeth should include at least 1 mm of dentin in order to provide the requisite ferrule effect needed for predictable retention for the crown (Sorenson & Engelman 1990; Fan et al. 1995; Libman & Nicholls 1995). Crown lengthening procedures can be accomplished in order to obtain greater access to dentin for increased retention of the crown, but the surgery is associated with moderate to significant surgical morbidity and accomplished at the expense of the supporting bone.

The Furcation-Involved Tooth

Posterior teeth with advanced bone loss are the most commonly lost teeth. Hirschfeld studied natural teeth over a 22-year period and found that 31.4% of molars and 4.9% of single-rooted teeth were lost (Hirschfeld & Wasserman 1978). Therefore, decisions to retain or extract posterior teeth generally involve multirooted molars. Both maxillary and mandibular molar teeth exhibit concavities associated with multiple roots. The anatomy may also be compromised with recurrent

Figure 1.4 Radiograph of mandibular right posterior segment that demonstrates advanced bone loss around the first molar. This tooth was a poor candidate for root resection and future use as an abutment for a 3-unit FPD.
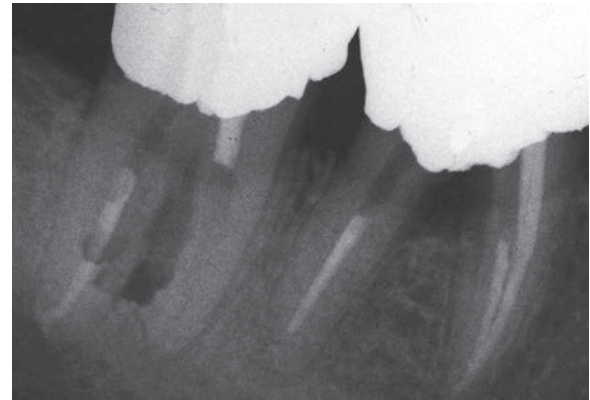

Figure 1.5 Radiograph after endodontic therapy for the mandibular right first and second molars prior to resection of the second molar's mesial root.

caries and lateral canals. In Figure 1.4, the mandibular right first molar had previous endodontic therapy, advanced bone loss around both roots and in the furcation, and mobility and was uncomfortable for the patient. The patient's chief complaint was related to the discomfort that she was feeling anytime she attempted to chew on the right side. Yet she did not want to have this tooth extracted. Even with a root resection, this tooth had a poor prognosis as an abutment for an FPD. A more appropriate choice would be extraction, grafting, and placement of one implant to replace the missing molar.

The most common causes of failure in posterior, furcation-involved teeth have been reported to be recurrent caries and endodontic failure (Buhler 1994). When clinical success is likely, root resection procedures can be clinically acceptable with a reasonable long-term prognosis. In Figures 1.5–1.7,

Figure 1.6 Mandibular FPD cemented in place.

Figure 1.7 Radiograph at FPD try in appointment.

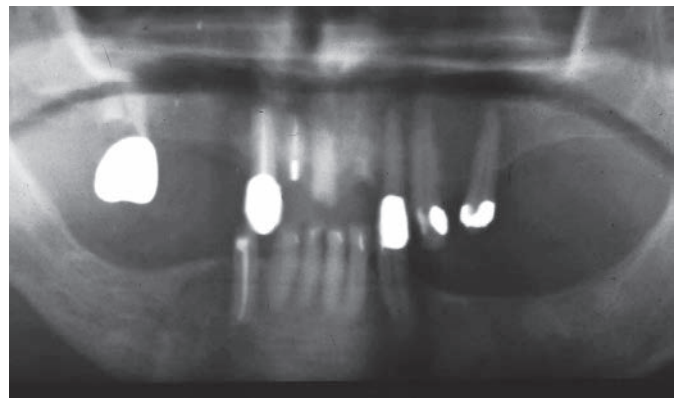Figure 1.8 Preoperative anterior view of centric occlusion.

Figure 1.9 Preoperative panoramic radiograph that demonstrated moderate horizontal bone loss, recurrent caries, and multiple missing teeth.

compromised mandibular molars were treated with endodontic therapy, posts, root resections, and a fixed periodontal splint. This radiograph was taken 15 years after the prosthesis was inserted.

The Periodontal-Prosthesis Patient

Dentistry has experienced significant advances in treatment alternatives for the severely compromised dentition. In the 1960s and 1970s, these advances resulted in salvaging many teeth that had previously been extracted (Yalisove & Dietz 1977). Conventional fixed and removable prosthodontic treatments were not applicable to treat severely compromised dentitions, especially in cases where there were multiple missing teeth and moderate to advanced bone loss. Amsterdam defined the sophisticated dental therapy to treat such patients as periodontal prosthesis (Amsterdam

1974). Periodontal prosthesis is the treatment required to stabilize and retain dentitions that have been weakened by the loss of alveolar bone and multiple teeth. In the past, periodontal prostheses were the primary means to treat these debilitated dentitions. Today, the use of dental implants has decreased the frequency for these complex patients to be treated with periodontal prosthesis (Nevins 1993).

This patient presented to the author in 1988 with multiple missing teeth, an end-to-end dental occlusion, a moderate to advanced bone loss, and a severe gag reflex (Figure 1.8). The diagnostic phase of treatment consisted of thorough radiographic and physical examinations (Figure 1.9). The treatment plan that was developed and agreed upon with the patient called for a diagnostic articulator mounting (Figure 1.10), diagnostic wax patterns (Figure 1.11), extraction of several hopeless teeth, periodontal osseous and soft tissue surgery, and a maxillary periodontal prosthesis (Figures 1.12–1.14). The mandibular incisal plane was recontoured in conjunction with the maxillary reconstruction.
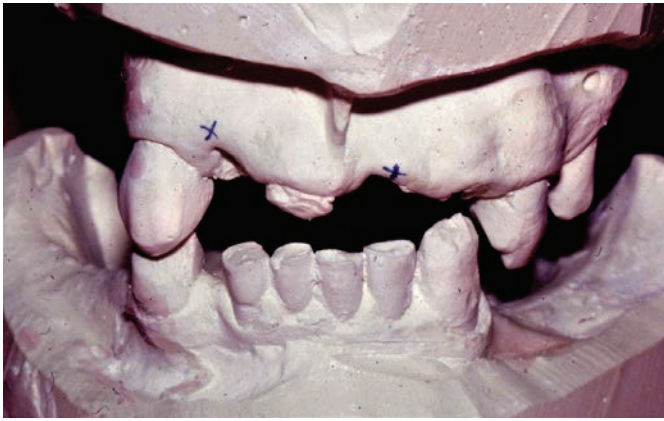
Figure 1.10 Preoperative diagnostic articulator mounting at the existing vertical dimension of occlusion (VDO).

Figure 1.11 Diagnostic wax patterns; incisal plane of mandibular teeth were modified, and the maxillary incisal plane was moved incisal per patient request.

Figure 1.12 Clinical anterior view with the maxillary copings portion of the periodontal prosthesis in place.

The patient functioned comfortably for several years and then presented with a problem with the maxillary right canine 8 years post insertion (Figure 1.15). This tooth was diagnosed as having a combined periodontal/endodontic lesion. The periodontal prosthesis was tapped off and the

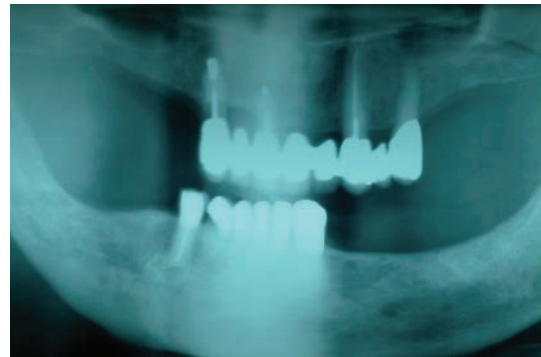**Figure 1.13** Periodontal prosthesis in place at insertion.

Figure 1.14 Postoperative panoramic radiograph. The patient could not tolerate a mandibular RPD; the mandibular posterior teeth were not replaced.

Figure 1.15 Clinical anterior view 8 years post insertion. The maxillary right cuspid was extracted secondary to a combined periodontal/endodontic lesion; the periodontal prosthesis was tapped off, the retainer #6 was filled with composite resin and contoured for use as an ovoid pontic, and the periodontal prosthesis was reinserted.

cuspid was extracted. The periodontal prosthesis was recemented and remained in place for an additional 8 years (16 years post insertion, the last recare appointment). Note the amount of residual ridge resorption gingival to the cuspid and lateral incisor pontics (Figure 1.16).

Figure 1.16 Clinical left lateral view 8 years post extraction of maxillary right cuspid (16 years post insertion of original prosthesis). Note the amount of alveolar ridge resorption gingival to the cuspid and lateral incisor pontics.
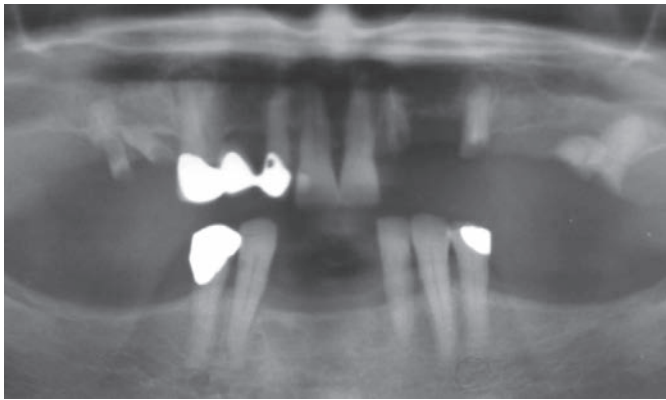

Figure 1.17 Preoperative panoramic radiograph that demonstrated severe dental caries, moderate bone loss, and multiple missing teeth.
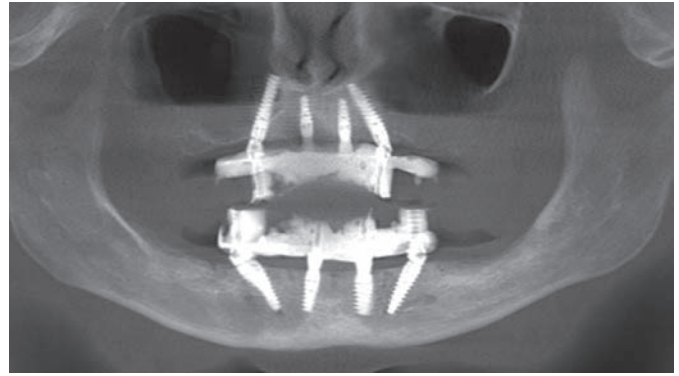

Figure 1.18 Postoperative panoramic radiograph after maxillary and mandibular implant placement and immediate occlusal loading (IOL) of the maxillary and mandibular prostheses.

Figure 1.19 Clinical view of patient from Figures 1.17 and 1.18, smiling with the definitive maxillary and mandibular implant prostheses in place.

Difficult Aesthetic Cases

The replacement of anterior teeth with dental implants is probably one of the greatest challenges that a dental implant team will face. There are numerous factors to consider in order to fabricate aesthetic, long-term, functional restorations: bone quality and bone quantity, gingival symmetry, periodontal biotype, three-dimensional (3D) orientation of the edentulous space and adjacent teeth, presence or absence of interdental papillae, and location of the lip during speaking, smiling, and at rest. Dentists and patients have come to expect excellent aesthetic and functional results in the anterior regions of the mouth (Chang et al. 1999).

If this patient presented to a dentist today, the aforementioned treatment certainly should be offered as a treatment alternative. The morbidity associated with the periodontal surgery, endodontic surgery, and all of the complexities of the fixed prosthodontic treatment probably would outweigh the morbidities involved in extraction of the teeth, grafting as needed, placement of implants, and implant prosthetic treatment with either fixed or removable prosthodontics. Implant placement and immediate occlusal function also could be considered. The net, long-term results with fixed implant-retained restorations would likely be more predictable on a long-term basis than the results that could be obtained with periodontal prosthesis (Figures 1.17–1.19).

However, implant-retained restorations may not always be the most appropriate treatment option. FPD and RPD may still be viable options for patients who need to replace anterior teeth (Figure 1.20). In the case of multiple missing

Figure 1.20 Clinical view of a patient missing a maxillary right lateral incisor who had inadequate bone volume for implant placement and did not want to have bone grafting accomplished in order to have an implant-retained crown. The missing lateral incisor was replaced with a 3-unit FPD; pink gingival porcelain was used to compensate for the loss of alveolar bone and soft tissues.

Figure 1.21 Radiograph of a patient with a nonrestorable maxillary left first molar, pneumatized maxillary sinus, and inadequate bone volume for implant placement.

Figure 1.22 This patient had lost her maxillary anterior teeth 10 years previous to this photograph. The anterior and posterior occlusal planes were at different levels. There was inadequate lip support with the existing RPD flange.
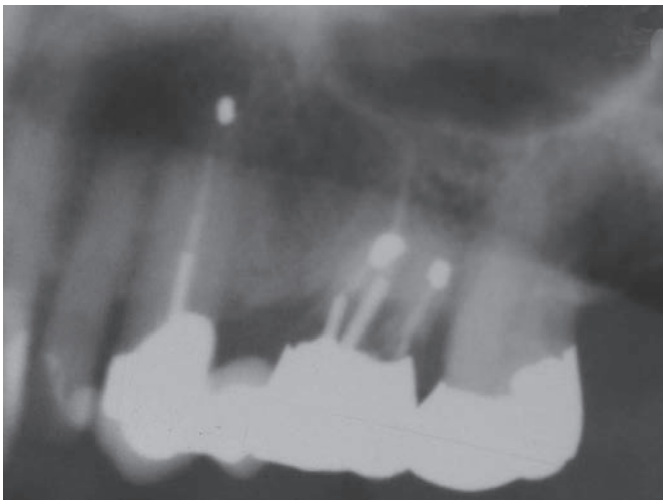

Figure 1.23 This is the same patient as in Figure 1.22. The posterior teeth were restored with crowns; the maxillary anterior teeth were replaced with a new RPD that provided adequate lip support and incisal display of the teeth.

teeth, anatomic limitations, and inadequate bone volume, an FPD may be more appropriate if bone grafting is needed (Figure 1.21). In the case of multiple missing teeth and significant alveolar ridge resorption, an RPD with a labial acrylic resin flange may be the treatment of choice in order to provide patients with the requisite lip support (Figures 1.22 and 1.23).

For aesthetic restorations, implants must be placed in optimal positions relative to the proposed locations of the teeth, not relative to the available bone (Garber 1995). Implant placement must also be viewed in three dimensions: mesial/distal, facial/lingual, and occlusal/cervical. Deficient sites need to be augmented with bone and/or soft tissue as needed in order to insure optimal implant placement. In this instance, there appeared to be adequate bone volume for implant placement on the periapical radiograph (Figure 1.24). At the surgical appointment, the bone was noted to be deficient vertically; the implant surgeon chose to place the implants in spite of the vertical deficiency (Figure 1.25). In spite of multiple issues associated with implant placement, location, and lack of keratinized tissues around the premolar implant, this patient has adapted to
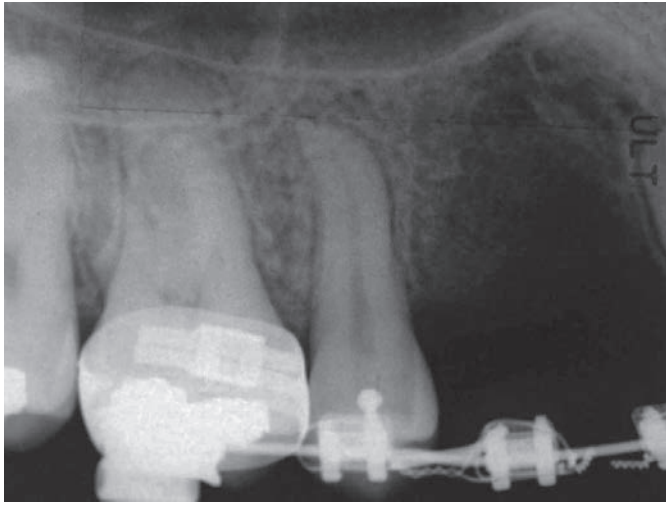
Figure 1.24 Preoperative periapical radiograph of the maxillary right quadrant that demonstrated adequate bone volume (in two dimensions) for implant placement to replace the missing teeth (maxillary right first premolar and cuspid).

Figure 1.26 Clinical view of the patient in Figure 1.25. Note the contours of the implant-retained crowns secondary to less than optimal implant placement.
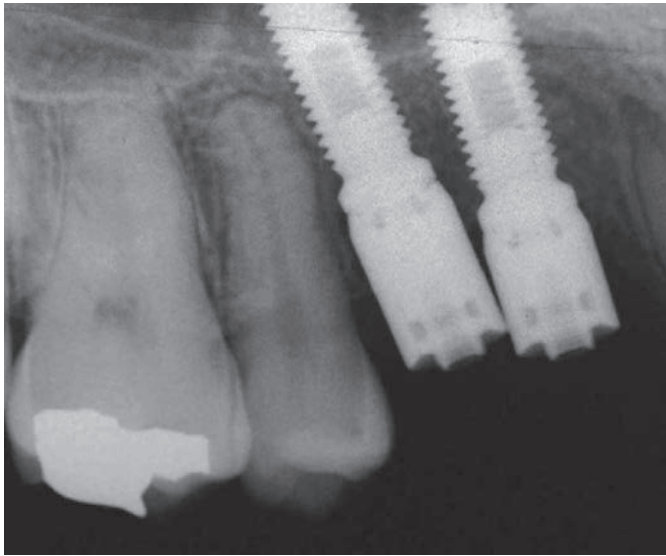

Figure 1.25 Postoperative radiograph of two implants that were placed too close together and too high into the alveolus relative to the cementoenamel junctions (CEJs) of the adjacent teeth.

the restorations and maintained them 10 years post implant insertion (Figure 1.26).

The restoration of edentulous spaces in the aesthetic zone with dental implants should probably not be undertaken by surgeons and restorative dentists with limited implant experience (Weisgold & Arnoux 1997). Thorough preoperative diagnostic work-ups are especially warranted prior to

Figure 1.27 Preoperative occlusal view of a maxillary diagnostic cast that demonstrated a Class I horizontal ridge defect.

embarking on treatment in the anterior maxillae (Hess et al. 1998). Ridge deformities have been classified into three types: Class I, loss of buccal/lingual width; Class II, loss of vertical height; and Class III, combination of Classes I and II (Seibert 1983). Bone regeneration therapy is now well accepted by dentistry. The horizontal Class I defect is predictable to treat (Figures 1.27 and 1.28). However, augmentation procedures may add time to the overall time frame of implant treatment, as well as adding expense for the treatment.

This RPD did not restore the restorative volume required for an aesthetic replacement of the missing maxillary central

Figure 1.28 Ten-week postoperative clinical view of the patient in Figure 1.27 that demonstrated the increase in buccal/lingual width of the edentulous ridge secondary to grafting with demineralized freeze-dried bone and placement of a resorbable membrane.

Figure 1.29 Clinical view of a transitional RPD that did not replace the missing hard and soft tissues associated with the missing maxillary left central incisor.

Figure 1.30 Clinical occlusal view that demonstrated the significance of the horizontal component of the defect that would have to be addressed prior to or during implant placement.

Figure 1.31 Surgical guide on the diagnostic cast would be appropriate for the implant surgeon to use during the augmentation portion of the surgical treatment.

incisor (Figure 1.29). The defect was significant in both vertical and horizontal planes. In this case, the ill-fitting partial denture was diagnostic for the surgeon by giving him/her an idea as to the volume of material required to eliminate the defect (Figure 1.30). A surgical guide would still be beneficial for the surgeon, even if an implant cannot be placed at the time of bone grafting (Figure 1.31).

DEVELOPMENT OF PROGNOSIS FOR THE DENTITION

Diagnosis and treatment planning for patients with compromised dentitions can be one of the more daunting challenges facing dental practitioners. A process should be developed that assists practitioners in formulating treatment plans that are evidenced based, predictable, and as practical as possible. Accurate diagnoses are critical for treatment success and need to be identified relative to periodontal disease, occlusion (skeletal and dental), and other anatomic considerations (maxillary sinus, inferior alveolar canal, etc.).

Patients who present with moderate to advanced periodontitis have several generic treatment options available to them: periodontal surgery with grafting, membranes, antimicrobial therapy, etc.; selective extraction and replacement with removable or fixed prostheses supported by natural teeth; selective extraction and replacement with removable or fixed prostheses supported by dental implants; or full-arch extractions and prosthetic replacement (Figure 1.32).

Figure 1.32 Preoperative clinical view of a patient with advanced periodontitis and a significant dental malocclusion who did not wish to maintain his dentition.

Certainly, an argument could be made for the patient in Figure 1.32 that with selective extraction, periodontal therapy, and fixed/removable prosthodontic treatment, the dentition could be salvaged and maintained for a number of years. However, what would the morbidity and expense be for the required treatments, and how long should the patient and clinician reasonably expect the reconstruction to last? Wang et al. (1994) studied the influence of furcation involvement on tooth loss over a period of 8 years. They reported that with and without furcation involvement, 23% and 13%, respectively, were lost after 8 years. Other authors have reported similar findings (Hirschfeld & Wasserman 1978; McFall 1982; Goldman et al. 1986).

Ravald and Johansson (2012) reported on the results of tooth loss in periodontally treated patients over 11–14 years. Sixty-four patients participated in the follow-up study. Reasons for tooth loss were identified through dental records, radiographs, and clinical photos. They identified factors contributing to tooth loss, via a logistic multilevel regression analysis. During the course of the study, 211 teeth were lost. They identified that the main reason for tooth loss was recurring periodontal disease ($n = 153$). Root caries and endodontic complications were responsible for 28 and 17 lost teeth, respectively. Thirteen teeth were lost for other reasons. Ravald and Johansson also reported that the number of teeth ($P = 0.05$) and prevalence of probing pocket depths, 4–6 mm ($P = 0.01$) at baseline; smoking ($P = 0.01$); and the number of recare visits with dental hygienists ($P = 0.03$) during the maintenance phase of therapy significantly contributed to the variations noted for tooth loss. They concluded that previously treated patients at their periodontal specialty office continued to lose teeth in spite of maintenance treatments at general practitioner offices and dental hygienists. They also concluded that the

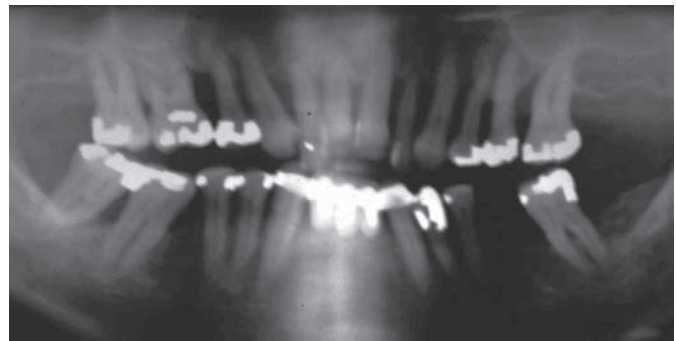**Figure 1.33** Preoperative clinical view of a patient 3 years post periodontal surgery.

Figure 1.34 Panoramic radiograph corresponding to Figure 1.33. The horizontal bone loss was stable over the previous 3 years.

main reason for tooth loss in their study was recurring periodontal disease. They also noted that tooth loss was significantly more prevalent among smokers than nonsmokers and concluded that tooth loss risk factors included smoking, low numbers of teeth preoperatively, and prevalence of 4–6 mm periodontal pockets.

Findings such as these may make it difficult for clinicians to recommend intensive periodontal and fixed prosthodontic therapy to patients where the support for the reconstruction is dependent on compromised molars.

In another case of a debilitated dentition, a patient presented 3 years post periodontal surgery (Figures 1.33 and 1.34). She spent approximately 20 minutes per day brushing, flossing, and rubber tipping in and around all of her teeth. The teeth were still sensitive, prone to food impaction, and unattractive. Selective extractions could have been performed, and the missing teeth could have been replaced with fixed or removable prostheses. The patient did not wish to spend any more time or money on maintaining her teeth and opted to have the teeth extracted and replaced with complete dentures. She healed uneventfully from the extractions and

Figure 1.35 Postoperative clinical view of patient in 1.33 with definitive maxillary complete denture and mandibular fixed hybrid implant prosthesis.

Figure 1.36 Clinical view of a patient 8 years post insertion of a maxillary overdenture supported by two overdenture abutment teeth. The abutment teeth were restored with copings. This patient lost a minimal amount of bone in the anterior maxillae secondary to the retention of these two abutment teeth.

then proceeded with implant placement and reconstruction with a maxillary complete denture and mandibular fixed hybrid prosthesis (Figure 1.35).

Morrow and Brewer (1980) presented a treatment planning concept for debilitated dentitions prior to the advent of implant dentistry as we know it today. They considered overdentures to be indicated if four or fewer retainable teeth remained in a dental arch. They considered fixed or removable partial prosthodontic treatment, or a combination, if more than four teeth remained. They stressed that the four teeth were not immutable and that treatment planning required flexibility as to the number and position of the abutments for overdentures. Morrow and Brewer recognized
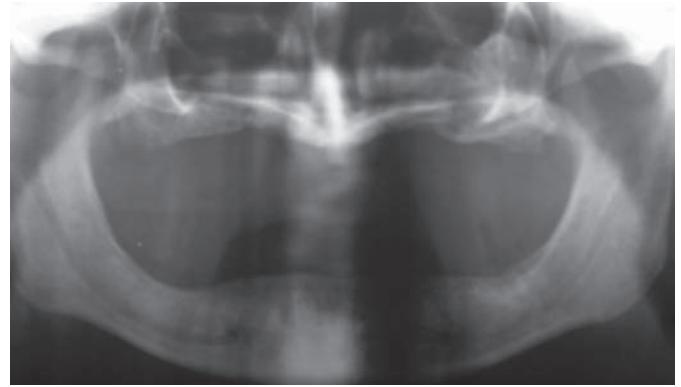

Figure 1.37 Panoramic radiograph of a patient who lost his maxillary teeth 25 years prior to this radiograph. The mandibular teeth were lost 2 years prior to this radiograph. Note the significant bone resorption that has occurred in the maxillae compared to how little bone has resorbed in the mandible.

that overdentures were not appropriate for every patient, but they also stated that there were few situations where complete dentures were preferable to overdentures, as they routinely saw the results of long-term edentulism and the difficulties associated with adaptation to complete dentures (Figures 1.36 and 1.37).

SUMMARY

Clinicians must constantly update their knowledge and clinical skills in order to provide state-of-the-art care to patients. Clinicians are responsible for gathering the physical and radiographic data required for an accurate diagnosis of patients' conditions. They are also required to provide treatment options to patients that are evidence based and predictable. Financial considerations also need to be taken into account by patients and clinicians. The treatment planning process will become less problematic for clinicians who do keep their knowledge and skills current, perform comprehensive examinations, and provide evidence-based treatment options. Patients will also benefit by having treatments performed that are best for them at the time the decision was made.

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