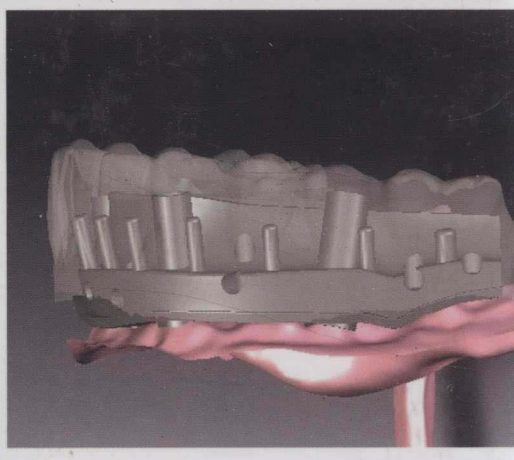
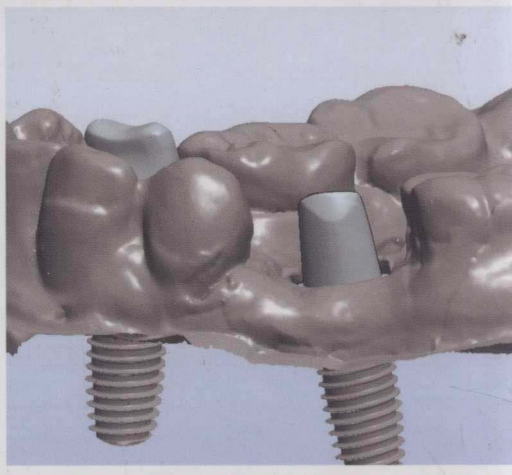
THIRD EDITION

Implant Restorations

A Step-by-Step Guide

CARL DRAGO





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A Step-by-Step Guide

3rd Edition

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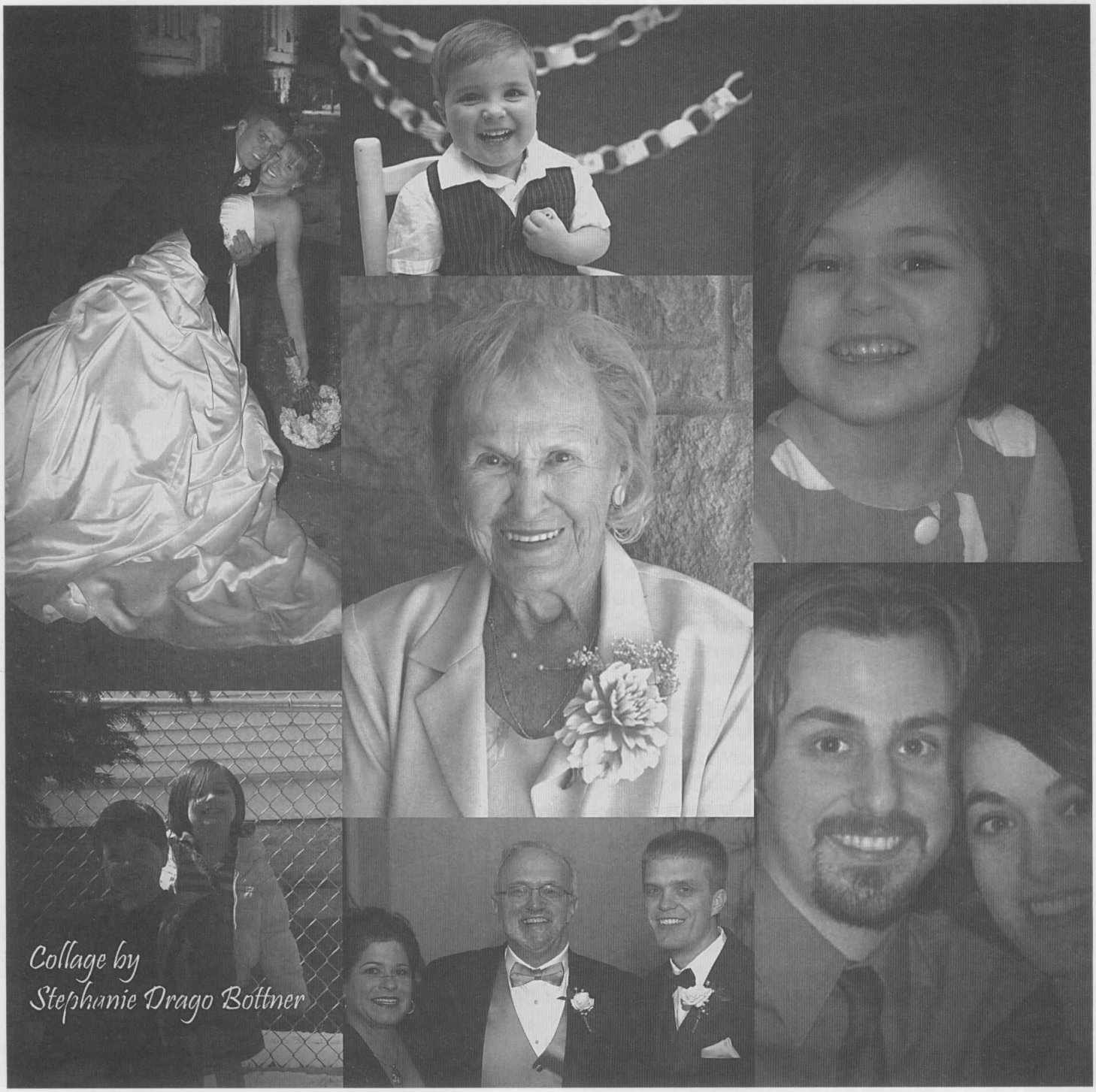
IMPLANT RESTORATIONS

Dedication

I would like to dedicate this textbook to my family, especially my mother, the late Betty Brisgal Drago (1920–2013)



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Foreword

Dental implantology is clearly one of dentistry's most exciting success stories. I was an invited scientific reviewer at the1982 Toronto Osseointegration Conference where Per-Ingvar Brånemark introduced the osseointegrated implant to North America. At this landmark conference, organized by Professor George Zarb, I was struck by the strong research foundation and the scientific orientation of the speakers. For more than 30 years, dental implantology has continued this strong evidence-based orientation and has achieved unparalleled success. The National Library of Medicine has indexed over 11,000 publications related to dental implants since 1989. The remarkable success rate and longevity of dental implants are well documented with over 600 implant-related randomized clinical trials, systematic reviews, and meta-analyses indexed by the National Library of Medicine. These clinical studies are supported by over 1800 animal studies.

Critical to the success of implants, however, are the clinical skills, the timing, and the coordination of the complex implant procedure. In this text, Dr. Drago has translated the enormous basic science and clinical research knowledge into practical step-by-step clinical procedures that can be implemented in a private practice setting. Detailed knowledge of the complex coordination of procedures, staff, and referrals for implant success is provided. This textbook, which is rich with clinical pictures and figures, will serve as an invaluable resource for the clinician, the office staff, the technician at the dental lab, and the referral team.

This text's author, Dr. Carl Drago, has been on the ground floor of implantology with over 30 years of clinical, research, and academic experience. He completed his first implant restoration in 1985 and has incorporated the many technological innovations that are critical for the success of implants into his clinical and academic careers. He has held faculty positions in four dental schools; published over 65 implant-related articles, two chapters, and three previous books; and presented over 150 implant courses at dental schools, study clubs, and dental meetings. He has lectured nationally and internationally and has served on a National Institutes of Health review committee on implants. Perhaps most importantly, he has over 30 years of practical clinical experience with implants. These experiences have provided him the insight and clinical judgment necessary to successfully translate the massive amount of basic and clinical implant-related research into a practical guide for the clinician.

This textbook was particularly exciting for me to review, as I was Dr. Drago's supervising professor for his Master's degree in the early 1980s at the University of Texas Health Science Center at San Antonio. Dr. Drago's passion for bringing the best science to clinical problems was clearly evident while completing his Master's degree in my laboratory at San Antonio. It is very gratifying to follow this scholar's continuing efforts to merge science and practical *hands-on* aspects into clinical practice. Dr. Drago's experiences in academics, private practice, and industry have given him a unique vantage point to succeed at this mission, as is documented in this practical textbook.

In summary, this clinical evidence-based text provides the step-by-step practical skills, procedures, and coordination strategies that allow the practitioner to achieve the high levels of success obtainable with modern implants. It is an important critical step in the translation of our best science to the clinical setting.

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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/

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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 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).

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

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 ($)
Impression		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