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Editors

Treatment Planning In Implant Dentistry

Second Edition

Springer

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Foreword

In 1982, the historic Branemark Conference on osseointegration was held in Toronto, Canada, and forever changed the course of restorative dentistry. The conference highlighted long-term data on multiple splinted titanium root-form implants inserted with a detailed surgical protocol. The implants were placed in the anterior mandible and supported hybrid prostheses opposing a maxillary complete denture. The outcomes were astounding, and clinicians worldwide scrambled to avail themselves with this amazing new technology.

In the initial few years of osseointegration, only one company was approved for use and sold in the United States. The sale of the surgical and restorative components from this company was restricted to surgical and restorative specialists (oral and maxillofacial surgeons, periodontists and prosthodontists) who had attended a certified course on the topic. This was likely a wise decision, and while limiting commercial sales, it tilted the odds of successful outcomes of therapy because of the quality and calibration of the providers.

In subsequent years, multiple manufacturers entered the market, and implants and their components became available to anyone who wanted them. Amidst this chaos, peer-reviewed research and case reports began to explore how and when clinicians could stray from the original Branemark protocol and still sustain high levels of clinical success. Clinicians also explored the use of implants in different types of bone, in partially dentulous cases, in the aesthetic zone and as anchorage of orthodontic movement. In this period, private practitioners, and dental schools, including the University of Southern California School of Dentistry (USCSD), contemplated the optimal process for incorporating this new technology into their practices and/or curriculum.

As Chair of the Department of Restorative Dentistry and Director of the Advanced Education in Prosthodontics Program at USCSD, understanding that implementing an implant dentistry programme at USCSD was essential, I made two critical decisions. The first was to appoint Dr. Winston Chee as the Director of Implant Dentistry, which was not centred in one department, but crossed multiple disciplines. Dr. Chee possessed the knowledge, clinical skills and personal courage to integrate this emerging technology into an already crowded and complex curriculum. The second, made in concert with Dr. Chee, was that implant dentistry was a restorative, rather than surgically driven, discipline.

The implant dentistry programme at USCSD has always been centred in the traditional periodontal-prosthetics treatment planning seminar, attended by resi-

dents and faculty from most of the specialty programmes for 2 h every week. The strength of the seminar was the presence of many highly qualified full- and part-time faculty in all clinical disciplines who had widely divergent philosophies regarding the optimum treatment approach for patients with complex periodontal and restorative needs. This inevitably resulted in detailed, passionate discussions regarding almost every patient presented in the seminar; however, consensus was eventually developed, and patient treatment initiated. In the early years, all implant-related treatment was completed in the specialty programmes. In the early 1990s, it was expanded to allow pre-doctoral students to restore implants that were placed in the advanced periodontics programme, with the students participating in the diagnosis and treatment planning phase under the supervision of a prosthodontist. The students would also assist in the implant placement appointment. Eventually, the advanced prosthodontics residents began placing implants under the supervision of advanced periodontics faculty.

Another key player in USCSD's implant programme was Dr. Sajid Jivraj who joined the faculty after graduating from the Advanced Education in Prosthodontics Program. Drs. Jivraj and Chee, along with other specialists from USCSD, teamed together to author numerous articles on a wide variety of topics related to implant dentistry that were published in the British Dental Journal.

These articles formed the core of the first edition of this textbook, and subjects covered included screw-retained versus cement-retained restorations, immediate implant placement, biomechanics and occlusion, treatment planning in the aesthetic zone, edentulous maxilla and mandible and many others.

The authors based the articles on evidence-based information, and all possessed high ethical standards and excellent clinical skills and made recommendations using a patient-centred approach.

Drs. Chee and Jivraj, and the other contributing authors, are to be congratulated for compiling a contemporary, comprehensive text to help guide clinicians and residents in various specialty programmes entering the world of complex interdisciplinary dental treatment of patients using dental implants.

Professor (Retired), The University of North Carolina at Chapel Hill
Chapel Hill, NC, USA

Terry Donovan

Preface

Dr. Jivraj and I co-authored the first edition of Treatment Planning in Implant Dentistry in 2007; many things have changed since then, and many things have not; these "things" would include decision-making, effects of systemic health, effects of medications, new materials and new methods, and the list goes on.

It remains that dental implants are one of the most significant developments in replacing missing teeth; when osseointegrated implants were introduced to North America in 1982 at the Toronto Conference, a strict protocol was presented and adhered to.

Since then, there have been many deviations to the early days of delivering dental implants; in the beginning, osseointegrated dental implant providers were limited to oral and maxillofacial surgeons, periodontists and prosthodontists; initially, most of these disciplines obtained training from continuing education programmes and then developed their own skills and pathways. Soon, dental implants were incorporated into the respective postgraduate programmes where all graduates were trained with the usage of dental implants. At present, dental schools have included dental implants into their curriculum, and replacing teeth with dental implants is accepted as a norm. In some dental schools, implant placement is taught to all students as routine, not to make them experts but to introduce them to the mode of treatment for patients.

With time, many innovations were implemented by clinicians, better delivery systems were developed, newer materials were introduced for clinical procedures and outcomes of treatment provided the profession with more information.

Most of the continuing education and publications that are available are focused on techniques and materials. There are in general three phases of treatment: first (1) data collection, diagnosis and then development of a treatment plan; (2) executing the treatment plan with suitable outcomes; and (3) maintenance and care of the patients.

This second edition of the book will focus on the first phase which is diagnosis and treatment planning; each chapter of the book with feature element of providing dental implants attempts to help clinicians make the best choice for their patients.

All the contributors to the book chapters are alumni of the Ostrow School of Dentistry of the University of Southern California; the chapter authors are periodontists and prosthodontists; our programme meets every Thursday for 2 h in treatment planning sessions—we have all the residents attend and many faculty in attendance.

Each resident in turn will collect data of patients that will be treated; the resident will present the data collected with images and then develop a course of treatment. Every resident from the time that I was a resident would be asking "why is the patient here", what is the "biologic price" and "if you do not know where you are going, you never get lost".

Why is the patient here—what are the patient's wants and needs, and what are the patient's complaints? For the clinician's thoughts, what is our diagnosis? How will management be for this patient?

What is the biologic price? What is the least invasive path towards a good outcome.

If you do not know where you are going, you never get lost: this is a paraphrase of a saying by Henry Kissinger, "if you don't know where you are going, every road will get you nowhere". One clear example of this would be some facilities which seem to have almost all their patients have the same treatment protocol. Wouldn't a proper diagnosis dictate differing treatment? Would some clinicians be "lost"?

Our alumni do not graduate as clones—based on the treatment planning programme, we all develop differently, but we consider all the factors that drive our treatment plans. It is the most important phase that we try to inculcate to our residents.

Readers of this book will clearly be able to develop a customized treatment plan that will lead to predictable and favourable outcomes for their patients. In more complex care where patients may require more tooth replacement with time, decisions to use implants already placed to support future restorations can be very helpful. Dr. Jivraj and I have had an association for over 30 years; it has been a pleasure to see him grow in stature in our profession and become a leader in clinical practice and education. It is my privilege to co-edit and co-author this book with Dr. Jivraj and help all clinicians with decision-making for their implant-related patient treatments.

Los Angeles, CA, USA Winston Chee

Acknowledgements

Acknowledgements by Winston Chee

There is nothing impossible to him who will try—Alexander the Great

From the first edition of Treatment Planning in Implant Dentistry to now, the task to update this edition was much more tedious than I thought.

To My Family

I want to thank my wife, Dr. Tina Siu, for being supportive of me in all facets. I would and could not have a great professional and academic journey; she has given me the time, the encouragement and any help that I would ask for. She was also responsible for raising my two children to adulthood; my daughter, Michelle, is a neurologist and my son, Daniel, an orthodontist. I cannot be more blessed with my beloved wife and family.

To My Mentors

Dr. Chong Lin Chew was an influential professor that I had from my dental school in Singapore; he was trained in the University of Indiana as a prosthodontist and dental materialist. He was stern as a teacher and encouraged me to get into an advanced prosthodontics programme to improve my professional career. From my relationship to him as a student, we are good friends and colleagues. My other mentor is Terry Donovan, who is an alumnus of our Advanced Education in Prosthodontics; he offered me a job as a faculty member at the University of Southern California and was very supportive. We have published many articles together. He had appointed me as his Co-director of the Advanced Prosthodontics Program and then later the Director of the Program. He also tasked me to initiate the implant dentistry programme at the dental school. It was a great journey for me, and along the way, I learnt much about dentistry and much about people. To my two mentors, I am thankful and indebted.

To My Alumni

I am so pleased to see you all gain stature in your professions, some in academics, some as researchers and many as clinicians. We have also had meetings in different continents, and we have all gathered to meet. We congregate to learn and to rekindle our friendships. Interestingly, we have many of our alumni meet each other for the first time—where they think and discuss issues about prosthodontics—and there is a strong commonality that develops.

I want to especially thank our alumni who contributed chapters to this book and those who shared their images with us.

To Saj

He was the one who coaxed me into editing this book, and it is only now that we have finished it that I am thankful—Saj you can edit the next one.

Acknowledgements by Saj Jivraj

> Don't fear the difficult times in life. They are the best way to prove to yourself that you can do difficult things—Matthew Hussey

As the years pass, the things that become important really come into perspective. It is to these important aspects of my life that I wish to dedicate this book.

To My Family

First and foremost, and without hesitation, I would like to thank my beautiful wife, Dilaz. She is my life, my inspiration and a wonderful mother to my two beautiful children, Sara and Zain. You said "yes" to everything which should have been "no"; you allowed me the time to become professionally what I dreamed about as a young graduate. You persevered when times got tough and gave up everything moving with me to the United States. You supported me through school and spent countless evenings on your own while I was preparing for the next day. For the countless hours I did not spend with you and the kids and for the unconditional love, friendship and unwavering support, I thank you. To Sara and Zain, words cannot express the profound love I have for you. You have taught me to appreciate life in ways I thought were not possible; the little things you do and say make me a better person, husband and father. I will always be by your side to support you in anything you do. Work hard and dream big and believe in the impossible. You can do what you set your mind to, and do not let anybody else tell you otherwise.

I would also like to dedicate this book to the memory of two exceptional women: Mrs Amina and Rukiya Jivraj who were taken from this world far too early. Not a day goes by when I do not think of you. I feel your presence in all the important decisions that I make. I miss you both dearly and wish we could have created more memories together. When people say, "Life is too short", I now understand what that means. I do know that we will meet again, and it is that day to which I look forward. I would also like to acknowledge Mrs. Zarina Parekh who became a second mother to me and who always inspired me to be and do my best and to never give up. Thanks also goes to Mehboob Jivraj, my eldest brother, who from a young age gave me the confidence and belief that I could do anything I set my mind to.

To My Colleagues

I would like to thank Drs. Winston Chee, Terry Donovan and George Cho, who believed in me and who provided me with the opportunity to complete my education in prosthodontics at the Herman Ostrow USC School of Dentistry. Thank you is not enough. I want you to know that I will be forever grateful and that opportunity

Dr. Robert Schneider is also acknowledged, who opened doors and believed that one day I would realize my potential at a time I was being told otherwise. I learned that believing in yourself is important. Your voice is important, and your dreams are important, because there is one you and you are worth it. I learned that even if people stand in your way as an obstacle, you must find a way to overcome it.

I would like to acknowledge all the students and faculty involved with the Advanced Prosthodontics and Periodontics Program at Herman Ostrow USC School of Dentistry from whom I have learnt so much and continue to do so.

I would be remiss if I did not thank my team at Anacapa Dental Art Institute: Laura Castellanos RDA who has assisted me for the last 10 years and has been instrumental in implementing protocols we use on a day-to-day basis—she is someone who always works with a smile on her face and makes a complex day go very smoothly; Sonia Escamilla for her positive demeanour, amazing leadership and ability to bring the best out of people; Ale Prado for keeping everything light when the day gets tough and willingness to do whatever it takes; Maricel Estoque for her excellent patient management skills and warm and caring attitude towards everyone she meets; Erika Simental for her kindness and professionalism; Amber Padilla RDH who started the journey with me as my assistant and progressed to becoming a wonderful hygienist; and Darlene Herrera RDH who has assisted me in the maintenance of these patients and whose attention to detail is exceptional. I cannot forget Karina Gutierrez, Yomaly Gutierrez, Ashley Gutierrez, Vanessa Murillo, Nancy Lara, Griselda Barraza Adriana Perez, Elain Carrera, Chelsea Benavidez and Alexa Ayala. My whole team is amazing. They make coming into work each day enjoyable and always go the extra mile for our patients. Their dedication and commitment are second to none, and I want to let you know that I appreciate everything you do. Special thanks to Octavio Guerra who behind the scenes makes our practice better every day.

I would like to thank the team at Digital Dental Arts Laboratory in Ventura for their exceptional work ethic and the ability to get the job done: Artem Avanesov, Raffi Rshtuni and Yvette Mistajo. Without a great laboratory partner, we cannot do what we do for patients.

To My Patients

Thanks to my patients who make each day enjoyable for me. Thank you for allowing me to compile these clinical photographs. It is caring for these patients that makes my profession so rewarding and makes me look forward to the next day.

To God

Thanks to God who has made everything possible. His guidance has allowed me to pursue my dreams and realize them.

Fight On

Contents

Rationale for Dental Implants

1

Winston Chee and Saj Jivraj

1.1 Non-replacement of Missing Teeth

At about 18 years of age, we have a full complement of teeth; we have 32 teeth that make 16 opposing tooth units. More often than not, many of us have our third molars removed and consider 28 teeth to be accepted as the norm. As time passes by, we observe that the occlusal system does not remain stable, and physiological and pathologic changes take place. Teeth shift, teeth wear, caries and periodontal disease cause tooth loss.

A dogma that many dental textbooks and many teachings at dental schools purport is that a full complement of teeth is required to have a healthy masticatory system that will satisfy oral health and function. For those that peruse the literature, the evidence leans toward the concept that a full complement of teeth is not necessary.

DeVan stated, "Our objective should be the perpetual preservation of what remains rather than the meticulous restoration of what is missing" [1].

Ramfjord stated, "Satisfactory function and occlusion as well as neuromuscular stability usually can be established if all the anterior teeth and bicuspids are present and the diet of modern man does not require an intact dentition to meet functional demands" [2].

Waerhaug stated, "Since the construction or a bridge or denture may have deleterious effects on periodontal health, this view should be re-examined. It is suggested that many patients would be better off if bridges or partial dentures were not constructed" [3].

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Fig. 1.1 Image of a patient with shortened dental arch; number of teeth is sufficient to fill buccal corridors and function adequately. (Figs. 1.1–1.4 courtesy of Dr. Sangho Byun)

In many cultures, the appearance of missing anterior teeth may not be acceptable and will demand replacement by patients to allow social interaction; more will be discussed with tooth replacement and aesthetics in this book (Chaps. 13 and 14). Patients with missing posterior teeth are less likely to ask for replacement but might be more motivated by clinicians to have them replaced (Chap. 12).

When suitable, our profession should offer the shortened dental arch (SDA) as an option for treatment. The shortened dental arch is a concept where most patients can function with fewer tooth pairs (opposing teeth) than full complements of teeth, with the SDA patients that can be satisfied with fewer teeth. It is our goal in dental care to ensure maintenance of a functional dentition throughout life. Having self-esteem, aesthetics, function and oral comfort would satisfy most patients; they may be satisfied with less than 14 occluding tooth pairs; limiting treatment goals may help to prolong dentitions [4–8] (Figs. 1.1, 1.2, 1.3 and 1.4).

1.2 Removable Prostheses

This section refers to removable prostheses without the use of dental implants. Removable prostheses do need to be provided when there are limitations due to finances for use of dental implants and when systemic health conditions preclude the use of dental implants.

Bite forces with complete dentures are about 20% of a dentate patient; this is largely due to pain on biting when mucosa is pinched between the denture base and underlying bone [9]. Other reasons that compromise function and comfort are instability, a gag reflex, xerostomia and psychological inability to accept removing the prostheses [9–12].

Even though there are patients who are satisfied with complete denture prostheses, these patients suffer continued bone loss over time. With age, changes that include a reduced saliva flow can cause poor retention and discomfort when using complete dentures. These factors can reduce satisfaction of the prostheses [13] (Figs. 1.5 and 1.6).

Fig. 1.2 Occlusal view of shortened dental arch maxilla with 10 units; all units are implant supported

Fig. 1.3 Occlusal view of shortened dental arch mandible with 10 functional units; two distal units are implant supported

For patients who present with complete dentures, they should be introduced to the benefits of incorporating dental implants for their betterment. Patients who may present with a terminal dentition likewise should be presented with the option of dental implants [14]. With the use of complete dentures, stability of the prostheses can be compromised with bone resorption, reduced saliva flow and reduced neuromuscular control. In addition, pain and discomfort are also manifested due to occluding forces being directed to the oral mucosa as mucosa is not meant to support occlusal forces.

With placement of implants, several types of restorations for edentulous patients can be offered, overdentures that are implant retained and tissue supported, overdentures that are implant retained and supported and fixed prostheses supported by implants. These restorations will be described in more detail in other chapters (Chaps. 15 and 16). When implants are placed, they will prevent continued resorption of bone in proximity; they will add to stability and retention and provide support for the restorations (Fig. 1.7).

For removable partial dentures (RPDs), their indications should be considered with care; the use of RPDs has been shown to shift the ecology of the oral cavity toward decay and periodontal disease. Literature has been presented that clearly

Fig. 1.4 Anterior view of both arches in occlusion

Fig. 1.5 Retained teeth preserve bone due to function

Fig. 1.6 Edentulous ridge with no stimulation to bone

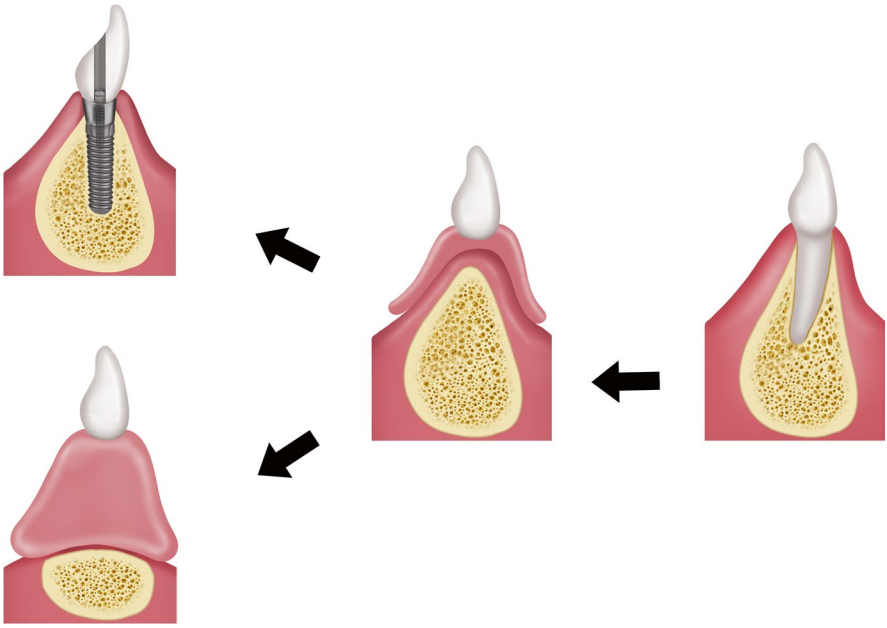

Fig. 1.7 Retention of bone with implant placed compared to the use of a removable prosthesis over time

demonstrates that teeth related to a partial denture develop decay more than teeth that are unrelated to the RPD [15]. Similarly, increased mobility and attachment loss occur at higher rates to teeth that are related to the removable prostheses [16]. With distal extension, RPD support for the missing teeth depends on mucosal support; lateral forces applied to the abutment teeth lead to forces that are detrimental to the abutment teeth [17]. In addition, in areas of mucosal support, the underlying bone is resorbed due to occlusal forces directed to the distal extension areas.

In addition, much of the dogma about clasp designs and altered cast impressions is not supported by the more current literature. For example, there are no differences to abutment tooth mobility with differing clasping assemblies though some design methods have been proposed in which they are able to prevent increased mobility to abutment teeth [18, 19]. Many studies indicate that the shortened dental arch can satisfy functional needs of many patients; avoiding the use of removable partial dentures would be a better option than using RPDs to replace missing posterior teeth [20–23]. When consulting with a patient, they should be informed that implant-supported restorations can replace distal extension partial dentures, and they can be told that a shortened dental arch can provide function without the use of an RPD but there can be some wear of the remaining teeth and shifting of the remaining teeth that can develop diastema. Alternatively, implant-supported restorations will be able to distribute forces to the dentition and will reduce any tooth migration.

Fig. 1.8 Adhesive-bonded fixed partial denture with support by one abutment

Fig. 1.9 Anterior view of restoration of mandibular right lateral incisor forces is minimal in this site

1.3 Fixed Partial Dentures Supported by Teeth

Adhesive-type fixed partial dentures are a category of fixed partial dentures where pontics are supported by being adhesively attached to abutment teeth; they can be indicated for use in short spans and are more efficacious in anterior teeth where less forces are applied. Survival rates after 10 years are reported to be about 89%, but many have been re-cemented at intervals, and additionally, chipping of ceramic layering occurs often over periods. Counter-intuitively, bonding to a single abutment will have fewer failures of bonding and will have longer periods of being attached compared to multiple abutment teeth [24, 25] (Figs. 1.8 and 1.9).

Conventional fixed partial dentures (FPDs) have been considered the standard of care prior to the advent of implant therapy. When preparing teeth to support pontics, a significant amount of tooth structure needs to be removed for an aesthetic outcome (Figs. 1.10, 1.11 and 1.12). This removal of tooth structure compromises the longevity of the tooth and can in some instances result in endodontic, periodontal and mechanical complications [26–29]. The long-term survival of fixed partial dentures has been reported to be 69% at 15 years and 46% at 20 years. Factors that predispose to failure included non-vital abutments and longer span prostheses [30–32]. The most common causes of failures are fracture of abutments and caries. With the

Fig. 1.10 Patient was using a removable partial denture; note the plaque accumulation; teeth are unrestored; before the advent of implants, these teeth were prepared

Fig. 1.11 A significant amount of healthy tooth structure was removed to accommodate the restoration

longer the span of an FPD, there is more difficulty to have abutments that do not fit as well due to distortions of materials—some materials used expand and some contract, leading to less precise fit causing cement wash-out and decay. Figures 1.13, 1.14 and 1.15 illustrate a fixed partial denture spanning #2–5 with #2 and #5 as abutments (maxillary right second molar to maxillary right #5 first premolar). The patient presents with the FPD displaced; intraorally, the images will show that the distal abutment #2 has been decemented for a period of time; the discoloration is visible, and some decay on the occlusal surface of the tooth preparation is evident; after this, decementation and mobility of the prosthesis cause the anterior abutment #5 to fracture.

1.4 Dental Implant Placement

It is required today that the use of dental implants is taught by all dental schools in North America; most of the schools incorporate patient treatment as part of the clinical experience for all pre-doctoral students. Several of the dental schools provide an opportunity for pre-doctoral students to place implants. In both aspects, restoration of implants and surgical placement of the implants will introduce the future dental professionals to the benefits and risks of providing dental implants.

In comparison to the other methods that have been described above, replacing teeth with osseointegrated implants is a significant advancement when replacing