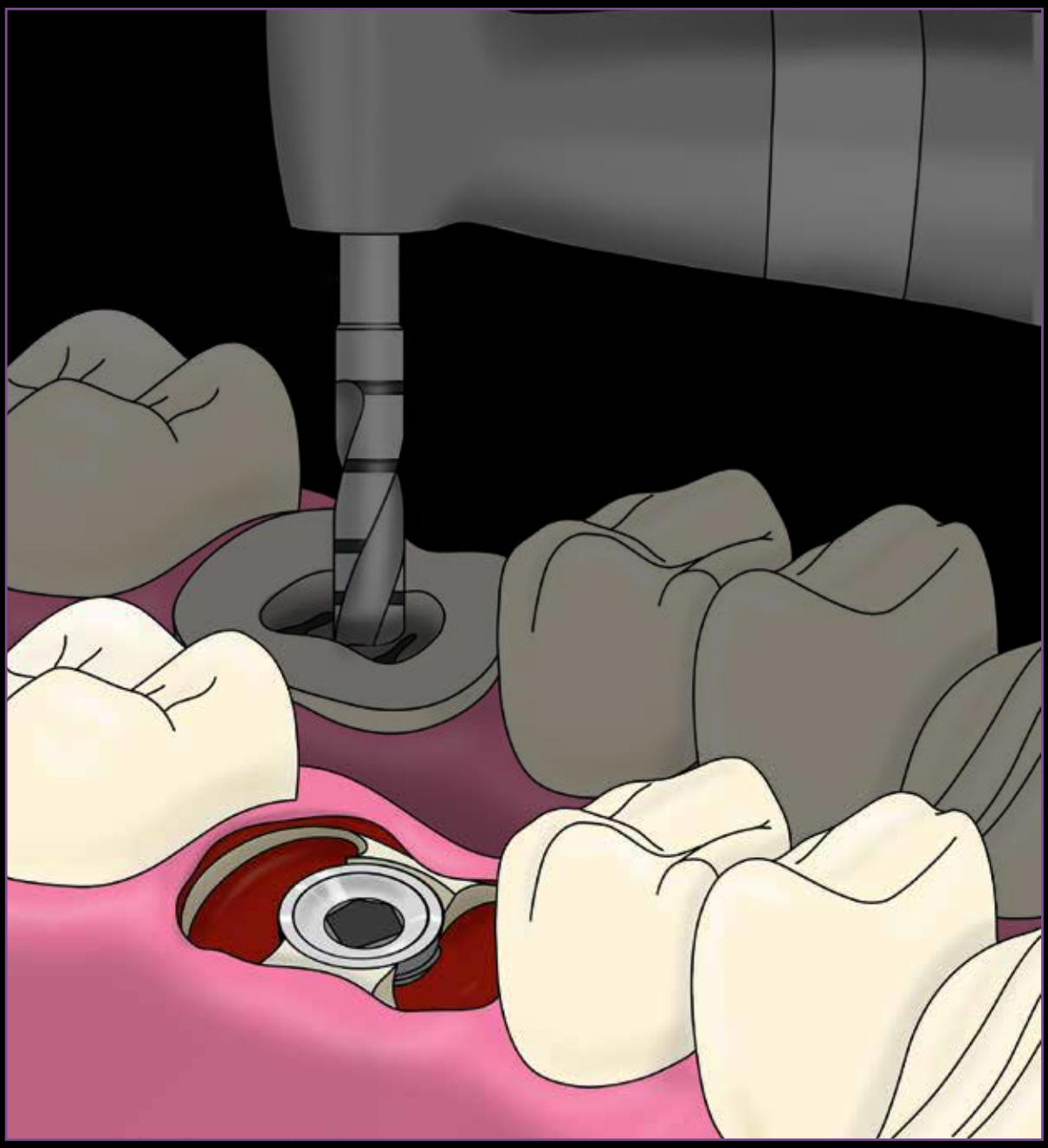
IMMEDIATE MOLAR IMPLANTS

EDITED BY
Douglas Deporter, DDS, Dipl Perio, PhD
Mohammad Ketabi, BDS, DDS, MDS



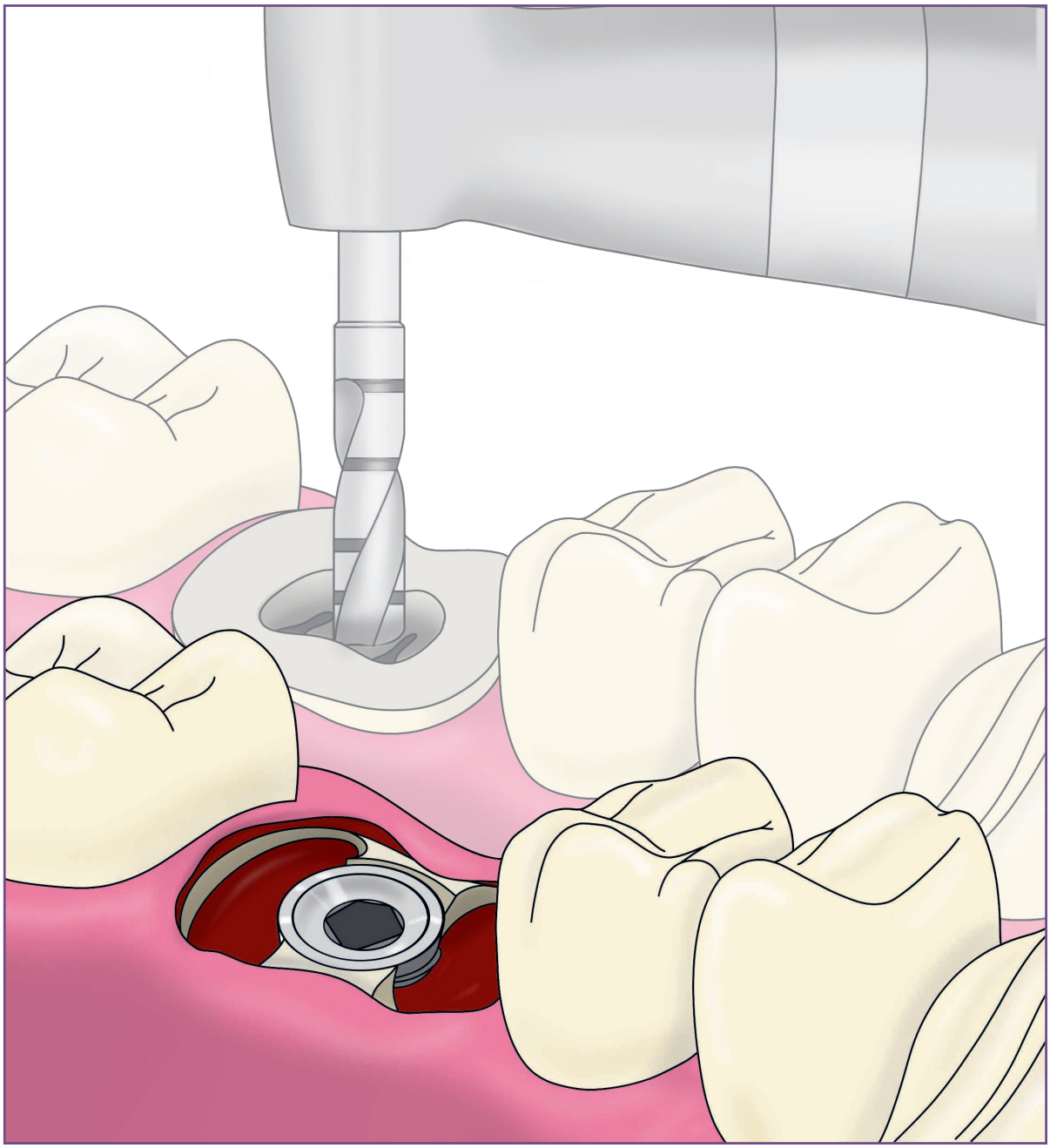
QUINTESSENCE PUBLISHING

Immediate Molar Implants

Dedication

Writing this book during a pandemic was a major challenge for us and our contributors, but we persisted. And what allowed us to remain optimistic was having the opportunity to interact with the very bright and talented graduate periodontic residents in both of our departments. It continues to be a humbling experience to interact with these outstanding young men and women, and it is to them that we dedicate this book.

Douglas Deporter & Mohammad Ketabi



IMMEDIATE MOLAR IMPLANTS

Edited by

Douglas Deporter, DDS, Dipl Perio, PhD

Professor
Discipline of Periodontology and Oral Reconstruction Center
Faculty of Dentistry
University of Toronto
Toronto, Canada

Mohammad Ketabi, BDS, DDS, MDS

Professor
Department of Periodontology and Implant Dentistry
Faculty of Dentistry
Islamic Azad University, Isfahan Branch
Isfahan, Iran

Adjunct Professor
Faculty of Dentistry
University of Toronto
Toronto, Canada

QUINTESSENCE PUBLISHING

Berlin | Chicago | Tokyo
Barcelona | London | Milan | Mexico City | Paris | Prague | Seoul | Warsaw
Beijing | Istanbul | Sao Paulo | Zagreb

One book, one tree: In support of reforestation worldwide and to address the climate crisis, for every book sold Quintessence Publishing will plant a tree (https://onetreeplanted.org/).

Library of Congress Cataloging-in-Publication Data

Names: Deporter, Douglas, editor. | Ketabi, Mohammad, editor.
Title: Immediate molar implants / edited by Douglas Deporter, Mohammad Ketabi.
Description: Batavia, IL : Quintessence Publishing Co, Inc, [2022] | Includes bibliographical references and index. | Summary: "This book systematically describes the current best practices for immediate implant placement in molar sites, including careful case selection, implant types, placement protocols, and adjunctive procedures to ensure implant success"-- Provided by publisher.
Identifiers: LCCN 2022017464 (print) | LCCN 2022017465 (ebook) | ISBN 9780867159547 (hardcover) | ISBN 9780867159813 (ebook)
Subjects: MESH: Immediate Dental Implant Loading | Molar | Dental Implants
Classification: LCC RK667.I45 (print) | LCC RK667.I45 (ebook) | NLM WU 640 | DDC 617.6/93--dc23/eng/20220801
LC record available at https://lccn.loc.gov/2022017464
LC ebook record available at https://lccn.loc.gov/2022017465

A CIP record for this book is available from the British Library.
ISBN: 978-0-86715-954-7

QUINTESSENCE PUBLISHING
USA

Quintessence Publishing Co, Inc
411 N Raddant Rd
Batavia, IL 60510
www.quintpub.com

5 4 3 2 1

Publishing Director: Bryn Grisham
Editor: Marieke Swerski
Design: Sue Zubek
Production: Sue Robinson

Printed in Croatia

CONTENTS

PREFACE

It is not that people lose their dreams because they've grown old—rather, they've grown old because they have lost their dreams.

My coeditor for this book, Mohammad Ketabi, reached out to me over a decade ago asking if he could visit with me on sabbatical for 6 months, and when he did come, we immediately felt simpatico working together. So comfortable in fact that he has spent similar academic visits every few years since then. On his last visit, he suggested that we undertake a systematic review on immediate molar implant (IMI) treatment, which we did and published in 2016.[1] A second paper outlining suggested guidelines for successful outcomes with IMIs followed in 2017.[2] Both of these publications generated enormous interest from others worldwide, so much so that we decided to undertake the current book project. Mohammad already had considerable experience using and teaching IMI methodology in Iran and elsewhere.

Make no mistake: Treating patients with IMIs is no romp in the park. Like the late luminary P-I Brånemark who conceived osseointegration as a medical breakthrough, those who pioneered the use of IMIs clearly knew the importance of dreaming and encouraged the rest of us to do so too. One by one, small modifications in technique have led to big gains for patients in less than a generation. However, the procedures using IMIs require careful planning, preferably with the assistance of cone beam computed tomography, considerable skill, and a good working knowledge of anatomy and bone biology. Feeling comfortable with doing localized, indirect sinus floor elevations as originally proposed by Robert Summers[3,4] is also a prerequisite with undertaking maxillary molar IMIs. And, of course, using minimally invasive surgery and knowing when and how to use particulate bone graft materials and barriers and/or to undertake immediate nonocclusal loading are also critical.

There is no one way to do immediate molar implantation, as will be seen in this book. Differences among experts do exist, and those experts who have contributed to this book have made this clear. However, all agree that a molar implant should be placed ideally into the tooth's interradicular septal bone and initially stabilized by contact with the buccal and linguopalatal buttresses of bone. Gaps should always be left buccally to avoid any contact with the buccal plate, especially if the latter is thin, and while gap grafting may not be essential, the clinician must know when grafting is necessary to avoid unwanted local buccolingual/palatal shrinkage of the alveolar ridge, leading to crestal bone loss, gingival recession, unfavorable soft tissue coloration, and eventually implant hardware exposure.

I personally have learned a great deal from interacting with the experts who contributed to this book, as I believe you will as well. All of them were forthcoming and generous in sharing their experiences and knowledge, and all are still undertaking pioneering work on a day-to-day basis. Let's keep the dream going strong!

References

1. Ketabi M, Deporter D, Atenafu EG. A systematic review of outcomes following immediate molar implant placement based on recently published studies. Clin Implant Dent Relat Res 2016; 18:1084–1094.
2. Deporter D, Ketabi M. Guidelines for optimizing outcomes with immediate molar implant placement. J Periodontal Implant Dent 2017;9:37–44.
3. Summers RB. The osteotome technique: Part 3—Less invasive methods of elevating the sinus floor. Compendium 1994;15: 698–710.
4. Summers RB. The osteotome technique: Part 4—Future site development. Compend Contin Educ Dent 1995;16:1090–1099.

ACKNOWLEDGMENTS

Compiling and editing a book for a highly regarded publisher like Quintessence is no small task, but their team made this second book with them a pleasant and rewarding experience. Despite delays due to COVID-19, the book Publishing Director, Bryn Grisham, was always supportive and understanding. In the end, this book project has kept me focused and (for the most part) sane during the coinciding unbelievably stressful pandemic that has interrupted all of our lives.

I also am truly grateful for the enthusiasm and support provided by our international group of contributors, each one a bright star helping us to unravel all the mysteries of immediate implant placement with or without immediate function. They have taken what seemed impossible and made it become reality. Everyone has been a privilege to work with, so generous with their knowledge and expertise and humble in their accomplishments. Thanks too to the graduate periodontic residents in our program at University of Toronto who were always keen to help, especially Drs Quang Nguyen and Ryan Noh. During the project, Ryan revealed that in addition to being a talented clinician, he is also a budding but already accomplished medical illustrator and offered his time and talent to do most of the illustrations in the book. The young people who we now receive in our training programs are truly gifted and a pleasure and honor to teach. I anticipate that many of them will contribute in a major way to the future of periodontics and implant dentistry.

Douglas Deporter

Special Thanks to Ryan Noh

Ryan Noh is currently enrolled in the Graduate Periodontic Program, Faculty of Dentistry, University of Toronto. Having been raised by parents who were both artists, he found a love of drawing at an early age. He worked selflessly and enthusiastically to create the majority of the artwork in this book, for which we are forever grateful. Hopefully, he learned a lot about immediate molar implants in the process.

During the past 20 years of my career as an academic, teacher, and practicing clinician, I have devoted much effort toward understanding, investigating, and applying the principles of implant dentistry. During this time, there have been so many changes and improvements in the field, but none more interesting and intellectually challenging for me and my colleagues and students than working toward the simplification and predictability of immediate molar implant (IMI) treatment.

From a patient's point of view, immediate implantation of any condemned tooth is perceived to be the most desirable treatment approach, as it requires the least time and least number of surgical interventions. As has been reported in multiple recent literature reviews, IMIs can have high survival rates, at least in the hands of experienced clinicians using well-defined protocols, and this book was conceived to bring together many of these internationally respected and acclaimed experts to share their hard-earned knowledge in using IMIs successfully.

Firstly, I especially want to thank my dear mentor, Prof Ali Akbar Khoshkhounejad, for his ongoing astute advice and generosity in sharing his extensive experiences with IMIs. Seeing and discussing with him his many remarkable clinical accomplishments was always an encouragement to me in bringing this book to completion. I also would like to thank Prof Moeintaghavi, Dr Ayobian, and Dr Nadaf for their ongoing encouragement and support.

I must confess that much of the work and difficulties encountered with this book project over the last 3 years of necessity had to fall on the shoulders of my coeditor, Prof Douglas Deporter, without whose diligence, hard work, expertise, and international connections, the task would have been impossible. In fact, our scientific collaborations and stimulating conversations over the past two decades have been for me a real privilege, pleasure, and treasure.

I present this book to all students, practicing clinicians, and dental academics interested in learning to excel in dental implant treatments, but especially to all the young, talented, and enthusiastic periodontic residents who have studied with me at the Islamic Azad University Dental School (Isfahan Branch), where I spent nearly 25 years of my life in different administrative and academic positions.

Last but not least, I dedicate this book to my wonderful family, Saeedeh, Shiva, Sara, and Mahdi, for their continuous support, encouragement, and understanding.

Mohammad Ketabi

CONTRIBUTORS

Andrew Ackermann, BChD, MChD
Private Practice Limited to Prosthodontics
Johannesburg, South Africa

Tanatorn Asvaplungprohm, DDS
Implant Dentistry Resident
Department of Periodontology and Implant Dentistry
New York University College of Dentistry
New York, New York

Ehsan Birang, DDS, MS
Assistant Professor
Department of Periodontics
Faculty of Dentistry
Iran University of Medical Sciences
Tehran, Iran

Samvel Bleyan, DDS, MS
Practice Limited to Periodontics and Prosthodontics
Moscow, Russia

Sang-Choon Cho, DDS
Clinical Associate Professor
Director of Advanced Program for International Dentists in Implant Dentistry
Department of Periodontology and Implant Dentistry
New York University College of Dentistry
New York, New York

Shadi Daher, DMD
Clinical Assistant Professor
Department of Oral and Maxillofacial Surgery
Boston University School of Dental Medicine

Private Practice Limited to Oral and Maxillofacial Surgery
Boston, Massachusetts

Maziar Ebrahimi Dastgurdi, DDS, MS
Private Practice
Toronto, Ontario

Massimo Del Fabbro, MsC, PhD
Professor
Department of Biomedical, Surgical, and Dental Sciences
University of Milan
Milan, Italy

Douglas Deporter, DDS, Dipl Perio, PhD
Professor
Discipline of Periodontology and Oral Reconstruction Center
Faculty of Dentistry
University of Toronto
Toronto, Ontario

Vahid Esfahanian, DDS, MS
Associate Professor
Department of Periodontology and Implant Dentistry
Faculty of Dentistry
Islamic Azad University, Isfahan Branch
Isfahan, Iran

Nasim Farkhani, DDS, MS
Assistant Professor
Department of Periodontology and Implant Dentistry
Faculty of Dentistry
Islamic Azad University, Isfahan Branch
Isfahan, Iran

Marcello Ferrer, DMD, MS
National Director of Periodontics and Implantology
San Sebastián University

Private Practice in Esthetics, Periodontics, and Implantology
Santiago, Chile

Stuart J. Froum, DDS
Adjunct Clinical Professor
Director of Clinical Research
Department of Periodontology and Implant Dentistry
New York University College of Dentistry

Private Practice
New York, New York

Howard Gluckman, BDS, MChD, PhD
Private Practice in Oral Medicine and Periodontics
Director of the Implant and Aesthetic Academy
Cape Town, South Africa

Adjunct Assistant Professor
Department of Periodontics
University of Pennsylvania School of Dental Medicine
Philadelphia, Pennsylvania

Andre Hattingh, BChD, MChD
Private Practice Limited to Periodontics
Sevenoaks, United Kingdom

Salah Huwais, MChD
Private Practice Limited to Periodontics and Implantology
Jackson, Michigan

Adjunct Assistant Professor
Department of Periodontics
University of Pennsylvania School of Dental Medicine
Philadelphia, Pennsylvania

Adjunct Assistant Professor
Department of Periodontics
University of Illinois at Chicago College of Dentistry
Chicago, Illinois

Jaffer Kermalli, BsC, DDS, MsC
Clinical Instructor
Graduate Periodontics Program
Faculty of Dentistry
University of Toronto

Private Practice Limited to Periodontics
Toronto, Ontario

Mohammad Ketabi, BDS, DDS, MS
Professor
Department of Periodontology and Implant Dentistry
Faculty of Dentistry
Islamic Azad University, Isfahan Branch
Isfahan, Iran

Ali Akbar Khoshkhounejad, DDS, MSc
Professor
Department of Periodontology
Tehran University of Medical Sciences

Private Practice
Tehran, Iran

Nikfam Khoshkhounejad, DDS, MSc
Assistant Professor
Department of Prosthodontics
Tehran Universtiy of Medical Sciences
Tehran, Iran

Hyongsup Kimm, DDS
Implant Dentistry Resident
Department of Periodontology and Implant Dentistry
New York University College of Dentistry
New York, New York

Martin Leung, BDS
Implant Dentistry Resident
Department of Periodontology and Implant Dentistry
New York University College of Dentistry
New York, New York

Maryse Manasse, DMD, MEd
Clinical Assistant Professor
Department of Periodontology and Implant Dentistry
New York University College of Dentistry
New York, New York

Mauro Marincola, DDS, MSD
Professor and Clinical Director
Dental Implant Unit
Faculty of Dentistry
University of Cartagena
Cartagena, Colombia

Rodrigo Neiva, DDS, MS
Chair
Department of Periodontics
University of Pennsylvania School of Dental Medicine
Philadelphia, Pennsylvania

Sourav Panda, MDS
Doctoral Candidate
Department of Biomedical, Surgical, and Dental Sciences
University of Milan
Milan, Italy

Associate Professor
Institute of Dental Science and SUM Hospital
Siksha O Anusandhan University
Bhubaneswar, India

Klenise Paranhos, DDS, MS
Adjunct Clinical Assistant Professor
Department of Periodontology and Implant Dentistry
New York University College of Dentistry

Clinical Assistant Professor
Touro College of Dental Medicine
New York Medical College
New York, New York

Viraj Patel, BDS
Implant Dentistry Resident
Department of Periodontology and Implant Dentistry
New York University College of Dentistry
New York, New York

Adriano Piattelli, MD, DDS, DrHC, DrHC
Full Professor
School of Dentistry
Saint Camillus International University for Health Sciences
Rome, Italy

Azadeh Rahmati, DDS, MS
Private Practice Limited to Oral Maxillofacial Radiology
Lahijan, Iran

Charles Schwimer, DMD
Adjunct Professor
Department of Periodontics
University of Pennsylvania School of Dental Medicine
Philadelphia, Pennsylvania

Clinical Professor
Department of Periodontics
University of Pittsburgh School of Dental Medicine

Private Practice
Pittsburg, Pennsylvania

Miguel Simancas-Pallares, DDS, MS, MSc
Associate Professor
Division of Pediatric and Public Health
Adams School of Dentistry
University of North Carolina School of Dentistry
Chapel Hill, North Carolina

Richard Smith, DDS
Associate Clinical Professor
Department of Prosthodontics
Columbia University College of Dental Medicine

Private Practice
New York, New York

Dong-Seok Sohn, DDS, PhD
Professor and Chair
Department of Oral and Maxillofacial Surgery
Catholic University Hospital
Daegu, South Korea

Silvio Taschieri, MD, DDS
Academic Researcher
Department of Biomedical, Surgical, and Dental Sciences
University of Milan

Associate Professor
Department of Odontostomatology
IRCCS Orthopedic Institute Galeazzi
Milan, Italy

Professor
Department of Surgical Dentistry
First Moscow State Medical University
Moscow, Russia

Margherita Tumedei, DDS, PhD
Researcher
Department of Biomedical, Surgical, and Dental Sciences
University of Milan
Milan, Italy

Buddhapoom Wangsrimongkol, DDS
Implant Dentistry Resident
Department of Periodontology and Implant Dentistry
New York University College of Dentistry
New York, New York

Yung Cheng Paul Yu, DDS
Clinical Assistant Professor
Department of Periodontology and Implant Dentistry
New York University College of Dentistry
New York, New York

1

INTRODUCTION TO IMMEDIATE MOLAR TREATMENT OPTIONS

Douglas Deporter

The use of endosseous dental implants to replace missing or hopeless teeth has become routine practice in contemporary patient treatment. Indeed, implant-supported or implant-retained prostheses often are considered the treatment of first choice in both partial and complete edentulism because of their reported excellent long-term performance and patient satisfaction. Nevertheless, while treatment costs for a single implant-supported molar crown can be comparable to a three-unit, tooth-supported fixed partial denture, the longer treatment times and multiple interventions needed to complete the implant-based treatment do remain hurdles in gaining patient acceptance.[1,2] The original and well-tested principles of implant placement in healed extraction sites with a submerged initial healing interval continue to be used, and certainly molar replacement with single implants using this approach is reported to be predictably successful in the long term, particularly in the mandible and when natural teeth are present on either side of the implant.[3–8] However, the public is now aware of accelerated treatment approaches such as All-on-4 and "Teeth in a day" that provide immediate implant placement and immediate implant function. This awareness has fed the need to develop faster but equally successful treatment protocols for molar replacement. One such protocol is the replacement of condemned molar teeth using immediate implant placement with or without immediate function, and this book reviews the history, current status, technique prerequisites, and recent advances for this approach using a variety of implant types.

Timing of Implant Placement

Several classifications have been proposed to specify the timing of implant placement in relation to tooth extraction.[9–12] We have chosen the classification of Hämmerle et al,[11] which is based on the extent of both soft and hard

TABLE 1-1 Classification of timing of implant placement*

CLASSIFICATION	DEFINITION	ADVANTAGES	DISADVANTAGES
Type 1	Implant placement immediately following tooth extraction and as part of the same surgical procedure	• Reduced number of surgical procedures • Reduced overall treatment time • Optimal availability of existing bone	• Site morphology may complicate optimal placement and anchorage • Thin tissue biotype may compromise optimal outcome • Potential lack of keratinized mucosa for flap adaptation • Adjunctive surgical procedures may be required • Procedure is technique sensitive
Type 2	Complete soft tissue coverage of the socket (4–8 weeks)	• Increased soft tissue area and volume facilitates soft tissue flap management • Resolution of local pathology can be assessed	• Site morphology may complicate optimal placement and anchorage • Treatment time is increased • Socket walls exhibit varying amounts of resorption • Adjunctive surgical procedures may be required • Procedure is technique sensitive
Type 3	Substantial clinical and/or radiographic bone fill of the socket (12–16 weeks)	• Substantial bone fill of the socket facilitates implant placement • Mature soft tissues facilitate flap management	• Treatment time is increased • Adjunctive surgical procedures may be required • Socket walls exhibit varying amounts of resorption
Type 4	Healed site (> 16 weeks)	• Clinically healed ridge • Mature soft tissues facilitate flap management	• Treatment time is increased • Adjunctive surgical procedures may be required • Large variations are present in available bone volume

*Reprinted with permission from Hämmerle et al.[11]

tissue healing after tooth extraction. Hämmerle's type 1 sites are those where an implant is placed into a fresh extraction socket. Type 2 sites are referred to as *early* placement sites, ie, those where an implant is delayed until soft tissue closure over the extraction site has been achieved (typically 4 to 8 weeks). Type 3 sites are referred to as *delayed* implant placement sites, meaning those sites where substantial new bone formation has been allowed to happen before implant placement (typically 12 to 16 weeks). Finally, type 4 sites are those where the extraction sites have healed fully (ie, longer than 16 weeks), the tooth having been removed at some point in the distant past. The suggested advantages and disadvantages of the four types are summarized in Table 1-1.[11]

From the patient's point of view, type 1 implantation, ie, truly immediate, is the most desirable as it takes the least time and least number of surgical interventions to achieve. There are, however, technical challenges for the surgeon, such as avoiding bur chatter, controlling the final implant position, gaining sufficient primary stability, and maintaining and/or manipulating adequate soft tissue for appropriate site closure.[13] If the site has a thin gingival biotype preoperatively (ie, < 2-mm soft tissue thickness) and/or minimal keratinized gingival tissue (< 2-mm width), even if it is possible to stabilize an immediate molar implant (IMI), its health in the long term may be compromised because of an increased risk of peri-implant crestal bone loss needed to reestablish biologic width relative to implant type and placement depth.[14–20] Thus, van Eekeren et al[19] recently reported that gingival biotype had an impact on bone-level implant placement but not on tissue-level implant placement or when the implant-abutment connection was at least 2.5 mm above the crestal bone level. They suggested that when treating patients with initial mucosal thicknesses of 2 mm or less, choosing a tissue-level implant with the implant-abutment connection 2.5 mm above the crestal bone level for a posterior site (ie, esthetically less demanding) could help to minimize crestal bone loss. These considerations help to explain why IMIs are classified as being difficult and requiring considerable experience and ability of the surgeon.[21]

The decision to undertake early implantation (type 2, after 4 to 8 weeks of site healing) could be made for a variety of reasons, such as an existing acute local infection at extraction or a desire to permit some soft tissue healing and increases in amount and thickness of keratinized tissue before implant insertion. However, it needs to be remembered that some loss of alveolar ridge width and height will certainly have occurred, especially if a flap had been raised for the extraction, as most alveolar remodeling happens within the first 3 to 6 months postextraction.[22] Outcomes following early placement in various tooth sites can be comparable with those following immediate or delayed implant placement.[23,24] Early implant placement after a ridge preservation grafting procedure done at the time of extraction also may be a helpful protocol,[25] although it would add at least one extra surgical procedure. Most recently, however, it has been reported that early placement after extraction can give success rates similar to ridge preservation grafting and implant placement after 4 months of healing, at least at nonmolar sites.[26]

The benefits of waiting 12 to 16 weeks postextraction (type 3 sites) are that substantial new bone formation will have occurred within the socket and that the state of maturity of the gingival tissues will facilitate their manipulation. The disadvantages of this approach are again the loss in alveolar ridge dimensions, the longer treatment times, and the fact that additional surgical costs may be incurred. For example, it may become necessary to use commercial graft and barrier materials to thicken thin cortical bone buccally after osteotomy preparation, manage bony dehiscences, and/or regain local ridge anatomy to optimize patient comfort and prosthetic emergence profiles.

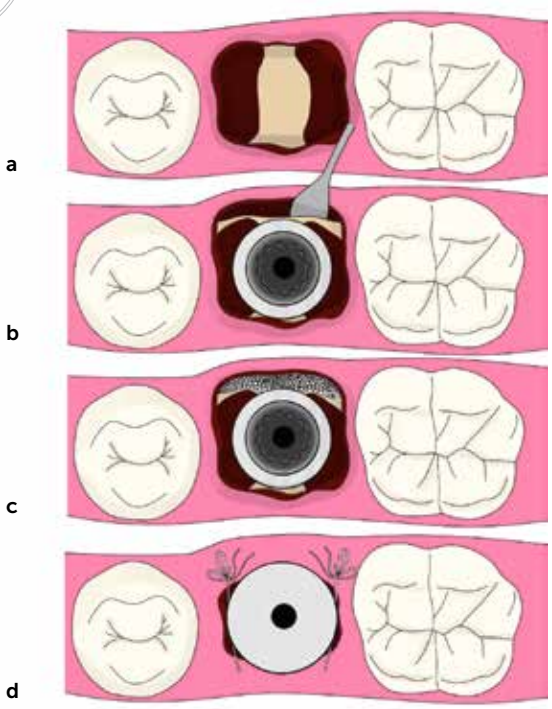


FIG 1-1 Buccal onlay grafting with xenograft can help to maintain alveolar ridge width. *(a)* Flapless surgery is used to remove a mandibular first molar revealing a type B interradicular septum (IRS) and an intact but thin (< 1.5 mm) buccal bone plate (see Box 1-1 for IRS classification). *(b)* A buccal full-thickness "pouch" was created using a small periosteal elevator. *(c)* Xenograft particles were packed into the pouch to reinforce the buccal bone. *(d)* The soft tissues were stabilized with sutures after placing a wide-diameter healing abutment.

Rationale and Early Work with IMIs

One of the original goals with immediate implant placement was that it would avoid or at least minimize the rapid alveolar ridge shrinkage that occurs both vertically and horizontally during normal extraction site healing. The greatest loss in alveolar ridge dimensions happens within the first 3 months postextraction, and by 1 year, buccolingual or buccopalatal ridge width shrinkage can be as high as 50%.[22,27] Worse still is the fact that the greatest loss in width happens midbuccally at the extraction socket, ie, exactly where the clinician wishes to locate an implant.[28] Looking at available human data, however, while losses in alveolar dimension can be reduced following immediate implant placement, they cannot be eliminated because many factors contribute to the losses.[29–33] Even when marginal bone gaps around immediate implants placed in molar extraction sites completely fill with new bone, resorption will still be seen on the external aspects of the associated ridge, particularly on the buccal.[29,34,35] Nevertheless, appropriate clinical management such as buccal particulate bone onlay/contour grafting can compensate for this thinning of buccal bone, provided that all socket walls remain intact following IMI placement[36,37] (Fig 1-1). If, as commonly happens, the buccal bony wall is missing or

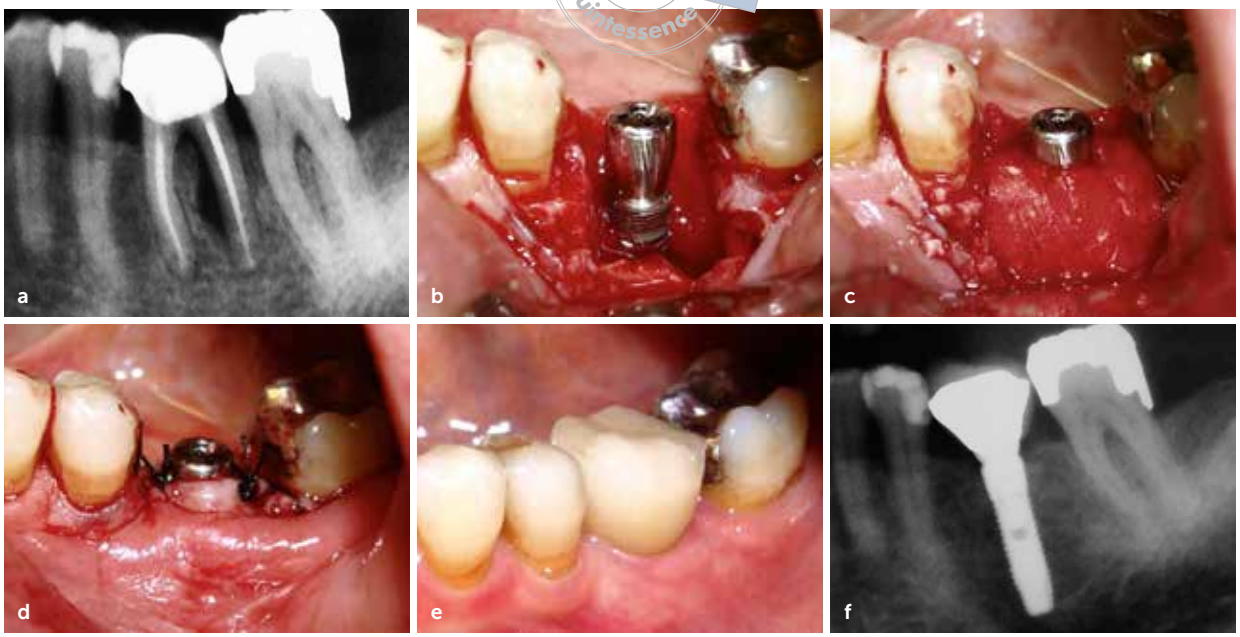


FIG 1-2 *(a)* The mandibular left first molar suffered failure of previous endodontic treatment and required extraction. *(b)* Flap elevation was needed to place this IMI, as the endodontic infection had caused considerable loss of buccal bone. However, the other three socket walls were intact and their crestal bone levels of sufficient height to suggest that GBR could be successful in restoring the lost buccal bone. *(c)* Because the IMI was well-stabilized, GBR (particulate allograft and collagen barrier) was used to promote regeneration of lost bone. *(d)* The immediate postoperative image of the implant site. *(e)* The clinical status of the restored IMI after 12 months in function. *(f)* The radiographic status of the IMI 12 months after the GBR procedure was performed. Note the excellent regeneration and stable crestal bone.

deficient, other treatment options can be chosen, the most common one being socket preservation grafting and delayed implant placement.[38]

Alternatively, if an IMI can be adequately stabilized, the deficiency often may be corrected with traditional guided bone regeneration (GBR) techniques[39] (Fig 1-2). One recent report claimed that—provided that flapless surgery was used to place IMIs at sites with buccal bone dehiscences (Elian type II sockets)—outcomes could have success similar to those with implants placed into intact sockets (Elian type I).[40] This was achieved by trimming and inserting a collagen membrane under the buccal soft tissue and densely packing xenograft into all defects around the seated implant, followed by placement of a healing abutment with a diameter corresponding to that of the extraction socket. The wide healing abutment will help to simulate primary soft tissue closure, sheltering the graft. Another group of investigators have since reported that densely packed xenograft alone can give the same benefit.[41] It was noted, however, that a healing interval of at least 6 months is needed to achieve favorable outcomes because xenograft has no known osteoinductive properties, and healing would be dependent on the response of osteoprogenitor cells of the periosteal layer of the buccal soft tissue.

While immediate implants were first used in the replacement of single-rooted teeth, innovators in implant dentistry were fast to translate the methodology to molar sites.[8,42–47] For example, Fugazzotto[45] described in detail an approach for placing immediate implants into the interradicular septum (IRS) bone of mandibular molars, focusing on ways to avoid bur chatter and drift (see chapter 3). He also reviewed the healing sequence following tooth extraction starting from clot formation. By 14 to 16 days, newly formed granulation tissue is replaced by connective tissue that subsequently converts to osteoid with calcification so that by 6 weeks, the socket is almost entirely filled with new trabecular bone. Fortunately, the placement of an immediate implant does not affect this normal healing sequence provided that the implant is sufficiently stable to avoid early micromovements.[48]

Fugazzotto further described protocols for maxillary IMIs[46] (see chapter 4). Osteotomy site location was first established in the IRS bone using a guide

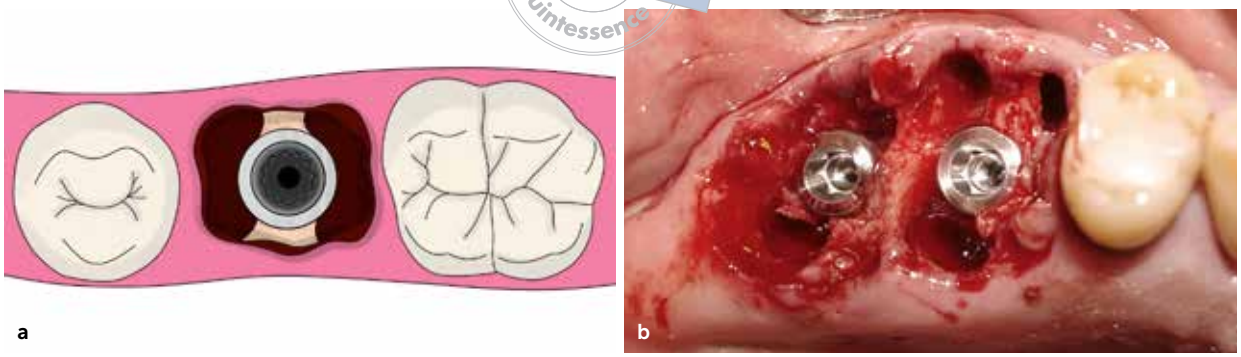


FIG 1-3 *(a)* An illustration of a site where an IMI could not be contained within IRS but was nevertheless stabilized by contact with the remaining lingual and buccal buttresses of the IRS. There is no actual contact between implant and buccal cortex, and the remaining peri-implant gaps have filled with blood and should heal with new bone fill provided that a large-diameter healing abutment will be added. *(b)* This first molar IMI was stabilized by the remaining buccal and palatal buttresses of a type B IRS.

drill, round bur, or narrow-diameter trephine, depending on the quantity of remaining apical bone. Thereafter, a series of handheld osteotomes of increasing diameter and a surgical mallet were used to finalize the osteotomy shape and depth as originally described by Summers.[49,50] Initial localization using a trephine was selected when there was insufficient remaining IRS bone height apically to receive the implant without disturbing the maxillary sinus. The trephine was used to create a core of IRS bone, taking care to stop short of the cortical sinus floor by about 1 mm. Thereafter, the core of bone released by the trephine was impacted apically with osteotomes to elevate the sinus floor. The safe insertion of a threaded implant could then be achieved. Others described a similar approach for maxillary first molars with 98% survival of implants at 3 years.[51] However, the recent introduction of the concept of osseodensification using Densah burs (Versah) for use in similar situations has eliminated the need for hammering on osteotomes, making placement of maxillary IMIs more patient-friendly[52] (see chapters 7 and 11).

Ideally, IMIs will be stabilized primarily either by being contained completely in IRS bone, or by contact with the remaining furcal bone buttresses located buccally and lingual/palatally without direct contact with the buccal and lingual/palatal socket walls (Fig 1-3). Unless these walls are very thick, insertion torque forces received by them could cause microfractures and early crestal bone loss. Any remaining gaps between the socket walls and implant periphery need not necessarily be grafted[34] (see also chapter 11) as long as the blood clots that have filled them can be sheltered by the repositioned flap margins in conjunction with appropriately sized healing abutments that can act as prosthetic sealing devices. More will be said of this later in this book.

When Immediate Molar Replacement Is Not Feasible

Before IMI therapy is proposed to a potential patient, the patient should be advised that the final decision on the feasibility of the approach cannot be made until after the tooth has been extracted. Factors such as root ankylosis, fracture of the buccal plate, unintended socket expansion during extraction, unexpected difficulty in tooth removal, or acute infection might make immediate implant placement impossible or less predictable. For example, if the extraction ends up being more traumatic than expected, requires elevation of a large mucoperiosteal flap, and/or results in significant loss of IRS and/or bone buccally or lingually/palatally, it may be necessary to delay implant placement and instead regain some of this lost bone using the techniques of socket preservation grafting.[53–56] There will always be value in using a flapless procedure to avoid disruption of the periosteal blood supply, but generally only if the original buccal bone at the crest has been determined to be intact.[55,57,58] Noteworthy is the fact that buccal bone loss after extraction has been reported to be significantly less if its original postextraction thickness was 3 mm rather than 1 mm.[59]

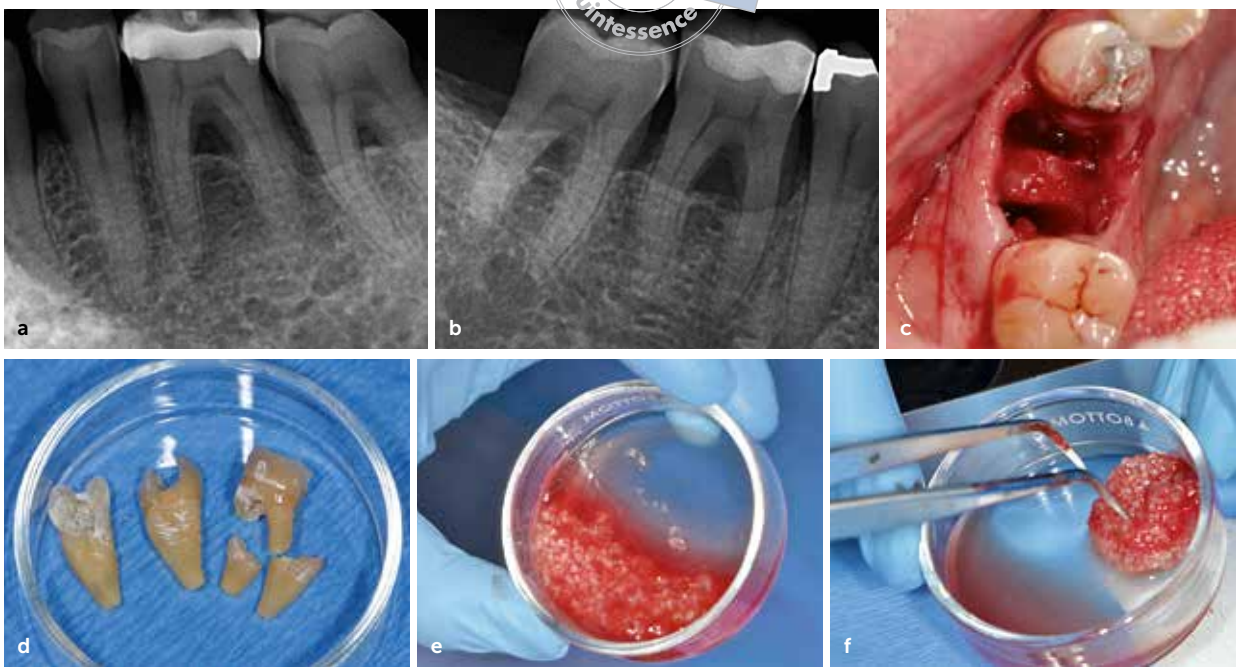


FIG 1-4 *(a)* The mandibular left first molar had a grade III furcation defect and was deemed hopeless in this man in his 50s who had insulin-dependent diabetes. *(b)* The mandibular right first molar in the same patient also required extraction. *(c)* The teeth were removed atraumatically without flap elevation after sectioning the roots through the furcation. The IRS for each of the teeth was classified as type B according to Smith and Tarnow.[67] (Surgery performed by Dr Suzette Guo, University of Toronto.) *(d)* The extracted tooth fragments are seen here after removal of all restorative materials as well as the pulpal and periodontal ligament soft tissues. *(e)* Once the tooth-derived particulate graft material was prepared using a dedicated processing machine, it was mixed with the liquid phase of platelet-rich concentrated growth factors (ie, autologous fibrin glue) obtained after centrifugation of a sample of the patient's venous blood in citrate-coated, white-capped plastic tubes as described by others.[63] *(f)* Mixing the patient's platelet growth factors and tooth graft particles resulted in a sticky pellet of tooth autograft biomaterial that could be easily used to fill the tooth sockets.

If a flap is raised for tooth extraction and the socket deemed unsuitable for an IMI, the principles of GBR are followed for socket preservation, commonly using a particulate graft material (generally a mineralized allograft or xenograft) isolated and covered with a protective membrane and/or autologous platelet-rich fibrin (PRF) clots.[60–64] While the particulate graft material may delay socket healing somewhat,[38] it has generally been accepted that *(1)* grafting is beneficial in reducing alveolar ridge shrinkage, and *(2)* a mineralized slowly resorbing particulate graft material is preferred.[56] Ideally, a barrier material that can be left exposed crestally is preferred, as this will not deleteriously affect the anatomy of the buccal vestibule in any attempt to gain primary flap closure and will promote an increase in the quantity of keratinized tissue.[65,66] Examples of socket preservation using two different barrier approaches in a single patient can be seen in Fig 1-4.

Case report

As can be seen in Figs 1-4a and 1-4b, both the left and right mandibular first molars had grade III furcation defects and required extraction. The remaining IRS bone for both was classified as type B (ie, sufficient to stabilize an IMI),[67] which, under other circumstances, would have been favorable for IMI placement (Fig 1-4c). However, the patient had insulin-dependent diabetes with a history of severe periodontitis, and the clinician cautiously opted for socket preservation and delayed implant placement. Rather than using a commercially available allograft or xenograft, it was decided to process the extracted tooth fragments to form a genetically compatible particulate dentin graft (Fig 1-4d; see chapter 6). This was prepared using a dedicated processing machine (TOP Graft VacuaSonic System, CosmoBioMedicare). The more traditional approach would have been to use a mineralized particulate allograft or a xenograft like Bio-Oss (Geistlich).

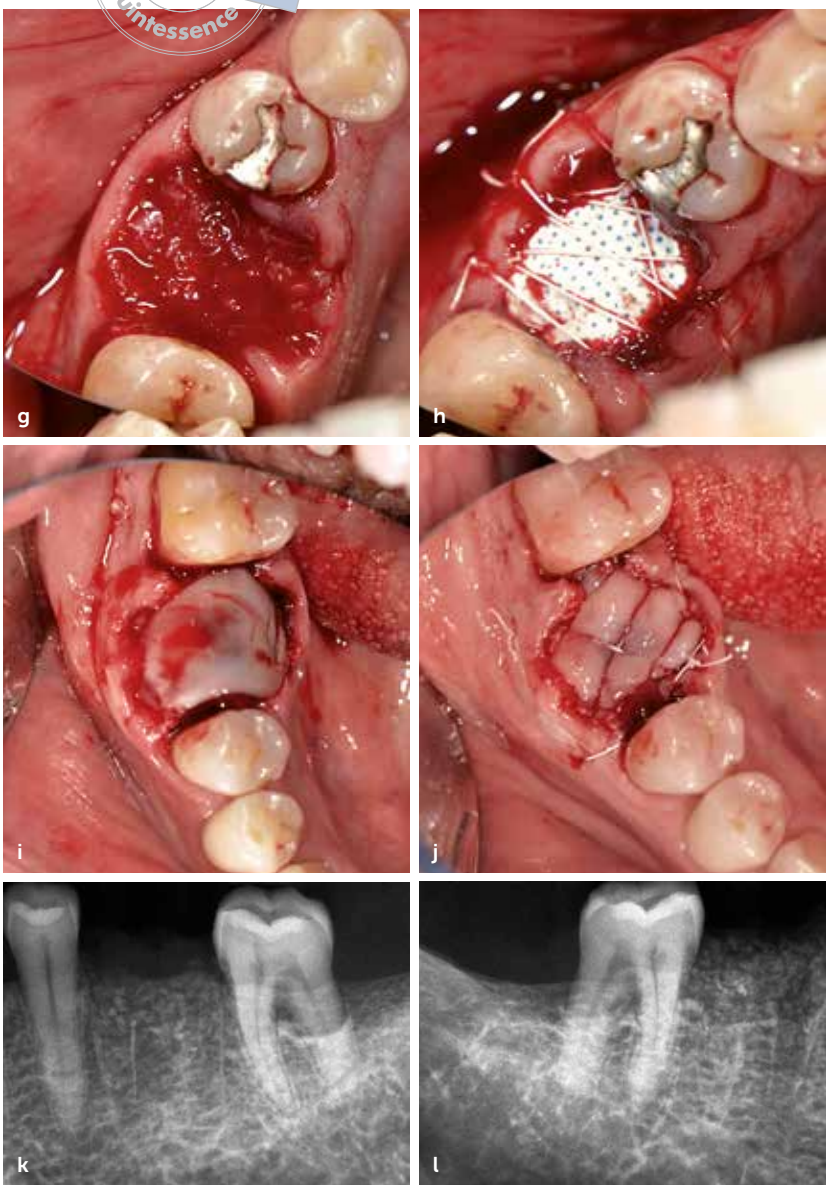


FIG 1-4 *(cont) (g)* The sticky particulate tooth autograft was packed into the extraction site. *(h)* A double-barrier technique[68] was used at the left site to protect the particulate graft material: After first using a collagen barrier (Bio-Gide, Geistlich), a dense PTFE barrier (Cytoplast, Osteogenics) was trimmed appropriately, placed over the first barrier, and secured with sutures. *(i)* After atraumatic extraction and placement of the tooth-derived particulate autograft, the right site was covered with two autologous PRF clots[63] as the only barrier. *(j)* The right site covered with autologous fibrin clots was sutured, leaving the clots exposed. *(k)* The immediate postoperative radiograph of the grafted left molar site. *(l)* The immediate postoperative radiograph of the grafted right molar site.

After preparation, the dentin graft particles were mixed with autologous liquid fibrinogen isolated by centrifugation from the patient's venous blood to form the equivalent of "sticky bone"[63] (Figs 1-4e and 1-4f). Both sockets were filled with this graft preparation enriched by addition of the liquid fibrinogen and its platelet-derived growth factors (Fig 1-4g). The left grafted socket was covered with two barrier materials, first a resorbable collagen membrane and then a dense polytetrafluoroethylene (PTFE) nonresorbable barrier that was left exposed to the oral cavity[65,68] (Fig 1-4h). On the patient's right side, the grafted socket was covered with two PRF clots prepared from the patient's own blood[63] and again left exposed (Figs 1-4i and 1-4j). Immediate postoperative radiographs of the grafted sockets can be seen in Figs 1-4k and 1-4l.

Both sites healed well, resulting in sufficient bone at 4 months to allow single implant placement using a nonsubmerged technique and later restoration with single metal-ceramic crowns (Figs 1-4m to 1-4q). Because all particulate bone graft materials are known to interfere somewhat with normal extraction socket healing,[69] some clinicians have suggested an alternative approach using only autologous PRF clots to fill

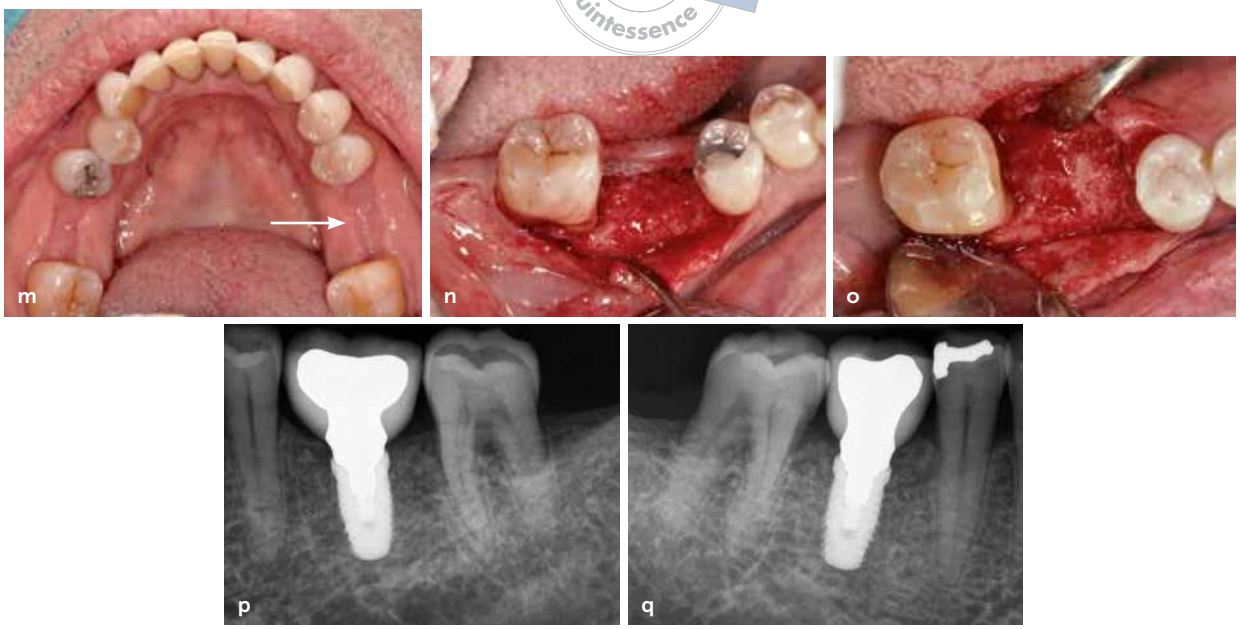


FIG 1-4 *(cont) (m)* A clinical photograph taken at the 6-week postoperative visit. Both molar sites appear to be healing well, but the patient reported having less discomfort at the side managed with the autologous fibrin clot barrier *(arrow)*. *(n)* A clinical photograph taken of the right side after 4 months of healing showing excellent new bone formation. *(o)* The contralateral site showing good site healing immediately before implant placement. *(p)* The restored left molar implant. *(q)* The restored right molar implant.

the socket.[70–72] One recent systematic review assessing the healing potential of a wide variety of grafting materials suggested that PRF was the most effective in promoting new vital bone formation.[73] However, another recent literature review with meta-analysis of published data using the latter approach suggested that more study is needed before routine usage can be prescribed.[74]

History of Immediate Molar Replacement

Early protocols for IMI placement provided scant details on procedural steps but led to acceptable outcomes for the time. In a small study published in 2000, Schwartz-Arad et al[75] reported outcomes for 56 IMIs placed in 43 patients during the period from 1989 to 1996. One implant was placed in 1989 and another 2 years later. This led to three IMIs being placed in 1993, 10 in 1994, 16 in 1995, and finally 23 in 1996, all by a single surgeon. In total, 17 IMIs were placed in maxillas and the remaining 39 in mandibles. If and how the procedure was modified over these 8 years was not indicated. Likewise, it was not stated whether there had been failed attempts in other patients. No criteria for patient selection were given, but it was reported that the majority of the implants had somehow been placed centrally in the molar sockets, while five molars had been replaced using two implants each, ie, one into each molar root socket. Implant lengths (10 to 14 mm) were chosen to engage as much apical bone as possible. Grafting of any peri-implant defects was done only at some sites, but indications were not given. The graft preferred was autogenous bone collected from implant burs or adjacent bone. Likewise, barriers were only occasionally used (six bioabsorbable collagen and two nonresorbable expanded PTFE, GORE-TEX, W. L. Gore) without explanation as to why the operator felt it necessary. Primary flap closure with the aid of releasing incisions was included where bone grafting and membranes had been used, but information was not given on how the remainder of the sites had been handled. Nevertheless, the 5-year cumulative survival rate was reported to be 89% (84% for men and 93.5% for women). Differences in outcomes also were found in maxilla versus mandible (82% vs 92% respectively) and with smoking (90% for nonsmokers vs 83% for smokers).

Fugazzotto[45,46] later described detailed protocols that he had developed for both mandibular and maxillary IMI placement. Osteotomies were created in suit-

INDEX

Page references followed by "f" denote figures; "b" denote boxes; and "t" denote tables.

D

E

F

G

H

J

L

M

O

P

R

S

T

U

W

Z