Immediate Loading of Dental Implants

Theory and Clinical Practice

Mithridade Davarpanah, MD
Head
Oral Rehabilitation Center
American Hospital of Paris
Neuilly-sur-Seine, France

Private Practice Limited to Periodontology and Surgical Implantology
Paris, France

Serge Szmukler-Moncler, DDS, IEP, PhD
Associate Professor
Department of Stomatology and Maxillofacial Surgery
University of Paris 6
Paris, France

Visiting Professor
Department of Odontology
Galeazzi Orthopedics Institute
University of Milan
Milan, Italy

International Consultant in Biomaterials and Implantology
Basel, Switzerland

QUINTESSENCE International

quintessence books

Paris, Berlin, Chicago, Tokyo, London, Milan, Barcelona, Istanbul,
São Paulo, Mumbai, Moscow, Prague, and Warsaw

Contents

Acknowledgments

Though acknowledgments are found in the first pages of a book, they are the last pages to be written—it could not happen any other way. Failure to include them would be not only an affront to tradition but also a denial of reality because of the many people, in addition to the primary authors, who have participated in the preparation of this work. All of their diverse and varied contributions have been important.

We want to pay tribute to the assistance and the valuable collaboration of Dr Myriam Achour, Dr Gregoire Audi, Dr Edouard Cohen, Dr Serge Benjamin Cohen, Dr Wanda Hajjar, Dr Eric Hazan, Dr Myriam Kebir-Quélin, Dr Jean-Luc Pineil, Dr P. Rajzbaum, Dr Christophe Raygot, Dr Gilles Rousseau, Dr Corinne Serfaty, and Dr Pascal Zyman; the laboratory technicians Jean-Paul Benhamou, Jean Binois, Ghislain Fournier, with whom we have had particularly fruitful communications, as well as Marc Leriche, Jean-Pierre Levot, Renaud Malherbe, and Richard Abulius; and the Laboratoire Céramiso. With skill and patience, Romain Mocellin, the graphic designer responsible for all of the illustrations, has greatly contributed to the readability of the book.

We also wish to recognize the contribution made by the assistants who work with us in daily practice: Evelyne, Sabrina, Aurélie, Nadia, and Roselyne at chairside; Elisabeth, Yasmine, Kim, Raania, and Isabelle in office management; Chaguit for updating our patient database, which greatly simplified our task and patient follow-up.

It is standard practice for authors to thank their spouses, their significant others, and their families. This is by no means an insincere exercise, because considerable time is required for research and writing, and authors consequently often neglect those closest to them; it is essential, therefore, to recognize and honor the tolerance of these loved ones. We thank Leila for her patience and her gift of that priceless commodity, time; Carolyne for having lavished indispensable consolation at all hours of the day and night; the nonmythical Troyan for having organized the flowing scribblings that emptied so many ink wells; Marian for chauffeuring services devotedly performed even in the darkest hours of the night; and Chaguit for tolerating the often interminable waiting.

If our children, Keyvan, Kourosh, Anoushka, Meïer-Alexander, Alex, and Mirona, suffered from our frequent lack of availability, they also rejoiced in the newfound freedom this afforded them.

Thanks must also be paid to our fathers, Cyrus and Natanael, and our mothers, Huguette and Bella. Whether they are with us in body or only in memory, they have played significant roles in this endeavor by being the original progenitors of the spirit that informs it. It is hoped that Maruan and Antoinette, who have had to accept geographic distance between themselves and their child, discern in the pages of this book the high esteem in which they are held.

Throughout the long hours of this book's creation, one of us sought out the restorative insight found at Pierrette's roundtables, both from Pupuce's inspired teaching and the assistance of Ruth and Chams. Peter from DOT in Rostock has helped significantly—without knowing it—to feed our fountain pen with ink of premium quality.

We would be remiss in not acknowledging the editorial guidance Dr Christian Knellesen has generously and unfailingly provided to us. Sometimes, he even agreed to put the cart before the horse and, surprisingly, this unusual harnessing seemed to make the team advance more speedily than ever. Sophie Gresse, like a guardian angel, deftly smoothed out all the rough edges and ensured that the cogs of our enterprise were always well oiled and turning effortlessly.

Preface

Who would have thought 11 years ago that an authoritative text, or even a simple book, could be written about immediate loading of dental implants? At that time, the struggle between the Swedish school, which advocated a two-stage surgical procedure with lengthy healing periods, and the Swiss school, which favored a one-stage procedure for implant placement, was still being hotly waged.

However, since 1997, developments have come at a dizzying pace. In that year, the first paper ever presented on immediately loaded implants won the first research prize at the meeting of the European Association for Osseointegration,[1] thanks in part to the efforts of one of the authors (SSM). In November of that same year, thanks also to the efforts of the same author (SSM), the first world convention exclusively focused on immediate loading took place. (Prof G. Favero and Prof A. Piattelli were the organizers.) Over the course of a day and a half in Venice, 300 participants learned what was occurring in European and North American universities under the auspices of renowned researchers and clinicians.

In 1998, the first review of the literature on immediate loading was published.[2] Then in 1999, Brånemark,[3] the father of the Swedish school, overturned his recommendations and published his first article on immediately loaded mandibular implants.

Since then, immediate loading has become one of the hottest as well as the most relevant topics in implant dentistry. The number of publications on this subject has increased exponentially. Every manufacturer of implants and every university has rushed to contribute to the clinical and experimental knowledge.

Practitioners with 25 years of experience are seeing a return to old ideas. In the 1970s and 1980s, immediate loading was used routinely in daily practice. Soon after, however, practitioners had to abandon the technique for fear of being discredited. Now these pioneers claim that there is nothing new under the sun. They are wrong in this assertion, however, because the immediate-loading protocols that were employed in the pre-Brånemark era have nothing in common with the technique that is practiced today.

For young practitioners immediate loading has never been a taboo subject, and they have no inkling of the historic conflict between the feuding factions. Immediate loading is just one of their natural points of reference.

Practitioners who are in the middle of these two groups and who should constitute, at least in the beginning, the bulk of the readership of this book, have the hardest road to follow. They were inculcated with the rigid principles of osseointegration, as promulgated by Brånemark, almost as though they were religious dogma. For them, switching from the lengthy healing protocols to immediate loading has demanded a veritable intellectual revolution, a cognitive rupture, a paradigm shift. They have had to burn their old idols, who only yesterday were adored gurus, and toss some of the most basic principles of their professional education into the rubbish heap after having condemned them as obsolete.

Those who have dared to take the crucial first step into this new world have been able to fully appreciate the difference between the daily practice of implant dentistry with and without immediate loading. To make this leap, these practitioners have had to integrate into their intellectual framework new ideas, a large body of fresh information, and a new approach to implant treatment. They have had to reorganize not only their relationships with collaborating surgeons, restorative dentists, and laboratory technicians but, indeed, their whole mode of operation. They have also had to recognize the intricacies of the new procedure, the different possibilities it offers and, above all, its limitations.

The authors of this book traversed this difficult path when its course was poorly charted. We groped our way along new trails, making tentative decisions, sometimes limping, sometimes stumbling, and finally succeeded in establishing a certain route. We have gathered the results of this protracted effort and present them here to the largest possible professional audience to provide access to an

advantageous and effective technique. As widespread acceptance of immediate loading becomes more and more inevitable, the patient becomes the principal beneficiary.

The Biomet 3i implant system and its specific components have been used throughout the book. Nevertheless, we have been careful to describe principles rather than specific components. No matter what implant system is employed, all readers of this book will derive useful information from it.

Practitioners who have experienced immediate loading are like travelers who have enjoyed a high-speed train. Once they have experienced it and learned to appreciate its advantages and efficiency, they never want to return to the old, slow ways of reaching their destinations.

References

1. Weber HP, Corso M, Sirota C, et al. Clinical and histometric analysis of osseointegration of immediately loaded free-standing implants in dogs [abstract]. Clin Oral Implants Res 1997;8:434.
2. Szmukler-Moncler S, Salama H, Reingewirtz Y, Dubruille JH. The timing of loading and the effect of micro-motion on the dental implant-bone interface: A review of the experimental literature. J Biomed Mater Res 1998;43:192–203.
3. Brånemark PI, Engstrand P, Ohrnell LO, et al. Brånemark Novum: A new treatment concept for rehabilitation of the edentulous mandible. Preliminary results from a prospective clinical follow-up study. Clin Implant Dent Relat Res 1999;1:2–16.

Contributors

Adriana Agachi, DDS
Journalist
Paris, France

Mihaela Caraman, DDS, MS
Attending Prosthodontist
Oral Rehabilitation Center
American Hospital of Paris
Neuilly-sur-Seine, France

Private Practice
Paris, France

Mithridade Davarpanah, MD
Head
Oral Rehabilitation Center
American Hospital of Paris
Neuilly-sur-Seine, France

Private Practice Limited to Periodontology and Surgical Implantology
Paris, France

Boris Jakubowicz-Kohen, DDS
Attending Prosthodontist
Oral Rehabilitation Center
American Hospital of Paris
Neuilly-sur-Seine, France

Private Practice
Paris, France

Paul M. Khoury, DDS
PhD Student
University of Hong Kong
Hong Kong, Republic of China

Stuart Malloy, DDS
Attending Prosthodontist
Oral Rehabilitation Center
American Hospital of Paris
Neuilly-sur-Seine, France

Private Practice
Paris, France

Pierre Raygot, DDS
Attending Prosthodontist
Oral Rehabilitation Center
American Hospital of Paris
Neuilly-sur-Seine, France

Private Practice
Paris, France

Serge Szmukler-Moncler, DDS, IEP, PhD
Associate Professor
Department of Stomatology and Maxillofacial Surgery
University of Paris 6
Paris, France

Visiting Professor
Department of Odontology
Galeazzi Orthopedics Institute
University of Milan
Milan, Italy

International Consultant in Biomaterials and Implantology
Basel, Switzerland

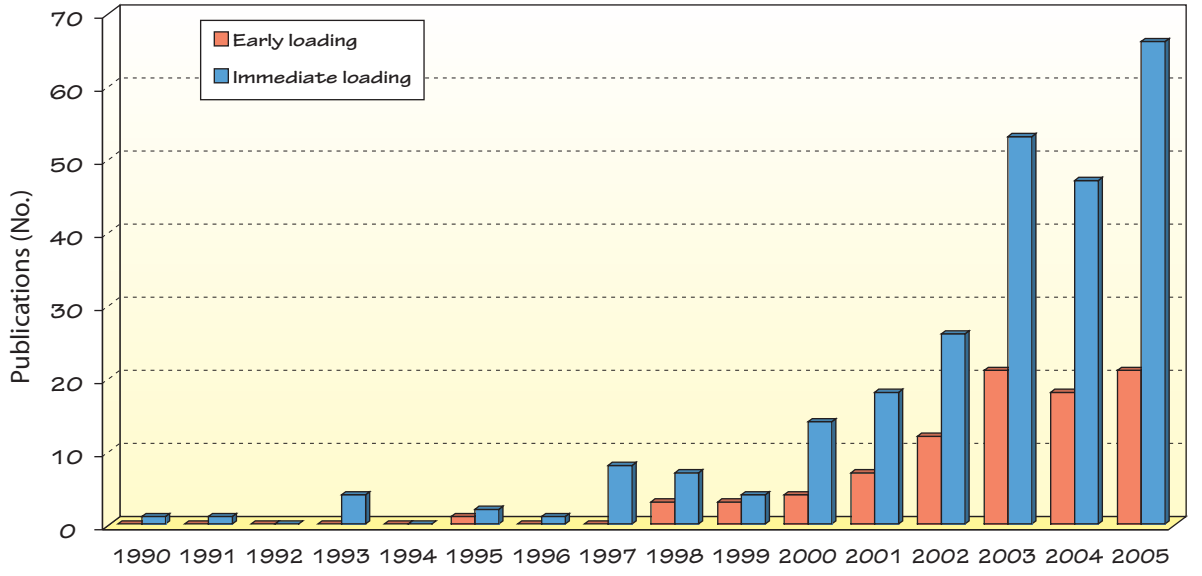
Tiziano Testori, MD, DDS
Head
Division of Implantology
Department of Odontology
Galeazzi Orthopedics Institute
University of Milan
Milan, Italy

Private Practice
Como, Italy

Introduction

In the last three decades, implant dentistry has emerged as a fully accepted discipline in dentistry. During this period of development, its concepts and treatment modalities have undergone tremendous changes. At first, only protocols involving two-stage surgery were recognized as providing reproducible and reliable results.[1] Later, a single-stage surgical procedure became acceptable.[2–6] Later still, the waiting periods for bone healing were shortened; instead of 3 to 8 months, no more than 6 to 8 weeks was deemed necessary.[7–10]

However, the rediscovery of the immediate-loading protocols, which for decades had been considered untenable, must be viewed as a veritable revolution.[11] We cannot completely dismiss the possibility that this renewed interest is merely a passing fancy, but the large number of publications and studies devoted to the technique are convincing evidence of the widespread acceptance of this procedure. An analysis of the literature of recent years shows that interest in immediate loading is growing steadily and that more attention is being directed at the clinical implications of immediate-loading protocols than at early loading (Fig 1).



▲ **Fig 1** Relative increase in the number of publications concerning immediate and early loading, year by year. The curves representing the two protocols are quite different. The number of publications about immediate loading is increasing rapidly.

Immediate-loading protocols have two distinct prerequisites. The first is biologic: the acquisition of osseointegration, despite the forces exerted during the healing phase, in conjunction with maintenance of a satisfactory esthetic response of the surrounding soft tissues. The second challenge is logistic: the prosthetic phase follows the surgical phase as swiftly as possible.

In effect, apart from the biologic aspect, the most distinctive difference between the protocols for immediate loading and those for early or conventional loading is chronologic, that is, the shortened interval between the surgical and the prosthetic phases. It is this sequential proximity that practitioners must learn to manage in terms of both the logistics of their own practice and coordination with all of the members of the multidisciplinary team. The complicated part is being able to already have thought about everything and to continue to think about everything at the same time.

Before the specific principles of the immediate-loading protocol are discussed, it is important to define this concept and agree on terminology. The following must be determined:

- The acceptable interval between implant placement and prosthetic loading
- The type of forces exerted on the implant and the prosthesis

Opinions vary about the maximal acceptable interval between implant placement and loading. Some researchers use the term *immediate loading* only when the provisional prosthesis is placed during the same session in which surgery is performed.[12] Others believe that, to qualify as an immediately loaded implant, the definitive prosthesis must be placed on the same day.[13] Still others accept a delay in loading of 48 hours[14] to 72 hours.[15] Regardless, these conceptualizations remain empirical because none of them is based on physiology and biologic reactions at the bone-implant interface.

The delay most often observed for orderly placement of a prosthesis directly after the surgical procedure ranges between several hours and 5 days. It would be tempting to use this practical framework in the definition of immediate loading. However, many studies have documented results of treatment that followed an arbitrarily determined delay of 48 to 72 hours. That is why we have used this interval throughout this volume, without in any way judging the validity of its parameters. For the time being, practitioners should respect this 48- to 72-hour interval until a more precisely documented paradigm has been established.

The biomechanical definition of *immediate loading* is also debated:

- For some researchers, the concept of immediate loading is satisfied as soon as the coronal portion of the prosthesis is inserted, even if it is kept out of occlusion.[15]
- For others, the term *immediate loading* can be applied only if the prosthesis is subjected to occlusal forces as soon as it is inserted.[12]

The difference is significant because the forces exerted on a prosthesis in full occlusion are expected to be greater than those on one that is out of occlusion.

Those who include all prostheses, in or out of occlusion, in their immediate-loading protocols also differ in their choice of descriptors. The two situations are described variously with these labels:

- *Immediate occlusal loading* vs *immediate functional loading*[15]
- *Immediate functional loading* vs *immediate nonfunctional loading*[16]
- *Immediate loading* vs *immediate provisionalization*[17–19]

Whatever they are called, these circumstances are the two themes covered by this book. In both cases, the practitioner embarks on the prosthetic treatment immediately after the surgery has been completed. This means that within 72 hours, a prosthesis will be exerting considerable pressure on the implants supporting it, in an interaction that is described as *immediate loading.* To simplify matters, throughout this book we refer to the two aspects as *immediate loading in occlusion* and *immediate loading out of occlusion.*

Clinicians will find management of the logistics in the two scenarios to be about the same. Only the strategies required for minimizing stresses exerted at the bone-implant interface will differ. Whenever possible, it is best to keep the restoration out of occlusion, but when this is impossible, as in treatment of an edentulous mandible or maxilla, occlusal forces should be minimized by distributing them over a greater number of implants.

When confronted with a new technique, the members of any given professional community respond to it in one of three ways: with enthusiasm, skepticism, or, in most cases, relative indifference. The concept of immediate loading is no exception; it has its enthusiasts, its detractors, and a large body of hesitators who take a wait-and-see approach. The last group needs time to accept the innovative procedure and to incorporate it into their daily practice.

We have taken an active role in establishing the foundation for the immediate-loading protocol and are eager to tell others what we have learned so that the greatest possible number of practitioners and patients will be able to benefit from this new technique. This book was designed to elucidate the basic principles of immediate loading, from patient selection to surgical procedures to the final adjustment of the completed restoration. In addition, the chapters describe solutions to the various challenges that may be encountered along the way. This comprehensive volume provides readers with concrete guidelines for a proven technique that simplifies implant procedures and provides clear benefits to patients.

References

1. Brånemark PI, Zarb GA, Albrektsson T. Tissue-Integrated Prostheses: Osseointegration in Clinical Dentistry. Chicago: Quintessence, 1985.
2. Buser D, Weber HP, Brägger U, Balsiger C. Tissue integration of one stage ITI implants: 3-Year results of a longitudinal study with hollow-cylinder and hollow screw implants. Int J Oral Maxillofac Implants 1991;6:405–412.
3. Weber HP, Buser D, Fiorellini JP, Williams RC. Radiographic evaluation of crestal bone levels adjacent to non-submerged titanium implants. Clin Oral Implants Res 1992; 3:181–188.
4. Buser D, Mericske-Stern R, Bernard JP, et al. Long-term evaluation of non-submerged ITI implants. 1. 8-Year life table analysis of a prospective multi-center study with 2359 implants. Clin Oral Implants Res 1997;8:161–172.
5. Bernard JP, Belser UC, Martinet JP, Borgis SA. Osseointegration of Brånemark fixtures using a single-step operating technique: A preliminary prospective one-year study in the edentulous mandible. Clin Oral Implants Res 1995;6:122–129.
6. Becker W, Becker BE, Israelson H, et al. One-step surgical placement of Brånemark implants: A prospective clinical study. Int J Oral Maxillofac Implants 1997;12:454–462.
7. Lazzarra RJ, Porter SS, Testori T, Galante J, Zetterquist LA. A prospective multicenter study evaluating loading of Osseotite implants two months after placement. J Esthet Dent 1998;10:280–289.
8. Testori T, Del Fabbro M, Feldman S, et al. A multi-center prospective evaluation of 2-months loaded Osseotite implants in the posterior jaws: 3-Year follow-up results. Clin Oral Implants Res 2002;13:154–161.
9. Roccuzzo M, Bunino M, Prioglio F, Bianchi SD. Early loading of sandblasted and acid etched (SLA) implants: A prospective split-mouth comparative study. Clin Oral Implants Res 2001;12:572–578.
10. Cochran DL, Buser D, Ten Bruggenkate C, et al. The use of reduced healing times on ITI implants with a sand-blasted and acid-etched (SLA) surface. Early results from clinical trials on SLA implants. Clin Oral Implants Res 2002;13:144–153.
11. Szmukler-Moncler S, Piattelli A, Favero GA, Dubruille JH. Considerations preliminary to the application of early and immediate loading protocols in dental implantology. Clin Oral Implants Res 2000;11:12–25.
12. Cooper LF, Rahman A, Moriarty J, Chaffee N, Sacco D. Immediate mandibular rehabilitation with endosseous implants: Simultaneous extraction, implant placement and loading. Int J Oral Maxillofac Implants 2002;17:517–525.
13. Aparicio C, Rangert B, Sennerby L. Immediate/early loading of dental implants: A report from the Sociedad Española de Implantes World Congress Consensus Meeting in Barcelona, Spain, 2002. Clin Implant Dent Relat Res 2003;5:57–60.
14. Cochran DL, Morton D, Weber HP. Consensus statements and recommended clinical procedures regarding loading protocols for endosseous dental implants. Int J Oral Maxillofac Implants 2004;19(suppl):109–113.
15. Szmukler-Moncler S, Salama H, Reingewirtz Y, Dubruille JH. The timing of loading and the effect of micro-motion on the dental implant-bone interface: A review of the experimental literature. J Biomed Mater Res 1998;43: 192–203.
16. Degidi M, Piattelli A. Immediate functional and non-functional loading of dental implants: A 2- to 60-month follow-up study of 646 titanium implants. J Periodontol 2003;74:225–241.
17. Wöhrle PS. Single-tooth replacement in the aesthetic zone with immediate provisionalization: Fourteen consecutive case reports. Pract Periodontics Aesthet Dent 1998;10: 1107–1114.
18. Garber DA, Salama MA, Salama H. Immediate total tooth replacement. Compend Contin Educ Dent 2001;22: 210–216.
19. Touati B, Guez G. Immediate implantation with provisionalization: From literature to clinical implications. Pract Periodontics Aesthet Dent 2002;14:699–707.

Chapter 5

Three-Dimensional Placement of Implants

Mithridade Davarpanah
Serge Szmukler-Moncler
Paul M. Khoury
Boris Jakubowicz-Kohen
Stuart Molloy

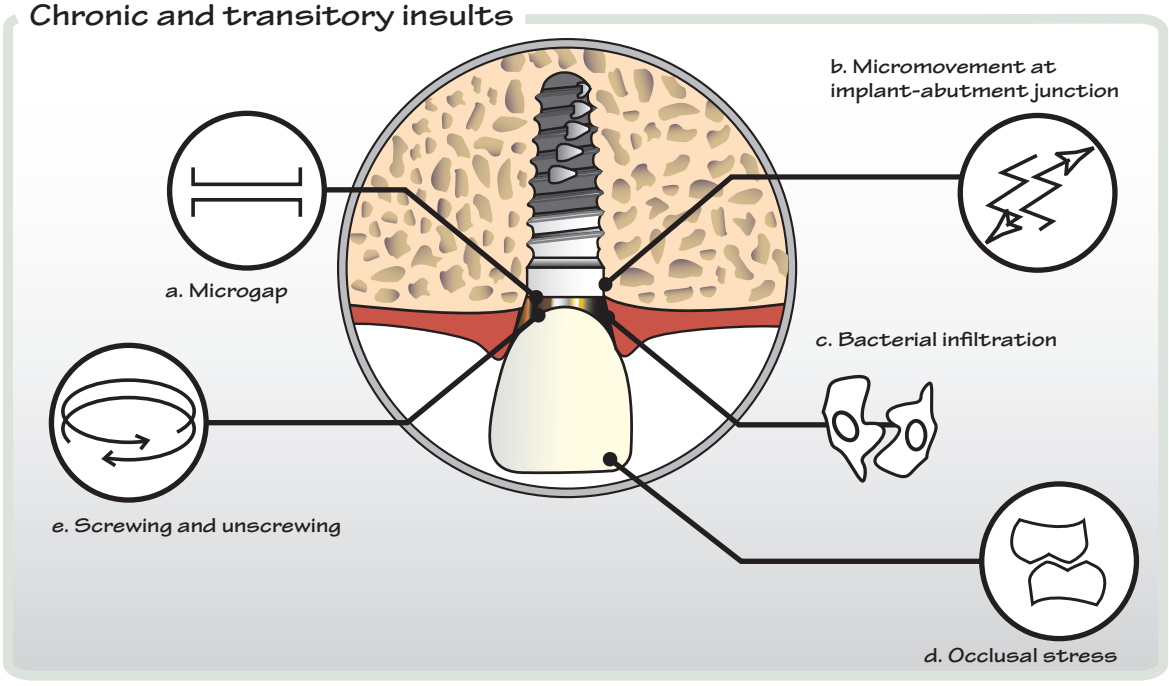
The correct placement of implants in all three dimensions must primarily be in harmony with the prosthetic requirements of the planned restoration. However, the shape and nature of the hard and soft tissues of the site and their anticipated reaction to implantation will also affect the three-dimensional (3D) positioning. The scope of possible circumstances for implant placement is outlined in Fig 5-1. Implants can be placed in either a healed site (Fig 5-2a) or a postextraction site (Fig 5-2b). For each of these locations, there are two possibilities:

1. The restoration has to conform to specific esthetic requirements related to the position of the papillae and gingival contour, as is the case when missing maxillary anterior teeth are replaced (see Figs 5-2a and 5-2b).
2. The restoration does not have to address soft tissue esthetics at all, as is the case when a completely edentulous mandible is restored (Figs 5-2c and 5-2d).

Implant placement should be prosthetically driven instead of surgically driven. Prosthetic considerations relate to biomechanical requirements of stress distribution as well as to esthetic concerns. When esthetic requirements are critical, precise 3D implant placement is paramount. However, when soft tissue esthetic considerations do not prevail, the surgeon has more flexibility in implant positioning.

▼ General Rules for Implant Placement

The 3D implant positioning must consider the following three planes: *(1)* mesiodistal, *(2)* bucco-lingual (or buccopalatal), and *(3)* coronoapical. These planes define the emergence site of the implant in the dental arch and the implant angulation. Implant positioning in all three planes must conform with the biologic rules described in the following sections.



▲ **Fig 5-4** Chronic and transitory insults at the implant-abutment junction. *(a)* Microgap between the abutment and the implant neck. *(b)* Micromovement between the abutment and the implant neck. *(c)* Bacterial infiltration at the implant-abutment junction. *(d)* Occlusal stress. *(e)* Transitory insults from repeated manipulation of the healing abutment.

Distance between implants and adjacent structures

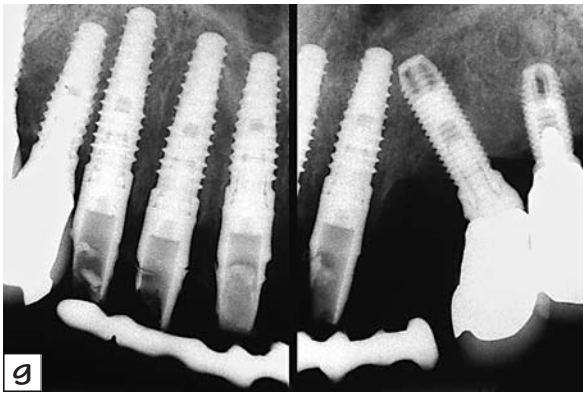
The principle of a minimal distance between two adjacent units, whether teeth or implants,[13,14] derives from the principle of preservation of the biologic width in the mesiodistal plane. Minimal distances of 3.0 mm between two implants and 1.5 mm between an implant and an adjacent natural tooth should be maintained (Fig 5-6). These values are based on the bone resorption that occurs during the first months of implant function in the vertical and horizontal directions (see Figs 5-6b and 5-6d). Both resorption patterns involve the surrounding bone to a distance of 1.0 to 1.5 mm (Fig 5-7).

Vertically, this bone loss translates to an apical migration of the peri-implant bone level. Laterally, it translates to a bone loss of equivalent distance between the two implants. When the distance between two implants is less than 3.0 mm (2 × 1.5 mm), the height of the bone crest is entirely resorbed[14] and the papilla no longer receives adequate support (see Fig 5-6b). On the other hand, when the distance between two implants is greater than 3.0 mm, the interimplant bone crest is preserved. The papilla receives the bone support it needs, assuring long-term maintenance of good esthetics (see Fig 5-6d). This resorption probably derives from the chronic insults previously described, but the precise etiology is not yet determined.

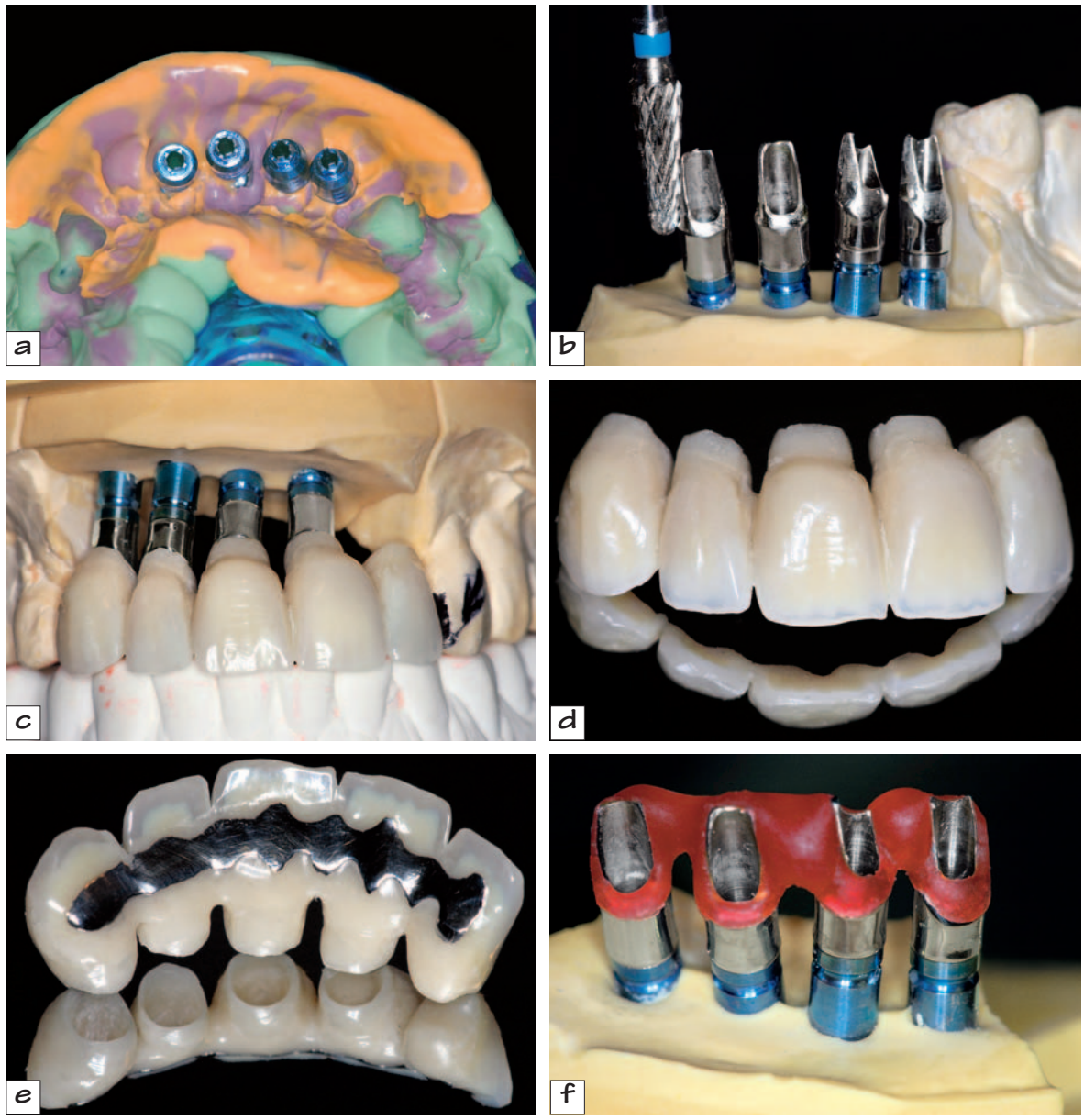
Bone resorption and roughness of the implant surface

Bone is a pressure-sensitive tissue that responds and adapts to stress. The changes in bone metabolism that astronauts experience as a result of the moon's microgravity demonstrate this property of osseous tissue. Bone responds in one of four different ways, depending on the intensity of stress to which the bone is subjected[15]:

1. Atrophy accompanied by bone resorption when stresses are lower than physiologic levels ε (< 100 με)
2. Balanced bone response when stresses are at a physiologic level (100 to 1,500 με)



▲ **Fig 11-33** Placement of the provisional prosthesis in the mouth. *(a)* Placement of abutments. The gingivae are highly edematous. *(b)* Occlusal assessment. The red marks indicate that the prosthesis is still making contact with the opposing teeth in protrusive movements of the mandible. *(c)* Prosthesis after the final occlusal adjustment. The prosthesis is out of dynamic occlusion. *(d and e)* Status of the soft tissues around the prosthesis, 48 hours after surgery. The gingival margins are well adapted, but the papillae have not yet filled in the spaces reserved for them. *(f)* Patient's low smile line. *(g)* Postoperative periapical radiographs. Note the presence of the interimplant crests, the titanium abutments, and the metal reinforcing bar. (Prosthesis by Dr P. Raygot and G. Fournier.)



▲ **Fig 11-32** Fabrication of the provisional prosthesis. *(a)* Impression with implant analogs in place. *(b)* Trimming of the abutments with a laboratory bur. *(c)* Prosthesis on the articulator. Note the distal extension. *(d)* Buccal view of the prosthesis and its extension. *(e)* Prosthesis with the cast metal bar. *(f)* Abutments in their positioning key. (Prosthesis by Dr P. Raygot and G. Fournier.)

Treatment variant: Patient with a thick periodontal biotype

The patient's periodontal biotype is important to the approach to and outcome of treatment. While the biotype of the patient described in the previous case was thin, the biotype of the patient described in the following section was thick (Fig 11-35a).

This patient presented for restoration of a segment of the anterior maxilla. The radiographic examination revealed advanced periodontal disease requiring tooth extractions (Fig 11-35b).