

Simplified Regenerative Procedures for Intraosseous



# SIMPLIFIED REGENERATIVE PROCEDURES

for Intraosseous Defects



*Edited by*

**Leonardo Trombelli, DDS, PhD**

Full Professor and Chair, Periodontology  
Director, Research Centre for the Study of Periodontal  
and Peri-Implant Diseases  
University of Ferrara

Operative Unit of Dentistry  
Azienda Unità Sanitaria Locale di Ferrara  
Ferrara, Italy

 **QUINTESSENCE PUBLISHING**

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

*To my mentor, Prof Giorgio Calura, with gratitude*



**Library of Congress Cataloging-in-Publication Data**

Names: Trombelli, Leonardo, editor.

Title: Simplified regenerative procedures for intraosseous defects / edited by Leonardo Trombelli.

Description: Chicago : Quintessence Publishing Co, Inc, [2020] | Includes bibliographical references and index. | Summary: "Atlas presenting surgical and nonsurgical methods to treat intraosseous defects, with a focus on the single-flap approach, including indications and contraindications for treating defects with each method and detailed descriptions of the steps required for each procedure"-- Provided by publisher.

Identifiers: LCCN 2019047285 (print) | LCCN 2019047286 (ebook) | ISBN 9780867159455 (paperback) | ISBN 9780867159929 (ebook)

Subjects: MESH: Periodontal Diseases--surgery | Guided Tissue Regeneration, Periodontal--methods | Surgical Flaps | Atlas

Classification: LCC RK361.A1 (print) | LCC RK361.A1 (ebook) | NLM WU 17 | DDC 617.6/32059--dc23

LC record available at <https://lcn.loc.gov/2019047285>

LC ebook record available at <https://lcn.loc.gov/2019047286>



© 2020 Quintessence Publishing Co, Inc

Quintessence Publishing Co, Inc  
411 N Raddant Road  
Batavia, IL 60510  
[www.quintpub.com](http://www.quintpub.com)

5 4 3 2 1

All rights reserved. This book or any part thereof may not be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, or otherwise, without prior written permission of the publisher.

Editor: Marieke Zaffron  
Design: Sue Zubek  
Production: Angelina Schmelter

Printed in the USA

# CONTENTS



**Foreword** *vi*  
**Preface** *vii*  
**Contributors** *ix*

**1 Introduction** *1*  
*Leonardo Trombelli, Roberto Farina, Anna Simonelli*

**2 Fundamentals in Periodontal  
Regeneration** *7*  
*Raluca Cosgarea, Dieter D. Bosshardt, Leonardo Trombelli, Anton Sculean*

**3 Nonsurgical Treatment of Intraosseous  
Defects** *41*  
*Mario Aimetti, Giulia Maria Mariani, Federica Romano, Anna Simonelli,  
Leonardo Trombelli*

**4 Simplified Surgical Regenerative  
Procedures: The Single-Flap  
Approach** *77*  
*Leonardo Trombelli, Roberto Farina, Anna Simonelli*

**Index** *139*

## **Video content**

Extra video content is available online wherever indicated by a QR code. Scan the QR codes in the text to access this supplementary information or visit the web page listed in the book.

# FOREWORD



It is always a great satisfaction when you are asked to write a foreword of a good book. This is especially true when the book expands our scientific culture and promotes the training of our students and professionals. Frequently, these books introduce new knowledge or new technologies. However, it is less frequent for a book to be purposely focused on training students and professionals on surgical procedures. This atlas focuses on evidence-based education and in acquiring relevant professional competencies in the surgical treatment of specific periodontal lesions (ie, intraosseous defects). The information provided is clear, well organized, and very practical, but at the same time it is rigorous and up to date with current knowledge, comprehensively covering the fundamentals of periodontal regeneration and the use of the different technologies. It particularly focuses on simplified surgical procedures aimed to attain the best possible regenerative outcomes with minimal invasiveness.

The author, Prof Leonardo Trombelli, has dedicated many years of his professional life to studying and researching successful long-term periodontal therapy and specifically the use of regenerative surgical interventions to improve the prognosis of periodontally affected teeth. He has published essential scientific articles that provide the basis for this book. His contribution to this work clearly demonstrates not only his excellent scientific background but also the teaching abilities that are needed to produce a book such as this, with scientific rigor and at the same time with practical relevance for students and professionals. Moreover, the many contributors in this work are not only well respected in Italy but also in Europe and beyond.

In summary, this book is clear and well written and provides very useful and relevant content to support dentists and periodontists in learning how to apply modern periodontal surgical interventions to achieve regeneration in teeth that have lost periodontal attachment as a consequence of periodontitis.

**Mariano Sanz, MD, DDS, DR Med**  
Professor and Chairman, Periodontology  
Faculty of Odontology  
Complutense University of Madrid  
Madrid, Spain



# PREFACE

*Man should be as eager to simplify his life as he is to complicate it.*  
—Henri-Louis Bergson

For 20 years, in collaboration with the whole research group at the Research Centre for the Study of Periodontal and Peri-Implant Diseases, University of Ferrara, we have been making a great effort in trying to find diagnostic and therapeutic solutions that could optimize endpoints while making clinical processes and pathways easier for practitioners and students. We started back in 2007 with a simplified method to access deep intraosseous defects (the *single-flap approach*, or SFA, that will be extensively described in this book). Then, in 2008, we introduced the Smart Lift technique—a simplified, standardized method to perform sinus elevations with a minimally invasive transcrestal surgical procedure (a method that has been extensively investigated and published on for more than 10 years). In 2009, we reported on a simplified method to assess the periodontal risk profile of the patient, based on five straightforward parameters that have been shown to be linked to the progression of periodontal breakdown. And more recently, in 2018, we published on a simplified method for horizontal bone augmentation, which is based on the creation of a periosteal pouch that acts as an osteogenic, space-providing membrane for bone grafting (the subperiosteal peri-implant augmented layer, or SPAL technique).

The development of simplified procedures has been a main focus of my career for two main reasons. First, I want to provide the profession with simple, straightforward, innovative solutions that may bring clinicians closer to procedures that are otherwise neglected because of their potential complexity. In search of simplified diagnostic and treatment procedures, we targeted those that are mostly perceived as successful only when performed by the talented and gifted hands of a few select colleagues. I am well aware that spreading the use of simplified procedures among dental professionals means amplifying the number of patients who may benefit from them. The second reason is related to my mission as a university faculty member. Teaching simple procedures can help the great majority of students to reach a high level of competence in a reasonable amount of time with a fast learning curve.

These two reasons represent the main driving force that brought me to write this book. With the large number of photographs and videos of many different clinical cases, the textbook has been designed as a sort of tutorial for both graduate students and practitioners who want to expand their knowledge and technical skill in the nonsurgical and surgical treatment of deep intraosseous defects, very common lesions in patients with Stage III and IV periodontitis. In particular, the SFA is thoroughly described with a step-by-step approach, starting from the analysis of diagnostic and prognostic patient/defect characteristics to the selection of surgical instruments, choice of flap design, methods for root debridement and



conditioning, use of appropriate regenerative technologies, description of suitable suture techniques for different flap designs, and the short- and long-term postsurgery care. A multitude of clinical cases are illustrated in great detail in order to provide a wide range of scenarios and conditions where the SFA can be easily and successfully applied.

In conclusion, I wish to acknowledge all the coauthors who have contributed to make this textbook a unique, up-to-date manual on regenerative procedures: Anton Sculean, Dieter Bosshardt, and Raluca Cosgarea, who have thoroughly described the fundamental principles of periodontal regeneration; Mario Aimetti, Giulia Mariani, and Federica Romano, who described novel nonsurgical approaches; and Roberto Farina for his talented help with the surgical chapter. A special thanks to Anna Simonelli, who spent a great amount of her postgraduate education and PhD program coordinating and monitoring a massive amount of clinical research on the SFA. Without her precious work, this textbook would have never reached such a level of quality and completeness. Also, I want to express my sincere gratitude to Quintessence Publishing, who from the very first moment has strongly and convincingly believed in this challenging editorial project. Last but not least, I want to thank my family: my wife, Cristina, and my children Emma and Andrea for their continuous, silent, and patient support.

# CONTRIBUTORS



**Mario Aimetti, MD, DDS**

Associate Professor, Periodontology  
Department of Surgical Sciences  
Dental School  
University of Turin  
Turin, Italy

**Dieter D. Bosshardt, PhD**

Associate Professor  
Department of Oral Surgery and Stomatology  
School of Dental Medicine  
University of Bern  
Bern, Switzerland

**Raluca Cosgarea, DDS**

Assistant Professor  
Department of Periodontology  
Philipps University of Marburg  
Marburg, Germany  
Assistant Professor  
Department of Prosthetic Dentistry  
Iuliu Hațieganu University of Medicine  
and Pharmacy  
Cluj-Napoca, Romania

**Roberto Farina, DDS, PhD, MSc**

Associate Professor, Oral Surgery  
Research Centre for the Study of  
Periodontal and Peri-Implant Diseases  
University of Ferrara  
Operative Unit of Dentistry  
Azienda Unità Sanitaria Locale di Ferrara  
Ferrara, Italy

**Giulia Maria Mariani, DDS, MSc**

Visiting Professor, Periodontology  
Department of Surgical Sciences  
Dental School  
University of Turin  
Turin, Italy

**Federica Romano, DDS**

Research assistant, Periodontology  
Department of Surgical Sciences  
Dental School  
University of Turin  
Turin, Italy

**Anton Sculean, DMD, Dr hc, MSc**

Full Professor and Chair, Periodontology  
Department of Periodontology  
School of Dental Medicine  
University of Bern  
Bern, Switzerland

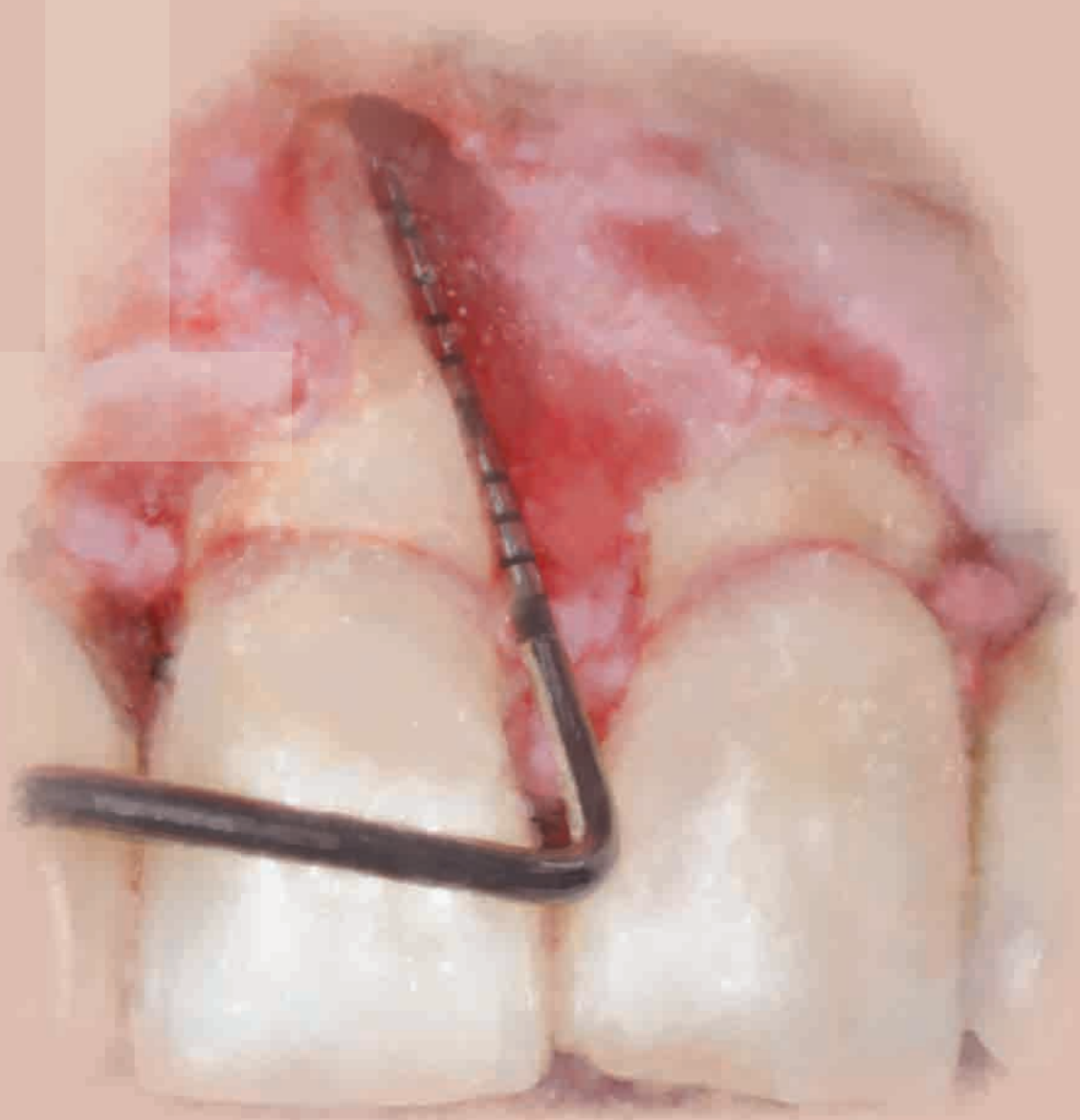
**Anna Simonelli, DDS, PhD**

Research Fellow, Periodontology  
Research Centre for the Study of  
Periodontal and Peri-Implant Diseases  
University of Ferrara  
Ferrara, Italy

**Leonardo Trombelli, DDS, PhD**

Full professor and Chair, Periodontology  
Director, Research Centre for the Study of  
Periodontal and Peri-Implant Diseases  
University of Ferrara  
Operative Unit of Dentistry  
Azienda Unità Sanitaria Locale di Ferrara  
Ferrara, Italy





# INTRODUCTION

*Leonardo Trombelli, DDS, PhD*

*Roberto Farina, DDS, PhD, MSc*

*Anna Simonelli, DDS, PhD*

---

## WHY A TEXTBOOK ON THE TREATMENT OF INTRAOSSEOUS DEFECTS?

The prevalence of intraosseous defects in adults was investigated on dried skulls<sup>1</sup> as well as through clinical<sup>2,3</sup> and radiographic assessments.<sup>4-8</sup> At the patient level, the presence of at least one intraosseous defect was detected with an incidence ranging between 25.5% and 51% in samples representative of the general population or specific age cohorts,<sup>1,6,7</sup> between 18% and 23% in patients seeking dental care,<sup>4,8</sup> and of 45.1% in a periodontally compromised cohort.<sup>2</sup> A retrospective study revealed that intraosseous lesions are at high risk of further progression, and they may lead to tooth loss if left untreated.<sup>9</sup> Papapanou and Wennström<sup>9</sup> retrospectively recorded the bone level changes as well as tooth loss over a 10-year period at tooth sites with intraosseous defects in individuals not treated with systematic periodontal therapy. The results demonstrated an increased frequency of tooth loss and bone loss with increasing depth of the intraosseous defect. In particular, the proportion of teeth lost between the 1- and 10-year examinations was 22%, 46%, and 68% for teeth with a defect depth of 2 mm, 2.5 to 4 mm, and  $\geq 4.5$  mm, respectively.

These observations reinforce the need for:

- A proper diagnosis of the intraosseous defect, which represents a common lesion in patients affected by Stage III and IV periodontitis.
- An appropriate treatment of the lesion that may successfully revert those conditions (probing depth [PD]  $\geq 5$  mm associated with bleeding on probing [BOP]) conducive to progressive attachment/bone loss.



## WHY A TEXTBOOK ON REGENERATIVE PROCEDURES?

The ideal outcome of the surgical treatment of a deep intraosseous defect is the regeneration of the tooth attachment apparatus destroyed by the process of periodontitis. From a histologic point of view, periodontal regeneration implies the formation of periodontal ligament fibers inserted into newly formed cementum and bone.<sup>10</sup> Data from human histologic studies have provided evidence that periodontal regeneration may be accomplished by using different regenerative technologies, including membranes and biologic agents<sup>11–15</sup> (see chapter 2).

Extensive clinical data have shown that compared with nonregenerative treatment, the surgical regenerative treatment of deep intraosseous lesions may result in a considerable improvement of probing parameters following the tissue maturation phase.<sup>16–21</sup> From a clinical point of view, periodontal regeneration may result in a substantial increase in clinical attachment level (CAL) gain (of at least 3 mm) and relevant bone fill of the intraosseous component of the lesion together with a maintainable, stable probing depth (ie, PD  $\leq$  4 mm in absence of BOP).

Sculean et al<sup>22</sup> published the results of a 10-year follow-up after the regenerative treatment of 38 intraosseous periodontal defects with different regenerative treatments: enamel matrix derivative (EMD), guided tissue regeneration (GTR), combination EMD and GTR, and open flap debridement (OFD). After treatment, all patients were placed in a 3-month supportive periodontal care program. At 1 year, a significantly greater CAL gain was achieved in the regeneration groups (ie, GTR, EMD, or combination) compared to OFD controls, and this was maintained substantially unvaried for a 10-year period.

A 20-year follow-up after regenerative treatment of intraosseous defects was recently reported in a cohort of 45 patients.<sup>23</sup> Defects were treated with three different modalities: GTR with modified papilla preservation flap, GTR with conventional access flap, and access flap alone without membrane. All patients were enrolled in a supportive periodontal care program with 3-month recalls. At both 1-year and 20-year reevaluation, a significantly better CAL gain and PD reduction was obtained by the two GTR treatments than the access flap. Moreover, the access flap surgery was associated with a greater disease recurrence.<sup>23</sup>

Collectively, available data seem to support the use of regenerative devices to ensure better short- and long-term outcomes than mere surgical debridement at deep intraosseous defects.

## WHY A TEXTBOOK ON SIMPLIFIED TREATMENT PROCEDURES?

Despite decades of well-established nonsurgical and surgical protocols and techniques, the treatment of deep intraosseous lesions still represents a challenge for clinicians. There is a perception that the regenerative treatment of an intraosseous lesion is both technically sensitive and costly, with limited outcome predictability in the hands of the average operator (ie, not specially trained or highly skilled). This perception is likely due to aspects related to debridement of any lesions via a “closed” approach (see chapter 3) and those associated with the difficulty in performing a correct flap design and suturing technique as well as in selecting the appropriate regenerative



technology. The purpose of this textbook is to present simplified procedures that may overcome these issues, at least in part, when treating an intraosseous defect.

The term *simplify* means the act of making something less complex. In the present textbook, we define a procedure aimed at improving the clinical conditions of a deep intraosseous lesion (in terms of substantial clinical and histologic attachment gain and bone fill, reduction of the PD to a maintainable condition, and limited to no postsurgery recession) as *simplified* when characterized by more favorable conditions for the patient and/or the clinical operator. Although the terms *simplification* and *minimal invasiveness* may appear as synonyms when referring to periodontal treatment, in our perspective *simplification* implies a substantially broader concept.

For the operator, a simplified procedure has the following characteristics<sup>24</sup>:

- Limited surgical equipment
- An easy-to-learn technique
- Limited need for additional treatments or devices (through the maximization of the inherent healing potential of the treated lesion)

For the patient, a simplified procedure should have a reduced impact on the following<sup>24</sup>:

- Posttreatment daily activities
- Posttreatment pain and discomfort (also reducing the required compliance for post-treatment regimens)
- Preexisting esthetics

For both patient and operator, a simplified procedure should reduce both treatment costs and chairside time needed for both treatment administration and follow-up visits.<sup>24</sup> This also results in fewer treatment costs.

Nonsurgical therapy as a standalone treatment always represents a “simplified” procedure, particularly when compared with surgical approaches. Among the available surgical options, simplified surgical procedures share a common technical aspect (ie, the elevation of a single flap on the buccal or palatal/lingual aspect), leaving the tissues on the opposite side intact. In this respect, this textbook will focus in detail on a novel surgical approach—the single-flap approach—that was first introduced in 2007<sup>25</sup> and repeatedly validated by different randomized clinical trials thereafter (see chapter 4). The single-flap approach was shown to be at least as effective as traditional papilla preservation techniques when evaluated either as a standalone protocol or in combination with regenerative devices.

The main goal of this textbook is to show the effectiveness of simplified surgical procedures to treat challenging intraosseous lesions. The authors’ ambition is to teach how clinicians may achieve substantial treatment outcomes associated with minimal esthetic impairment and a more tolerable postoperative course.

Simplifying both the nonsurgical and surgical treatment phases will achieve the following outcomes:

- Reshape the learning curve, thus increasing the generalizability of treatment outcomes
- Improve patient access to care by limiting biologic and economic costs



## REFERENCES

1. Larato DC. Intrabony defects in the dry human skull. *J Periodontol* 1970;41:496–498.
2. Söder B, Jin LJ, Söder PO, Wikner S. Clinical characteristics of destructive periodontitis in a risk group of Swedish urban adults. *Swed Dent J* 1995;19:9–15.
3. Vrotsos JA, Parashis AO, Theofanatos GD, Smulow JB. Prevalence and distribution of bone defects in moderate and advanced adult periodontitis. *J Clin Periodontol* 1999;26:44–48.
4. Nielsen IM, Glavind L, Karring T. Interproximal periodontal intrabony defects. Prevalence, localization and etiological factors. *J Clin Periodontol* 1980;7:187–198.
5. Papapanou PN, Wennström JL, Gröndahl K. Periodontal status in relation to age and tooth type. A cross-sectional radiographic study. *J Clin Periodontol* 1988;15:469–478.
6. Wouters FR, Salonen LE, Helldén LB, Frithiof L. Prevalence of interproximal periodontal intrabony defects in an adult population in Sweden. A radiographic study. *J Clin Periodontol* 1989;16:144–149.
7. Soikkonen K, Wolf J, Närhi T, Ainamo A. Radiographic periodontal findings in an elderly Finnish population. *J Clin Periodontol* 1998;25:439–445.
8. Dundar N, Ilgenli T, Kal BI, Boyacioglu H. The frequency of periodontal infrabony defects on panoramic radiographs of an adult population seeking dental care. *Community Dent Health* 2008;25:226–230.
9. Papapanou PN, Wennström JL. The angular bony defect as indicator of further alveolar bone loss. *J Clin Periodontol* 1991;18:317–322.
10. Sander L, Karring T. Healing of periodontal lesions in monkeys following the guided tissue regeneration procedure. A histological study. *J Clin Periodontol* 1995;22:332–337.
11. Nyman S, Lindhe J, Karring T, Rylander H. New attachment following surgical treatment of human periodontal disease. *J Clin Periodontol* 1982;9:290–296.
12. Heijl L, Heden G, Svärdröm G, Ostgren A. Enamel matrix derivative (EMDOGAIN) in the treatment of intrabony periodontal defects. *J Clin Periodontol* 1997;24:705–714.
13. Bosshardt DD, Sculean A, Windisch P, Pjetursson BE, Lang NP. Effects of enamel matrix proteins on tissue formation along the roots of human teeth. *J Periodontol Res* 2005;40:158–167.



14. Majzoub Z, Bobbo M, Atiyeh E, Cordioli G. Two patterns of histologic healing in an intrabony defect following treatment with enamel matrix derivative: A human case report. *Int J Periodontics Restorative Dent* 2005;25:283–294.
15. Nevins M, Kao RT, McGuire MK, et al. Platelet-derived growth factor promotes periodontal regeneration in localized osseous defects: 36-month extension results from a randomized, controlled, double-masked clinical trial. *J Periodontol* 2013;84:456–464.
16. Trombelli L, Heitz-Mayfield LJ, Needleman I, Moles D, Scabbia A. A systematic review of graft materials and biological agents for periodontal intraosseous defects. *J Clin Periodontol* 2002;29(suppl 3):117–135.
17. Giannobile WV, Somerman MJ. Growth and amelogenin-like factors in periodontal wound healing. A systematic review. *Ann Periodontol* 2003;8:193–204.
18. Trombelli L, Farina R. Clinical outcomes with bioactive agents alone or in combination with grafting or guided tissue regeneration. *J Clin Periodontol* 2008;35(suppl 8):117–135.
19. Koop R, Merheb J, Quiryne M. Periodontal regeneration with enamel matrix derivative in reconstructive periodontal therapy: A systematic review. *J Periodontol* 2012;83:707–720.
20. Matarasso M, Iorio-Siciliano V, Blasi A, Ramaglia L, Salvi GE, Sculean A. Enamel matrix derivative and bone grafts for periodontal regeneration of intrabony defects. A systematic review and meta-analysis. *Clin Oral Investig* 2015;19:1581–1593.
21. Kao RT, Nares S, Reynolds MA. Periodontal regeneration—Intrabony defects: A systematic review from the AAP Regeneration Workshop. *J Periodontol* 2015;86(suppl 2):S77–S104.
22. Sculean A, Kiss A, Miliauskaitė A, Schwarz F, Arweiler NB, Hannig M. Ten-year results following treatment of intra-bony defects with enamel matrix proteins and guided tissue regeneration. *J Clin Periodontol* 2008;35:817–824.
23. Cortellini P, Buti J, Pini Prato G, Tonetti MS. Periodontal regeneration compared with access flap surgery in human intra-bony defects 20-year follow-up of a randomized clinical trial: Tooth retention, periodontitis recurrence and costs. *J Clin Periodontol* 2017;44:58–66.
24. Trombelli L, Simonelli A, Minenna L, Vecchiatini R, Farina R. Simplified procedures to treat periodontal intraosseous defects in esthetic areas. *Periodontol 2000* 2018;77:93–110.
25. Trombelli L, Farina R, Franceschetti G. Single flap approach in periodontal surgery [in Italian]. *Dent Cadmos* 2007;75:15–25.

# INDEX



Page references followed by “f” denote figures, “t” denote tables, and “b” denote boxes.

## A

AAP. *See* American Academy of Periodontology.  
Acellular root cementum, 19  
Air polishing, 52–53, 53f  
Allografts, 15  
Alloplastic materials, 15  
Amelogenins, 19–20  
American Academy of Periodontology, 41  
Amino acid glycine powder air polishing, 52  
Antimicrobials, for plaque removal, 53–55, 53f–55f  
Autogenous grafts, 14–15

## B

Barrier membranes, 12–13  
Basic fibroblast growth factor, 25  
BDXs. *See* Bovine-derived xenografts.  
bFGF. *See* Basic fibroblast growth factor.  
Bioactive glasses, 18  
Biofilm, 41, 84, 110f  
Bite guard, 82, 83f  
Bleeding on probing, 1, 59–60, 78  
BMPs. *See* Bone morphogenetic proteins.  
Bone grafts. *See also* Grafts.  
    allografts, 15  
    autogenous, 14–15  
    in periodontal regeneration, 14–17  
Bone morphogenetic proteins  
    BMP-2, 26–27  
    BMP-3, 27  
    BMP-6, 27  
    BMP-7, 27–28  
    BMP-12, 28  
    BMP-14, 28  
    description of, 15, 26  
    periodontal regeneration uses of, 26–28  
    wound healing uses of, 26–28  
Bone substitute, enamel matrix derivative with, 122–129, 124f, 126f–128f  
BOP. *See* Bleeding on probing.  
Bovine-derived xenografts, 15

## C

CAL. *See* Clinical attachment level.  
Calculus, 42f–43f  
    Er:YAG laser removal of, 51  
    manual devices for removal of, 53  
    residual, after professional mechanical plaque removal, 61, 61f  
    subgingival, 41f–42f, 48, 52  
    supragingival, 42f, 52  
Cartilage-derived morphogenetic protein 1, 27  
CDMP-1. *See* Cartilage-derived morphogenetic protein 1.  
Cellulose acetate laboratory filter, 12

Cemental tear, 78f  
Cementum, 8, 10, 17f  
Chlorhexidine gluconate, 54–55, 54f–55f  
Clinical attachment level, 69f  
    antimicrobial effects on, 54  
    description of, 2, 13, 15  
    enamel matrix derivative effects on, 120  
    papilla preservation techniques' effect on, 88  
    preoperative loss of, 85f  
    single-flap approach effects on, 95f, 108f  
Clot, fibrin, 7–9, 66–67, 111  
Collagen, 7–9, 97  
Collagen matrix, 10  
Cone-beam computed tomography, 102  
Connective tissue attachment, 8–11  
Connective tissue graft with single-flap approach, 131–133, 132f–134f  
Coralline xenografts, 16  
Coronally positioned single-flap approach, 93  
CP-SFA. *See* Coronally positioned single-flap approach.  
Critical probing depth, 59

## D

DBBM. *See* Demineralized bovine bone mineral.  
Decalcified freeze-dried bone allografts, 15–16  
Demineralized bovine bone mineral, 85f  
Dental hygienist, 46  
Dental plaque  
    biofilm of, 41, 110f  
    interdental cleaning for, 47, 47f  
    interproximal cleaning for, 47  
    professional mechanical plaque removal. *See* Professional mechanical plaque removal.  
    self-performed control of, 46–48, 47f–48f  
    tooth brushing for, 46–47, 47f  
Dentin tubules, 10  
DFA. *See* Double-flap approach.  
DFDBA. *See* Decalcified freeze-dried bone allografts.  
Diabetes mellitus, 61, 62f  
Diastema, 56  
Diode laser, 51  
Double-flap approach  
    morbidity after, 98–99  
    single-flap approach versus, 93, 95f, 97–99, 97f, 99f  
Doxycycline gel, 53

## E

Early healing index, 95–97, 96f, 97f, 119f  
EDTA. *See* Ethylenediaminetetraacetic acid.  
EHI. *See* Early healing index.  
Electric toothbrushes, 46  
EMD. *See* Enamel matrix derivative.  
Emdogain, 20–21, 22f  
EMPs. *See* Enamel matrix proteins.

Enamel matrix derivative  
 bone substitute with, 122–129, 124f, 126f–128f  
 clinical attachment level effects of, 120  
 definition of, 120  
 derivation of, 20  
 effectiveness of, 120  
 flapless procedure and, 67–68, 68f, 70  
 graft biomaterial with, 123f, 124–125  
 growth factor activity in, 20  
 guided tissue regeneration and, 2, 21–23  
 histologic animal and human studies of, 21–23, 22f–23f  
 in periodontal regeneration, 20–23  
 periodontal tissue affected by, 20–23  
 single-flap approach with, 99, 120–129, 121f–124f, 125  
 wound healing effects of, 20–21  
 xenografts and, 23

Enamel matrix proteins, 19–20

Epidermal wound healing, 7, 8f

Epithelial attachment, 8–11

Epithelial downgrowth, 9

ePTFE. *See* Expanded polytetrafluoroethylene.

Er:YAG laser, 51

Erythritol, 52

Ethylenediaminetetraacetic acid, 69f, 121f

Expanded polytetrafluoroethylene, 9–10, 88

## F

FDBA. *See* Freeze-dried bone allografts.

FGFs. *See* Fibroblast growth factors.

Fibrin clot, 7–9, 66–67, 111

Fibroblast(s)  
 basic fibroblast growth factor from, 25  
 enamel matrix derivative effects on, 20

Fibroblast growth factors, 25

Flap design  
 anatomical characteristics associated with, 88, 90  
 classification of, 88  
 for intraosseous defects, 82, 84, 86–90  
 suturing techniques based on, 88, 90

Flap surgery. *See also* Double-flap approach; Single-flap approach.  
 guided tissue regeneration and, 86  
 suturing technique, 86

Flapless procedure  
 advantages of, 70  
 definition of, 67  
 enamel matrix derivatives with, 67–68, 68f, 70  
 intraosseous defects treated with, 70, 70f–71f  
 limitations of, 70  
 operative protocol for, 69, 69f  
 posttreatment regimen after, 70

Flossing, 47

FP. *See* Flapless procedure.

Freeze-dried bone allografts, 15–16

## G

Gingival recession  
 after single-flap approach, 114f, 129–133, 129f–134f  
 minimally invasive nonsurgical therapy and, 65

Gracey mini curettes, 51f, 64–65

Grafts  
 allografts, 15  
 autogenous, 14–15

bone, 14–17  
 decalcified freeze-dried bone allografts, 15  
 enamel matrix derivative with, 123f, 124–125  
 freeze-derived bone allografts, 15  
 xenografts, 15–16, 17f

Granulation tissue, 7–8, 85f

Growth differentiation factor-5, 27–28

Growth differentiation factor-7, 27–28

Growth factors  
 enamel matrix derivative and, 20  
 fibroblast, 25  
 insulin-like, 25  
 periodontal regeneration uses of, 24–28  
 platelet-derived, 24  
 transforming growth factor  $\beta$ , 26

GTR. *See* Guided tissue regeneration.

Guided tissue regeneration  
 animal studies of, 11  
 barrier membranes used in, 12–13  
 basic fibroblast growth factor and, 25  
 biological concepts in, 11–18, 12f–13f, 16f–17f  
 development of, 11  
 enamel matrix derivative and, 2, 21–23  
 flap surgery and, 86  
 intraosseous defects treated with, 114–118, 115f–117f  
 long-term studies of, 2  
 modified papilla preservation technique for, 88  
 nonresorbable membranes used in, 12–13  
 periodontal regeneration, 11–12, 12f  
 principles of, 10  
 resorbable membranes used in, 13–14  
 single-flap approach and, 82f, 114–118, 115f–117f  
 smoking effects on, 78

## H

HA. *See* Hydroxyapatite.

Hertwig epithelial root sheath layer, 19

Hirschfeld file scalers, 106, 115f

Horizontal mattress suture, 106, 107f

Hydroxyapatite, 16, 18

Hydroxyapatite-based graft, with single-flap approach, 114, 118, 118t, 119f

## I

IGFs. *See* Insulin-like growth factors.

Incision line, for single-flap approach, 102–103, 104f

Inflammatory cells, 7

Insulin-like growth factors, 25

Interdental cleaning, 47, 47f

Interdental papillae, 107f

Interproximal cleaning, 47

Interproximal space, narrow, 106

Interproximal tissue maintenance technique, 88, 92t

Intrabony defects. *See also* Intraosseous defects.  
 alloplastic grafts for, 18  
 bovine-derived xenografts for, 15, 16f  
 cone-beam computed tomography of, 102  
 enamel matrix derivative for, 21  
 flapless procedure with enamel matrix derivatives for, 68f  
 mandibular second molar, 67f

Intraoral autogenous grafts, 14

Intraosseous defects. *See also* Intrabony defects.





angle of, 81f  
 characteristics of, 79–80  
 classification of, 79, 80f  
 cortical perforations for, 106  
 debridement of, in single-flap approach, 106, 112f  
 deep, 84f  
 depth of, 81f  
 distribution of, 100f  
 flap design for, 82, 84, 86–90  
 flapless procedure for, 70, 70f–71f. *See also* Flapless procedure.  
 infrabony component of, 79, 79f  
 interproximal, 131f  
 minimally invasive nonsurgical therapy for. *See* Minimally invasive nonsurgical therapy.  
 modified papilla preservation technique for, 88, 89f  
 multiple, single-flap approach for, 106, 108f–110f  
 one-wall, 79, 80f, 101  
 prevalence of, 1  
 prognosis for, 81f  
 progression of, 1  
 regenerative treatment of, 2  
 single-flap approach and guided tissue regeneration for, 82f  
 suprabony component of, 79, 79f  
 surgical treatment of. *See* Surgical treatment.  
 three-wall, 79, 80f, 101  
 tooth loss caused by, 1  
 two-wall, 79, 80f  
 width of, 79  
 ITM technique. *See* Interproximal tissue maintenance technique.

## L

Laser therapy, 51, 52f  
 Long junctional epithelium, 9, 9f, 14–15, 18

## M

Macrophages, 7  
 Magnetostrictive scalers, 49f  
 Membranes, in periodontal regeneration, 12–14  
 Mesenchymal stem cells, 20  
 Millipore, 12  
 Mini curettes, 50, 51f, 64  
 Minimal invasiveness, 3  
 Minimally invasive nonsurgical therapy  
   clinical results of, 65  
   enamel matrix derivatives with, 67. *See also* Flapless procedure.  
   gingival recession and, 65  
   rationale for, 64  
   recommendations for, 65b  
   regenerative potential of, 66–67  
   treatment protocol for, 64–65, 65b  
 Minocycline, 53  
 MINST. *See* Minimally invasive nonsurgical therapy.  
 Mitogenic factors, 20  
 M-MIST. *See* Modified minimally invasive surgical technique.  
 Modified Bass technique, 46  
 Modified minimally invasive surgical technique, 93  
 Modified papilla preservation technique, 88, 89f, 92f  
 MPPT. *See* Modified papilla preservation technique.  
 MSCs. *See* Mesenchymal stem cells.  
 Mucogingival flap, 7–8

## N

Nd:YAG laser, 51  
 Neutrophils, 7, 8f  
 Nonresorbable membranes, 12–13  
 Nonsurgical therapy  
   appropriateness of, 41  
   clinical outcomes of, 55–60, 56f–60f  
   goals of, 41–46  
   patient reevaluation after, 64  
   for periodontitis, 41–64  
   professional mechanical plaque removal. *See* Professional mechanical plaque removal.  
   as simplified procedure, 3  
   stability as endpoint of, 56  
   tooth mobility affected by, 56

## O

Obesity, 61  
 OFD. *See* Open flap debridement.  
 Open flap debridement  
   description of, 12, 14  
   guided tissue regeneration and enamel matrix derivative versus, 22–23  
 Oral hygiene, home-based programs for, 47  
 Osseointegration, 11  
 Osteoconduction, 15  
 Osteogenic protein 1, 27–28  
 Osteogenin, 27–28  
 Oxytalan fibers, 21

## P

Palatal single-flap approach, 105f, 107f, 130f, 131  
 Papilla preservation techniques  
   clinical attachment level affected by, 88  
   description of, 86, 88  
   indications for, 92t  
   single-flap approach versus, 3  
 PDGF. *See* Platelet-derived growth factor.  
 PDL. *See* Periodontal ligament.  
 PDT. *See* Photodynamic therapy.  
 PerioChip, 55, 55f  
 Periodontal ligament  
   fibroblasts of, 20  
   insulin-like growth factor effects on, 25  
   regenerative potential of, 10  
 Periodontal pockets, 66f  
 Periodontal probe, 48, 49f  
 Periodontal regeneration  
   allografts in, 15  
   alloplastic materials for, 15  
   autogenous grafts in, 14–15  
   bone grafts in, 14–17  
   bone morphogenetic proteins for, 26–28  
   cells involved in, 10–11  
   decalcified freeze-dried bone allografts for, 15  
   enamel matrix derivative for, 20–23, 22f–23f  
   experimental studies of, 14  
   flap design in, 84  
   freeze-dried bone allografts for, 15  
   growth factors for, 24–28  
   guided tissue regeneration in, 11–12, 12f, 16f  
   membranes in, 12–14  
   outcomes of, 78  
   periodontal infection control for, 69f

predictability of, 86  
 suturing technique for, 86  
 technical factors for, 84–86, 85f  
 technology for, 86  
 transforming growth factor  $\beta$  in, 26  
 xenografts for, 15–16, 17f  
 Periodontal tissue, enamel matrix derivatives effect on, 20–23  
 Periodontal wound healing, 7–11  
 Periodontitis  
   biofilm control for, 41, 41f  
   case study of, 44f–45f  
   definition of, 41  
   modifiable risk factors for, 46  
   nonsurgical management of, 41–64  
 PGA membranes. *See* Polyglycolic acid membranes.  
 Phagocytosis, 7  
 Phosphorus pentoxide, 18  
 Photodynamic therapy, 51–52, 52f  
 Piezoelectric scalers, 49f  
 PLA membranes. *See* Polylactic acid membranes.  
 Plaque. *See* Dental plaque.  
 Plasma proteins, 7  
 Platelet-derived growth factor, 24–25  
 PMPR. *See* Professional mechanical plaque removal.  
 Polyglycolic acid membranes, 13–14  
 Polylactic acid membranes, 9, 13–14  
 Polymers, 18  
 Polymorphonuclear neutrophils, 8f  
 PPT. *See* Papilla preservation technique.  
 Primary intention healing, 10, 13, 85f, 94  
 Probing depths  
   critical, 59  
   nonsurgical therapy effects on, 59  
   patient-related factors that affect, 61  
 Professional mechanical plaque removal  
   air polishing for, 52–53, 53f  
   antimicrobials for, 53–55, 53f–55f  
   clinical outcomes of, 55–60, 56f–60f  
   instrumentation for, 48–50, 49f–50f  
   laser therapy for, 51, 52f  
   limitations of, 61, 61f–63f  
   manual instruments for, 49, 49f  
   mini curettes for, 50, 51f  
   periodontal probe used in, 48, 49f  
   photodynamic therapy for, 51–52, 52f  
   residual calculus after, 61, 61f  
   sonic instruments for, 49–50  
   subgingival, 61, 61f–63f  
   ultrasonic instruments for, 49f–50f, 49–50

## R

Recombinant human BMP-2, 27  
 Recombinant platelet-derived growth factor-BB  
   description of, 24–25, 111  
   single-flap approach with, 118–120, 120f  
 Regenerative treatment, 2  
 Root debridement, in single-flap approach, 106, 112f  
 Root planing. *See* Scaling and root planing.  
 Root resorption, 8  
 Root surface demineralization, 10–11

## S

Scaling and root planing  
   antimicrobials and, 54  
   bone formation after, 67  
   residual deposits after, 67  
 SFA. *See* Single-flap approach.  
 Sharpey fibers, 27  
 Silicone dioxide, 18  
 Simplified papilla preservation technique, 88, 89f, 92t  
 Simplified procedure, 3  
 Single-flap approach  
   advantages of, 93, 94f–95f  
   buccal, 93, 105f  
   characteristics of, 90–91, 91f  
   clinical attachment level affected by, 95f, 108f  
   connective tissue graft with, 131–133, 132f–134f  
   coronally positioned, 93  
   defect debridement in, 106, 112f  
   double-flap approach versus, 93  
   early wound stability after, 94–98, 95f–98f  
   enamel matrix derivative with, 99, 125  
   flap elevation in, 103, 105f  
   frequency of, 100–101  
   gingival recession after, 114f, 129–133, 129f–134f  
   guided tissue regeneration and, 82f  
   history of, 3  
   hydroxyapatite-based graft with, 114, 118, 118t, 119f  
   incision line for, 102–103, 104f  
   indications for, 92, 92t  
   intraosseous defects treated with  
     flap design effects on, 113–114  
     multiple, 106, 108f–110f  
     without regenerative devices, 113f  
   morbidity after, 98–99  
   oral hygiene after, 110  
   palatal, 105f, 107f, 130f, 131  
   papilla preservation techniques versus, 3  
   postoperative pain with, 99, 100f  
   postsurgery regimen for, 110, 110f  
   presurgical protocol for, 102  
   reasons for selecting, 92–93  
   recession after, 129–133, 129f–134f  
   regenerative devices with  
     biologic agents, 118–129  
     composite outcome measure for, 125, 128  
     enamel matrix derivative, 120–129, 121f–124f  
     guided tissue regeneration, 114–118, 115f–117f  
     necessity of, 111–114  
     recombinant human platelet-derived growth factor, 118–120, 120f  
   root debridement in, 106, 112f  
   surgical protocol for, 102–111, 104f–105f, 107f–111f  
   suturing technique for, 106, 107f  
   wound closure in, 106, 107f  
   wound stability after, 94–98  
 Smear layer, 10  
 Smoking, 61, 78, 110, 111f  
 Sodium bicarbonate air polishing devices, 52  
 Sodium oxide, 18  
 Sonic instruments, 49–50  
 SPPT. *See* Simplified papilla preservation technique.  
 SRP. *See* Scaling and root planing.  
 Subgingival calculus, 41f–42f, 48, 52  
 Supragingival calculus, 42f, 52  
 Surgical treatment  
   clinical variability in, 77  
   indications for, 77–83

planning of, 82  
simplified procedures, 3  
timing of, 77  
tooth mobility assessments, 82, 83f

## T

TGF- $\beta$ . *See* Transforming growth factor  $\beta$ .  
Tooth brushing, for dental plaque removal, 46–47, 47f  
Tooth loss, 1  
Tooth mobility, 56  
    assessment of, before surgical treatment, 82, 83f  
    presurgical, 82  
Tooth morphogenesis, 26  
Transforming growth factor  $\beta$ , 26  
 $\beta$ -Tricalcium phosphate, 18, 24

## U

Ultrasonic instruments, 49f–50f, 49–50  
Ultrasonic scaler tips, 50

## W

Wound  
    dehiscence of, 94  
    maturation of, 10–11  
Wound healing  
    animal experiments in, 10  
    bone morphogenetic proteins for, 26–28  
    enamel matrix derivative effects on, 20–21  
    epidermal, 7, 8f  
    fibrin clot in, 7–9, 66–67, 111  
    periodontal, 7–11  
    transforming growth factor  $\beta$  in, 26  
Wound stability  
    after single-flap approach, 94–98, 95f–98f  
    description of, 9–10

## X

Xenografts  
    enamel matrix derivative and, 23  
    periodontal regeneration uses of, 15–16, 17f

