NEWMAN AND CARRANZA'S CLINICAL PERIODONTOLOGY

THIRTEENTH EDITION

NEWMAN Takei Klokkevold Carranza

ELSEVIER

Newman and Carranza's Clinical Periodontology

THIRTEENTH EDITION

MICHAEL G. NEWMAN, DDS, FACD

Professor Emeritus Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

HENRY H. TAKEI, DDS, MS,

FACD

Distinguished Clinical Professor Sections of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

PERRY R. KLOKKEVOLD, DDS, MS, FACD

Associate Professor Program Director, Periodontics Residency Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California Editor Emeritus

FERMIN A. CARRANZA, DR ODONT, FACD

Professor Emeritus Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

ELSEVIER

Table of Contents

Instructions for online access

Cover image

Title Page

Copyright

Editors

Contributors

About the Book

About The Authors

Michael G. Newman, DDS, FACD Henry H. Takei, DDS, MS, FACD Perry R. Klokkevold, DDS, MS, FACD Fermin A. Carranza, DR ODONT, FACD

Preface

Acknowledgments

Video Contents

Introduction: The Historical Background of Periodontology

Chapter Outline

Early Civilizations

The Classical World

The Middle Ages

The Renaissance

The Eighteenth Century

The Nineteenth Century

The Twentieth Century

The History of This Book

References

Part 1 Evidence-Based Practice

Chapter 1 Evidence-Based Decision Making

Background and Definition

Principles of Evidence-Based Decision Making

Evidence-Based Decision-Making Process and Skills

Conclusion

Chapter 2 Critical Thinking

Twelve Tools for Assessing Evidence

Conclusion

References

Part 2 Biologic Basis of Periodontology

Section I Normal Periodontium

Chapter 3 Anatomy, Structure, and Function of the Periodontium

- **Oral Mucosa**
- Gingiva
- **Periodontal Ligament**
- Cementum
- **Alveolar Process**
- Development of the Attachment Apparatus
- External Forces and the Periodontium
- Vascularization of the Supporting Structures
- References

Chapter 4 Aging and the Periodontium

- Effects of Aging on the Periodontium
- Effects of Aging on the Progression of Periodontal Diseases
- Aging and the Response to Treatment of the Periodontium
- References

Section II Classification and Epidemiology of Periodontal Diseases

Chapter 5 Classification of Diseases and Conditions Affecting the Periodontium

Gingival Diseases

Periodontitis

Medication-Related Osteonecrosis of the Jaw

Necrotizing Periodontal Diseases

Abscesses of the Periodontium

Periodontitis Associated With Endodontic Lesions

Developmental or Acquired Deformities and Conditions

References

Chapter 6 Fundamentals in the Methods of Periodontal Disease Epidemiology

The Need for Epidemiology

Epidemiologic Study Designs

Causes

Diagnosis

References

Section III Etiology of Periodontal Disease

Chapter 7 Periodontal Disease Pathogenesis

Histopathology of Periodontal Disease Inflammatory Responses in the Periodontium Linking Pathogenesis to Clinical Signs of Disease Resolution of Inflammation Immune Responses in Periodontal Pathogenesis Concept of Host Susceptibility References

Chapter 8 Biofilm and Periodontal Microbiology

The Oral Cavity From a Microbe's Perspective Bacteria and Their Biofilm Mode of Living Characteristics of Biofilm Bacteria (Life in "Slime City") Bacterial Transmission and Translocation Nonbacterial Inhabitants of the Oral Cavity Microbiologic Specificity of Periodontal Diseases The Transition From Health to Disease Virulence Factors of Periodontopathogens Future Advances in Periodontal Microbiology References

Chapter 9 Practical Molecular Biology of Host–Microbe Interactions Microbe-Associated Molecular Patterns Toll-Like Receptors Nucleotide-Binding Oligomerization Domain–Like Receptors Complement System Antimicrobial Peptides

Immunomodulatory Therapies

References

Chapter 10 Resolution of Inflammation

Inflammation Acute Inflammation Is Self-Limited

Unresolved Chronic Inflammation in Periodontal Diseases

Systemic Link

Therapeutic Actions of Resolution Mediators

Final Remarks

References

Chapter 11 Precision Dentistry

Genomic Advances in the 21st Century

Genetic Basis for Individual Differences in Disease Risk

Precision Dentistry: Using Genetics for Personalized Treatment

Acknowledgments

References

Chapter 12 Smoking and Periodontal Disease

The Smoking Epidemic

Effects of Smoking on the Prevalence and Severity of Periodontal Diseases

Effects of Smoking on the Etiology and Pathogenesis of Periodontal Disease

Effects of Smoking on the Response to Periodontal Therapy Effects of Smoking Cessation on Periodontal Treatment Outcomes References

Chapter 13 The Role of Dental Calculus and Other Local Predisposing Factors

Calculus Other Predisposing Factors References

Section IV Relationship between Periodontal Disease and Systemic Heath

Chapter 14 Influence of Systemic Conditions

Hematologic Disorders and Immune Deficiencies

Endocrine Disorders and Hormonal Changes

Genetic Disorders

Stress and Psychosomatic Disorders

Nutritional Influences

Medications

Other Systemic Conditions

Conclusion

References

Chapter 15 Impact of Periodontal Infection on Systemic Health

Pathobiology of Periodontitis Focal Infection Theory Revisited Evidence-Based Clinical Practice Subgingival Environment as a Reservoir for Bacteria Periodontal Disease and Mortality Periodontal Disease and Mortality Periodontal Disease, Coronary Heart Disease, and Atherosclerosis Periodontal Disease and Stroke Periodontal Disease and Stroke Periodontal Disease and Pregnancy Outcome Periodontal Disease and Pregnancy Outcome Periodontal Disease and Acute Respiratory Infections Periodontal Disease and Asthma Periodontal Medicine in Clinical Practice Conclusions References

Section V Gingival Pathology

Chapter 16 Defense Mechanisms of the Gingiva Sulcular Fluid

Leukocytes in the Dentogingival Area

Saliva

References

Chapter 17 Gingival Inflammation

Stage I Gingival Inflammation: The Initial Lesion Stage II Gingival Inflammation: The Early Lesion Stage III Gingival Inflammation: The Established Lesion Stage IV Gingival Inflammation: The Advanced Lesion References

Chapter 18 Clinical Features of Gingivitis

Course and Duration Description Clinical Findings References

Chapter 19 Gingival Enlargement

Terminology and Classification Diagnosis Types of Gingival Enlargement Other Forms of Gingival Enlargement References

Chapter 20 Acute Gingival Infections

Necrotizing Ulcerative Gingivitis

Primary Herpetic Gingivostomatitis

Pericoronitis

Conclusions

Chapter 21 Gingival Disease in Childhood

Periodontium of the Primary Dentition
 Periodontal Changes Associated With Normal Development
 Gingival Diseases of Childhood
 Periodontal Diseases of Childhood
 Gingival Manifestation of Systemic Disease in Children
 Oral Mucosa in Childhood Diseases
 Therapeutic Considerations for Pediatric Patients
 Conclusions
 References

Diseases That Can Manifest as Desquamative Gingivitis

Drug-Related Eruptions

Miscellaneous Conditions That Mimic Desquamative Gingivitis

References

Section VI Periodontal Pathology

Chapter 23 The Periodontal Pocket

Classification

Clinical Features

Pathogenesis

Histopathology

Periodontal Disease Activity

Site Specificity

Pulp Changes Associated With Periodontal Pockets

Relationship of Attachment Loss and Bone Loss to Pocket Depth

Area Between Base of Pocket and Alveolar Bone

Relationship of Pocket to Bone

Periodontal Abscess

Lateral Periodontal Cyst

References

Chapter 24 Bone Loss and Patterns of Bone Destruction

Bone Destruction Caused by the Extension of Gingival Inflammation

Bone Destruction Caused by Trauma From Occlusion

Bone Destruction Caused by Systemic Disorders

Factors Determining Bone Morphology in Periodontal Disease

Bone Destruction Patterns in Periodontal Disease

Conclusion

References

Chapter 25 Periodontal Response to External Forces Adaptive Capacity of the Periodontium to Occlusal Forces Trauma From Occlusion Stages of Tissue Response to Increased Occlusal Forces Effects of Insufficient Occlusal Force

Reversibility of Traumatic Lesions

Effects of Excessive Occlusal Forces on Dental Pulp

Relationship Between Plaque-Induced Periodontal Diseases and Trauma From Occlusion

Pathologic Tooth Migration

Summary

References

Chapter 26 Masticatory System Disorders That Influence the Periodontium

Temporomandibular Joint

Muscles and Nerves of the Masticatory System

Centric Relation

Biomechanics of the Masticatory System

Dysfunction and Deterioration

Orofacial Pain

Comprehensive Evaluation

Diagnostic Decision Making

Acknowledgments

References

Chapter 27 Chronic Periodontitis

Clinical Features

Risk Factors for Disease

References

References

Chapter 28 Aggressive Periodontitis

Overview

Historical Background

Classification and Clinical Characteristics

Epidemiology

Pathobiology and Risk Factors

Therapeutic Considerations in Aggressive Periodontitis Patients

References

Chapter 29 Necrotizing Ulcerative Periodontitis

Clinical Features

Microscopic Findings

Patients With HIV/AIDS

Etiology of Necrotizing Ulcerative Periodontitis

Malnutrition

Conclusion

References

Chapter 30 Pathology and Management of Periodontal Problems in Patients With Human Immunodeficiency Virus Infection

Pathogenesis

Epidemiology and Demographics

Classification and Staging

Oral and Periodontal Manifestations of Human Immunodeficiency Virus Infection

Dental Treatment Complications

Gingival and Periodontal Diseases

Periodontal Treatment Protocol

References

Part 3 Clinical Periodontics

Section I Diagnosis, Prognosis, and Treatment Plan

Chapter 31 Levels of Clinical Significance

Tangible Versus Intangible Benefits

Size of the Treatment Effect

Defining Four Levels of Clinical Significance

Summary

References

Chapter 32 Periodontal Examination and Diagnosis

Overall Appraisal of the Patient

Health History

Dental History

Photographic Documentation

Clinical Examination

Tactile Periodontal Examination

Periodontal Charting

Examination of the Teeth and Implants

Radiographic Examination

Laboratory Aids to Clinical Diagnosis

Periodontal Diagnosis

Assessment of Biofilm Control and Patient Education

Conclusion

References

Chapter 33 Radiographic Aids in the Diagnosis of Periodontal Disease

Normal Interdental Bone

Radiographic Techniques

Bone Destruction in Periodontal Disease

Radiographic Appearance of Periodontal Disease

Digital Intraoral Radiography

Advanced Imaging Modalities

Conclusion

References

Chapter 34 Clinical Risk Assessment

Definitions

Risk Factors for Periodontal Disease

Risk Determinants/Background Characteristics for Periodontal Disease

Risk Indicators for Periodontal Disease

Risk Markers/Predictors for Periodontal Disease

Clinical Risk Assessment for Periodontal Disease

Conclusion

References

Chapter 35 Determination of Prognosis

Definitions

Types of Prognosis

Factors in Determination of Prognosis

Prognosis of Specific Periodontal Diseases

Determination and Reassessment of Prognosis

Conclusion

References

Chapter 36 The Treatment Plan

Overall Treatment Plan

Sequence of Therapy

Explaining the Treatment Plan to the Patient

Conclusion

Chapter 37 Electronic Dental Records and Decision Support Systems

Functionalities and Components Available in Electronic Dental Records

Electronic Dental Record Use in Dental Practices

Future of Electronic Dental Records and Decision Support Systems in Dentistry

Section II Management of Patients with Special Needs

Chapter 38 Conscious Sedation

Rationale for Sedation During Periodontal and Implant Surgical Procedures

American Dental Association Policy Statement and Guidelines for Conscious Sedation

Definitions and Levels of Sedation

Minimal Sedation and Anxiolysis

Moderate Sedation

Sedation Failures

Emergency Preparedness

Conclusions

References

Chapter 39 Periodontal Treatment of Medically Compromised Patients

Cardiovascular Diseases

Endocrine Disorders

Hemorrhagic Disorders

Renal Diseases

Liver Diseases

Pulmonary Diseases

Medications and Cancer Therapies

Prosthetic Joint Replacement

Pregnancy

Infectious Diseases

References

Chapter 40 Sleep-Disordered Breathing

New and Evolving Role of the Dentist Sleep-Related Breathing Disorders and the Periodontium Dental Identification of Signs and Symptoms Sleep, Breathing, and Apnea Diagnosis of Obstructive Sleep Apnea Treatment Options for Obstructive Sleep Apnea Oral Devices for Mandibular Repositioning Device Design and Compliance Conclusions References

Chapter 41 Periodontal Therapy in the Female Patient

Puberty

Menses

Pregnancy

Oral Contraceptives

Menopause

Conclusions

Chapter 42 Periodontal Treatment for Older Adults

The Aging Periodontium Demographics Dental and Medical Assessments Periodontal Diseases in Older Adults Periodontal Treatment Planning Conclusions References

Chapter 43 Treatment of Aggressive and Atypical Forms of Periodontitis

Aggressive Periodontitis Periodontitis Refractory to Treatment Necrotizing Ulcerative Periodontitis Conclusions References

Section III Diagnosis and Treatment of Periodontal Emergencies

Chapter 44 Treatment of Acute Gingival Disease

Necrotizing Ulcerative Gingivitis

Primary Herpetic Gingivostomatitis

Pericoronitis

Conclusion

References

Chapter 45 Treatment of Periodontal Abscess

Classification of Abscesses

Specific Treatment Approaches

References

Chapter 46 Endodontic-Periodontic Lesions

Factors Initiating Pulpal and Apical Diseases

Classification of Pulpal and Apical Diseases

Biologic Effects of Pulpal Infection on Periodontal Tissues

Biologic Effects of Periodontal Infection on the Dental Pulp

Effects of Endodontic Pathosis on Development of Retrograde Periimplantitis

Interactions Between Extraradicular Infection and the Periodontium

Differential Diagnosis of Pulpal and Periodontal Infection

Treatment Considerations

Summary

References

Section IV Nonsurgical Treatment

Chapter 47 Phase I Periodontal Therapy

Rationale

Treatment Sessions

Sequence of Procedures

Results

Healing

Decision to Refer for Specialist Treatment

Conclusion

References

Chapter 48 Plaque Biofilm Control for the Periodontal Patient

The Toothbrush

Powered Toothbrushes

Dentifrices

Toothbrushing Methods

Interdental Cleaning Aids

Gingival Massage

Oral Irrigation

Caries Control

Chemical Plaque Biofilm Control With Oral Rinses

Disclosing Agents

Frequency of Plaque Biofilm Removal

Patient Motivation and Education

Conclusion

References

Chapter 49 Breath Malodor Semantics and Classification Epidemiology Etiology Fundamentals of Malodor Detection Diagnosis of Malodor Treatment of Oral Malodor Conclusion References

Chapter 50 Scaling and Root Planing*

- **Classification of Periodontal Instruments**
- **General Principles of Instrumentation**
- Principles of Scaling and Root Planing
- Instrument Sharpening
- References

Chapter 51 Sonic and Ultrasonic Instrumentation and Irrigation

Power-Driven Instruments: Overview

Mechanism of Action of Power Scalers

Type and Benefit of Power Instruments

Clinical Outcomes of Power-Driven Instruments

Principles of Instrumentation

Home and Self-Applied Irrigation

Mechanism of Action of Irrigation

Clinical Outcomes of Irrigation

Individuals With Special Considerations

Action of a Tip With Filaments Cleaning Around an Implant

Conclusion

References

Chapter 52 Systemic Anti-infective Therapy for Periodontal Diseases

Definitions

Systemic Administration of Antibiotics

Serial and Combination Antibiotic Therapy

Conclusion

References

Chapter 53 Locally Delivered, Controlled-Release Antimicrobials

Background and Objectives

Drug Development and Registration

Clinical Use

Case Reports

Conclusions

References

Chapter 54 Host Modulation

Introduction

Systemically Administered Agents

Locally Administered Agents

Host Modulation and Comprehensive Periodontal Management

Sub-antimicrobial-Dose Doxycycline

Emerging Host Modulatory Therapies

Host Modulation Factors in Systemic Disorders

Summary

References

Chapter 55 Occlusal Evaluation and Therapy

Pathogenesis

Evidence-Based Decision Making

Terminology

Occlusal Function and Dysfunction

Parafunction

Clinical Examination

Occlusal Therapy

Conclusions

References

Chapter 56 Orthodontics

Abstract

Keywords

Chapter Outline

Benefits of Orthodontic Therapy

Preorthodontic Osseous Surgery

Orthodontic Treatment of Osseous Defects

Orthodontic Treatment of Gingival Discrepancies

Conclusion

References Abstract Keywords Chapter Outline Introduction Implant Interactions in Orthodontics Conclusion

Section V Surgical Treatment

Chapter 57 Phase II Periodontal Therapy

Objectives of the Surgical Phase

Pocket Elimination Versus Pocket Maintenance

Reevaluation After Phase I Therapy

Critical Zones in Pocket Surgery

Indications for Periodontal Surgery

Methods of Pocket Therapy

Conclusions

References

Chapter 58 Periodontal and Peri-Implant Surgical Anatomy

Mandible

Maxilla

Exostoses

Muscles

Anatomic Spaces

Conclusion

References

Chapter 59 General Principles of Periodontal Surgery

Outpatient Surgery

Hospital Periodontal Surgery

Surgical Instruments

Conclusion

References

Chapter 60 Periodontal Surgical Therapy

Rationale for Periodontal Access Surgery

Fundamentals of Periodontal Surgery

Periodontal Surgical Techniques

Conclusion

References

Chapter 61 Treatment of Gingival Enlargement

Chronic Inflammatory Enlargement

Periodontal and Gingival Abscesses

Drug-Induced Gingival Enlargement

Leukemic Gingival Enlargement

Gingival Enlargement During Pregnancy

Gingival Enlargement During Puberty

References

Chapter 62 Resective Osseous Surgery

Selection of Treatment Technique

Rationale

Normal Alveolar Bone Morphology

Terminology

Factors in Selection of Resective Osseous Surgery

Examination and Treatment Planning

Methods of Resective Osseous Surgery

Osseous Resection Technique

Flap Placement and Closure

Postoperative Maintenance

Specific Osseous Reshaping Situations

Conclusion

References

Chapter 63 Periodontal Regeneration and Reconstructive Surgery

Assessment of Periodontal Wound Healing

Reconstructive Surgical Techniques

Factors That Influence Therapeutic Success

Future Directions for Periodontal Regeneration

Conclusion

Chapter 64 Furcation

Etiologic Factors

Diagnosis and Classification of Furcation Defects

Local Anatomic Factors

Anatomy of the Bony Lesions

Indices of Furcation Involvement

Treatment

Nonsurgical Therapy

Surgical Therapy

Prognosis

References

Chapter 65 Periodontal Plastic and Aesthetic Surgery

Terminology Objectives Cause of Marginal Tissue Recession Factors That Affect Surgical Outcome Techniques to Increase Attached Gingiva Techniques to Deepen the Vestibule Techniques to Deepen the Vestibule Techniques to Remove the Frenum Techniques to Improve Aesthetics Tissue Engineering Criteria for Selection of Techniques Conclusions

References

Chapter 66 Leukocyte- and Platelet-Rich Fibrin

Introduction

General Characteristics of L-PRF Membranes

Extraoral Applications of L-PRF

L-PRF in the Treatment of Periodontal Bony Defects

L-PRF for Ridge Preservation

L-PRF and Sinus Floor Elevation

L-PRF and Implant Surgery

L-PRF for Periodontal Mucogingival Surgery

L-PRF and Medication-Related Osteonecrosis of the Jawbone

Initial Observations on the PRF-Block

Conclusions

References

Chapter 67 Periodontal Microsurgery

Philosophy of Periodontal Microsurgery

Advantages of Microsurgery

Magnification Systems

Microsurgical Sutures

Aesthetic Periodontal Microsurgery

Microsurgical Knots

Conclusions

Chapter 68 Lasers in Periodontal and Peri-implant Therapy
Laser Physics and Biologic Interactions
Laser Applications in Periodontics
Lasers in the Management of Periodontitis
Lasers in the Management of Peri-implantitis
Complications and Risks of Laser Therapy
Conclusion
References

Section VI Periodontal-Restorative Interrelationships

Chapter 69 Preparation of the Periodontium for Restorative Dentistry

Rationale for Therapy

Sequence of Treatment

Control of Active Disease

Preprosthetic Surgery

Conclusion

References

Chapter 70 Restorative Interrelationships

Biologic Considerations

Aesthetic Tissue Management

Occlusal Considerations in Restorative Therapy

Special Restorative Considerations

References

Chapter 71 Multidisciplinary Versus Interdisciplinary Approaches to Dental and Periodontal Problems

Educational Trends Toward Multidisciplinary Specialist Education in Implant Treatment

The Future

Section VII Supportive Care and Results of Periodontal Treatment

Chapter 72 Supportive Periodontal Treatment

Rationale for Supportive Periodontal Treatment

Maintenance Program

Classification of Posttreatment Patients and Risk Assessment

Referral of Patients to the Periodontist

Tests for Disease Activity

Conclusion

References

Chapter 73 Results of Periodontal Treatment

Prevention and Treatment of Gingivitis

Prevention and Treatment of Loss of Attachment

Tooth Mortality

Conclusion

References

Part 4 Oral Implantology

Section I Biology, Diagnosis, Biomechanics, and Treatment Plan

Chapter 74 Peri-implant Anatomy, Biology, and Function

Implant Geometry (Macrodesign)

Implant Surface Characteristics (Microdesign)

Hard Tissue Interface

Soft Tissue Interface

Clinical Comparison of Teeth and Implants

Conclusion

References

Chapter 75 Clinical Evaluation of the Implant Patient

Case Types and Indications

Pretreatment Evaluation

Risk Factors and Contraindications

Posttreatment Evaluation

Conclusion

References

Chapter 76 Diagnostic Imaging for the Implant Patient

Standard Projections

Cross-Sectional Imaging

Interactive "Simulation" Software Programs

Patient Evaluation

Clinical Selection of Diagnostic Imaging

Conclusion

References

Chapter 77 Prosthetic Considerations for Implant Treatment

Implant Considerations

Abutment/Prosthesis Considerations for Single Units

Management of Partially Edentulous Implant Treatment in the Aesthetic Zone

Fully Edentulous: Prosthetic Considerations

Conclusion

References

Section II Surgical Procedures

Chapter 78 Basic Implant Surgical Procedures

General Principles of Implant Surgery

Two-Stage "Submerged" Implant Placement

One-Stage "Nonsubmerged" Implant Placement

Conclusion
Chapter 79 Localized Bone Augmentation and Implant Site Development

- Guided Bone Regeneration
- Localized Ridge Augmentation
- Alveolar Ridge Preservation/Management of Extractions
- Conclusion
- References

Chapter 80 Advanced Implant Surgical Procedures

- Maxillary Sinus Elevation and Bone Augmentation
- Supracrestal/Vertical Bone Augmentation
- Growth Factors in Bone Augmentation
- Conclusion
- References

Chapter 81 Aesthetic Management of Difficult Cases (Minimally Invasive Approach)

- Surgical Strategy for Predictable Aesthetics
- Immediate Implant Placement for Predictability and Aesthetics
- Surgical Management of Difficult Cases (Minimally Invasive Approach)
- Conclusion
- References

Chapter 82 Dental Implant Microsurgery

- Conclusion
- References

Chapter 83 Piezoelectric Bone Surgery

Clinical Characteristics of Ultrasonic Cutting Clinical Applications Advanced Clinical Applications Conclusion References

Chapter 84 Digitally Assisted Implant Surgery

Digitally Assisted Implant Surgery

Conclusion

References

Section III Complications

Chapter 85 Implant-Related Complications and Failures

Definitions of Implant Survival and Success

Types and Prevalence of Implant Complications

Types of Dental Implants

Surgical Complications

Biologic Complications

Complications Related to Augmentation Procedures

Complications Related to Placement and Loading Protocols

Prosthetic or Mechanical Complications

Aesthetic and Phonetic Complications

Conclusions

References

Section IV Supportive Care and Results of Implant Treatment

Chapter 86 Supportive Implant Treatment

Rationale for Supportive Implant Treatment

Examination of Implants

Assessment of Peri-Implant Health

Implant Maintenance

Treatment of Peri-Implant Diseases

Referral of Patients to the Periodontist

References

Chapter 87 Results of Implant Treatment

Defining Implant Outcomes

Factors That Influence Implant Outcomes

Aesthetic Results and Patient Satisfaction

Conclusions

References

Part 5 Atlas of Periodontal Diseases

Chapter 88 Atlas of Periodontal Diseases Plaque-Induced Gingival Diseases **Causes of Periodontal Diseases**

Gingival Diseases Modified by Systemic Factors

Gingival Diseases Associated With Blood Dyscrasias

Drug-Induced Gingival Diseases

Non–Plaque-Induced Gingival Lesions

Gingival Lesions of Genetic Origin

Gingival Manifestations of Systemic Conditions

Traumatic Lesions: Factitious, latrogenic, and Accidental

Cysts and Tumors

Chronic Periodontitis

Aggressive Periodontitis

Periodontitis as a Manifestation of Systemic Diseases

Genetic Disorders

Necrotizing Periodontal Diseases

Abscesses of Periodontium

Index

Copyright

ELSEVIER

1600 John F. Kennedy Blvd. Ste 1800 Philadelphia, PA 19103-2899

NEWMAN AND CARRANZA'S CLINICAL PERIODONTOLOGY ISBN: 978-0-323-52300-4 THIRTEENTH EDITION

Copyright © 2019 by Elsevier, Inc. All rights reserved.

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the Publisher. Details on how to seek permission, further information about the Publisher's permissions policies, and our arrangements with organizations such as the Copyright Clearance Center and the Copyright Licensing Agency can be found at our website: www.elsevier.com/permissions.

This book and the individual contributions contained in it are protected under copyright by the Publisher (other than as may be noted herein).

Notices

Knowledge and best practice in this field are constantly changing. As new research and experience broaden our understanding, changes in research methods, professional practices, or medical treatment may become necessary.

Practitioners and researchers must always rely on their own experience and knowledge in evaluating and using any information, methods, compounds, or experiments described herein. In using such information or methods, they should be mindful of their own safety and the safety of others, including parties for whom they have a professional responsibility. With respect to any drug or pharmaceutical products identified, readers are advised to check the most current information provided (i) on procedures featured or (ii) by the manufacturer of each product to be administered, to verify the recommended dose or formula, the method and duration of administration, and contraindications. It is the responsibility of practitioners, relying on their own experience and knowledge of their patients, to make diagnoses, to determine dosages and the best treatment for each individual patient, and to take all appropriate safety precautions. To the fullest extent of the law, neither the Publisher nor the authors, contributors, or editors assume any liability for any injury and/or damage to persons or property as a matter of products liability, negligence, or otherwise or from any use or operation of any methods, products, instructions, or ideas contained in the material herein.

Previous editions copyrighted 2015, 2012, 2006 by Saunders, an imprint of Elsevier Inc.

Library of Congress Control Number: 2018944001

Content Strategist: Alexandra Mortimer Senior Content Development Manager: Lucia Gunzel Publishing Services Manager: Catherine Albright Jackson Senior Project Manager: Doug Turner Designer: Brian Salisbury

Printed in China

Last digit is the print number: 987654321



Editors

Associate and Section Editors

Fermin A. Carranza DR ODONT, FACD

Professor Emeritus Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Satheesh Elangovan BDS, DSc, DMSc

Professor Department of Periodontics University of Iowa College of Dentistry and Dental Clinics Iowa City, Iowa

Marcelo Freire DDS, PhD, DMSc

Associate Professor Department of Genomic Medicine and Infectious Disease J. Craig Venter Institute La Jolla, California

Søren Jepsen DDS, MD, MS, PhD

Professor and Chairman Department of Periodontology Operative and Preventative Dentistry University of Bonn, Germany

Perry R. Klokkevold DDS, MS, FACD

Associate Professor Program Director, Periodontics Residency Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Michael G. Newman DDS, FACD

Professor Emeritus Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Philip Preshaw BDS, FDS RCSEd, FDS (Rest Dent) RCSEd, PhD

Professor of Periodontology Institute of Cellular Medicine School of Dental Sciences Newcastle University Newcastle upon Tyne, United Kingdom

Henry H. Takei DDS, MS, FACD

Distinguished Clinical Professor Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Wim Teughels DDS, PhD

Professor Periodontology Section University Hospitals Leuven Department of Oral Health Services KU Leuven Leuven, Belgium **Online Editors**

Satheesh Elangovan BDS, DSc, DMSc Professor Department of Periodontics University of Iowa College of Dentistry and Dental Clinics Iowa City, Iowa

Michael G. Newman DDS, FACD

Professor Emeritus Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Contributors

Alfredo Aguirre DDS, MS

Professor Department of Oral Diagnostic Sciences School of Dental Medicine University at Buffalo The State University of New York Buffalo, New York

Edward P. Allen DD, PhD

Private Practice Dallas, Texas

Robert R. Azzi DDS

Department of Periodontology University of Paris, VII Paris, France

Janet G. Bauer DDS

Advanced Education Services Center for Dental Research Loma Linda University School of Dentistry Loma Linda, California Professor Emerita School of Dentistry University of California, Los Angeles Los Angeles, California

Mitchell J. Bloom DMD

Clinical Associate Professor Ashman Department of Periodontology and Implant Dentistry New York University College of Dentistry Private Practice Periodontology and Implant Dentistry New York, New York

Jaime Bulkacz DR ODONT, PhD

Lecturer Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Bobby Butler BS, DDS

Affiliate Faculty, Periodontics School of Dentistry University of Washington Seattle, Washington

Paulo M. Camargo DDS, MS, MBA, FACD

Professor and Tarrson Family Endowed Chair in Periodontics Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Fermin A. Carranza DR ODONT, FACD

Professor Emeritus Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Ana B. Castro DDS, MSc

Periodontology Section University Hospitals Leuven Department of Oral Health Services KU Leuven

Leuven, Belgium

Frank Celenza DDS

Associate Clinical Professor Postgraduate Orthodontics Rutgers School of Dental Medicine Newark, New Jersey

Leandro Chambrone DDS, MSc, PhD

Associate Professor Unit of Basic Oral Investigation School of Dentistry El Bosque University Bogota, Colombia Professor Master of Science Dentistry Program Ibirapuera University São Paulo, Brazil

Ting-Ling Chang DDS

Clinical Professor Chair of the Section of Prosthodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Yu-Cheng Chang DDS, MS

Instructor Department of Periodontics The Robert Schattner Center School of Dental Medicine University of Pennsylvania Philadelphia, Pennsylvania

Sang Choon Cho DDS

Clinical Assistant Professor Periodontology and Implant Dentistry New York University College of Dentistry New York, New York

Chih-Hung Chou PhD

Manager Molecular Biology Department WuXi AppTec Philadelphia, Pennsylvania

Evelyn Chung DDS

Clinical Professor Residency Program Director, GPR Section of Hospital Dentistry School of Dentistry University of California, Los Angeles Los Angeles, California

Sebastian G. Ciancio DDS

Distinguished Service Professor and Chair Department of Periodontics and Endodontics University at Buffalo The State University of New York Buffalo, New York

David L. Cochran DDS, MS, PhD, MMSci

Chair and Professor Department of Periodontics School of Dentistry UT Health San Antonio San Antonio, Texas

Joseph P. Cooney BDS, MS

Clinical Professor Emeritus Restorative Dentistry University of California, Los Angeles Los Angeles, California

Simone Cortellini DDS, MSc

Periodontology Section University Hospitals Leuven Department of Oral Health Services KU Leuven Leuven, Belgium

J. David Cross DDS

Private Practice Springfield, Illinois

Sophie De Geest DDS, MSc

Clinical Consultant Periodontology Section University Hospitals Leuven Department of Oral Health Services KU Leuven Leuven, Belgium

Charlotte De Hous DDS, MSc

Clinical Resident in Dentistry Periodontology Section University Hospitals Leuven Department of Oral Health Services KU Leuven Leuven, Belgium

Christel Dekeyser DDS

Head of Periodontology Section Periodontology Section University Hospitals Leuven Department of Oral Health Services KU Leuven Leuven, Belgium

Raymond R. Derycke DDS, CEO, Haptitude

Scott R. Diehl BS, PhD

Professor Department of Oral Biology Rutgers School of Dental Medicine Professor Department of Health Informatics Rutgers School of Health Professions Newark, New Jersey

Jonathan H. Do DDS

Assistant Clinical Professor Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California Private Practice Limited to Periodontics and Implant Surgery Poway, California

Henrik Dommisch DDS, PhD

Professor Periodontology and Synoptic Dentistry Charité—Universitätsmedizin Berlin Berlin, Germany Associate Professor Oral Health Sciences University of Washington Seattle, Washington

Donald F. Duperon DDS, MSc

Professor Emeritus Section of Pediatric Dentistry School of Dentistry University of California, Los Angeles Los Angeles, California

Satheesh Elangovan BDS, DSc, DMSc

Professor Department of Periodontics University of Iowa College of Dentistry and Dental Clinics Iowa City, Iowa

Daniel H. Etienne DDS, MS

Honorary Associate Professor in Periodontology Pitié-Salpêtrière Hospital Denis Diderot University Paris, France

Richard D. Finkelman DDS, PhD

Senior Clinical Pharmacology Medical Director Clinical Pharmacology and Pharmacokinetics Shire Lexington, Massachusetts

Joseph P. Fiorellini DMD, DMSc

Professor Department of Periodontics The Robert Schattner Center School of Dental Medicine University of Pennsylvania Philadelphia, Pennsylvania

Jane L. Forrest BSDH, MS, EdD

Professor of Clinical Dentistry Dental Public Health and Pediatric Dentistry Herman Ostrow School of Dentistry University of Southern California Los Angeles, California

Marcelo Freire DDS, PhD, DMSc

Associate Professor Department of Genomic Medicine and Infectious Disease J. Craig Venter Institute La Jolla, California

Scott H. Froum DDS

Clinical Assistant Professor Department of Peiodontology School of Dental Medicine Stony Brook University Stony Brook, New York Private Practice New York, New York

Stuart J. Froum DDS

Clinical Professor and Director of Clinical Research Periodontology and Implant Dentistry New York University College of Dentistry New York, New York

Ying Gu DDS, PhD

Associate Professor General Dentistry School of Dental Medicine Stony Brook University Stony Brook, New York

Thomas J. Han DDS, MS

Clinical Professor Department of Periodontics Herman Ostrow School of Dentistry University of Southern California Los Angeles, California

M. Cenk Haytac DDS, PhD

Professor Department of Periodontology Faculty of Dentistry Cukurova University Adana, Turkey

James E. Hinrichs DDS, MS

Professor Department of Developmental and Surgical Sciences Division of Periodontology School of Dentistry University of Minnesota Minneapolis, Minnesota

Eva L. Hogan MD, DDS, MS

Lecturer Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Richard Holliday BDS (Hons), MFDS RCSEd, MFDS an eundem RCSEng, MClinRes, MPerio RCSEd

NIHR Doctoral Research Fellow/Specialty Registrar in Restorative Dentistry Newcastle Dental Hospital Newcastle upon Tyne, United Kingdom

Ching-Yu Huang PhD

Assistant Professor Department of Computer Science Kean University Union, New Jersey

Philippe P. Hujoel DDS, MS, MSD, PhD

Professor, Oral Health Sciences Adjunct Professor, Epidemiology School of Dentistry University of Washington Seattle, Washington

Carol A. Jahn RDH, MS

Director Professional Relations and Education Water Pik, Inc. Fort Collins, Colorado

Nicholas Jakubovics BSc, PhD

Senior Lecturer in Oral Microbiology Centre for Oral Health Research, School of Dental Sciences Newcastle University Newcastle upon Tyne, United Kingdom

Mo K. Kang DDS, PhD

Professor and Chairman Jack A. Weichman Endowed Chair Section of Endodontics Division of Constitutive and Regenerative Sciences School of Dentistry University of California, Los Angeles Los Angeles, California

Alpdogan Kantarci DDS, PhD

Associate Staff Member Applied Oral Sciences Forsyth Institute Cambridge, Massachusetts Associate Professor Cellular and Molecular Biology Henry M. Goldman School of Dental Medicine Boston University Lecturer Harvard School of Dental Medicine Boston, Massachusetts

Richard T. Kao DDS, PhD

Private Practice Cupertino, California Clinical Professor Division of Periodontology School of Dentistry University of California, San Francisco Adjunct Clinical Professor Department of Periodontology Arthur A. Dugoni School of Dentistry University of the Pacific San Francisco, California

Moritz Kebschull DMD

Associate Professor Department of Periodontology, Restorative and Preventive University Hospital Bonn Bonn, Germany Adjunct Associate Professor of Dental Medicine Division of Periodontics Section of Oral, Diagnostic, and Rehabilitation Sciences Columbia University College of Dental Medicine New York, New York

David M. Kim DDS, DMSc

Associate Professor

Department of Oral Medicine, Infection, and Immunity Harvard School of Dental Medicine Boston, Massachusetts

Keith L. Kirkwood DDS, PhD

Professor and Chair Craniofacial Biology Medical University of South Carolina Charleston, South Carolina

Perry R. Klokkevold DDS, MS, FACD

Associate Professor Program Director, Periodontics Residency Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Vincent G. Kokich DDS, MSD *

Department of Orthodontics School of Dentistry University of Washington Seattle, Washington

Olga A. Korczeniewska PhD

Research Associate I Department of Diagnostic Sciences Rutgers School of Dental Medicine Newark, New Jersey

Georgios A. Kotsakis DDS, MS

Assistant Professor Department of Periodontics School of Dentistry University of Washington Seattle, Washington

Fengshen Kuo PhD, MS Bioinformatics Engineer III

Memorial Sloan Kettering Cancer Center New York, New York

Isabelle Laleman DDS, MSc

Periodontologist Periodontology Section University Hospitals Leuven Department of Oral Health Services KU Leuven Leuven, Belgium

Clarice S. Law DMD, MS

Associate Clinical Professor Pediatric Dentistry and Orthodontics Section of Pediatric Dentistry School of Dentistry University of California, Los Angeles Los Angeles, California

Yasmin Mair DDS, MS

Visiting Assistant Professor Department of Oral Diagnostic Sciences School of Dental Medicine University at Buffalo The State University of New York Buffalo, New York Assistant Professor Oral Diagnostic Sciences King Abdulaziz University Jeddah, Saudi Arabia

Sanjay M. Mallya BDS, MDS, PhD

Associate Professor, Program Director, and Chair Section of Oral and Maxillofacial Radiology School of Dentistry University of California, Los Angeles Los Angeles, California

Angelo J. Mariotti DDS, PhD

Chair and Professor Division of Periodontology College of Dentistry The Ohio State University Columbus, Ohio

Michael J. McDevitt DDS

Visiting Faculty Periodontics College of Dental Medicine Augusta, Georgia Private Practice of Periodontics Atlanta, Georgia

Adriana McGregor DDS

Private Practice Westlake Village, California

Brian L. Mealey DDS, MS

Professor and Graduate Program Director Department of Periodontics University of Texas Health Science Center at San Antonio San Antonio, Texas

Shebli Mehrazarin DDS, PhD

Resident Division of Periodontics Section of Oral, Diagnostic, and Rehabilitation Sciences Columbia University College of Dental Medicine New York, New York

Philip R. Melnick DMD

Lecturer Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Robert L. Merin DDS, MS

Private Practice Woodland Hills, California

Greg W. Miller DDS

Private Practice Deer Park, Washington

Syrene A. Miller BA

Project Manager National Center for Dental Hygiene Research and Practice Culver City, California

Ian Needleman BDS, MSc, PhD

Professor of Restorative Dentistry and Evidence-Based Healthcare Department of Periodontology UCL Eastman Dental Institute London, United Kingdom

Michael G. Newman DDS, FACD

Professor Emeritus Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Karen F. Novak DDS, MS, PhD

Clinical Professor Department of Periodontics and Dental Hygiene Special Assistant to the Dean School of Dentistry Health Science Center at Houston University of Texas Houston, Texas

M. John Novak BDS, LDS, MS, PhD

Professor of Periodontics, Retired Director, Delta Dental of Kentucky Clinical Research Center University of Kentucky College of Dentistry Lexington, Kentucky

Chad M. Novince DDS, MSD, PhD

Assistant Professor Oral Health Sciences Medical University of South Carolina Charleston, South Carolina

Joan Otomo-Corgel DDS, MPH

Associate Clinical Professor Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Kwang-Bum Park DDS

Director MINEC Institute of Clinical Periodontics and Implantology Lecturer in Oral Anatomy and Histology Kyung-Pook National University Taegu, South Korea

Anna M. Pattison BS, MS

Co-Director Pattison Institute Los Angeles, California

Gordon L. Pattison DDS

Private Practice Co-Director Pattison Institute Los Angeles, California

Dorothy A. Perry RDH, PhD, MS

Professor Emeritus School of Dentistry University of California, San Francisco San Francisco, California

Nelson R. Pinto DDS

Periodontology and Implant Dentistry

University of Los Andes Las Condes Santiago, Chile

Flavia Q. Pirih DDS, PhD

Associate Professor Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Alan M. Polson DDS

Professor Department of Periodontics The Robert Schattner Center School of Dental Medicine University of Pennsylvania Philadelphia, Pennsylvania

Philip M. Preshaw BDS, FDS RCSEd, FDS (Rest Dent) RCSEd, PhD

Professor of Periodontology School of Dental Sciences Institute of Cellular Medicine Newcastle University Newcastle upon Tyne, United Kingdom

Marc Quirynen DDS, PhD

Professor Periodontology Section University Hospitals Leuven Department of Oral Health Services KU Leuven Leuven, Belgium

Terry D. Rees DDS, MSD

Professor Department of Periodontics Baylor College of Dentistry Texas A&M University Dallas, Texas

Carlos Rossa Jr., DDS, MSc, PhD

Associate Professor Diagnosis and Surgery School of Dentistry at Araraquara-Univ Estadual Paulista Sao Paulo, Brazil

Maria Emanuel Ryan DDS, PhD

Vice President and Chief Dental Officer Colgate Palmolive Company Piscataway, New Jersey

Hector L. Sarmiento DMD, MSc

Assistant Clinical Professor Department of Periodontics The Robert Schattner Center School of Dental Medicine University of Pennsylvania Philadelphia, Pennsylvania

E. Todd Scheyer DDS, MS

Private Practice Houston, Texas

Titus Schleyer DMD, PhD

Professor of Biomedical Informatics Indiana University School of Medicine Research Scientist Center for Biomedical Informatics Regenstrief Institute Indianapolis, Indiana

Todd R. Schoenbaum DDS, FACD

Associate Clinical Professor Director of Continuing Dental Education School of Dentistry University of California, Los Angeles

Los Angeles, California

Dennis A. Shanelec DDS Private Practice

Kitetsu Shin DDS, PhD

Santa Barbara, California

Professor of Periodontology Meikai University School of Dentistry Sakado, Saitama, Japan

Gerald Shklar DDS ⁺

Department of Oral Medicine and Diagnostic Sciences Harvard School of Dental Medicine Boston, Massachusetts

Daniela R. Silva DDS, MS

Chair and Residency Program Director Associate Clinical Professor Section of Pediatric Dentistry School of Dentistry University of California, Los Angeles Los Angeles, California

Thomas N. Sims BS, DDS

Senior Lecturer Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Sue S. Spackman DDS

Division of General Dentistry Center for Dental Research Loma Linda University School of Dentistry Loma Linda, California

Frank M. Spear DDS, MSD Founder and Director Spear Education Scottsdale, Arizona

Panagiota G. Stathopoulou DDS

Assistant Professor Department of Periodontics The Robert Schattner Center School of Dental Medicine University of Pennsylvania Philadelphia, Pennsylvania

Corey Stein DMD, MS

College of Dental Medicine Western University of Health Sciences Pomona, California

Henry H. Takei DDS, MS, FACD

Distinguished Clinical Professor Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Dennis P. Tarnow DDS

Clinical Professor Director of Implant Education Columbia University College of Dental Medicine New York, New York

Andy Temmerman DDS, MSc, PhD

Assistant Professor Periodontology Section University Hospitals Leuven Department of Oral Health Services KU Leuven Leuven, Belgium

Sotirios Tetradis DDS, PhD

Professor and Senior Associate Dean

Section of Oral and Maxillofacial Radiology School of Dentistry University of California, Los Angeles Los Angeles, California

Wim Teughels DDS, PhD

Professor Periodontology Section University Hospitals Leuven Department of Oral Health Services KU Leuven Leuven, Belgium

Vivek Thumbigere-Math BDS, PhD

Guest Researcher National Institutes of Health Bethesda, Maryland

Thankam P. Thyvalikakath DMD, MDS, PhD

Associate Professor and Director of Dental Informatics Core Department of Cariology, Operative Dentistry, and Dental Public Health Indiana University School of Dentistry Research Scientist Center for Biomedical Informatics Regenstrief Institute Indianapolis, Indiana

Leonard S. Tibbetts DDS, MSD

Private Practice Arlington, Texas

Kenneth C. Trabert DDS, MEd

Clinical Professor Emeritus Section of Endodontics Division of Constitutive and Regenerative Sciences School of Dentistry University of California, Los Angeles Los Angeles, California

Onur Ucak Turer DDS, PhD

Associate Professor Department of Periodontology Faculty of Dentistry Cukurova University Adana, Turkey

Istvan A. Urban DMD, MD, PhD

Assistant Professor Graduate Implant Dentistry Loma Linda University Loma Linda, California Associate Professor Periodontology University of Szeged Szeged, Hungary Private Practice Budapest, Hungary

Jose Luis Tapia Vazquez, DDS, MS

Assistant Professor Department of Oral Diagnostic Sciences School of Dental Medicine University of Buffalo The State University of New York Buffalo, New York

Giuseppe Vercellotti PhD

Adjunct Assistant Professor School of Health and Rehabilitation Sciences Division of Health Sciences The Ohio State University Columbus, Ohio

Tomas Vercellotti DDS, MS

Honorary Professor and Faculty Member University College of London London, United Kingdom Private Practice Genoa, Italy

Keisuke Wada DDS, PhD, DMSc, DMD

Associate Professor and Program Director Kornberg School of Dentistry Temple University Philadelphia, Pennsylvania

Michael Whang DDS

Lecturer Section of Periodontics School of Dentistry University of California, Los Angeles Los Angeles, California

Adrian K. Zacher MBA

Founder and Managing Director Snorer.com Oxford, United Kingdom

⁺Deceased.

⁺Deceased.

About the Book

Newman and Carranza's Clinical Periodontology, thirteenth edition, is the definitive global reference text in periodontics. Edited by Drs. Michael G. Newman, Henry H. Takei, Perry R. Klokkevold, editor emeritus Fermin A. Carranza, and associate editor Satheesh Elangovan, this book provides the highest quality information for students, residents, and practitioners.

The thirteenth edition is truly transformational. It fully engages modern information technology while maintaining and refining its decades of educational excellence. This edition improves on the previous one by more accurately reflecting the essential core information of periodontology and state-of-the-art methods in both the science and clinical knowledge base. Experts from more countries than ever have contributed to reflect a unifying view of the basic information related to the science and technology of modern periodontics.

The content on Expert Consult site is much improved in every aspect, including better speed, quality, functionality, access, and linking. There are more animations, videos, and case reports and one of the most comprehensive image libraries on periodontal pathology ever assembled. New case scenarios offer readers the opportunity to challenge their knowledge of integrated information in much more "real-life" patient encounters.

The print book is a complete and thorough presentation of periodontology essentials while retaining the style and quality that makes *Newman and Carranza's Clinical Periodontology* the number one periodontal textbook in the world. Advances in printing and digital technology make this edition more "readable" than ever before.

About The Authors

Michael G. Newman, DDS, FACD



Dr. Michael G. Newman graduated from the University of California, Los Angeles (UCLA), College of Letters and Sciences with a degree in psychology. He completed his dental training at the UCLA School of Dentistry in 1972. Dr. Newman received a Certificate in Periodontics and Oral Medicine at the Harvard School of Dental Medicine and a Certificate in Oral Microbiology from the Forsyth Dental Institute under the mentorship of Dr. Sigmund Socransky. He is a Diplomate of the American Board of Periodontology and is Professor Emeritus of Periodontics at the UCLA School of Dentistry. Dr. Newman is a fellow and past president of the American Academy of Periodontology. In 1975, he won the Balint Orban Memorial Prize from the American Academy of Periodontology. He has been in private practice of periodontics for more than 25 years. In 2007, Dr. Newman received the Gold Medal, the highest honor bestowed by the American Academy of Periodontology.

Dr. Newman has published more than 260 abstracts, journal articles, and book chapters and has co-edited nine textbooks. He has served as an ad-hoc reviewer for the National Institute of Dental and Craniofacial Research, was a consultant to the Council on Scientific Affairs of the American Dental Association, and is a reviewer for numerous scientific and professional journals and governmental research organizations.

Professor Newman has lectured throughout the world on microbiology, antimicrobials, evidence-based methodology, risk factors, and diagnostic strategies for periodontal disease. He has a strong interest in applied science and the transfer of new technology for practical use. Dr. Newman is a consultant to major dental and pharmaceutical companies throughout the world. He is the founding editor-in-chief of the *Journal of Evidence-Based Dental Practice (JEBDP)* and *The JEBDP Annual Report Series* and was the associate editor of the *International Journal of Oral and Maxillofacial Implants*.

Henry H. Takei, DDS, MS, FACD


Dr. Henry H. Takei graduated in 1965 from the Marquette University School of Dentistry in Milwaukee, Wisconsin. He completed his Periodontics Certificate and Master of Science degree in 1967 at Marquette University and the Veterans Administration Hospital in Wood, Wisconsin.

Presently, Dr. Takei is a Distinguished Clinical Professor of Periodontics and Consultant in Periodontics at the University of California, Los Angeles (UCLA), School of Dentistry and a consultant in periodontics at the Veterans Administration Hospital in Los Angeles. In addition to his educational activities, he maintains a private practice limited to periodontics and implant surgery.

Dr. Takei has published numerous clinical and scientific articles on periodontal surgery and has contributed chapters to five textbooks. He has been actively involved in continuing education and has lectured throughout the world on clinical periodontology and implant surgery.

Dr. Takei has been honored nationally and internationally with awards from numerous periodontal organizations, universities, and study clubs for his contributions to education. He is also a Fellow of both the American College of Dentists and the International College of Dentists and has been elected into Omicron Kappa Upsilon.

He received the Distinguished Alumnus Award from Marquette

University in 2001 and the Honorary Distinguished Alumnus Award from UCLA in 1998. The American Academy of Periodontology has honored Dr. Takei with the prestigious Master Clinician Award in 2006. This award is the highest clinical recognition from this national periodontal organization. In 2016, two universities in Japan, Meikai University and Asahi University, presented Dr. Takei with the Honorary Doctorate Degree for many years of academic and clinical collaboration.

Perry R. Klokkevold, DDS, MS, FACD



Dr. Perry R. Klokkevold graduated from the University of California, San Francisco, School of Dentistry in 1986. His postdoctoral clinical training includes a General Practice Residency in Hospital Dentistry completed in 1987, a Postgraduate Periodontal Residency completed in 1994, and a Surgical Implant Fellowship completed in 1995. All of his postgraduate training was completed at the University of California, Los Angeles (UCLA), School of Dentistry. He earned a Master of Science degree in Oral Biology at UCLA in 1995.

Dr. Klokkevold is a Diplomate of the American Board of Periodontology and a Fellow of the American College of Dentists. He is an Associate Professor in the Division of Constitutive and Regenerative Sciences, Section of Periodontics, at the UCLA School of Dentistry and Program Director of the UCLA Postgraduate Periodontics Residency program. Dr. Klokkevold served as Clinical Director and Program Director of the General Practice Residency program in Hospital Dentistry at the UCLA School of Dentistry from 1987 to 1992. He has maintained a faculty practice limited to the specialty of periodontics and dental implant surgery at UCLA since 1995.

Dr. Klokkevold has published more than 60 articles for international peer-reviewed journals and has written more than 100 book chapters for 13 books, including five editions of *Clinical Periodontology,* on topics including periodontal medicine, influence of systemic disease and risk factors on periodontitis to bone regeneration, and dental implants. He has served as a reviewer for several journals, among them the *Journal of Periodontology* and the International Journal of Oral and Maxillofacial Implants. Dr. Klokkevold lectures nationally and internationally on many periodontal and implant-related topics. He has been invited to serve as an expert consultant/reviewer for five international conferences organized by the American Academy of Periodontology and the Academy of Osseointegration on topics that include implant therapy, bone augmentation and implant site development, periodontal regeneration, and lasers in periodontal therapy.

Fermin A. Carranza, DR ODONT, FACD



Dr. Fermin A. Carranza graduated from the University of Buenos Aires School of Dentistry in Argentina in 1948 and completed his postdoctoral training in periodontics at Tufts University School of Dental Medicine in 1952 under the mentorship of Dr. Irving Glickman.

Dr. Carranza is Professor Emeritus of Periodontology at the University of California, Los Angeles (UCLA), School of Dentistry. He was head of the Department of Periodontics at the University of Buenos Aires from 1966 to 1974 and at UCLA from 1974 until his retirement in 1994.

Dr. Carranza has published more than 218 scientific papers and abstracts on basic and applied aspects of periodontics and 18 books, including the past five editions of *Clinical Periodontology*. He has received numerous awards and recognition for his work, including the IADR Science Award in Periodontal Disease and the Gies Award of the American Academy of Periodontology.

Dr. Carranza has lectured throughout the world on clinical periodontology, pathology, and therapy.

Preface

With the help of Elsevier's advanced technology and high standards of quality, an international team of editors and contributors have developed the most comprehensive periodontal resource available, *Newman and Carranza's Clinical Periodontology*, thirteenth edition. The book's companion website is rich with images, animations, videos, question sets, case reports, PowerPoint slides, audio slides, virtual microscope, multidisciplinary case scenarios, and more. No other resource offers such a comprehensive approach to providing high quality content.

Since publication of the first edition of this book in 1953, periodontology has made tremendous advancements. Scientific analysis of periodontal tissues and the elucidation of mechanisms and causes of disease have extended far beyond histology and physiology into the realm of cellular and molecular biologic understanding.

Implant dentistry has become a major component of periodontology, and this book offers a wide coverage of important treatment modalities.

New therapeutic goals and clinical techniques, based on an improved understanding of disease and healing, have facilitated better outcomes and brought us closer to achieving the ultimate goal of optimal periodontal health and function. Today, reconstruction and regeneration of lost periodontal structures, replacement of compromised teeth with implants, and creation of aesthetic results are integral parts of clinical practice.

The multifaceted, complex task of producing the thirteenth edition required the collaboration of numerous experts from

various fields, and their contributions are invaluable. We know that this new edition will continue to be a useful resource for to dentists, dental hygienists, periodontists, students, educators, and researchers.

Having this resource available will contribute to the continuous progress of our profession.

Michael G. Newman Henry H. Takei Perry R. Klokkevold Fermin A. Carranza

Acknowledgments

Clinical Periodontology has been a trusted and valuable periodontics resource for students, residents, academicians, scientists, and clinicians since the early 1950s. Dr. Irving Glickman was the originator and author of *Clinical Periodontology* for the first four editions, which were published in 1953, 1958, 1964, and 1972. Dr. Glickman was professor and chairman of the Department of Periodontology at Tufts University School of Dental Medicine, in Boston, Massachusetts.

Dr. Fermin A. Carranza, once a student of and collaborator with Dr. Glickman, assumed responsibility to author and continue the book after Dr. Glickman's death in 1972 at age 58. Dr. Carranza was professor and chairman of periodontics at the University of California, Los Angeles (UCLA), School of Dentistry. The subsequent four editions were published in 1979, 1984, 1990, and 1996 under the leadership and guidance of Dr. Carranza.

Dr. Michael G. Newman joined Dr. Carranza in 1996 as co-editor of the eighth edition. Dr. Newman was adjunct professor of periodontics at the UCLA School of Dentistry. Dr. Carranza retired to become professor emeritus at UCLA, and the responsibility of maintaining the book's tradition of almost half a century changed hands once again, this time to Dr. Newman. The subsequent four editions were published in 2002, 2006, 2012, and 2015 under the direction of Dr. Newman. The title of the ninth edition was changed from *Clinical Periodontology* to *Carranza's Clinical Periodontology* to acknowledge and honor Dr. Carranza for his leadership and dedication to this renowned resource. Dr. Henry H. Takei joined Dr. Newman and Dr. Carranza in 2002 as co-editor of the ninth edition. Dr. Takei was clinical professor of periodontics at the UCLA School of Dentistry. Dr. Takei currently holds the title of Distinguished Clinical Professor of Periodontics at UCLA School of Dentistry.

Dr. Perry R. Klokkevold joined Drs. Newman, Takei, and Carranza in 2006 as co-editor of the tenth edition. Dr. Klokkevold is an associate professor and the program director of Postgraduate Periodontics at the UCLA School of Dentistry. Dr. Carranza became editor emeritus for the tenth and subsequent editions.

The title of the thirteenth edition has been changed to *Newman and Carranza's Clinical Periodontology* to acknowledge and recognize Dr. Newman's leadership in maintaining the book's reputation as a high-quality and forward-looking resource for those who practice periodontology and implant dentistry.

The level of understanding and the practice of clinical periodontics have evolved tremendously since the mid-20th century. Advances in basic science and clinical techniques have increased the knowledge base so dramatically that it is virtually impossible for individuals to master and retain all the information.

It is also certain that the task of researching, preparing, and assembling the enormous amount periodontology-related content necessary for this book had to be borne by many experts who shared their experience and knowledge. We express our deep gratitude to all the contributors whose expertise, ideas, and efforts built this valuable resource over the years. Many scientists and clinicians have shared their wisdom and expertise in previous editions of *Carranza's Clinical Periodontology*, as associate editors, section editors, and contributors, though some of their names no longer appear.

Our appreciation is given to Elsevier and particularly to Jennifer Flynn-Briggs and Lucia Gunzel. Their expertise and detailed attention to every word and every concept contributed greatly to producing a quality book and a truly useful website.

We also express appreciation to Dr. Satheesh Elangovan who joined the team for the thirteenth edition as associate editor. The online version of the book continues to assume greater importance to our readers. Elsevier's electronic capabilities provide a rich, useful, and complete resource and are directed by Dr. Elangovan.

We express gratitude to our parents, colleagues, friends, and mentors who have always been so tolerant, encouraging, and understanding and who guided our first steps in our profession and helped us develop our ideas in the field.

Dr. Newman: My family, Susan, Andrea, Kara, Callahan and Natalie, Scott, Zoey and Eleanor; my parents, Paul, Rose, John, and Inez. Sigmund S. Socransky, Fermin A. Carranza, Jr., and Henry H. Takei. My gratitude to my co-editors and contributors whose expertise and willingness to participate in this work have made this book an excellent educational standard.

Dr. Takei: My wife, June; my children, Scott and Akemi; their spouses, Kozue and David; my grandchildren, Hana, Markus, Carter, and Arden. My graditude to my mentors Dr. Fermin A. Carranza, Jr., Dr. Donald Van Scotter, Dr. Delbert Nachazel, and Dr. John Pfeiffer. Thank you to my three co-editors and friends Michael G. Newman, Fermin A. Carranza, Jr., and Perry R. Klokkevold. Special gratitude to Laura Miyabe for her professional support. I would like to acknowledge and thank all of my periodontal postdoctoral students at UCLA for their help and support throughout the preparation of this classic textbook. Another note of thank you to Dr. Sasan Garakani for the many hours of collaboration and help that he provided in the review of literature and organizing the references for numerous chapters.

Dr. Klokkevold: My wife, Angie; my daughters, Ashley and Brianna; my parents Carl and Loretta; my gratitude and appreciation to my mentors Dr. Henry H. Takei, Dr. John Beumer III, Dr. Bradley G. Seto, Dr. Charles N. Bertolami, and Dr. Thomas Han. I am grateful to the many talented residents who matriculated through UCLA Postgraduate Periodontics for the passion and inspiration they bring to me as an educator and clinician. Finally, I give special thanks to my co-editors, Dr. Michael G. Newman, Dr. Henry H. Takei, and Dr. Fermin A. Carranza, Jr., for their friendship, support, and encouragement. Dr. Carranza: My wife, Rita; my children, Fermin, Patricia, and Laura; and my grandchildren, Irving Glickman, Fermin Carranza, Sr., and Romulo L. Cabrini. My gratitude also to my co-editors, who will continue the tradition of this book.

Michael G. Newman Henry H. Takei Perry R. Klokkevold Fermin A. Carranza

Video Contents

Chapter 8 Biofilm and Periodontal Microbiology

Video 8.1 Bacteria compete with their neighbors by secreting antibacterial molecules such as inhibitory peptides (bacteriocins) or hydrogen peroxide (H_2O_2)

Video 8.2 Plaque growth

Video 8.3 Difference in plaque growth between heavy and light plaque former Video 8.4 Colonization inhibition Video 8.5 Phase contrast

Chapter 24 **Bone Loss and Patterns of Bone Destruction**

Video 24.1 Vertical bone loss animation Chapter 46 Endodontic-Periodontic Lesions: Pathogenesis, Diagnosis, and Treatment Considerations

Video 46.1 Fractured teeth slide show Chapter 51 Sonic and Ultrasonic Instrumentation and Irrigation

> Video 51.1 Ultrasonic debridement Video 51.2 Ultrasonic debridement

Video 51.3 Pulsating action of a jet tip Video 51.4 Depth of penetration with a dental water jet Video 51.5 Action of a tip with bristles around orthodontic brackets Video 51.6 Action of a tip with filaments cleaning around an implant Video 51.7 Action of the site-specific tip into a pocket Chapter 64 Furcation: Involvement and Treatment Video 64.1 Bone loss with furcation slide show Chapter 65 Periodontal Plastic and Aesthetic Surgery Video 65.1 Periodontal plastic and aesthetic surgery Chapter 69 Preparation of the Periodontium for **Restorative Dentistry** Video 69.1 Effects of single tooth loss Chapter 70 Restorative Interrelationships Video 70.1 Smile design principles animation Chapter 75 Clinical Evaluation of the Implant Patient Video 75.1 Single aesthetic implant slide show Chapter 78 Basic Implant Surgical Procedures Video 78.1 Single tooth implant video Video 78.2 Dental implant case presentation

Introduction: The Historical Background of Periodontology

Gerald Shklar⁺, Fermin A. Carranza

Chapter Outline

Early Civilizations The Classical World The Middle Ages The Renaissance The Eighteenth Century The Nineteenth Century The Twentieth Century The History of This Book

Gingival and periodontal diseases have afflicted humans since the dawn of history. Studies in paleopathology have indicated that destructive periodontal disease, as evidenced by bone loss, affected early humans in such diverse cultures as ancient Egypt and early pre-Columbian America. The earliest historical records that involve medical topics reveal an awareness of periodontal disease and the need for treatment. Almost all early writings that have been preserved have sections or chapters dealing with oral diseases, and periodontal problems comprise a significant amount of space in these writings. Calculus and systemic disease were frequently postulated as causes of periodontal disorders.

However, methodic and carefully reasoned therapeutic discussions did not exist until the Arabic surgical treatises of the Middle Ages. Modern treatment, with illustrated text and sophisticated instrumentation, did not develop until the time of Pierre Fauchard during the eighteenth century.

Early Civilizations

Oral hygiene was practiced by the Sumerians, the Babylonians, and the Assyrians; this included gingival massage in combination with various herbal medications.^{25,33}

Periodontal disease was the most common of all diseases found in the embalmed bodies of the ancient Egyptians.^{7,44} The Ebers papyrus contains many references to gingival disease and offers a number of prescriptions for strengthening the teeth and gums.¹⁴

The medical works of ancient India and China devote significant space to oral and periodontal problems and oral hygiene,⁴⁷ and they describe gingival inflammations, periodontal abscesses, and gingival ulcerations.^{12,21} The early Hebrews also recognized the importance of oral hygiene. Many pathologic conditions of the teeth and their surrounding structures are described in the Talmudic writings.

The Classical World

Among the ancient Greeks, Hippocrates of Cos (460 BC-377 BC), the father of modern medicine, discussed the function and eruption of the teeth and the etiology of periodontal disease. He believed that inflammation of the gums could be caused by accumulations of "pituita" or calculus, with gingival hemorrhage occurring in cases of persistent splenic maladies.^{10,27}

Among the Romans, Aulus Cornelius Celsus (25 BC-50 AD) referred to diseases that affect the soft parts of the mouth and their treatment, including oral hygiene. Paul of Aegina (625 AD-690 AD) wrote that tartar deposits must be removed with either scrapers or a small file and that the teeth should be carefully cleaned after the last meal of the day.⁴¹

The Middle Ages

The decline and fall of the Roman Empire that plunged Europe into an age of darkness was accompanied by the rise of Islam and the golden age of Arabic science and medicine. The Arabic treatises derived their information from Greek medical treatises, but many refinements and novel approaches were added, particularly in surgical specialties.⁴⁵

Albucasis (936-1013) was born and lived in Moorish Spain. His 30-volume medical encyclopedia, called *al-Tasrif*, was translated into Latin during the twelfth century, and it was the medical text used in European universities until the seventeenth century. The contributions of Albucasis to dentistry and periodontology were outstanding achievements.¹ He had a clear understanding of the major etiologic role of calculus deposits, and he described the techniques of scaling the teeth with the use of a set of instruments that he developed (Fig. I.1), splinting loose teeth with gold wire, and filing gross occlusal abnormalities.



FIG. I.1 Illustration of Albucasis' periodontal instruments, showing scalers *(sc)*, files *(f)*, and the wiring of loose teeth *(w)*.

Avicenna (980-1037) was possibly the greatest of the Persian physicians. His *Canon*, a comprehensive treatise on medicine, was in continuous use for almost 600 years. Avicenna used an extensive "materia medica" for oral and periodontal diseases and rarely resorted to surgery.³

The Renaissance

During the Renaissance—with the rebirth of classical scholarship, the development of scientific thought and medical knowledge, and the flowering of art, music, and literature—significant contributions were made to anatomy and surgery.

Albucasis' work was expanded during the fifteenth century by the Turkish author Serefeddin Sabuncuoglu (1385-1468), who included illustrations of the surgical removal of hypertrophic and swollen gingiva and lingual frenum (Fig. I.2). Drug treatment should be initiated if there are swollen gums, mobile teeth, and pus formation. If there is no response, surgical treatment should be performed. A tube is placed on the gums. A hot cautery is inserted into the cannula, and the gingival tissue is cauterized. If this is correctly applied, the adjacent teeth will be warm.



FIG. I.2 Illustration by Serefeddin Sabuncuoglu showing gingival cauterization. (From Abulcasis and redrawn by Professor Ilter Uzel, Turkey.)

Paracelsus (1493-1541) developed an interesting and unusual theory of disease: the doctrine of calculus. Paracelsus recognized the extensive formation of tartar on the teeth and related this to toothache. He considered toothache to be comparable to the pain produced by calculus in other organs, such as the kidneys.³⁹

Andreas Vesalius (1514-1564), who was born in Brussels, taught at the University of Padua and wrote a magnificent book about anatomy that included many excellent illustrations.⁴⁸ Bartholomeus Eustachius (1520-1574) of Rome was another outstanding anatomist who wrote a small book about dentistry, *Libellus de Dentibus* ("A Little Treatise on the Teeth"), which contained 30 chapters.¹⁶ This was the first original book about the teeth, and it included a description of the periodontal tissues as well as information about the diseases of the mouth, their treatment modalities, and the rationale for treatment. For the treatment of periodontitis, Eustachius recommended both the scaling of calculus and the curettage of granulation tissue so that actual reattachment of the gingival and periodontal tissues could take place.

The Frenchman Ambroise Paré (1509-1590) was the outstanding surgeon of the Renaissance, and his contributions to dental surgery included gingivectomy for hyperplastic gingival tissues.⁴⁰ He also understood the etiologic significance of calculus and used a set of scalers to remove the hard deposits on the teeth.

The first book in the common language of German and specifically devoted to dental practice, which was entitled *Artzney Buchlein* or *Zene Artzney* ("Medicine of the Teeth"), was published in Leipzig in 1530.² It contains three chapters devoted to periodontal problems, including a crude concept of systemic and local factors in the etiology of periodontal disease. The presence of local infective agents or "worms" is also mentioned.

A variety of ointments, which are often astringent in nature, is suggested, and the binding of loose teeth to sound ones with silk or gold thread is recommended. Cauterizing the gingiva with a hot iron is mentioned.

The Italian physician, mathematician, and philosopher Girolamo Cardano (1501-1576) appears to have been the first to differentiate among the types of periodontal disease. In a publication dated 1562, he mentions one type of disease that occurs with advancing age and leads to progressive loosening and loss of teeth as well as a second very aggressive type that occurs in younger patients.²⁶ It was not until late in the twentieth century that this classification was rediscovered and became widely accepted.

Anton van Leeuwenhoek (1632-1723) of Delft, Holland, was a layman, but he had an inquisitive mind and a hobby of grinding lenses that allowed him to develop the microscope. He used it to discover microorganisms, cellular structure, blood cells, sperm, and various other microscopic structures, including the tubular structure of dentin.^{9,13} Using material from his own mouth, Leeuwenhoek first described oral bacterial flora, and his drawings offered a reasonably good presentation of oral spirochetes and bacilli (Fig. I.3). He even performed antiplaque experiments involving the use of strong vinegar in his own mouth and in vitro on bacteria in a dish.¹³



bacilli, and other microorganisms.

The Eighteenth Century

Modern dentistry essentially developed in eighteenth century Europe, particularly France and England. Pierre Fauchard, who was born in Brittany in 1678, is rightly regarded as the father of the dental profession as we know it. His book, *The Surgeon Dentist*, which was published in 1728, covered all aspects of dental practice, including restorative dentistry, prosthodontics, oral surgery, periodontics, and orthodontics¹⁷ (Fig. I.4). Fauchard described in detail his periodontal instruments and the scaling technique for using them (Fig. I.5).



FIG. I.4 Frontispiece of Fauchard's book entitled *The Surgeon Dentist* (1746 edition).



John Hunter (1728-1793), who was the most distinguished anatomist, surgeon, and pathologist of eighteenth-century England, wrote an excellent treatise on dentistry entitled *The Natural History of the Human Teeth*.³⁰ He offered remarkably clear illustrations of the anatomy of the teeth and their supporting structures, and he described the features of periodontal diseases.

A contemporary of Hunter, Thomas Berdmore (1740-1785), was considered the outstanding dentist in England. In 1770, he published a book that had several chapters devoted to periodontal problems.⁴

The Nineteenth Century

Leonard Koecker (1785-1850) was a German-born dentist who practiced in Baltimore. In a paper in 1821, he mentioned the careful removal of tartar and the need for oral hygiene by the patient, recommending that it be performed in the morning and after every meal with the use of an astringent powder and a toothbrush, with care taken to place "the bristles ... into the spaces of the teeth." Koecker was an early advocate of the "odontogenic focal infection" theory, and he recommended the extraction of all severely involved teeth and roots, including all unopposed molars, to prevent systemic infections.³⁵

Levi Spear Parmly (1790-1859) was a New Orleans, Louisiana, dentist who is considered the father of oral hygiene and the inventor of dental floss.^{11,18}

During the mid-nineteenth century, John W. Riggs (1811-1885) was the leading authority on periodontal disease and its treatment in the United States; in fact, at the time, periodontitis was known as "Riggs' disease" (Fig. I.6). Riggs graduated from the Baltimore College of Dental Surgery in 1854 and practiced in Hartford, Connecticut, where he died on November 11, 1885. Riggs seems to have been the first individual to limit his practice to periodontics and therefore can be considered the first specialist in this field. Riggs' publications, however, are limited. In an 1876 paper, Riggs was a strong proponent of the so-called conservative approach to periodontal therapy; he developed the concept of oral prophylaxis and prevention, advocated for the cleanliness of the mouth, and opposed surgery, which at the time consisted of gingival resection.⁴³



FIG. I.6 John W. Riggs (1811-1885). (From Hoffman-Axthelm W: *History of dentistry,* Chicago, 1981, Quintessence.)

Riggs and his disciples had great influence on the dental profession. Among Riggs' followers were L. Taylor, D.D. Smith, R.B. Adair, and W.J. Younger. The instruments designed by Younger⁵⁷ and later modified by his student Robert Good were used widely until well beyond the middle of the twentieth century.

Several major developments in medical science occurred during the second half of the nineteenth century and started the era that can be called *modern medicine*, which includes dentistry.^{9,36} The first was the discovery of anesthesia by Horace Wells (1813-1848) of Hartford, Connecticut, in 1845 and by William Morton (1819-1868) of Boston, Massachusetts, in 1846, who discovered the general anesthetic effects of nitrous oxide and ether, respectively. *Local anesthesia* was developed by the Vienna ophthalmologist Carl Köller (1857-1944), who produced anesthesia of the eye with drops of cocaine. Procaine (Novocaine) was developed in 1905 by the Munich chemists Alfred Einhorn and Richard Willstädter. Later, with the addition of adrenaline, which was discovered separately in the United States by Jokichi Takamine and Thomas Bell Aldrich, local anesthesia was born.²⁹

The second scientific breakthrough was made by the French chemist Louis Pasteur (1822-1895), who established the *germ theory of disease*. Subsequently, the German physician Robert Koch (1843-1910), in a series of brilliant investigations, discovered the microorganism that causes the cattle disease anthrax and the bacterial etiology of tuberculosis and cholera.

The concepts of Pasteur were transferred to clinical and surgical practice by Joseph Lister (1827-1912) of England, and thus the era of antisepsis—and later, asepsis—in surgery was born. Anesthesia and antisepsis made possible extraordinary advances in surgical techniques.

Pasteur, Koch, and their collaborators and followers—Elie Metchnikoff, Emile Roux, Paul Ehrlich, Emil von Behring, Shibasaburo Kitasato, and many others—discovered the bacterial etiologies of numerous diseases (e.g., pneumonia, puerperal fever, diphtheria, meningitis, plague, dysentery, syphilis) and gave birth to two sciences that became basic to periodontics: bacteriology and immunology.

A third scientific finding that changed the practice of dentistry in

general and of periodontics in particular was the *discovery of radiographs* by the German physicist Wilhelm Röntgen (1845-1923; also written as *Roentgen*). Röntgen's discovery was made in 1895 at the University of Würzburg and was purely a basic science finding, but it was immediately taken up by physicians and dentists, and it proved to be a crucial development in periodontics and many other areas of medicine and dentistry.

Also during the late nineteenth century, studies by Rudolph Virchow (1821-1902), Julius Cohnhein (1839-1884), Elie Metchnikoff (1845-1916), and others had started to reveal the microscopic changes that occur during inflammation.^{8,9} This resulted in an understanding of the pathogenesis of periodontal disease on the basis of histopathologic studies. The Russian N.N. Znamensky described the complex interaction of local and systemic factors in the etiology of periodontal disease. His observations and concepts were summarized in 1902 in a classic paper in which he described the presence in inflamed gingivae of a cellular infiltrate that extends deeper as the disease progresses, thereby causing the bone resorption associated with multinucleated cells (osteoclasts) and Howship lacunae⁵⁸ (Fig. I.7).



FIG. I.7 Microscopic features of periodontal disease as presented by Znamensky.

The first individual to identify bacteria as the cause of periodontal disease appears to have been the German dentist Adolph Witzel (1847-1906).^{23,56} The first true oral microbiologist, however, was the American Willoughby D. Miller (1853-1907), whose professional activities took place in Berlin, where he embarked on a research career that introduced modern bacteriology principles to dentistry. Although his greatest accomplishments were in caries research, in his classic book, The Microorganisms of the Human Mouth, which was published in 1890, he described the features of periodontal disease and considered the role of predisposing factors, irritational factors, and bacteria in its etiology. He believed that the disease was not caused by a specific bacterium but by a complex array of various bacteria that are normally present in the oral cavity. This constitutes what was later known as the nonspecific plaque hypothesis, which went unchallenged for seven decades.^{23,37}

Bacterial plaque was described by J. Leon Williams (1852-1932), an American dentist who practiced in London and who in 1897 described a gelatinous accumulation of bacteria adherent to the enamel surface in relation to caries.⁵⁵ In 1899, G.V. Black (1836-1915) coined the term *gelatinous microbic plaque*.⁵

Salomon Robicsek (1845-1928) was born in Hungary and practiced dentistry in Vienna. He developed a surgical technique that consisted of a scalloped, continuous gingivectomy excision that exposed the marginal bone for subsequent curettage and remodeling.⁴⁶

The first description in 1901 of a possible role of trauma from occlusion and bruxism in periodontal disease is generally attributed to the Austrian dentist Moritz Karolyi (1865-1945), who also recommended its correction by grinding occlusal surfaces and preparing bite plates.³⁴

Necrotizing Ulcerative Gingivitis

Necrotizing ulcerative gingivitis had been recognized during the fourth century BC by Xenophon, who mentioned that Greek soldiers were affected with "sore mouth and foul-smelling breath." In 1778, Hunter described the clinical features of this disease and differentiated it from scurvy and chronic periodontitis.

Hyacinthe Jean Vincent (1862-1950),^{23,49} a French physician working at the Pasteur Institute in Paris, and Hugo Carl Plaut (1858-1928)⁴² in Germany described the spirillum and fusiform bacilli associated with what later became known as *Vincent's angina*. In 1904, Vincent described the presence of these organisms in ulceronecrotic gingivitis.⁵⁰

The Twentieth Century

During the first third of the twentieth century, periodontics flourished in central Europe, with two major centers of excellence: Vienna and Berlin.²²

Vienna

The Vienna school developed the basic histopathologic concepts on which modern periodontics was built. The major representative from this group was Bernhard Gottlieb (1885-1950), who published extensive microscopic studies of periodontal disease in human autopsy specimens (Fig. I.8).¹⁹ His major contributions appeared in the German literature during the 1920s, and they described the attachment of the gingival epithelium to the tooth, the histopathology of inflammatory and degenerative periodontal disease, the biology of the cementum, active and passive tooth eruption, and traumatic occlusion. A book published in 1938 by Gottlieb and Orban presented a complete review in English of the concepts developed by Gottlieb and his coworkers in Vienna.²⁴



FIG. I.8 Bernhard Gottlieb (1885-1950). (From Gold SI: *J Clin Periodontol* 12:171, 1985.)

A younger contemporary of Gottlieb's in Vienna was Balint J. Orban (1899-1960) (Fig. I.9), who carried out extensive histologic studies on periodontal tissues. These studies serve as the basis for much of current therapy. Other members of the Viennese school were Rudolph Kronfeld (1901-1940), Joseph P. Weinmann (1889-1960), and Harry Sicher (1889-1974). All of these scientists emigrated to the United States during the 1930s and contributed greatly to the progress of American dentistry.



FIG. I.9 Balint J. Orban (1899-1960). (From J Periodontol 31:266, 1960.)

Berlin

The Berlin group consisted mostly of clinical scientists who developed and refined the surgical approach to periodontal therapy. Prominent in this group were Oskar Weski (Fig. I.10) and Robert Neumann (Fig. I.11).



FIG. I.10 Oskar Weski (1879-1952). (From Hoffman-Axthelm W: *History of dentistry,* Chicago, 1981, Quintessence.)



FIG. I.11 Robert Neumann (1882-1958). (Courtesy Dr. Steven I. Gold, New York.)

Weski (1879-1952) carried out pioneering studies that correlated radiographic and histopathologic changes in patients with periodontal disease.⁵³ He also conceptualized the periodontium as being formed by the cementum, gingiva, periodontal ligament, and bone, and he gave it the name *paradentium*; this was later changed for etymologic reasons to *parodontium*, which is a term that is still used in Europe.

Neumann (1882-1958), in a book published in 1912³⁸ (with new editions in 1915, 1920, and 1924), described the principles of periodontal flap surgery, including osseous recontouring as it is currently known²⁰ (Fig. I.12). Other clinicians who described flap surgery at the beginning of the twentieth century were Leonard Widman of Sweden (1871-1956)⁵⁴ and A. Cieszynski of Poland. A bitter controversy developed among Widman, Cieszynski, and Neumann during the 1920s with regard to the priority of describing the periodontal flap.



FIG. I.12 Surgical procedure advocated by Robert Neumann during the early part of the twentieth century. *Top,* After raising a mucoperiosteal flap, its edge is trimmed with scissors to leave a scalloped outline. *Bottom,* Osseous recontouring with burs. (From Gold SI: J *Periodontol* 53:456, 1982.)

The United States and Other Countries

In the United States, before World War II, important contributions to periodontal surgery were made by A. Zentler, J. Zemsky, G.V. Black, O. Kirkland, A.W. Ward, A.B. Crane, H. Kaplan, and others. In 1923, Ward introduced the surgical pack under the trade name Wondr-Pak.⁵¹

The nonsurgical approach was championed by Isadore Hirschfeld (1882-1965) of New York, who wrote classic papers about oral hygiene,²⁸ local factors, and other topics. In 1913, Alfred Fones (1869-1938) opened the first school for dental hygienists in Bridgeport, Connecticut.⁹

In other countries, H.K. Box (Canada); M. Roy and R. Vincent (France); R. Jaccard and A.-J. Held (Switzerland); F.A. Carranza, Sr, and R. Erausquin (Argentina); W.W. James, A. Counsell, and E.W. Fish (Great Britain); and A. Leng (Chile) are well known for their important contributions. Probably the most comprehensive book about periodontics published during the first half of the twentieth century was *El Paradencio, Su Patologia y Tratamiento,* which was written by the Uruguayan F.M. Pucci in 1939.

Focal Infection

The concept of systemic diseases originating in dental and oral infections had been mentioned in the Assyrian clay tablets (seventh century BC), by Hippocrates (460-370 BC), in the Babylonian Talmud (third century AD), and by Girolamo Cardano and the German Walter Hermann Ryff during the sixteenth century.^{29,52} During the nineteenth century, Benjamin Rush (a famous physician and one of the signers of the American Declaration of Independence) in 1818 and Leonard Koecker in 1828 recognized the role of oral sepsis in rheumatic and other diseases. Later during the nineteenth century, W.D. Miller also mentioned oral infections as the cause of many diseases.³⁷

In a paper published in 1900³¹ and a decade later in a lecture at McGill University in Montreal, Quebec, Canada,³² William Hunter (1861-1937), a British physician, indicted dentistry as being the cause of oral sepsis, which in turn caused rheumatic and other chronic diseases. This idea was taken up by Billings, Rosenow, and many others, who advocated the extraction of all teeth with periodontal or periapical infections to prevent systemic diseases. This led to the wholesale extraction of teeth and the removal of the tonsils.

The focal infection theory fell into disrepute when it was found that extractions failed to eliminate or reduce the systemic diseases to which the infected teeth were supposed to be linked.¹⁵ However, the concept was revisited during the 1990s, this time with a more solid research foundation.

Dental Implants

The replacement of human teeth with implants has been attempted for centuries. Skulls with metal or stone implants have been found in a Gallo-Roman necropolis in France and dated from the second century AD; they were also found in a mandible of Mayan origin dated about 600 AD.⁹

In 1806, the Italian M. Maggiolo attempted to place solid-gold roots in human jaws. Later during the nineteenth century, several other investigators used porcelain and metallic implants. During the first half of the twentieth century, several attempts were made to use elaborate surgical techniques and complicated constructs of gold and other precious metals. Microscopic investigations were begun to address the tissue response to various metals.

In 1939, A.E. Strock of Harvard University started implanting cobalt–chromium (Vitallium) screws into tooth sockets. After World War II, numerous attempts were made with different materials and shapes of implants, including tantalum twisted spiral (Formiggini), Vitallium tree shaped (Lee), acrylic tooth root replica (Hodosh), Vitallium double helical spiral (Chércheve), tantalum tripodal pins (Scialom), tantalum vent-plant and titanium blade (Linkow), and vitreous carbon.⁹

During the 1950s, the Swedish orthopedic surgeon Per-Ingvar Bränemark developed a technique that involved the use of titanium screw-shaped intraosseous implants. This proved to be quite successful, and it was gradually adopted by the dental profession after the 1982 international conference in Toronto, Ontario, Canada. The success and predictability of Bränemark's technique are attributed to the achievement of direct contact between vital bone and the implant surface without intervening soft tissue; this phenomenon was later termed *osseointegration*.⁶ Numerous variations of the Bränemark concept were presented by A. Kirsch, G.A. Niznick, A. Schroeder, and others, and they are widely used at present.

After World War II

The United States and Scandinavia took leading roles in basic and clinical periodontal research during and after the 1950s, with major advances made in the fields of experimental pathology, microbiology, immunology, and therapy.

In the United States, five individuals led the efforts to advance our understanding of disease processes and the technical approaches needed to address them: Irving Glickman (1914-1972) (Fig. I.13), Henry M. Goldman (1911-1991), Balint J. Orban (1899-1960) (see Fig. I.8), Sigurd P. Ramfjord (1911-1997), and Helmut A. Zander (1912-1991). In the clinical area, the influence of John Prichard (1907-1990) and Saul Schluger (1908-1990) led to new concepts and new directions in the pursuit of clinical success and excellence.



FIG. I.13 Irving Glickman (1914-1972).

The leading figure of the Scandinavian group was Jens Waerhaug (1907-1980) (Fig. I.14) of Oslo, Norway, whose dissertation entitled *The Gingival Pocket* (1952) and whose lifetime of research opened a new era in the understanding of the biology of the periodontium and the management of periodontal problems.



FIG. I.14 Jens Waerhaug (1907-1980). (From J Clin Periodontol 7:534, 1980.)

The next generations centered their attention more on the role of microorganisms and the host response, including its defensive and its destructive aspects. Their contributions, as well as those of their predecessors, are documented in this book.

Several workshops and international conferences have summarized existing knowledge regarding the biologic and clinical aspects of periodontology. Worthy of mention are those that were conducted in 1951, 1966, 1977, 1989, 1996, 1999, and 2008, which were cosponsored and published by the American Academy of Periodontology.

The American Academy of Periodontology, which was founded in 1914 by two female periodontists, Grace Rogers Spalding (1881-1953) and Gillette Hayden (1880-1929), has become the leader in organized periodontics. Its monthly scientific publication, *Journal of Periodontology*, presents all current advances in this discipline. In Europe, the periodontal societies have joined to form the European Federation of Periodontology, which meets regularly at the Europerio meeting. Their official publication is *Journal of Clinical Periodontology*. Other scientific periodontal journals in English include *Journal of Periodontal Research*, *Periodontology* 2000, and *International Journal of Periodontics and Restorative Dentistry.* With regard to journals in other languages, *Journal de Parodontologie* (France), *Periodoncia* (Spain), and *Journal of the Japanese Association of Periodontology* deserve mention.

Periodontal education in the United States also has grown during the second half of the twentieth century, and most dental schools have separate and independent units for teaching and research in this discipline. Periodontics was recognized as a specialty of dentistry by the American Dental Association in 1947. The first university-based programs for the training of specialists in periodontics were begun in several universities (e.g., Columbia, Michigan, Tufts) during the late 1940s; these 1-year programs expanded to 2-year programs about 10 years later. In 1995, the American Academy of Periodontology mandated that all postgraduate periodontal programs increase to a 3-year curriculum because of the increased knowledge in periodontics and the expansion of the scope of periodontics to include the placement of dental implants and the administration of conscious sedation. Currently in the United States, more than 50 periodontal graduate programs are based in universities and hospitals.

The History of This Book

The originator of this book and the author of its first four editions, which were published in 1953, 1958, 1964, and 1972, was Dr. Irving Glickman (see Fig. I.13), professor and chairman of the Department of Periodontology at Tufts University School of Dental Medicine in Boston, Massachusetts.

Dr. Glickman was an outstanding researcher, a superb educator, and a gifted speaker and writer whose concepts shaped periodontal thinking for many years. His style of writing, his ideas, and his philosophy of dental practice can still be found in many areas of this book.

After Dr. Glickman's death in 1972 at age 58, responsibility for continuing this book moved to Dr. Fermin A. Carranza, who had been a student and collaborator of Dr. Glickman. At the time, Dr. Carranza was professor and chairman of periodontics at the School of Dentistry of the University of California, Los Angeles. The
following four editions were published in 1979, 1984, 1990, and 1996 under the guidance of Dr. Carranza, who is now professor emeritus at the University of California, Los Angeles.

In 2002, the task of maintaining the book's tradition of almost half a century changed hands once again. Drs. Michael G. Newman and Henry H. Takei joined Dr. Carranza to take major responsibility for the ninth edition. Starting with the tenth (2006) edition, they were joined by Dr. Perry Klokkevold.

References

- 1. Albucasis. *La chirurgie*. Bailliére: Paris; 1861 [(Translated by L LeClere)].
- 2. Artzney Buchlein. *Leipzig*. 1530 [Michael Blum. (English translation in *Dent Cosmos* 29:1, 1887)].
- 3. Avicenna. *Liber Canonis*. [Venice] 1507 [(Reprinted, Hildesheim, 1964, Georg Olms.)].
- 4. Berdmore T. *A treatise on the disorders and deformities of the teeth and gums*. B White: London; 1786.
- 5. Black GV. *Special dental pathology*. Medico-Dental Publishers: Chicago; 1915.
- 6. Bränemark PI, Hansson BO, Adell R, et al. Osseointegrated implants in the treatment of the edentulous jaw: experience from a 10-year period. *Scand J Plast Reconstr Surg Suppl*. 1977;16:1.
- 7. Breasted JH. *The Edwin Smith surgical papyrus*. University of Chicago Press: Chicago; 1930.
- 8. Carranza FA. *Héroes de la medicina*. EUDEBA: Buenos Aires; 2008.
- 9. Carranza FA, Shklar G. *The history of periodontology*. Quintessence: Chicago; 2003.
- 10. Castiglione A. *History of medicine*. ed 2. Knopf: New York; 1941.
- 11. Chernin D, Shklar G. Levi Spear Parmly: father of dental hygiene and children's dentistry in America. *J Hist Dent*. 2003;51:15.
- 12. Dabry P. La medicine chez les Chinois. Plon: Paris; 1863.
- 13. Dobell C. Anton van Leeuwenhoek and his "little animals,".

Harcourt: New York; 1932 [(Reprinted, New York, 1960, Dover Publications)].

- 14. Ebbel B. *The papyrus Ebers*. Levin and Munksgaard: Copenhagen; 1937.
- 15. Editorial. JAMA. 1952;150:490.
- 16. Eustachius B. *A little treatise on the teeth*. 1999 [Science History Publishers/USA. (Edited and introduced by DA Chernin and G Shklar; translated by JH Thomas.)].
- 17. Fauchard P. *Le chirurgien dentiste, ou traite des dents*. J Maruiette: Paris; 1728 [(Reprinted in facsimile, Paris, Prélat, 1961; English translation by L Lindsay, London, 1946, Butterworth & Co.)].
- 18. Fischman SL. The history of oral hygiene: how far have we come in 6000 years. *Periodontol* 2000. 1997;15:7.
- 19. Fleischmann L, Gottlieb B. Beitrage zur histologie und pathogenese der alveolarpyorrhoe. *Z Stomatol*. 1920;2:44.
- 20. Gold SI. Robert Neumann: a pioneer in periodontal flap surgery. *J Periodontol*. 1982;53:456.
- 21. Gold SI. Periodontics: the past. Part I. Early sources. J Clin Periodontol. 1985;12:79.
- 22. Gold SI. Periodontics: the past. Part II. The development of modern periodontics. *J Clin Periodontol*. 1985;12:171.
- 23. Gold SI. Periodontics: the past. Part III. Microbiology. J Clin Periodontol. 1985;12:257.
- 24. Gottlieb B, Orban B. *Biology and pathology of the tooth and its supporting mechanism*. Macmillan: New York; 1938 [(Translated and edited by M Diamond.)].
- 25. Guerini V. *History of dentistry*. Lea & Febiger: Philadelphia; 1909.
- 26. Held A-J. *Periodontology—from its origins up to 1980: a survey*. Birkhauser: Boston; 1989.
- 27. Hippocrates. *Works*. Heinemann: London; 1923 [(Edited and translated by WHS Jones and ET Withington, 1931.)].
- 28. Hirschfeld I. *The toothbrush: its use and abuse*. Dental Items of Interest Publishers: New York; 1939.
- 29. Hoffman-Axthelm W. *History of dentistry*. Quintessence: Chicago; 1981.
- 30. Hunter J. The natural history of the human teeth. J Johnson:

London; 1771 [(Reprinted as Treatise in the natural history and diseases of the human teeth. In Bell T, editor: *Collected works*, London, 1835, Longman Rees.)].

- 31. Hunter W. Oral sepsis as a cause of disease. *Br Med J*. 1900;1:215.
- 32. Hunter W. An address on the role of sepsis and antisepsis in medicine. *Lancet*. 1911;1:79.
- 33. Jastrow N. The medicine of the Babylonians and Assyrians. *Proc Soc Med London*. 1914;7:109.
- 34. Karolyi M. Beobachtungen ber pyorrhea alveolaris. *Vjschr Zahnheilk*. 1901;17:279.
- 35. Koecker A. An essay on the devastation of the gums and the alveolar processes. *Philadelphia J Med Phys Sci.* 1821;2:282.
- 36. Major RHL. *A history of medicine*. Charles C Thomas: Springfield, IL; 1954.
- 37. Miller WD. The human mouth as a focus of infection. *Dent Cosmos*. 1891;33:689.
- 38. Neumann R. *Die alveolarpyorrhoe und ihre behandlung*. Meusser: Berlin; 1912.
- 39. Paracelsus. R Oldfenbourg: Munich; 1922. *Sämtliche Werke* (*Collected works in modern German*). vol 14 [(Edited by K Sudhoff.)].
- 40. Paré A. *Oeuvres completes*. Bailliére: Paris; 1840 [(Edited by JF Malgaigne.)].
- 41. Paul of Aegina. *The Seven Books*. Sydenham Society: London; 1844 [(Translated by F Adams)].
- 42. Plaut HC. Studien zur bakteriellen diagnostik der diphtherie und der anginen. *Dtsch Med Wochenschr*. 1894;20:920.
- 43. Riggs JW. Suppurative inflammation of the gums and absorption of the gums and alveolar process. *Pa J Dent Sci.* 1876;3:99 [(Reprinted in *Arch Clin Oral Pathol* 2:423, 1938.)].
- 44. Ruffer MA. *Studies in the paleopathology of Egypt*. University of Chicago Press: Chicago; 1921.
- 45. Shklar G. Stomatology and dentistry in the golden age of Arabian medicine. *Bull Hist Dent*. 1969;17:17.
- 46. Stern IB, Everett FG, Robicsek K. S. Robicsek: a pioneer in the surgical treatment of periodontal disease. *J Periodontol*. 1965;36:265.

- 47. Susruta samhita. KKL Bhishagratna: Calcutta; 1907.
- 48. Vesalius A. *De humanis corporis fabrica*. [Basle] 1542 [(Reproduced in facsimile, Brussels, 1966, Culture et Civilisation)].
- 49. Vincent HJ. Sur l'etiologie et sur les lesions anatomopathologiques de la pourriture d'hospital. *Ann de l'Inst Pasteur*. 1896;10:448.
- 50. Vincent HJ. Recherche sur l'etiologie de la stomatitis ulceromembraneuse primitive. *Arch Int Laryngol.* 1904;17:355.
- 51. Ward AW. Inharmonius cusp relation as a factor in periodontoclasia. *J Am Dent Assoc.* 1923;10:471.
- 52. Weinberger BW. *An introduction to the history of dentistry*. Mosby: St Louis; 1948.
- 53. Weski O. Roentgenographische-anatomische studien auf dem gebiete der kieferpathologie. *Vjrsch Zahnh.* 1921;37:1.
- 54. Widman L. Surgical treatment of pyorrhea alveolaris. *J Periodontol.* 1971;42:571.
- 55. Williams JL. A contribution to the study of pathology of enamel. *Dent Cosmos*. 1897;39:169.
- 56. Witzel A. The treatment of pyorrhea alveolaris or infectious alveolitis. *Br J Dent Sci.* 1882;25(209):153.
- 57. Younger WJ. Pyorrhea alveolaris. *Schweiz Vierteljähresscrift Zahnheilk*. 1905;15:87.
- 58. Znamensky NN. Alveolar pyorrhoea: its pathological anatomy and its radical treatment. *J Br Dent Assoc*. 1902;23:585.

[†]Deceased.

PART 1 Evidence-Based Practice

OUTLINE

Chapter 1 Evidence-Based Decision Making Chapter 2 Critical Thinking Assessing Evidence

CHAPTER 1

Evidence-Based Decision Making

Jane L. Forrest, Syrene A. Miller, Greg W. Miller, Satheesh Elangovan, Michael G. Newman

CHAPTER OUTLINE

Background and Definition Principles of Evidence-Based Decision Making Evidence-Based Decision-Making Process and Skills Conclusion

Each day, dental care professionals make decisions about clinical care. It is important that these decisions incorporate the best available scientific evidence to maximize the potential for successful patient care outcomes. It is also important for readers of this book to have the background and skills necessary to evaluate information they read and hear about. These evaluative skills are as important as learning facts and clinical procedures. *The ability to find, discriminate, evaluate, and use information is the most important skill that can be learned as a professional and lifelong learner*. Becoming

excellent at this skill will provide a rewarding and fulfilling professional career.

Background and Definition

Using evidence from the medical literature to answer questions, direct clinical action, and guide practice was pioneered at McMaster University, Ontario, Canada, in the 1980s. As clinical research and the publication of findings increased, so did the need to use the medical literature to guide practice. The traditional clinical problem-solving model based on individual experience or the use of information gained by consulting authorities (colleagues or textbooks) gave way to a new methodology for practice and restructured the way in which more effective clinical problem solving should be conducted. This new methodology was termed *evidence-based medicine* (EBM).¹²

Key Definitions

- **Evidence:** Evidence is considered the synthesis of all valid research that answers a specific question and that, in most cases, distinguishes it from a single research study.²
- **Evidence-based medicine:** The integration of the best research evidence with our clinical expertise and our patient's unique values and circumstances.³¹
- **Evidence-based dentistry:** An approach to oral health care that requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the patient's oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences.⁴

The use of evidence to help guide clinical decisions is not new. However, the following aspects of EBM are new:

• The methods of generating high-quality

evidence, such as randomized controlled trials (RCTs) and other well-designed methods

• The statistical tools for synthesizing and analyzing the evidence (systematic reviews [SRs] and meta-analysis [MA])

• The ways for accessing the evidence (electronic databases) and applying it (evidence-based decision making [EBDM] and practice guidelines)^{9,10}

These changes have evolved along with the understanding of what constitutes the evidence and how to minimize sources of bias, quantify the magnitude of benefits and risks, and incorporate patient values.¹³ "In other words, evidence-based practice is not just a new term for an old concept and as a result of advances, practitioners need (1) more efficient and effective online searching skills to find relevant evidence and (2) critical appraisal skills to rapidly evaluate and sort out what is valid and useful and what is not."²⁸

EBDM is the formalized process and structure for learning and using the skills for identifying, searching for, and interpreting the results of the best scientific evidence, which is considered in conjunction with the clinician's experience and judgment, the patient's preferences and values, and the clinical and patient circumstances when making patient care decisions. Translating the EBDM process into action is based on the abilities and skills identified in Box 1.1.³¹

Box 1.1

Skills and Abilities Needed to Apply an Evidence-Based Decision-Making Process³¹

1. Convert information needs and problems into clinical questions so that they can be answered.

- 2. Conduct a computerized search with maximum efficiency for finding the best external evidence with which to answer the question.
- 3. Critically appraise the evidence for its validity and usefulness (clinical applicability).
- 4. Apply the results of the appraisal, or evidence, in clinical practice.
- 5. Evaluate the process and your performance.

Principles of Evidence-Based Decision Making

The use of current best evidence does not replace clinical expertise or input from the patient, but rather provides another dimension to the decision-making process,^{11,16,19} which is also placed in context with the patient's clinical circumstances (Fig. 1.1). It is this decisionmaking process that we refer to as "evidence-based decision making" and is not unique to medicine or any specific health discipline; it represents a concise way of referring to the application of evidence to clinical decision making.



FIG. 1.1 Evidence-based decision making. (Copyright Jane L. Forrest, reprinted with permission.)

EBDM focuses on solving clinical problems and involves two fundamental principles, as follows¹³:

- 1. Evidence alone is never sufficient to make a clinical decision.
- 2. Hierarchies of quality and applicability of evidence exist to guide clinical decision making.

EBDM is a structured process that incorporates a formal set of rules for interpreting the results of clinical research and places a lower value on authority or custom. In contrast to EBDM, traditional decision making relies more on intuition, unsystematic clinical experience, and pathophysiologic rationale.¹³

Evidence-Based Dentistry

Since the 1990s, the evidence-based movement has continued to advance and is widely accepted among the health care professions, with some refining the definition to make it more specific to their area of health care. The American Dental Association (ADA) has defined evidence-based dentistry (EBD) as "an approach to oral health care that requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the patient's oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences."⁴ They also have established the ADA Center for Evidence-Based Dentistry (ebd.ada.org) to facilitate the integration of EBD into clinical practice.

The ADA's definition is now incorporated in the Accreditation Standards for Dental Education Programs.³ Dental schools are expected to develop specific core competencies that focus on the need for graduates to become critical thinkers, problem solvers, and consumers of current research findings to enable them to become lifelong learners. The accreditation standards require learning EBDM skills so that graduates are competent in being able to find, evaluate, and incorporate current evidence into their decision making.³

Key Fact

PICO

The first step in evidence-based decision making is asking the right question. The key is to frame a question that is simple and at the same time highly specific to the clinical scenario. Dissecting the question you want to ask into its components—problem or population (P), intervention (I), comparison group (C) and outcomes (O)—and then combining them will facilitate a thorough and precise evidence search.³¹

Evidence-Based Decision-Making Process and Skills

The growth of evidence-based practice has been made possible through the development of online scientific databases such as MEDLINE (PubMed) and Internet-based software, along with the use of computers and mobile devices, for example, smart phones, that enable users to quickly access relevant clinical evidence from almost anywhere. This combination of *technology* and *good evidence* allows health care professionals to apply the benefits from clinical research to patient care.²⁹ EBDM recognizes that clinicians can never be completely current with all conditions, medications, materials, or available products, and it provides a mechanism for assimilating current research findings into everyday practice to answer questions and to stay current with innovations in dentistry. Translating the EBDM process into action is based on the abilities and skills identified in Box 1.1.³¹ This is illustrated clearly in a real patient case scenario (management of a patient with trauma-related avulsion and luxation of teeth) that is introduced in Case Scenario 1.1 (Figs. 1.2 and 1.3) and used throughout the chapter.

Case Scenario 1.1

Clinical Application of Evidence-Based Decision Making The clinician received a call from the parents of a 13-year-old female patient who had been struck in the face with a softball. She was being examined by paramedics in a town 30 minutes north of the dental office. The paramedics cleared the patient of any head or neck injury and other medical issues and informed the dentist that dental trauma was her primary injury. The dentist and his assistant met the parents and the patient at the office 45 minutes following the dental trauma. The patient's teeth remained in her mouth following the incident. Fig. 1.2A shows the initial examination of the patient. The preference of the patient and her parents was to "do anything to keep the teeth." After the site was cleaned and irrigated, it was apparent that there was complete avulsion of the maxillary right central incisor from the socket and lateral luxation of the maxillary left central and lateral incisors. In addition, there was alveolar bone fracture partially encasing the roots of the maxillary left central and lateral incisors (Fig. 1.2B.) The clinician replanted the teeth and reapproximated the gingival tissue with sutures (Fig. 1.2C). A stable and accurate ribbond and flowable composite splint were placed (Fig. 1.2D), and a radiograph was taken (Fig. 1.2E).

Radiographic Examination

The radiograph shows reimplantation of maxillary central incisors and left lateral incisor in correct socket location and confirmed proper reapproximation of the alveolar bone that was fractured with maxillary left central and lateral incisors. The stent also is apparent in this radiograph showing the splinting of the displaced teeth.

Due to the difficulty of splint placement and not wanting to risk displacing the teeth or breaking the splint prematurely, the clinician was hesitant to proceed with endodontic treatment until he had access to dependable information. The dentist had two questions regarding the treatment of the patient. He needed to determine the optimal timing of the pulp extirpation and splinting that would result in the best outcome and prognosis for healing. Fig. 1.3 diagrams the decision-making pathway from telephone call to resolution.²⁴



References	4637
Part 5 Atlas of Periodontal Diseases	4645
Chapter 88 Atlas of Periodontal Diseases	4646
Plaque-Induced Gingival Diseases	4651
Causes of Periodontal Diseases	4657
Gingival Diseases Modified by Systemic Fac	etors 4670
Gingival Diseases Associated With Blood D	yscrasias 4673
Drug-Induced Gingival Diseases	4678
Non–Plaque-Induced Gingival Lesions	4681
Gingival Lesions of Genetic Origin	4685
Gingival Manifestations of Systemic Conditi	ons 4688
Traumatic Lesions: Factitious, Iatrogenic, an	d Accidental 4700
Cysts and Tumors	4710
Chronic Periodontitis	4715
Aggressive Periodontitis	4724
Periodontitis as a Manifestation of Systemic	Diseases 4731
Genetic Disorders	4734
Necrotizing Periodontal Diseases	4742
Abscesses of Periodontium	4747
Index	4751