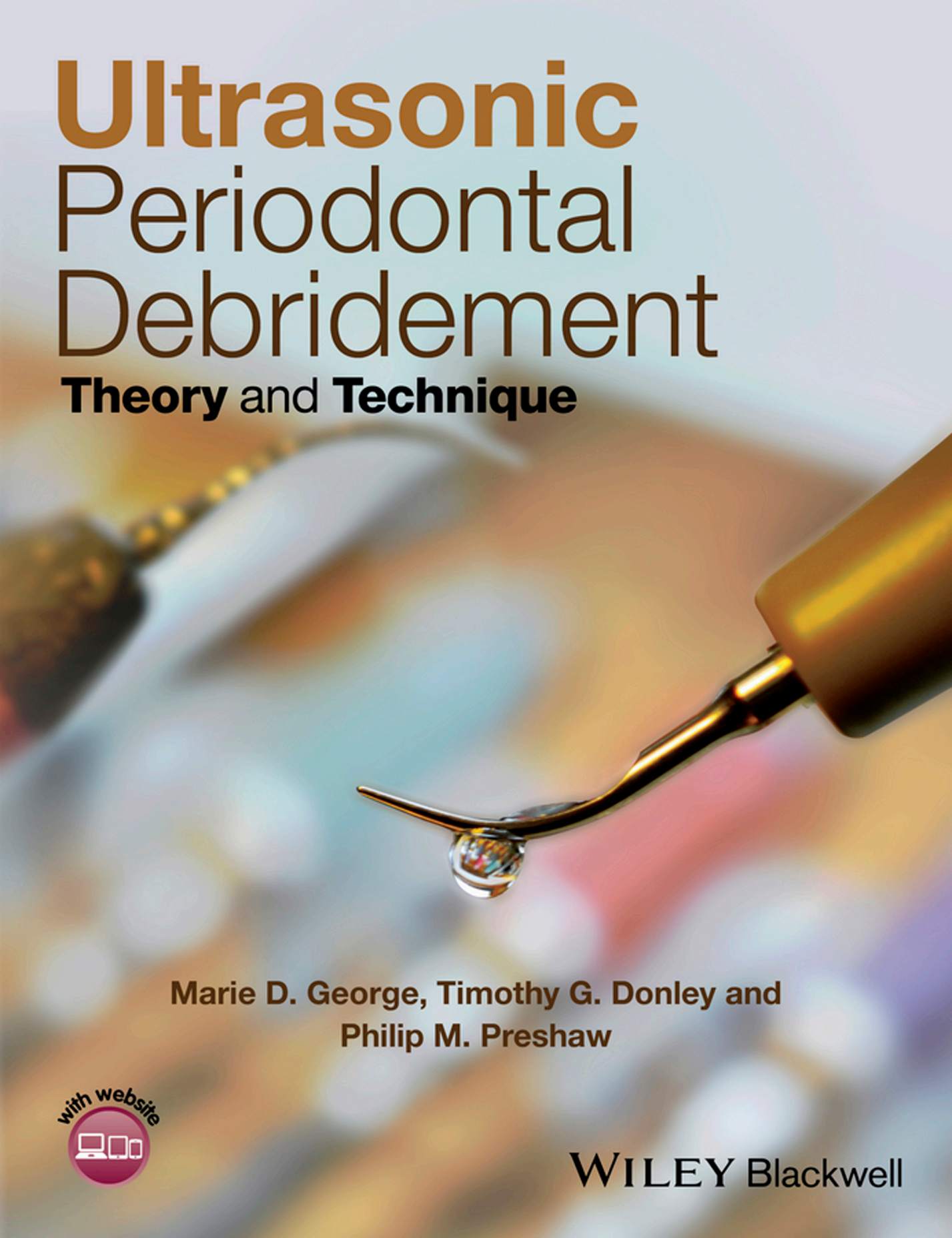
Ultrasonic Periodontal Debridement

Theory and Technique



Marie D. George, Timothy G. Donley and Philip M. Preshaw

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Marie D. George
Adjunct Faculty
University of Pittsburgh School of Dental Medicine, Pittsburgh, PA
Community College of Philadelphia, USA

Timothy G. Donley
Private Practice, Periodontics & Implantology, Bowling Green, KY
Adjunct Professor, Dental Hygiene, Western Kentucky University, USA

Philip M. Preshaw
Professor of Periodontology
School of Dental Sciences and Institute of Cellular Medicine
Newcastle University, UK

WILEY Blackwell

Editorial offices
1606 Golden Aspen Drive, Suites 103 and 104, Ames, Iowa 50010, USA
The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK
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About the Authors

Marie D. George, RDH, MS

Marie D. George is a clinician, author, and educator, with current appointments as an Adjunct Instructor in the Department of Dental Hygiene at both the University of Pittsburgh School of Dental Medicine and the Community College of Philadelphia. Her past appointments at the University of Pittsburgh include Assistant Professor of Dental Hygiene and Clinical Research Coordinator in the Department of Periodontics. She received a Bachelor of Science Degree in Dental Hygiene from West Liberty State College (now West Liberty University) and a Master of Science Degree in Dental Hygiene from West Virginia University, where she was a two-time recipient of the Procter and Gamble/ADHA Institute for Oral Health Fellowship. She has developed and presented evidence-based educational programs specific to ultrasonic instrumentation to dental hygiene students, pre- and post-doctoral dental students and faculty, and practicing clinicians, nationally and internationally.

Timothy G. Donley, DDS, MSD

Timothy G. Donley is currently in the private practice of Periodontics and Implantology in Bowling Green, KY and is an Adjunct Professor in the College of Health and Human Services at Western Kentucky University. After graduating from the University of Notre Dame, Georgetown University School of Dentistry, and completing a general practice residency, he practiced general dentistry. He then returned to Indiana University where he received a Master of Science Degree in Periodontics. He has published numerous articles in peer-reviewed journals. He lectures throughout the world on topics of interest to clinical hygienists and dentists.

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

Philip M. Preshaw is Professor of Periodontology at Newcastle University, United Kingdom. He received his Dental Degree from the University of Newcastle in 1991 and his PhD in 1997. He is a registered specialist in Periodontics and is a Fellow of the Royal College of Surgeons of Edinburgh. His main research interests are investigations of the pathogenesis of periodontal disease, and links between diabetes and periodontal disease. Professor Preshaw lectures frequently, and has numerous publications in peer-reviewed scientific journals. He has been awarded a UK National Institute of Health Research (NIHR) National Clinician Scientist Fellowship, a Distinguished Scientist Award from the International Association for Dental Research, and a King James IV Professorship from the Royal College of Surgeons of Edinburgh.

Foreword

In periodontics, a notable paradigm shift occurred in the late 1980s when scientific evidence began to clearly indicate that the host response to the microbial challenge, and not the oral microbes and their end-products themselves, was responsible for periodontal destruction. This opened a new era in our profession – one in which understanding and controlling the host response became of paramount importance. We are now in the midst of another shift – one that directly affects the non-surgical approach to periodontal treatment by focusing on biofilm disruption and conservation of tooth structure rather than calculus and cementum removal. How fitting that this book, *Ultrasonic Periodontal Debridement: Theory and Technique*, has been written to address the rationale and techniques for implementing this new paradigm into practice. Organized and written in a practical way, the content will resonate with all clinicians engaged in helping patients control their periodontal disease. Written by Marie George, RDH, MS; Timothy Donley, DDS, MSD; and Philip Preshaw, BDS, FDS, RCSEd, PhD, this book provides evidence-based data from clinical studies which support the fundamental instrumentation principles and techniques that are described. The authors bring their combined years of experience in dental hygiene education, periodontal practice, and periodontal academia to provide the reader with a sound guide to the use of ultrasonics as the primary treatment modality in periodontal debridement. As a trained dental hygienist and periodontist engaged in academic dentistry, I found this book to be the most thorough resource on ultrasonic debridement I have read.

The book is organized into three sections. Section I focuses on foundational knowledge. In this section, the authors provide a historical and literature-based perspective on the evolving paradigm of the etiology and pathogenesis of periodontal disease. They further describe how the evolution of our understanding of the disease process should now lead to an evolution in how we treat our patients. To support this concept, the authors provide a thorough review of the evidence on the effectiveness of ultrasonic versus hand instruments in removing the plaque biofilm and calculus, and the efficacy of these two instrumentation techniques in resolving the clinical manifestations of disease. Overall, this section provides the scientific evidence and rationale for the current paradigm shift away from scaling and root planing (SRP) with hand instruments to biofilm disruption and deposit removal using ultrasonic debridement.

Section II focuses on sonic and ultrasonic scaling technology and techniques. It includes the principles of ultrasonic transduction, oscillation, and mechanisms of action (mechanical, irrigation, cavitation, and acoustic microstreaming). The authors move on to provide a review of operational variables critical to ultrasonic debridement that includes operating frequency, power setting, and water flow rate. Evidence of the impact of each of these variables on the disruption of the plaque biofilm, removal of calculus, and damage to the root surface is provided. A comprehensive discussion of ultrasonic tip

design and selection, along with a description of the clinical consequences of improper selection, complete this section. Excellent tables and figures are provided that augment the technical descriptions in the text.

Section III provides the practical clinical application of the information from the first two sections. A review of patient assessment and the role of clinical parameters in determining the diagnosis and treatment needs are included. Also included is a review of the relationship among pocket anatomy, deposit type, and tooth anatomy, and instrument selection. This section closes with detailed information on the fundamental principles and techniques of ultrasonic instrumentation. It is an excellent resource for the practitioner wanting in-depth understanding of the principles and techniques for ultrasonic instrumentation and the ideal strategies for instrument sequencing. It contains a wealth of clinical "how to" images depicting exactly what should be done by tooth and by area of the mouth, supplemented with details on tip selection and instrumentation techniques for advanced furcation defects and implants.

Finally, three case studies are included to provide further details on how to approach the decision-making process and, ultimately, the rationale for selecting ultrasonic debridement as the treatment of choice for non-surgical periodontal therapy. The case studies comprise a patient description, clinical photographs, and clinical charting and radiographs as well as excellent descriptions and clinical images depicting instrument selection and placement. The level of detail in the descriptors and images in this section and throughout this book sets it apart from others that cover periodontal instrumentation techniques.

Throughout this book, authors George, Donley, and Preshaw provide a framework for making evidence-based, non-surgical therapeutic decisions when treating patients with periodontal disease. As stated in the book "It is clear that over the last few decades, our understanding of periodontal pathogenesis and microbiology has advanced significantly, and it is important to now interpret this information in the context of the clinical situation to help us decide upon the best treatment strategies for our patients." I sincerely believe that all who read this book will find it to be their "go to" evidence-based resource on the theory, rationale, and technique for the effective use of ultrasonic debridement in providing periodontal therapy to their patients.

Karen F. Novak, D.D.S., M.S., Ph.D.
Professor, Department of Periodontics
& Dental Hygiene
Associate Dean for Professional Development
& Faculty Affairs
University of Texas Health Science Center at
Houston School of Dentistry

Preface

The purpose of this book is to provide the reader with clear, evidence-based guidance in the practicalities of periodontal ultrasonic instrumentation. The material is organized as a guide that the clinician can follow, and commences with the theory of ultrasonic debridement therapy, followed by detailed, precise instruction in ultrasonic instrumentation technique, and concludes with a series of case studies of real-life clinical scenarios.

Why is such a book needed? After all, there are many excellent textbooks on periodontology currently available. However, a surprising finding is that little attention is paid to the principles of ultrasonic therapy in most periodontology textbooks, certainly much less than is devoted to the intricacies of manual instrumentation or periodontal surgical techniques. Yet, the ultrasonic scaler is one of the instruments most frequently used by dental clinicians worldwide.

This book is aimed at all clinicians who treat patients with periodontal diseases, students (both dental students and dental hygienist students), dental residents, general dentists, dental hygienists, and periodontists. It is intended to be a resource that all dental clinicians can utilize to improve their understanding of why ultrasonic debridement therapy is the core treatment strategy for managing periodontitis, and the practicalities of how to do it.

The publication of this book is very timely as today's dental professionals find themselves in the midst of a paradigm shift in terms of the best way to provide periodontal treatment. In previous decades, periodontal treatment had focused on calculus and cementum removal as the primary end-points of periodontal therapy; this was the scaling and root planing (SRP) era. However, modern understanding of the processes and therapeutic strategies in the treatment of periodontal disease has shifted the approach that is used in non-surgical periodontal therapy away from SRP to a treatment modality that is focused on biofilm disruption and conservation of tooth structure; this is the concept of periodontal debridement therapy, and is the topic of this book.

Accordingly, the approach to clinical instrumentation is also changing, and the standard of care is shifting from a manual instrumentation approach (which met the objectives of SRP therapy) to ultrasonic instrumentation, which meets the objectives of periodontal debridement therapy.

Many clinicians, however, still remain unsure about how exactly they should perform ultrasonic debridement, and often mistakenly apply the principles of manual instrumentation to ultrasonic instruments. The instruction and development of manual instrumentation skills continue to predominate in dental and dental hygiene educational programs. Many clinical curricula for students of dental and dental hygiene include an unwarranted prerequisite for demonstrated competency in hand instrumentation before exposure to ultrasonic instrumentation, which perpetuates the inappropriate application of manual instrumentation techniques to ultrasonic instruments. Yet, ultrasonic instruments are completely different from manual instruments, and should be used in a completely different way.

Historically, there has been a lack of comprehensive instructional resources specific to ultrasonic instrumentation. The objective of this textbook is to meet this need by providing the faculty and students with a core text to facilitate the practical instruction of ultrasonic instrumentation theory and technique, and align curricula to the current, evidence-based treatment concept of periodontal debridement. The book is also very relevant for dental clinicians at all stages of their career and training who wish to improve their knowledge of ultrasonic debridement techniques.

Marie D. George
Timothy G. Donley
Philip M. Preshaw

Acknowledgments

The content of this book is founded on the work of scientists, researchers, engineers, and clinicians, including those cited within and others less recognized, whose expertise and accomplishments are responsible for the advancements made in periodontal science and ultrasonic technology. We value your contributions and hope this book does your work justice.

We acknowledge the creativity and skill of our photographers and illustrators: Daniel Bair, DMD, University of Pittsburgh School of Dental Medicine, Department of Periodontics – clinical photography; Robert Benton, RDB Imaging, LLC, Dover, PA – typodont and equipment photography; Thomas Robbins, graphic illustrator, York, PA; and Tyler Webster, graphic artist, Bowling Green, KY.

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Marie D. George
Timothy G. Donley
Philip M. Preshaw

About the Companion Website

This book is accompanied by a companion website:

www.wiley.com/go/george/ultrasonic

The website includes:

- Powerpoints of all figures from the book for downloading
- PDFs of tables from the book

SECTION I

FOUNDATIONAL CONCEPTS

Chapter 1

The treatment of periodontal disease: the shift from "SRP" to "Periodontal Debridement"

CHAPTER OBJECTIVES

1. To provide a historical perspective regarding the development of instrumentation concepts in periodontal therapy.
2. To consider the historical focus on endotoxin, and how this led to the preeminence of root planing as a treatment strategy to remove calculus and cementum.
3. To consider the role of the plaque biofilm in driving periodontal inflammation, and the importance of the inflammatory host response in periodontal tissue breakdown.
4. To explain the current understanding of periodontal pathogenesis and periodontal microbiology, and how this has informed the development of modern periodontal treatment strategies.
5. To review the evidence that supports the paradigm shift away from root planing (a damaging form of periodontal therapy) to periodontal debridement therapy (root surface debridement), which achieves the aims of biofilm disruption and removal while at the same time preserving cementum.

Periodontal disease is not new. Archeological investigations have revealed evidence of alveolar bone loss affecting human remains dating from around 700,000 years ago (Dentino et al., 2013). Descriptions of conditions that we would now refer to as periodontitis can be found in a number of ancient textbooks, papyruses, and manuscripts, such as *al-Tasrif*, the medical encyclopedia written by Albucasis (936–1013) in Moorish Spain. This document was translated into Latin during the twelfth century, and was one of the primary medical texts used in European universities until the seventeenth century (Shklar and Carranza, 2012). In addition to describing the clinical features of periodontitis, some of these early authors also described treatment strategies for the condition. For example, Albucasis focused on the role of calculus in the disease process, and his works included depictions of a variety of instruments for the removal of calculus that bear a striking similarity to many of the periodontal instruments still being used today (Figure 1.1).

Over the centuries, and more specifically, over recent decades, our understanding of periodontal diseases has evolved exponentially, and as a result, so have the treatment strategies that we employ to manage the condition. Therefore, we no longer treat periodontitis by washing the mouth with wine and water, as advocated by

Ultrasonic Periodontal Debridement: Theory and Technique, First Edition. Marie D. George, Timothy G. Donley and Philip M. Preshaw.

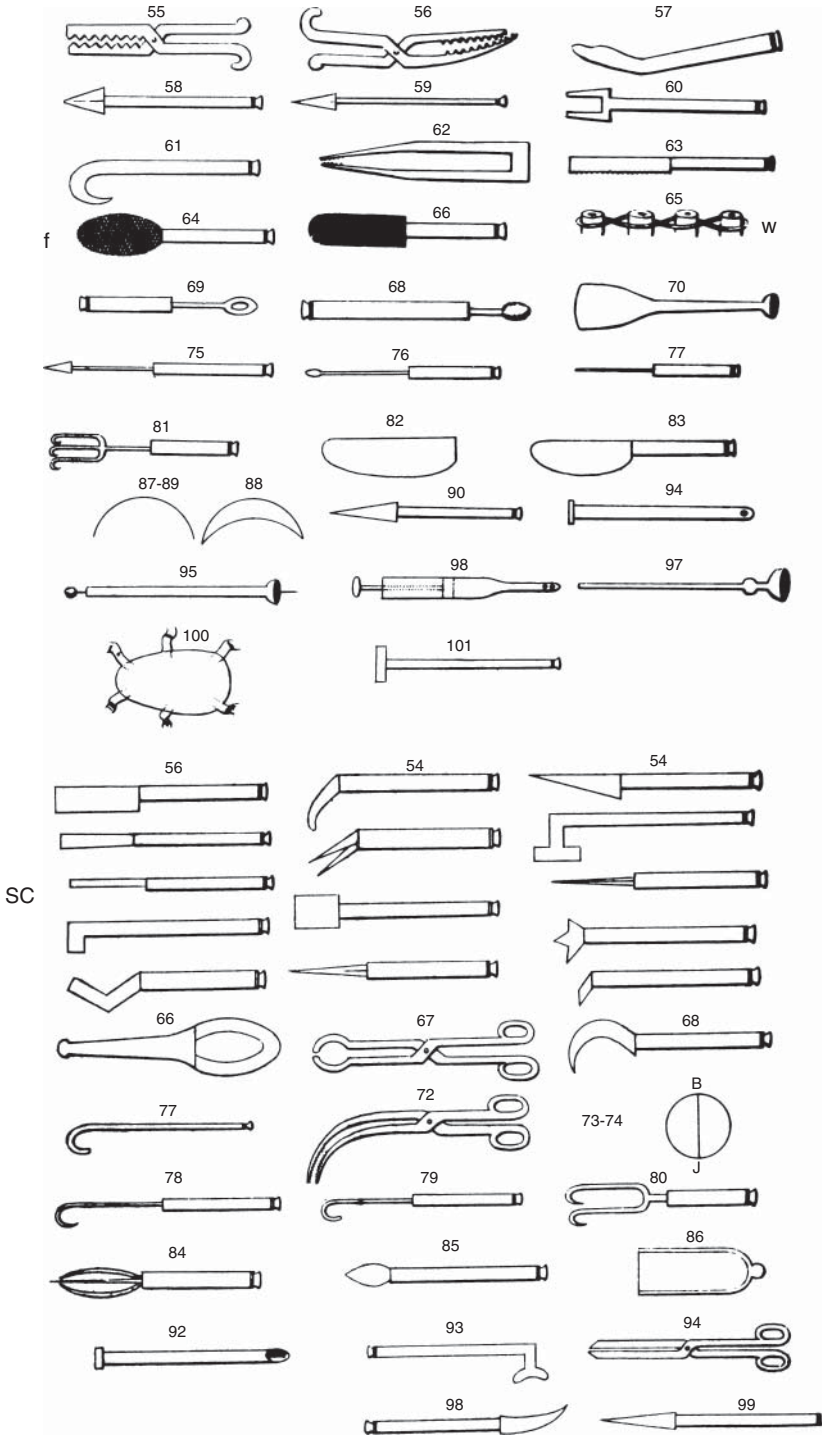

Figure 1.1 Illustration of Albucasis' periodontal instruments. Note the instruments recognizable as (SC) scalers (left side, halfway down), as well as (f) files (top left, 4th instrument down), blades and scissors, and (w) wiring for mobile teeth (top right, 4th illustration down). (*Source*: Carranza, 2012. Reproduced with permission of Elsevier)

Fauchard (1678–1761), the "father of modern dentistry," in his 1728 dentistry textbook *Le Chirurgien Dentiste*. To help us decide which treatment methods are the most appropriate for modern day clinicians to utilize, it is important to briefly review the scientific advances that have been made in periodontology, as these have greatly influenced the treatment protocols that have been used in clinical practice over recent years.

EARLY CONCEPTS OF THE PATHOGENESIS OF PERIODONTAL DISEASE

Calculus the irritant

If we spend a moment to imagine the likely oral health status of many of the people living in the Middle Ages, in the time of Albucasis, for example, we would probably conjure up images of abundant calculus deposits, inflamed gingival tissues, gingival bleeding, and halitosis. It is understandable that these early dentists focused on the role of calculus "accretions" as the cause of the problem, and developed methods for trying to remove the deposits. The etiological role of calculus in the pathogenesis of periodontal disease was unquestioned for many centuries. In the United States of America, Riggs (1810–1885) regarded calculus as the cause of periodontal disease, and treated the condition by the meticulous removal of calculus from pockets, "curettage" of the soft tissues, and oral hygiene instruction (Dentino et al., 2013). For many years, periodontal disease was referred to as "Riggs' Disease"; such was the influence of this pioneering clinician.

The emergence of microbiology as a discipline, coupled with improvements in microscopy, led to studies of the bacterial composition of dental plaque. The term "pyorrhea alveolaris" was introduced in the late nineteenth century to denote conditions in which gingival pockets developed, which permitted bacteria to "infect and destroy" the periodontal tissues and the alveolar bone. During this era, the importance of local factors in the etiology of periodontal disease was unquestioned, and calculus was viewed as being directly responsible for the tissue damage that was observed in patients with periodontitis. This concept led directly to the emergence of treatment strategies that focused exclusively on calculus removal as the endpoint of periodontal therapy.

The role of plaque

The etiological role of plaque in the development of gingival inflammation was confirmed in experimental studies on gingivitis conducted in the 1960s: upon cessation of oral hygiene practices over periods of 3–4 weeks, plaque accumulation resulted in gingivitis, which was reversed following plaque removal and resumption of normal oral hygiene (Loe and Silness, 1963; Loe et al., 1965). These studies were revolutionary in that they moved the focus of attention away from calculus and more toward plaque as the predominant etiological factor of periodontal diseases.

But how did plaque "cause" periodontal disease? The *nonspecific plaque hypothesis* made the assumption that periodontal disease (as well as caries) resulted from the production and release of harmful substances from the entire plaque mass. Inherent to this theory were the suppositions (i) that there must be a threshold for these substances (above which periodontal disease will develop, and below which it will not), and (ii) that the amount of plaque present is the main determinant of risk for disease. In other words, this theory suggests that the more plaque a patient has, the more periodontal disease he/she will have. But any clinician knows that this does not hold true; some patients have very poor oral hygiene and lots of plaque, but do not develop advanced periodontitis, and conversely, some patients with good oral hygiene and minimal plaque levels can develop advanced disease.

Further microbiological investigations led to the emergence of the *specific plaque hypothesis* (Loesche, 1976). This theory held that only certain types of plaque cause disease, because they contain specific bacteria that are particularly pathogenic; for example, they release irritants such as endotoxin, H_2S, lactic acid, and bacterial collagenase, which cause injury to the periodontal tissues. It is noteworthy that both the nonspecific and the specific plaque hypotheses considered periodontal tissue breakdown to result from a direct effect of harmful substances released from the plaque bacteria.

Endotoxin

The term "*endotoxin*" was originally introduced to denote toxic substances within bacterial cells that were released upon death of the bacteria. Today, the term is used synonymously with the term "*lipopolysaccharide*" (LPS), which is a component of the outer cell wall of gram-negative bacteria. LPS consists of a polysaccharide chain linked covalently to a lipid moiety, and it is essential for maintaining the structural integrity of the bacterial cell wall. LPS induces strong immune and inflammatory responses in higher order species such as humans and other animals, which is why it is so important in the pathogenesis of a number of diseases, including periodontal disease. LPS invokes strong immune–inflammatory responses precisely because it is present in gram-negative bacteria; higher order species have evolved to be able to detect and respond to LPS because it signals the presence of such bacteria.

Research in the 1960s and 1970s identified that endotoxin was present in the outer surfaces of cementum in teeth affected by periodontitis (Daly et al., 1980). It was hypothesized that this endotoxin would limit the effectiveness of periodontal therapy, because even if plaque and calculus were removed from the root surface, the endotoxin still present in the cementum would continue to irritate the tissues and thus compromise healing following treatment. This presumption led to the preeminence of the treatment concept known as "root planing," often combined as a treatment strategy with scaling, and abbreviated as "SRP" ("*scaling and root planing*").

SCALING AND ROOT PLANING (SRP)

SRP became established as a periodontal treatment concept because of the prevailing belief that calculus, endotoxin, and necrotic cementum needed to be removed from the root surface. Necrotic cementum was considered to be that part of the cementum (the outer layer) that was impregnated with endotoxin from the overlying plaque mass. *Root planing* was therefore employed to vigorously remove this outer layer of cementum by heavy-duty planing of the root surface (think about planing a door to make it fit the door frame better).

What were the objectives of SRP?

We firstly need to decide what is meant by SRP, which actually refers to two separate treatment techniques, "scaling" and "root planing." Root planing was described as a treatment procedure in the early parts of the twentieth century (Hartzell, 1913; Stillman, 1917) and since then, there have been many different definitions of scaling and root planing in the periodontal literature over the decades. In the 1953 edition of Glickman's *Clinical Periodontology* textbook, the use of scalers is described to remove calculus deposits and to "smooth the tooth surface" by the removal of "softened, necrotic cementum" (Glickman, 1953). Root planing is not mentioned at all, but another treatment strategy, "curettage," is. Curettage was described as the "management of the inner surface of the soft tissue