



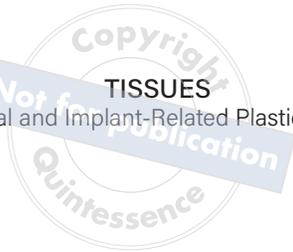
# TISSUES

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Critical Issues in Periodontal and Implant-Related  
Plastic and Reconstructive Surgery

LEANDRO CHAMBRONE, DDS, MSc, PhD | GUSTAVO AVILA ORTIZ, DDS, MS, PhD

with special contributions by SALVADOR GARCIA VALENZUELA, DDS



**TISSUES**

Critical Issues in Periodontal and Implant-Related Plastic and Reconstructive Surgery



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# TISSUES

## Critical Issues in Periodontal and Implant-Related Plastic and Reconstructive Surgery

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*To Giulia & Rafael*  
Leandro

*To Irene, María & Sofía*  
Gustavo

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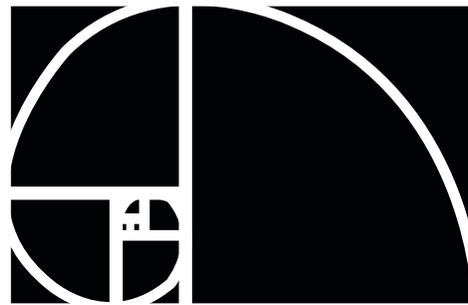
*Clint Stevens*



"Black then white are all I see in my infancy  
Red and yellow then came to be  
Reaching out to me  
Lets me see

As below, so above and beyond, I imagine  
Drawn beyond the lines of reason  
Push the envelope  
Watch it bend"

TOOL - Lateralus





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# THE AUTHORS



## **Leandro Chambrone**

Dr Leandro Chambrone received a DDS and a Certificate in Orthodontics and Dentofacial Orthopedics from Methodist University of São Paulo in Brazil. Subsequently, he earned a masters degree and PhD degree in periodontics from the University of São Paulo. He serves as a faculty member in several prestigious institutions in North America, South America, and Europe. He holds positions of Associate Professor at Egas Moniz University (Portugal), Ad honorem Associate Professor at El Bosque University (Colombia), Visiting Professor at the University of Iowa, and Adjunct Associate Professor at Penn School of Dental Medicine. Beyond his enthusiasm and dedication as an educator and health care provider, Dr Chambrone is also heavily involved in clinical research and evidence-based dentistry. He has authored over 150 papers, including some commissioned consensus reviews for the American Academy of Periodontology and the European Federation of Periodontology. Dr Chambrone currently serves as Section Editor of Clinical Research for *The International Journal of Oral Implantology* and Section Editor of Periodontics for the *Journal of Esthetic and Restorative Dentistry*.



## **Gustavo Avila Ortiz**

Dr Gustavo Avila Ortiz obtained a DDS degree and completed his PhD at the University of Granada (Spain) before moving to Ann Arbor, Michigan, where he completed an MS degree and a Certificate in Periodontics at the University of Michigan. He has over 10 years of experience as an educator and has worked to advance the profession as a member of numerous institutional committees and scientific organizations; he is also a Diplomate of the American Board of Periodontology. He was a faculty member at the University of Michigan School of Dentistry and at the University of Iowa College of Dentistry, where he was the Phillip A. Lainson Professor and Chair of the Department of Periodontics. Dr Avila Ortiz serves as Associate Editor for the *Journal of Periodontology* and Co-Editor for *Clinical Advances in Periodontics*, the official journals of the American Academy of Periodontology. He has authored more than 100 articles published in peer-reviewed journals as well as several book chapters. Aside from being regularly engaged in scholarly, administrative, and continuing education activities in different academic institutions, Dr Avila Ortiz maintains a private practice limited to periodontics and implant dentistry at Atelier Dental in Madrid, Spain.





### **Salvador Garcia Valenzuela**

Dr Salvador Garcia Valenzuela earned his DDS degree and a Certificate in Oral Implantology from Universidad de la Salle Bajío in Mexico. Subsequently, he received postdoctoral training in periodontics and implant dentistry at Universidad Quetzalcóatl in Mexico. He devotes most of his time to clinical practice with an emphasis on oral rehabilitation, periodontics, implant dentistry, and oral medicine. Dr Garcia Valenzuela is a founder and the current academic director of Perioteam Training Center. Additionally, he currently holds a visiting faculty position in the Postgraduate Program in Periodontics at the Universidad Autonoma de Ciudad Juarez in Mexico. Dr Garcia Valenzuela is particularly interested in the management of periodontal and peri-implant soft tissues and has collaborated as an author on articles and book chapters published in the area of periodontal and implant-related surgery.

# FOREWORDS

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More than 30 years have passed since the term *periodontal plastic surgery* was first introduced and defined. Throughout these years, a myriad of novel procedures and scientific breakthroughs addressing the treatment of deformities of the gingiva, mucosa, and underlying bone have come and gone. Some have been validated by long-term scientific evidence, while others are still undergoing constant evolution. With the achievement of predictable tooth-replacement therapies leveraging dental implants, there is an ever-increasing need for predictable treatment of the peri-implant tissues.

Profiting from their vast experience in research, in clinical practice, and, of course, as academic educators, Drs Leandro Chambrone and Gustavo Avila Ortiz have assembled a comprehensive and up-to-date guide for modern periodontics and implant-related procedures. Embodying the spirit of translational medicine, these authors have managed to transfer findings derived from scientific evidence into practice settings with the goal of improving treatment outcomes and, most importantly, overall patient satisfaction.

This book begins with an overview of biologic principles as well as critical concepts for identifying and diagnosing deformities affecting the periodontal and peri-implant tissues. In the subsequent chapters, Drs Chambrone and Avila Ortiz address the armamentarium employed for surgical procedures and give concise, to-the-point descriptions of the principles behind the performance of diverse surgical techniques. Furthermore, a detailed compilation of the materials used for grafting or improving soft and hard tissues is also gracefully presented. Closing this volume, Drs Chambrone and Avila Ortiz have exemplified the practice of evidence-based dentistry by presenting many surgical cases that encompass the clinical applications of the concepts previously described.

I believe that this book will aid both novice and experienced clinicians by bringing them up to speed on the current status of periodontal and implant-related plastic and reconstructive surgery and hopefully help them navigate the sea of knowledge that has been produced in our field.

**Giovanni Zucchelli, DDS, PhD**  
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In regenerative dentistry, the reconstruction of soft and hard tissues surrounding teeth and implants has remained a significant challenge for decades. The regeneration of alveolar bone, periodontal ligament, and supporting structures around teeth or the rebuilding of the alveolar ridge to allow for strategic implant placement requires a methodical approach. Authored by leaders in evidence-based dentistry and clinical sciences, Drs Leandro Chambrone and Gustavo Avila Ortiz, *TISSUES* exquisitely blends art and science in regenerative therapy, evoking a unique ethos fusing the two. The vision for each clinical approach is supported by the rationale for the selection of the proper armamentarium and biomaterial based on scientific evidence. As Isaac Asimov eloquently stated, "There is an art to science and a science in art; the two are not enemies, but different aspects of the whole." The elegant harnessing of the compilation of the tissues, the tools, the grafts, the flaps, and the surgeries is a distinctive approach for reconstructive periodontal and peri-implant procedures blending science and art.

Chapter 1 on the "tissues" underscores and beautifully describes the importance of the organs and tissues of the oral cavity, with an emphasis on the supporting apparatus of teeth and dental implants. This basis sets the stage for understanding the biology of the structures required for promoting an orchestrated wound repair of oral defects. The next chapter on the "tools" highlights the rapidly evolving armamentaria that are crucial for the proper management of soft and hard tissues for regenerative

therapeutic reconstruction. Chapter 3 on the "flaps" showcases innovations that have been advanced over the years toward enhanced minimally invasive techniques leading to better wound healing outcomes with reduced patient morbidity. Chapter 4 on the "grafts" describes a wide array of natural and synthetic bone and soft tissue replacements including autografts, allografts, xenografts, and alloplasts. The usage of these biomaterials provides flexibility to the clinician for graft options based on global availability of new technologies in clinical practices. The final chapter on the "surgeries" merges the key concepts from the preceding parts to design and deliver to the patient evidence-based therapies coalescing clinical expertise, scientific evidence, and patient preferences.

I am confident that you will enjoy this text designed for trainees and specialists in periodontics, oral surgery, and implant dentistry. Drs Chambrone and Avila Ortiz furnish the reader an erudite perspective blending cutting-edge technical approaches with advanced scientific principles. This book serves to extend our knowledge to apply leading plastic reconstructive therapies to optimize periodontal, oral, and peri-implant clinical care.

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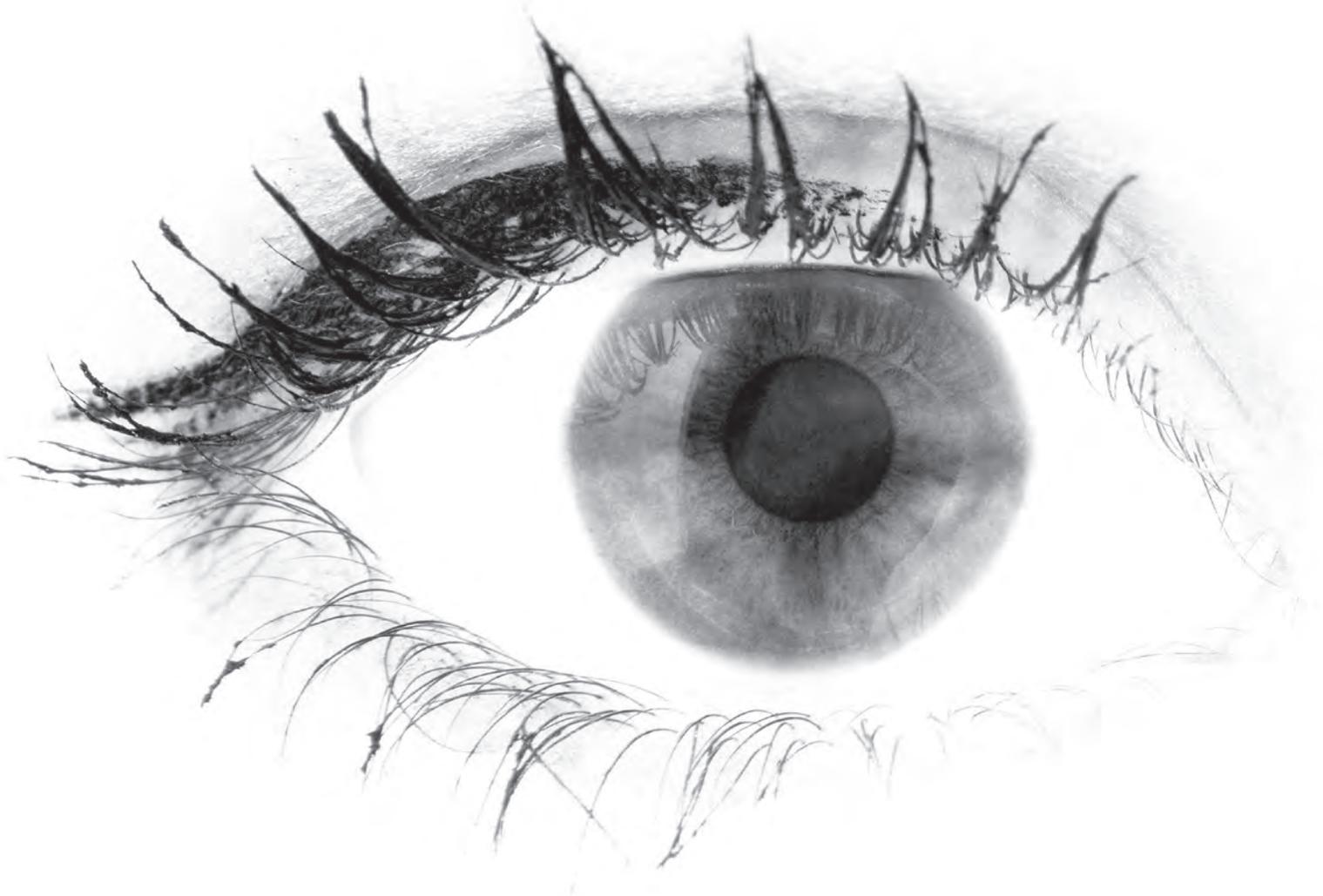


# Warning to Seafarers

Various instruments, graft materials, biologics, and implant systems are displayed in the iconography enclosed in this book. Brand names may be identifiable or easily inferred by experienced readers. Although each of the authors has personal preferences, we do not endorse any of the commercial products shown. It is undeniable that satisfactory therapeutic short- and long-term outcomes may be obtained with select products from different manufacturers as long as the fundamental principles of diagnosis, case selection, treatment planning, surgical execution, postoperative care, and maintenance are understood and applied accordingly.

*Enjoy the trip!*





"No wrong, no right  
I'm gonna tell you, there's no black and no white  
No blood, no stain  
All we need is... one vision"

QUEEN - One Vision

# PREFACE



Since we completed our formal academic training, the dental profession has continuously evolved on the basis of empirical and scientific discovery. The past two decades have witnessed a profound transformation in the way that dentistry is practiced and taught worldwide. This transformation bore the integration of evidence-based dentistry, major advances in 3D radiographic imaging for diagnosis and treatment planning, a deeper understanding of the etiopathogenesis of oral diseases (such as caries and periodontitis, including the oral-systemic link), the development of new restorative and surgical biomaterials, clinical translation of tissue engineering research, the application of novel technologies for enhanced diagnosis (eg, caries detection devices, biomarkers) and treatment (eg, high-torque handpieces, laser therapy), the use of magnification in clinical dentistry, the refinement of minimally invasive surgical and restorative protocols, the utilization of temporary anchorage devices and clear plastic aligners in orthodontic therapy, the consolidation of dental implant therapy as the prime alternative for functional and esthetic rehabilitation of missing teeth, and, more recently, the incorporation of digital dentistry workflows.

Research in bioactive materials and nanoscience, augmented and virtual reality, and artificial intelligence and big data usage holds great promise and, in synergy with the expansion of interprofessional collaboration, is expected to significantly improve health care outcomes through the optimization of personalized therapies with a focus on disease prevention and long-term maintenance of health.

Although nobody knows what the future will ultimately bring, one thing we know for sure: The wheel of innovation and change will inevitably continue to spin. As a consequence, the boundaries of established knowledge will expand beyond the status quo, and new opportunities will emerge to elevate the level of oral health care that can be

offered to patients. However, we firmly believe that a solid understanding and command of the foundational principles underlying adequate treatment planning and execution of any clinical procedure are required to properly harness innovation.

This book was primarily created with the intent of sharing our perspective on the application of periodontal and implant-related plastic and reconstructive surgery in contemporary clinical practice with an emphasis on a set of core concepts. Our vision is based on a holistic approach that encompasses four elemental domains that gravitate around one pivotal component—the actual surgical intervention—toward which all threads converge.

One of the fundamental pillars of clinical practice in our profession is the intersection between art and science. While knowledge emanating from clinical creativity and empirical observation has often been disregarded or even harshly criticized in the light of evidence-based dentistry, we should actually embrace it, celebrate it, and recognize it is an inherent component of dentistry without which our collective and individual capacity to grow and evolve would be sterile. Consequentially, a purposeful attempt to balance evidence-based content with a practical approach was made from the initial stages of preparation of this book.

We are passionate about learning and sharing. This book captures much of what we have learned over the years regarding periodontal and implant-related plastic and reconstructive surgery, and we truly hope that our efforts to share our knowledge and perspective will have a positive impact in the lives of many patients around the globe.

Finally, we would like to express our deepest gratitude to our respective families, friends, mentors, and colleagues who have supported (and put up with) us over the years of our professional journey.

And thanks to all of you for reading our book!

Leandro & Gustavo

"You say you want a revolution  
Well, you know  
We all want to change the world"

THE BEATLES - Revolution





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"If you start me up  
If you start me up I'll never stop"

THE ROLLING STONES - Start Me Up





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# INTRO

*Surgery* is an intervention performed with the intent of altering the structure of the human body by the removal or reconstruction of tissues for the diagnosis, prevention, and/or therapeutic treatment of conditions or disease processes. In the medical field, the adjectives *plastic* and *reconstructive* specifically apply to therapeutic interventions aimed to restore, repair, reshape, and/or enhance the function or appearance of parts of the body that are affected by a disease or condition.

Based on the original definition of *periodontal plastic surgery* proposed in 1988 by P.D. Miller<sup>1</sup> and a subsequent modification published in 2015 that included dental implants,<sup>2</sup> *periodontal and implant-related plastic and reconstructive surgery* may be broadly defined as a surgical discipline that encompasses a group of diverse therapeutic interventions aimed at preventing and correcting anatomical, developmental, traumatic, iatrogenic, and inflammatory-induced alterations and deformities of the periodontium, edentulous ridges, and peri-implant tissues.

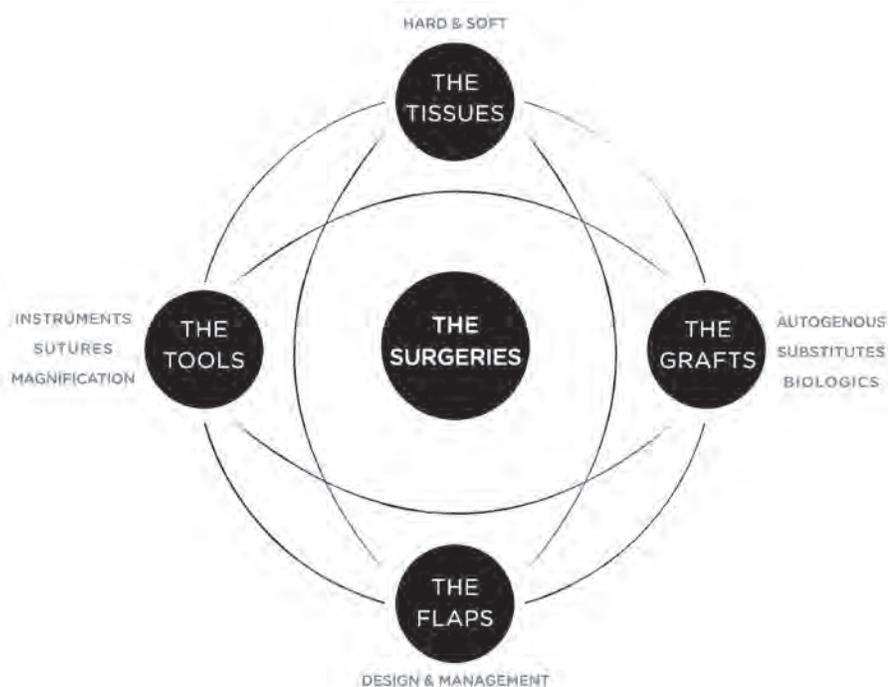
A comprehensive list of periodontal and implant-related plastic and reconstructive surgical interventions commonly performed in contemporary clinical practice is displayed in the box on the facing page. In essence, these interventions are primarily geared toward the restoration or enhancement of oral tissue structures to recreate an environment compatible with patient satisfaction and sustainable, long-term periodontal and peri-implant health, function, and esthetics.

The indications for periodontal and peri-implant plastic and reconstructive surgical therapy have grown considerably since the beginning of the 21st century because of three main reasons:

1. The consolidation of a solid base of scientific evidence and empirical knowledge.
2. The development of new biomaterials and the refinement of surgical instruments and techniques.
3. An increase in the demand for this type of intervention from the population.

The success of periodontal and implant-related plastic and reconstructive surgical therapy is based on several fundamental principles, including a profound understanding of the characteristics of periodontal and peri-implant tissues in health and disease, proper selection and utilization of surgical armamentarium, adequate flap design and management, and an understanding of the properties and indications of different graft materials and biologics. All of these elements are interconnected and, in the mind of the expert clinician, become one in the process of treatment planning and patient care.

In subsequent chapters of this book, a total of five core components of periodontal and implant-related plastic and reconstructive surgical therapy are addressed in a concise and practical manner (Fig 1). Chapter 1 (*The Tissues*) is aimed at providing a “clinically



**FIG 1** Diagrammatic representation of the relationship between the core components of this book. Note that the surgical intervention is at the center of this illustration, denoting that a proper understanding and command of the other four elements is primordial to achieve predictable and successful therapeutic results.

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## Plastic and reconstructive surgical interventions commonly performed in periodontal, edentulous, and peri-implant sites in contemporary clinical practice

### PERIODONTAL SITES

- Elimination of aberrant frenula
- Removal of gingival pigmentation
- Anatomical crown exposure
- Treatment of mucogingival conditions
  - Gingival augmentation
  - Root coverage
- Regeneration of infrabony and furcation defects

### EDENTULOUS SITES

- Alveolar ridge preservation / reconstruction
- Alveolar ridge augmentation
  - Soft tissue augmentation
  - Bone augmentation
- Maxillary sinus floor augmentation

### PERI-IMPLANT SITES

- Correction of peri-implant marginal mucosa defects
- Peri-implant soft tissue phenotype modification
- Repair of peri-implant osseous defects

oriented" perspective on the most significant aspects of the structure and biology of the tissues that constitute the periodontium and the peri-implant apparatus. This chapter also describes different classifications to categorize and manage a variety of tissue deformities, as well as the basic principles of wound healing relative to intraoral surgical procedures. After a meticulous assessment of the periodontal and peri-implant tissues to identify treatment needs, performing the most suitable and predictable surgical intervention is key for success. Hence, in chapters 2, 3, and 4, relevant aspects of the triad formed by *The Tools* (ie, surgical equipment), *The Flaps*, and *The Grafts* are thoroughly discussed. Although these three basic components are addressed separately, it is important to mention that, in most clinical scenarios, they are tightly interrelated

and influence one another in clinical decision-making processes. Finally, in chapter 5 (*The Surgeries*), following a brief introductory review pertaining to some essential surgical principles, the concepts covered in previous chapters are tied up through the description of a selection of clinical cases that illustrate the application of periodontal and implant-related plastic and reconstructive surgery on the basis of current evidence.

## REFERENCES

1. Miller PD Jr. Regenerative and reconstructive periodontal plastic surgery. Mucogingival surgery. *Dent Clin North Am* 1988;32:287-306.
2. Chambrone L. Evidence-Based Periodontal and Peri-implant Plastic Surgery: A Clinical Roadmap from Function to Aesthetics. Cham, Switzerland: Springer, 2015.

"Of all the things I value most of all  
I look inside myself  
And see my world  
And know that it is good"

BLACK SABBATH - Spiral Architect





# 1

---

## THE TISSUES

This chapter addresses clinically relevant aspects pertaining to the biology and structure of periodontal and peri-implant tissues and provides an overview of different classifications to categorize deformities that are commonly encountered in periodontal, peri-implant, and edentulous sites. The basic principles of wound healing are also reviewed.



## TISSUE

noun /'tiSHoo/

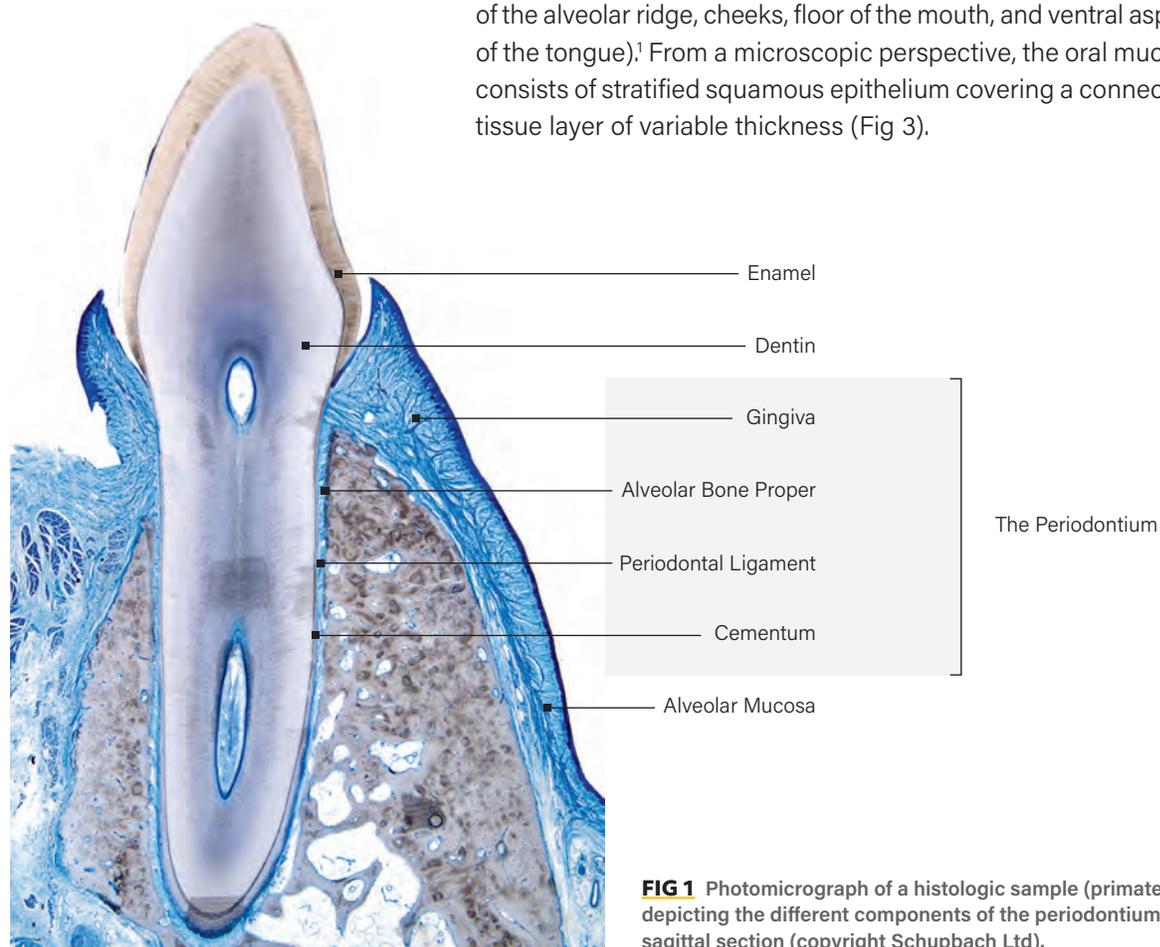
Level of structural organization in multicellular organisms that consists of an aggregate of cells together with their extracellular matrix.

## 1. THE PERIODONTIUM

The periodontium (the attachment apparatus) is a functional unit that provides support to the teeth and is constituted by the gingiva, alveolar bone proper, periodontal ligament, and cementum (Fig 1).

### Oral mucosa

The oral mucosa is the soft tissue that lines the oral cavity (Fig 2). It can be categorized into three main types: (1) *masticatory mucosa*, which includes the gingiva and the soft tissue of the hard palate (or palatal vault); (2) *specialized mucosa*, which coats the dorsum of the tongue; and (3) *lining mucosa*, which covers the remaining areas of the oral cavity (ie, inner surface of the lips, vestibule, part of the alveolar ridge, cheeks, floor of the mouth, and ventral aspect of the tongue).<sup>1</sup> From a microscopic perspective, the oral mucosa consists of stratified squamous epithelium covering a connective tissue layer of variable thickness (Fig 3).



**FIG 1** Photomicrograph of a histologic sample (primate) depicting the different components of the periodontium in a sagittal section (copyright Schubach Ltd).



**FIG 2** Occlusal views of a maxillary and a mandibular arch. The hard palate is completely covered by masticatory mucosa.

The primary cell type of the epithelium is the keratinocyte (Fig 4). Keratinocytes are polymorphic cells with a rapid proliferation rate whose main function is to protect against microbial colonization and invasion. Keratinocytes are capable of producing a wide range of biologic products, including keratin. Keratin is a fibrous structural protein that is naturally produced in specific areas of the oral epithelium as a protective guard to withstand normal masticatory activity and other mechanical disturbances, such as tooth brushing.

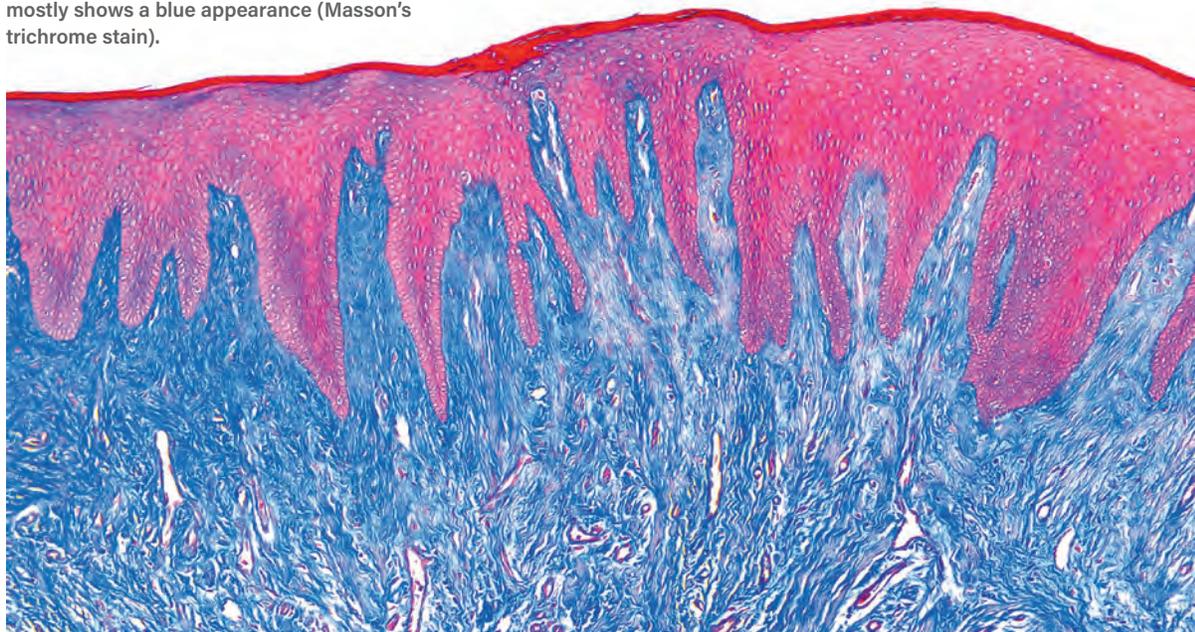
The oral epithelium may consist of four main layers or strata. From least to most differentiated (also most superficial), these are the basal layer or stratum germinativum, the prickle cell layer or stratum spinosum, the granular cell layer or stratum granulosum, and the keratinized layer or stratum corneum (Fig 5).

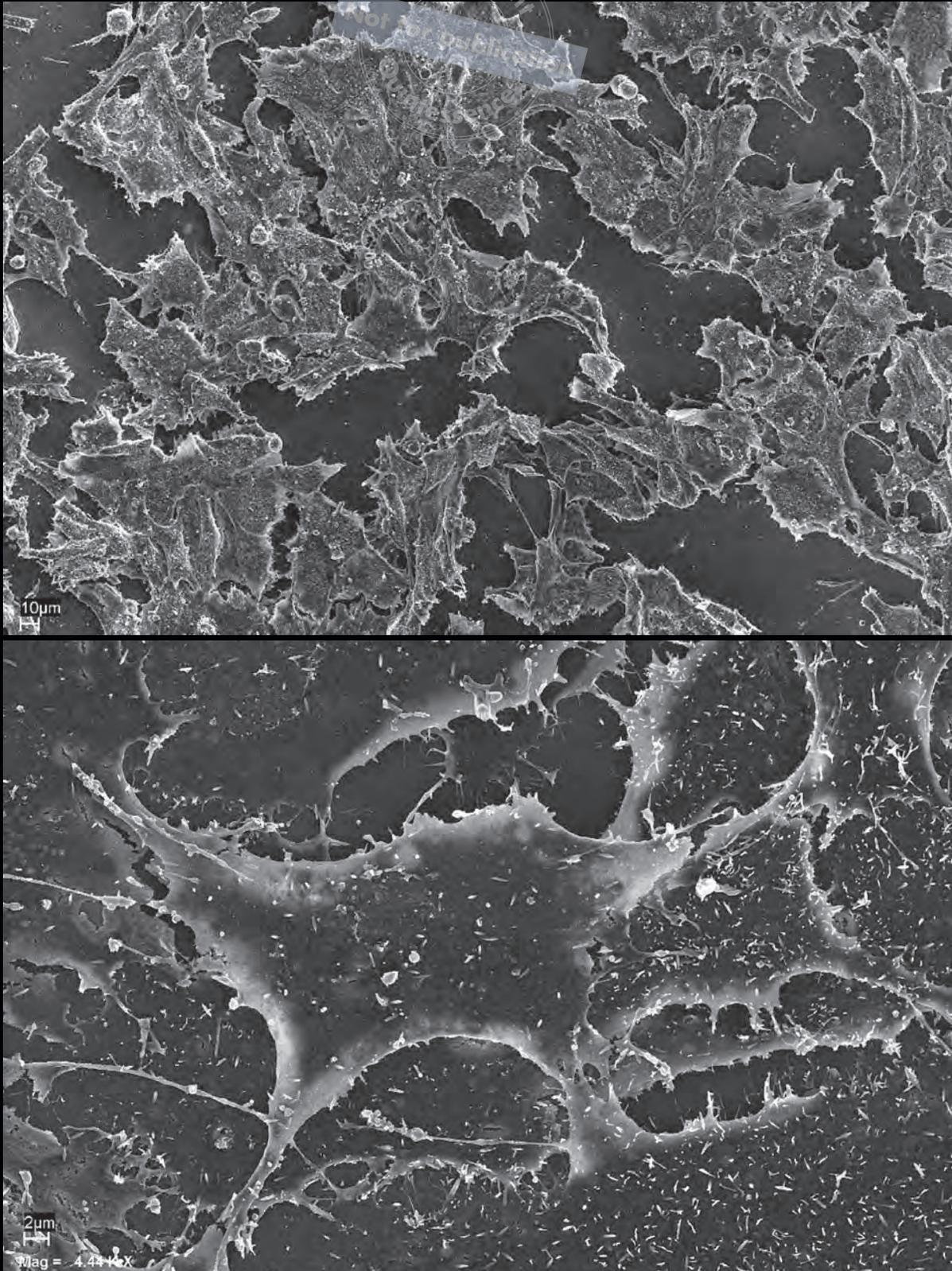
The stratum corneum of the oral epithelium may present two distinct patterns of keratinization: (1) orthokeratinized, which is characterized by the absence of cell nuclei; and (2) parakeratinized, which contains keratinocytes exhibiting polarized nuclei

(Fig 6). The stratum corneum is absent in some areas of the oral mucosa (eg, alveolar mucosa), which are instead covered by nonkeratinized epithelium (Fig 7).

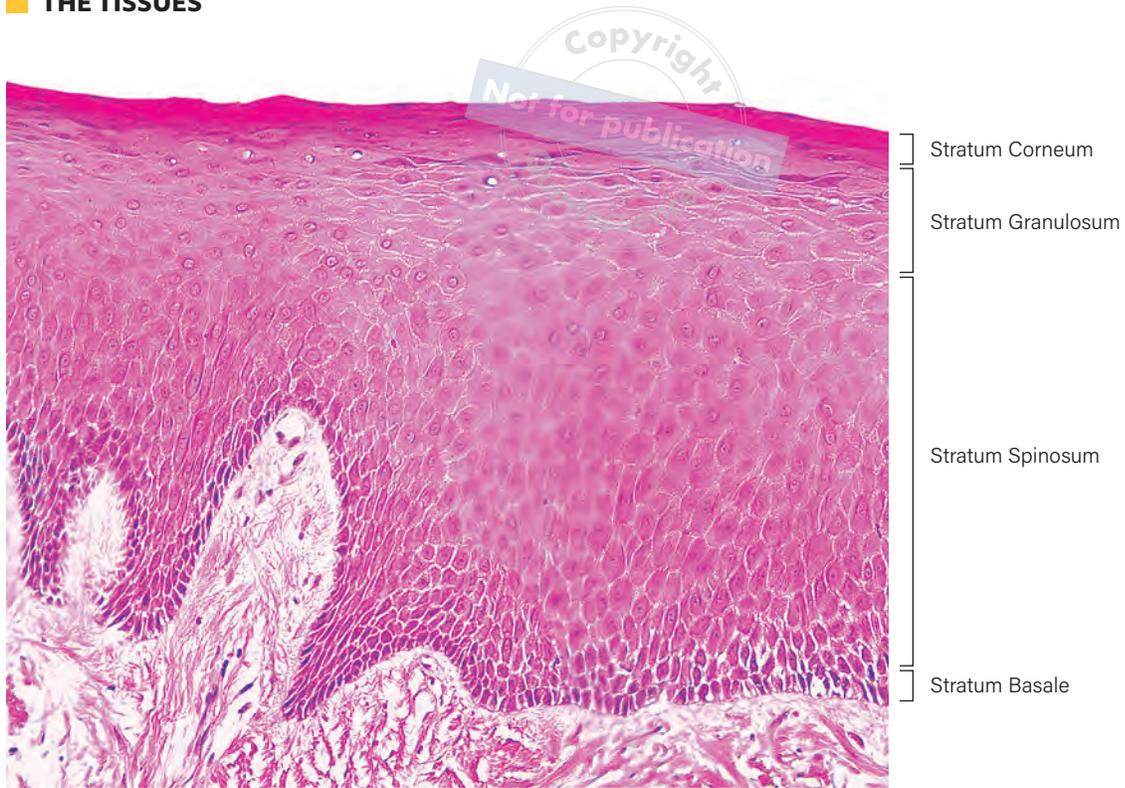
The connective tissue underlying the epithelium may contain two compartments: (1) the lamina propria, a fibrous layer situated immediately beneath the epithelium; and (2) the submucosa, a stratum exhibiting lower fibrous density that is rich in vascular structures, salivary glands, and adipocytes. However, depending on the anatomical location, there may be a complete absence of submucosa, such as in the gingiva and in some regions of the hard palate.<sup>2</sup> The lamina propria may be subdivided into two distinct layers: papillary and reticular. The papillary layer is more superficial and interlocks with the epithelial projections. It contains loosely organized collagen fibers and capillary loops. The reticular layer mainly consists of thick and dense bundles of collagen fibers that exhibit a netlike arrangement with a tendency to a parallel organization respective to the surface of the mucosa<sup>3</sup> (Fig 8).

**FIG 3** Photomicrograph of a histologic sample of intraoral human keratinized mucosa. The epithelial layer is stained in red/pink, while the underlying connective tissue mostly shows a blue appearance (Masson's trichrome stain).

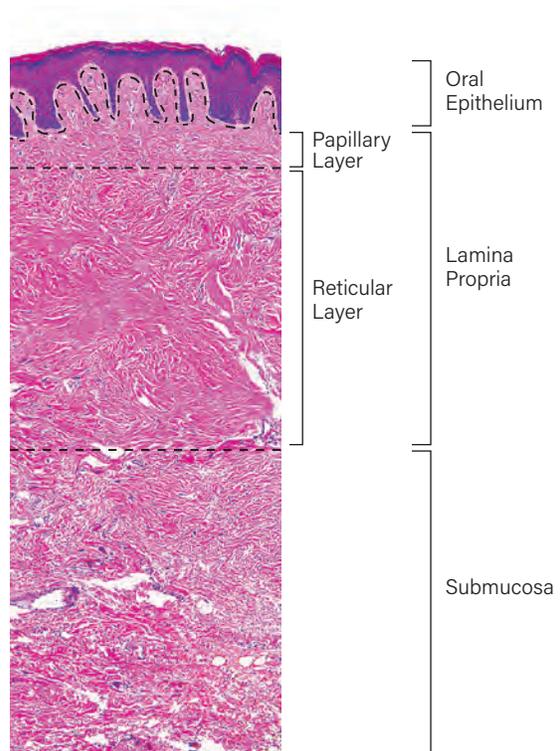




**FIG 4** Scanning electron microscopy (SEM) images of a culture of oral keratinocytes. The top image shows multiple keratinocytes, while the bottom image at a higher magnification highlights a keratinocyte with a starlike appearance.

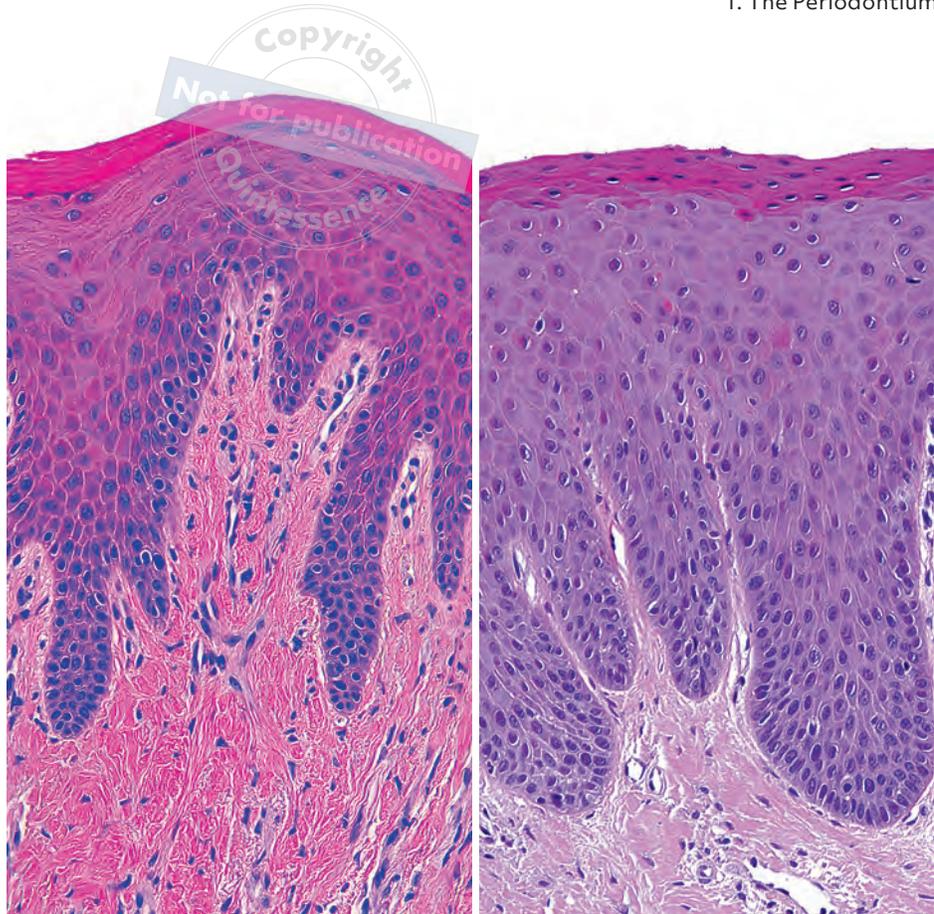


**FIG 5** Layers (or strata) of keratinized stratified squamous epithelium in a histologic sample of human oral mucosa. *Stratum basale*: Formed by highly proliferative keratinocytes presenting a small cytoplasm and a somewhat cuboid or rectangular shape. The newly formed cells migrate away from the basal layer through the other three epithelial layers, until reaching the stratum corneum. The basal layer is in direct contact with the basement membrane, which separates the epithelium from the underlying connective tissue or lamina propria. *Stratum spinosum*: Formed by large polyhedral spinous-appearing cells with prominent peripheral cytoplasmic processes, also known as *prickle cells*. Generally, this is the thickest stratum of oral epithelia. *Stratum granulosum*: Formed by keratinocytes exhibiting a flattened appearance and larger nuclei, but smaller size compared to those in the stratum spinosum. Dense keratohyalin granules may be observed in the cytoplasm of some of the most superficial cells, underneath the stratum corneum. *Stratum corneum*: Formed by keratinocytes presenting a flat morphology that are arranged in a wavy pattern. As keratinocytes migrate toward the surface, their organelles disintegrate. Two patterns of keratinization may be observed in the stratum corneum: orthokeratinized and parakeratinized.



**FIG 8** Photomicrograph of a human histologic sample illustrating the main layers of the oral mucosa.

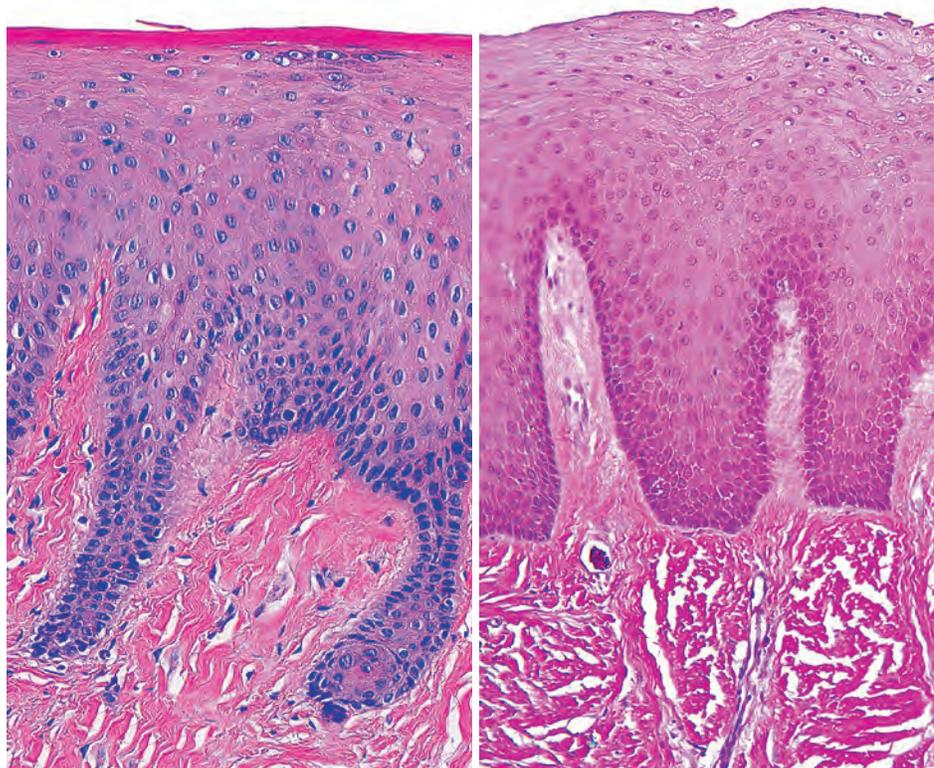
**FIG 6** (left) Orthokeratinized oral epithelium. (right) Parakeratinized oral epithelium (human histology).



Orthokeratinized

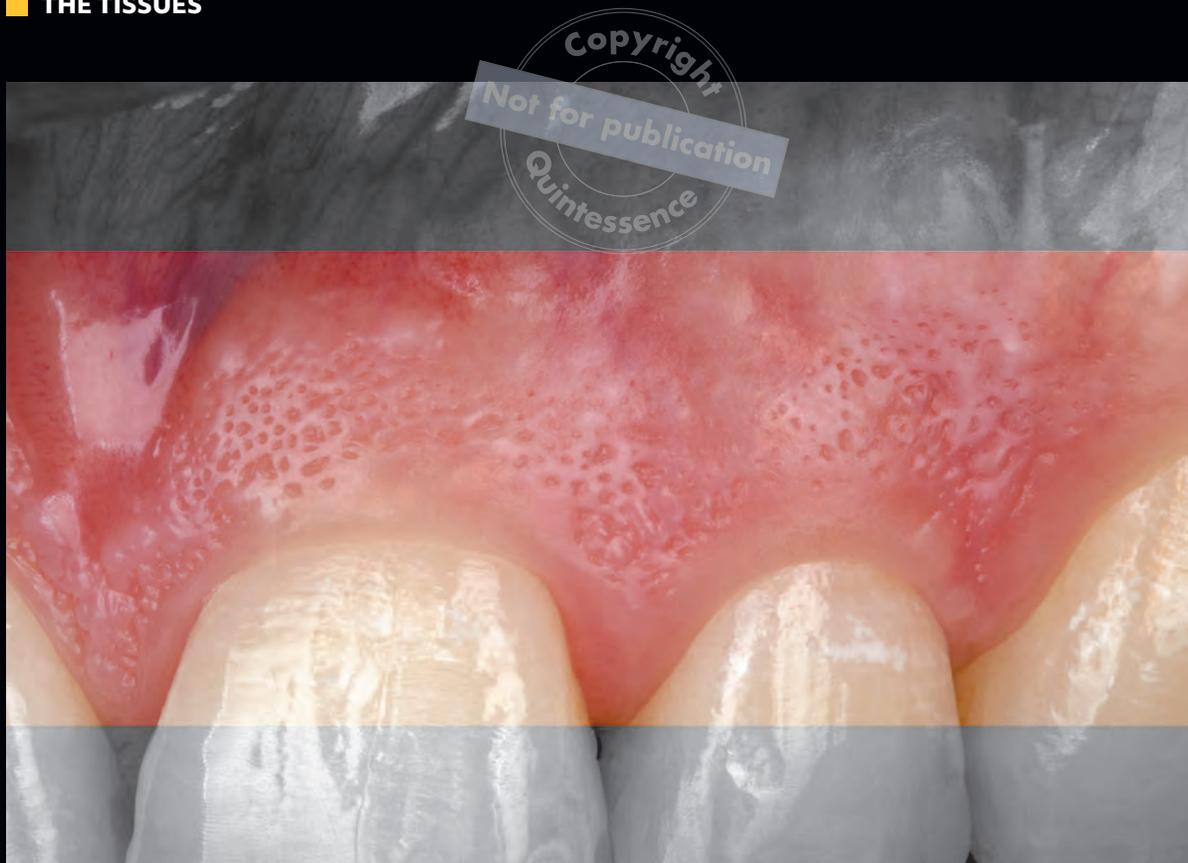
Parakeratinized

**FIG 7** Photomicrographs illustrating the difference between human keratinized and nonkeratinized oral epithelium.



Keratinized Epithelium

Nonkeratinized Epithelium



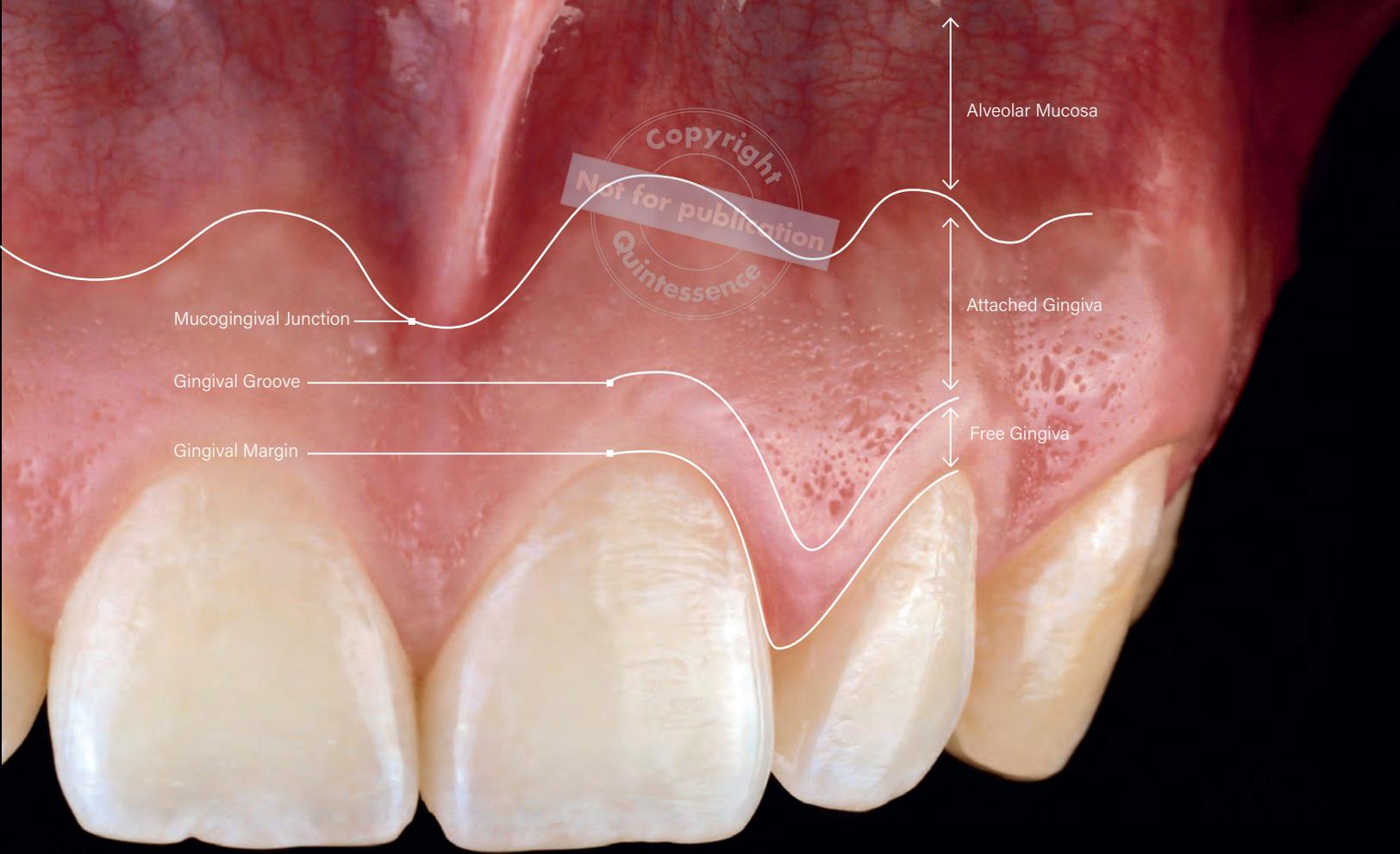
**FIG 9**

## Gingiva

The gingiva is the most peripheral component of the periodontium and can be defined as the collar of fibrous soft tissue that invests the cervical region of a tooth and is contiguous with its periodontal ligament and the alveolar mucosa<sup>4</sup> (Fig 9).

The gingiva extends in a coronal direction from the zenith of the gingival margin (*limbus gingivae*) to the mucogingival junction, where it meets the alveolar mucosa, with the exception of the hard palate, which is completely covered by masticatory mucosa. Although the gingiva is de facto a functional unit with variations in shape, contour, and clinical morphology,<sup>5</sup> it may be divided into two distinct topographic regions that hold clinical significance: the free gingiva and the attached gingiva (Fig 10).

The free (or marginal) gingiva is the most coronal portion of the gingiva. It is circumferentially but loosely adhered to the enamel surface through the junctional epithelium, and it forms the external wall of the gingival sulcus (or crevice). At its most apical boundary, a shallow, V-shaped horizontal depression known as the *gingival groove* may be identified on the gingival surface, although its presence is not ubiquitous<sup>6</sup> (Fig 11). This anatomical feature, which was originally described by Balint Orban,<sup>7</sup> demarcates the boundary between the free and the attached gingiva in health (ie, the base of the gingival sulcus).



**FIG 10** Clinical image showing the regions of the gingiva (free and attached) and the location of the mucogingival junction.



**FIG 11** Clinical images demonstrating the location of the gingival groove on the facial aspect of the maxillary right central and lateral incisors. In healthy sites, the periodontal probe approximately penetrates to the apical end of the free gingiva.

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