Introduction: Vision of Regenerative Periodontology  xi
Alpdogan Kantarci, Andreas Stavropoulos and Anton Sculean

Biological Basis of Periodontal Regeneration  1
Alpdogan Kantarci

The ultimate goal of periodontal therapy is homeostatic regeneration of lost attachment of alveolar bone and gingival connective tissue to the exposed root surfaces with a fully functional and healthy periodontal ligament that is covered with a healthy epithelium. This goal needs a complete understanding of the biological mechanisms inherent to healing and inflammatory processes.

Decontamination and Biomodification of Periodontally Affected Root Surface for Successful Regeneration: Is There Room for Improvement?  11
Jamil Awad Shibli, Magda Feres, Luciene C. Figueiredo, Nidia Castro dos Santos, and Belen Retamal-Valdes

Periodontitis is a multifactorial inflammatory condition associated with an oral microbiome dysbiosis that results in gingival inflammation and clinical attachment loss. Periodontal therapies are based on scaling and root planing to disturb the bacterial biofilm mechanically and remove calculus and contaminated cementum. Research does not support the use of root modifiers for decontamination and biomodification of periodontally affected root surfaces. Standardized clinical trials in large populations, assessing biological and patient-reported outcome measures, are necessary to evaluate candidate biomaterials for decontamination and biomodification of periodontally affected root surfaces.

Inflammation and Periodontal Regeneration  39
Hatice Hasturk

Technological innovations in cellular and molecular aspects of tissue engineering – scaffolds, stem cells and 3D printed tissues – have been dramatically increased in the last decade. However, regenerative treatment still has challenges in translation to clinic. This is partly due to failure of addressing an essential element of wound healing, inflammation. It is now well-recognized that inflammation is an active process. This paradigm shift opened up a new avenue of therapeutic approaches called “host-modulation.” Host-modulation therapies capable of modulating inflammatory response at multiple levels and mimicking the natural sequence of wound healing offer a new direction and promising clinical translation.
Stem Cell Applications in Periodontal Regeneration 53
Mark Bartold and Saso Ivanovski

In this review, the authors consider the substantial advances that have been made in recent years in stem cell-based periodontal regeneration. These advances involve identifying dental- and nondental-derived stem cells with the capacity to modulate periodontal regeneration, human clinical trials, and emerging concepts, including cell banking, good manufacturing processes, and overall clinical translation.

The Evolution of Surgical Techniques and Biomaterials for Periodontal Regeneration 75
Giorgio Pagni, Lorenzo Tavelli, and Giulio Rasperini

The understanding of biological concepts in wound healing together with the evolution in biomaterials applied in periodontal regeneration allowed for improved, minimally invasive surgical techniques with a wider range of application and adapted to achieve multiple goals at the same time. Regenerating attachment was never the sole end point, but maintaining the patient’s own natural dentition in health and esthetics is becoming a feasible goal even in cases considered challenging just a few years ago. In this article we report on the evolution of techniques and biomaterials and their application in esthetic and challenging cases.

Soft Tissue Regeneration at Natural Teeth 87
Raluca Cosgarea, Alpdogan Kantarci, Andreas Stavropoulos, Nicole Arweiler, and Anton Sculean

This article provides an overview of the best-documented surgical techniques for recession coverage and draws conclusions for the clinician. Use of a connective tissue graft with either coronally advanced flap (CAF) or tunnel is the most predictable technique for the treatment of single and multiple gingival recessions. Long-term results exist only for CAF with/without connective tissue graft providing evidence for long-term stability with only minor relapses. Soft tissue replacement materials and biologics may represent a valuable modality to additionally improve the clinical outcomes obtained with CAF alone or, in certain clinical situations, to serve as an alternative to autogenous tissue.

Regenerative Periodontal Therapy in Intrabony Defects and Long-Term Tooth Prognosis 103
Andreas Stavropoulos, Kristina Bertl, Anton Sculean, and Alpdogan Kantarci

In this chapter, the results from a relatively recently performed systematic appraisal of the literature on the long-term outcome of regenerative periodontal treatment in intrabony defects are presented. Periodontal regenerative procedures in intrabony defects yield significantly better clinical outcomes compared with conventional surgery and result in high rates of tooth retention on a medium- to long-term basis. Combination approaches seem, in general, more efficacious compared with monotherapy.
Scaffolds in Periodontal Regenerative Treatment 111
Shuntaro Yamada, Siddharth Shanbhag, and Kamal Mustafa

Successful periodontal regeneration requires the hierarchical reorganization of multiple tissues including periodontal ligament, cementum, alveolar bone, and gingiva. The limitation of conventional regenerative therapies has been attracting research interest in tissue engineering-based periodontal therapies where progenitor cells, scaffolds, and bioactive molecules are delivered. Scaffolds offer not only structural support but also provide geometrical clue to guide cell fate. Additionally, functionalization improves bioactive properties to the scaffold. Various scaffold designs have been proposed for periodontal regeneration. These include the fabrication of biomimetic periodontal extracellular matrix, multiphasic scaffolds with tissue-specific layers, and personalized 3D printed scaffolds. This review summarizes the basic concept as well as the recent advancement of scaffold designing and fabrication for periodontal regeneration and provides an insight of future clinical translation.

Nanomedicine and Periodontal Regenerative Treatment 131
Olivier Huck, Céline Stutz, Pierre-Yves Gegout, Hayriye Özçelik, Nadia Benkirane-Jessel, Catherine Petit, and Fareeha Batool

Current periodontal treatments aim to control bacterial infection and decrease inflammation. To optimize contemporary conventional treatments that present limitations owing to an inability to reach the lesion site, new methods are based on nanomedicine. Nanomedicine allows delivery of host-modulatory drugs or antibacterial molecules at the lesion site in an optimal concentration with decreased toxicity and risk of systemic side effects. Chitosan and polylactic-co-glycolic acid-loaded nanoparticles, carbon quantum dots, and mesoporous silicates open new perspectives in periodontitis management. The potential therapeutic impact of the main nanocarriers is discussed.

Biomarkers and Periodontal Regenerative Approaches 157
Ulvi Kahraman Gürsoy, Mervi Gürsoy, and Eija Könönen

The ultimate goal in periodontal therapy is the complete re-establishment of the lost tissues. Dental researchers and clinicians are continuously working to develop current therapeutic techniques and technologies that can regenerate damaged periodontal tissues. Predicting the outcome of the treatment is a challenging endeavor, because a variety of local and systemic variables can affect the success of the applied regenerative therapy. To real-time monitor the biological changes during periodontitis or after periodontal treatment, various biomarkers have been studied in periodontology. This article discusses the available evidence on the use of biomarkers in the detection of periodontal regeneration.