Anton Sculean

Periodontal Regenerative Therapy

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Foreword

Regenerative medicine does not only represent an evolving field, but it also greatly enhances the quality of the lives of our patients. In the development of this book, its editor, Tony Sculean, along with an outstanding gathering of authors, has produced an important text in periodontal regenerative therapy. This book presents the current best approaches in the treatment of periodontal osseous and soft tissue defects. Certainly, the field of periodontal reconstructive therapy has developed over the years from a primarily debridement and root surface preparation approach to one that incorporates surgical technique, biological concepts, and biomaterial enhancement to promote regeneration. Periodontal tissue engineering is a discipline that greatly employs advancements in materials science and biology to promote regeneration of bone, ligament, and cementum. This area of dentistry has virtually led all of the other specialties by targeting innovative therapies to complex tissues and interfaces. These approaches in periodontology are being exploited in other fields of medicine for bone and soft tissue engineering, as well as in more focused areas such as total tooth engineering or implant site development. In this book, Dr. Sculean has brought together critical aspects to aid student, clinicians, and clinical researchers on the fundamentals of the field of periodontal regenerative therapy. This comprehensive and insightful text prepares individuals in the field to understand fundamental concepts as well as examine future developments in a variety of emerging areas of periodontology.

From a technical standpoint, this text is an impressive compilation of topics presented by top leaders in the field of periodontal regeneration. The book has been carefully prepared to aid the readership in the understanding of basic principles of diagnosis, prognosis, and treatment, to technical and scientific facets related to regeneration. Careful presentations of the importance of critical factors of periodontal wound repair and surgical approaches are provided to clearly illustrate the importance of the art and science of periodontal regenerative medicine. There are also sections on the use of important biological factors used for tissue repair such as enamel matrix proteins, growths factors, and morphogens targeted to accelerate and improve bone and soft tissue volume in reconstructive procedures. More recent innovations in the utilization of novel scaffolding matrices and cell/gene delivery approaches to repair localized defects are also presented. Further, there are sections that demonstrate in-depth analysis on the use of guided tissue regeneration for soft tissue defects as well as both local intrabony and furcation osseous lesions. The demonstrations of the technical points will be beneficial to the reader in the optimization of periodontal treatments to the broadening armamentarium. This book also notably brings together the interdisciplinary aspects critical to patient care with techniques on restorative, endodontic, and orthodontic applications. Further cutting-edge insights are provided on the use of microsurgical techniques that can enhance the end results of the “art” aspect of periodontal reconstruction. Thus, it will greatly contribute to the biological and technical skills of the reader and advance their “big picture” of periodontal reconstructive therapy.

We are truly in an exciting period in dentistry as it relates to periodontal tissue engineering and regenerative medicine. Many formidable developments are on the horizon in the coming years and this book lays the groundwork to prepare us for this future!

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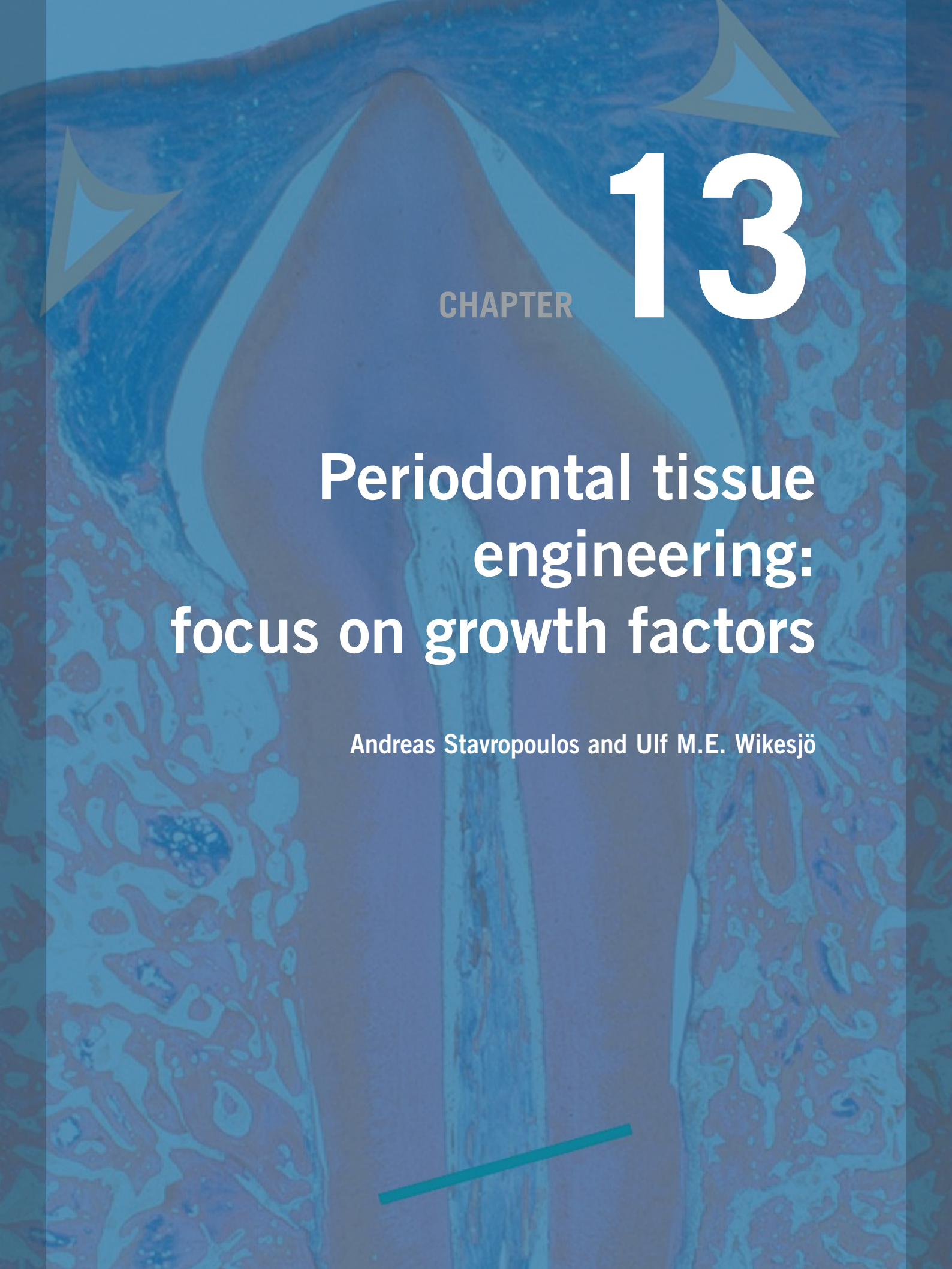

CHAPTER 13

Periodontal tissue engineering: focus on growth factors

Andreas Stavropoulos and Ulf M.E. Wikesjö

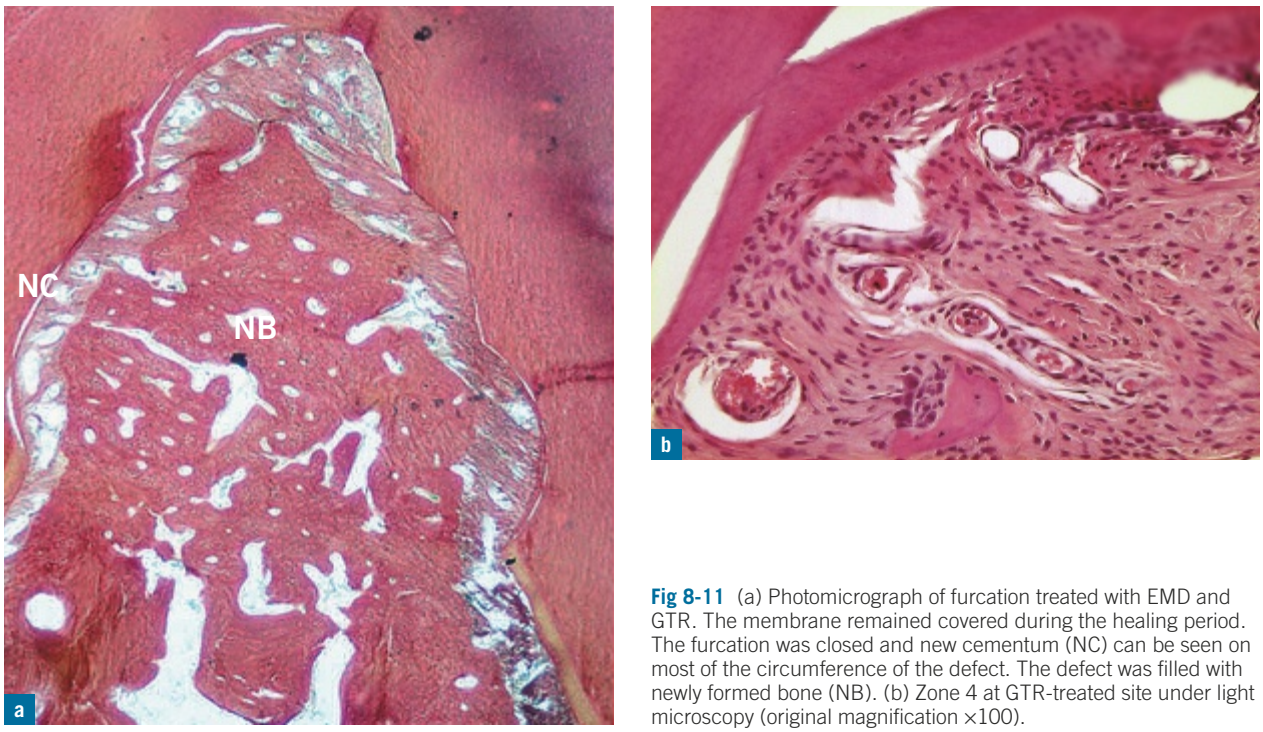

Fig 8-11 (a) Photomicrograph of furcation treated with EMD and GTR. The membrane remained covered during the healing period. The furcation was closed and new cementum (NC) can be seen on most of the circumference of the defect. The defect was filled with newly formed bone (NB). (b) Zone 4 at GTR-treated site under light microscopy (original magnification ×100).

Clinical studies

There is only one case series study (with a limited number of patients) where the treatment of Class III mandibular furcation defects was evaluated following the use of EMD alone or in combination with a bioresorbable membrane.[57] Nine patients with chronic periodontitis presenting a total of 14 Class III mandibular furcation defects were included in the study. The surgical treatment of the defects comprised: (1) EMD in four defects, (2) GTR in three defects, and (3) EMD and GTR in seven defects. The PAL-H and PAL-V at each furcation site (buccal and lingual) were measured by the same previously calibrated examiner prior to surgery and after 6 and 12 months. None of the treatments resulted predictably in complete healing of the defects and there was no obvious difference between the various treatment modalities. At 6 and 12 months, partial closure of the Class III involvements had occurred in 6 of the 14 treated furcations and the PAL-V consistently improved following all three treatment modalities (Table 8-3). The remaining teeth still presented through-and-through furcation defects at 6 and 12 months following treatment (Fig 8-12). Within the limits of

Table 8-3 Clinical outcomes 6 and 12 months after treatment of Class III furcation involvements with GTR, EMD, or GTR and EMD.

	GTR		EMD		GTR and EMD	
	6 months	12 months	6 months	12 months	6 months	12 months
No. sites	3	3	4	4	7	6
Membrane exposure	2	2	–	–	5	5
Open	1	2	2	2	4	4
Partially closed	2	1	2	2	3	2
Completely closed	0	0	0	0	0	0

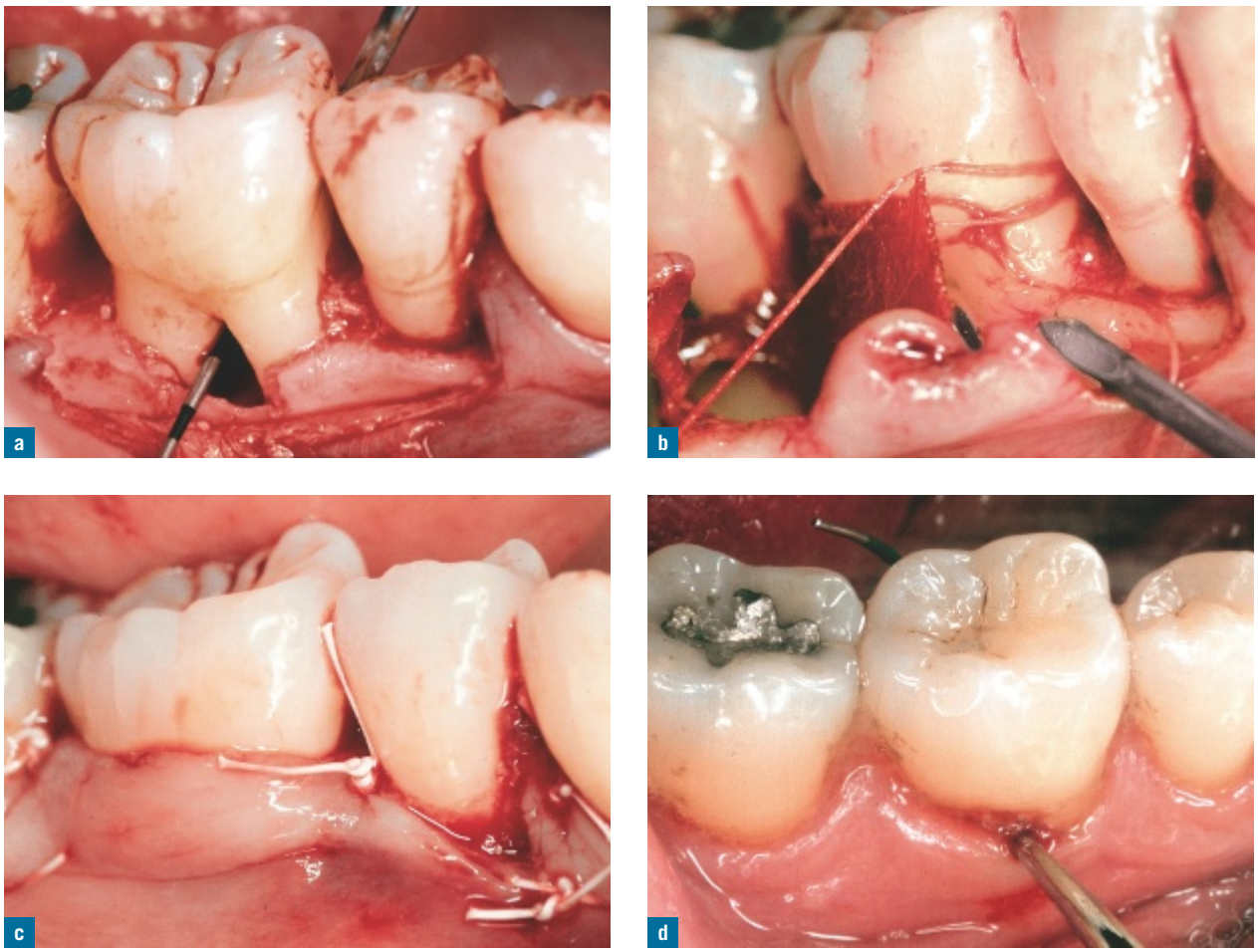

Fig 8-12 (a) Intraoperative view of mandibular left molar reveals a large Class III furcation defect. (b) A bioresorbable membrane is fixed to the tooth using loose sutures while EMD is applied onto the root surfaces of the furcation area. (c) Following the tight suturing of the membrane into position, the flap closure is achieved with a combination of horizontal mattress and interproximal sutures. (d) At 12 months after surgery, the furcation defect was still open. Source: Donos, N. et al, International Journal of Periodontics and Resorative Dentistry 2004;24:363–369, used with permission of Quintessence Publishing Co. Inc.,Chicago, IL.

this case series study and taking into account the limited number of patients and furcation involvements included in each treatment group, it can be suggested that the use of EMD alone or in combination with GTR does not result in predictable regeneration of Class III mandibular defects. Even though it has been demonstrated that EMD has significant potential for periodontal regeneration, it seems that it does not have the necessary osteoinductive[58] or osteoconductive properties[59,60] to promote closure of a Class III furcation defect in a clinical setting.

Conclusions

EMD represents an alternative to GTR for the treatment of Class II buccal furcation involvements. The treatment of Class III furcation involvement still constitutes a challenge since EMD alone or in combination with GTR is not clinically effective.

Currently, the available results from the preclinical and clinical studies do not support the use of EMD in lingual Class II or Class III furcation defects in mandibular or maxillary molars.

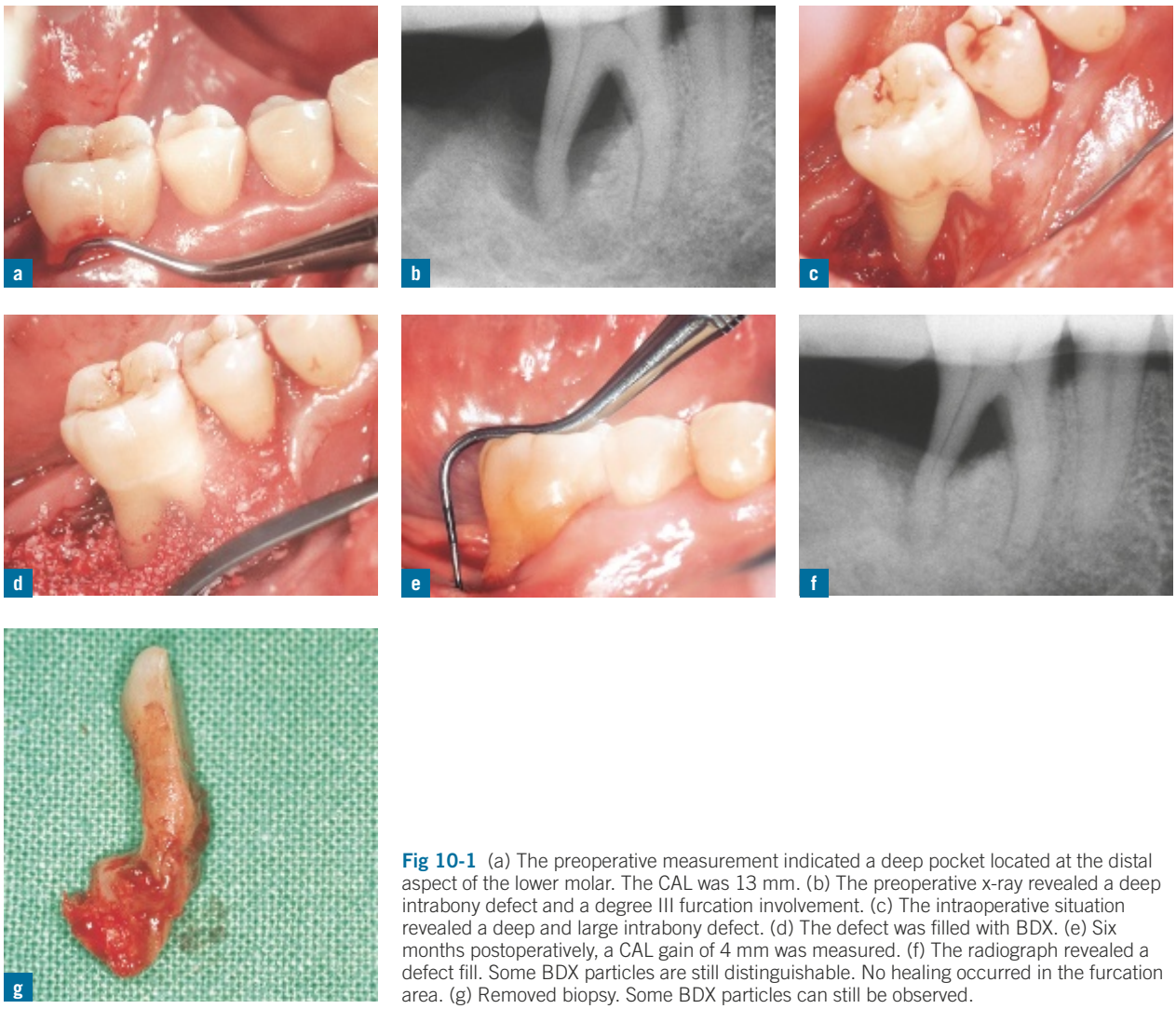

Fig 10-1 (a) The preoperative measurement indicated a deep pocket located at the distal aspect of the lower molar. The CAL was 13 mm. (b) The preoperative x-ray revealed a deep intrabony defect and a degree III furcation involvement. (c) The intraoperative situation revealed a deep and large intrabony defect. (d) The defect was filled with BDX. (e) Six months postoperatively, a CAL gain of 4 mm was measured. (f) The radiograph revealed a defect fill. Some BDX particles are still distinguishable. No healing occurred in the furcation area. (g) Removed biopsy. Some BDX particles can still be observed.

epithelium stopped at the most coronal aspect of the newly formed cementum, whereas most BDX particles were surrounded by a bone-like tissue (Figs 10-1 and 10-2). Subsequent studies have also provided histologic evidence that BDX combined with collagen (BDX Coll) may also promote periodontal regeneration in human intrabony defects.[42] In the mentioned study, two deep intrabony defects localized at single-rooted teeth were treated with flap surgery and defects were filled with BDX Coll.[42] The clinical evaluation at 9 months after regenerative surgery demonstrated CAL gains of 5 mm and 9 mm, respectively. Healing occurred in both cases through formation of new cementum, new periodontal ligament, and new alveolar bone. Controlled clinical studies indicated that treatment of intrabony defects with BDX may lead to results comparable to treatment with DFDBA.[43] However, there are currently no published data from controlled clinical studies comparing the healing of intrabony or furcation defects by means of flap surgery with or without BDX.

The use of coralline calcium carbonate as a bone substitute was introduced some decades ago. Depending on the pretreatment modality, the natural coral is transformed into nonresorbable porous hydroxyapatite or into a resorbable calcium carbonate. Controlled clinical studies have demonstrated higher probing depth (PD) reduction, CAL gain, and defect fill at grafted sites compared with the nongrafted ones.[44–47] Comparative studies indicated that in intrabony defects, similar results

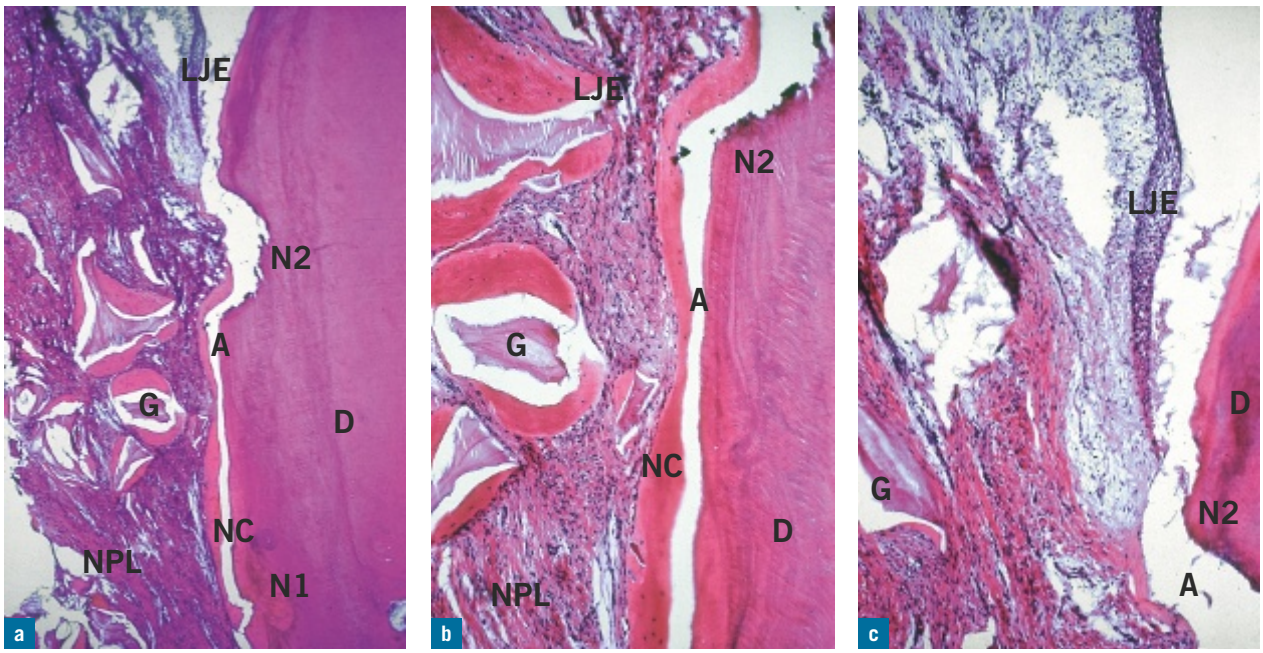

Fig 10-2 (a) The healing in the case depicted in Fig 10-1 occurred in new cementum (NC) and new periodontal ligament (NPL) formation along the area delineated by the apical (N1) and coronal (N2) notches. The BDX (G) particles are surrounded by a bone-like tissue. D: dentin, A: artifact, LJE: long junctional epithelium. (Original magnification 25x: hematoxylin-eosin stain). (b) Higher magnification of the middle aspect of the defect shown in (a). The new cementum (NC) displays a cellular character and is deposited on the dentin (D) surface. The BDX particles (G) are surrounded by a bone-like tissue. NPL: new periodontal ligament, A: artifact. (Original magnification 150x: hematoxylin-eosin stain). (c) Higher magnification of the coronal part of the defect shown in (a). The graft particles are embedded in connective tissue. LJE: long junctional epithelium, A: artifact, G: BDX, N2: coronal notch, D: dentin. (Original magnification 150x: hematoxylin-eosin stain)

may be obtained following grafting with FDBA, DFDBA, or porous hydroxyapatite on natural coral bases.[23,48] Moreover, results from a controlled clinical study have found results in favor of this material when compared with DFDBA.[49] Histologic studies from animals and humans have, however, failed to show evidence for periodontal regeneration following grafting with natural coral. The healing was predominantly characterized by formation of a long junctional epithelium and connective tissue encapsulation of the graft particles.[50–53]

Alloplastic materials

Alloplastic materials are synthetic, inorganic, biocompatible, and/or bioactive bone substitutes that are believed to promote healing of bone defects through osteoconduction. The following alloplastic materials have been employed in regenerative periodontal therapy: hydroxyapatite (HA), beta-tricalcium phosphate (β-TCP), polymers, and bioactive glasses.

Hydroxyapatite

HA is available in either nonresorbable or resorbable form. Histologic studies from animals and humans have indicated only limited and unpredictable periodontal regeneration following treatment of intrabony defects with HA.[54–61] The healing was mostly characterized through formation of a long junctional epithelium, whereas most HA particles were encapsulated in connective tissue. Formation of new bone occurred only occasionally, and only in the proximity of the bony walls. Controlled clinical studies have shown higher PD reductions, CAL gains, and defect fill at grafted than at nongrafted sites.[62–66] A recent randomized controlled clinical study has evaluated the healing of intrabony defects after treatment with a newly developed biphasic calcium phosphate (BCP), autogenous bone spongiosa (ABS), or open flap debridement. At 1 year following therapy, the clinical evaluation has demonstrated comparable results for BCP and ABS.[67] The results from systematic reviews, however, demonstrated a high heterogenity between the studies.[68]