Evidence-Based Periodontal and Peri-Implant Plastic Surgery

A Clinical Roadmap from Function to Aesthetics

Leandro Chambrone
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Foreword 1

Developments in biomedical sciences, the steadily accelerating advances in scientific knowledge, and the dizzying acquisition of new technologies would make it seem that the traditional format of a treatise or atlas would be outdated because of new digital means of communication. This is not always true. Indeed, the new book, *Evidence-Based Periodontal and Peri-Implant Surgery: A Clinical Roadmap from Function to Aesthetics* by Professor Leandro Chambrone, is destined to become an irreplaceable tool for study, for critical assessments, and for furthering knowledge about the advances in the rapidly advancing domain of mucogingival plastic surgery. The author and his Latin American colleagues—all acknowledged leaders in the field—have tackled this important branch of periodontology, focusing attention on the management of soft tissues surrounding teeth and implants to achieve significantly positive clinical–aesthetic results.

It is with great scientific precision and emphasis on the current philosophy of evidence-based medicine that the first six chapters deal with the biological and anatomical–physiological principles at the base of every surgical procedure. Indications for surgery, operating techniques, limitations, and potential complications are described in detail for various clinical situations such as gingival recessions, tissue augmentation procedures, and crown lengthening. Chapters 7 and 8 are particularly interesting as they offer suggestions for the multidisciplinary construction of decision trees in clinical practice.

The texts are enriched by splendid illustrations. The techniques are explained in detail with the help of exceptionally clear diagrams and drawings, and the bibliography is as complete as it is concise.

This book/atlas is a highly recommendable and extremely readable tool not only for experienced periodontal surgeons but also for students and recent dental school graduates.

The book, which is invaluable in itself, reflects the professionalism, vast cultural background, and exceptional preparation of Professor Chambrone, an indefatigable researcher whom all members of the dentistry and oral surgery communities know and admire.

My compliments go to the author and his staff also for the beautiful presentation of this book.

I would like to extend heartfelt best wishes to my friend Leandro and his colleagues: They will certainly be rewarded for the enormous effort they put into this book/atlas—una opera d'arte!

Florence, Italy Giovanpaolo Pini Prato

Foreword 2

This complete periodontal textbook has compiled information enabling the reader to clearly understand the complex discipline of periodontal plastic surgery. A significant portion of the world's population has demonstrated susceptibility to aesthetic and/or functional problems involving the mucogingival complex and required professional attention.

The book provides appropriate and up-to-date information concerning the diagnosis, the therapeutics available to control the condition, and the importance of long-term maintenance. The capabilities of the periodontist to guide patients in a constructive fashion predictably results in the maintenance of the natural dentition, which most people prefer. This, of course, takes account of the predictability of osseointegrated implants.

The author has presented an understanding of the disease/condition process that can be applied in any dental office. It provides a thorough opportunity to familiarize the reader with the methods of therapy and the limitations that can be achieved. There is a remarkable section of the textbook demonstrating step-by-step surgical procedures of benefit to the patient. A significant portion is dedicated to mucogingival surgery; a most common reason for many patients to visit a periodontist is their recognition of gingival recession. The author has provided insight into incision design, flap management, and selection of the appropriate procedure. The successful outcome of any treatment regime requires attention to a series of patient-related issues, sound knowledge of the anatomy, and surgical training, which are prerequisites for predictable results.

The predictability of periodontal regeneration has developed over the past decades and is greatly influenced by the recognition of which strategic tooth can be saved and which biomaterials can provide the best result. A frequent contemporary dilemma is found in the decision-making process as to whether to regenerate lost periodontium or to replace a compromised tooth with a dental implant. This everyday decision may result in a collision of therapies. Adequate presurgical planning, appropriate quality and quantity of available bone, and excellent surgical technique will all play a vital role in a successful outcome. Leandro Chambrone has captured the moment with a detailed analysis of therapies for the periodontally compromised patient. This is an excellent, well-documented textbook that should be found in the library of every dental practitioner.

Swampscott, USA Myron Nevins

Preface

It is somewhat interesting what ways life takes and how things happen in our lives. I had never even the idea of writing a scientific book or even the purpose of presenting it in a different concept than peridontology textbooks have ever done. However, the first contact invitation performed by Springer Verlag for a new book on *Periodontal Plastic Surgery* led me to develop a bunch of new ideas on how to present additional information to what several very good books on the same topic had already published. After thinking for a while, the best option seemed to explore all the knowledge obtained during the 8 years I have been studying working on "evidence-based dentistry," with all the clinical work developed during 15 years of private practice. Thus, the development of a book entitled *Evidence-Based Periodontal and Peri-Implant Plastic Surgery* emerged to support the rational and clinical use of different surgical procedures in "real-world clinical scenarios" or, in other words, to really sediment the original concept of evidence-based dentistry and provide a rational and viable sequence of combined events: (1) the assessment of the best source of information available for each specific clinical condition or disease; (2) the proposal of an order of "best to worst" treatment options that may be offered to solve the "problem" of the patient taking into account the clinician's expertise; and (3) the patient's choice after considering the clinical options and one's personal preferences.

It is expected that the proposal of any particular concept should rely on a vision of how to share its content within a large audience, but in fact, my idea (and certainly, I can talk on behalf of all colleagues participating in this project) is that this book could be useful for clinicians attending in conventional private practices: nothing more, nothing less than that. Together with some young and talented Latin American clinicians and Prof. Dr. Luiz Armando Chambrone (who "presented" us with his know-how of 50 years of clinical expertise), I am very glad to offer the readers a way to go further on existing knowledge to determine the best practical way to treat their patients with periodontal plastic procedures or, in other words, to adequately support decision-making for the most common clinical scenarios found in private practice (i.e., to make the translation of research information into clinically usable tools for daily practice).

Thanks for reading, and "enjoy the ride".

Mogi das Cruzes, Brazil Leandro Chambrone

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Evidence-Based Decision-Making: An Overview

1

Leandro Chambrone

1.1 Defining the Concepts: Evidence-Based Dentistry and Its Application to Periodontology and Periodontal Plastic Surgery

The hall of periodontal surgical procedures has been constantly amplified since the mid-1950s by the development of techniques, biomaterials and the knowledge retrieved by basic/clinical research acquired, in order to combine the advantages of function's reestablishment with improvement of aesthetics. A single search of the *National Centre for Biotechnology Information*, *US National Library of Medicine* database (PubMed) using the terms "periodontal surgery" (http://www.ncbi.nlm.nih.gov/pubmed/?term=periodontal+surgery) provides access to more than 14,000 publications. Such a huge amount of references regards to all types of study designs; all of them presented together and without ranking the quality of information. As a result, the decision-making process may be jeopardized when low-quality data are erroneously used to guide a treatment plan.

Since the middle 1990s, periodontology has been moving its "eyes" to "evidence-based approaches: the search of treatment options sustained by the highest quality findings of the evidence available, the patient's oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences [1–4] (Fig. 1.1). Nowadays, evidence-based periodontology represents the most confident source of information for clinical decision-making (i.e. the selection of a treatment option instead of another) and for the search of alternative/novel therapies alike [3–10]. The employment of these criteria can identify and assess the entire base of evidence in a comprehensive manner, in order to respond a focused and relevant clinical question. For most of the diseases and conditions, more than a single procedure is available for use. Consequently, clinician may choose the best option for each patient individually, based on the expected results, potential complications/adverse effects, acceptance of the selected treatment by the patient and costs. Overall, the selection of "gold standard" procedures is the main focus of patients and professionals.

One of the most important characteristics of evidence-based decision-making regards to the translation of the results of research to conventional clinical practice. Apparently, this does not seem to represent a difficult task; however, it is dependent of a critical appraisal of what different (many times a bunch of) studies have identified as clinically relevant for use and the meticulous handling of these information.

An "evidence-based periodontology" now concentrates its efforts in asking about the known and unknown information of interest, finding and appraising the best sources of evidence and examining and adjusting such outcomes for clinical practice in order to provide the best treatment options to patients' needs [10]. The main tools used to achieve such purpose (systematic reviews [SR] and meta-analysis studies) have been growing in popularity because they may provide standardized, precise, consistent and qualified data combination of several quality-assured individual studies [1]. For instance, clinicians may search for the evidence in case reports, case series and randomized clinical trials and arbitrarily give the same "weight" (relevance) to them all (Fig. 1.2). The purpose of an evidence-based decision-making is to truly provide the directions to be followed when considering different options of treatment by allowing the clinicians to draw trustworthy conclusions based on the "scientific truth" and the ways to apply it in their practices [1, 3].

Based on that, "evidence-based periodontal plastic surgery" was defined as "the systematic assessment of clinically relevant scientific evidence designed to explore the aesthetic and functional effects of treatment of defects of the gingiva, alveolar mucosa and bone, based on clinician's

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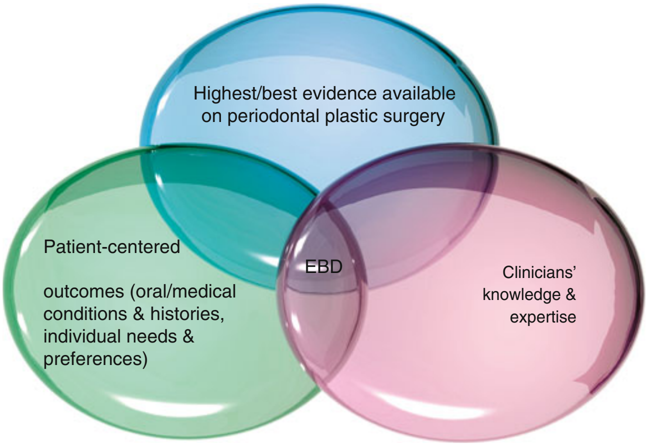

Fig. 1.1 Evidence-based dentistry (*EBD*) diagram "for periodontal plastic surgery (PPS)"

knowledge and patient-centred outcomes, such as perception of aesthetic conditions, functional limitations, discomfort, root sensitivity, level of sociability after surgery and preferences" [8–11]. Consequently, the primary argument to creating a background to judge and improve the quality of treatment with periodontal and peri-implant plastic surgery procedures should be the identification of the appropriate base of evidence for each respective therapy.

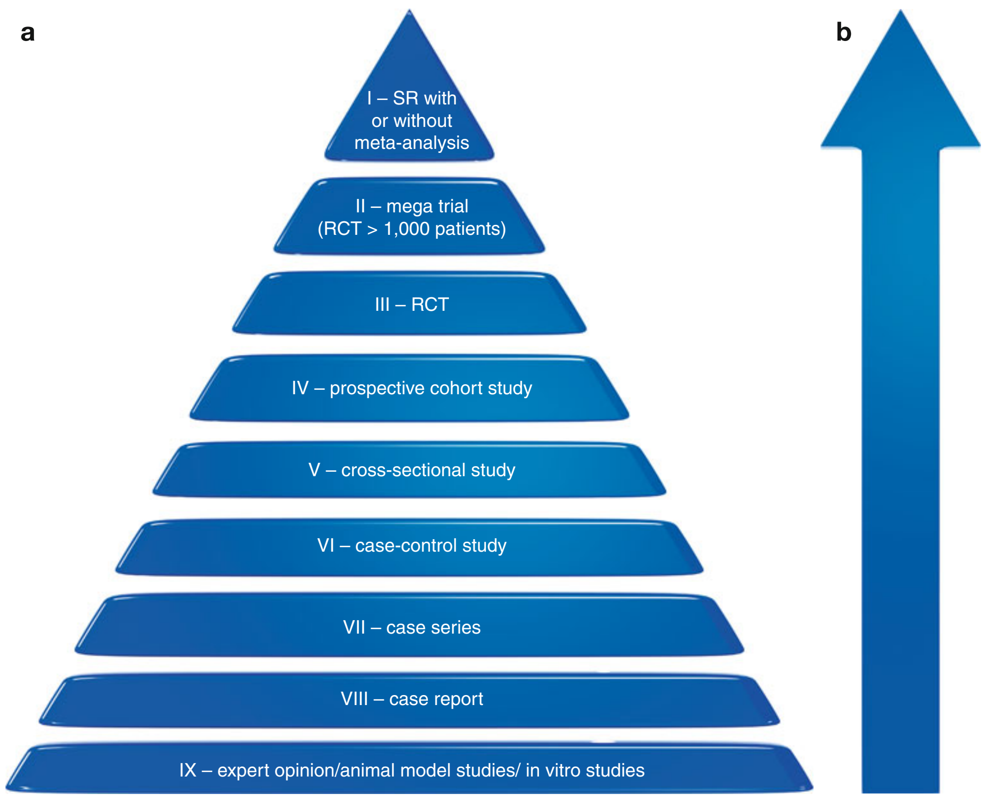

Fig. 1.2 Level of validity and confidence of outcomes according to study type [1]

1.2 Evidence-Based Decision-Making: "Why Should I Base My Treatment Plan on Evidence-Based Clinical Approaches?"

The implication of truly basing a treatment plan on evidence-based clinical approaches for health promotion relies in the use of a structured sequence of criteria in the retrieval and extraction of the best source of information available for a condition or disease [10]. These steps regularly followed by high-quality systematic reviews (SRs) and overviews (i.e. reviews of SRs) undoubtedly search to convert the information of efficacy research to clinical effectiveness; that is the translation of the results achieved at university research to conventional daily practice.

It is important to consider that SRs are planned to recognize, appraise and combine information from clinical trials to provide evidence-based responses and alternatives to clinical research problems [1, 3–11]. Queries linked to development of the clinical decision-making process, estimation of the value of treatment modalities and assessment of disparities in daily practice motivate clinicians to "read" an SR. Thus, these issues can provide important scientific basis of information for clinicians since they identify current knowledge (i.e. what is known and unknown) [1, 3–11].

On the other hand, some obstacles related to the best ways of interpreting the findings of these review studies may be transposed. Most of the clinicians are not trained on how to critically manage the group of findings of an SR neither to identify the central points that could not have been adequately reported in the publication. Consequently, a noticeable difficulty in interpreting their outcomes strengthens the condition that an SR has to report as maximum as possible (and in a transparent manner) the main criteria employed in the preparation of its research protocol. As such, it will provide the clinicians and experts that will read it the capacity to understand and distinguish what has been reported [1]. Based on that, the translation of research findings to clinical practice (by the critical assessment of the evidence available) will be able to guide the decision-making process.

1.3 Systematic Reviews: "Why Are They Useful?" and "Should They Limit My Practice?"

In general, systematic reviews base their result in five stages (Fig. 1.3) [1, 3, 8]:

1. Definition of a clear question (i.e. establishment of a focused question based on the *PICO/PECO* criteria)
2. Definition of inclusion and exclusion criteria
3. Search for the information of relevance
4. Extraction and critical assessment of the information
5. Systematic/logical data pooling
6. Reporting of conclusions based on the summary of the evidence
7. Reporting of what is known and unknown

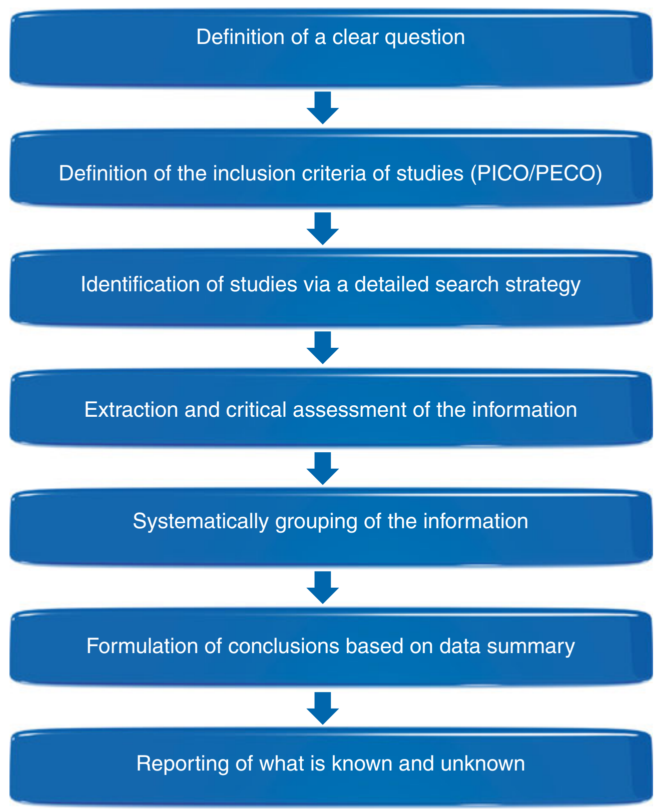

Fig. 1.3 Stages of a systematic review [1, 3]

A systematic review of interventions (for instance, one designed to evaluate treatment of gingival recessions) applies the *PICO* criteria to formulate the focused question, where *P* represents "patient population" (e.g. patients with gingival recessions), *I* "intervention" (e.g. the type of intervention(s) and conditions related to the prognosis of the treatment of the recessions), *C* "comparison" (e.g. the "gold standard" procedure and the main treatment alternatives for soft-tissue root coverage) and *O* "outcomes" (i.e. the results of treatment in terms of patients' satisfaction, recession depth reduction, functional improvements) [1, 3, 8].

The main resources and advantages of an SR relate to the precise assessment of an increased amount of data (when compared to individual studies) and its inherent greater statistical power, as well as by its robustness. Preferably, a randomized clinical trial is the type of study used to prepare an SR; however, other "lower" quality studies, such as (nonrandomized) controlled clinical trials and case series may be used as well when enough evidence is unavailable. The inclusion of such studies may decrease the real effect of treatment or even does not give support to the assumptions of interest (i.e. they may not allow the achievement of a convincing answer to the raised focused question).

Apart from the potential advantages and disadvantages of SRs, it is important to highlight that the lack of evidence (or information) of a procedure in a predetermined moment in time does not mean that the clinical evidence on the efficacy/effectiveness of such a procedure does not exist. In other words, clinical expertise may guide decision-making as well, when not enough information is available.

1.4 Clinical Remarks: "Can an Evidence-Based Decision-Making Process Be Really Relevant and Clinically Viable for Private Daily Practice?"

From a theoretical point of view, an "evidence-based decision-making" could be developed based on the questioning of the importance of the disease/condition, achievement and analysis of the best information available and adjustment and application of the results of research to the treatment of my patients. Overall, these steps are able to provide the "scientific truth" to the community of researchers involved in this process, patients and clinicians as well. On the other hand, the amount of information achieved after following these steps, or even the identification of a "lack of evidence", should not be interpreted simplistically like a "clinical guide".

Regarding to the answer of the question whether an evidence-based decision-making process can be really relevant and clinically viable for private daily practice, it seems no longer acceptable to propose a treatment planning not focused on the best level of information available for each treated case. Conversely, it does not mean that new or alternative procedures might be used when definitive information is still scarce, so clinical expertise may fulfil the gap of knowledge until strong evidence becomes available. Independent of the existence of enough evidence to support or refute the proposal of a periodontal/peri-implant plastic surgical therapy, clinicians should follow the principles of combining the best level of information available, clinician's expertise and patient's preferences.

Definitions for the Strength and Direction of Recommendation Regarding the Need of Therapy and Procedures

Within all chapters of this book, summary of the reviews/critical remarks of the literature and evidence quality rating/strength of recommendation of procedures were based on the criteria defined by the US Preventive Services Task Force (USPSTF) adapted by the American Dental Association [12]:

- Strong – Evidence strongly supports providing this intervention
- In favour – Evidence favours providing this intervention
- Weak – Evidence suggests implementing this intervention after alternatives have been considered
- Expert opinion for – Evidence is lacking; the level of certainty is low. Expert opinion guides this recommendation
- Expert opinion against – Evidence is lacking; the level of certainty is low. Expert opinion suggests not implementing this intervention
- Against – Evidence suggests not implementing this intervention or discontinuing ineffective procedures

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Periodontal Anatomy and Its Role on the Treatment Planning of Aesthetic Areas

2

Leandro Chambrone, Umberto Demoner Ramos, and Carlos A. Ayala Paz

2.1 The Periodontium: The Balance Between Function and Aesthetics

The periodontium can be defined as "the tissues that invest and support the teeth including the gingiva, alveolar mucosa, cementum, periodontal ligament, and alveolar and supporting bone" [1] (Fig. 2.1).

Shaped during teeth's formation and development, these structures may be modified during a subject's life, leaving their "pristine" characteristics, as result of several inherent local, environmental, and systemic conditions. For instance, parafunctional habits/heavy occlusal forces may promote a reinforcement of the bone trabeculae and the deposition of cellular cementum at the root apex (Fig. 2.2a) [2, 3], periodontitis promotes a resorption of alveolar bone and loss of periodontal ligament (Fig. 2.2b–e) [4, 5], and tobacco smoking may decrease peripheral vascularization and increase keratinization of oral gingival epithelium [6]. Also, even in well-maintained subjects who practiced oral hygiene and returned periodically for maintenance care appointments, slight to moderate incidence of periodontal destruction (0.02–0.1 mm/year) may increase with age, especially between 50 and 60 years of age [7]. Apart of any "positive" or "negative" impact on the periodontium, it is of paramount importance to consider that the conditions of periodontal structures surrounding a natural tooth are directly associated to the patient's quality of life by maintaining the ability to chew, digest food, and smile. Conversely, the clinical response of an individual tooth to periodontal treatment over time may not be easy to be predicted precisely, particularly if the tooth has been exposed to periodontal disease and anatomic and/or traumatic conditions [5, 8–11].

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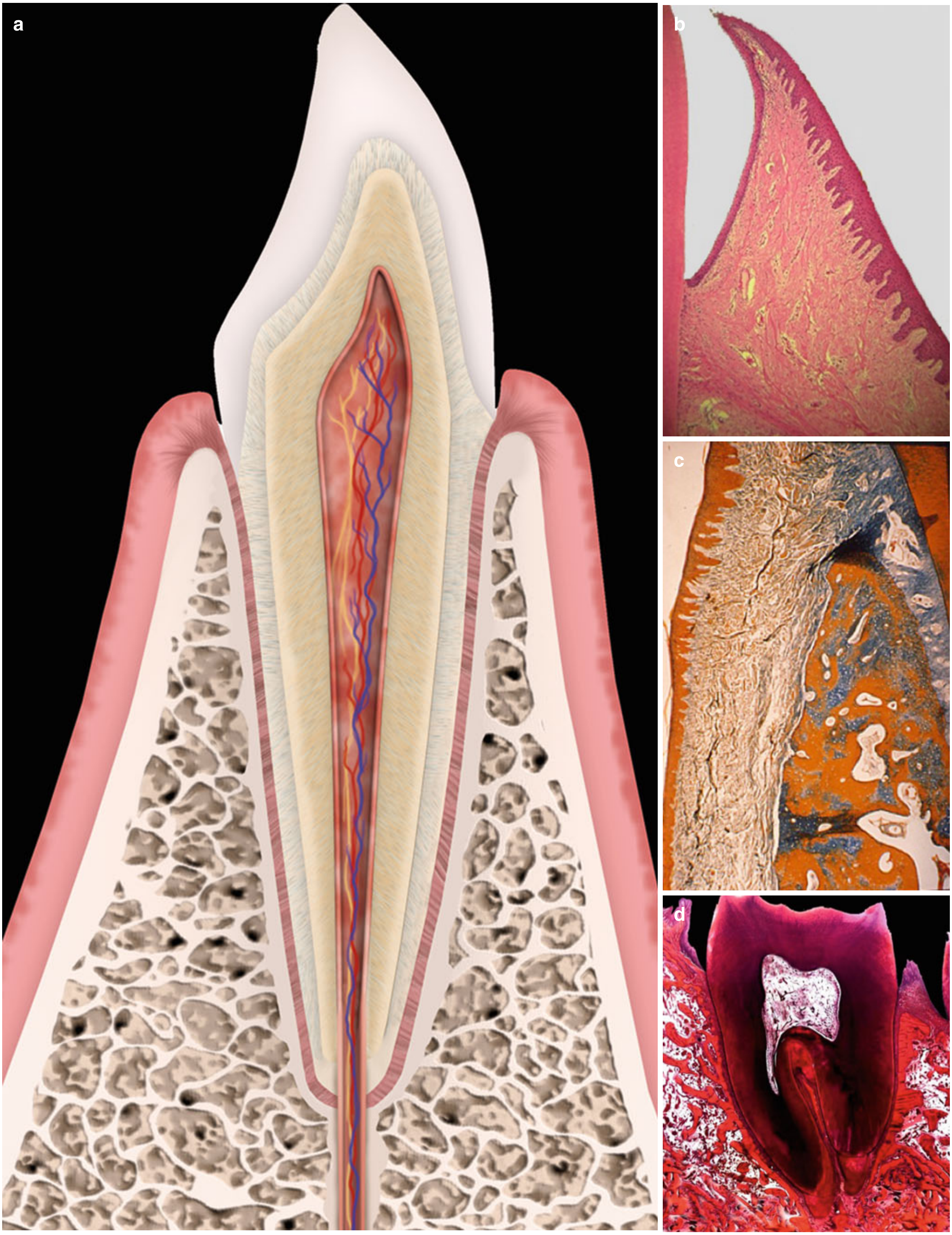

Fig. 2.1 Periodontal tissues: the cementum, alveolar bone, periodontal ligament, and gingiva

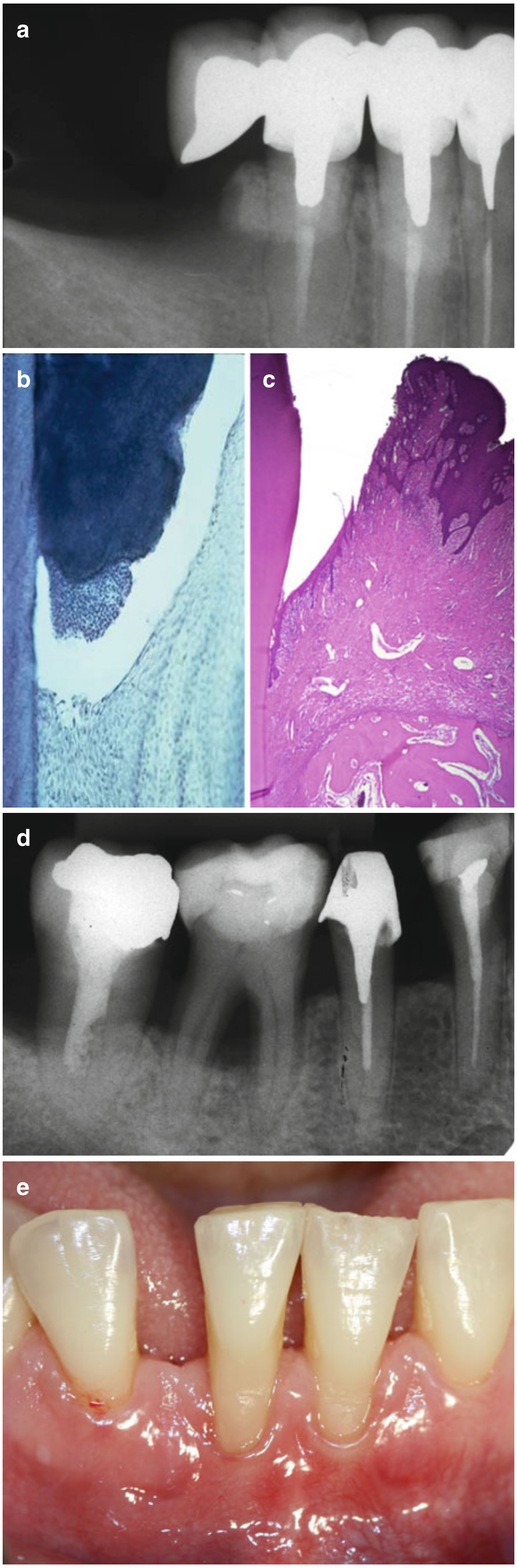

Fig. 2.2 Increase of the cementum and trabecular bone in response to occlusal forces (bony exostosis) (**a**); periodontitis (**b**–**e**)

In the field of periodontics/periodontology, when a patient presents discrepancies in soft tissue morphology, osseous architecture, tooth morphology (e.g., color alteration and shape), and positioning, aesthetical and/or functional treatment approaches may optimize the "pink" and "white" aesthetics concomitantly. Especially within aesthetic areas, the treatment of soft/hard tissue deformities represents an important challenge for the dental clinician, since it may involve a complex, multidisciplinary decision-making process for the concomitant accomplishment of health and harmony between dental and periodontal tissues. For such cases, the balance between function and aesthetics will be dependent on the clinician's skills and knowledge on tissue anatomy and morphology. Thus, the actual treatment paradigm must be associated with composed functional (e.g., reestablishment of health and proper occlusion) and aesthetical/cosmetic approaches, or in other words, the treatment planning of aesthetic areas must lead to satisfactory clinical and aesthetic long-term results, by achieving a pleasant and harmonious smile [8–11].

2.2 The Anatomy of Soft Tissues Surrounding Human Teeth: The Mucogingival Complex

"The mucogingival complex" is formed by the portion of the oral mucosa that covers the alveolar process including the gingiva (keratinized tissue) and the adjacent alveolar mucosa [1]. Clinically, the gingiva ("the fibrous investing tissue, covered by keratinised epithelium, that immediately surrounds a tooth and is contiguous with its periodontal ligament and with the mucosal tissues of the mouth") [1] can be found around the cervical portion of the teeth and is characterized by (a) a pink and opaque color, (b) scalloped appearance/contour, (c) a stippling texture that reminds an "orange peel," and (d) firm consistence, (e) may present melanic pigmentation, and (f) may vary in width, and (g) it usually assumes its definitive shape and texture following the eruption of permanent teeth (Fig. 2.3) [12, 13].

In terms of clinical anatomic limits, the gingiva is delimited by the free/marginal gingiva ("that part of the gingiva that surrounds the tooth and is not directly attached to the tooth surface/the most coronal portion of the gingiva that forms the wall of the gingival crevice in health") [1] and the attached gingiva ("the portion of the gingiva that is firm, dense, stippled, and tightly bound to the underlying periosteum, tooth, and bone"). The free/marginal gingiva includes the interdental papilla ("that portion of the gingiva that

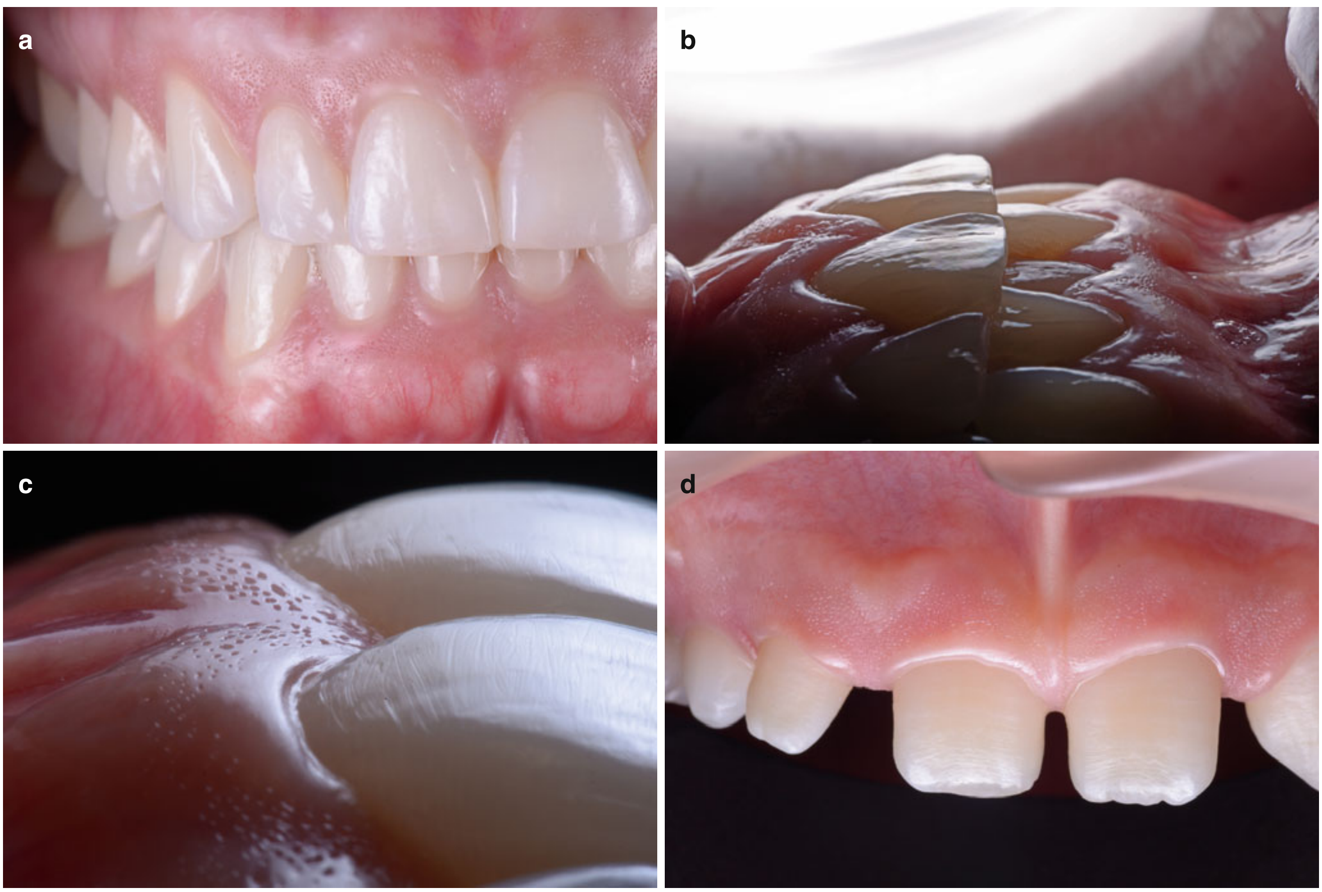

Fig. 2.3 Clinical characteristics of the gingiva

occupies the interproximal spaces [the interdental extension of the gingiva]") [1] and the col ("a valley-like depression of the interdental gingiva that connects facial and lingual papillae and conforms to the shape of the interproximal contact area") [1]. Within anterior interproximal sites, the interdental papilla assumes a triangular shape, whereas at the posterior teeth these are more "smooth-edged" given the impression that the posterior papilla is formed by two parts, one buccal and one lingual separated by the col area [13, 14]. Usually, the free/marginal gingiva extends to the gingival groove ("a shallow, V-shaped groove or indentation that is closely associated with the apical extent of free gingiva and runs parallel to the margin of the gingiva") [1] where it "connects" to the attached gingiva [13, 14]. Regarding the attached gingiva it extends from the apical limit of the free/marginal gingiva to the mucogingival junction, its width may vary between the anterior and posterior teeth, and it may increase with age (Fig. 2.4) [13, 14].

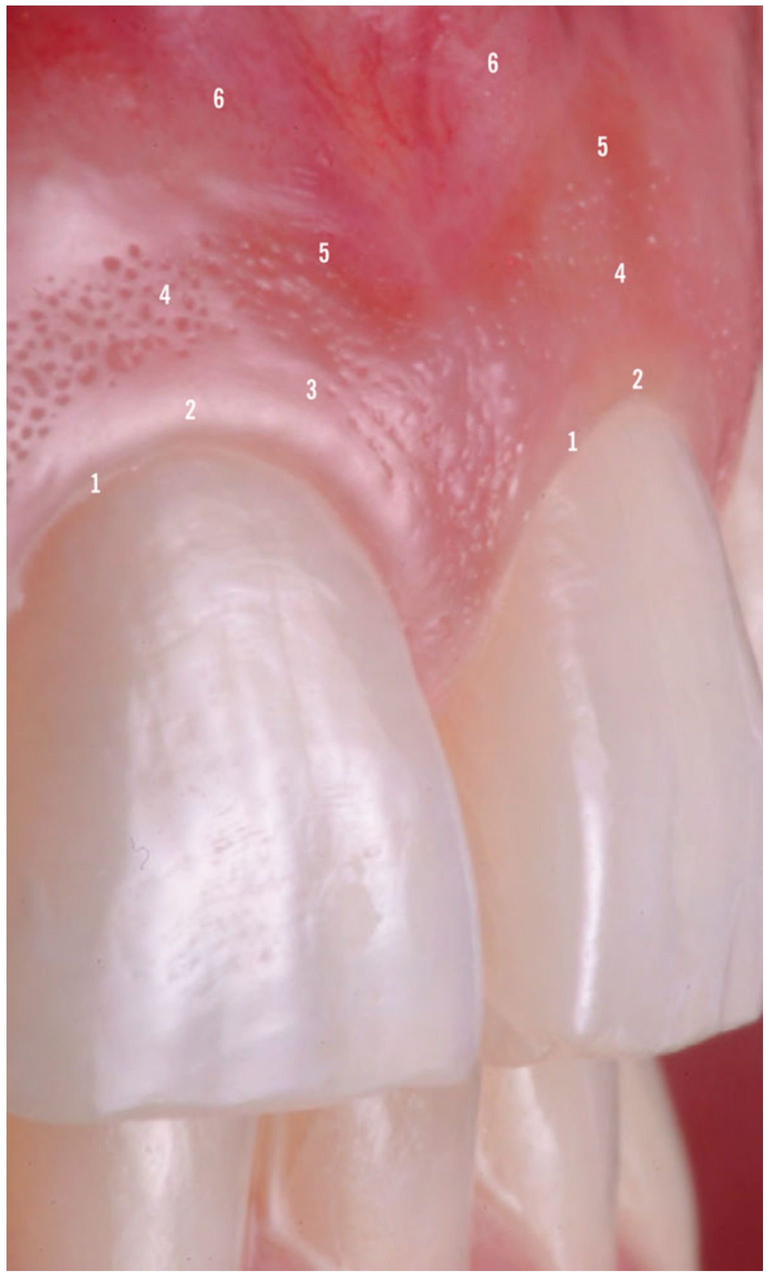

Fig. 2.4 Anatomic limits of the gingiva. *1* Gingival margin, *2* free gingival margin, *3* gingival groove, *4* attached gingiva, *5* mucogingival junction, *6* alveolar mucosa

Microscopically, the gingiva is formed by three epithelial (oral, oral sulcular/crevicular, and junctional) and one connective tissue layer (Fig. 2.5). With the assistance of biopsy samples of human teeth sectioned in a buccal–lingual plane, it can be seen that the buccal gingiva facing the oral cavity presents a layer of keratinized stratified squamous epithelium denominated "oral epithelium" that extends from the mucogingival junction to the gingival margin (Fig. 2.6). This epithelium is formed by four layers/stratums (Fig. 2.7):

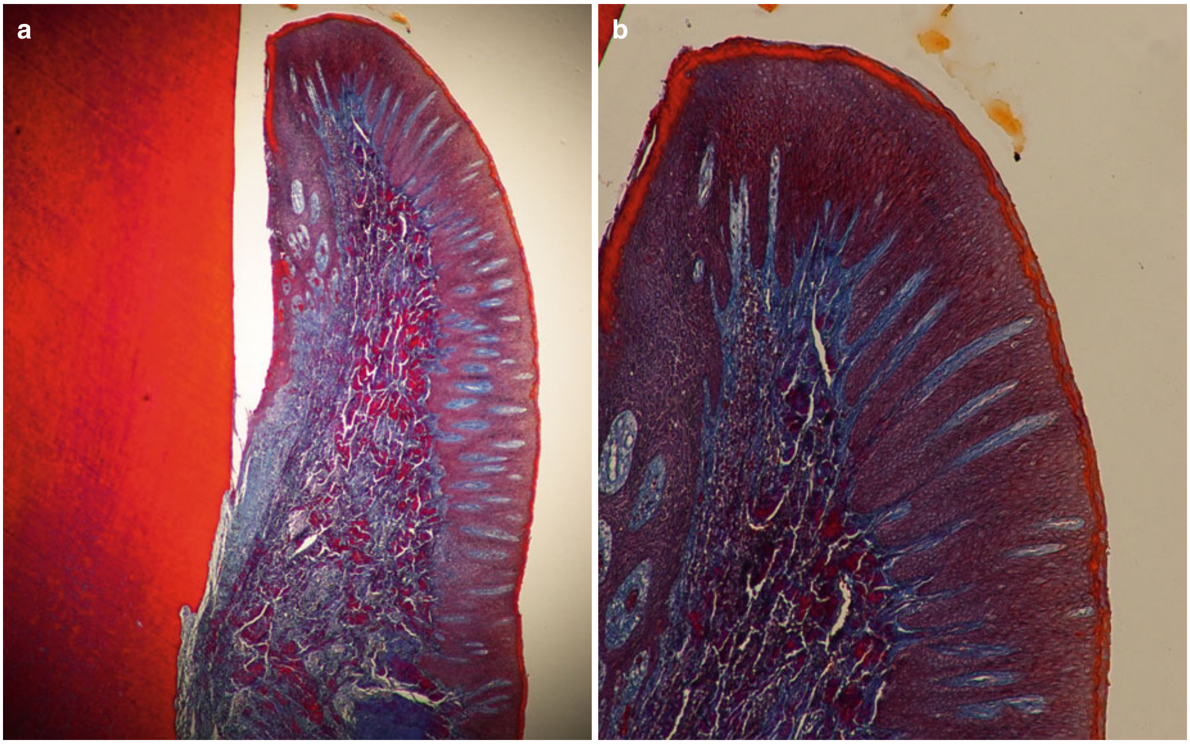

Fig. 2.5 The oral epitheliums (40×) (**a**) and (100×) (**b**)

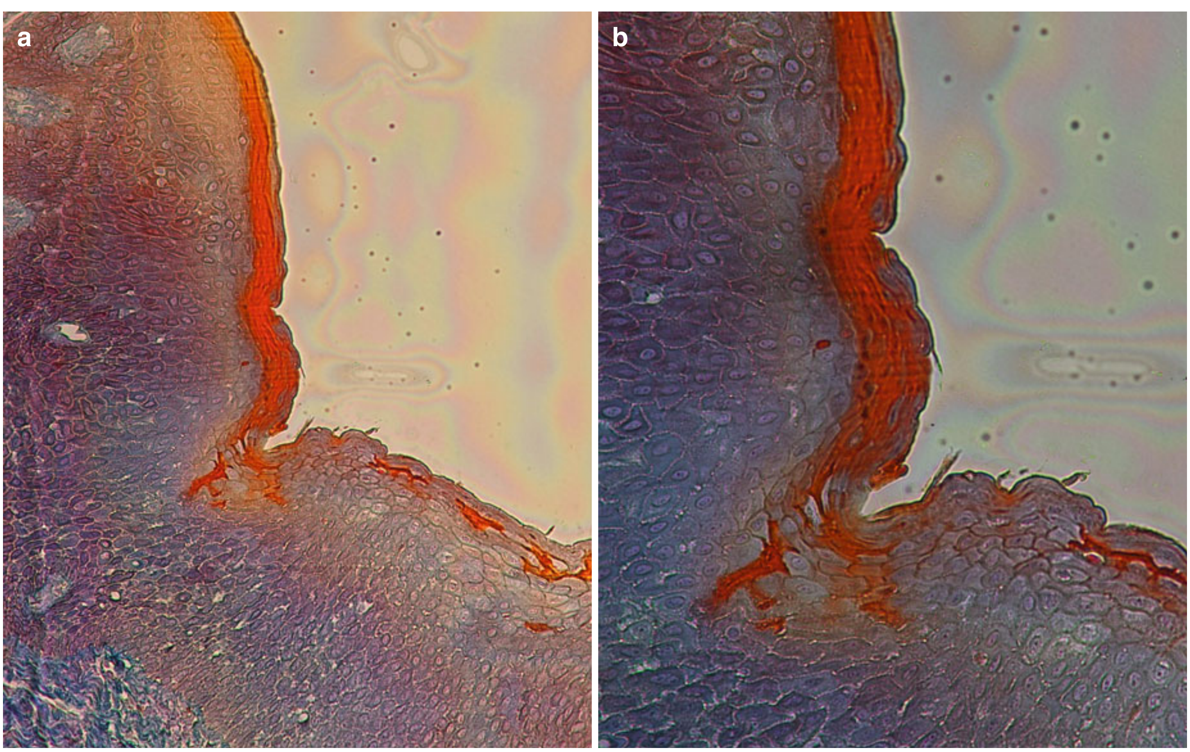

Fig. 2.6 Mucogingival junction (100×) (**a**) and (200×) (**b**)

- Basale: Formed by rounded and small proliferative cells, known as keratinocytes. These mother cells multiply constantly forming new cells (daughter cells) that will follow through the other three stratums until reaching the corneum one [13, 15]. Also, they are in contact with the basement membrane (the membrane that separates the connective tissue of the lamina propria from the gingival epithelium) [13, 15].
- Spinosum: Considered to be the thickest stratum of all, it is formed by large polyhedral spinous-appearing cells [13, 15].
- Granulosum: This layer received this name because of the presence of flattened-shaped cells that present within their cytoplasm the presence of dense cytoplasmic keratohyalin granules (this protein provides the "grainy aspect" of this stratum and leads to nuclei and organelle disintegration) [13, 15].
- Corneum: Formed by flattened keratin cells. They may provide the configuration of a keratinized epithelium when the nuclei and organelles are no longer present or of a parakeratinized epithelium when remaining components of the nuclei may be found [13, 15].

Within the oral epithelium, different types of cells may be found, such as melanocytes (cells that produce the dark, amorphous pigment of the skin, hair, and the choroid coat of the eye and that give the darkish color of the gingiva – Fig. 2.8) [1], Langerhans (defense cells originated of macrophages), and Merkel (sensorial/tactile) cells [13, 15].

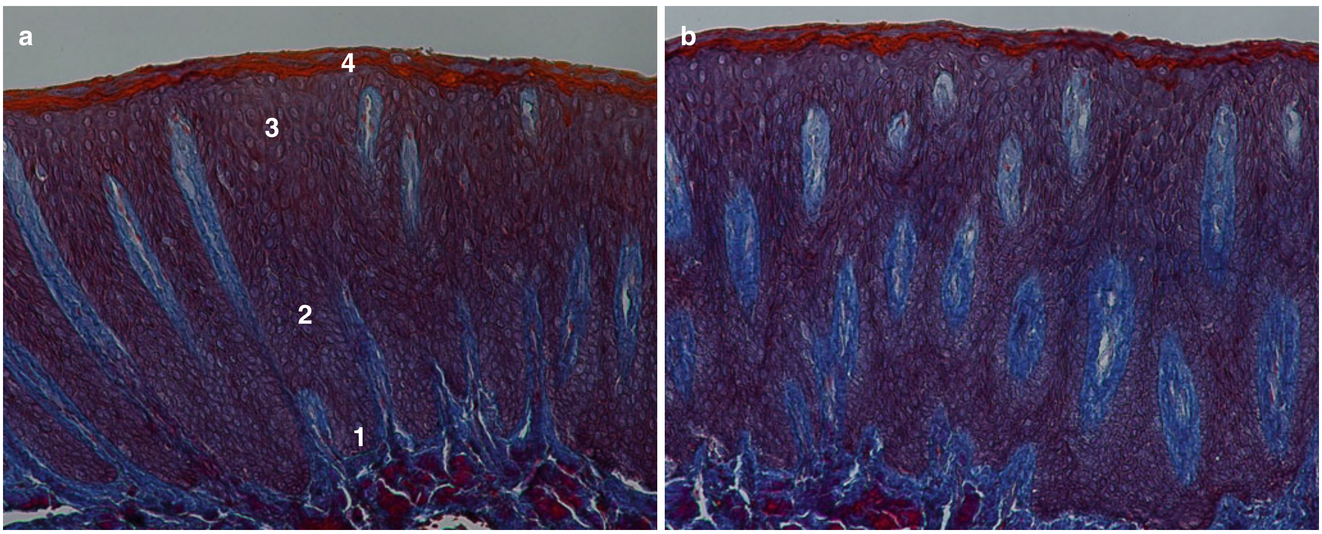

Fig. 2.7 Epithelial layers (*1* basale, *2* spinosum, *3* granulosum, *4* 0 corneum (200×))

Fig. 2.8 Pigmented gingiva (melanocytes of the oral epithelium)

At the gingival margin, the oral epithelium "continues" through the interior of the gingival sulcus/crevice (i.e., the shallow fissure between the marginal gingiva and the enamel or cementum) [1], and there it becomes the oral sulcular/crevicular epithelium, a nonkeratinized stratified squamous epithelium formed by three layers (basale, spinosum, and granulosum) [13–15]. Despite being described as "nonkeratinized," there has been evidence of areas/portions of keratinization mainly close to the entrance of the crevice (Fig. 2.9). Additionally, in the presence of gingival health, it will allow the formation of a gingival sulcus/crevice of 0.69 mm that extends from the gingival margin to the bottom of the crevice all around the tooth [16].

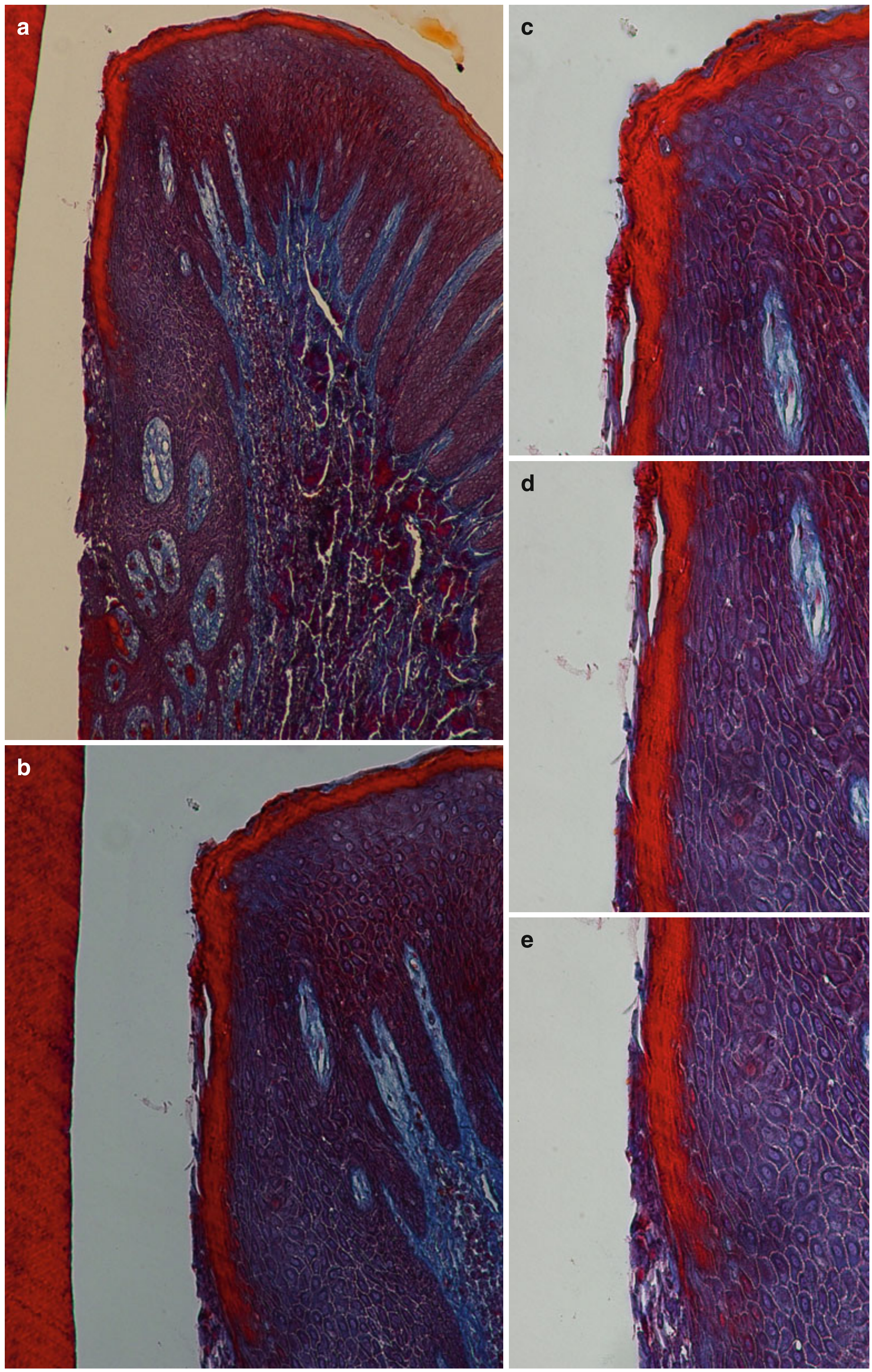

Fig. 2.9 Sulcular/crevicular epithelium (100×) (**a**, **b**) and (200×) (**c**–**e**)

The bottom of the gingival crevice separates the sulcular of the junctional epithelium, which is defined as "a single or multiple layer of nonkeratinizing cells adhering to the tooth surface at the base of the gingival crevice" [1]. It is formed by 15–30 parallel layer cells at its most coronal portion adjacent to the oral sulcular/crevicular epithelium to just a few cells at its most apical position [15]. Despite presenting just two strata (basale and suprabasale), the junctional epithelium is characterized by its capacity of sealing the internal or the external environment and by its high capacity of cellular turnover (as provided by its basal layer) and bigger intercellular spaces than the other two epitheliums (Fig. 2.10) [13, 15]. These features provide the ability not only of attachment, but of protection because of cell desquamation at its most coronal portion (i.e., close to the base of the gingival sulcus/crevice) and permeability to polymorphonuclear neutrophils (which are quite evident) [13, 15].

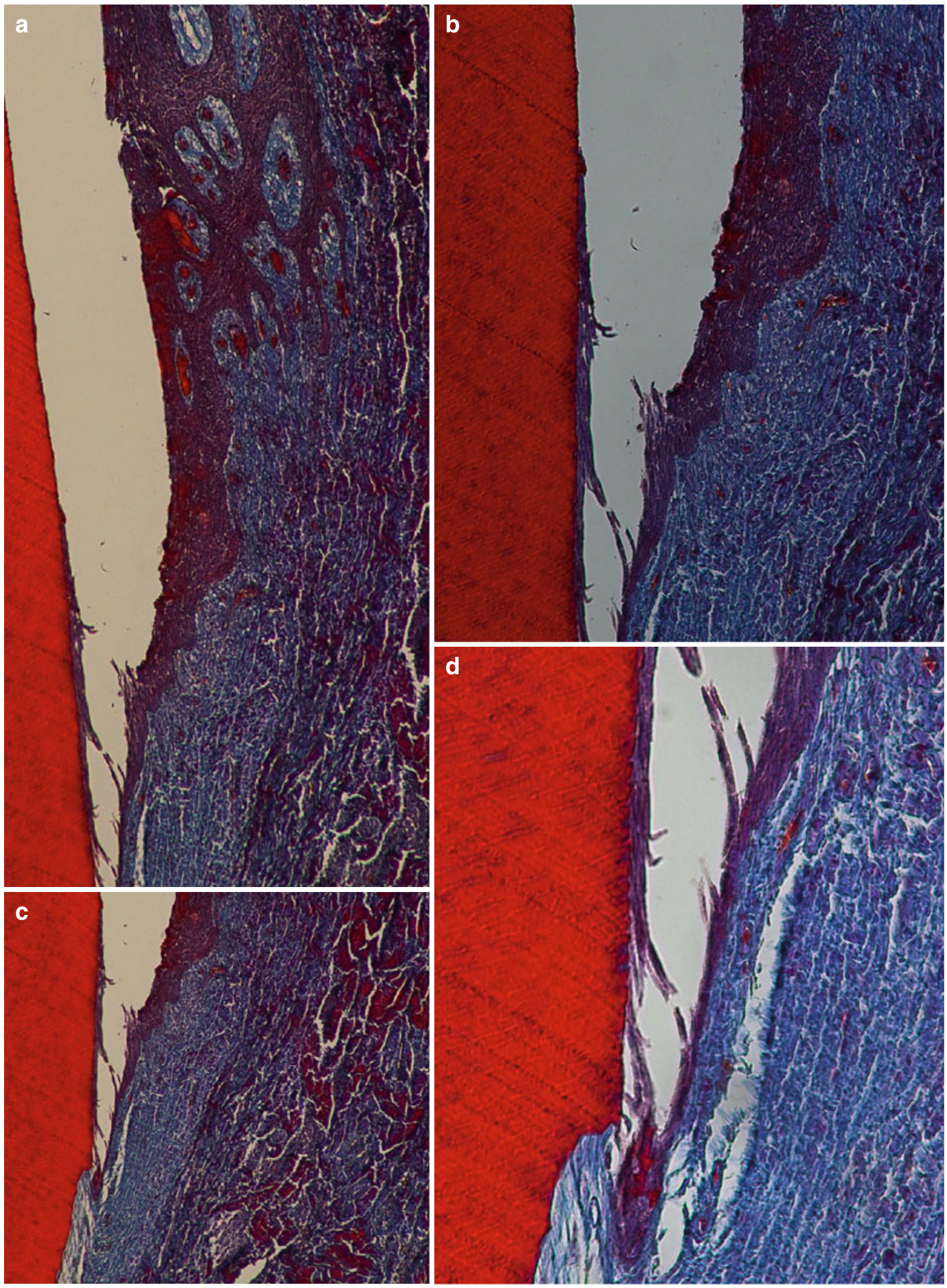

Fig. 2.10 The junctional epithelium (transition between the sulcular epithelium and the junctional epithelium). Note to the readers: the specimens presented in this chapter are derived from a clinical study on soft tissue root coverage. They were only used with the purpose of providing a histologic description of gingival epithelium and connective tissue. Probing depth was performed immediately before tooth extractions; thus, portions of the junctional epithelium are not completely attached to the root surface (technical artifact) (100×) (**a**, **b**) and (200×) (**c**, **d**)

All epitheliums are underlined by a connective tissue layer of the lamina propria ("the connective tissue coat just beneath the epithelium and the basement membrane") [1]. For the oral epithelium, the interface formed with the connective tissue is irregular and comprises "fingerlike projections" of connective tissue from the papillary layer ("connective papilla") that extends into depressions on the undersurface of the epithelium ("epithelial crests") [16]. These ridge-like projections of epithelium into the underlying stroma of connective tissue [1] (or rete pegs when seen in histological sections– Fig. 2.11) improve its attachment to the lamina propria [16]. The sulcular/crevicular epithelium also presents such "rete ridges" but in a diminished number, while at the junctional epithelium these are not present [17].

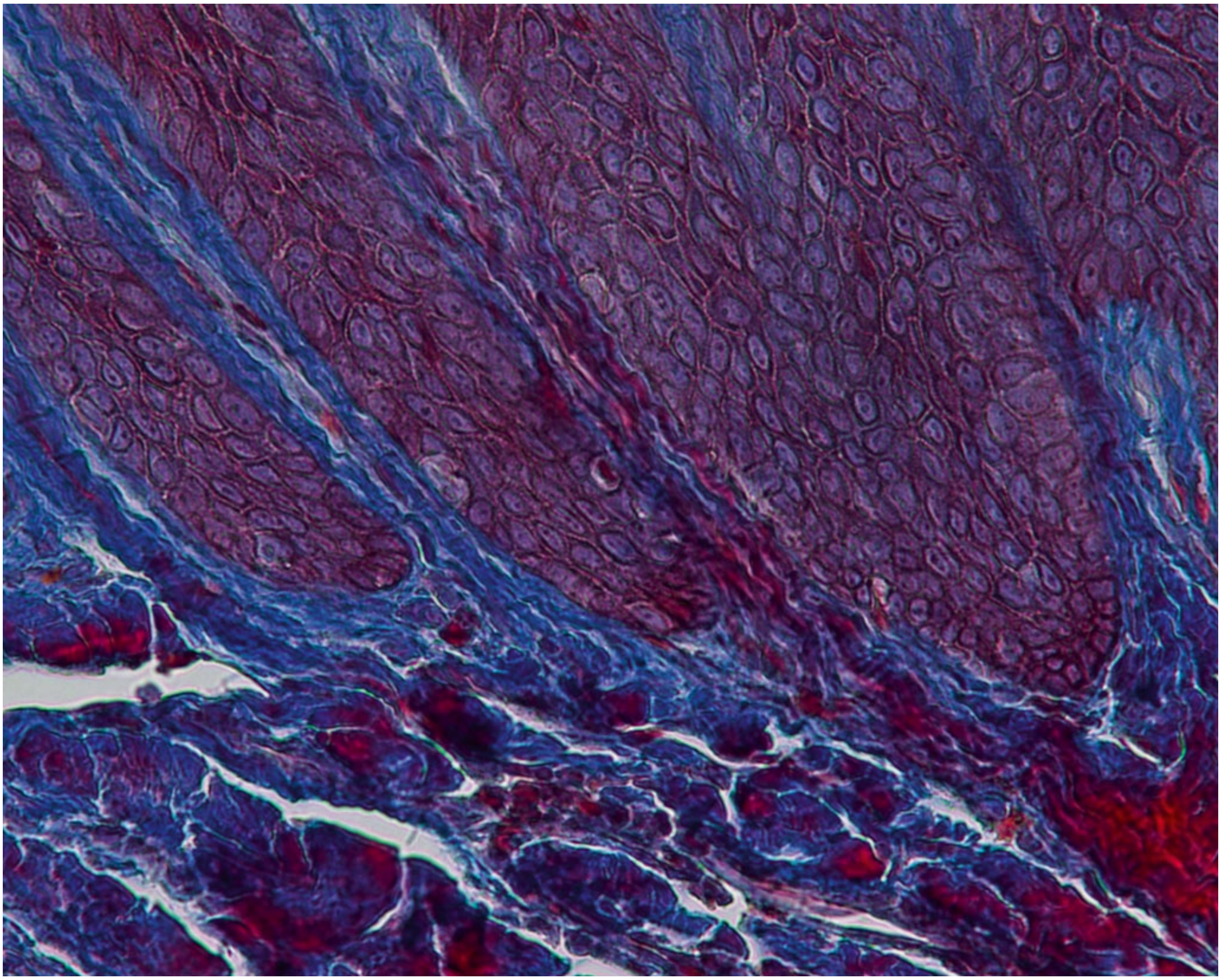

Fig. 2.11 Rete pegs (200×)

Regarding the components of the gingival connective tissue, it is formed by fibroblasts (65 % of all tissues) and other cells (i.e., mast cells, macrophages, undifferentiated mesenchymal cells, neutrophils, and plasma cells), fibers, blood vessels, and nerve fibers that are intended to act for cell nutrition, tissue healing, as well as mechanical (by the group of collagen fibers and the viscosity of the amorphous intercellular substance of the extracellular matrix) and phagocytic (via macrophages, neutrophils, antigen–antibody reactions, and activation of the complement system) mechanisms of defense [13, 15] Figs. 2.12 and 2.13.

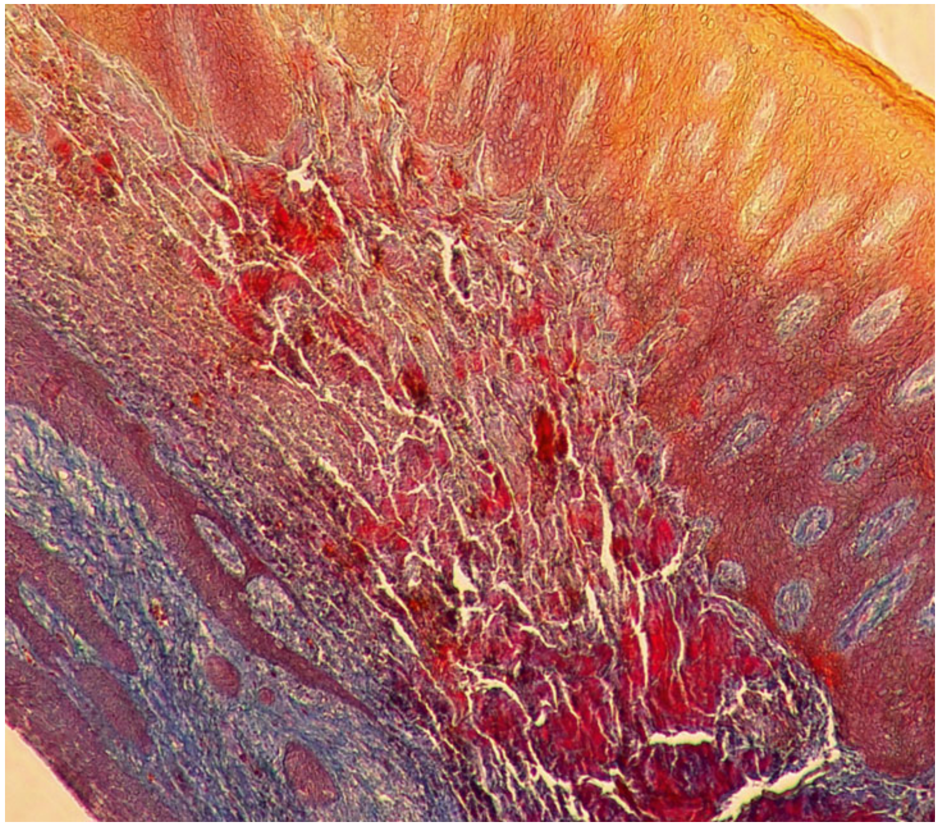

Fig. 2.12 Gingival connective tissue (100×)

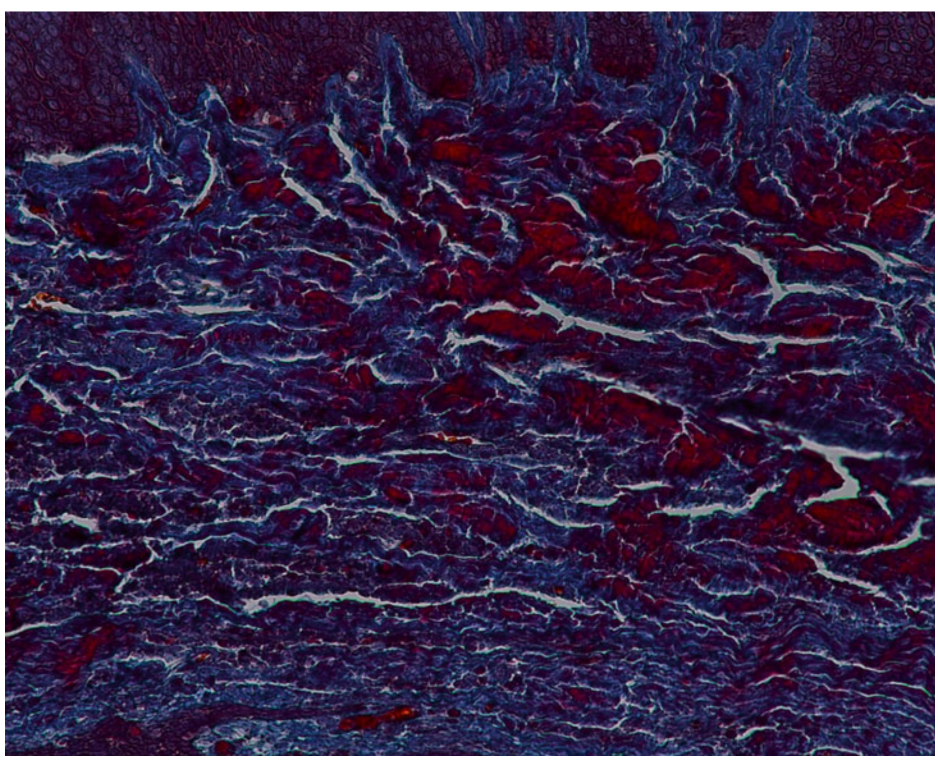

Fig. 2.13 The gingival connective tissue (note the presence of the inflammatory cell within the tissue) (200×)

Although parts of the fibers are irregularly distributed through the connective tissue layer, most of them consisting of a dense network of collagen fiber bundles form an organized supra-alveolar fiber apparatus. Their function and location are illustrated in Figs. 2.14 and 2.15 (notes 1–9) and depicted as follows [1, 13, 15]:

- Dentogingival fibers: Group of collagenous fibers that extend from the cervical cementum to the lamina propria of the free and attached gingiva (1).
- Dentoperiosteal fibers: Group of fibers running from the cementum over the periosteum of the outer cortical plates of the alveolar process where they insert into the alveolar process or muscle in the vestibule of the floor of the mouth (2).
- Alveolo-gingival fibers: Group of collagenous fibers that radiate from the bone of the alveolar crest into the lamina propria of the free and attached gingiva (3).
- Circular/semicircular fibers: Group of collagenous fiber bundles within the gingiva that encircle the tooth in a ring-like fashion (4).
- Intergingival and transgingival fibers: These groups of fibers are narrowly associated to the semicircular fibers.

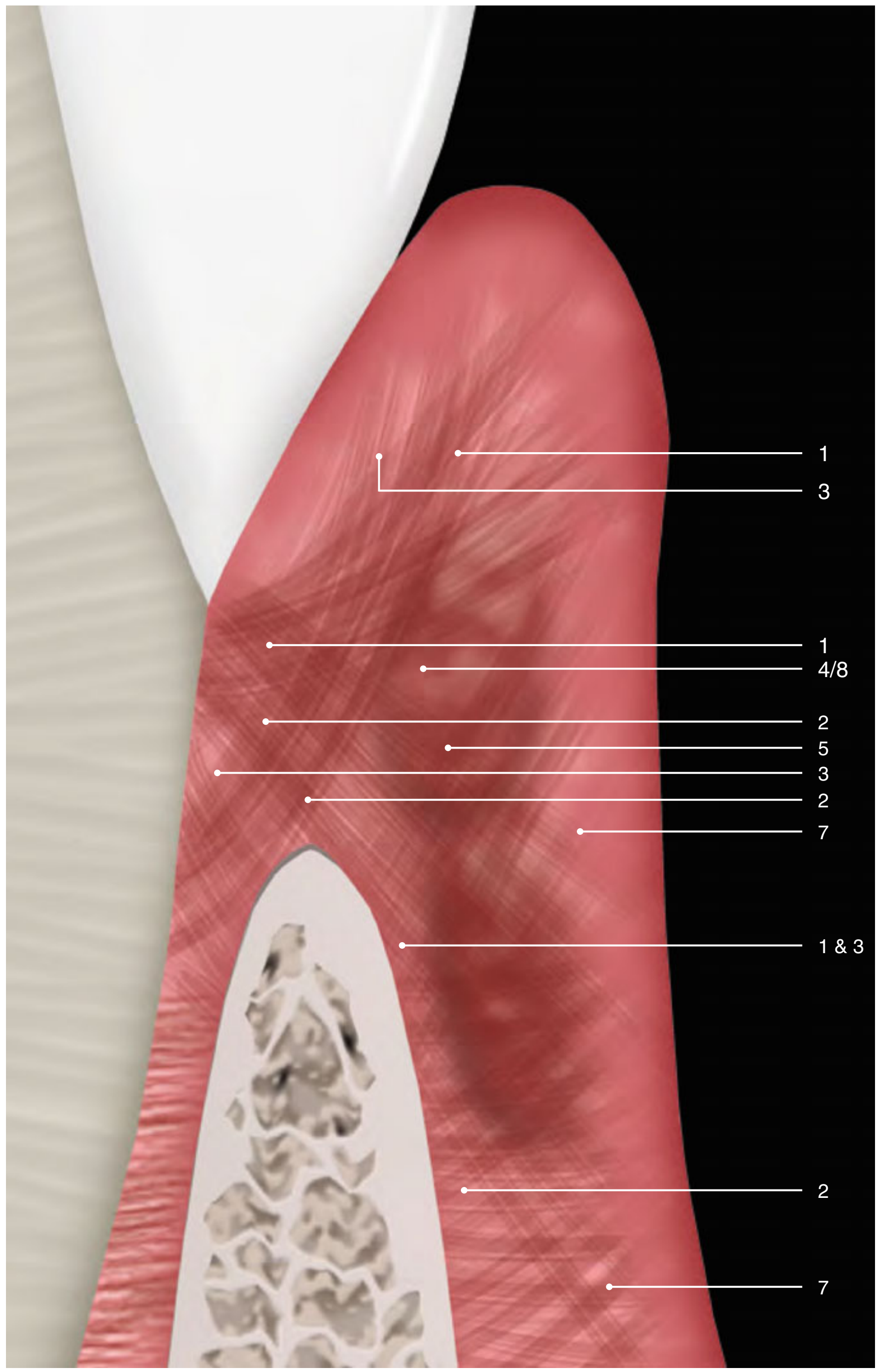

Fig. 2.14 Supragingival fibers: view 01 (as described by Schroeder and Listgarten [13])

They ascend in the cementum and outspread through the intergingival fibers and interdental septum and eventually merge with the semicircular fibers of the adjacent tooth (5).

- Interpapillary fibers: Group of collagenous fibers running between the gingival connective tissue of facial and lingual aspects of the posterior papilla (running in a buccolingual direction through the interdental tissue) (6).
- Periosteo-gingival fibers: Group of collagenous fibers that extend from the periosteum of the outer cortical plates to the lamina propria of the gingiva (7).
- Intercircular fibers: Group of fibers located both buccally and lingually and run in a mesiodistal manner to join circular fibers of adjacent teeth (8).
- Transseptal fibers: Collagenous fibers that run interdentally from the cementum just apical to the base of

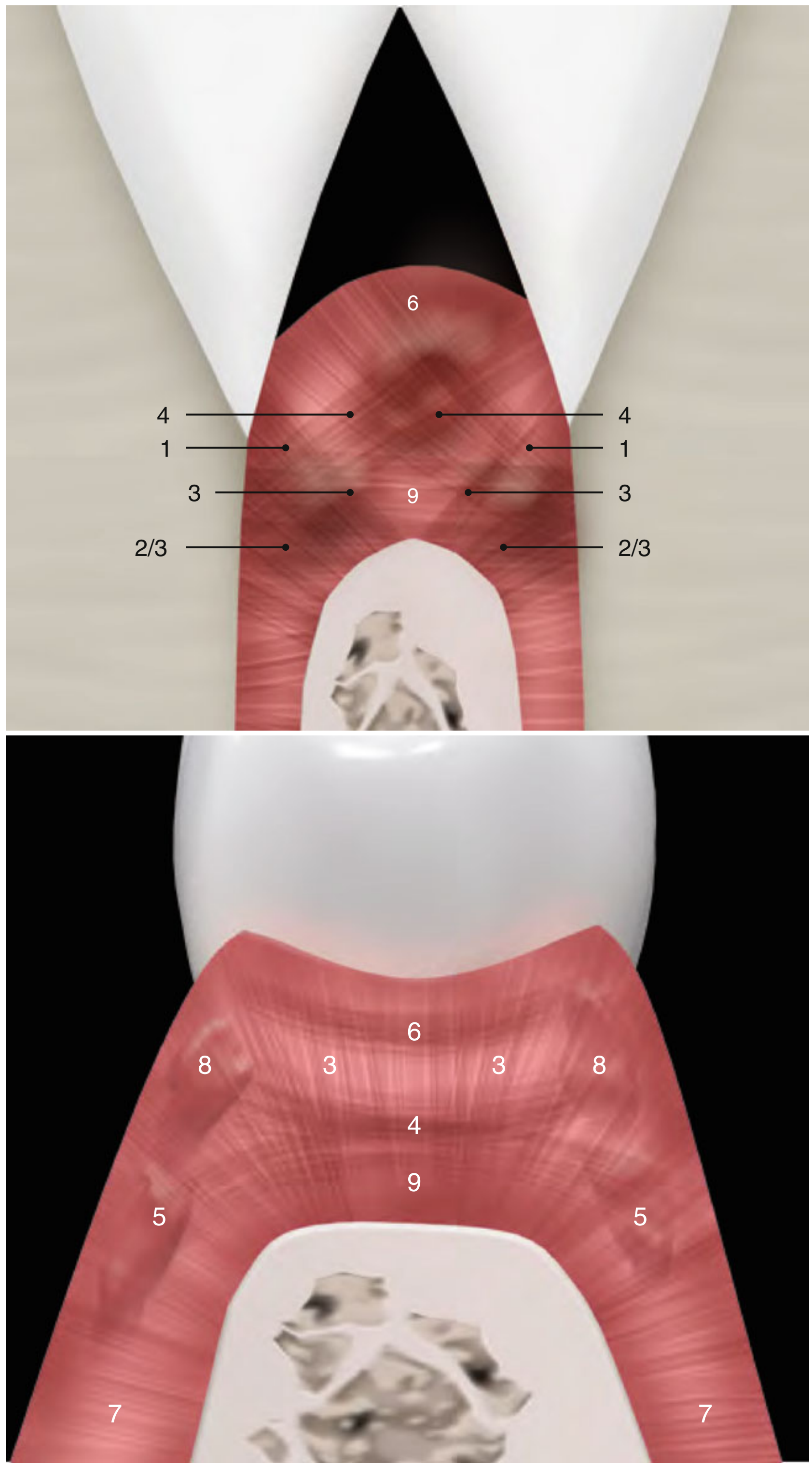

Fig. 2.15 Supragingival fibers: views 02 and 03 (as described by Schroeder and Listgarten [13])

the junctional epithelium of one tooth over the alveolar crest to insert into a comparable region of an adjacent tooth (9).

Additionally, other types of fiber bundles such as oxytalan ("fibers found in all connective tissue structures of the periodontium that appear to consist of thin, acid-resistant fibrils – their function is unknown") [1], reticular (type III collagen fibers secreted by reticular/fibroblast cells that give support to the lamina propria of the gingiva), and elastic (around blood vessels) are present at the gingival connective tissue.

With respect to the neurovascular composition of the gingival connective tissue, the vascularization of the gingiva is primarily supplied by blood vessels located at the periodontal ligament and at the supraperiosteal portion of the lamina propria (i.e., supraperiosteal vessels) and by the intraseptal artery [13, 15]. These vessels/artery and capillary loops will originate from two vascular networks of arteriovenous anastomoses, the subepithelial and the dentogingival plexus (Fig. 2.16) [15]. Regarding the neural elements, these are its great majority surrounding/close to blood vessels and composed by myelinated fibers that play a sensory part [15].

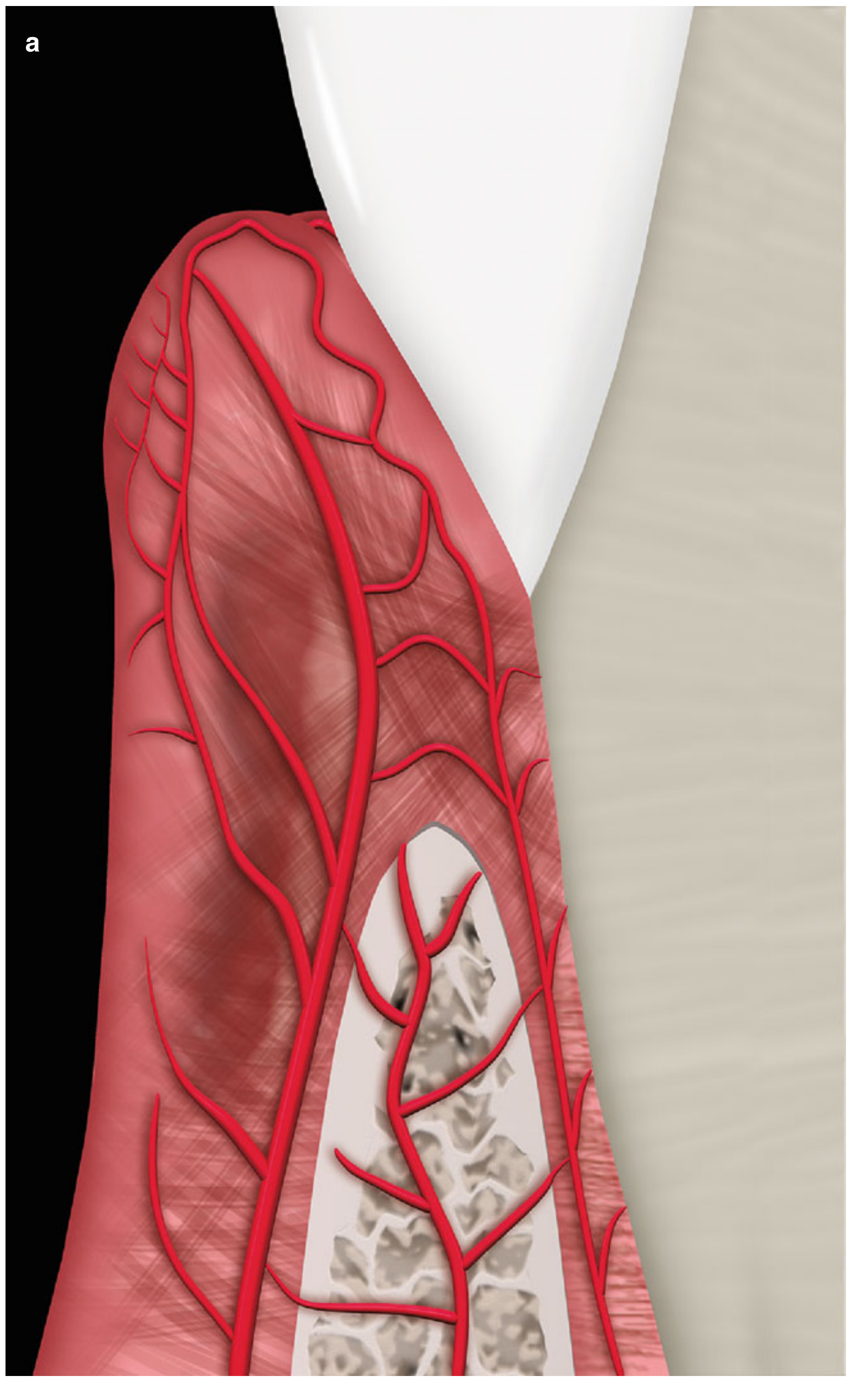

Fig. 2.16 Gingival vascularization

Fig. 2.16 (continued)

2.3 Anatomy of Supporting Periodontal Tissues: The Clinical Role of Cementum, Alveolar Bone, and Periodontal Ligament Conditions

The clinical role of the cementum, the alveolar bone, and the periodontal ligament conditions is briefly depicted below [1, 18]:

- It is described as "the thin, calcified tissue of ectomesenchymal origin, similar to the alveolar, covering the roots of teeth which embedded collagen fibers attach the teeth to the alveolus" [1]. Its function is related to repair and attachment, as well as it is continuously deposited over a tooth's life. It can be of acellular/primary (i.e., "that portion of the cementum that does not incorporate cells – it is formed during the root's formation") or cellular/secondary (i.e., "that portion of the cementum that contains cementocytes – it is formed during a tooth's life in the apical third of the root as a response to occlusal forces") origin (Fig. 2.17) [1, 18].
- Alveolar bone: "The hard form of connective tissue that constitutes the majority of the skeleton of most vertebrates. It consists of an organic component and an inorganic, or mineral, component. The organic matrix contains a framework of collagenous fibers and is impregnated with the mineral component, chiefly calcium phosphate and hydroxyapatite, that impart rigidity to bone. The alveolar process supports to alveoli, and consists of cortical bone, cancellous trabeculae, and the alveolar bone proper." [1] It can be divided into alveolar bone proper ("compact bone that composes the alveolus (tooth socket), also known as the lamina dura or cribriform plate – the fibers of the periodontal ligament insert into it") and basal bone ("the bone of the mandible and maxilla exclusive of the alveolar process"). Also, the alveolar bone may also be characterized

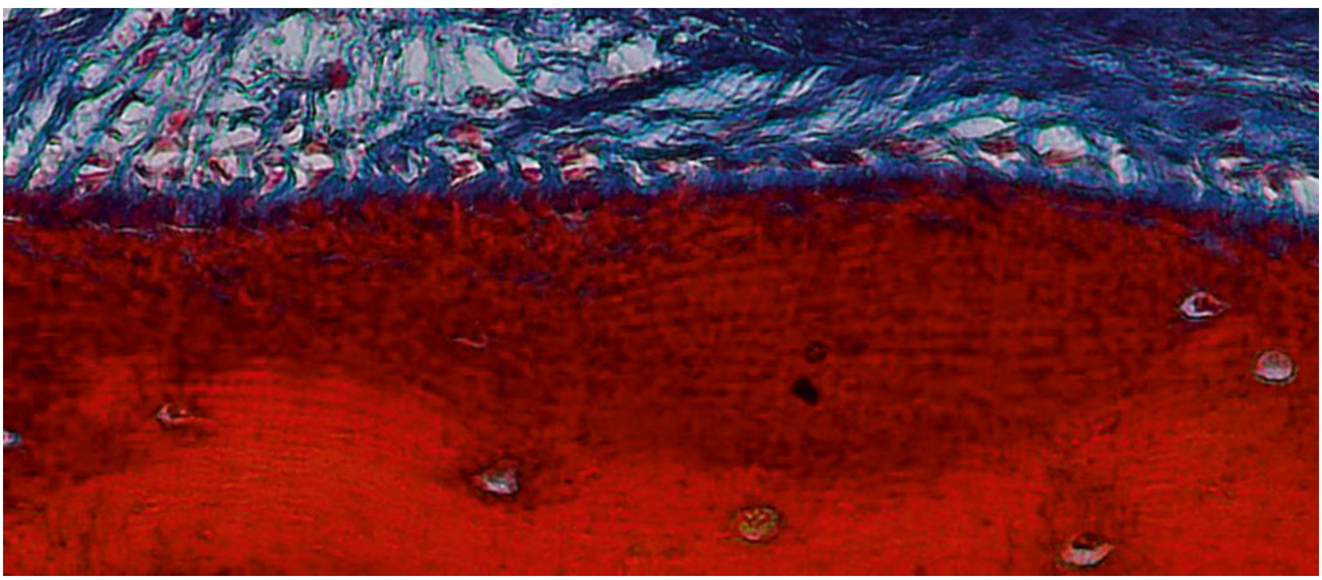

Fig. 2.17 Cementum and Sharpey's fibers (200×)

by its structure as bundle ("a type of alveolar bone, so-called because of the "bundle" pattern caused by the continuation of the principal [Sharpey's] fibers into it"), cancellous ("bone having a reticular, spongy, or lattice-like structure"), compact ("bone substance that is dense and hard"), or cortical bone ("the compact bone at the surface of any given bone") [1]. The osseous morphology is dependent of the structures attached to the tooth, as well as to the structure and position of a tooth (Fig. 2.18) [18].

- Periodontal ligament: fibers that allow tooth attachment, and occlusal forces transmission to the alveolar bone (Sharpey's fibers), protection to the neurovascular components, bone and cementum remodeling, and nutrition and proprioceptive sensitivity [18]. Among the fibers of the periodontal ligament, several types of cells may be found, such as fibroblasts, osteoblasts, osteoclasts, cementoblasts, cementoclasts, mesenchymal cells, epithelial cells, macrophages, and mast cells (Fig. 2.19) [18].

Fig. 2.18 Alveolar bone

Fig. 2.19 Alveolar bone (closer view)

Together with the knowledge of the soft tissue anatomy, the characteristics of these tissues, mainly of the alveolar bone, play an important role on the development of soft tissue deformities even without the presence of dental biofilm. Anatomical features of the alveolar bone, such as bone fenestrations (i.e., window-like apertures or openings in the alveolar bone over the root of a tooth without comprising the marginal crestal bone) [1, 19–22] and dehiscence (i.e., areas in which the root is denuded of bone and portions of the root surface are covered only by soft tissue, and this area extends to through the marginal alveolar bone) [19–22], may be important for the development of periodontal disease and non-plaque-induced gingival lesions, as well as for the prognosis of a periodontal plastic surgery procedure (Fig. 2.20). For instance, approximately 10 % of the teeth may present fenestrations or dehiscence of the bone, but when accounting the presence of such defects "per subject," this value increase up to 60 % [19]. Also, 12 % of maxillary central incisors may present lack of bone covering the root surface beneath the gingival tissues [20], and in the presence of malocclusions, the frequency of fenestrations and dehiscence may significantly increase to approximately 35 and 50 %, respectively, especially in the anterior region of the mandible (Figs. 2.21 and 2.22) [21, 22]. In addition, it should be noted that histological information indicates that the buccal bone wall is thinner than the lingual wall and both crests are located at a similar distance from the cementoenamel junction [23].

Fig. 2.20 Osseous dehiscence (premolars) and fenestrations (canine and lateral incisor) at the mandibular arch

Fig. 2.21 Osseous fenestrations (canines and incisors)

Fig. 2.22 (**a**–**c**) Anatomic conditions of the alveolar bone around crowded teeth

2.4 Additional Anatomic Conditions to Be Considered During the Decision-Making Process for Gingival Surgery: The Palatal Vault, the Periodontal Biotype, the Keratinized Tissue Band Around Natural Teeth, and the Biological Width

The palatal vault may play an important role during the decision-making process due to its inherent anatomical characteristics, in terms of potential damages and complications (e.g., small bleeding up to hemorrhage) that may occur to the greater palatine artery and their major branches [24, 25]. Known as the main artery supplying blood to the masticatory mucosa of the palatal vault, the greater palatine artery emerges on to the inferior surface of the hard palate through the greater palatine foramen and follows anteriorly close to the alveolar ridge up to the incisive foramen, where it leaves the palate (Fig. 2.23) [24–27]. Also, the greater palatine nerve accompanies this artery, and it is related to anesthetic procedures of the anterior teeth and palatal mucosa [24–28].

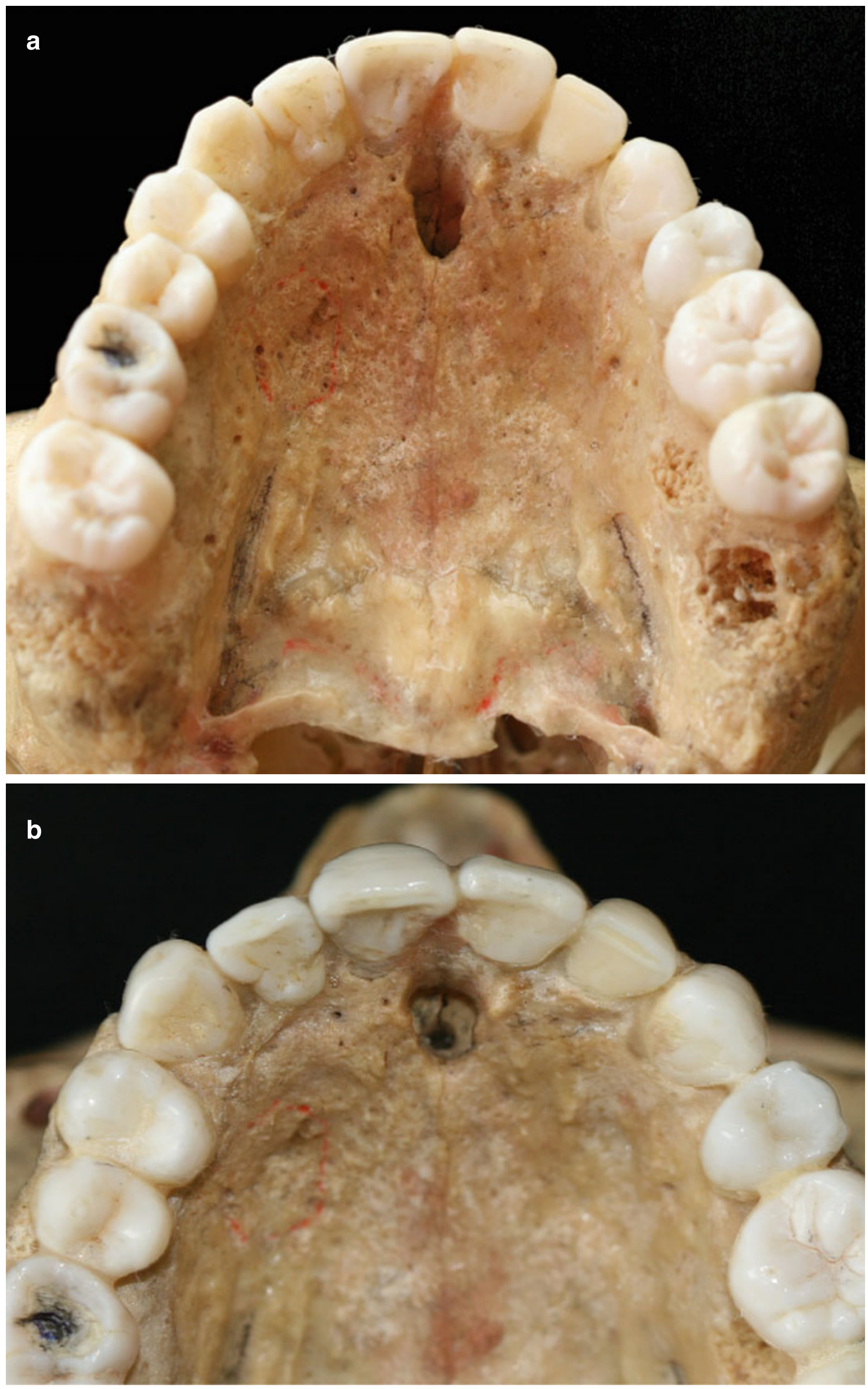

Fig. 2.23 Palatal vault – incisive foramen (**a**, **b**), greater palatine foramen (**c**, **d**), and schematics of the greater palatine artery (**e**)

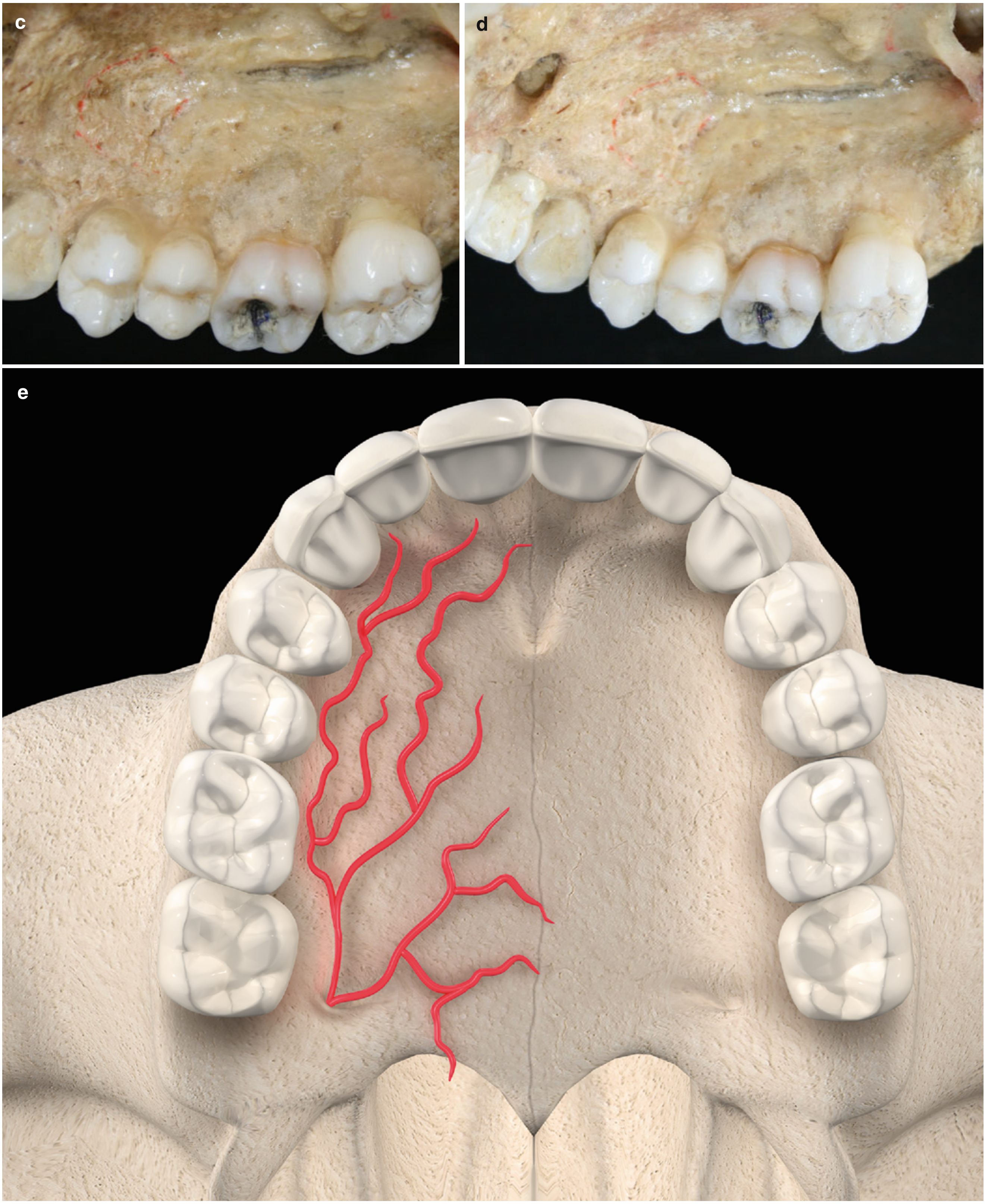

Fig. 2.23 (continued)

The knowledge of these topographic aspects is of great importance during flap procedures performed at the lingual posterior region of the maxilla, as well as to the achievement of free gingival grafts or subepithelial grafts harvested between the distal aspect of the canine and the midpalatal region of the second molar (i.e., the usual area used to obtain these grafts) [24, 25]. The selection of a palatal donor bed and the surgical harvesting procedures may vary but mainly from areas with less fat composition. Additional important information on this area is described in Chap. 3 (Treatment of Recession-Type Defects).

Another important anatomic condition that may modify the soft tissue behavior around the individual tooth over time is the periodontal biotype. In the late 1980s, the "quality" of the periodontal tissues and its impact on the prognosis of periodontal plastic surgery has gained considerable importance [29–31]. For instance, periodontal biotypes categorized as "thin and scalloped" or "thick and flat" [29] (Fig. 2.24) present different characteristics that deserve special attention, as described by Cohen [32]: A "thin and scalloped" biotype may be found among subjects presenting delicate and tiny highly scalloped gingival and osseous architecture, bone dehiscence and/or fenestrations, a gingival margin located over the cementoenamel junction (CEJ), few or nonkeratinized tissue (KT), and some specific dental characteristics (small contact areas and long triangular-shaped teeth) [32], and this seems associated to an increased susceptibility to gingival recession when compared to teeth with a "thick and flat" periodontal biotype [30, 31]. On the other hand, subjects with "thick and flat" biotypes are described to present dense, flat gingival and osseous architecture, a gingival margin lying coronal to the CEJ, ample width of keratinized tissue, squared-shaped teeth with "contact areas instead of contact points," and a rounded convexity of the facial bone plate [32]. Moreover, subject may present a third type of biotype (thick and scalloped) represented by "a clear thick fibrotic gingiva, slender teeth, narrow zone of KT and a high gingival scallop" [33].

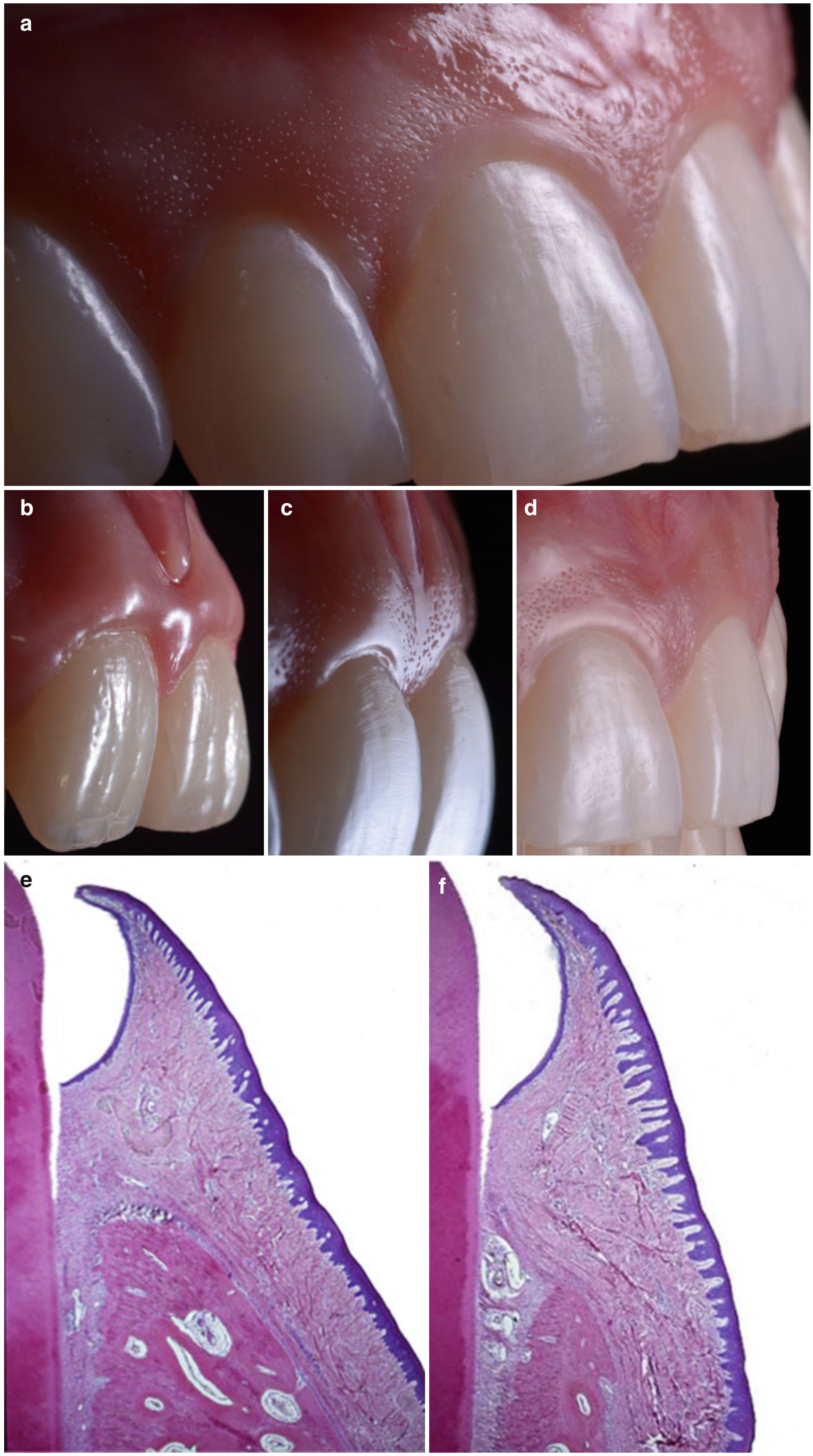

Fig. 2.24 (**a**–**f**) Periodontal biotypes (to note the histologic characteristics of a thick (**e**) and of a thin and scalloped biotype (**f**))

In gingival terms, the periodontal biotype seems to play an important role on the surgical prognosis most because of interdental papillary gingiva and the KT condition. For the interdental gingiva, teeth presenting long and narrow shape, with tiny incisally located contact points (e.g., subjects with a "thin and scalloped" biotype), are more inclined to present greater distances between the contact point and the interproximal crestal bone.

Regarding to KT and attached gingiva, it has long been suggested that their presence around a natural tooth and their augmentation when deemed necessary are the key elements of treatment planning involving periodontal plastic surgery. This assumption regards to early data on this topic, where a minimum band of 2 mm of keratinized tissue (with at least 1 mm of tissue attached) was considered necessary to maintain periodontal health [34]. On the other hand, Kim and Neiva [35] in its recent systematic review commissioned by the *American Academy of Periodontology* (AAP) observed that the definition of the precise extent of KT is still controversial, but in clinical terms, they reported important answers/conclusions to some different clinical scenarios/focused questions (these are reproduced below) [35]:

1. "***What are the alternatives to autogenous gingival grafting to increase the zone of keratinized attached gingiva***?" [35]

Answer(**s**)/**Conclusion**(**s**): "Alternative methods and materials have shown to provide enough attached keratinized tissue to correct areas lacking or with minimal KG (<2 mm) around teeth in short-term and in small-sample size studies. The advantages of these approaches are avoidance of donor areas and unlimited supply. However, long-term follow-up studies as well as randomized controlled trials should be conducted to strengthen this treatment approach." [35]

2. "***What is the patient reported outcome with minimal keratinized tissue compared to those that have received an enhanced zone of keratinized tissue***?" [35]

Answer(**s**)/**Conclusion**(**s**): "Alternative methods and materials appear to result in less patient discomfort after gingival augmentation procedures when compared to FGG. They have also shown to result in better color and texture match to surrounding tissue when compared to FGG. However, study investigators need to standardize how they collect the patient reported outcome so the obtained results can be compared to other studies." [35]

3. "***What is the ideal thickness of an autogenous gingival graft? Is a thick autogenous gingival graft more effective than a thin autogenous gingival graft***?" [39]

Answer(**s**)/**Conclusion**(**s**): "A palatal graft should be at least 0.75 mm thick. Thin grafts tend to result in more esthetic outcomes while thick grafts provide more functional resistance. Thick grafts tend to follow significant primary contraction while thin grafts are more prone to secondary contraction. The type of biotype may play an important role in maintaining optimal periodontal health, but disagreements exist among clinicians when describing the types of biotypes." [35]

4. "***Which restorative circumstance requires an increased zone of keratinized tissue or is keratinized tissue important***?" [35]

Answer(**s**)/**Conclusion**(**s**): "Authors have noted limitation of recent clinical studies as well as randomized control studies and systemic reviews to answer this question. However, clinical observations would suggest sites with minimal or no keratinized gingiva and associated with restorative margins are more prone to gingival recession and inflammation. Thus, gingival augmentation is indicated for sites with minimal or no KG and receiving intracrevicular restorative margins based on clinical observations." [35]

5. "***Does orthodontic intervention affect the soft tissue health and dimension***?" [35]

Answer(**s**)/**Conclusion**(**s**): "Authors have noted limitation of recent clinical studies as well as randomized control studies and systemic reviews to answer this question. However, historic clinical observations and recommendations can be referenced to answer this question. The direction of the tooth movement and the bucco-lingual thickness of the gingiva play important roles in soft tissue alteration during the orthodontic treatment. There is higher probability of recession during tooth movement in areas with <2 mm of KG. Gingival augmentation can be indicated prior to the initiation of orthodontic treatment in areas with <2 mm" [35].

One last (but important) complex involving the gingival tissues regards to the "width" of supracrestal components around each tooth. Known in the literature as the "biologic width," the supracrestal gingival complex involves the sulcular/crevicular and the junctional epitheliums, as well as the supracrestal connective attachment (Fig. 2.25) [36]. According to the classic study by Gargiulo et al. [36], the dimensions (extension) of this complex in means are as follows:

- Sulcular/crevicular epithelium: 0.69 mm
- Junctional epithelium: 0.97 mm
- Connective tissue attachment: 1.07 mm

Overall, it should be also noted that these outcomes are expressed as mean values, as well as the dimensions of the junctional epithelium may present greater variability [36]. Further studies have been conducted on this topic, and their general outcomes are depicted in this chapter at "Critical summary of the results of systematic reviews."

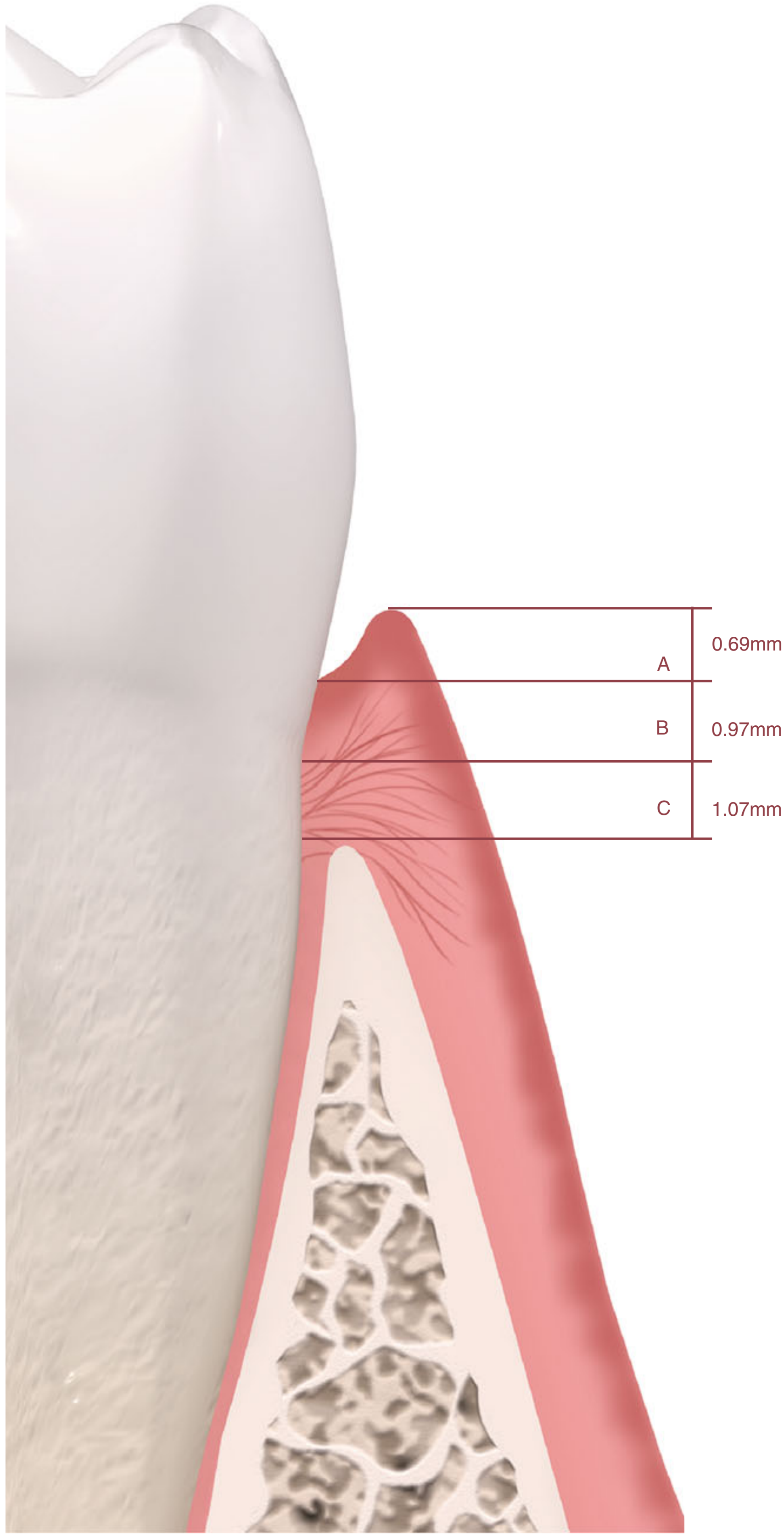

Fig. 2.25 Biologic width. *A* gingival sulcus, *B* junctional epithelium, and *C* connective tissue

2.5 The Importance of Interdental Papilla

The importance of the interdental papilla could have been depicted above, but this for periodontal plastic surgery deserves a separate topic. The interdental space has a pyramidal form and is delimited by the crestal bone, the contact point, and it is expected that it should be totally fulfilled by the interdental papilla in healthy conditions. This space filling may be lost because of periodontal disease. The form of interdental space is mainly established by the vertical dimension between the contact point and the alveolar crest (vertical) and the distance between adjacent teeth (horizontal). Those dimensions vary between teeth groups on the same patient and tooth shape from one patient to another.

Papilla loss causes unpleasant aesthetic problem such as black triangles [37]. In addition, it may jeopardize phonetics and lead to food impaction between teeth. Nordland and Tarnow proposed a classification to papilla loss [38] based on four classes of interdental papilla (Fig. 2.26):

- Normal: complete filling of interdental embrasure [38]
- Class I: papilla loss with the tip of interdental papilla between contact point and interproximal cementoenamel junction [38]
- Class II: papilla loss with the tip of interdental papilla lying apically to the interproximal CEJ, but coronally to the buccal CEJ [38]
- Class III: when the papilla loss extends at the level or apical to buccal CEJ [38]

A number of studies analyzed the anatomical factors that may influence the presence or absence of interdental papilla in healthy subjects [39–45]. Most of those studies consider interdental papilla presence when interdental space is totally fulfilled with gingiva. For instance, thick and wide interproximal dental papillae can positively influence the percentage of complete root coverage [46–48]; however, the papillae anatomy is directly associated with the distance from the contact point to the bone crest. When the measurement from the contact point to the bone crest is 5 mm or less, the papilla is present almost 100 % of the time, whereas when the distance is 6 mm, the papilla is present 56 % of the time [39]. When this distance is between 7 and 10 mm, the papilla is missing most of the time [39].

As mentioned above, the interdental space is not only delimited by vertical distance between contact point and bone crest. Root proximity is responsible for the interproximal alveolar crest shape [40–49] and is prone to interfere on papilla morphology. Cho et al. [40] performed a study analyzing horizontal (interradicular) and vertical distances. A total of 206 healthy interdental areas were measured (51 anterior, 69 premolar, and 86 molar) in 80 patients. The results demonstrated that a distance of 4 mm between the contact point and alveolar crest presented 89.7 % of papilla presence and that this percentage reduces when the distance increases. When both measures were considered together, an interradicular distance of 1–2 mm, associated with a vertical distance of 4 mm, presented 100 % of papilla presence; an interradicular distance of 1.5 and 5 mm of vertical distance was associated with 88.9 % of papilla filling the interdental space. This paper demonstrated that interradicular distance should be taken in consideration when papilla presence is required [40]. Other aspects can be considered too. Teeth with rectangular form were more likely to present interdental papilla [41], as well as increasing age might be associated papillary recession [50].

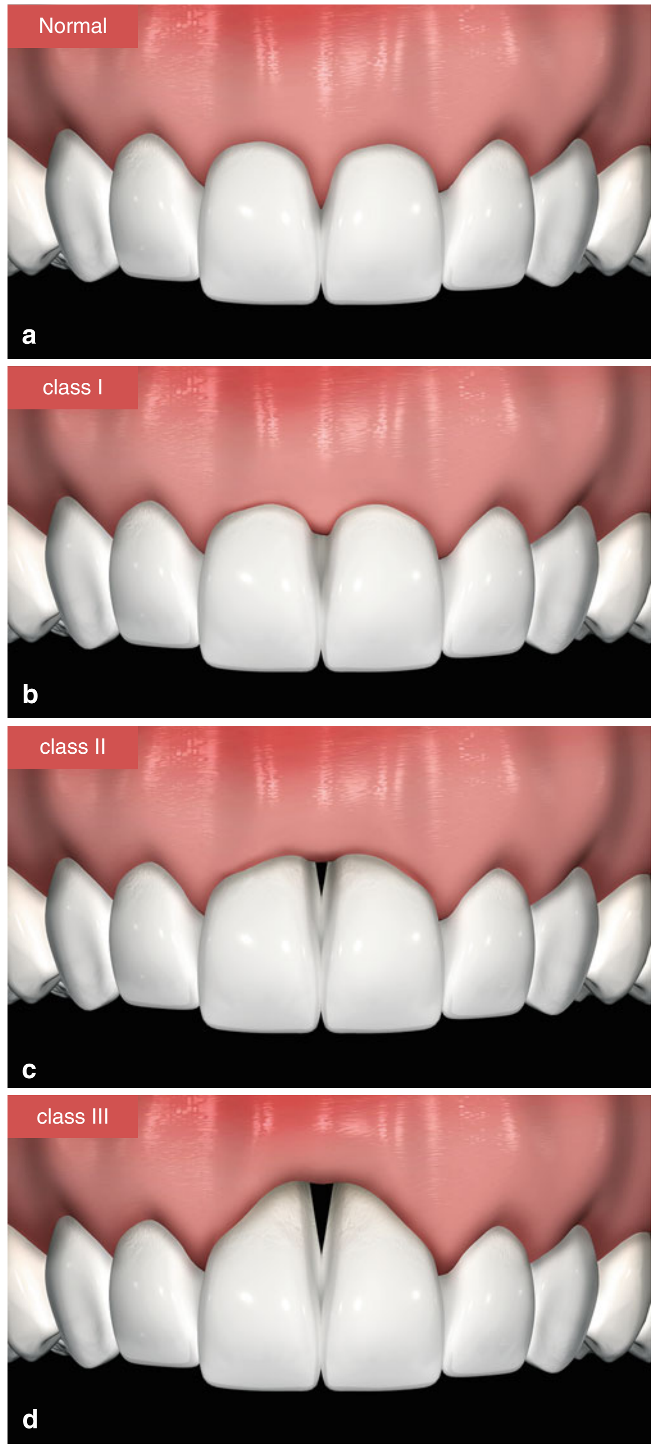

Fig. 2.26 (**a**–**d**) Schematic representation of the papilla loss classification by Nordland and Tarnow [38]

2.6 Rationale, Concepts, and Basic Surgical Principles of Periodontal Plastic Surgery

Although treatment planning involving periodontal plastic surgery procedures requires strong knowledge on anatomy of periodontal tissues and scientific background, the most common basic surgical principles of dental surgery should be followed to accomplish the foreseen outcomes. The proper diagnosis of the condition of interest as well as the selection of the best surgical approaches to each individual patient and sites can improve the odds of achieving the expected prognosis.

Periodontal plastic surgery involves the use of flap procedures (i.e., "a loosened section of tissue separated from the surrounding tissues except at its base" [1]) that may be classified by the AAP according to their thickness: the partial/split thickness (i.e., "a surgical flap of epithelium/mucosa and connective tissue that does not include the periosteum" [1]) or the mucoperiosteal/full thickness (i.e., a mucosal flap [usually the gingiva and alveolar mucosa] that includes the periosteum [1]) flaps (Fig. 2.27). Fundamentally, a flap may be categorized based on its location, shape, design, and proposal (Figs. 2.28, 2.29, 2.30, 2.31, 2.32, 2.33, 2.34, and 2.35) [1]:

- Double papilla pedicle flap: "The use of the papillae on the mesial and distal of a tooth as laterally positioned flaps sutured together over the tooth root" [1]
- Envelope flap: "A flap retracted from a horizontal linear incision, as along the free gingival margin, with no vertical incision" [1]
- Gingival flap: "A flap that does not extend apical to the mucogingival junction" [1]
- Modified Widman flap: "A scalloped, replaced, mucoperiosteal flap, accomplished with an internal bevel incision, that provides access to the root for root planing" [1]
- Mucogingival flap: "A flap that includes both gingiva and alveolar mucosa" [1]
- Papillary Pedicle flap: "A laterally rotated flap employing the gingival papilla" [1]
- Pedicle flap: "A surgical flap with lateral releasing incisions" [1]
- Positioned flap: "A surgical flap that is moved or advanced laterally, coronally, or apically to a new position" [1]
- Replaced/repositioned flap: "A flap replaced in its original position" [1]
- Sliding flap: "A pedicle flap moved to a new position" [1]

Additionally, other types of flaps were also described in the literature, such as the papilla preservation flap [51], modified papilla preservation flap [52], and the simplified papilla preservation flap [53] that may be used, for instance, for open flap debridement associated or not to regenerative approaches.

Altogether with flap procedures, grafts and biomaterials of different origins may be used for PPS, and these are defined by the AAP [1] as:

- Graft: "(a) Any tissue or organ used for implantation or transplantation; (b) A piece of living tissue placed in contact with injured tissue to repair a defect or supply a deficiency; (c) To induce union between normally separate tissues" [1]
- Allograft/allogeneic graft: "A graft between genetically dissimilar members of the same species" [1]
- Alloplast: "A synthetic graft or inert foreign body implanted into tissue" [1]
- Autograft/autogenous graft: "Tissue transferred from one position to another within the same individual" [1]
- Heterograft/xenogeneic graft: "A graft taken from a donor of another species" [1]

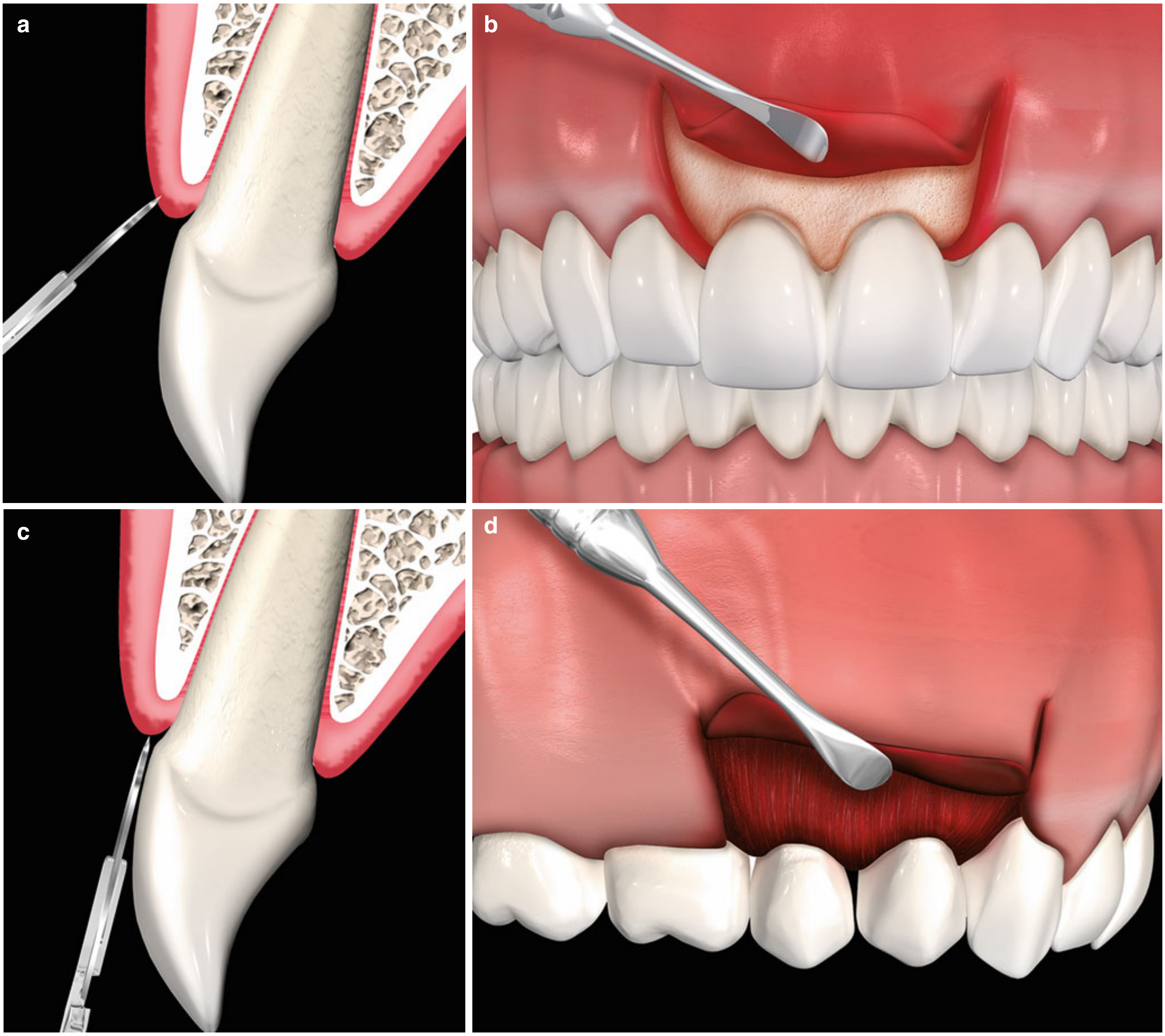

Fig. 2.27 Incision to bone crest (**a**), full-thickness flap (**b**), incision used for soft tissue separation (**c**), partial-thickness flap (**d**)

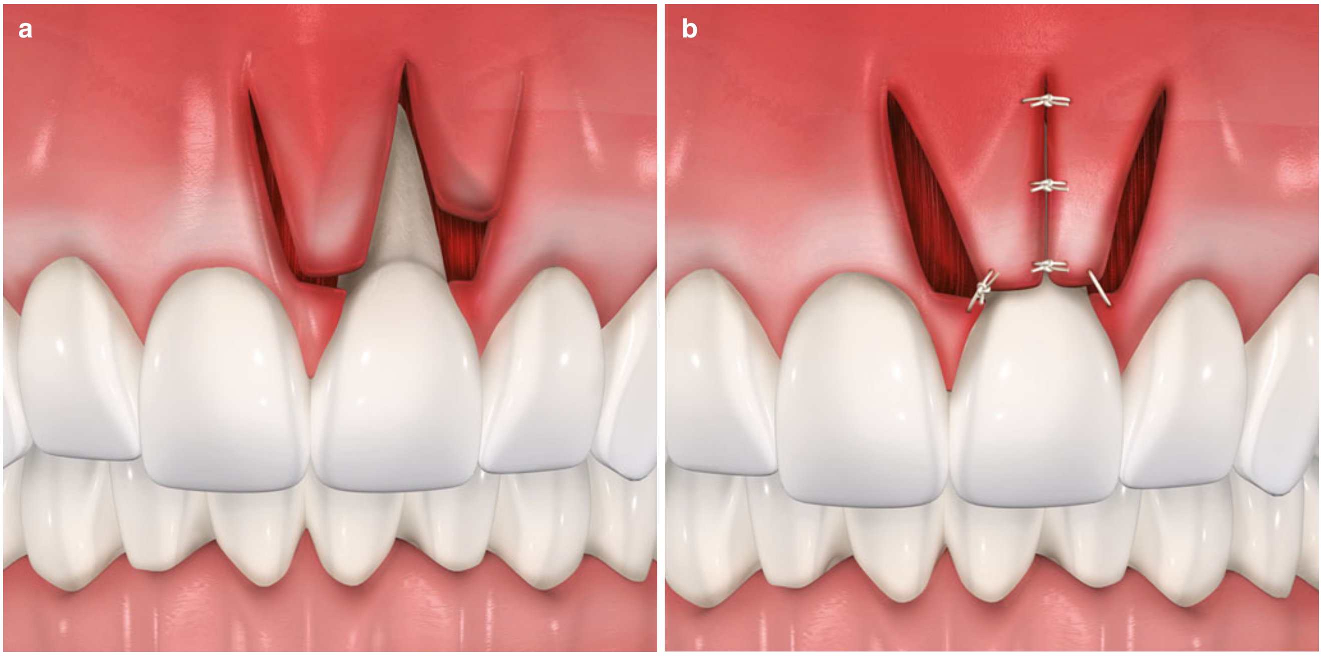

Fig. 2.28 (**a**, **b**)Double papilla pedicle flap

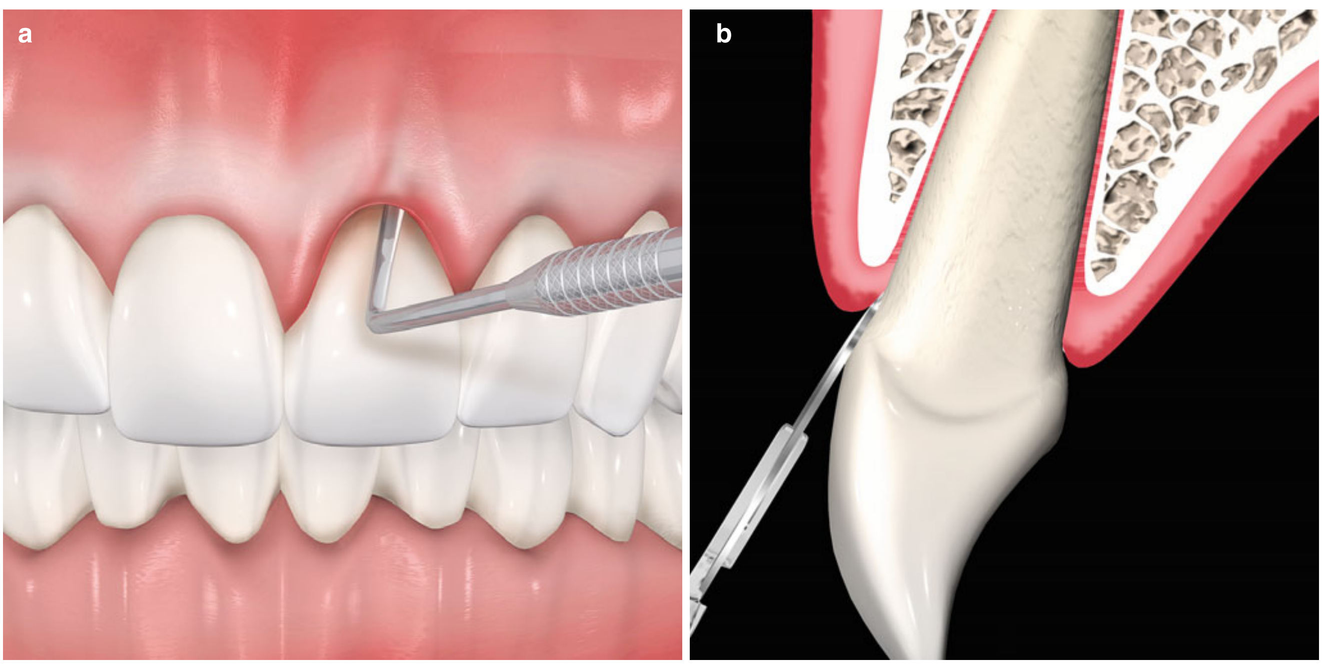

Fig. 2.29 (**a**, **b**) Envelope flap

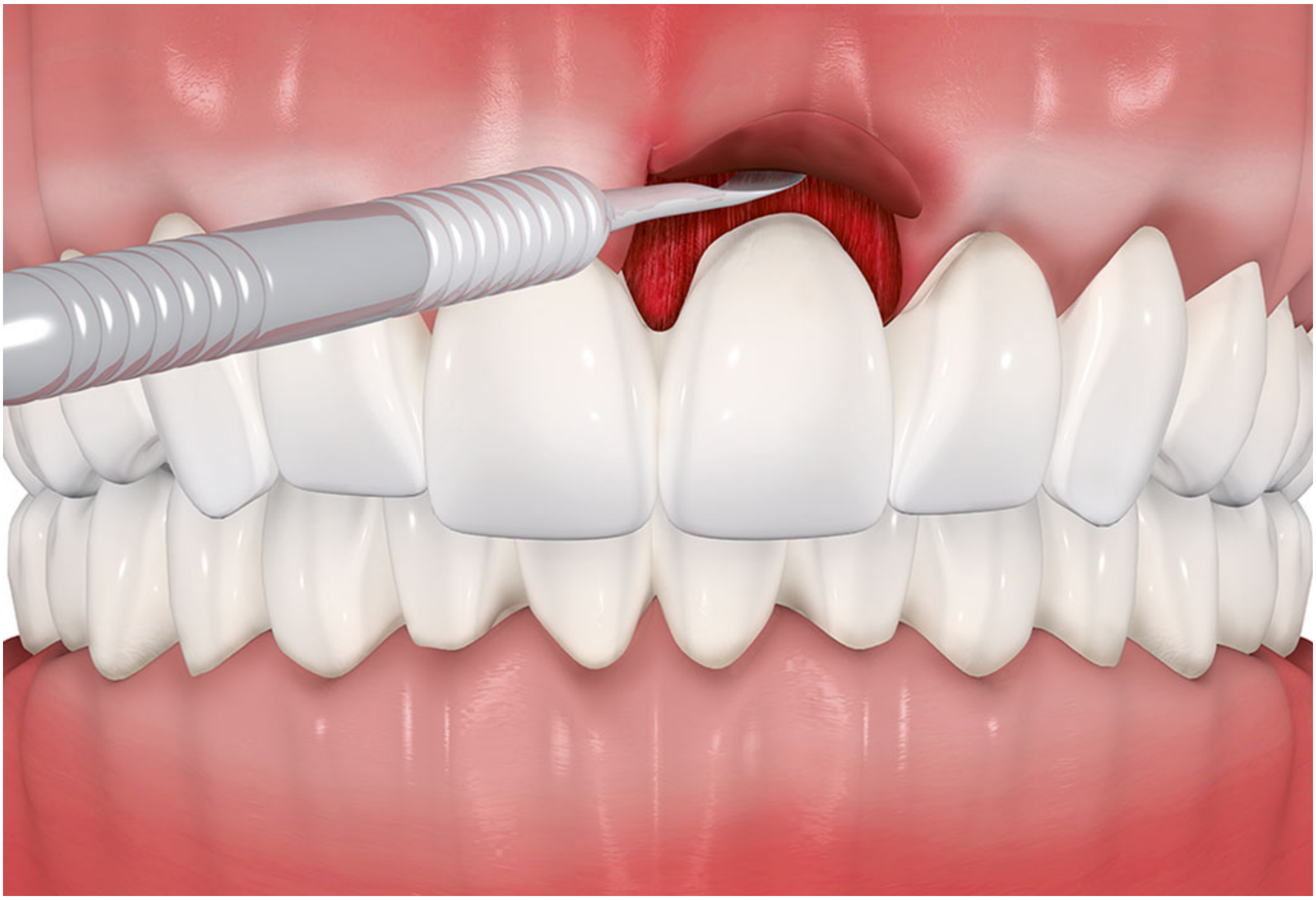

Fig. 2.30 Gingival flap

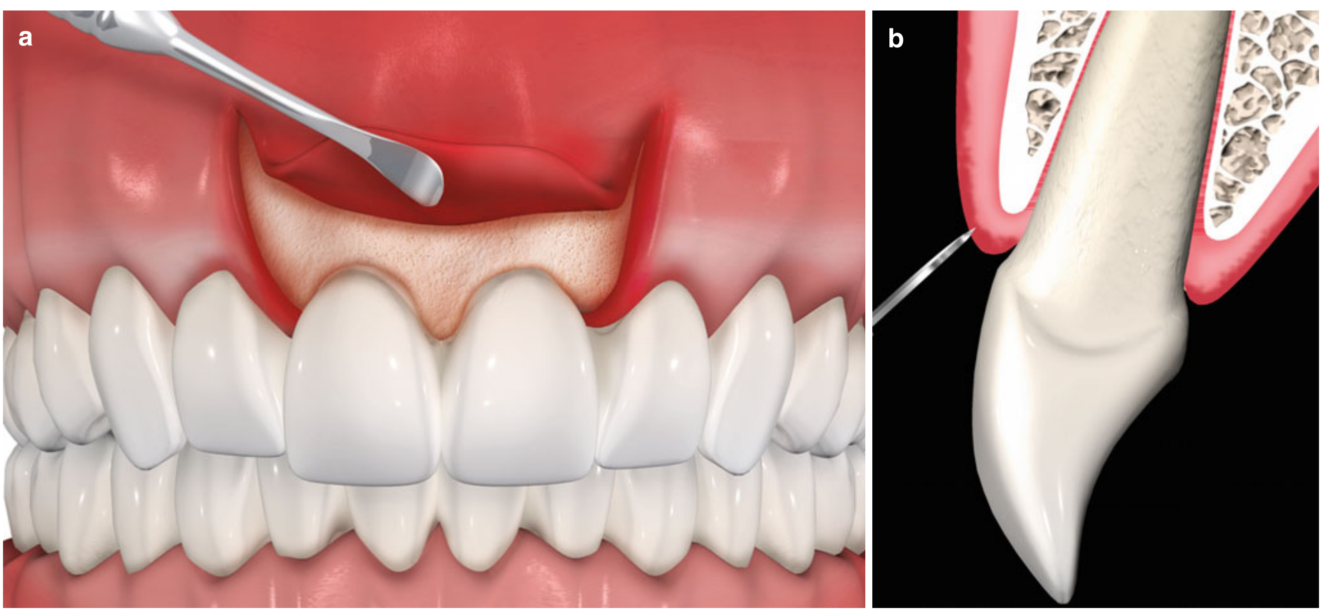

Fig. 2.31 Modified Widman flap

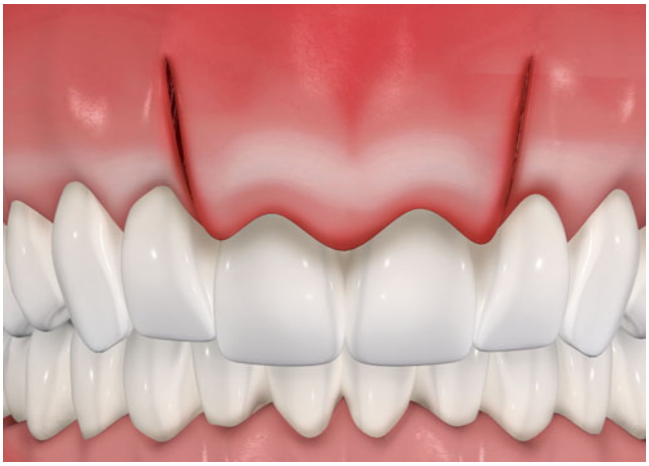

Fig. 2.32 Mucogingival flap

Fig. 2.33 Pedicle flap

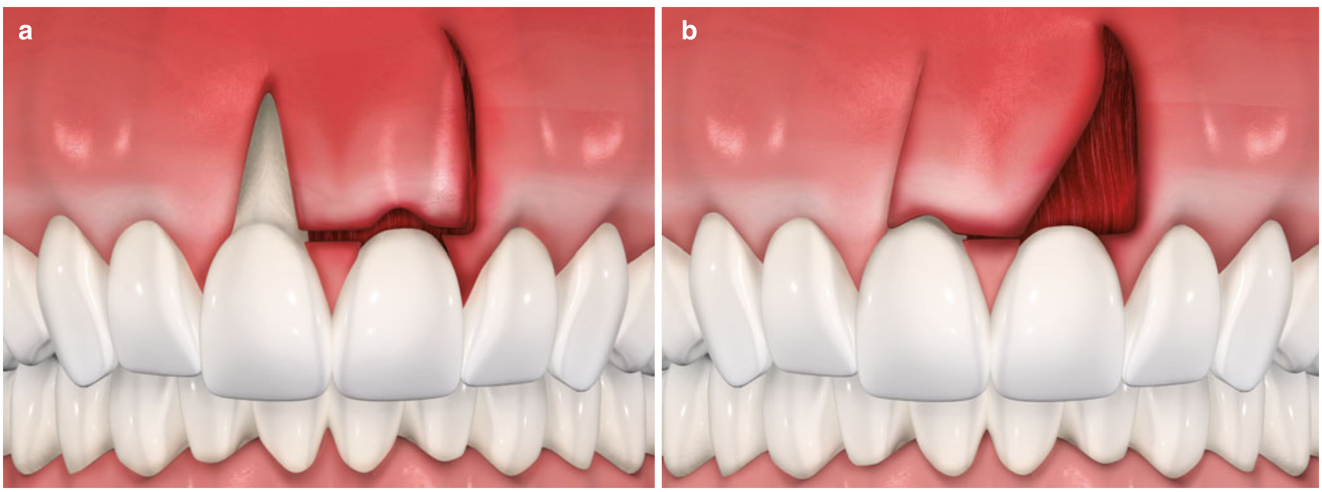

Fig. 2.34 (**a**, **b**) Positioned flap/sliding flap

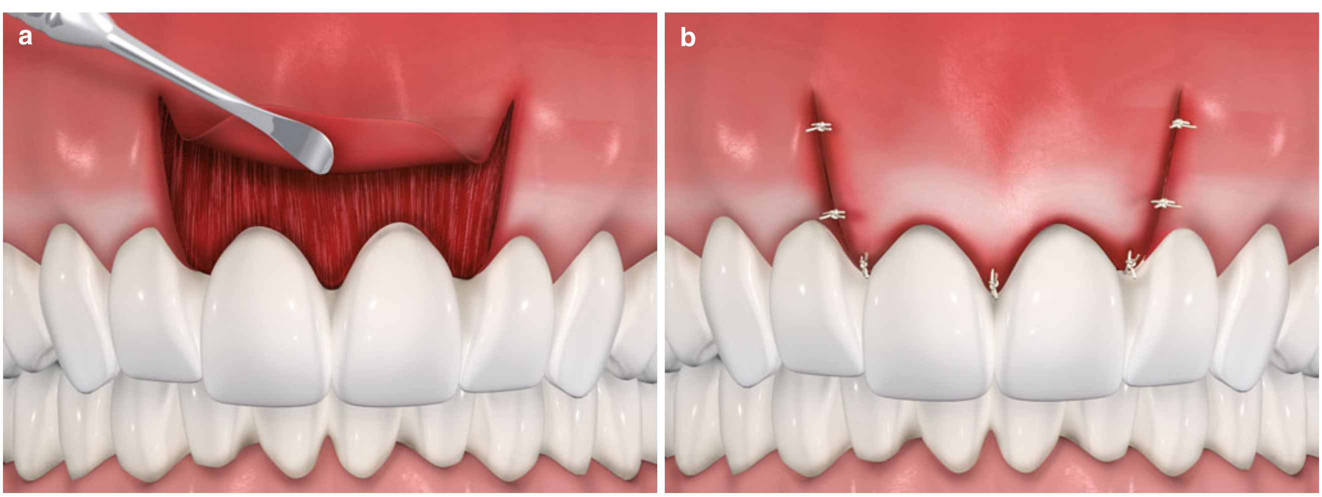

Fig. 2.35 (**a**, **b**) Replaced/repositioned flap

Apart of the types of flap or grafts used during the surgical procedure, as a general rule, other important pre-, trans-, and postsurgical steps should be accomplished as well:

- Before surgery: Any surgical procedure should be carefully planned, in terms of prognosis (Will the surgical procedure improve the functional and/or aesthetical outcomes of my patients? Will these outcomes be able to fulfill my patient's expectations?), limitations (What can and what cannot be achieved with the proposed therapy based on my patient's diagnosis? How should I proceed? Is there any local and/or systemic condition that can hinder the expected results?), adverse effects/complications (Is the procedure of choice safe? What are the involved risks associated to it?), and long-term stability (Can the results be maintained by long-term periods?). Overall, complete medical and dental histories should be obtained and carefully evaluated, as well as lack of periodontal inflammation and adequate plaque control (≤20 %) should be present. In addition, the patient must be aware of all technical steps to be performed and agree with procedure of choice.
- During surgery: All surgical steps should be followed (i.e., correct preparation of the surgical instruments (Figs. 2.36 and 2.37), patient's antisepsis and anesthesia, adequate surgical sequence, and precise suture). All types of surgery are based on incisions, that is, "a cut or surgical wound made by a knife, electrosurgical scalpel, laser, or other such instrument" [1]. Care should also be taken when selecting any particular type of incision. For instance, an "external bevel" incision aims to reduce the thickness of the mucogingival complex from the outside surface, as in a gingivectomy (i.e., "the excision of a portion of the gingiva; usually performed to reduce the soft tissue wall of a periodontal pocket" [1]), while an "internal bevel (or inverse, reverse or inverted)" one is indicated to reduce the thickness of the mucogingival complex from the sulcular side [1]. Also, the use of releasing incisions (those made to enhance the mobility of a periodontal flap [1]) should be carefully evaluated in areas of high aesthetic demands. Moreover, comprehensive instructions to the patient regarding hygiene and postsurgical care of the treated site as well as lack of hurry when performing "plastic procedures" should be emphasized in order to extract the maximum potential of each specific procedure.
- After surgery: To provide all the support to the patients, in terms of maintaining them in the strict hygiene program established. It should be considered that the oral microbial environment at the oral cavity may modify the wound healing of a surgical site. Thus, any focus of infection (e.g., periodontal pockets) should be extirpated, optimal oral hygiene standards should be accomplished, and the use of effective antiseptic agent should be indicated [54]. For example, patients must be prescribed 0.12 % chlorhexidine digluconate and instructed to rinse gently twice a day for 14–21 days, and sutures may be removed between 8 and 21 days, depending on the procedure performed. It is important to highlight that patients should contact their clinicians in case of doubts or complications/adverse effects. Also, during this period, they should be instructed not to brush the teeth in the treated area. Analgesics and antibiotics may be prescribed if needed, and all patients should be seen every week for 4 weeks; then once a month for 4 months. At 4 months postsurgery, all patients should be oriented to follow regular periodontal maintenance care with individualized time intervals, based on the patient's characteristics (e.g., level of dental biofilm control, smoking habits, manual skills, cooperation) [54]. Regarding oral wound healing, Sculean et al. [55] described that (1) it has been seen that the gingival and palatal mucosa does not seem genetically and not essentially functionally determined [55]; (2) the granulation tissue originating from the periodontal ligament or from *lamina propria* can stimulate keratinization, but it seems that the deeper the connective tissue at the palatal vault, the smaller is the potential of keratinization (i.e., connective tissue harvested from areas immediately below the keratinized layer has a superior potential of keratinization) [55]; and (3) the epithelial healing of surgically treated sites looks accomplished 1–2 weeks postsurgery (for root coverage procedures, the physical integrity of a maturing wound between the flap and the root surface is completed 2 weeks after surgery [55].

In addition, it should be highlighted that the choice of any soft tissue augmentation/reduction procedure is grounded on five basic factors inherent to all surgical procedures: (1) rate of success/odds of failure, (2) reproducibility, (3) health condition, (4) patient's compliance with the proposed treatment plan, and (5) cost–benefit [1–7]. Whenever one or more of these conditions are lacking, the treatment plan should be revised, and preferably the patient should not be submitted to any surgical procedure at all.

Fig. 2.36 Basic surgical instrument set used for periodontal plastic surgery (**a**) additional instruments may be included based on the type of surgical procedure (**b**) instruments positioned in a functional/logical sequence (**c**)

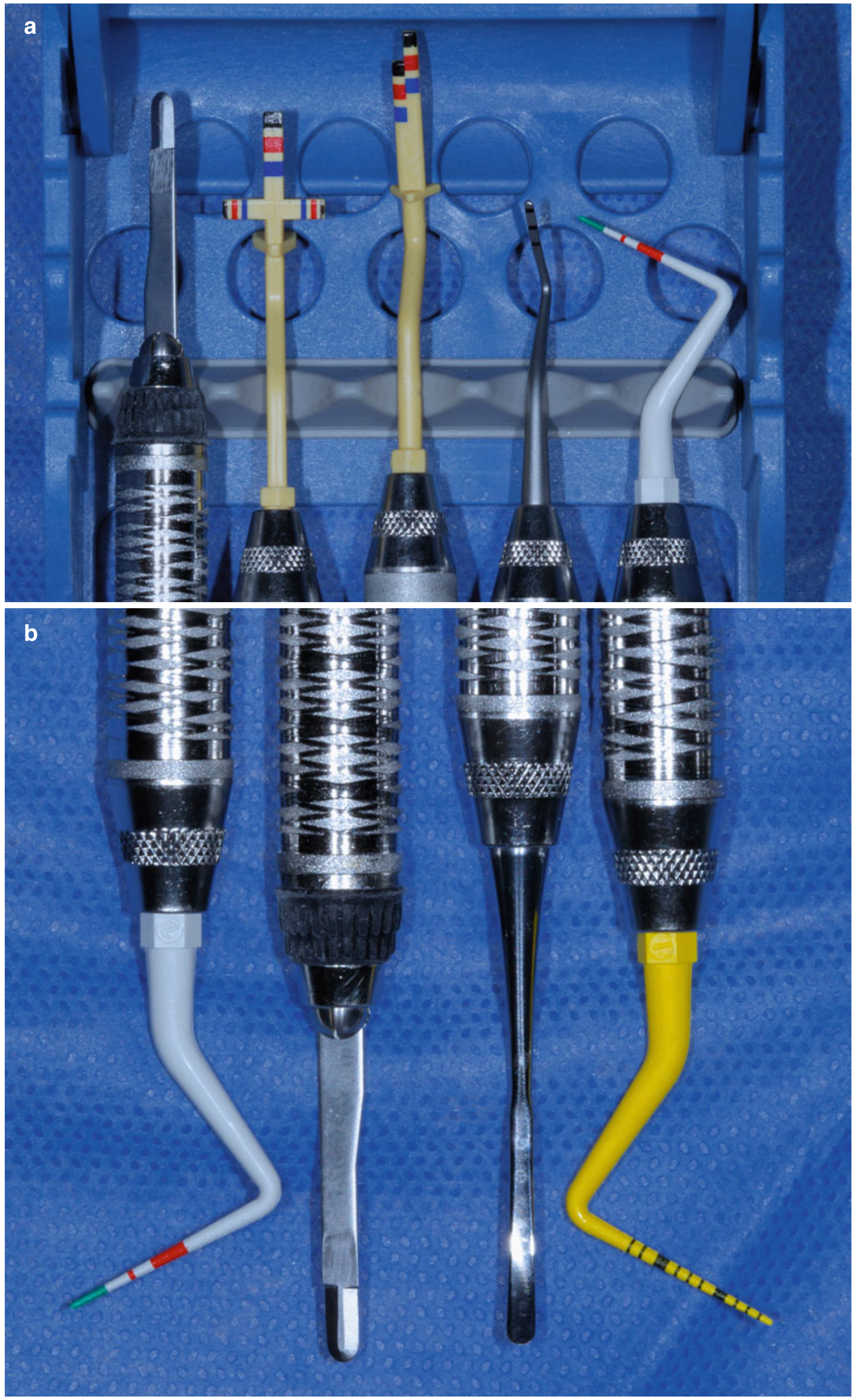

Fig. 2.37 (**a**, **b**) Set of instruments used for clinical crown lengthening procedures

2.7 Clinical Concluding Remarks: "What Is the Importance of the Anatomical Characteristics of the Periodontium, and Mainly the Gingival Tissue, on My Treatment Planning?"

The decision-making process for the "plastic" surgical treatment of gingival tissues, similar to any other periodontal therapy, requires a solid knowledge of the anatomical characteristics of the periodontal tissues. Altogether with them, a correct treatment planning will involve rational procedure selection, attention to basic surgical principles, and mainly the cooperation of the patient. It should be clear in mind that independently of the best source of materials, instruments, and even the quality and expertise of the clinician, selection of a procedure not accounting the local anatomy of the periodontium will decrease the potential of success of the procedure, or even promote additional harms to the patient.

It should also be considered that soft tissue augmentation procedures may involve the use of autogenous grafts (i.e., free gingival grafts and subepithelial connective tissue grafts) that are undoubtedly harvested from donor sites presenting adequate/enough quantity of available tissue, but also the selection of any "donor area" is based on the location of the recipient site and clinician's own preferences [54]. Preferably, the harvesting technique should provide adequate quantity of tissue but reduced trauma, pain, and minimum adverse effects/complications as well.

It can be noted that here are few studies regarding the presence and absence of interdental papilla. Most of them do not present previous statistical power tests. In addition, there is a lack of grouping in the papilla site in the anterior and posterior teeth. Despite these limitations, when treating papilla recession or an aesthetic area with veneering or any prosthetic treatment, a distance of 4 mm between the contact point and bone crest should be respected, and, when a restorative alveolar interface procedure is indicated on preprosthetic periodontal surgery, the distance between roots should be between 1 and 2 mm. In addition, it is important to establish a functional contact point immediately after the crown lengthening procedure in order to optimize a subsequent prosthetic treatment.

Continued research is necessary to improve the effects of soft tissue substitutes [56]. Thus, each of these issues should be carefully reviewed before initiating a periodontal plastic surgical procedure.

Critical Summary of the Results of Systematic Reviews

Systematic reviews conclusions: For the biologic width, there is no consensus of "universal dimension" of this complex, but this is certainly associated to the marked heterogeneity among included studies (i.e., methods/specimens examined and outcome measures selected for analysis) [57]. For the periodontal biotypes, weak to moderate associations between the tooth, gingiva, and osseous proportions and positive relationship between gingival thickness, keratinized tissue, and bone morphology may be expected [33].

Summary of the reviews and critical remarks: Fourteen studies were included in the first review [57], but several shortcomings related to included studies prevent an adequate assessment of the outcomes of these studies. In addition, most of the information available on other studies regarding the anatomical characteristics of the periodontium is not compiled using systematic approaches. Due to the nature of this studies (many of them histological), it is reasonable to consider the information available relevant and clinically useful. Similarly, only some cross-sectional studies could be retrieved for analysis in the second review, and the proposed classifications did not present clear definitions [33].

Evidence quality rating/strength of recommendation (ADA 2013) [58]: Expert opinion for – Evidence is lacking; the level of certainty is low. Expert opinion guides this recommendation.

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Rationale for the Surgical Treatment of Single and Multiple Recession-Type Defects

3

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3.1 Rationale for the Treatment of Single and Multiple Recession-Type Defects

3.1.1 The Dilemma of the Gingival Recession

As defined by the American Academy of Periodontology (AAP), gingival recession (GR) [1] is a term that designates the oral exposure of the root surface due to a displacement of the gingival margin apical to the cemento-enamel junction, and it is also frequently related to the decline of dental (white) and gingival (pink) aesthetics as well as buccal cervical dentine hypersensitivity [2–10].

Affecting different groups of subjects all around the world [11–13], the "periodontal treatment" of GR (i.e. the use of soft tissue root coverage procedures) has been critically developed since the mid-1950s in order to reduce the area of root exposure (i.e. decrease recession depth), as well as to improve clinical attachment level and, whether needed, create/improve the band of keratinised tissue. Currently, the successful treatment of recession-type defects is based on the use of clinically predictable periodontal plastic surgery (PPS) procedures. The term PPS (as first proposed by Miller in 1988) regards the use of diverse surgical techniques aimed to correct and prevent anatomical, developmental, traumatic or plaque disease-induced defects of the gingiva, alveolar mucosa or bone [14].

Recession defects do not improve spontaneously, and their development and perpetuation can also modify patients' behaviour (i.e. level of sociability) and create functional limitations (i.e. prevent for an adequate hygiene of the affected tooth) [2–10]. As a result, the surgical correction of these defects via soft tissue root coverage (as part of periodontal plastic surgery) appears as an important theme during the clinical decision-making process. Given that the field of PPS is dynamic and motivating and it is constantly renewed and improved by the development of new biomaterials and procedures, the collection of all these factors gathered by the improvement of knowledge provides the basis of structured treatment approaches and reflects *contemporary evidence-based periodontology*.

3.1.2 The Development of Gingival Recession: "What Are the Main Aetiologic Agents Related to This Defect?"

As important as the visual identification of the presence of a gingival recession is determining the potential causative agents related to the defect. The literature is vast, and mainly, the following factors should be evaluated at the first visit to the dental office (Fig. 3.1):

- Periodontal and/or tooth anatomy – lack of attached gingiva [15], presence of muscular inserts near the free gingival margin [16], inadequate tooth alignment [17] and reduced thickness of the alveolar bone plate and root prominences [18, 19]
- Disease-related factors – presence of aggressive or chronic periodontitis [20, 21] or viral infection [22]
- Improper dental treatment procedures – tooth presenting prosthetic/composite restorations with margins invading the biological space [23, 24]
- Mechanical trauma – trauma associated with toothbrushing [25, 26] or other objects in close contact to the gingival margin, e.g. lip piercing [27]

During anamnesis and clinical examination, any of these "differential" conditions should be analysed and shared with the patient. Apart from the primary aetiology of the defect, it should be clear in mind that its "elimination" (i.e. the removal of the factors associated with the onset and progression of the lesion and the provision of adequate information on that to the patient) is more important than any simple or highly sophisticated root coverage procedure [2–10].

Fig. 3.1 Some potential aetiologic agents associated to the development of gingival recessions. Teeth crowding (**a**), reduced thickness of the alveolar bone plate (**b**), muscular inserts close the gingival margin + dental biofilm accumulation (**c**), periodontitis (**d**), improper extraction of a supernumerary tooth (**e**), trauma (oral piercing) (**f**), ortodontic tooth movement beyond the buccal alveolar bone plate (**g**), traumatic toothbrushing (**h**), lack of keratinised gingiva (**i**)

3.1.3 Anatomy of Gingival Recessions: "How Should I Classify Them?"

Together with the identification of the agents causing the recession, the characterisation of the anatomical structures surrounding an exposed root surface demands special attention as well. This is because the diagnosis of the defects, as similar to all other fields of medicine and dentistry, can provide a "snapshot" and guide the treatment plan options.

Of an assorted group of classification systems described in the literature created to characterise and "quantify" the amount of tissue loss over the exposed root surface [28–33], the "classification of marginal tissue recession" proposed by Miller in 1985 [30] is certainly the most used and accepted one by regular clinicians and the scientific community. This classification system is based on the amount of soft tissue lost over the root surface and the condition of interproximal periodontal tissues, and it can separate defects into four classic morphological groups (Fig. 3.2):

- Class I: "Marginal tissue recession which does not extend to the mucogingival junction. There is no periodontal loss (bone or soft tissue) in the interdental area, and 100 % root coverage can be anticipated" [30].
- Class II: "Marginal tissue recession which extends to or beyond the mucogingival junction. There is no periodontal loss (bone or soft tissue) in the interdental area, and 100 % root coverage can be anticipated" [30].
- Class III: "Marginal tissue recession which extends to or beyond the mucogingival junction. Bone or soft tissue loss in the interdental area is present or there is malpositioning of the teeth which prevents the attempting of 100 % root coverage. Partial root coverage can be anticipated" [30].
- Class IV: "Marginal tissue recession which extends to or beyond the mucogingival junction. The bone or soft tissue loss in the interdental area and/or malpositioning of teeth is so severe that root coverage cannot be anticipated" [30].

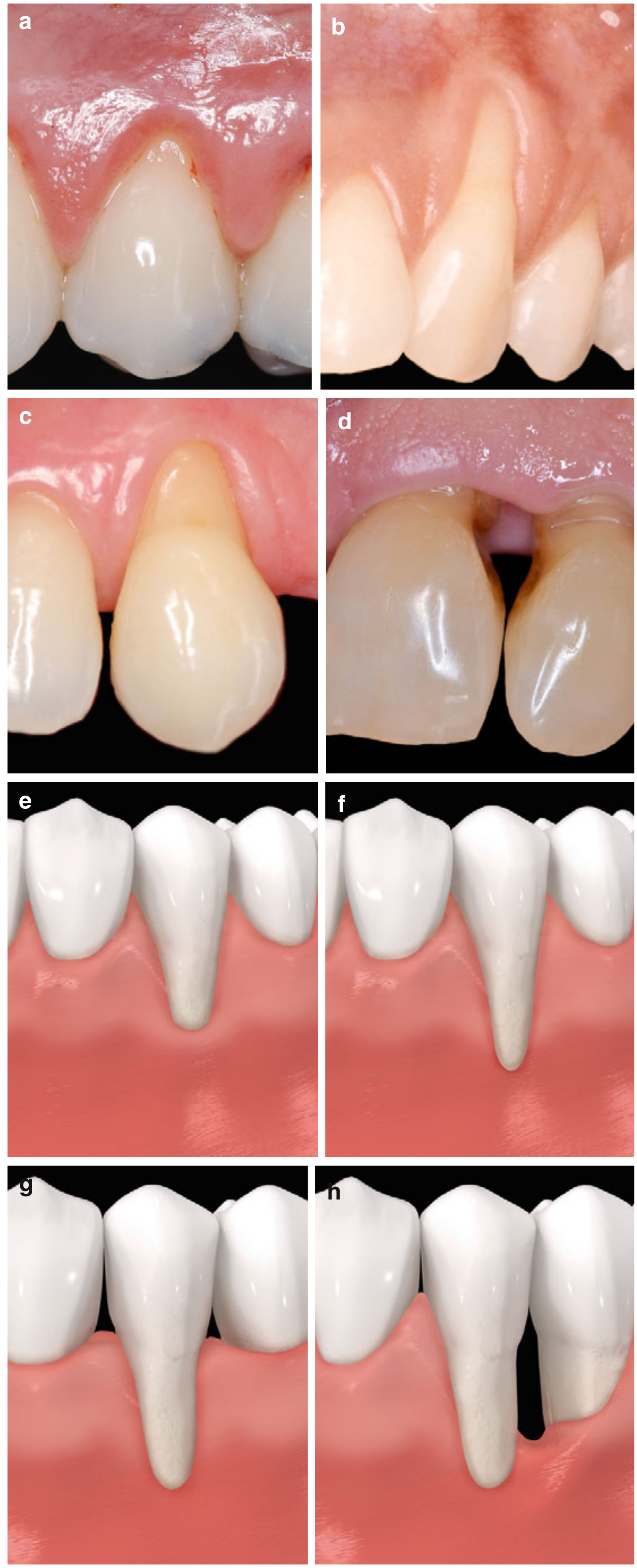

Fig. 3.2 Class I (**a**, **e**), Class II (**b**, **f**), Class III (**c**, **g**), Class IV (**d**, **h**)

3.1.4 Additional Conditions to Be Considered During Preparing the Treatment Plan: Smoking and Recipient Site's Characteristics

The detrimental impact of smoking on nonsurgical and surgical periodontal therapy has long been studied [3, 7, 9, 10]. There is clear evidence that smokers may benefit from soft tissue root coverage; however, the use of SCTG does not provide the same effect of treatment as that achieved in nonsmokers [3, 7, 9, 10]. At 6 months post-therapy, smoking may affect the outcomes of therapy. It may be expected that there are 17.5 % less root coverage and around 36 % fewer sites with complete root coverage in smokers treated with SCTG [10]. By taking these numbers into account, it can be seen that at least three defects in smokers need to be treated to result in one more defect reaching CRC than in the nonsmokers [10]. At 1 year after treatment, recessions treated with SCTG + CAF present significant less root coverage for smokers (89.0 %) than nonsmokers (92.6 %). At 3 years, these values drop to 68.0 % versus 81.5 %, respectively [10]. Likewise, the number of sites exhibiting complete root coverage decreased between these time periods in both groups (i.e. for nonsmokers, it moved from 72.5 to 42.5 %), but within smokers, it was very drastic (62.1–12.5 %) [10].

These results may be associated to interleukin 1 gene polymorphism (i.e. smokers testing positive to it seem to be at an increased risk of periodontal breakdown after treating the recessions) [34], the anatomy of the palatal vault of smokers (less vascularised/inferior number of blood vessels) [35] and the flap thickness (it has been suggested that defects ≥0.95 mm were 100 % covered in nonsmokers, while for some smokers, it did not happen) [36]. These conditions seem to influence revascularisation and incorporation of the SCTG and overall wound healing [3, 10]. On the other hand, the effect of treatment to smoking and nonsmoking patients with CAF seems the same at 6-month follow-up; however, there is limited information available for a definitive analysis [3, 10]. In addition, heavy smokers (≥10 cigarettes/day) may be benefited by the treatment of their recessions as well, but the use of graft or flap procedures alone may not be enough [3, 10]. The use of enamel matrix derivative associated to ADMG + CAF suggests better clinical outcomes than defects treated without such a protein [37].

For recessions presenting also non-carious cervical lesions (i.e. root abrasion due to traumatic toothbrushing), the use of resin-modified glass ionomer or microfilled resin composite prior to surgery (and the subsequent coverage of part of these restorations) does not cause detrimental negative effects on bleeding on probing [38–43] or subgingival microflora [44]. The depth and the vertical extension of the cervical lesion should be assessed prior to any treatment. Deeper cervical lesions may lead to greater coverage, but CRC of the defect might not be achieved [45].

Moreover, the option of restoring or not these defects before treatment may be critically accounted (Fig. 3.3), since there has not been a significant difference in the amount of root coverage between restored and non-restored lesions, and virtually half of the cervical restorations presented colour change after 2 years of treatment (e.g. an aditional question may arise, how these restoration can be removed/changed?). Also, SCTG + CAF seems to perform better than CAF [42]. Thus, it seems more advantageous to treat the recession first (i.e. to perform the chosen root coverage procedures), wait for early healing (at least 6 months) and then perform the definitive restoration of the remaining cervical lesion. Zucchelli et al. [46] suggested that the selection of procedures should be based on the following types of combined defect: (a) Types I and II (radicular cervical lesions plus Class I or II GR), RC alone; (b) Type III (crown-radicular cervical lesion plus Class I, II or III GR), coronal and radicular odontoplasty + restoration + RC; (c) Type IV (radicular cervical lesion plus Class III or crown-radicular cervical lesion plus Class I or II with the deepest point of the cervical lesion localised at the level of the anatomic crown), coronal and radicular odontoplasty + restoration + RC; and (d) Type V (radicular cervical lesion plus Class III or IV GR with the cervical lesion located "on that portion of the root surface that was not coverable with soft tissues"), restoration alone [46]. Additionally, the contralateral tooth may be used to identify and reconstruct the cemento-enamel junction level of the teeth with non-carious cervical lesions [47].

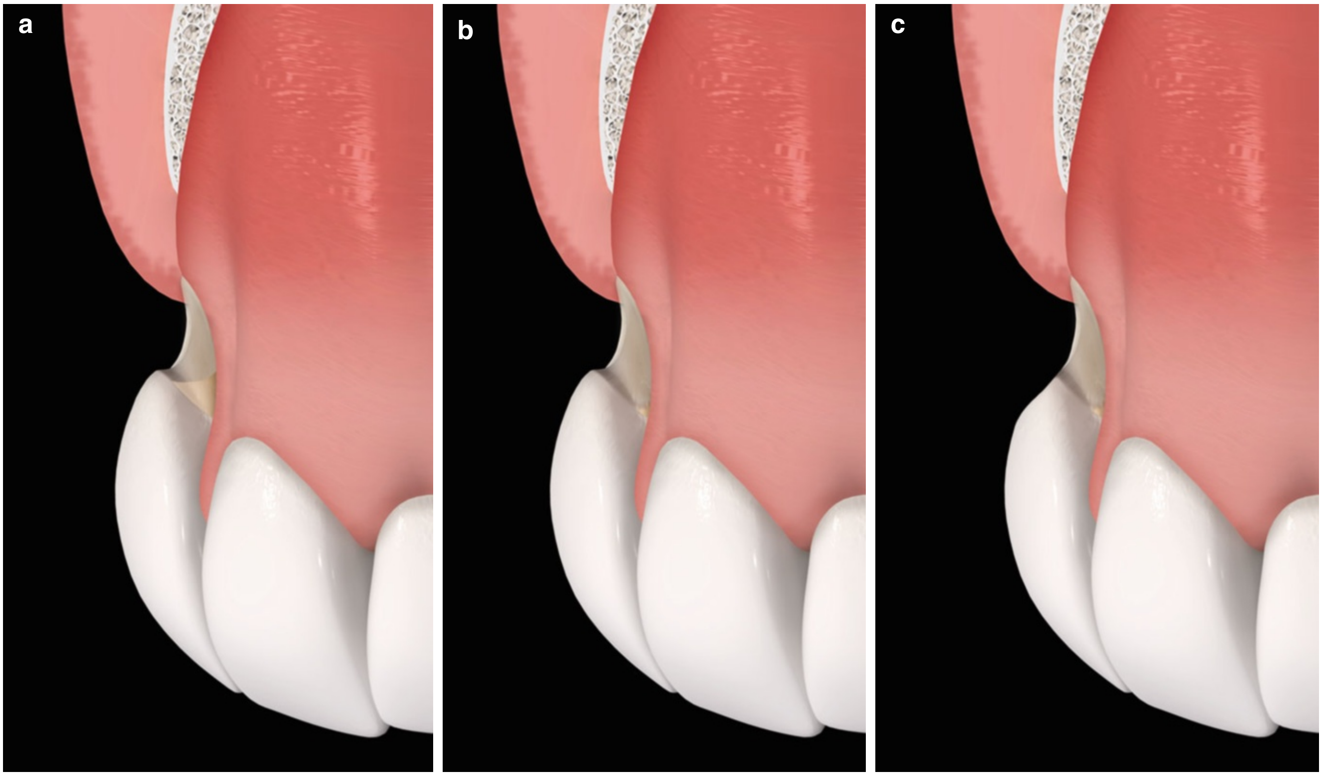

Fig. 3.3 Types of non-carious cervical lesion [46] – gingival recession associated to root abrasion (**a**), gingival recession associated to root abrasion and loss of dentinary support of the enamel (**b**), gingival recession associated to root abrasion and enamel loss (**c**)

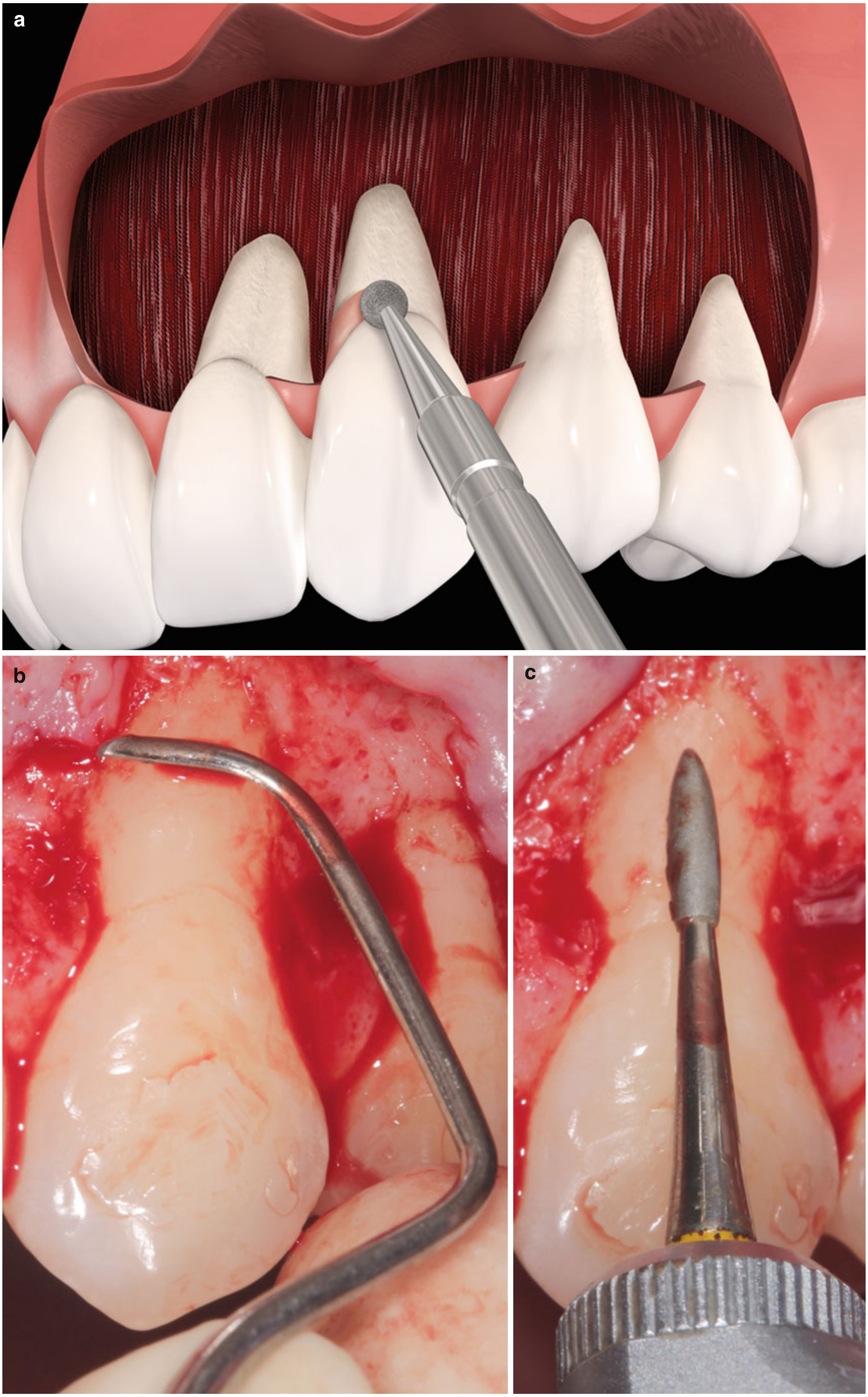

Fig. 3.4 Removal of old restorations (**a**), scaling and root planning (**b**), finishing with rotary instruments/handpiece (**c**)

With respect to teeth with caries or previously restored, these may be successfully treated, but the carious dentin/root restorations need to be removed and the root surfaces be meticulously planned prior to surgery (Fig. 3.4). Independently of treating exposed roots with or without caries/lesions, it is of paramount importance to perform thoroughly "cleaning" of the anticipated surface to be covered. Scaling and root planning with hand or ultrasound instruments and root polishing may be used [10]. Chemical agents like 1 % citric acid, EDTA and tetracycline hydrochlorides may be used as well, but these will not promote additional benefits to the surgical therapy applied (Fig. 3.5) [2–10].

In addition, both maxillary/mandibular and anterior/posterior teeth may be equally benefited by treatment of their associated recessions, but gains in the amount of keratinised tissue can be superior in sites located in the upper arch (without importance from a clinical point of view) [48, 49]. Furthermore, evidence indicates that palatal/lingual defects may be safely treated by SCTG.

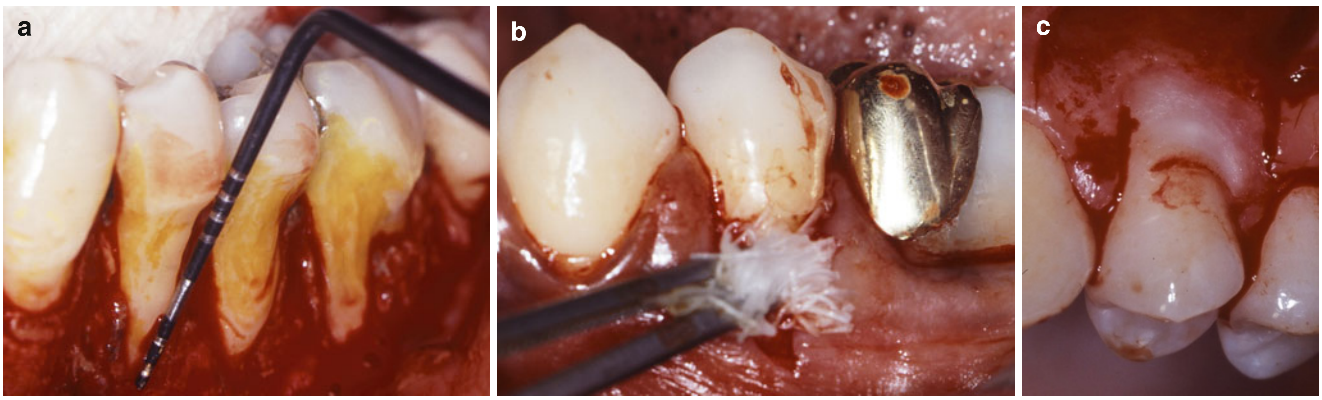

Fig. 3.5 Use of root modification agents. Tetracycline hydrochloride (**a**), citric acid (**b**), EDTA (**c**)

3.1.5 Diversity of Clinical Scenarios and Clinician's Reflection of Treatment Options to Be Considered

Many times, the treatment plan of recession-type defects may not only account for the best treatment option available but to the inherent characteristics of the defect/area to be treated as well. For instance, not only localised and narrow Class I recessions will be forwarded to treatment (in fact, many patients presenting such defects do not mind in treating them). The occurrence of dissimilar "clinical scenarios" may increase the degree of difficulty during decision-making once their treatment will not only lead with the best evidence available but with clinician's experience and patients' expectations as well. Thus, questions related to the potential treatment options available and the importance of treating that specific types of defect require attention.

With respect to the diversity of potential clinical scenarios faced day by day by clinicians attending at private clinical practice, the *American Academy of Periodontology* [10] in its recent workshop has pointed out some common conditions and questions that may be accounted to help them during the preparation of a treatment plan:

Clinical scenario #1: *A complex case involving multiple recession-type defects in aesthetic areas* [10]:

Is there sufficient donor tissue to be removed from the palatal vault? Is it safe to use a flap procedure alone? or Should other biomaterial be used? What factors will lead me to the best choice? [10]

Clinical scenario #2: *Treatment of Miller's* [17] *Class III and IV recession* [10]:

How can I improve my odds of achieving a satisfactory result? Is it possible to use a flap procedure alone or should I associate a graft/biomaterial to it? Will a restorative/prosthetic approach be required? [10]

Clinical scenario #3: *Treatment of GRs not surgically treated but restored with composites* [10]:

What is the best technique/material to graft over these previously restored root surfaces? Should the restoration be removed or changed? Is it safe and predictable to surgically treat these areas? [10]

Clinical scenario #4: *Treatment of NCCL root surfaces* [10]:

Should that alter the treatment approach? Do these areas need to be restored? If yes, before, during or after the surgical procedure? [10]

Clinical scenario #5: *Treatment of carious root surfaces* [10]:

Is it possible to cover carious root surfaces? After removing the caries it is obvious a restoration will be necessary. How does that change the treatment plan? Similarly to abraded surfaces, do these areas need to be restored before, during or after the surgical procedure? [10]

Clinical scenario #6: *Lack of adequate donor site* (e.g. *small and shallow palatal vault*) [10]:

What are the risks and benefits associated to the use of allogenous or xenogenous graft substitutes? Do they provide an evidence of long term stability? [10]

Clinical scenario #7: *Most patients are interested not only in root coverage but in achieving the best colour and texture match* [10]:

What technique should be used to achieve these goals? [10]

Clinical scenario #8: *Best treatment options for the treatment of Class I and II recessions* [10]:

Are the results of therapy stable? What is known about the attachment of the graft/flap to the root and should I care? Is it possible to estimate the outcomes and propose treatment options (i.e. establish a decision tree)? Is it possible to obtain satisfactory results when treating smoking patients? [10]

Clinical scenario #9: *Other defect's risk factors for root coverage* [10]:

Are the geometry and the degree of recession important (e.g. narrow and deep versus wide and shallow)? Is the amount of available keratinized attached gingiva important in the decision making process? Does the degree of keratinized gingiva in the final outcome affect the long-term stability of cases? [10]

3.1.6 Healing of the Recessions After Treatment: "Why Is It Important and Why Should I Care?"

Information on human histology is not easy to be accessed due to inherent ethical conditions related to it. Within the available cases published in the literature, on acellular dermal matrix graft, coronally advanced flap, enamel matrix derivative, free gingival graft, guided tissue regeneration, laterally positioned flap, subepithelial connective tissue grafts and xenogenic collagen matrix, wound healing may be anticipated consisting of long junctional epithelium and connective tissue attachment (with fibres parallel to the root surface) (Fig. 3.6) [10]. Additionally, some degree of tissue regeneration may happen in the most apical portion of the defects mostly for EMD- and GTR-based procedures (i.e. new connective tissue attachment with newly formed cementum and crestal bone) [10].

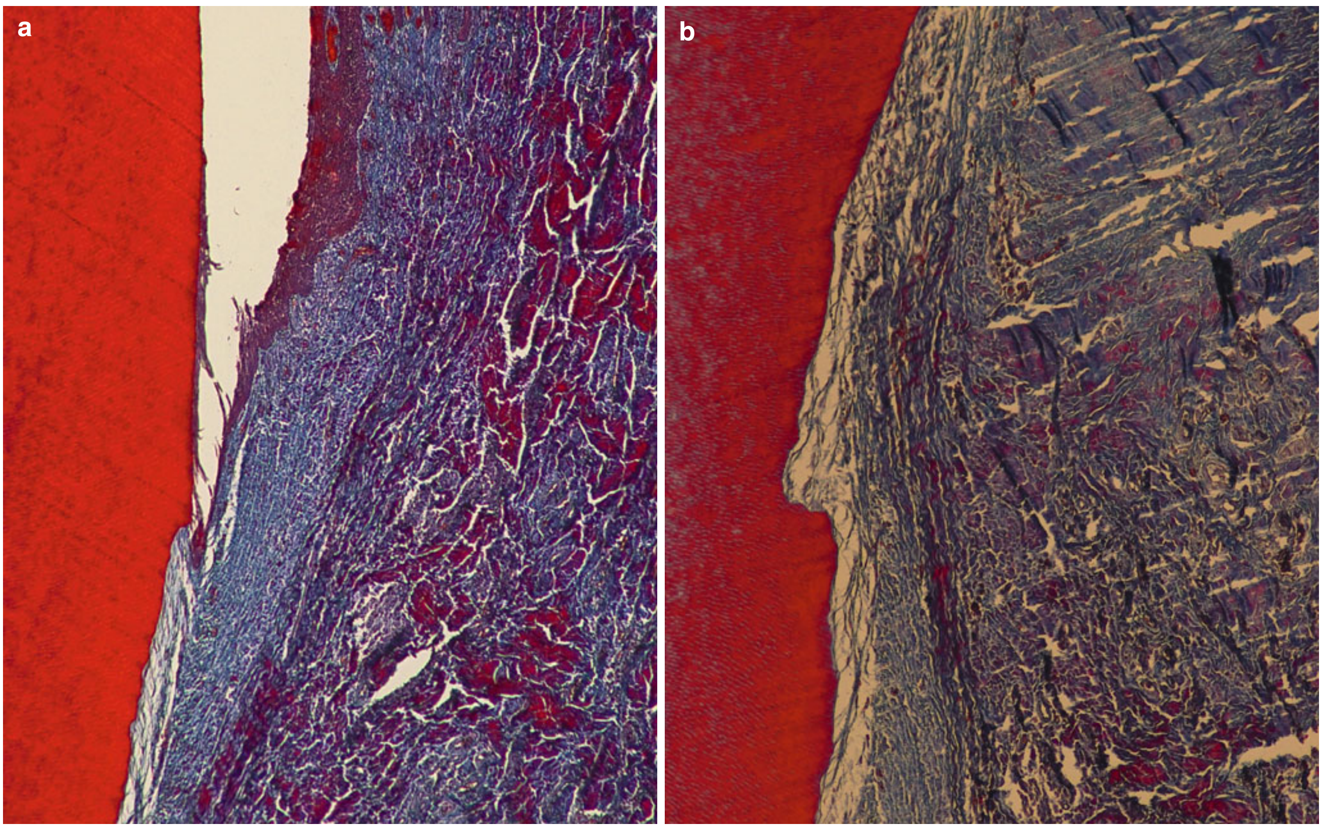

Fig. 3.6 Histologic healing – formation of a long junctional epithelium and connective tissue attachment (100× (**a**), 200× (**b**))

Consequently, after treatment, it is expected a shallow gingival sulcus that may be maintained over the long term when the causal agent was treated/removed. On the other hand, when the causal agent of the recession is not removed, apical migration of the gingival margin may quickly occur. In clinical terms, it should be noted that the majority of patients seeking root coverage procedures are not periodontitis patients and their defects are of traumatic origin (e.g. traumatic toothbrushing). For such patients, clinicians should pay attention to correct/adequate detrimental hygiene measures (Fig. 3.7) and remove other potential traumatic agents (e.g. oral piercings) in order to maintain the stability of the result achieved with the treatment [10].

In general clinical terms, which results should I expect at private practice in terms of unusual healing response and long-term stability?

Unusual healing responses associated to the use of SCTG, such as root resorption [50], formations of cyst-like areas [51, 52] or bone exostosis [53], were described in the literature but involve a very restricted number of defects. In general terms, these unexpected outcomes do not weaken the safety and success of the connective graft. Additionally, some degree of creeping attachment (i.e. the coronal displacement of the gingival margin covering exposed root surfaces) may occur when subepithelial connective tissue grafts, and mainly free gingival grafts, are the choice of treatment [54]. For all of these unusual conditions, their occurrence cannot be anticipated.

The recent AAP paper [10] observed that at least 70 % of recession reduction can be anticipated 2 or more years after treating the recessions, but the number of defects showing 100 % defect coverage can drastically vary (up to 67.5 % of variation) depending on the type of surgical procedure and the follow-up period. For instance, Pini Prato and co-workers [55] described that "a coronal displacement of the gingival margin was observed in the SCTG+CAF treated sites, while an apical relapse of the gingival margin was found in the CAF-treated sites between the 6-month and 5-year follow-ups".

It seems that the improvement on the keratinised tissue band, in terms of width and thickness gain (i.e. the concomitant root coverage and biotype change), is also responsible for keeping the stability of the results obtained with therapy. Overall, the use of subepithelial connective tissue grafts or enamel matrix derivatives in association to the coronal advancement of the gingival margin over the exposed root surface can provide the most stable outcomes. In contrast, coronally advanced flap alone and guided tissue regeneration were described as those procedures losing significantly more soft tissue [2, 4, 5, 8–10].

In addition, the elimination of the causative agent of the recession (e.g. traumatic toothbrushing, periodontal disease, etc.) and compliance with regular periodontal maintenance seem directly associated to long-term stability of results achieved with surgical therapy [56].

Fig. 3.7 Recession caused by traumatic toothbrushing (**a**), presence of a gingival fissure at the base of the defect (**b**); 60 days after proper toothbrushing (**c**), clinical improvements could be noted as well as the gingival fissure is no longer visible (**d**)

3.1.7 Role of Flap Preparation and Suture on Soft Tissue Root Coverage

Flap preparation and suture may not be underestimated during the surgical sequence. Recently, Burkhardt and Lang [57] highlighted some important issues on these surgical steps that demand special attention, and these are reproduced below:

1. Flap preparation (design, advancement, adaptation and stabilisation) deserves special attention when split- or full-thickness flaps are placed on avascular surfaces (root surface, dental implants, restorations), mainly in sites presenting aesthetic demands [57].
2. Tissue vascularisation guides flap design and favours graft incorporation ("the anatomical structures and their vascular supply are key issues") [57].
3. Flap lengthening regularly involves one or two vertical releasing incisions and a periosteal incision at the base of the buccal flap, given that the periosteum is primarily formed by dense collagen fibres (i.e. the use of a periosteal cut can release the flap tension and allow easy stretch of the elastic fibres of the adjacent mucosa) [57].
4. Flap advancement may be limited by the length of the gingival recession to be covered, as well as greater extent of buccal flap advancement requires releasing incisions [57]. The use of verticals can lead to the formation of scars, alter mucosal texture and modify the anticipated aesthetic results. The use of flaps without vertical incisions (when applicable) leads to similar outcomes than the traditional approaches with vertical ones [57].
5. Ideal flap preparation and releasing incisions should be based on the following: (1) incision of the sulcular area around the teeth and avoidance of marginal and para-marginal incisions, (2) the use of releasing incision as short and as medially as possible and (3) not performing releasing incisions on the buccal root prominences as the mucosal tissues covering the roots are usually thin and delicate [57].
6. Since suture can interrupt the microcirculation of flaps and modify wound healing, these can remain as little as absolutely needed for primary stability (each individual case should be considered, and not a "standard" regime of a seven- to 10-day period, for instance) [57].

3.1.8 American Academy of Periodontology Recommendations on Soft Tissue Root Coverage [10]

Information on the inclusive evaluation performed by the *American Academy of Periodontology* at its recent workshop on *Enhancing Periodontal Health Through Regenerative Approaches* were used to answer specific important questions commonly made by clinicians in their daily practice, regarding the best possible choice of treatment modality to satisfy their patients' needs [10].

Regarding the specific questions on soft tissue root coverage addressed by the AAP, the following can be considered during the decision-making process (as reported in the publication by Chambrone and Tatakis [10]):

"**1**. "***What is the efficacy/effectiveness of root coverage procedures by the degree of recession***?"[10] – The vast majority of the studies in the literature evaluated Miller Class I and II single recession defects" [10]. The following are all types of recession defects:

"(**a**) **Miller's** [17] **class I and II GR**: [10] All RC procedures can reduce recession depth and improve clinical attachment without changing of probing depth of single or multiple recession-type defects, SCTG-based procedures provided the best outcomes for clinical practice due to their superior percentages of coverage and improved possibility of completely covering the defects, as well as significant increase of KT when compared to most of the other procedures. The combination of CAF with ADMG, EMD and CM also provided gains, many of them similar to SCTG-based procedures, and thus these may be considered as adequate substitute treatment approaches. Defects treated at mandible as well as at posterior sites (i.e. molars) can be safely and satisfactory treated as well. The final outcomes achieved seem to benefit by the use of magnification during the surgical procedures, but little evidence was available for analysis. Conversely, smoking may decrease the expected results of SCTG" [10].

"(**b**) **Miller's class III and IV**: [10] For Class III defects, these may benefit by the use of RC procedures (at short-term) when SCTG-based procedures were used. Alternatively, EMD + CAF, ADMG + CAF and GTR + CAF can be used as graft substitutes. Overall, the marginal level of the gingival tissue of teeth adjacent to the GR seems to be the clinical reference point when planning and foreseen the expected results of Class III defects. Concerning Class IV recessions, the data from the limited number of case reports suggests that these defects may be improved after treatment, but the amount of root coverage cannot be anticipated, as well as restorative procedures may be necessary in order to reach the final expected esthetical outcomes" [10].

"**2**. "***Which factors may influence the outcomes*** (***i.e. smoking status and root surface conditions***)?" ***For instance***, "***Is it possible to accomplish root coverage for teeth with non-carious cervical lesions***, ***root caries or cervical root***

resorption?" [10] – It was clearly demonstrated that smoking may significantly decrease the effect of therapy, especially when SCTG-based procedures had been used. With respect to the surface conditions and from the limited number of studies available, it could be seen that non-carious cervical lesions, whether restored with composites/ionomer materials or not, may be safely treated by SCTG+CAF and CAF. Moreover, there is no evidence on the optimal timing for non-carious cervical lesions restoration (before/during RC procedure or after wound healing). For teeth previously restored or presenting caries, there is some evidence indicating the positive effects of treatment of these areas by RC procedures, but for both conditions there is a need of removal of old restorations/caries prior to the surgical therapy (i.e. the need for a "clean/disease-free root surface") [10]".

"**3**. "***What is the anticipated success and attachment apparatus of root coverage enhancements with autogenous grafts compared to alternative methods and materials***?" [10] – As already mentioned, SCTG-based procedures seem to be the best option in terms of clinical outcomes and cost-benefit ratio. On the other hand, the use of matrix grafts (ADMG and CM) and EMD may be used as safe substitutes for autogenous grafts in patients with great demands of donor tissue (e.g. patients with multiple recession type defects) or patients who do not want to be submitted to a secondary surgical procedure at the palatal vault. Histologically, most of the techniques may result in the formation of a long junctional epithelium (over the previously exposed root surface) and connective tissue attachment with fibers parallel to the root surface. Diversely, GTR and EMD procedures can lead to partial periodontal regeneration (i.e. formation of new cementum, alveolar bone and periodontal ligament inserted in the new formed cementum) [10]".

"**4**. "***What are the long term and short term advantages of root surface biomodification***? [10]" – The long-term outcomes (≥24 months) presented in the literature indicate that SCTG-based procedures and EMD+CAF may provide superior outcomes than CAF, as well more stable results. Overall, great part of the root coverage achieved at short-term may be maintained long-term. The use of root modification agents or other surface biomodification procedures did not provide superior gains on clinical outcomes, either short- or long-term, than those expected for procedures performed without such agents [10]".

"**5**. "***What are the relative risks from a patient's viewpoint with the different approaches to root coverage procedures***? [10]" – Regarding patient-centered outcomes, all RC procedures were considered safe and effective for attaining root coverage and satisfactory esthetics. Data on root hypersensitivity is still scant, but recent data suggests the positive impact of RC treatment on such an outcome. Moreover, a small percentage of patients may experience post-operative bleeding, swelling and pain. It could be considered that patients seem to prefer procedures that involve only one surgical site when considering these early post-operative adverse effects, but these were not associated with the final esthetic/functional outcomes [10]".

"**6**. "***Should connective tissue grafts contain epithelium and/or periosteum***? [10]" – The use of SCTG containing epithelium and/or periosteum does not provide additional gains than SCTG without epithelium or periosteum, but the existing evidence is very limited [10]".

"**7**. "***Do we have evidence for innovation when treating thin and thick biotypes with existing treatment modalities***? [10]" – SCTG, ADMG and CM can positively change thin periodontal biotypes of recession sites to thick periodontal biotypes. As reported within long-term studies, patients treated with graft procedures (and their consequent biotype improvement) benefited by more stable outcomes and less recession recurrence. Overall, it seems reasonable to suggest that biotype modification (i.e. thin to thick biotypes) should be considered when planning and treating recession-type defects due to the positive more stable long-term outcomes reported [10]".

3.1.9 Clinical Concluding Remarks: "What Should I Expect of the Treatment of Gingival Recession Defects?"

The treatment of a gingival recession is safe and leads to significant clinical reductions in recession depth and attachment level within Miller Class I and II defects. Class III recession may be benefited as well, but the amount of coverage will be based on the amount of interproximal tissue lost (usually the amount of root coverage expected is based on the position of the gingival margin of the adjacent teeth).

Altogether with the improvements on the aesthetic condition, a decrease of dentin hypersensitivity and prevention of caries/cervical lesion over the exposed root surface may be expected. Both single and multiple recessions may be benefited by periodontal plastic surgery, but apart from the type of procedure or recession, the rationale for treatment should be focused on the clinician's knowledge and patient-centred outcomes (e.g. aesthetic assessment, functional limitations, discomfort, root sensitivity and preferences). Overall, a small percentage of patients may experience early post-operative bleeding, swelling and pain, but these do not modify the final aesthetic/functional outcomes. Moreover, it should be noted that the amount of vascularisation adjacent to a root surface is crucial when a flap is moved over avascular sites (root surface); consequently, it is adequate to extend the base of the pedicle (flap) to improve the local blood supply during early healing [56].

Likewise, flap stabilisation and suture coronal to the CEJ are important and desirable too [56], but other local conditions should be considered during the decision-making process (choice of best procedures), such as periodontal conditions (lack of biofilm inflammation), recession anatomy (classification, depth and width), anatomy of adjacent soft tissue (thickness and presence of keratinised tissue) and tooth/root conditions (tooth position and root prominence) [56].

Critical Summary of the Results of Systematic Reviews

Systematic reviews conclusions: All periodontal plastic surgery procedures are safe and can lead to clinical significant gains in gingival recession depth and in clinical attachment level [2–10].

Summary of the reviews and critical remarks: Most of the research on the treatment of recession-type defects highlights the positive effect of treatment in terms of defect- and patient-centred outcomes, such as the amount of root coverage and aesthetical improvement. The incidence of adverse effects, such as discomfort with or without pain, is very low, and when present, these may occur at the early phase of healing. Additionally, such events do not lead to changes in the final anticipated functional (root hypersensitivity) and/or aesthetic outcomes [2–10].

Evidence quality rating/strength of recommendation (*ADA 2013*) [58]: Strong – evidence strongly supports this intervention (i.e. treatment of recession-type defects).

3.2 Laterally Positioned Flap-Based Procedures

3.2.1 Historical Note

Described in 1956 by Grupe and Warren [59], this technique was based on the preparation of a full-thickness pedicle flap using the soft tissue (gingiva and mucosa) of a tooth adjacent to the gingival recession and its positioning/rotation over the exposed root surface in order to cover it. Despite its promising results on the restitution of the lost soft tissue and aesthetic improvement, loss of gingiva at the donor site was frequent as well.

Almost a decade later, modifications to the original technique (including papillary tissue-based procedures) were proposed to reduce the adverse effects related to the donor sites, as well as to improve the coverage of the recipient site. Between 1964 and 1968, several groups of clinicians/researchers proposed the following changes:

- Corn [60] and Robinson [61] proposed the use of edentulous ridges adjacent to the recipient site as donor bed.
- Staffileno [62] suggested the use of a partial-thickness flap created by sharp dissection to maintain the donor bed covered by periosteum.
- Friedman and Levine [63] improved the area of the flap by increasing its width to include two adjacent teeth and thus to reduce the exposure of the facial alveolar ridge surface.
- Goldman et al. [64] recommended the use of mixed flap capable to cover both the donor and recipient beds. In this technique, the recipient site should be covered with the full-thickness portion of the flap, whereas the donor area should be covered by the split-thickness flap to prevent for any bone exposure.
- Pennel et al. [65] introduced the use of an oblique incision to improve the area of coverage and to facilitate the accommodation of the flap, by permitting the concomitant lateral and coronal positioning/moving of the flap.
- Grupe [66] modified his former technique, by leaving a narrow band (1 mm) of marginal gingival tissue at the donor tooth to prevent for tissue loss at this area.
- Ariaudo [67] extended the flap to four or more adjacent teeth.
- Cohen and Ross [68], based on Pennel's et al. [65] modification, tried to reduce the exposure of the donor bed by advocating the use of a double papilla flap rotated from the interdental areas of the defect.

Furthermore, other subsequent modifications and standardisations of technique by Bjorn [69], Smukler [70], Patur [71], Guinard and Caffesse [72], Leis and Leis [73], Bahat et al. [74], Milano [75] and more recently Zucchelli et al. [76] were proposed either to improve the characteristics of the flap or to provide better protection to the donor areas. In addition, with the development and results of other techniques after the mid-1980s, especially those involving the use of subepithelial connective tissue grafts, soft tissue substitutes and guided tissue regeneration combined with coronally advanced flap procedures, the scientific community seems has lost interest in the evaluation of LPF.

3.2.2 Type of Defect to Be Indicated

Treatment of localised Class I or II GR [30] (Class III may be benefited by this procedure) adjacent to the donor teeth presenting a width of attached keratinised tissue (KT) of at least 2 mm and thick periodontal biotype

3.2.3 Type of Defect not to Be Indicated

Treatment of localised or multiple GR adjacent to the donor teeth presenting a width of attached keratinised tissue (KT) <2 mm and thin periodontal biotype

3.2.4 Basics of the Surgical Sequence

Following local anaesthesia, the recipient site should be prepared to accommodate the LPF. An incision is made around the recession defect creating a 1-mm-wide gingival collar. After this, the collar is excised, and two vertical incisions are made at the ends of the gingival recession and extended to the alveolar mucosa. These incisions are then connected by a horizontal incision and the recipient site is de-epithelialised. In the donor site (i.e. adjacent tooth), a horizontal submarginal incision is made at the mesial end of the gingival recession and extended in the mesial-distal direction.

A vertical releasing incision should be made at the end of the horizontal incision and extended to the alveolar mucosa. It is important to highlight that the interdental papilla distal to the defect should be preserved as much as possible. After that, a full- or partial-thickness flap (depending on the type of LPF-based technique used) is raised with blade dissection, and a 3-mm-wide collar of intact gingiva should be left undisturbed around the donor tooth. After flap incision and dissection, the exposed root surface should be thoroughly, but carefully, planned with hand curettes and/or finishing burs. At this stage, root modification agents may be used, but no additional clinical benefits should be expected. The planned root surface is rinsed with saline; the flap is laterally positioned at the level or beyond (coronal) of the cemento-enamel junction and sutured by 5-0 or 6-0 nylon/Teflon sutures (Fig. 3.8). It is also essential to note that the flap should be passively adapted over the recipient site (i.e. it must remain stable at that position even without sutures), so all muscle inserts located on the internal side of the flap should be removed leaving the flap with no tension. Subsequently, a non-eugenol periodontal dressing may be placed over the donor sites. The dressing and sutures are removed 14 days after surgery.

In addition, patients should be instructed not to brush the tooth in the treated area, as well as they are prescribed 0.12 % chlorhexidine gluconate and instructed to rinse gently twice a day for 2–3 weeks or until safe and comfortable tooth-brushing can be performed. Overall, analgesics, anti-inflammatory drugs and/or systemic antibiotics are prescribed if needed, as well as no adverse effects are expected in the donor or recipient sites.

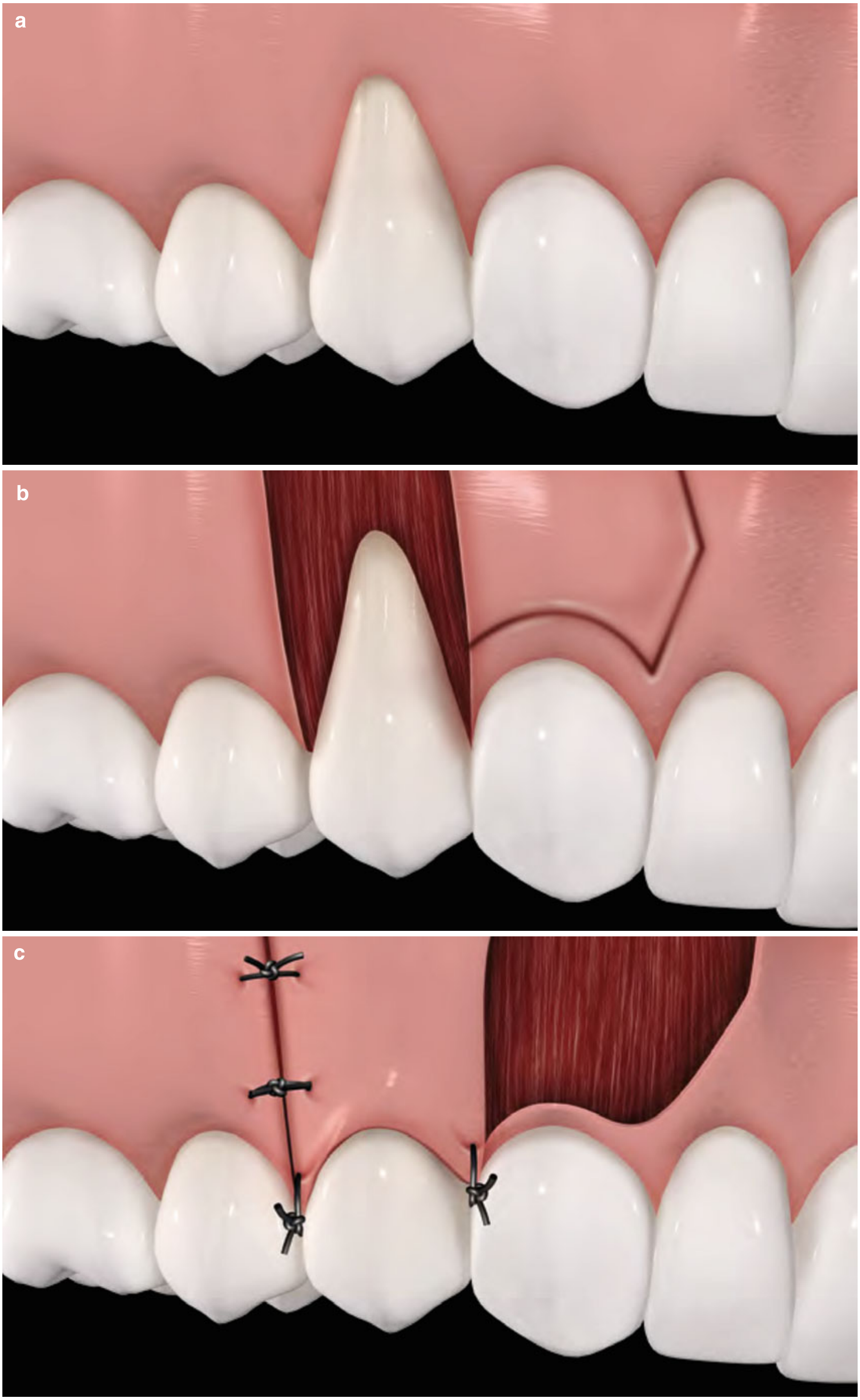

Fig. 3.8 Laterally positioned flap. Baseline (**a**), recipient bed preparation and delimitation of the flap over the donor bed (**b**), partial-thickness flap positioned and sutured over the recipient bed (**c**)

3.2.5 Clinical Remarks: Implications for Practice and Clinical Decision-Making on Soft Tissue Coverage

The use of LPF may lead to significant reduction in recession depth and clinical attachment level gain for Miller Class I and II localised defects, as well as a great part of the root coverage achieved at short term may be maintained long term. Creeping attachment may occur in donor and recipient sites, but the amount of coronal displacement of the gingival tissue cannot be defined. By requiring only one surgical site, its use is easier and less painful, and the chair time is smaller than SCTG, which, in practical terms, may be better indicated for less experienced clinicians. On the other hand, in terms of achieving complete root coverage, this technique is less effective than SCTG-based procedures, as well as its use is limited to localised areas, with an adjacent thick periodontal biotype. Consequently and despite their clinical advantages, the use of LPF is better suitable when SCTG could not be used (Figs. 3.9, 3.10, 3.11, 3.12, 3.13, 3.14 and 3.15).

Critical Summary of the Results of Systematic Reviews

Systematic reviews conclusions: No data derived from RCTs were assessed regarding LPF [5–8].

Summary of the reviews and critical remarks: Most of the research available for this procedure relies on studies performed at the 1970s and early 1980s (the use of RCTs to test root coverage relates to the early 1990s). Of the most recent literature, four studies (one of them a RCT) show that:

Santana et al. [77] – MRC of 95.5 % and CRC of 83.3 % (15/18) at 6 months

Ricci et al. [78] – MRC of 61.9 %; sites with CRC of 15 % (3/20) at 12 months

Zucchelli et al. [76] – MRC of 96.0 % and CRC of 80 % (96/120) at 12 months

Chambrone and Chambrone [49] – MRC of 93.8 % and CRC of 62.5 % (20/32) at 24 months

Evidence quality rating/strength of recommendation (*ADA 2013*) [58]: Weak – evidence suggests implementing this intervention after alternatives have been considered.

Fig. 3.9 Case I. (**a**–**g**) Class I gingival recession on tooth 14. Baseline (**a**) flap (13) positioned and sutured over the recession (**b**), 4-year follow-up (**c**, **d**), 9-year follow-up (**e**), 16-year follow-up (**f**, **g**)

Fig. 3.10 Case II. (**a**–**i**) Class I recession on tooth 13. Baseline (**a**). Removal of restoration, incisions for flap and gingival collar delimitation – tooth 12 (**b**), flap laterally positioned and sutured (**c**), 1-month follow-up (**d**), 12-month follow-up (**e**), 8-year follow-up (**f**), 15-year follow-up (**g**), long-term stability 15 years the procedure after (**h**), 24-year follow-up (new metal ceramic crowns were installed at the donor and recipient teeth 7 years prior this evaluation)

Fig. 3.11 Case III. (**a**–**f**) Gingival recession in smoking patient (>20 cigarettes per day) on tooth 31. Baseline – recession developed due to the association of muscle insert close to the gingival margin, dentinary hypersensitivity and biofilm accumulation (**a**, **b**), clinical condition after the basic procedures (**c**). Horizontal incision around the recession (**d**), flap positioned over the exposed root (**e**), 8-year follow-up (**f**)

Fig. 3.12 Case IV. (**a**–**d**) Class II gingival recession on tooth 41 – smoking patient (20 cigarettes per day). Baseline (**a**), flap delimited (**b**), flap laterally positioned and sutured (**c**), 7-month follow-up (**d**)

Fig. 3.13 Case V. (**a**–**c**) Class III gingival recession at tooth 41. Baseline (**a**), baseline radiograph (**b**), 2-year follow-up (**c**)

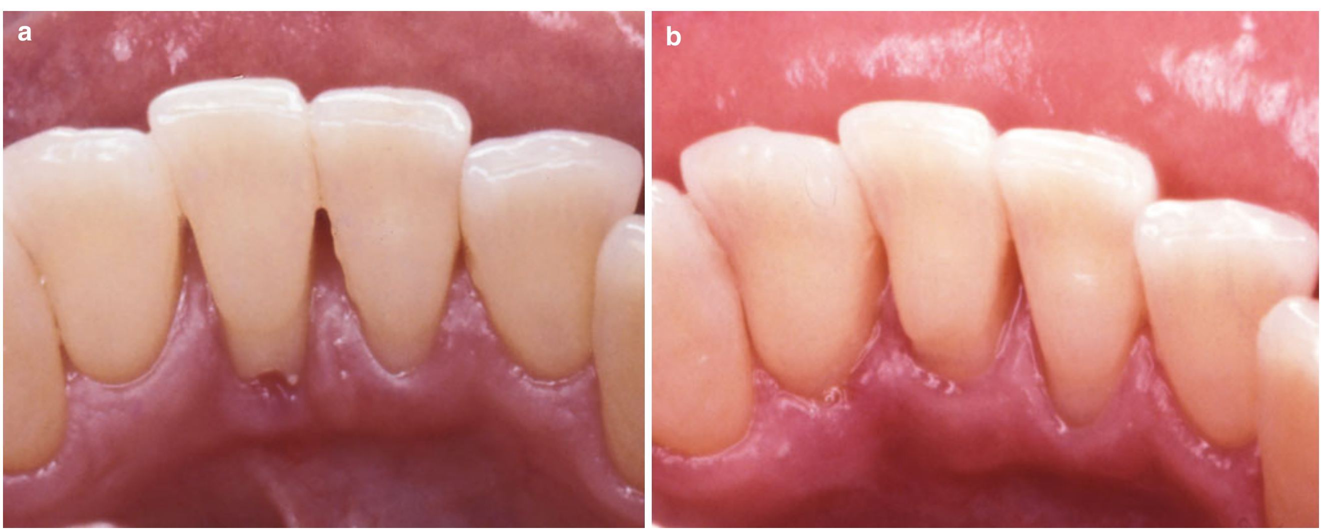

Fig. 3.14 Case VI. (**a**, **b**) Lingual Class II recession associated to external root resorption – tooth 41. Baseline (**a**). 4-month follow-up (**b**)

Fig. 3.15 (**a**–**d**) Class III gingival recession adjacent to a lip frenum (prior to orthodontic treatment) – tooth 31. Baseline (**a**), double papilla flap positioned and sutured over the exposed root surface (**d**), 1-month follow-up (**c**), 4-month follow-up (**d**)

3.3 Coronally Advanced Flap-Based Procedures

3.3.1 Historical Note

Historical reports proposing the advancement of the gingival marginal tissue over an exposed root surface were published initially in 1907 (by Harlan) and 1912 (by Rosenthal) in the USA [79]. However, Norberg [80] may be considered as the first author to describe a clinically viable technique involving the use of the coronally advanced flap (CAF).

At the end of the 1940s, different modifications and improvements of the CAF were also proposed [81–89]. Of them, the following surgical variations deserve reasonable attention:

- Harvey [85] after evaluating the outcomes of his early study [83] proposed the increase of the keratinised tissue band with a free gingival graft (FGG) 6 months before the surgery of coronal flap advancement.
- Bernimoulin et al. [86] similar to Harvey [85] proposed the use of an FGG 2 months before the root coverage procedure.
- Tarnow [87] described a new flap design, the semilunar coronally advanced flap, to be used in areas presenting a band of keratinised tissue. According to the publication, areas lacking keratinised tissue should be treated with an FGG 2 months before the coronal advancement of the flap.
- Zucchelli and de Sanctis [88] presented changes to the CAF procedure to improve the predictability of multiple recession-type defects. The authors proposed the use of a horizontal incision and a split-full-split approach to create an "envelope flap" with no releasing incisions in order to preserve the maximum soft tissue thickness above the root exposure. This incision should be extended laterally to include at least one adjacent tooth of each side of the GR.
- de Sanctis and Zucchelli [89] proposed the use of their split-full-split approach (similar to the previously referenced one [88]) to the conventional CAF procedure with vertical releasing incisions for the treatment of localised GRs.

3.3.2 Type of Defect to Be Indicated

Treatment of localised or multiple Class I GR [30] presenting a width of attached keratinised tissue (KT) of at least 2 mm and thick periodontal biotype. Class III GR [30] may be benefited by this procedure also when adequate amount of keratinised tissue (similar to Class I) is present.

3.3.3 Type of Defect Not to Be Indicated

Treatment of localised or multiple GR presenting a width of attached keratinised tissue (KT) <2 mm and thin periodontal biotype.

3.3.4 Basics of the Surgical Sequence

Following local anaesthesia, an intrasulcular incision is made at the tooth presenting the gingival recession, and two vertical incisions are made at the ends of the gingival recession and extended to the alveolar mucosa. For procedures not involving releasing incisions [88], the intrasulcular incision should be extended to one to two teeth adjacent of the recession to allow advancement of the flap over the exposed root surface without tension. Subsequently, a partial-thickness flap is elevated by sharp dissection, the interdental papilla are de-epithelialised and the exposed root surface should be thoroughly, but carefully, planned with hand curettes and/or finishing burs. Likewise to all root coverage procedures, at this stage, root modification agents may be used, but no additional clinical benefits should be expected. The planned root surface is rinsed with saline; the flap is coronally advanced at the level or beyond of the cemento-enamel junction and sutured by 5-0 or 6-0 nylon/Teflon sutures (Figs. 3.16 and 3.17). It is also crucial to note that the flap should be passively adapted over the recipient site (i.e. it must remain stable at that position even without sutures), so all muscle inserts located on the internal side of the flap should be removed leaving the flap with no tension (similar to the laterally positioned flap). The sutures may be removed 7–21 days after surgery. In addition, patients should be instructed not to brush the tooth in the treated area, as well as they are prescribed 0.12 % chlorhexidine gluconate and instructed to rinse gently twice a day for 2–3 weeks or until safe and comfortable toothbrushing can be performed. Overall, analgesics, anti-inflammatory drugs and/or systemic antibiotics are prescribed if needed, as well as no adverse effects are expected in the treated sites.

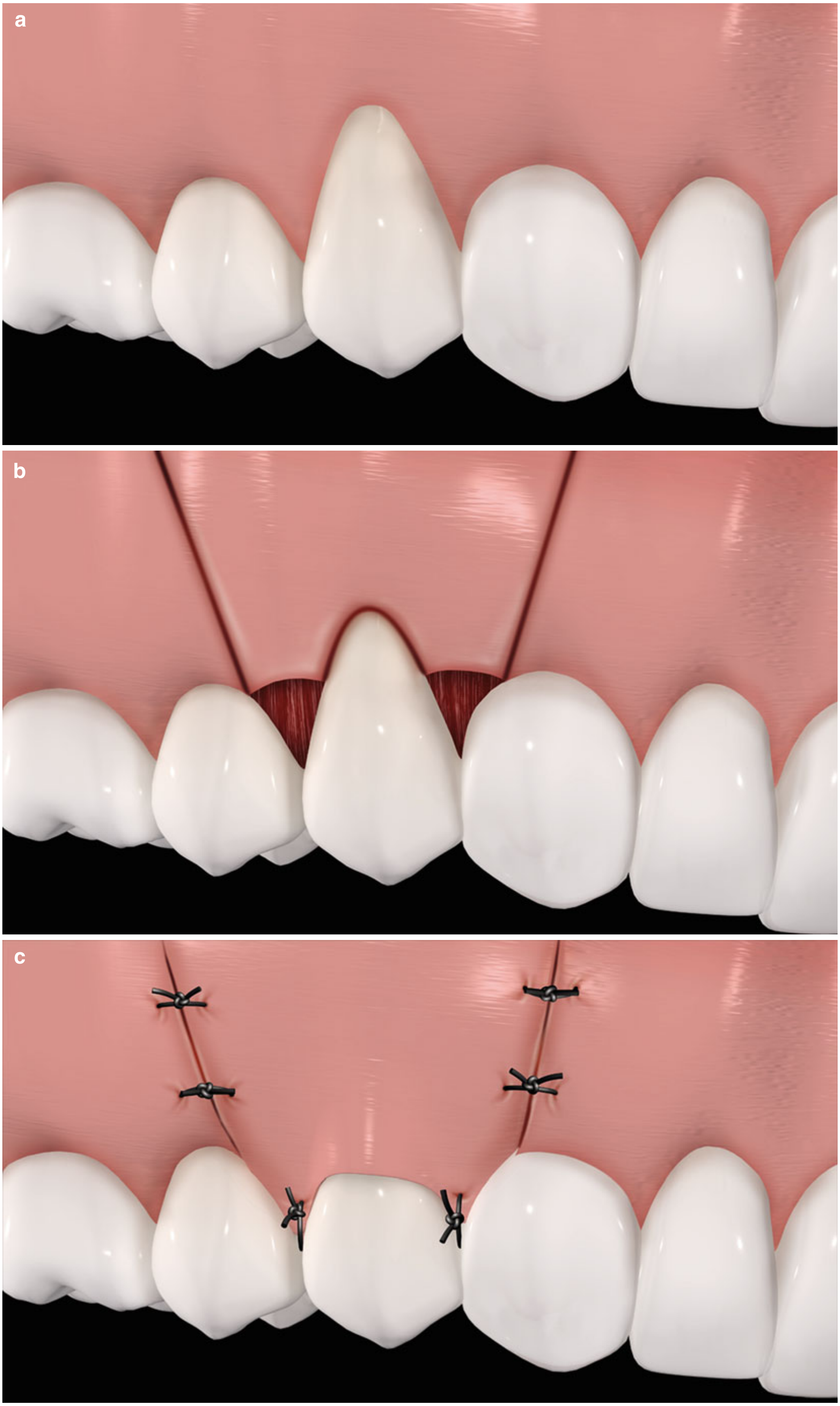

Fig. 3.16 (**a**–**c**) Coronally advanced flap with vertical releasing incisions. Baseline (**a**). Releasing incision delimitation and removal of the epithelium of the adjacent interdental papillae (**b**), flap coronally advanced and sutured (**c**)

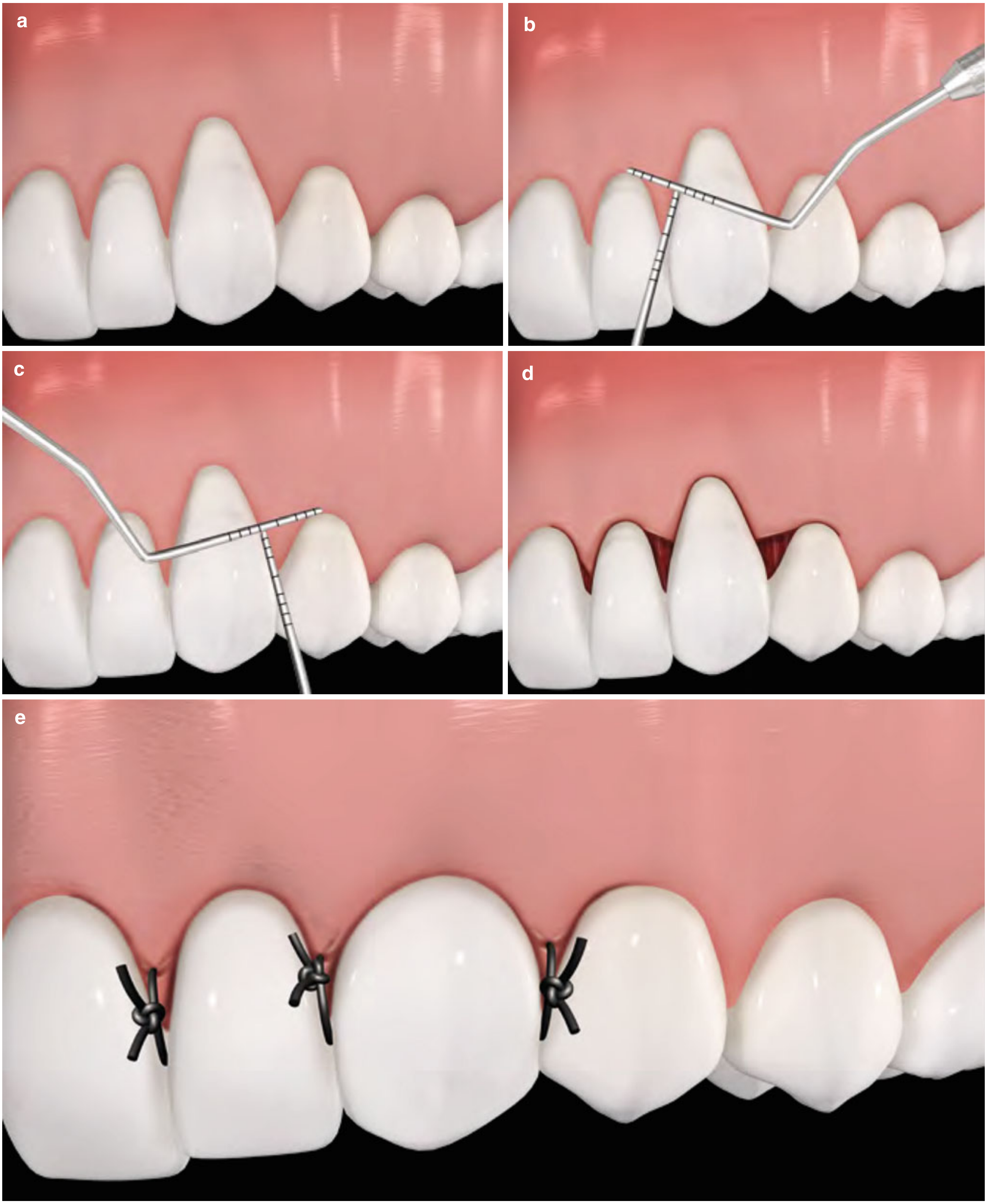

Fig. 3.17 (**a**–**e**) Coronally advanced flap without vertical releasing incisions. Defects (**a**), determination of the papillary incisions (**b**, **c**), papillae de-epithelialised (**d**), flap coronally advanced and sutured (**e**)

3.3.5 Clinical Remarks: Implications for Practice and Clinical Decision-Making on Soft Tissue Coverage

The use of CAF alone propitiates significant reductions in recession depth, as well as CAL gain for Miller Class I [30] single or multiple defects at short term. Similar to the laterally positioned flaps, they are less technically demanding, faster and less painful than connective graft-based procedures, and again they may be better indicated for less experienced clinicians. However, long-term maintenance of results seems to be directly linked to the type of periodontal biotype and toothbrushing habits. CAF alone may be associated with a great amount of apical relapse of gingival margin position over time. In terms of mean root coverage and complete root coverage achieved, this technique is less effective than SCTG-based procedures or CAF plus biomaterials (i.e. enamel matrix derivative, acellular dermal matrix grafts or xenograft matrix grafts). Thus, the use of coronally advanced flap alone is better suitable for the treatment of localised or multiple recession-type defects when SCTG or the above-mentioned biomaterials could not be used (Figs 3.18, 3.19, 3.20 and 3.21).

Critical Summary of the Results of Systematic Reviews

Systematic reviews conclusions: There is a clear evidence that CAF alone leads to significant clinical gains in GR and attachment level gain, but without improvements in the width of KT [2, 4–8, 10].

Summary of the reviews and critical remarks: The base of evidence on CAF is very solid. For example, within GR ≥3 mm, MRC varied from 55.94 to 86.7 %, while CRC varied from 7.7 to 60.0 % [5, 6]. Overall, the results found in systematic reviews showed that SCTG, EMD and matrix grafts enhanced clinical outcomes of CAF alone, whereas the use of guided tissue regeneration did not.

Evidence quality rating/strength of recommendation (*ADA 2013*) [58]: In favour – evidence favours providing this intervention.

Fig. 3.18 Case I. (**a**–**i**) Class I gingival recessions on teeth 13 and 14 – Baseline (**a**), recession depth of 3 mm (**b**), planning the papillary incisions (**c**), horizontal incisions performed as reported by Zucchelli and de Sanctis [88] (**d**), flap raised without releasing incisions (**e**), papillae de-epithelialisation (**f**), flap coronally advanced and sutured as much as possible (with no tension) (**g**), 14-day follow-up (**h**), 4-month follow-up (**i**)

Fig. 3.19 Case II. (**a**–**d**) Shallow multiple recession defects (Class I). Baseline (**a**), flap elevated (**b**), flap coronally advanced and sutured (**c**), 2-year follow-up (**d**)

Fig. 3.20 Case III. (**a**–**l**) Multiple Class I gingival recessions at the maxilla. Baseline (**a**); baseline, right side (**b**); baseline, left side (**c**); incisions performed, frontal view (**d**); incisions performed, right view (**e**); incisions performed, left view (**f**); flap coronally advanced and sutured, frontal view (**g**); flap coronally advanced and sutured, right side (**h**); left side (**i**). 1-year follow-up, frontal view (**j**); 1-year follow-up, right side (**k**); 1-year follow-up, left side (**l**)

Fig. 3.20 (continued)

Fig. 3.21 Case IV. (**a**–**d**) Deep Class I gingival recessions on multiple teeth. Baseline (**a**), flap raised (**b**), flap coronally advanced and sutured (**c**), 2-year follow-up (**d**) (Case conducted in association to Dr. Rodrigo Carlos Nahas de Castro Pinto)

3.4 Free Gingival Graft-Based Procedures

3.4.1 Historical Note

As described by Baer and Benjamin [79] in its historical note, the use of a "gingival graft" was first described during a meeting of the *American Dental Club of Paris* in December 6, 1902, and subsequently published in 1904 in the format of an abstract at *Dental Cosmos*. According to this note [79], a graft removed from "the region located behind the third molar" was used to cover a gingival recession.

The use of palatal vault as donor site of free gingival grafts (FGG) was first described in 1963 by Björn [90] who originally described this technique for deepening the vestibular fornix. Regarding the treatment of recession-type defects, King and Pennel [91, 92] and Nabers [93] were those who first employed FGG for soft tissue root coverage. Standardised surgical sequences were described subsequently:

- Sullivan and Atikins [33, 94] modified the preparation of the recipient site to improve the blood supply and decrease the odds of tissue necrosis over the root surface.
- Miller [95, 96] demonstrated the use and predictability of 2-mm-thick FGG in the treatment of deep-wide recessions (>3 mm). The author emphasised that the exposed root should be thoroughly and vigorously planned to decrease the surface of root surface in contact with the graft and increase the contact area between the graft and the receipt site as well (Fig. 3.22).
- Carvalho et al. [97] proposed the combination of connective tissue pedicle flaps rotated from the interproximal papilla with FGG to improve the revascularisation of the graft over the root surface. In this procedure, the de-epithelialised papillary pedicles are positioned and sutured over the root surface before the suture of the FGG at the recipient site (Fig. 3.23).
- Borghetti and Gardella [98] similar to Miller [95, 96] also proposed the use of thick FGGs (mean of 1.81 mm), but limited to narrow defects.

3.4.2 Type of Defect to Be Indicated

Treatment of narrow (<3 width) localised or multiple Class I or II GR [30] located in areas without aesthetical demands. Class III GR [30] may be benefited by this procedure as well, but the degree of predictability is uncertain.

3.4.3 Type of Defect Not to Be Indicated

Recession defects located in aesthetic areas may be benefited by this procedure, but the final colour of the tissue covering the previous exposed surface will not match the adjacent gingiva. No evidence on Class IV defects is available

3.4.4 Basics of the Surgical Sequence

Following local anaesthesia, the exposed root surface should be thoroughly and vigorously planned with hand curettes and/or finishing burs, and root modification agents may be used (but no additional clinical benefits should be expected). Initially, a horizontal incision is made in the interdental papillae at the level of the cemento-enamel junction [95, 96], and an intrasulcular incision is made at the tooth presenting the gingival recession. Two vertical incisions are made at the ends of the horizontal incision and extended to the alveolar mucosa. Subsequently, a thin, partial-thickness flap is dissected up to the apical limits of the vertical incision and completely excised (the recipient bed becomes de-epithelialised). Being the recipient site prepared, an FGG is trimmed from the palate according to the size of need to cover the recipient site and sutured by 5-0 or 6-0 interrupted/suspensory nylon/Teflon sutures. It is also crucial to note that no "dead spaces" should be present between the surface of the graft and root surface/*lamina propria* bed [95, 96]. The sutures are removed 7–14 days after surgery. In addition, patients should be instructed not to brush the tooth in the treated area, as well as they are prescribed 0.12 % chlorhexidine gluconate and instructed to rinse gently twice a day for 2–3 weeks or until safe and comfortable toothbrushing can be performed. Overall, analgesics, anti-inflammatory drugs and/or systemic antibiotics are prescribed if needed, as well as no adverse effects are expected in the treated sites.

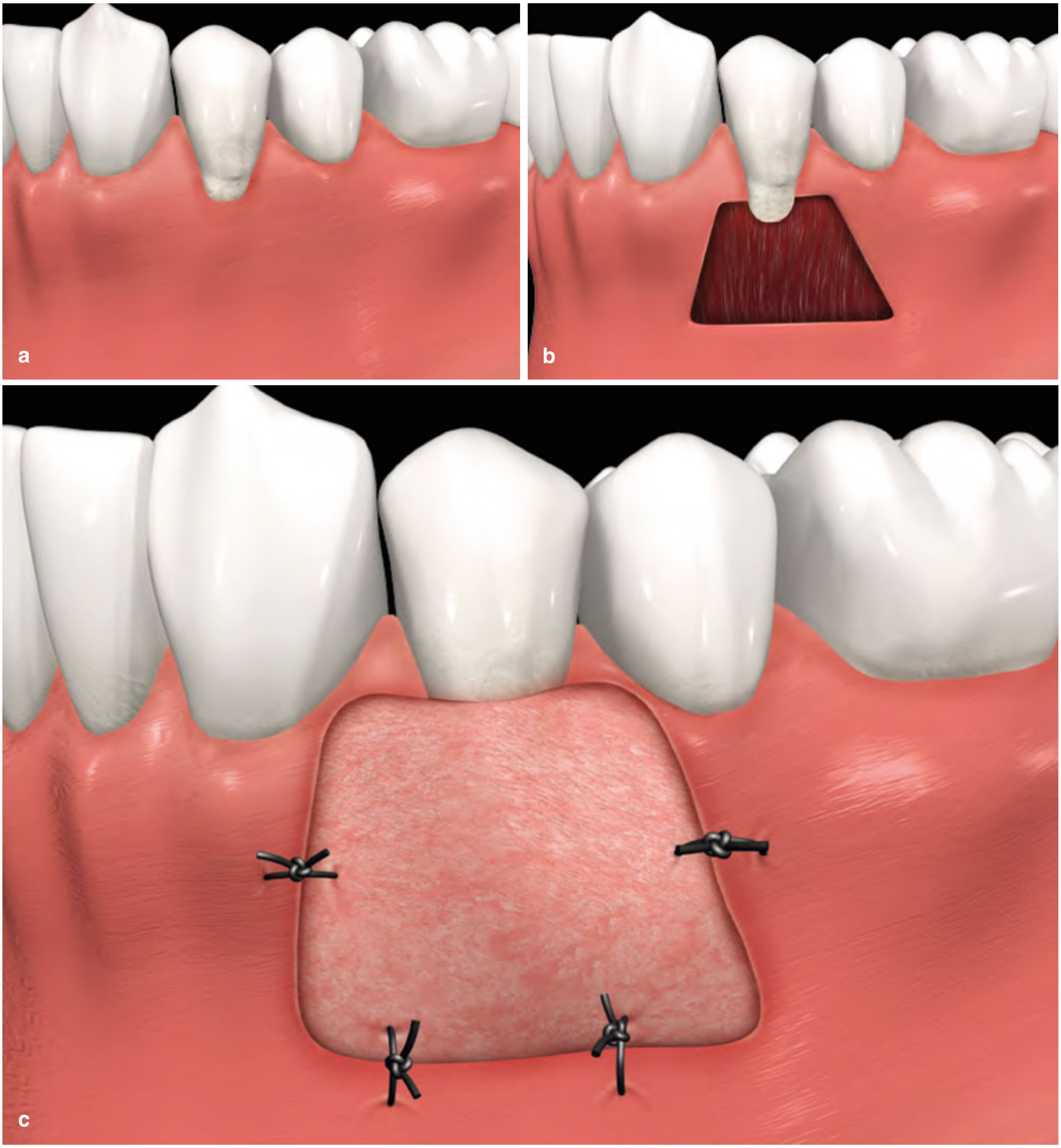

Fig. 3.22 Free gingival graft

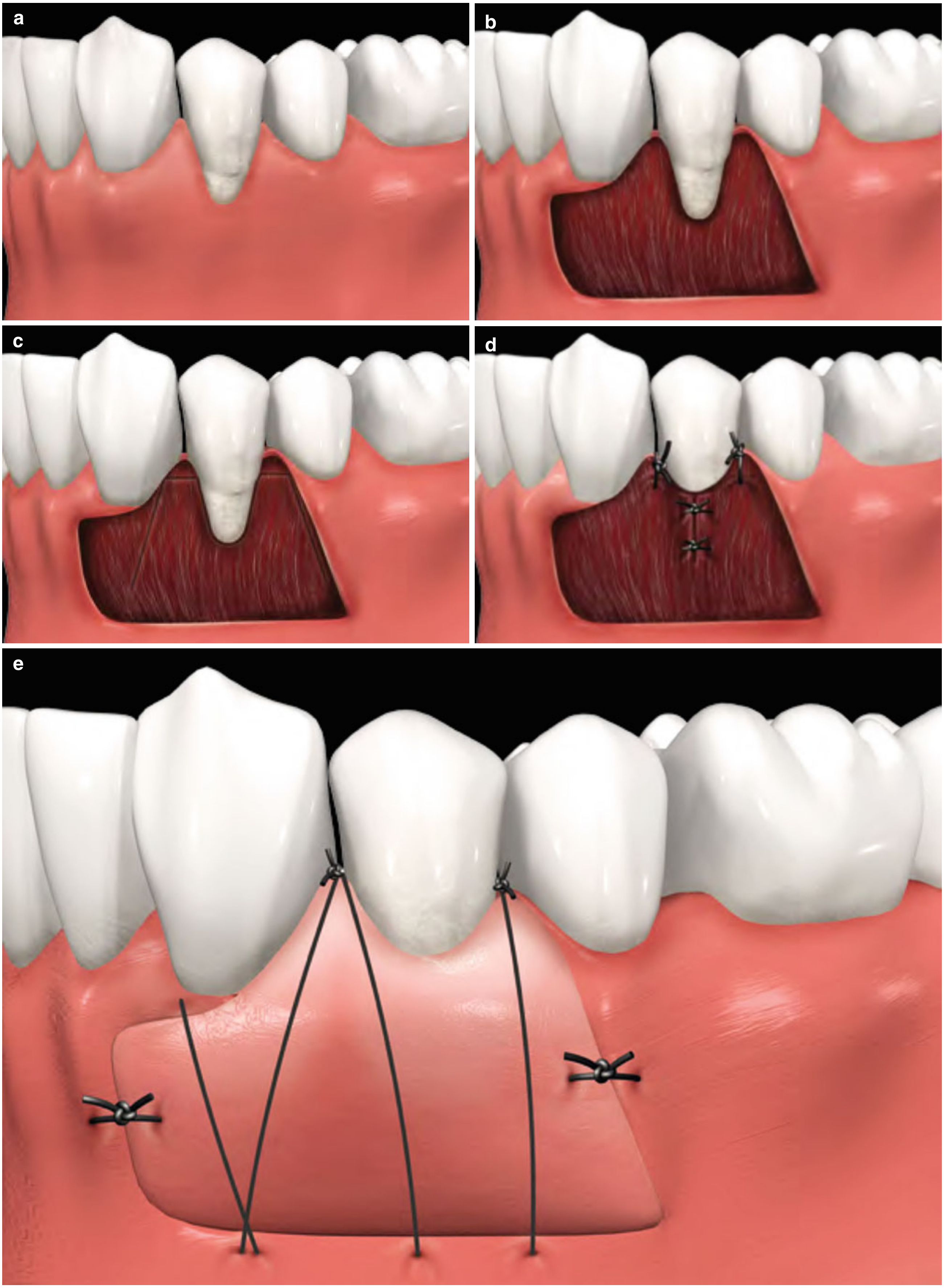

Fig. 3.23 De-epithelialised double papilla flap + free gingival graft

3.4.5 Clinical Remarks: Implications for Practice and Clinical Decision-Making on Soft Tissue Coverage

The use of FGG can reduce recession depth and improve clinical attachment level, but it efficacy is inferior to all other soft tissue root coverage procedures. On the other hand, it may increase the keratinised tissue width and modify the periodontal biotype. Although the results of FGG may be improved over time by the coronal displacement of the gingival margin (creeping attachment) [10], the amount of this "advantageous" outcomes may not be anticipated (i.e. 0.3–9 mm of creeping attachment has been reported in the literature) [10].

In addition, the association of pedicle flaps to FGG may be used in clinical practice, but there is no scientific information on the outcomes of such combined procedures (Figs. 3.24, 3.25, 3.26, 3.27, 3.28, 3.29, 3.30, 3.31 and 3.32).

Critical Summary of the Results of Systematic Reviews

Systematic reviews conclusions: The evidence suggests that FGG may lead to significant clinical gains in GR, attachment level and the width of KT [2, 5–7, 10].

Summary of the reviews and critical remarks: The base of evidence on efficacy studies is limited for FGGs [2, 5–7, 10]. FGG seems more predictable when used in nonaesthetic sites and narrow (<3 mm wide) defects. Also, FGG may present 1/3 less root coverage than SCTG, as well superior morbidity related to the donor site [10]. Regarding to the outcomes of the main effectiveness/efficacy studies:

Miller [96] – in their practice-based study, of the 21 Class III mandibular defects treated with FGG (recession depth range 4–9 mm), 19 (90.5 %) reached CRC (an outcome inferior to those reported to Class I defects [100 % CRC or 13/13] and superior to Class II ones [87.9 % CRC or 58/66]). Also, MRC of 98.1 % was reported for Class III defects.

Jahnke et al. [99] – MRC of 37.9 % and CRC of 11.1 % at 6 months

Ito et al. [100] – MRC (multiple recession defects) of 76.3 % at 6 months and 86.2 % at 12 months

Paolantonio et al. [101] – MRC of 53.2 % and CRC of 8.6 % at 5 years

Evidence quality rating/strength of recommendation (ADA 2013) [58]: Weak – evidence suggests implementing this intervention after alternatives have been considered.

Fig. 3.24 Case I. (**a**–**l**) Class II mandibular single recession (nonaesthetic site). Baseline (**a**, **b**), removal of the sulcular epithelium (**c**), note the presence of a muscle insert close to the gingival margin of the recession (**d**), de-epithelialisation of the area (**e**), de-epithelialised site (**f**), de-epithelialised site (**g**), papillary pedicle flaps raised and positioned over the root surface (**h**), pedicle flap sutured over the root surface (**i**), FGG sutured over the de-epithelised pedicle flaps (**j**), 6-month follow-up (**k**), and site probing at last follow-up (**l**)

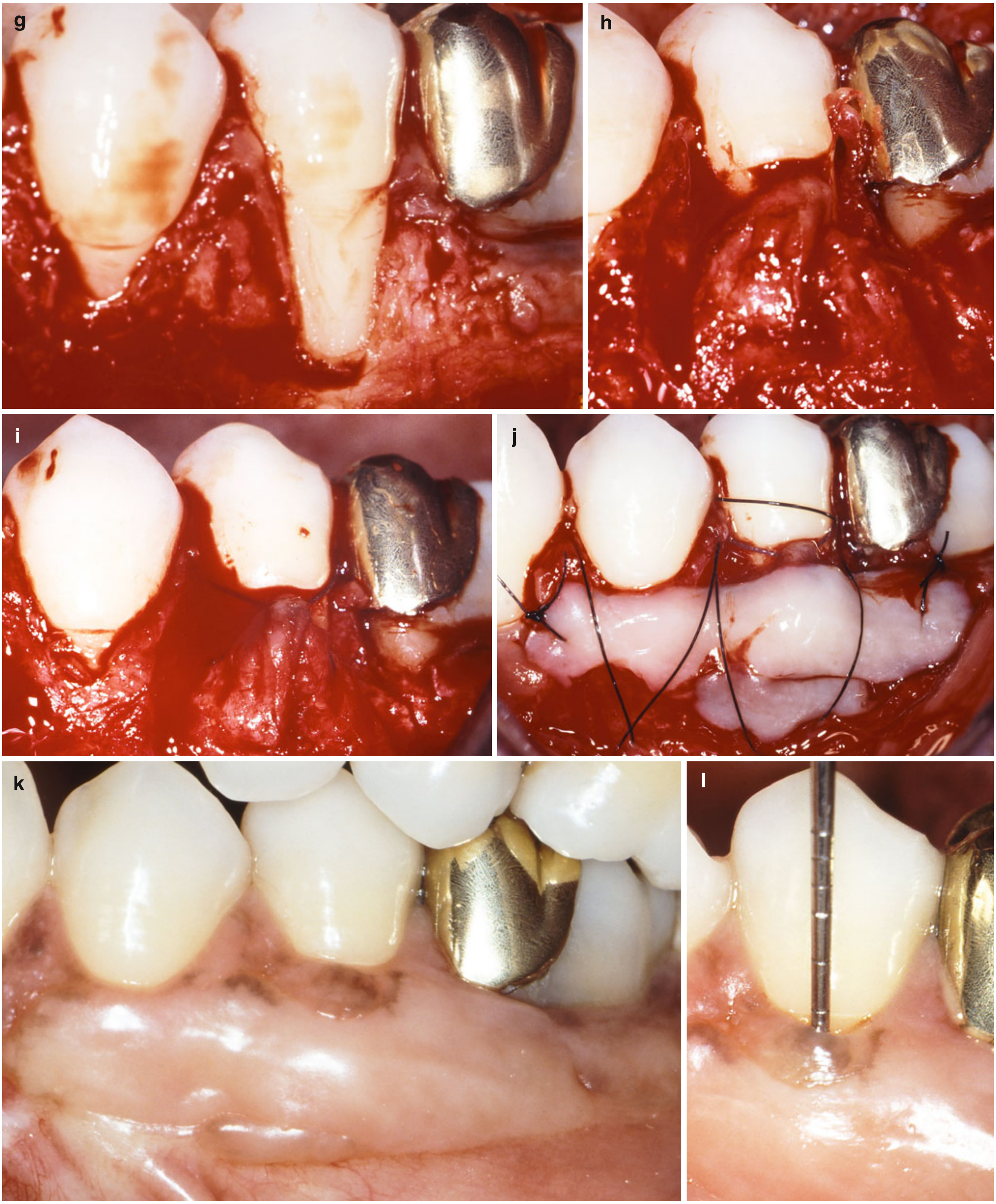

Fig. 3.24 (continued)

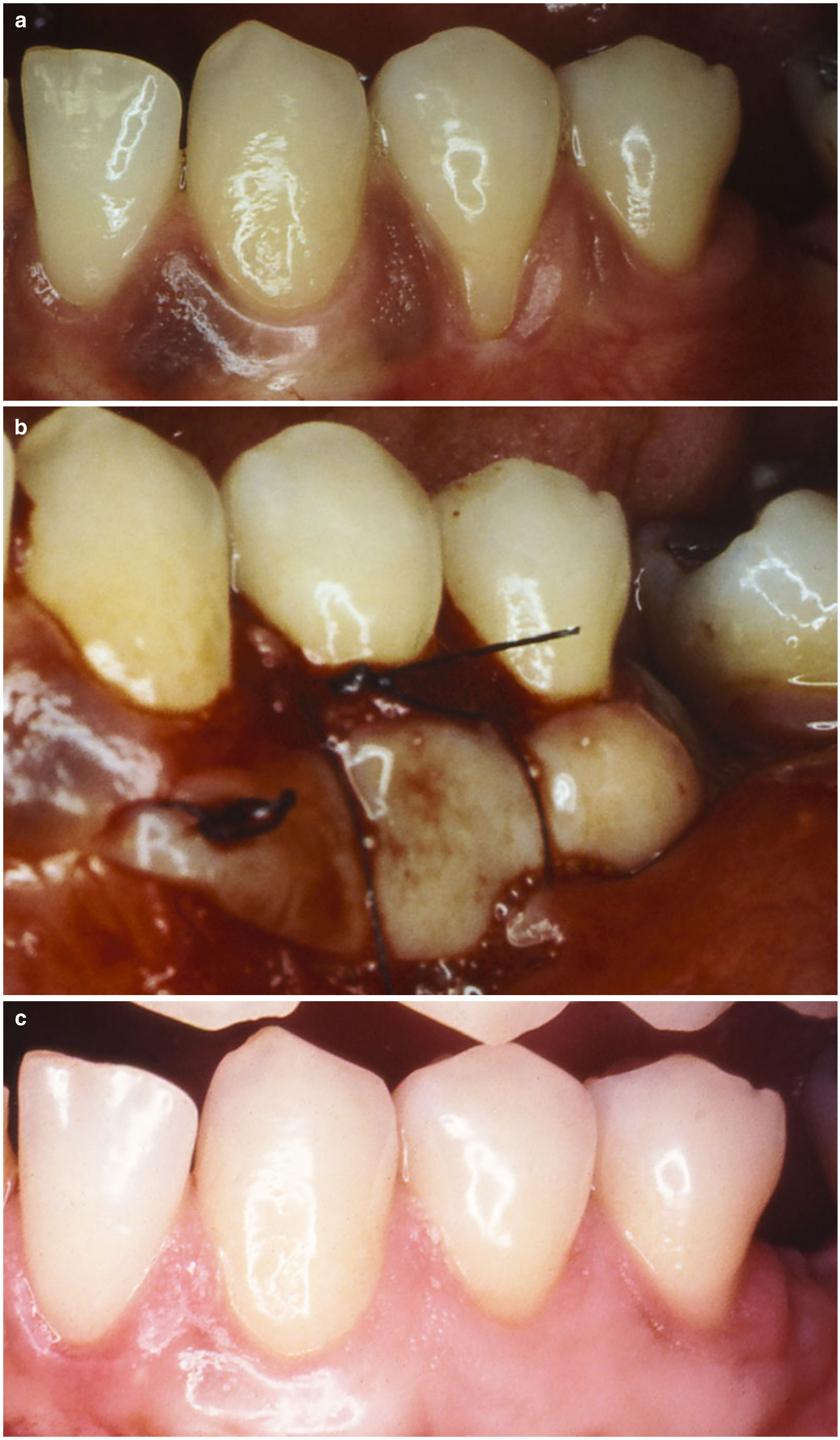

Fig. 3.25 Case II. (**a**–**c**) Class II recession and a thin periodontal biotype. Baseline (**a**), free gingival graft sutured at the previously prepared site (**b**), 6-month follow-up showing keratinised tissue improvement

Fig. 3.26 (**a**–**f**) Class II recession after orthodontic treatment associated to dentin hypersensitivity and biofilm accumulation. Baseline (**a**); baseline, inflammation of the free gingival margin caused by dental biofilm (**b**); site probing after removal of the inflamed epithelial margin (**c**); de-epithelised papillary pedicle flaps positioned and sutured over the root surface (**d**); free gingival graft sutured (**e**); 1-year follow-up

Fig. 3.27 Case IV. (**a**–**f**) Multiple recession-type defects. Baseline (**a**), muscle insert close to the gingival margin of tooth 34 (**b**), de-epithelised papillary pedicle flaps positioned over the root surface of tooth 34 (**c**), free gingival graft sutured (**d**), 1-year follow-up (**e**), probing of tooth 34 during last examination (**f**)

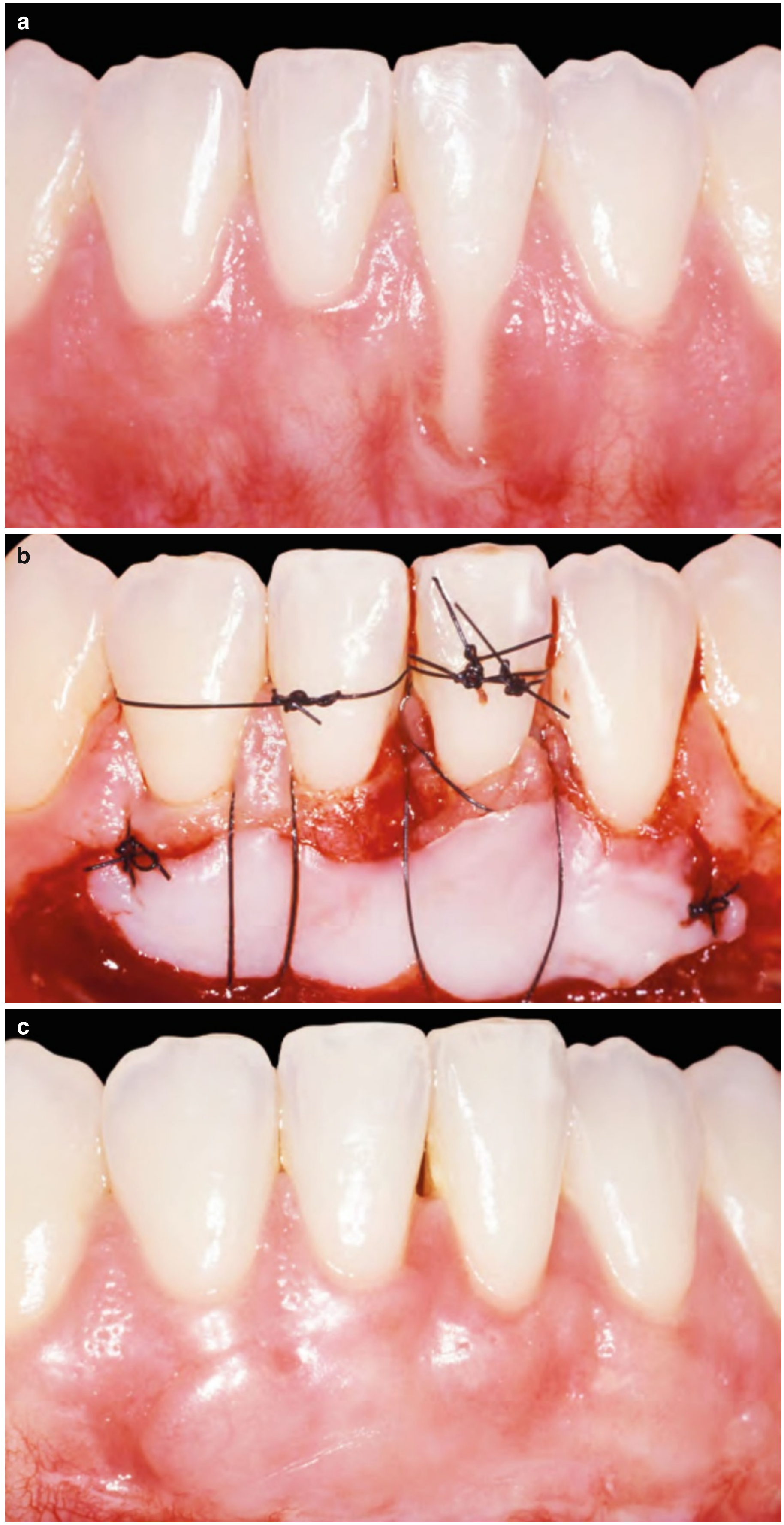

Fig. 3.28 Case V. (**a**–**c**) Class II single recession over tooth 31. Baseline (**a**), free gingival graft sutured over de-epithelised papillary pedicle flaps sutured over the tooth surface of tooth 31 (**b**), 1-year follow-up (**c**)

Fig. 3.29 Class III and IV gingival recessions at the anterior mandible. Baseline (**a**), thin periodontal biotype and lack of keratinised tissue (**b**), de-epithelised pedicle flaps sutured over the exposed root surfaces (**c**), free gingival graft sutured over the recipient bed (**d**), 2-year follow-up (**e**), significant clinical keratinised tissue increase (**f**)

Fig. 3.30 Case VIII. (**a**–**f**) Multiple Class I and III recessions. Baseline (**a**); epithelial wall of the gingiva removed (**b**); free gingival graft sutured over the root surfaces of teeth 32, 31 and 41 (**c**); 14-day follow-up (note the occurrence of "bridging healing" of the graft over the previously exposed root surfaces (**d**); 1-month follow-up (**e**); 6-month follow-up (**f**)

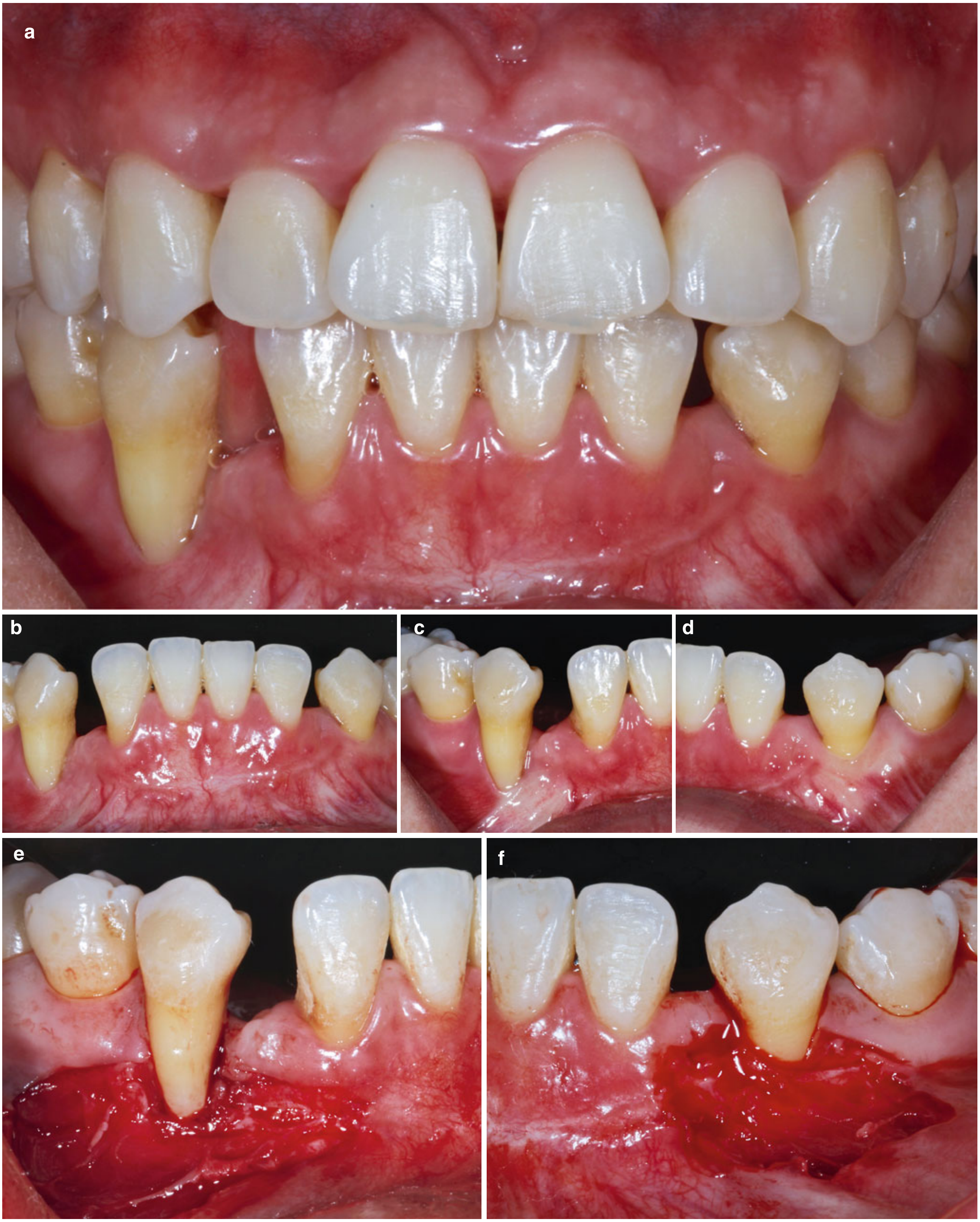

Fig. 3.31 Case VIII. (**a**–**m**) Baseline (**a**, **b**); baseline, tooth 43 (**c**); baseline, tooth 33 (**d**); removal of gingival epithelium (**e**, **f**); free gingival grafts removed from the palate (**g**); graft sutured at the recipient sites (**h**, **i**); grafts sutured, frontal view (**j**); 1-month follow-up (**k**); 4-month follow-up, frontal view (**l**, **m**)

Fig. 3.31 (continued)

Fig. 3.32 Case IX. (**a**–**g**) Baseline (**a**, **b**), removal of gingival epithelium of the recipient site (**c**), free gingival graft harvested from the palate (**d**), free gingival graft sutured at the recipient site (**e**), 14-day follow-up (**f**), 3-month follow-up (**g**)

3.5 Subepithelial Connective Tissue Graft-Based Procedures

3.5.1 Historical Note

The first report on the use of a subepithelial connective tissue graft (SCTG) obtained from the palatal vault was described by Edel [102] in 1974, who proposed the non-submerged use of this graft (as a free gingival graft) for keratinised tissue width gain, as well as to decrease the degree of morbidity at the donor site.

Nonetheless, Langer and Calangna [103, 104] were those who originally proposed the "submerged" use of SCTG with aesthetic purposes for the treatment of concavities and deformities of atrophic alveolar ridges. From the mid-1980s, several procedures involving the use of SCTG for soft tissue root coverage were proposed, and the following deserve special attention:

- Langer and Langer [105] – based on the positive outcomes achieved within the treatment of edentulous ridges, these authors described a procedure that employed the SCTG associated to a split-thickness coronally advanced flap (CAF) with releasing incision for the treatment of localised and multiple recession-type defects. According to these authors, the double blood supply formed by the periosteum adjacent to the recession and the *lamina propria* of the CAF could improve the predictability of the results.
- Raetzky [106] described a procedure called "the envelope technique" for the treatment of single recession defects. In this procedure, the gingival collar corresponding to the gingival sulcus is removed, and a split-thickness intrasulcular incision is used to dissect the soft tissue apical and adjacent to the recession to create "an envelope" where a "half-moon-shaped" SCTG obtained from the palate was inserted and fixed with cyanoacrylate tissue adhesive (there were no attempts to completely cover the graft).
- Nelson [107] with the aim of improving the area of vascularisation at the recipient site presented a technique named by him as "bilaminar reconstructive procedure" where the interdental papilla adjacent to the recession should be dissected to create two full-thickness interproximal flaps. After that, a SCTG should be placed over the recession area and "covered" by the papillary flaps that were positioned and sutured over the graft.
- Harris [108] proposed a modification to Nelson's [107] procedure by changing the papillary flaps to partial-thickness pedicles.
- Schädle and Matter-Grütter [109] added a releasing incision to the "envelope" [106] procedure. Such a vertical incision should be performed from the gingival margin to the alveolar mucosa and be located one tooth away from the distal side of the recession.
- Bruno [110] also modified Raetzke's [106] technique by performing a perpendicular horizontal incision at the mesial and distal recession papilla at level of the cemento-enamel junction. The author also proposed the use of a SCTG including the periosteum of the donor site which was positioned at the created "envelope", sutured at the periosteum of the recipient site and covered by the split-thickness flap coronally advanced over the graft.
- Bouchard et al. [111] proposed the use of SCTG with epithelial collar associated to CAF covering the non-epithelialised portion of the graft.
- Allen [112, 113] proposed changes to the envelope [106] technique in order to treat multiple recession defects. Those changes consisted of dissecting a split-thickness flap extending to the interproximal sites (at the level of the cemento-enamel junction) to create a "tunnel" between adjacent recessions where the SCTG was introduced.
- Azzi and Etienne [114] proposed the coronally advanced tunnel approach based on the preparation of a mucoperiosteal tunnel extending apically to the mucogingival junction and under each papilla to allow the flap to be moved in a coronal direction without tension.
- Zabalegui et al. [115] similar to Allen [112, 113] designed a tunnel approach where the intrasulcular incision should be extended 3–5 mm laterally to amplify the recipient bed and favour the adaptation of the graft.
- Blanes and Allen [116] in order to increase the blood supply combined the use of bilateral pedicle flaps to the tunnel technique [112, 113].
- Zadeh [117] described a minimally invasive approach (the vestibular incision subperiosteal tunnel access [VISTA]) valid for localised and multiple recessions located in the maxillary anterior region and based on an incision performed in the maxillary anterior frenum and the elevation of a subperiosteal tunnel. According to the author, this approach could be associated to subepithelial connective tissue grafts and other type of soft tissue substitutes.

3.5.2 Type of Defect to Be Indicated

Treatment of localised or multiple Class I and II GR [30]. But Class III and IV GR [30] may be benefited by this procedure as well.

3.5.3 Type of Defect Not to Be Indicated

None, but predictability may not be anticipated for Class IV defects [30].

3.5.4 Basics of the Surgical Sequence with Vertical Incisions for Single Defects [105]

Following local anaesthesia, the exposed root surfaces should be thoroughly, but carefully, planned with hand curettes and/or finishing burs. A horizontal intrasulcular incision is made around the recession and extended 3 mm to the mesial and distal portions of the interdental papilla at the level of the cemento-enamel junction. After that, two bevelled vertical releasing incisions are made at the end of the horizontal incision and extended to the alveolar mucosa. A partial-thickness flap is raised with sharp dissection, and the facial portions of the interdental papillae are de-epithelialised. As similar to other surgical root coverage procedures, root modification agents may be used at this stage.

After flap incision and dissection, the subepithelial connective tissue graft is obtained from the palate, between the distal aspect of the canine and the mid-palatal region of the second molars (Fig. 3.33) [105, 108, 109, 118, 119]. The removal of the graft may be performed using different techniques, such as the trap door [108] or Bruno's [110] approach. The graft obtained from the palate should be trimmed to fit the recipient site (to cover the width of the exposed root surface at the level of the cemento-enamel junctions and 3 mm of the alveolar bone adjacent to the defect) [118] and sutured with resorbable sutures of polylactic acid, gut or chromic gut material (Figs. 3.34, 3.35 and 3.36).

Following graft suture, the flap is coronally advanced at the level or beyond of the cemento-enamel junction (to cover as much as possible the SCTG) and sutured by 5-0 or 6-0 nylon/Teflon sutures. It is also crucial to note that the flap should be passively adapted over the recipient site (i.e. it must remain stable at that position even without sutures), so all muscle inserts located on the internal side of the flap should be removed leaving the flap free of tensions.

The sutures are removed 14 days after surgery. In addition, patients should be instructed not to brush the tooth in the treated area, as well as they are prescribed 0.12 % chlorhexidine gluconate and instructed to rinse gently twice a day for 2–3 weeks or until safe and comfortable toothbrushing can be performed. Overall, analgesics, anti-inflammatory drugs and/or systemic antibiotics are prescribed if needed, as well as no adverse effects are expected in the treated sites.

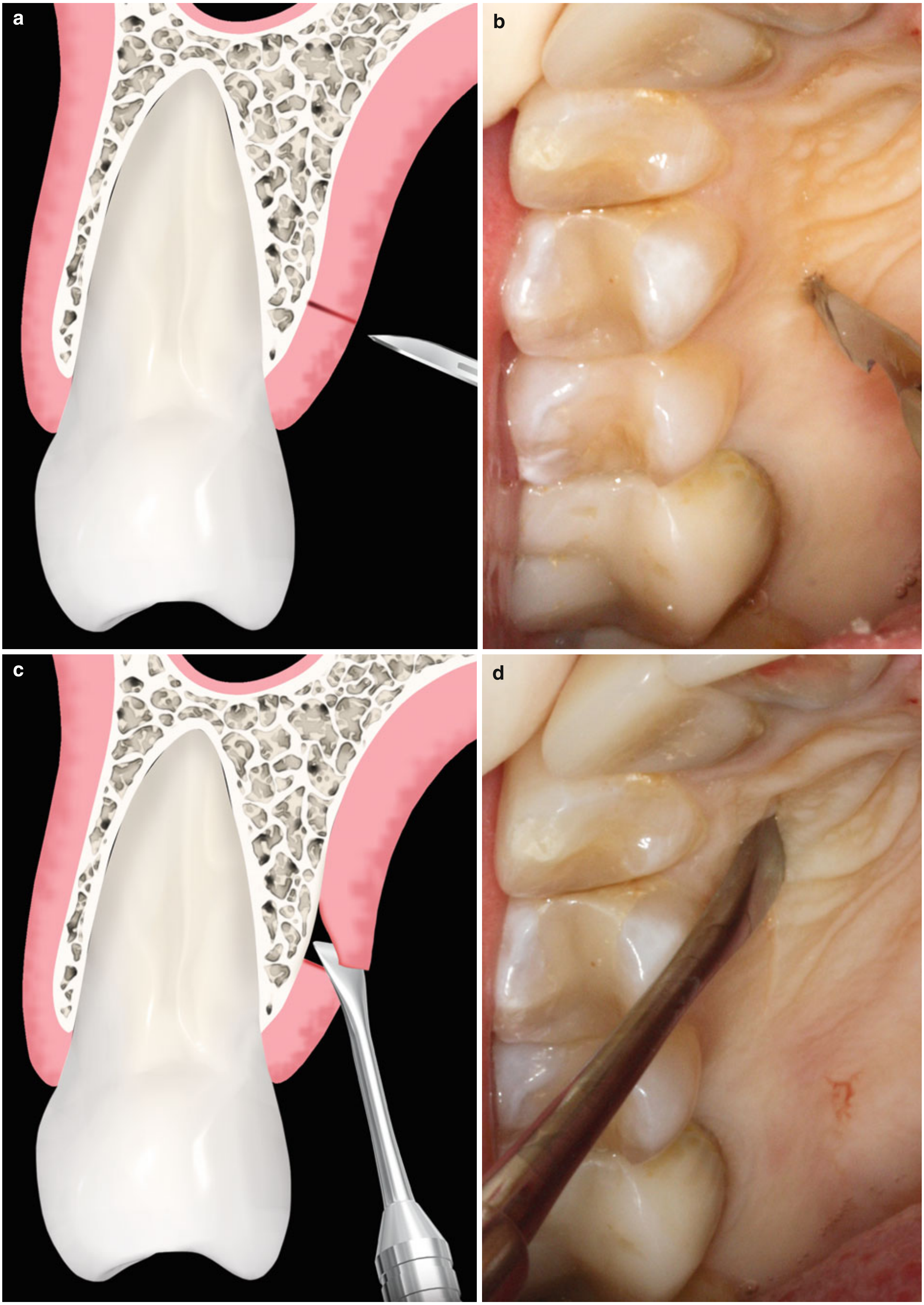

Fig. 3.33 (**a**–**h**) Description of a standardised procedure for subepithelial connective tissue graft harvesting [19]. Perpendicular incision to the palatal tissue to the bone (**a**, **b**), elevation of a 1–2-mm full-thickness flap (**c**, **d**), dissection of a partial-thickness flap (**e**, **f**), graft removal from the palatal flap (**g**, **h**)

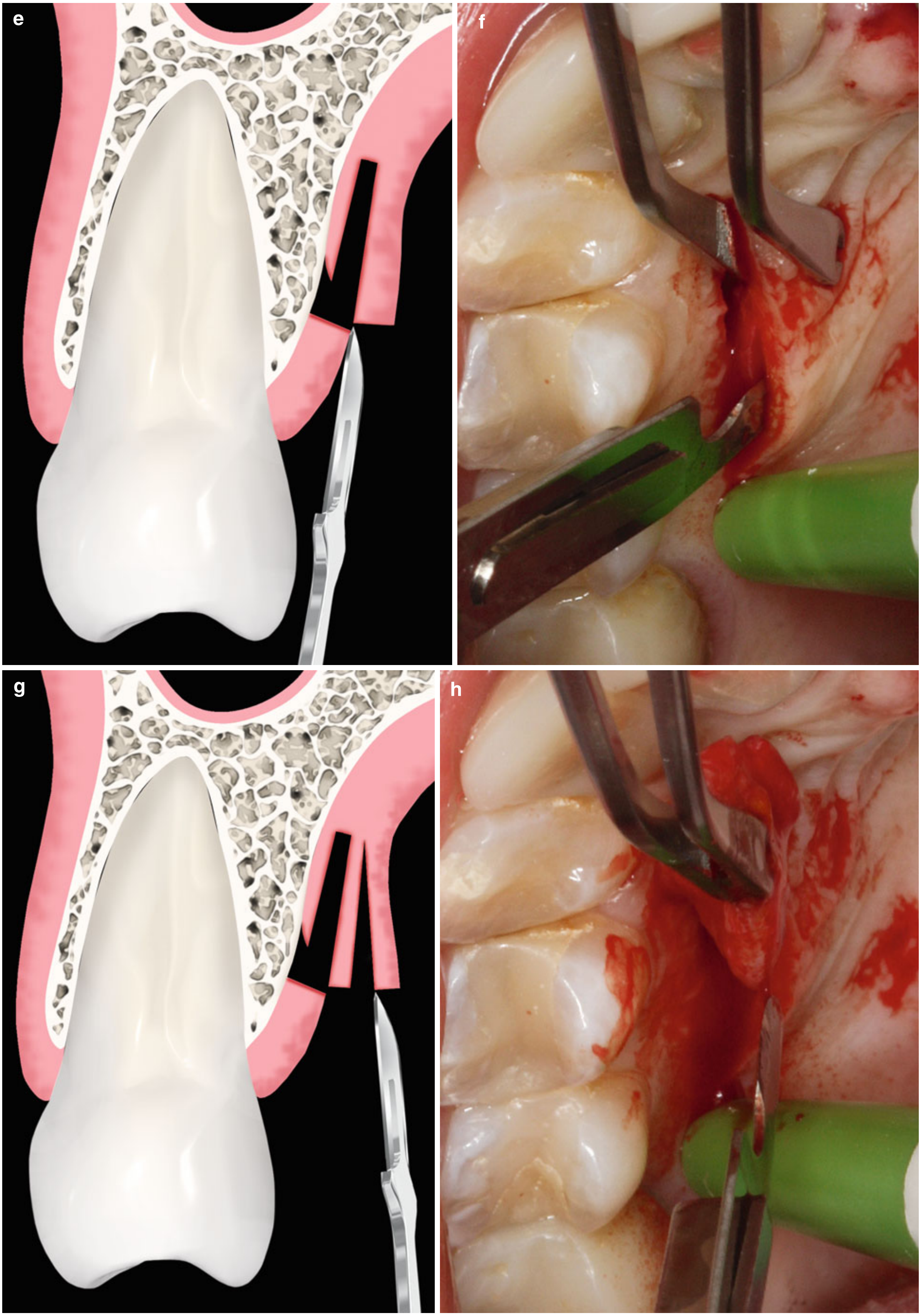

Fig. 3.33 (continued)

Fig. 3.34 Tunnel approach - (**a**–**e**) Baseline (**a**); incisions and dissection via gingival sulcus (**b**); interpapillar dissection, tunnel elevated (**c**); subepithelial connective tissue graft insert through the tunnel flap (**d**); flap coronally advanced and sutured (**e**)

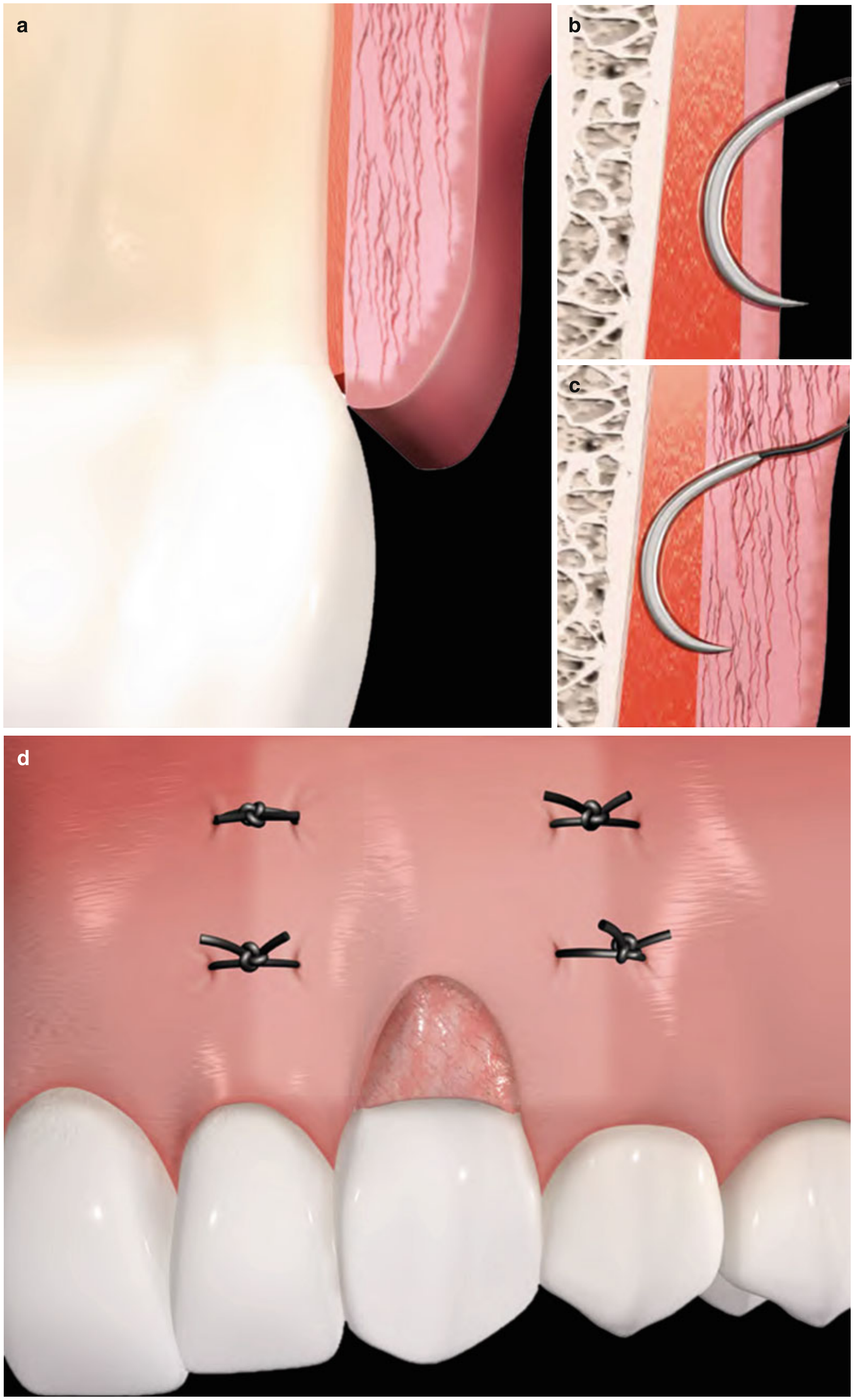

Fig. 3.35 (**a**–**d**) Suture of the graft and flap (root surface graft and flap – there are no "dead spaces" between the root surface and the graft or between the graft and the flap) (**a**); graft suture – with the flap raised, the graft is sutured to the periosteum/lamina propria adjacent to the root surface by absorbable sutures (**b**); flap sutured to the periosteum adjacent to the recession (**c**); frontal view of the sutured graft and flap

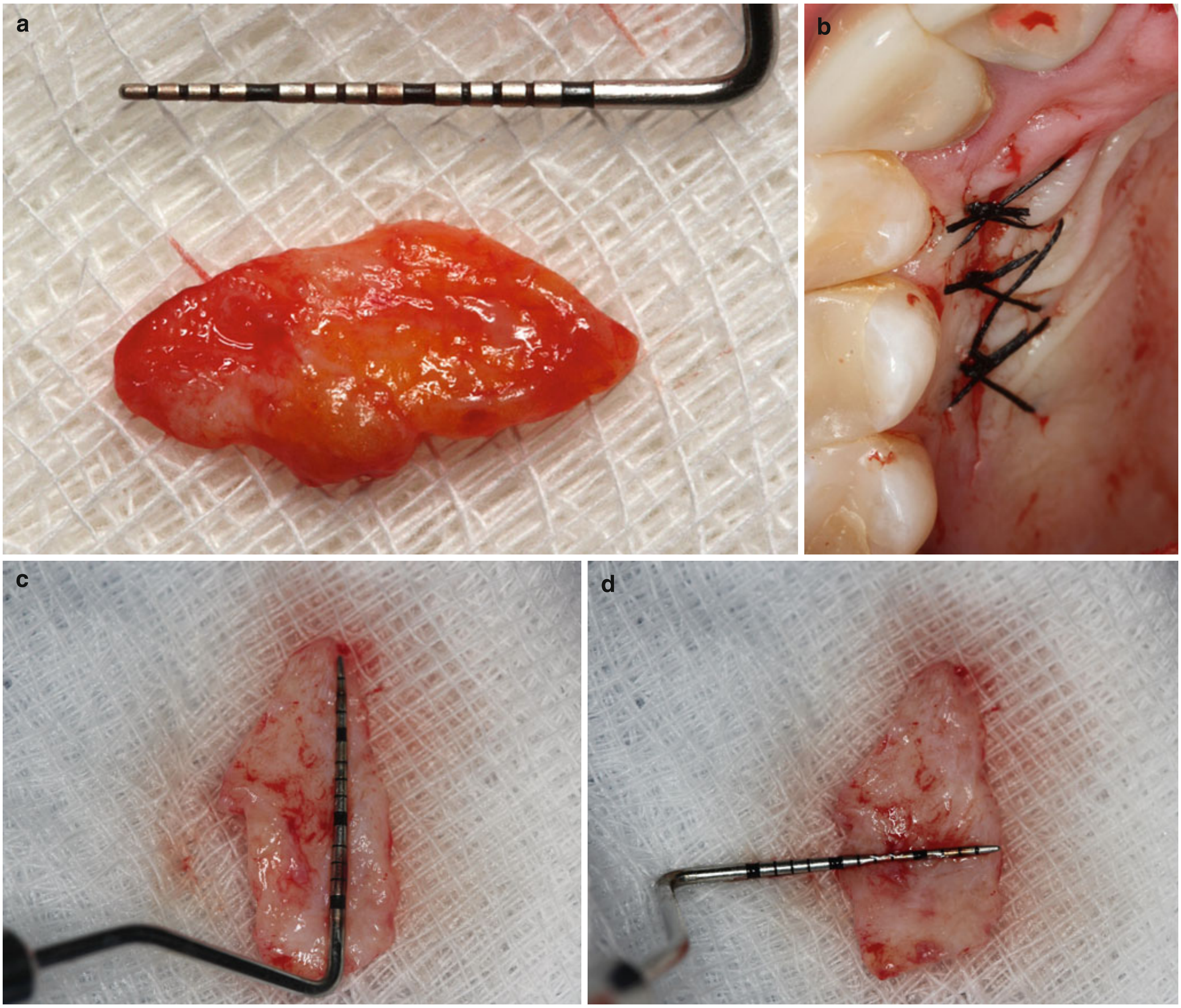

Fig. 3.36 (**a**–**d**) Graft harvested from the palate (**a**); donor site suture (**b**); some anatomic/dimensional aspects associated to the use of subepithelial connective tissue grafts harvested from the palatal vault (**c**, **d**). Wide grafts may be removed depending to the anatomical characteristics of the palatal vault; however, these may include fat tissue as well (**a**)

3.5.5 Clinical Remarks: Implications for Practice and Clinical Decision-Making on Soft Tissue Coverage

With respect to the effect of treatment of Class I and II recession defects, SCTG-based procedures led to the most significant gains in defect coverage and in KT width, increases in number of sites with CRC and greater long-term stability of outcomes. For Class III defects, these may significantly benefit from the use of RC procedures (at short term) when SCTG-based procedures were used, but the same predictability reported to Class I or II defects cannot be expected. In clinical terms, the amount of coverage achieved will follow (be based on) the marginal gingival tissue of adjacent teeth.

The preparation of the recipient site via CAF without vertical incisions may be used as well (Fig. 3.34) [8]. These procedures have been advocated to decrease the degree of morbidity and to improve aesthetic (i.e. prevent for scar formation) and blood supply. Conversely, there is not enough scientific evidence to support or refute the superiority of these procedures (i.e. the outcomes of these studies did not provide superior outcomes to those achieved by "conventional" procedures, as well as there is a lack of short- and long-term data on SCTG+tunnel approaches/flap without vertical incisions vs. conventional CAF technique+SCTG) [8].

Although some degree of morbidity (i.e. pain and bleeding) may be present during early healing (up to 7 days), the palatal vault provides suitable dimensions to allow harmless graft removal even when harvesting more than once from the same location [8]. Conversely, the use of graft substitutes/biomaterials (i.e. acellular dermal matrix graft, xenographic matrix and enamel matrix derivative) can be safe substitutes for SCTG in patients with great demands of donor tissue (e.g. patients with multiple recession-type defects) or patients who do not want to be submitted to a secondary surgical procedure at the palatal vault.

In general terms, the SCTG is up to now the best procedure available for clinical practice (i.e. the gold standard), and thus it should be considered the soft tissue graft material of primary choice during the decision-making process (Figs. 3.37, 3.38, 3.39, 3.40, 3.41, 3.42, 3.43, 3.44, 3.45, 3.46, 3.47, 3.48, 3.49, 3.50, 3.51, 3.52, 3.53, 3.54, 3.55, 3.56, 3.57, 3.58, 3.59, 3.60, 3.61, 3.62, 3.63, 3.64, 3.65, 3.66, 3.67 and 3.68).

Critical Summary of the Results of Systematic Reviews

Systematic reviews conclusions: SCTG-based procedures lead to the best outcomes for clinical practice (i.e. superior percentages of MRC and CRC and significant increase of KT) when compared to most of the other surgical techniques [2, 4–8].

Summary of the review and critical remarks: The base of evidence on SCTG-based procedures is very vast and dense. The short- and long-term outcomes (≥24 months) presented in the literature indicate that SCTG-based procedures may provide superior and more stable outcomes than CAF alone, CAF+biomaterials, LPF and FGG [10]. For example, concerning the achievement of CRC and the "number needed to treat" (i.e. how many defects would need to be treated with a respective procedure to result in one more defect achieving CRC than would have occurred using SCTG-based procedures), three recessions with FGG, five to seven with CAF and six with GTR need to be treated so that one can reach this benefit over defects treated with SCTG [2, 4–8, 10].

Evidence quality rating/strength of recommendation (*ADA 2013*) [58]: Strong – evidence strongly supports providing this intervention.

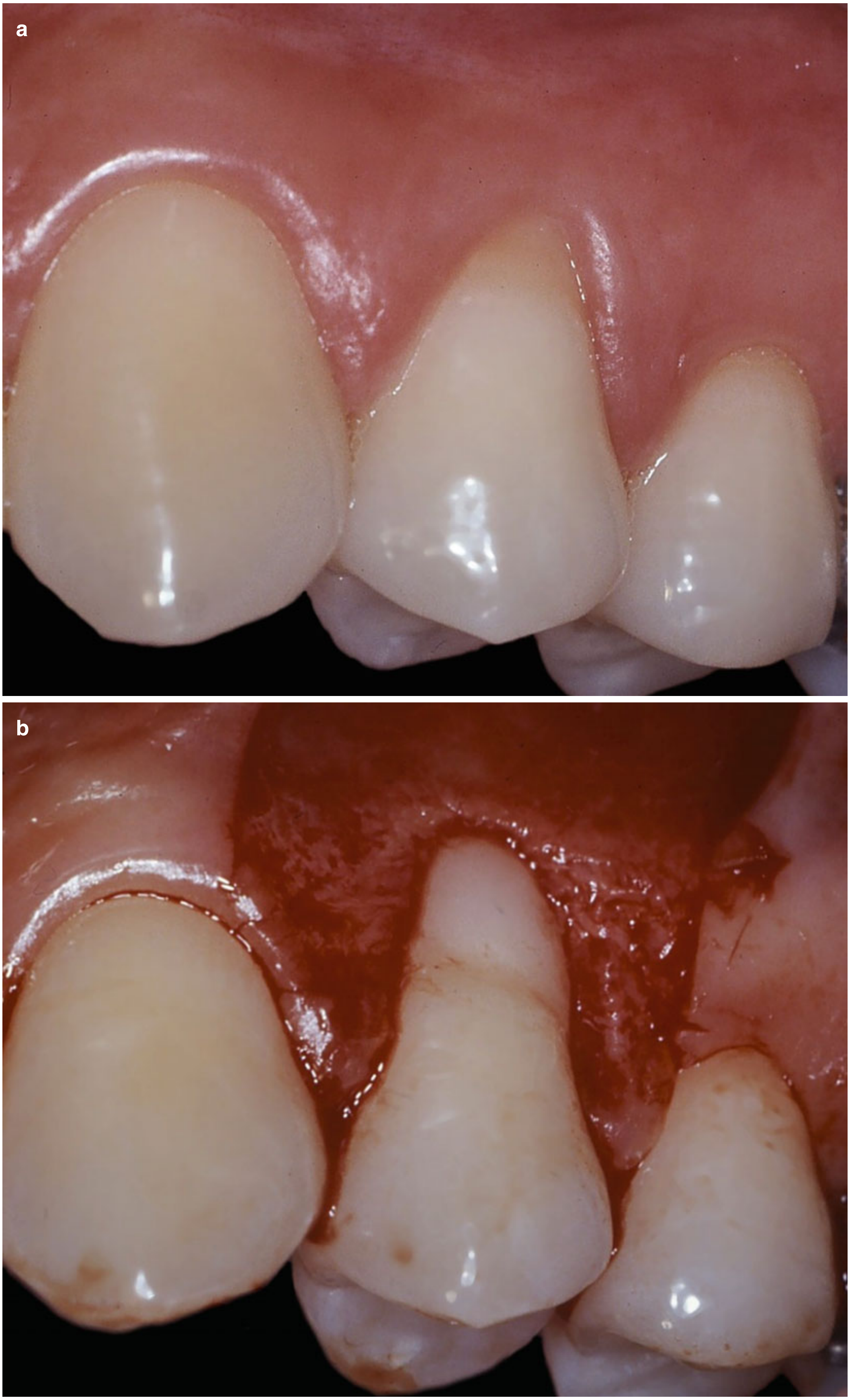

Fig. 3.37 Case I. (**a**, **f**) Class I gingival recession at tooth 14. Baseline (**a**), partial-thickness flap with releasing incisions raised (**b**), subepithelial connective tissue graft positioned and sutured at the recipient site (**c**), flap coronally advanced and sutured covering as much as possible the mucogingival junction (**d**), 6-month follow-up (**e**), 9-month follow-up (**f**)

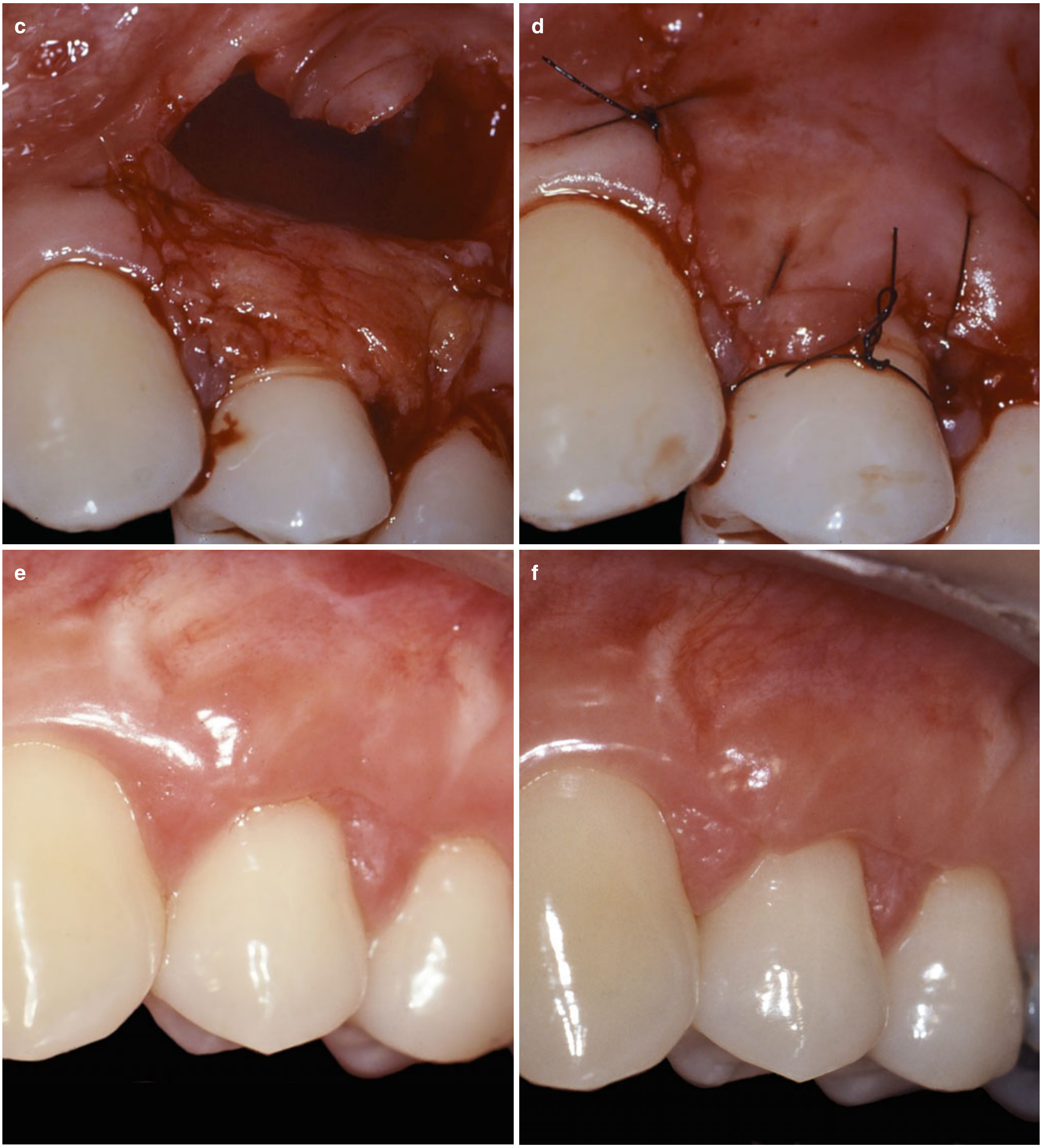

Fig. 3.37 (continued)

Fig. 3.38 Case II – Class II gingival recession that was previously restored by composites. Baseline (**a**); presence of a composite restoration, the patient reported that the defect continued developing after the placement of the restoration (**b**); restoration removal (**c**); EDTA applied after flap rising (**d**); use of a "trap door" approach for graft removal (**e**); positioning of the graft at the level of the cemento-enamel junction of the recipient tooth (**f**); after suture, the flap was coronally advanced and sutured covering completely the graft (**g**); donor site suture (**h**); 30-day follow-up (**i**); 3-year follow-up (**j**)

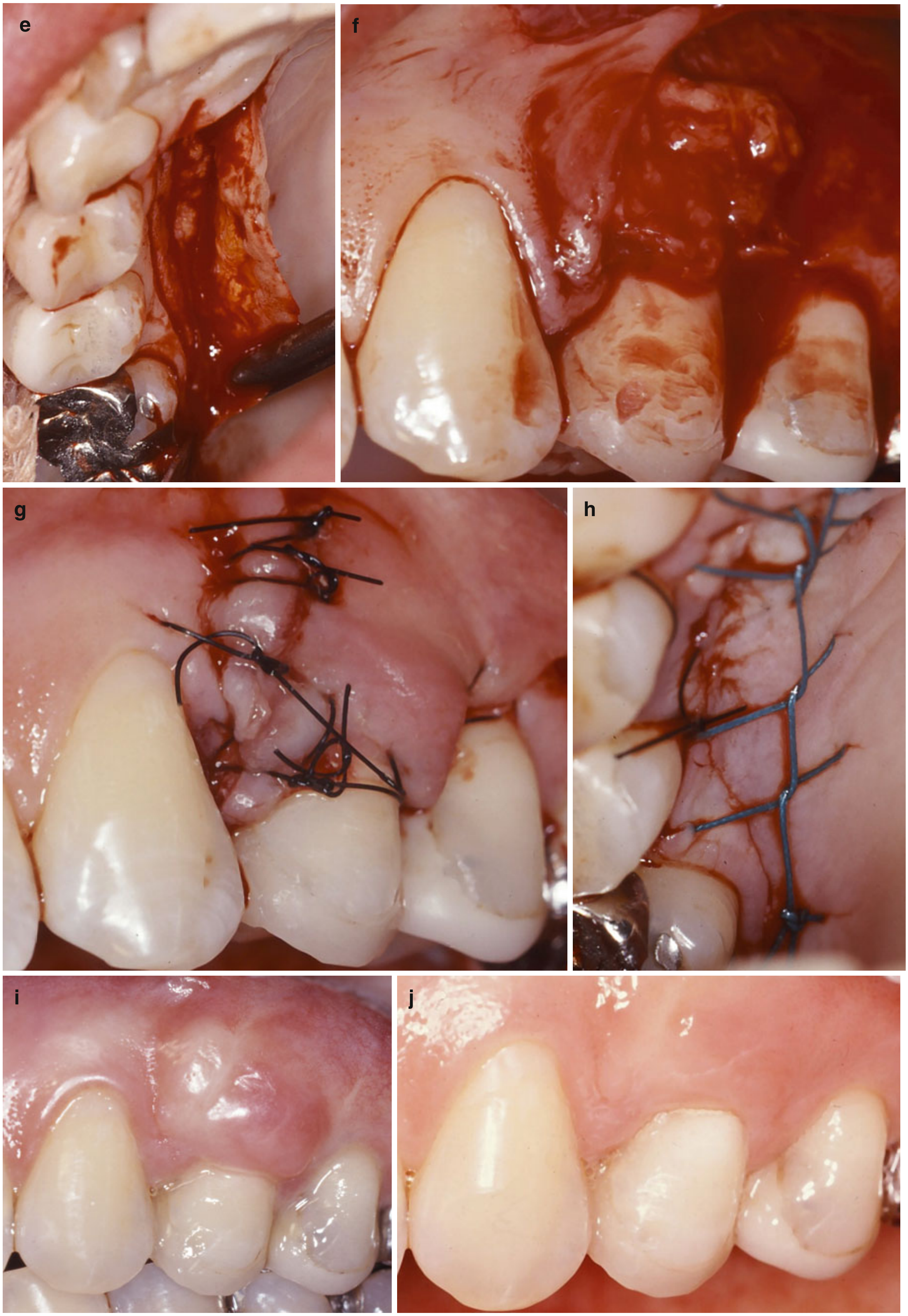

Fig. 3.38 (continued)

Fig. 3.39 Case III. (**a**–**g**) Class I and II multiple recession-type defects with non-carious cervical lesion. Baseline (**a**); horizontal and vertical incisions (**b**); flap dissection (**c**); flap raised (**d**); subepithelial connective tissue graft harvesting (**e**); 14 days of follow-up (**f**); 2 years of follow-up; , complete root coverage was achieved at tooth 23 where dentin loss was evident, whereas the area of enamel loss at tooth 2 could not be covered by the procedure

Fig. 3.40 Case IV. (**a**–**h**) Baseline – clinical view of cervical composite restorations at teeth 14 and 15 and a non-carious cervical lesion over tooth 53. (**a**) Immediately after the replacement of the original restorations by new resin composite restorations on both premolar root surfaces, intrasulcular and papillary incisions were performed; (**b**) subepithelial connective tissue graft harvested from the palate; (**c**) graft sutured at the recipient site; (**d**) flap advancement being tested; (**e**) flap coronally advanced and sutured covering as much as possible the cemento-enamel junction; (**f**, **g**) 3-month follow-up showing at both restored and non-restored surfaces (This case was originally published by Chambrone and Castro Pinto [38])

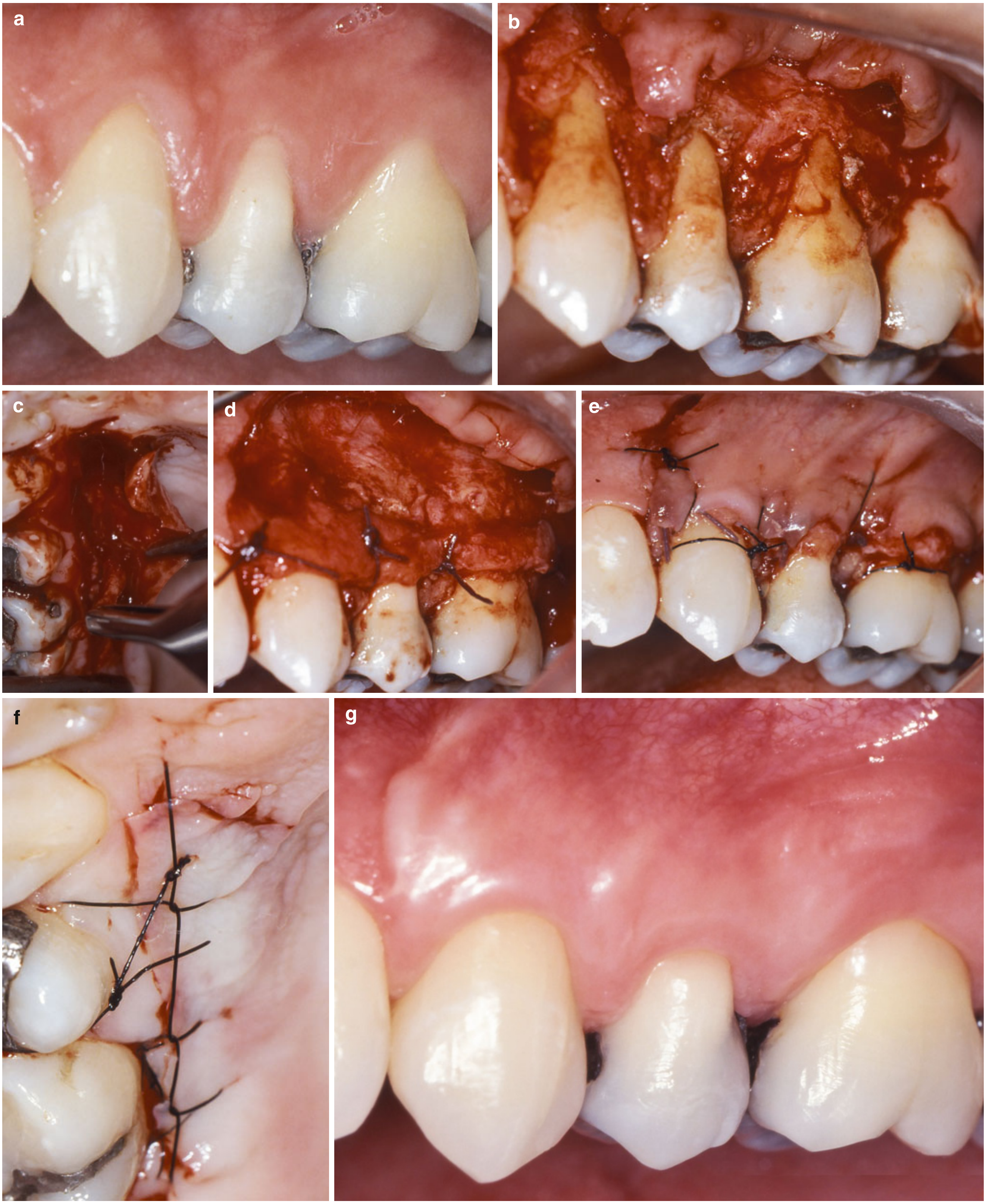

Fig. 3.41 Case V. (**a**–**g**) Multiple recession-type defects over teeth 23, 25 and 26. Baseline (**a**), root surfaces after partial-thickness flap rising (**b**), subepithelial connective tissue harvesting (**c**), graft sutured at the level of the cemento-enamel junction (**d**), the partial-thickness flap coronally advanced and sutured (**e**), donor site suture (**f**), 6-month follow-up (**g**) (This case was originally published by Chambrone and Chambrone [48])

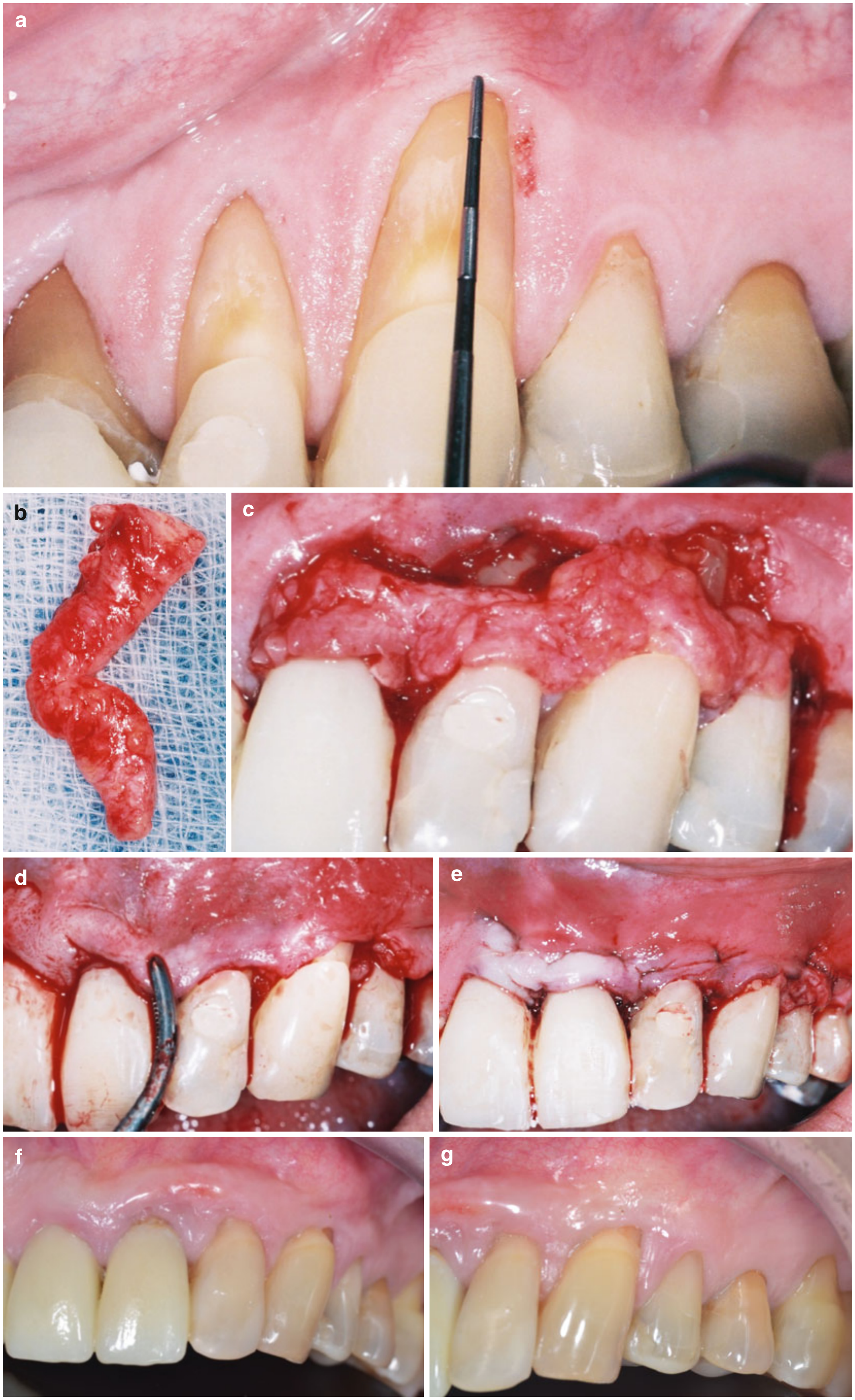

Fig. 3.42 Case VI. (**a**–**g**) Multiple Class I, II and III recession-type defects over teeth 21, 22, 23, 24 and 25. Baseline (**a**); subepithelial connective tissue graft harvested from the palate (**b**); graft positioned at the level of the cemento-enamel junction (**c**); testing the advancement of the flap (**d**); flap coronally advanced and sutured over the graft (**e**); 2-year follow-up, frontal view (**f**); 2-year follow-up, lateral view (**g**)

Fig. 3.43 Case VII. (**a**–**m**) – Class III gingival recession adjacent to edentulous alveolar ridge. Baseline (**a**); radiographic exam demonstrating the extension of periodontal loss (**b**); 4.5 mm recession depth (**c**); incisions (**d**); flap raised (**e**); flap laterally positioned and sutured over tooth 13 root (**f**); 3-month follow-up, a residual recession of 2 mm was still present; as a result, a 2nd surgical procedure was performed (**g**); flap incision, 2nd procedure (**h**); flap raised without releasing incisions (**i**); subepithelial connective tissue graft sutured over the root surface of tooth 13 (**j**); flap coronally advanced and sutured (**k**); 6-month follow-up after the grafting procedure (**l**); 2-year follow-up, 2nd procedure (**m**)

Fig. 3.43 (continued)

Fig. 3.44 Case VIII. (**a**–**e**) Class I gingival recession with a non-carious cervical lesion over tooth 13. Baseline (**a**); subepithelial connective tissue graft harvested from the palate (**b**); graft sutured to the recipient site, tooth 13 (**c**); flap coronally advanced covering the graft (**d**); 2-year follow-up (**e**)

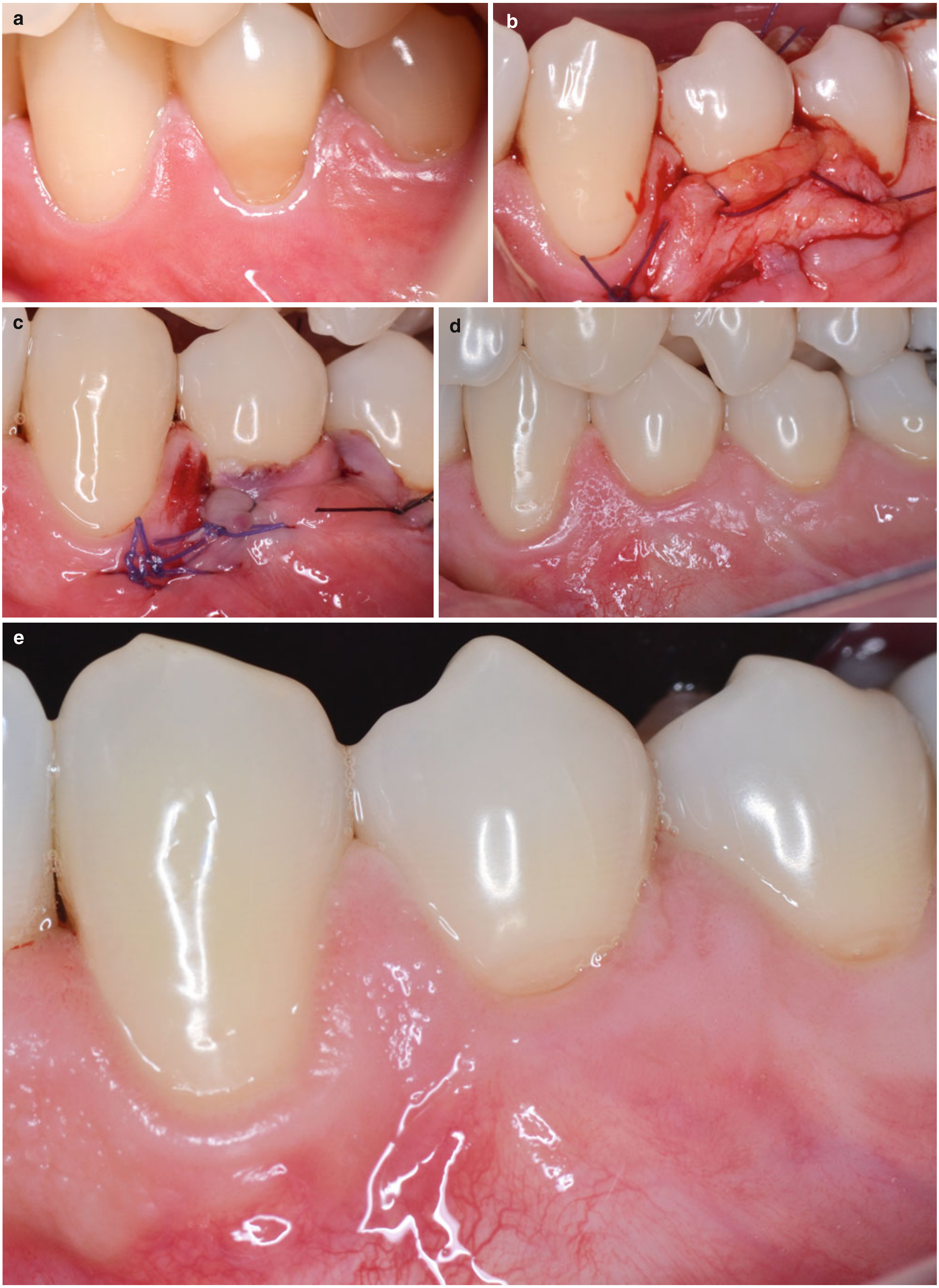

Fig. 3.45 (**a**–**e**) Class I gingival recession at tooth 34. Baseline (**a**), subepithelial connective tissue graft sutured at the recipient site (**b**), flap coronally advanced and sutured covering the graft (**c**), 14-month follow-up (**d**), 16-month follow-up (**e**)

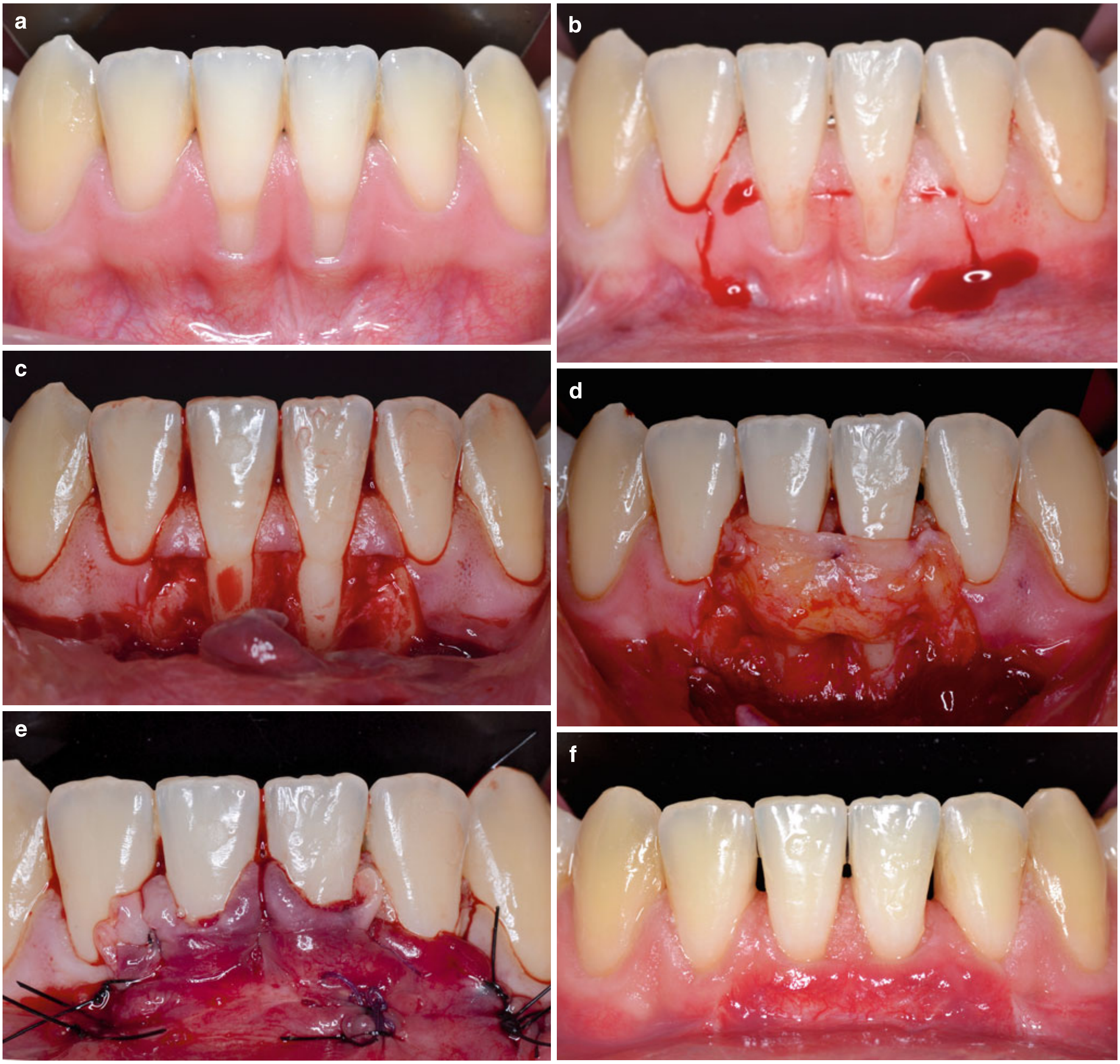

Fig. 3.46 Case X. (**a**–**f**) Multiple recession-type defects over teeth 31 and 41. Baseline (**a**), horizontal and vertical incisions performed (**b**), partial-thickness flap raised (**c**), subepithelial connective tissue graft sutured over the root surfaces of teeth 31 and 41 (**d**), flap coronally advanced and sutured (**e**), 1-year follow-up (**f**)

Fig. 3.47 Case XI – Class II gingival recession over tooth 41 after orthodontic treatment. Baseline (**a**), vertical and horizontal incisions performed (**b**), flap raised (**c**), subepithelial connective tissue graft positioned and sutured over the incisions (**d**), flap coronally advanced and partially sutured (**e**), lateral sutures performed (**f**), 6-month follow-up (**g**), 12-month follow-up; note that the patient returned to a traumatic toothbrushing (**h**)

Fig. 3.48 Case XII. (**a**–**g**) Single gingival recession over an improperly positioned incisor (31), baseline (**a**); baseline, the inadequate gingival anatomy favoured dental biofilm accumulation (**b**); flap raised (**c**); subepithelial connective tissue graft positioned over the root surface (**d**); flap coronally advanced and sutured (**e**); 7-month follow-up (**g**)

Fig. 3.49 Case XIII. (**a**–**e**) Single Class I gingival recession over tooth 31 associated to a high lip frenum. Baseline (**a**), horizontal and vertical incisions performed (**b**), subepithelial connective tissue grafts positioned over the recipient site (**c**), flap coronally advanced and sutured (**d**), 1-year follow-up (**e**)

Fig. 3.50 Case XIV – patient presenting multiple sites of gingival recession on the mandible and maxilla. Each side of the palatal vault was harvested twice (a total of 4 grafts were used) – baseline (**a–d**), incisions performed (**e**), flap raised (**f**), graft harvesting (**g**), graft dimensions (**h**), graft positioned (**i**), flap coronally advanced and sutured (**j**), palatal suture (**k**), 6-month follow-up (**l**)

Fig. 3.50 (continued)

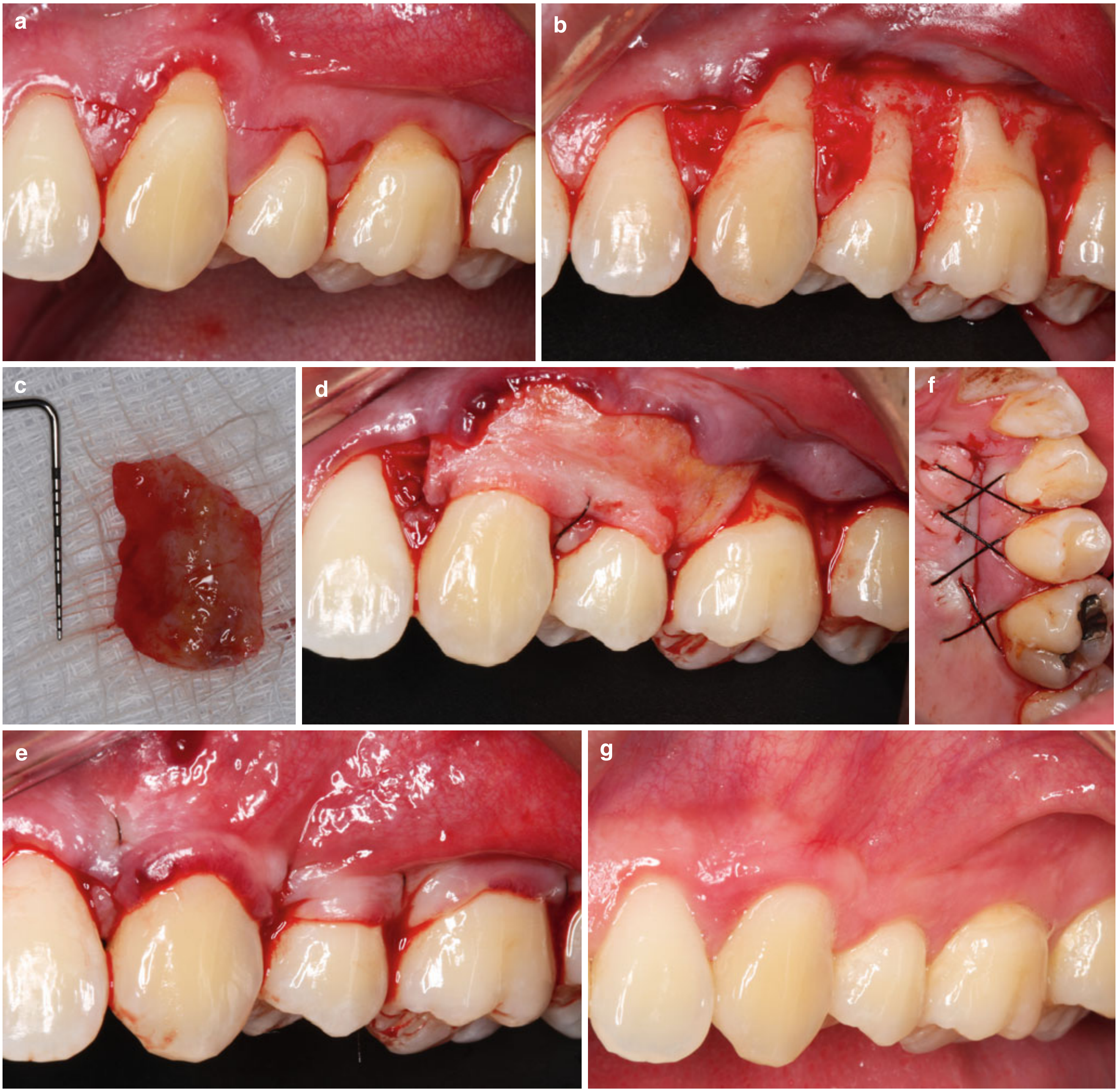

Fig. 3.51 Case XV. (**a**–**l**) (same patient) – incisions (**a**), flap raised (**b**), dimensions of the grafts (**c**), graft sutured (**d**), flap coronally advanced and sutured (**e**), donor site sutured (**f**), 6-month follow-up (**g**), incisions (**h**), flap raised (**i**, **j**), graft positioned at the recipient site (**k**), 6-month follow-up (**l**)

Fig. 3.51 (continued)

Fig. 3.52 Case XVI (same patient) incisions (**a**); dimensions of the graft (**b**); graft positioned (**c**); flap coronally advanced and sutures (**d**); 6-month follow-up (**e**); 1-year follow-up, anterior maxilla (**f**); 1-year follow-up, anterior mandible (**g**); 1-year follow-up of the last procedure (**h**)

Fig. 3.53 Case XVII. (**a**–**f**) Multiple Class I recession-type defects over teeth 24 and 25 treated with a tunnel flap approach. Baseline (**a**), flap tunnel raised (**b**), subepithelial connective tissue graft sutured through the tunnel flap (**c**), 15-day follow-up (**d**), 1-year follow-up (**e**, **f**)

Fig. 3.54 Case XVIII. (**a**–**j**) Multiple Class I recession-type defects over teeth 11, 21, 22 and 23 treated with tunnel flap + subepithelial connective tissue graft (teeth 22 and 23). Baseline, frontal view (**a**); baseline, lateral view 1 (**b**); baseline, lateral view 2 (**c**); tunnel flap raised, teeth 11 and 21 (**d**); flap tunnel raised, teeth 22 and 23 (**e**); flap tunnel coronally advanced and sutured covering the graft completely (**f**); 6-month follow-up, frontal view (**g**); 6-month follow-up, lateral view (**h**); harmony of the gingival zenith (**i**); small scar over tooth 23 (**j**)

Fig. 3.55 Case XIV. (**a**–**h**) Multiple Class I recession-type defects over teeth 11, 12, 13, 14 and 15 treated with a tunnel flap approach. Baseline (**a**), tunnel flap raised (**b**, **c**), subepithelial connective tissue graft harvested from the palate (**d**), graft positioned through the tunnel flap (**e**), tunnel flap coronally advanced and sutured (**f**), 15-day follow-up (**g**), 3-month follow-up (**h**)

Fig. 3.56 Case XX – multiple Class III recession defects over teeth 11 and 21 treated with a tunnel flap approach and connective tissue graft. Baseline (**a**), surgical instruments used for tunnel flap preparation (**b**), flap dissection (**c**), tunnel flap raised (**d**), site to be grafted (**e**), graft harvested from palate (**f**), expected position for the graft under the tunnel (**g**), tunnel flap coronally advanced and sutured (**h**), palatal suture (**i**), 6-month follow-up (**j**)

Fig. 3.56 (continued)

Fig. 3.57 Case XXI. (**a**–**r**) Multiple Class I recession-type defects over teeth 13 (metal ceramic crown supporting a fixed partial denture) and 14 treated with tunnel flap approach and subepithelial connective tissue grafts. Baseline (**a**); baseline, palatal vault view (**b**); tunnel flap prepared (**c**); graft harvesting (**d**–**g**); flap dimensions (**h**, **i**); donor site after graft harvesting (**j** and **k**); graft positioned through the tunnel raised (**l**); tunnel flap coronally advanced and sutured (**m**); palatal suture (**n**); 15-day follow-up - recipient site (**o**); 15-day follow-up - donor site (**p**); 6-month follow-up (**q**); 1-year follow-up (**r**)

Fig. 3.57 (continued)

Fig. 3.58 Case XXII. (**a**–**g**) Single Class I recession treated with tunnel flap approach and subepithelial connective tissue graft. Baseline (**a**), testing flap tension (**b**), graft being harvested (**c**), placement of the graft through the tunnel flap (**d**), donor site suture (**e**), tunnel flap coronally advanced and sutured (**f**), 1-year follow-up (**g**)

Fig. 3.59 Case XXIII. (**a**–**f**) Multiple Class I recession-type defects over teeth 22, 23, 24 and 25 (tooth 23 presenting a non-carious cervical lesion) treated with tunnel flap approach and subepithelial connective tissue graft. Baseline (**a**), flap rising (**b**), tunnel flap prepared (**c**), graft introduced to the tunnel (**d**), tunnel flap coronally advanced and sutured (**e**), 6-month follow-up (**f**)

Fig. 3.60 Case XXIV. (**a**–**e**) Multiple Class I recession-type defects over teeth 13, 14 and 15 treated with tunnel flap approach and subepithelial connectie tissue graft. Baseline (**a**), graft positioning (**b**), tunnel flap coronally advanced and sutured (**c**), 3-week follow-up (**d**), 3-year follow-up (**e**)

Fig. 3.61 Case XXV. (**a**–**d**) Multiple Class I recession-type defects over teeth 12, 11 and 21 treated with tunnel flap approach and subepithelial connective tissue graft. Baseline (**a**), graft being positioned (**b**), tunnel flap coronally advanced and sutured (**c**), 3-year follow-up (**d**)

Fig. 3.62 Case XXVI. (**a**–**f**) Single Class I recession over tooth 41 treated with tunnel flap approach and subepithelial connective tissue graft. Baseline (**a**), tunnel flap (**b**), graft positioning (**c**), tunnel flap coronally advanced and sutured (**d**), 6-month follow-up (**e**), 2-year follow-up (**f**)

Fig. 3.63 Case XXVII. (**a**–**h**) Multiple Class I recession-type defects treated with tunnel flap approach and subepithelial connective tissue graft. Baseline (**a**); baseline, thin periodontal biotype (**b**); tunnel flap prepared (**c**); graft positioned (**d**); tunnel flap coronally advanced and sutured (**e**); 6-month follow-up (**f**); last follow-up (**g**, **h**)

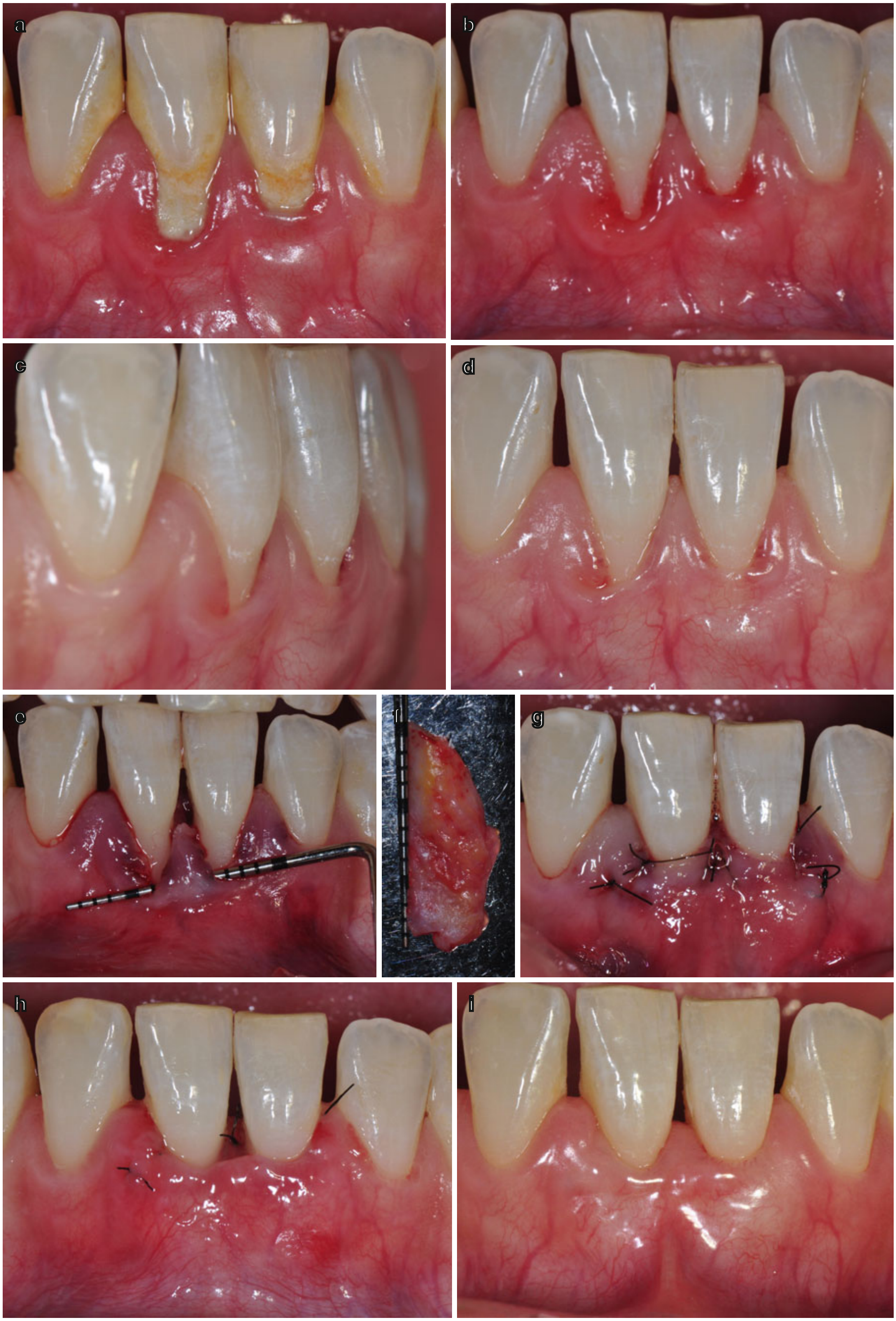

Fig. 3.64 Case XXVIII. (**a**–**k**) Multiple Class III recession-type defect over teeth 31 and 41 treated with tunnel flap approach and subepithelial connective tissue graft. Baseline, gingival recessions associated to dental biofilm accumulation (**a**); baseline, after basic procedures (**b**); baseline, 1 month after the basic procedures (**c**, **d**); tunnel flap raised (**e**); graft harvested (**f**); tunnel flap coronally advanced and sutured (**g**); 14-day follow-up (**h**); 1-year follow-up (**i**); lack of clinical gingival inflammation (**j**, **k**)

Fig. 3.64 (continued)

Fig. 3.65 Case XXIX. (**a**–**h**) Multiple Class III recession-type defects over teeth 31 and 41. Treated with tunnel flap approach and subepithelial connective tissue graft. Baseline (**a**), root surfaces after basic procedures (**b**), needed extension of the recipient site to accommodate the graft (**c**), graft harvested (**d**), dimensions of the graft compatible to the recipient site (**e**), graft interposed (**f**), graft sutured (**g**), 6-month follow-up (**h**)

Fig. 3.66 Case XXX. (**a**–**f**) Multiple Class III recession-type defects over teeth 32, 31, 41 and 41 treated with tunnel flap approach and subepithelial connective tissue graft. Baseline (**a**), tunnel flap elevated (**b**), checking the dimension of the graft and the recipient site (**c**), graft interposed between the root surfaces and the tunnel flap (**d**), flap coronally advanced and sutured (**e**), 6-month follow-up (**f**)

Fig. 3.67 Case XXXI. (**a**–**d**) Multiple Class III recession-type defects over teeth 43 and 45 associated to non-carious cervical lesions. Baseline (**a**), subepithelial connective tissue graft being harvested (**b**), graft positioned at the recipient site (**c**), 1-year follow-up (**d**)

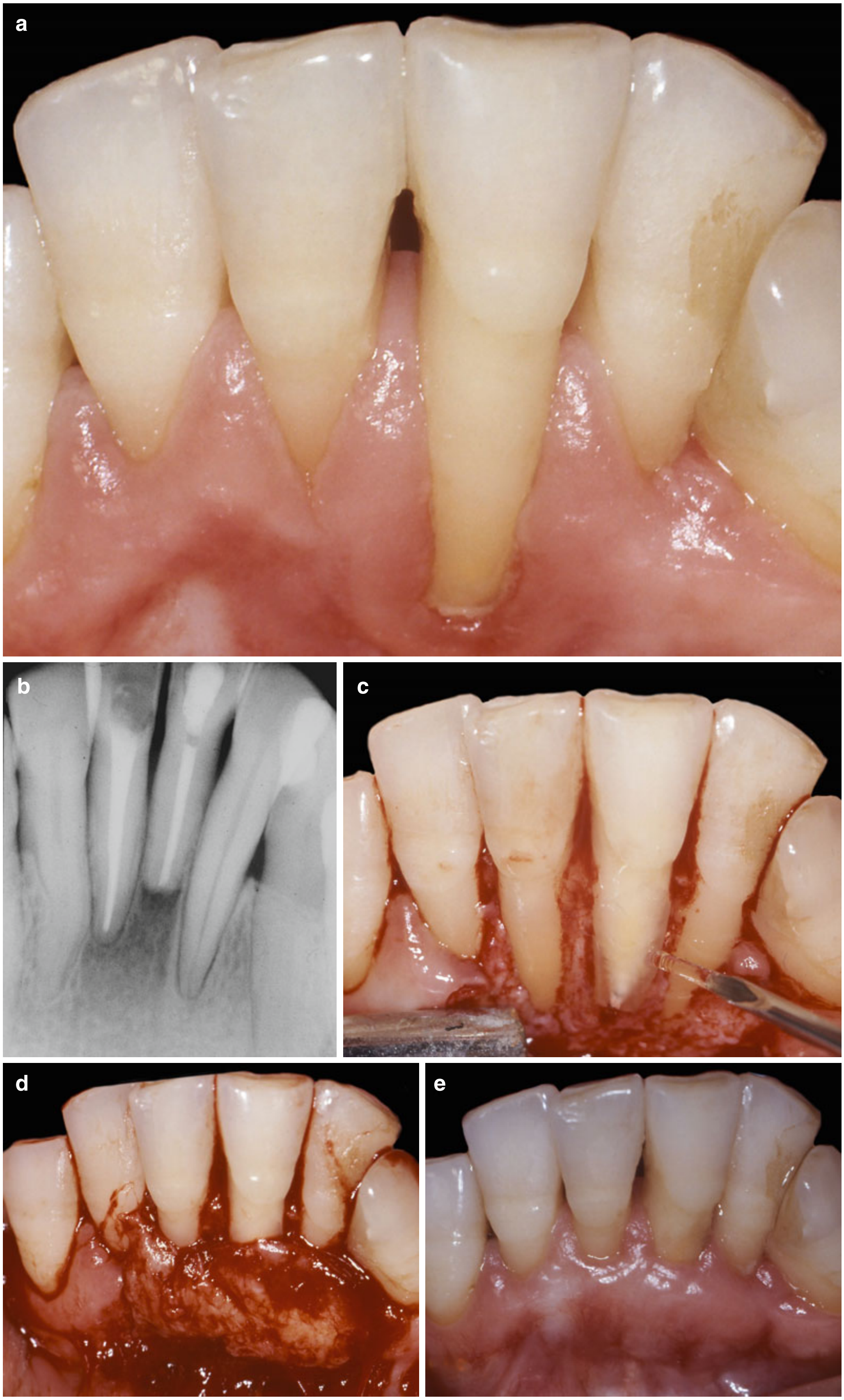

Fig. 3.68 Case XXXII. (**a**–**e**) Class III gingival recession over tooth 41. Baseline gingival recession to the root apex (**a**); radiographic exam showing the periapical condition of tooth 41, apicoectomy performed previously (**b**); clinical aspect of the root surface of tooth 41 after vigorous scaling and root planning (**c**); subepithelial connective tissue graft positioned at the recipient site (**d**); 6-month follow-up (**e**)

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4 Complications, Adverse Effects, and Patient-Centered Outcomes of Soft Tissue Augmentation Procedures and the Use of Gingival Soft Tissue Substitutes

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4.1 Complications, Adverse Effects, and Patient-Centered Outcomes of Soft Tissue Augmentation Procedures

4.1.1 Potential Complications and Adverse Effects Associated with Soft Tissue Grafting Procedures: "To Which Extent Are They Important?"

The base of systematic reviews available for gingival recession treatment, the use of CAF alone or in association with allogeneic, xenogeneic, or alloplastic biomaterials (e.g., matrix grafts or enamel matrix derivative) has been described as being less painful and more comfortable, due to the need of only one surgical site [1–7]. Conversely, it has been demonstrated that use of SCTG, FGG, and non-absorbable membranes has been associated with increased morbidity and some complications, such as postoperative pain, bleeding and swelling during the early phase of healing (Fig. 4.1a–c), and membrane exposure/contamination [1–7].

For instance, in a large practice-based study [8] considering the use of free gingival grafts (FGGs), subepithelial connective tissue grafts (SCTGs), and acellular dermal matrix grafts (ADMGs) for Class I and II root coverage, moderate to severe pain and swelling were the most significant adverse events, but less than 6 % of the sample experienced moderate or severe bleeding, and all of them were associated with the use of autogenous grafts [8]. The use of FGG was reported as the most painful procedure, followed by SCTG and ADMG. Additionally, longer chair-time procedures were straight associated to postoperative discomfort, such as pain and swelling, as well as the rate of pain and bleeding where superior for FGG than for SCTG [8]. On the other hand, it should be also noted that the incidence of infection (less than 1 %), bleeding (3.0 %), swelling (5.4 %), and pain (18.6 %) after the use of SCTG can be considered low to moderate [9].

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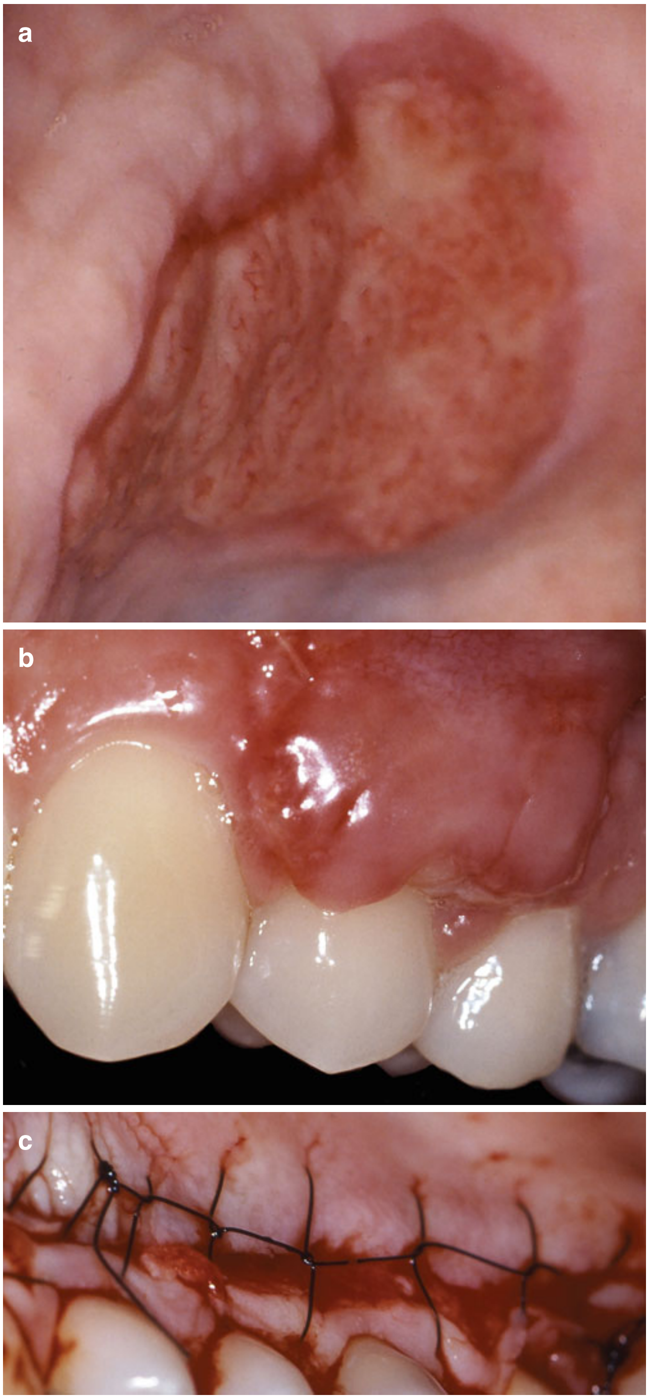

Fig. 4.1 Pain during early healing of donor sites of free gingival grafts caused by the exposure of the connective tissue layer of palatal gingival tissue (**a**). Swelling during early phase of healing of sites treated with subepithelial connective tissue grafts (**b**). Bleeding of a donor site of subepithelial connective tissue graft even after suture (**c**)

It is also important to highlight that despite the possible occurrence of some adverse events related to the treatment with SCTG (i.e., development of cyst-like areas [10, 11], root resorption [12, 13], or bone exostosis [14]), these were restricted to a very limited number of cases and cannot per se undermine the safety/success of autogenous grafts. Regarding the development of bony exostosis (i.e., unknown etiology of peripheral localized benign bone overgrowth, with a base continuous to the original bone and which seems to have a nodular, flat, or pedunculate protuberance) [15], these were also reported at sites where free gingival grafts (FGG) have been used to increase the amount of keratinized tissue (Fig. 4.2a–c). The reduced base of literature suggests that periosteal trauma/fenestration is probably the primary main-causing agent linked with exostosis development in grafted sited by FGG [16]. Likewise, and as explained in Chap. 3, additional reductions in the recession depth may occur after healing of the treated sites due to creeping attachment (Fig. 4.3a–i).

In addition, it has been clearly demonstrated that all periodontal plastic surgical procedures when properly performed are safe, as well as only a reduced number of patients can experience postsurgical complications (i.e., pain, swelling, or bleeding) or unusual healing outcomes [1–7].

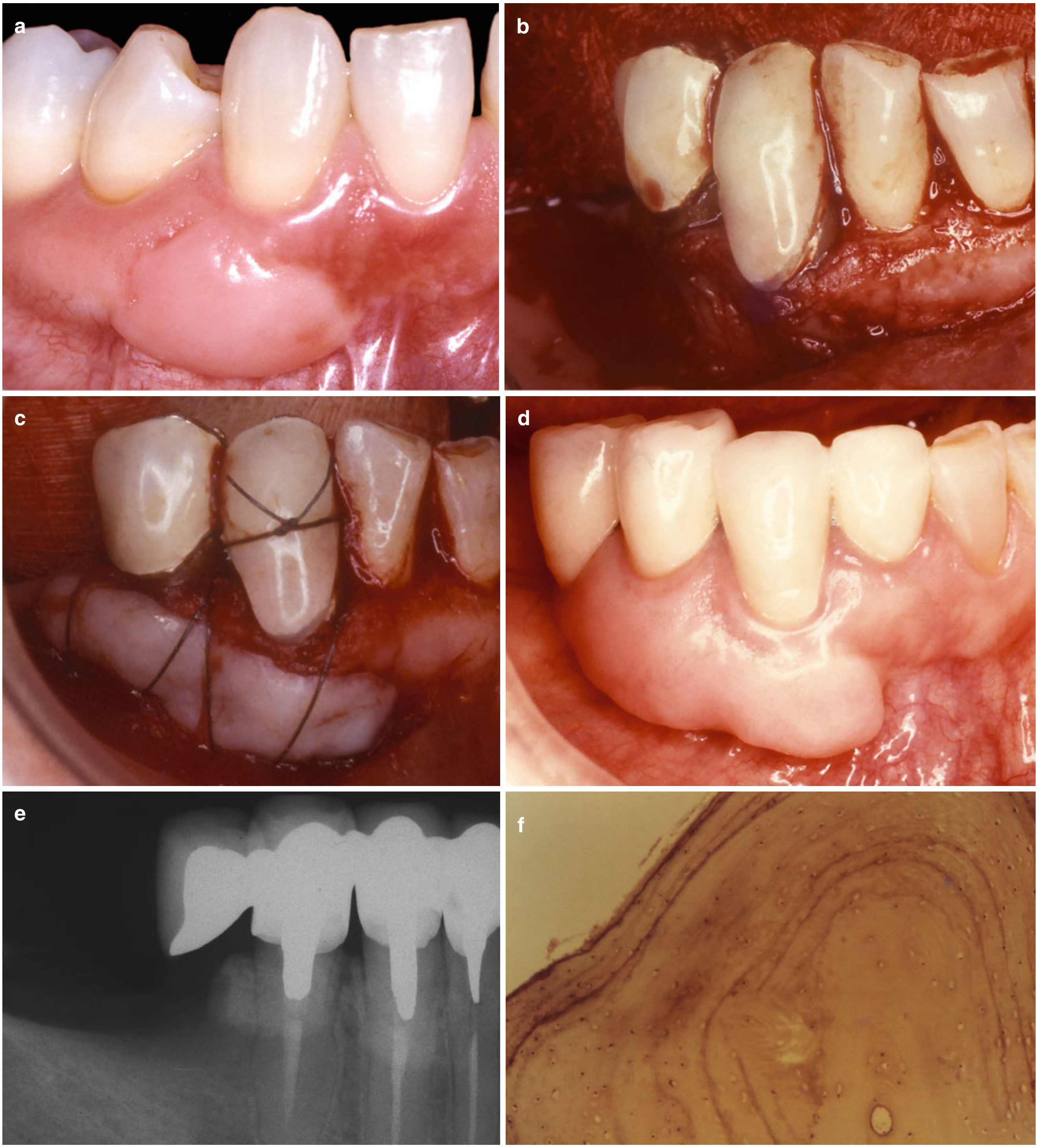

Fig. 4.2 Bone exostosis developed 5 years after frenectomy + periosteal fenestration + free gingival graft (**a**). Bone exostosis developed 15 years after a free gingival graft (**b–f**): accidental periosteal fenestration at teeth 44 & 43 (**b**), graft sutured (**c**), pronounced overgrowth at the graft site (**d**), increased radiopacity during radiographic exam (**e**), and very dense lamellar bone formation at graft site compatible to the exostosis diagnosis (**f**) (Figures originally published at Chambrone and Chambrone [16])

Fig. 4.3 (**a**–**i**) Class IV – Gingival recession in a heavy smoker patient >20 cigarettes a day (**a**),, baseline radiography (**b**), 4 months after a laterally positioned flap – presence of gingival recessions at tooth 13 (donor site) and 11 (recipient site) (**c**, **d**). 8 years follow-up – clinically relevant creeping attachment was evident on the donor and recipient sites (**e**, **f**) – 8 years follow-up radiography (**g**). Amount of creeping attachment achieved 8 years after surgery (**h**). Probing depth compatible to a health condition (**i**) (Figures originally published at Chambrone and Chambrone [28])

4.1.2 Patient-Centered Outcomes: "The Role of a Patient as the Clinician Coworker"

As reported previously, it can be argued that patients might prefer procedures involving only one surgical site when those potential early postoperative complication/adverse effects are taken into account; however, data included in previous systematic reviews also showed that these outcomes were not associated with the final esthetic/functional outcomes [1–7].

With respect to the influence of root coverage on cervical dentin hypersensitivity and quality of life of patients, a recent study on the treatment of Class I GRs treated with SCTG + CAF demonstrated that thermal [cold] and evaporative [air blast] stimuli can be significantly reduced 3 months postsurgery [17]. Yet, the treatment of recession defects (independent of the amount of root coverage achieved and the treatment approach used) positively influenced patients' oral health-related quality of life [17, 18].

Concerning patients' perceptions and requests for treatment and postsurgical satisfaction, it has been recently considered that perception of buccal defects by patients should be taken into consideration during decision-making [19]. Most of the patients don't mind the presence of GR, as well as considered such defects asymptomatic in nature and with no esthetical and/or functional relevance (73 %) [19]. In addition, 2/5 of the patients' requests for surgical correction of the defects occurred because of esthetic concerns and only 1/5 as a result of cervical dentin hypersensitivity [20].

Taken into account the patient-reported outcomes on esthetical and functional demands, it has been suggested that most of the graft, flap, and soft tissue substitutes provide similar color/texture of the tissues, except for the use of free gingival grafts (Fig. 4.4a–h) [1–7]. On the other hand, less traumatic procedures, such as CAF without vertical incisions, seem to offer better postoperative course during early healing [7].

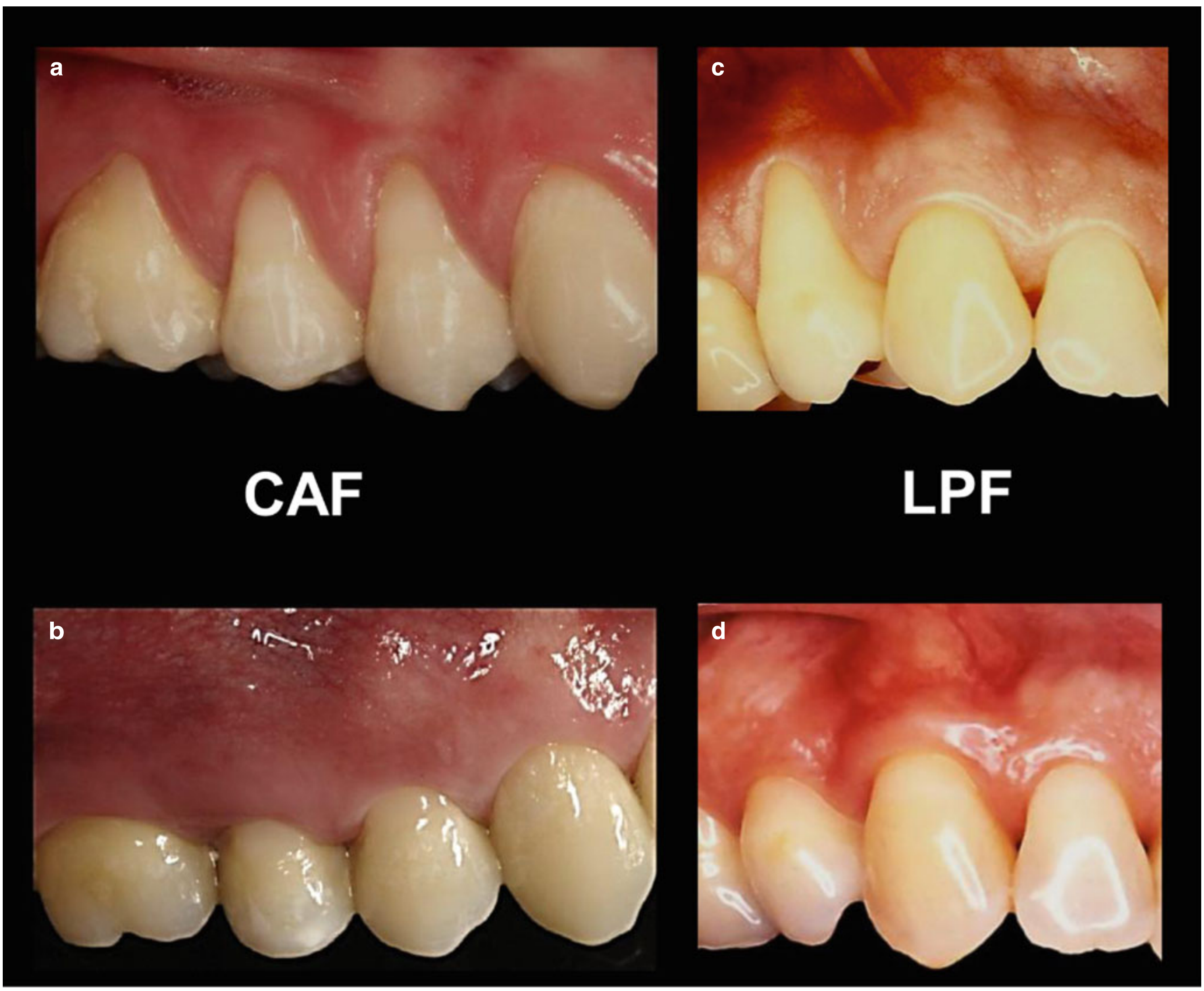

Fig. 4.4 Best color match and esthetics – flaps versus grafts. *CAF* coronally advanced flap (**a**, **b**), *LPF* laterally positioned flap (**c**, **d**), *SCTG* subepithelial connective tissue grafts (**e**, **f**), *FGG* free gingival grafts (**g**, **h**)

Fig. 4.4 (continued)

4.1.3 Clinical Concluding Remarks: "To Treat or Not to Treat Recession-Type Defects and Sites Lacking Keratinized Tissue"?

In clinical terms, it is clear that soft tissue augmentation procedures are safe and very well accepted by patients. The potential complications and adverse effects associated with such procedures are restricted to a limited number of cases and cannot per se undermine the safety/success of autogenous grafts. However, it is also clear that less traumatic procedures, with less chair time and involving only one surgical site, are preferred by most patients. These preferences are associated only with the surgical technique chosen and to some degree of pain, swelling, and/or bleeding some patients may experience at the early phases of healing of donor sites of autogenous grafts, but they do not have any impact on the final esthetical/functional outcomes or even amount to contraindications for treatment.

It is clear that less traumatic procedures, with less chair time and involving only one surgical site, are preferred by most patients. Independent of such preference, most of the treated patients considered esthetics as their main concern and, in their great majority, the final outcomes of the performed surgical procedure (irrespective of inclusion of one or more surgical sites) fulfilled their personal expectations. However, differences among patients' and clinicians' expectations and the manner they consider the success of treatment may be accounted as well. Apart of such preferences, most of the treated patients considered esthetics as their main concern and, in their great majority, the final outcomes of the performed surgical procedure may fulfill patients' personal expectations [1–7].

Critical Summary of the Results of Systematic Reviews

Systematic reviews co*nclusions*: All periodontal plastic surgery procedures are safe, as well as no relevant detrimental effects have been demonstrated associated with the main RC employed in daily practice [1–7]. On the other hand, there is not enough evidence to support or refute the assumption that RC may decrease hypersensitivity [17].

Summary of the reviews and critical remarks: Most of the research on the treatment of recession-type defects highlights the positive effect of treatment in terms of defect- and patient-centered outcomes. The incidence of adverse effects, such as discomfort with or without pain, is very low, and when present, these may occur at early phase of healing. Additionally, such events do not lead to changes in the final anticipated functional (root hypersensitivity) and/or esthetical outcomes [1–7].

Evidence quality rating/strength of recommendation (*ADA 2013*) [21]: Strong – Evidence strongly supports providing these interventions (i.e., treatment of recession-type defects and keratnized tissue augmentation)

4.2 The Use of Soft Tissue Substitutes

4.2.1 Historical Note and Types of Substitutes

The use of soft tissue substitutes for root coverage procedures, treatment of alveolar ridge deformities, and augmentation of the keratinized tissue band has been broadly proposed since the late 1990s. Specifically to the potential materials capable to be used in periodontal and peri-implant plastic surgery, allogenic and xenogeneic grafts have been developed [1, 3–7], and the main commercial brands are depicted below:

- The Alloderm® Regenerative Tissue Matrix (BioHorizons IPH Inc., Birmingham, AL, USA) or ADMG is the most studied soft tissue substitute since its development in 1994. It is an allograft material obtained from a human donor skin tissue through a process that removes its cell components (in order to remove potential sources of disease transmission and immunologic reaction), while preserving the remaining bioactive components and the extracellular matrix, which is subsequently freeze dried [22–24]. According to its manufacturer, it "supports tissue regeneration by allowing rapid revascularization, white cell migration and cell population – ultimately being transformed into host tissue for a strong, natural repair."
- The Puros® Dermis Allograft Tissue Matrix (Zimmer Dental Inc., Carlsbad, CA, USA) is an allograft material (i.e., sterile dehydrated dermis from donated human) that "retains the natural three-dimensional collagen structure/matrix and mechanical properties of native dermis," as well as it "provides a natural collagen scaffold to support replacement by new endogenous tissue."
- The PerioDerm™ Acellular Dermis Soft Tissue Matrix (DENTSPLY International, Inc., Tulsa, OK, USA) is a freeze-dried allograft material derived from donated human skin, and it "is minimally processed to remove epidermal and dermal cells (viable cells and antigens) to minimize the risk of rejection and inflammation of the surgical site while preserving the extracellular matrix (the framework for cellular infiltration and vascularization)." It is also described by "supporting the migration of host cells from wound margins and surrounding tissues."
- The Geistlich Mucograft® (Geistlich Pharma AG, Switzerland) is a purified, nonantigenic pure porcine collagen bilayer matrix. As described by its manufacturer, one of the layers is compact ("compact collagen fibers that protect against bacterial infiltration in open healing situations and allow tissue adherence as a prerequisite for favorable wound healing"), while the other is spongious ("a thick [2.5–5.0 mm], porous collagen spongious structure that should be placed in contact with the host tissue").

In addition, the association of other biomaterials has been used to improve the outcomes of CAF-based procedures. Of them, the porcine enamel matrix derivative protein (EMD – Straumann® Emdogain, Straumann Holding AG, Basel, Switzerland) has been used for more than 10 years as an interesting and safe approach. Despite the additional costs related to the purchase of this biomaterial, it has been demonstrating superior outcomes in recession depth reduction, concomitant clinical attachment level, and keratinized tissue width gain when compared to CAF alone, as well as in regenerating part of the periodontal tissues at recession defects [1, 3–7].

4.2.2 Type of Defect/Condition to Be Indicated

Treatment of localized or multiple Class I and II GR [25] (with any of the abovementioned biomaterials), as well as for the treatment of alveolar ridge deformities (gain in soft tissue volume) and increase in the keratinized tissue width/band around teeth and implants (except for the enamel matrix derivative)

4.2.3 Type of Defect/Condition Not to Be Indicated

Non-submerged surgical root coverage sites

4.2.4 General Surgical Aspects on the Use of Soft Tissue Substitutes

Overall, the allogeneic grafts should be rehydrated by sterile saline in room temperature for at least 2 min, whereas the xenogeneic collagen matrix and the enamel matrix derivate are ready to use (the collagen matrix need to be only trimmed to size and sutured to the recipient site dry). Overall, they should be used in the same manner of SCTG, but they have to be completely covered by a coronally advanced flap (*the Mucograft may be sutured exposed to the oral cavity in sites requiring only keratinized tissue augmentation).

4.2.5 Clinical Remarks: Implications for Practice and Clinical Decision-Making

As reported in previous chapter, the use of SCTG-based procedures provided the best short- and long-term clinical outcomes to the patients (i.e., recession depth reduction, clinical attachment level, and keratinized tissue gain), as well as cost-benefit ratio. Apart from these conditions, the use of acellular dermal matrix grafts or xenogeneic collagen matrix is certainly adequate and harmless to soft tissue substitutes to be used in areas demanding root coverage or soft tissue/keratinized tissue augmentation in patients with great demands of donor tissue (e.g., patients with multiple recession-type defects) or patients who do not want to be submitted to a secondary surgical procedure at the palatal vault. Similarly, the enamel matrix derivative, at short and long term, leads to positive outcomes when used for conditions involving root coverage associated to keratinized width increase. Histologically, it may lead to the formation of a long junctional epithelium (over the previously exposed root surface) and connective tissue attachment with fibers parallel to the root surface (for root coverage procedures), but it is expected to have partial regeneration of the cementum, alveolar bone, and periodontal ligament when Emdogain is used.

Concerning exclusively the improvement of the keratinized tissue band in sites not requiring root coverage, free gingival grafts are still considered to be the "gold standard" procedure because of its incomparable (or higher) rate of success, but graft substitutes may be used as possible options to palatal tissue harvesting for sites requiring gingival augmentation (Figs. 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17, and 4.18) [27].

Critical Summary of the Results of Systematic Reviews

Systematic reviews conclusions: Regarding the treatment of gingival recessions, EMD and dermal matrix grafts (mainly ADMG) can significantly improve recession depth, clinical attachment level, and the keratinized tissue band (MRC and CRC are comparable to ones reported by SCTG). Xenogeneic collagen matrix (XCM) may be used as well, but the amount of information on this material is still limited [1, 3–7]. For the increase of the width and volume of keratinized tissue, ADMG and XCM performed worse than SCTG or FGG [26].

Summary of the reviews and critical remarks: The base of evidence on ADMG-based procedures is somewhat long and solid. In statistical terms, there is no significant differences between ADMG and SCTG procedures in terms of MRC and CRC (but SGTG showed a trend of better outcomes), but ADMG may provide 15 % more MRC than CAF alone (at 6 months). For XCM, it led to 9 % less MRC than SCTG [7]. For non-root coverage procedures, short-term evidence suggests the use of ADMG and XCM as safe substitutes to autogenous grafts [27].

Evidence quality rating/strength of recommendation (*ADA 2013*) [21]: Strong (for EMD and ADMG), evidence strongly supports providing this intervention; and in favor (for XCM), evidence favors providing this intervention.

Fig. 4.5 (**a**–**e**) Case I – Single class I gingival recession on tooth 24 associated to a noncarious cervical lesion treated with Alloderm® Baseline (**a**). Horizontal and vertical incisions performed (**b**). Graft sutured over the exposed root surface at the level of the probable cementoenamel junction (**c**). Flap coronally advanced and sutured covering the graft completely (**d**), 4 months follow-up (**e**)

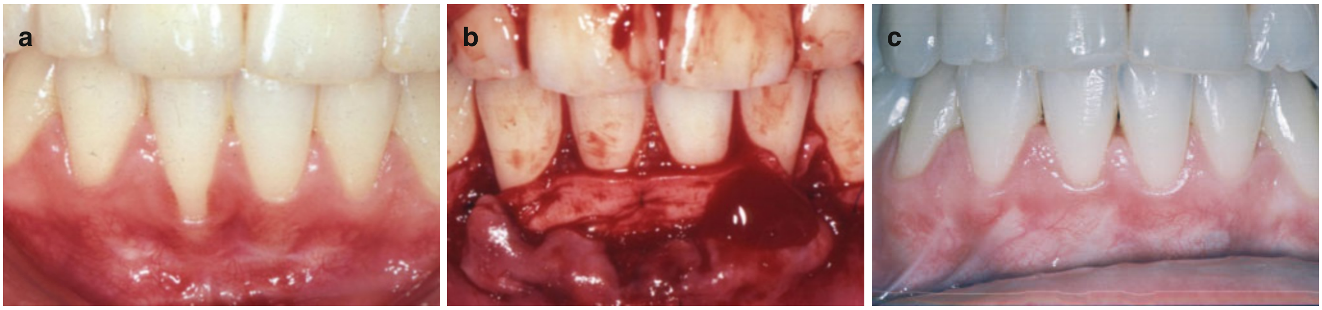

Fig. 4.6 Case II (**a**–**c**) – -Single class II gingival recession over tooth 41 treated with Puros Dermis

Fig. 4.7 (**a**–**g**) Case III – Single class II gingival recession on tooth 13 associated to a noncarious cervical lesion treated with Puros Dermis®. Baseline (**a**, **b**). Graft sutured over the exposed root surface at the level of the cementoenamel junction (**c**). Flap coronally advanced and sutured covering the graft as much as possible (**d**), 1-year follow-up (**e**–**g**)

Fig. 4.8 (**a**–**j**) Case IV – Multiple class I gingival recessions on teeth 12, 13, and 14 associated to noncarious cervical lesion treated with Mucograft®. Baseline (**a**). Recession depth of tooth 13 (**b**). Horizontal and vertical incisions performed (**c**). 3D aspect of the soft tissue substitute (**d**), graft (general view) (**e**), graft height (**f**), graft width (**g**), flap raised (**h**), flap coronally advanced and sutured covering the graft completely (**i**), 1-year follow-up (**j**)

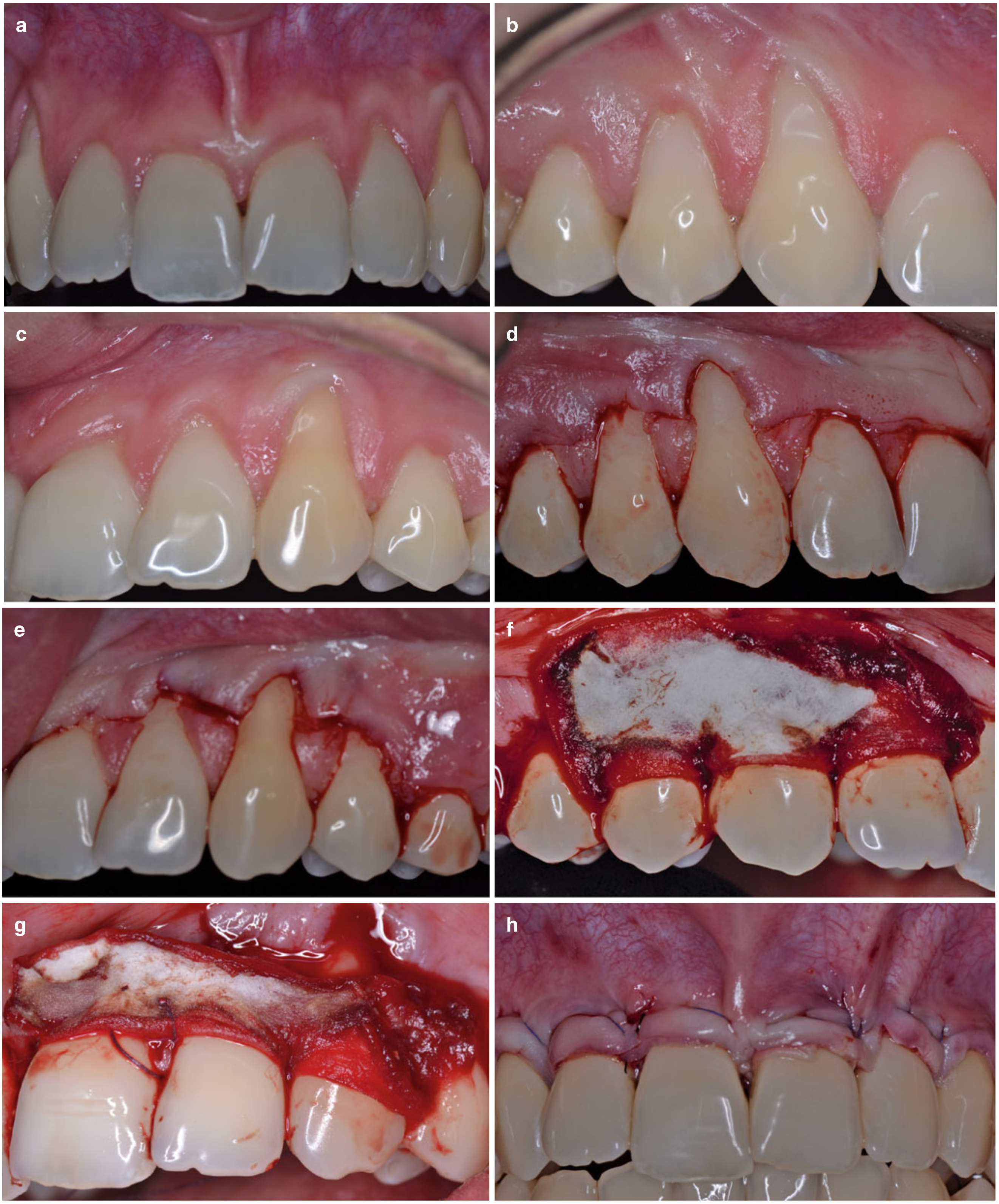

Fig. 4.9 (**a**–**m**) Case V – Multiple class I and II gingival recessions on the anterior maxillary teeth treated with Mucograft®. Baseline (**a**–**c**), horizontal and papillary incisions performed (**d**, **e**), graft sutured (**f**, **g**), flap coronally advanced and sutured covering the graft completely (**h**–**j**), 8 months follow-up (**k**–**m**)

Fig. 4.9 (continued)

Fig. 4.10 (**a**–**g**) Case VI – Multiple class I gingival recessions on teeth 12, 11, and 21 treated with Mucograft®. Baseline (**a**), tunnel flap raised (**b**), graft (**c**), graft being positioned (**d**), graft positioned (**e**), tunnel flap coronally advanced and sutured covering completely the graft (**f**), 1 year follow-up (**g**)

Fig. 4.11 (**a**–**i**) Case VII – Single class II gingival recession on tooth 23 associated with a noncarious cervical lesion treated with Mucograft®. Baseline (**a**), evident loss of root dentin (**b**), flap raised (**c**), graft sutured over the root surface (**d**), flap coronally advanced and sutured covering completely the graft (**e**), 2 weeks follow-up (**f**), 8 weeks follow-up (**g**, **h**), 2 years follow-up (**i**)

Fig. 4.12 (**a**, **b**) Case VIII – Multiple class I and II gingival recessions on the anterior segment of maxilla of a heavy smoker patient (>20 cigarettes a day) treated with Alloderm®. Baseline (**a**), 2 years follow-up (**b**)

Fig. 4.13 (**a**–**g**) Case IX – Multiple class I and II gingival recessions associated to noncarious cervical lesions on the anterior segment of maxilla treated with platelet-rich fibrin. Baseline (**a**–**c**), 3 weeks follow-up (**d**), 1 year follow-up (**e**–**g**)

Fig. 4.14 (**a**–**f**) Case X – Single class I gingival recession on tooth 35 treated with Alloderm®. Baseline (**a**), graft sutured to the recipient site (**b**, **c**), flap coronally advanced and sutured covering the graft completely (**d**), 4 months follow-up (**e**, **f**)

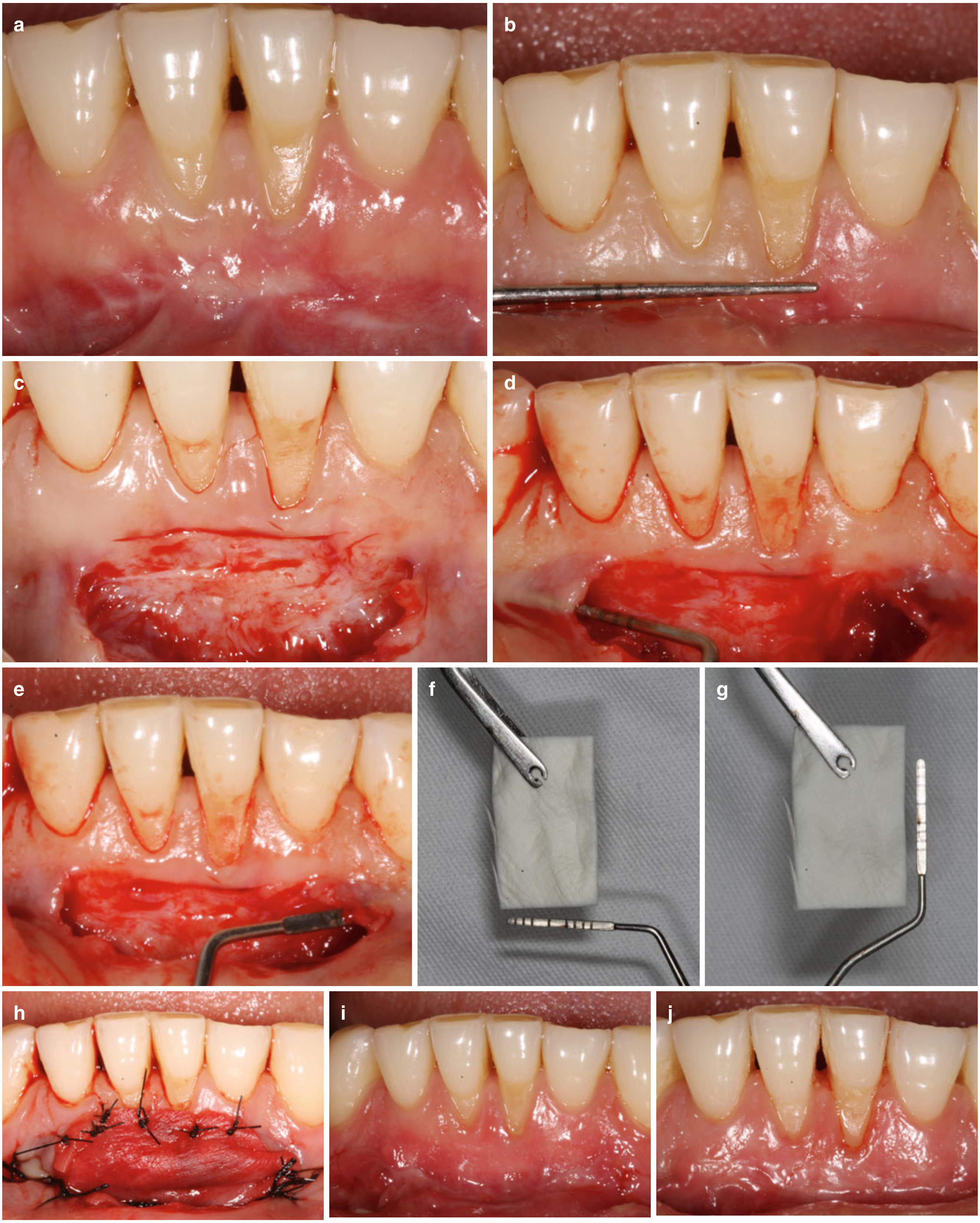

Fig. 4.15 (**a**–**j**) Case XI – Lip frenum removal at the anterior mandible associated to soft tissue grafting with Mucograft®. Baseline (**a**), lack of keratinized tissue (**b**), frenum removal (**c**), dissection of the recipient site to accommodate the graft (**d**, **e**), dimensions of the graft (**f**, **g**), graft sutured to the recipient site (**h**), 2 weeks follow-up (**i**), 6 weeks follow-up (**j**)

Fig. 4.16 (**a**–**e**) Case XII – Multiple class I and II recession-type defects on teeth 15, 14, 13, 12, 11, 21, 22, 23, 24, and 25 associated to noncarious cervical lesions treated with Puros Dermis®. Baseline (**a**–**c**), flaps raised (**d**). Grafts sutured (**e**–**g**) flaps coronally advanced and sutured covering completely the grafts (**h**) 6 months follow-up (**i**, **j**)

Fig. 4.16 (continued)

Fig. 4.17 (**a**–**j**) Case XIII – Multiple class I, II, and III recession-type defects on the anterior maxilla treated with Alloderm®. Baseline (**a**–**e**), recession after scaling of the exposed root surfaces (**f**), VISTA tunnel flap coronally advances and positioned with sutures and resin composites at each individual tooth presenting a gingival recession – note the vestibular incision used for graft positioning (**g**) grafts positioned via the tunnel flap and vertical incision suture (buccal frenulum) (H) clinical appeareance at the end of the procedure (**i**–**k**) 21 days follow-up – day of suture removal (**l**) 4 motnhs follow-up smile (**m**). This case was kindly provided by Prof. Homayoun Zadeh (the mentor of VISTA procedure)

Fig. 4.17 (continued)

Fig. 4.18 Four months results (**a**–**d**)

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Esthetical Clinical Crown Lengthening, Lip Repositioning, and Gingival Depigmentation

5

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5.1 Esthetical Clinical Crown Lengthening

5.1.1 The Smile, My "Business Card"

For many people, the smile is considered the "business card" because it may reflect a part of the individual behavior and feeling of each one of us. Healthy, harmonious, and pleasant smiles are associated to four elements:

1. Smile line and its symmetry with facial structures: the human face presents anatomical structures that may guide the clinician during patient's examination and decision-making process. The face may be divided in three thirds, where the mid and the lower are of more esthetical importance [1, 2]. The parallelism between the interpupillary, the ophriac (the line drawn over the eyebrows), the alar, and the commissural lines may assist the orientation of the incisal and occlusal planes and the gingival contours (these should be parallel to those facial lines) [1, 2]. The midfacial line (a line perpendicular to the interpupillary line) divides the face in two symmetrical parts, and this should be coincident to the midline of the dentition (this line also allows the assessment of contralateral teeth discrepancies related to size, shape, and axial inclination) [1, 2].
2. Soft tissue morphology and its contours around the six maxillary anterior teeth – the correct proportion of gingival line (i.e., the line joining the tangents of the gingival zeniths [the most apical aspect of the free gingival margin] of the central incisor and canine) [3–5].
3. Tooth morphology/proportions: the correct proportions of canines, lateral, and central incisions regarding its individual length and width (the tooth length/width ratio) [6, 7].
4. Osseous architecture (thickness/irregularities of the alveolar bone) and its location in relation to the cementoenamel junction (i.e., 1–2 mm apically located) [6, 8].

5.1.2 "Pink" and "White" Esthetics: "Why Is It Important to Establish Balanced Proportions?"

Clinical crown lengthening procedures have long been used to reestablish the biological width of fractured/carious teeth [6, 9–11]. With the increasing demand for "pink" and "white" esthetics, treatment of anterior maxillary areas should encompass the functional and esthetical reestablishment of a balanced, healthy, and attractive smile. Nowadays, such objectives may be obtained via important changes occurring in the fields of periodontology and restorative dentistry as reflected by their different esthetical/cosmetic approaches [12–16].

Within patients presenting completely erupted teeth and no history of tooth/gingival alterations (i.e., gingival recession, non-carious cervical lesions, caries, restorations, occlusal overload, soft tissue overgrowth, gingival inflammation, periodontitis, or previously submitted to periodontal surgical procedure) the gingival zenith of the canines seems to be located apically to the gingival zenith of the incisors; however, the gingival zenith of the lateral incisors may be located below (for almost 80 % of all subjects) or on the gingival line [5]. Moreover, it has been demonstrated that the gingival zeniths of all maxillary anterior teeth are not completely displaced toward the distal aspect, that is, "the more anterior the tooth, the greater the prevalence and distal displacement of the gingival zenith" [17].

On the other hand, altered passive eruption (a tooth exposure secondary to apical migration of the gingiva [18]) may cause excessive gingival display upon smiling and overlapping of portions of the anatomical crown by the soft tissues [8, 13, 15]. As a result, the negative imbalance between the amount of soft tissue and the shortened length of the clinical crowns may alter the smiles' esthetic appearance. With respect to passive eruption of the "dentogingival junction" in adults, this can be assessed based on two anatomic relationships [8]:

- Gingiva–anatomic crown relationship (Fig. 5.1) – this can be divided in type I (where the gingival margin is located incisal to the cementoenamel junction and the gingival dimension is prominently wider from the margin to the mucogingival junction) or type II (normal dimension of the gingival margin to the mucogingival junction) [8].
- Alveolar crest-cementoenamel junction relationship (Fig. 5.2) – this can be divided in subtype A (where the distance between these structures is around 1.5 mm, and a normal attachment of gingival fibers into the cementum is observed) or subtype B (both structures are at the same level) [8].

In addition, the knowledge on the anatomical characteristics of periodontal tissues of maxillary anterior teeth (i.e., gingival zenith and location of the alveolar bone crest with respect to the cementoenamel junction) and smile line/facial structures may be used clinically to determine the ideal unilateral positioning of the gingival margin during periodontal surgical treatment alone or in combination with multidisciplinary approaches involving orthodontic and prosthetic therapies [17].

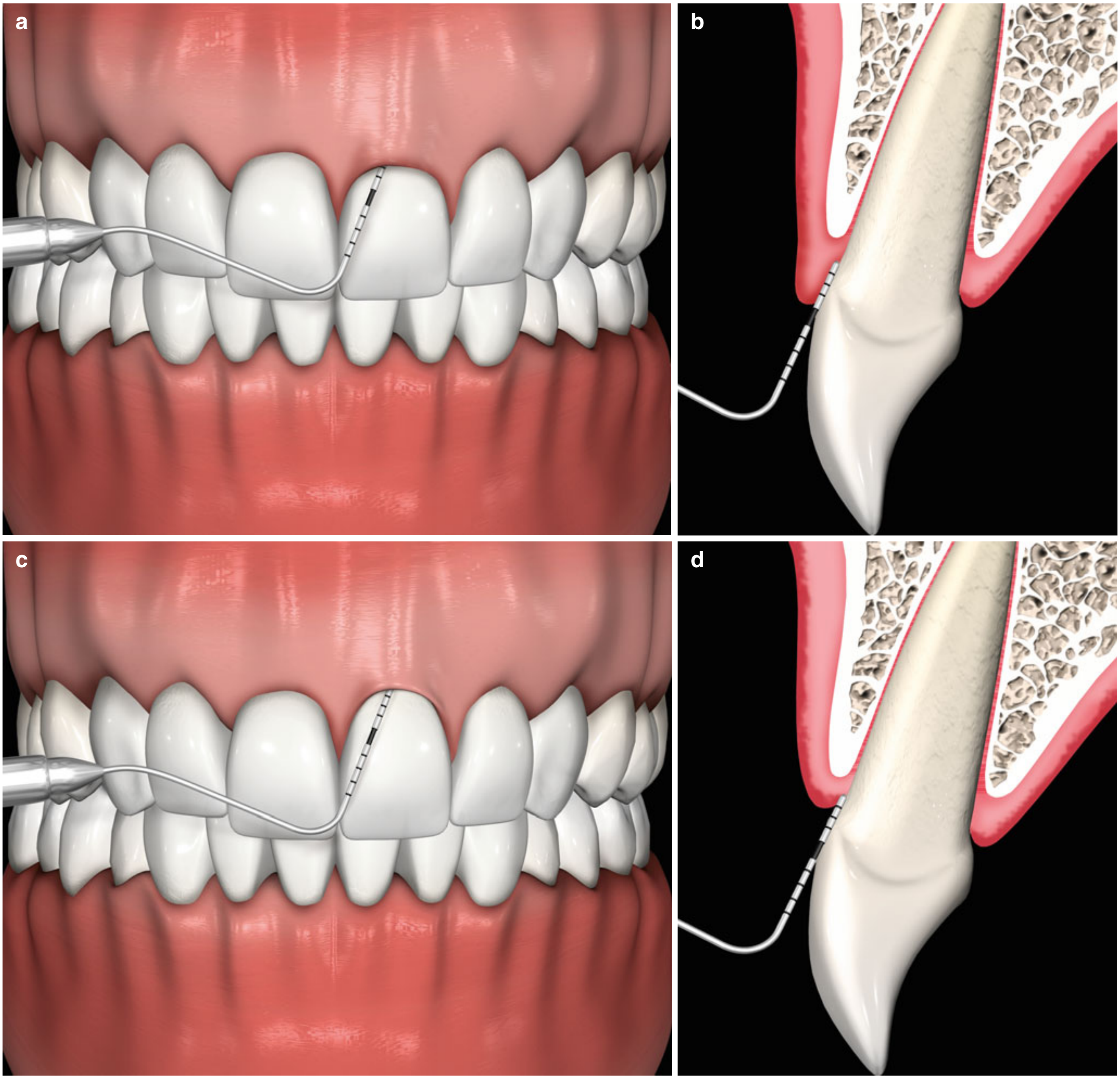

Fig. 5.1 Gingiva–anatomic crown relationship. Type I – the gingival margin is located incisal to the cementoenamel junction, and the gingival dimension is prominently wider from the margin to the mucogingival junction (**a**, **b**). Type II – normal dimension of the gingival margin to the mucogingival junction (**c**, **d**)

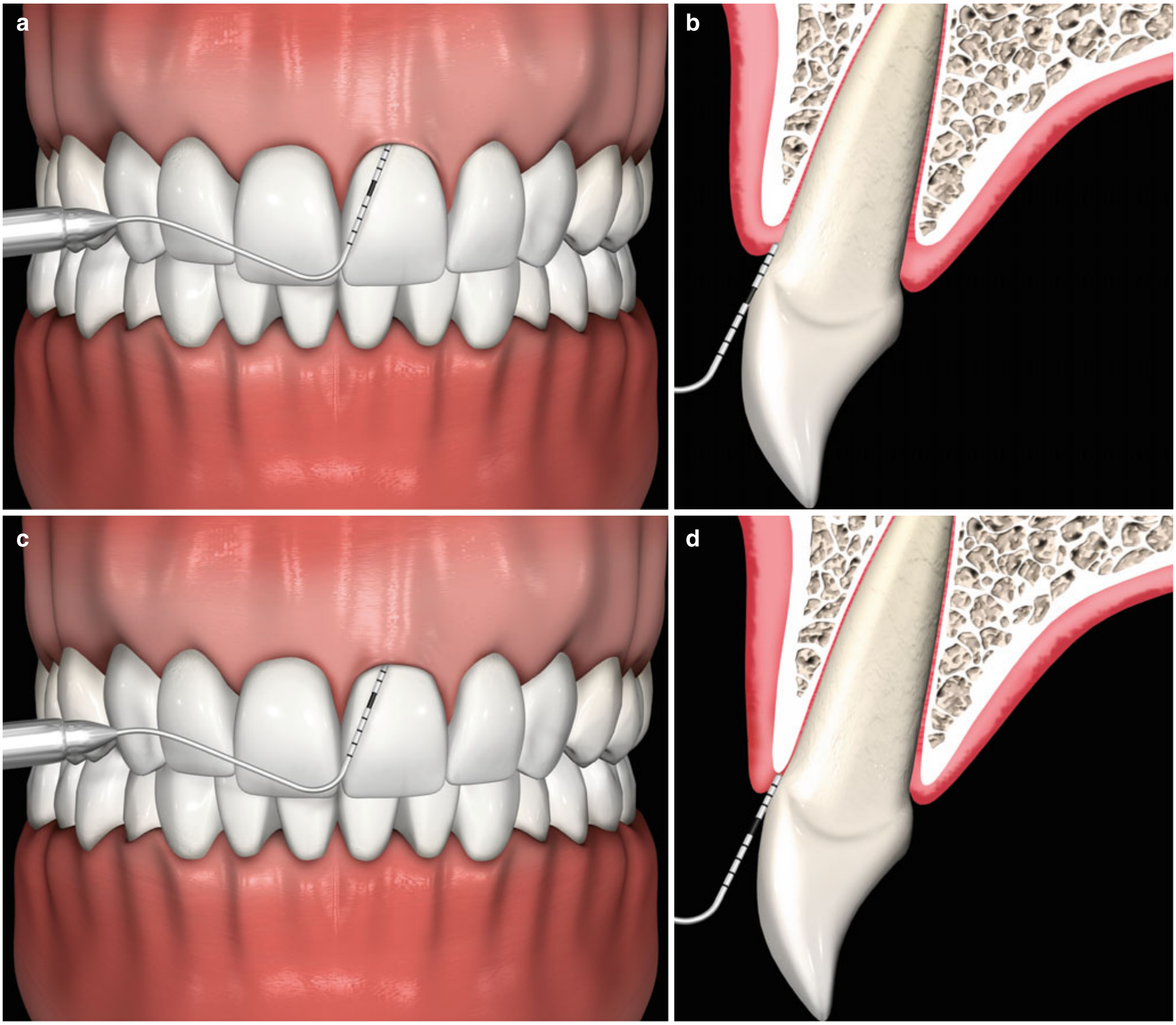

Fig. 5.2 (**a**–**d**) Alveolar crest–cementoenamel junction relationship. Subtype A – the distance between these structures is around 1.5 mm, and a normal attachment of gingival fibers into the cementum is observed (**a**, **b**). Subtype B – both structures are at the same level (**c**, **d**)

5.1.3 Esthetical Clinical Crown Lengthening: "What May Be Expected After the Use of Periodontal Plastic Surgery Procedures?"

Despite being considered of more esthetic than of functional concerns, it has been demonstrated that an excessive gingival display (or gummy smile) may have a detrimental impact on the opinion of "a patient's attractiveness, friendliness, trustworthiness, intelligence, and self-confidence" [14].

Descriptions of the use and outcomes of clinical lengthening procedures for the correction of anatomical discrepancies of the gingival and osseous architectures (e.g., altered dental eruption), gummy smile, and prior to prosthetic restorations may be found in the literature, and these approaches have encompassed the use of periodontal surgical techniques alone or in association to restorative procedures:

- Pontoriero and Carnevale [9] evaluated the stability of the marginal periodontal tissues up to 12 months following surgical crown lengthening performed at the anterior and posterior teeth. A mean gingival coronal displacement of the gingival margin of 1.2 mm was found at buccal/lingual sites and 0.5 mm at interproximal sites from the end of the surgical procedure to the last follow-up – this outcome seemed associated to thick periodontal biotypes.
- Lanning et al. [10] observed that the biological width is reestablished to its original dimension 6 months after surgery, as well as when the amount of bone to be removed is based on the future margins of the restoration and the original length of the biological width – definitive restorations may be performed 3 months after treatment (even in esthetic areas).
- Deas et al. [11] also observed a significant gingival rebound of 30.8 % of gain of crown height achieved with surgical procedure, 6 months following treatment, related to the flap position over the alveolar bone crest at suturing.
- Perez et al. [19], in contrast to Deas et al. [11], demonstrated that following a 6-month healing period, the supracrestal gingival unit (i.e., biologic width) of buccal sites was reduced by 14.1 %.
- Joly et al. [12] described a minimally invasive flapless approach valid for patients presenting a wide band of keratinized tissue and thin bone (i.e., patients with a thin or intermediate biotypes).

5.1.4 Type of Defect/Condition to Be Indicated

Treatment of patients with high smile line (gummy smile) or with discrepancies in the gingival margin (zenith) of anterior teeth that may impact the patient's esthetics (i.e., patient's personal report describing a deteriorated esthetic appearance due to its "gingival smile")

5.1.5 Type of Defect Not to Be Indicated

Exposure of no more than 2 mm of gingival tissue during a natural smile (i.e., medium or low smile line) and in areas where the stability of the dentition may be compromised

5.1.6 Basics of the Surgical Sequence

For the flapless esthetic clinical crown lengthening procedure [12], an adequate band of keratinized tissue and a thin bone should be present. In this procedure, sulcular or inverted beveled incisions are performed on the anterior teeth requiring crown lengthening based on the amount of bone/soft tissue to be removed and the new position of the gingival margin established (in relation to the cementoenamel junction). This may be facilitated with the assistance of a diagnostic wax-up, a clinical mock-up, and an acrylic individual surgical guide since it assists the picturing of the future position of gingival margins and restorations' shape (when indicated). These steps permit a more accurate, predictable, and less traumatic/invasive surgical procedure. After that, the collars of gingiva should be removed, and osseous remodeling takes place via "gingival sulcus" using micro-chisels, and no suture procedures are required (Fig. 5.3).

With respect to the conventional surgical procedure, full-thickness flap rising should be performed after the removal of soft tissue collar. Osseous resection may be carried out using chisels or rotatory instruments with carbide burs, and the flap is positioned at the level or apical to cementoenamel junction (based on the periodontal/restorative treatment proposed) and sutured by 5-0 or 6-0 nylon/Teflon sutures (Fig. 5.4). The sutures are removed 14 days after surgery. In addition, patients should be instructed not to brush the teeth in the treated area, as well as they are prescribed 0.12 % chlorhexidine gluconate and instructed to rinse gently twice a day for 2–3 weeks, or until safe and comfortable toothbrushing can be performed. Overall, like all other periodontal plastic surgery procedures, analgesics, anti-inflammatory drugs, and/or systemic antibiotics are prescribed if needed, as well as no adverse effects are expected in the treated sites.

Fig. 5.3 (**a**–**e**) Esthetical clinical crown lengthening – flapless procedures [12], baseline (**a**), clinical mock-up positioned determining the future gingival margin and guiding the external beveled incisions (**b**), removal of gingival collars (**c**), osteotomy via the gingival sulcus (**d**), no sutures are performed (**e**)

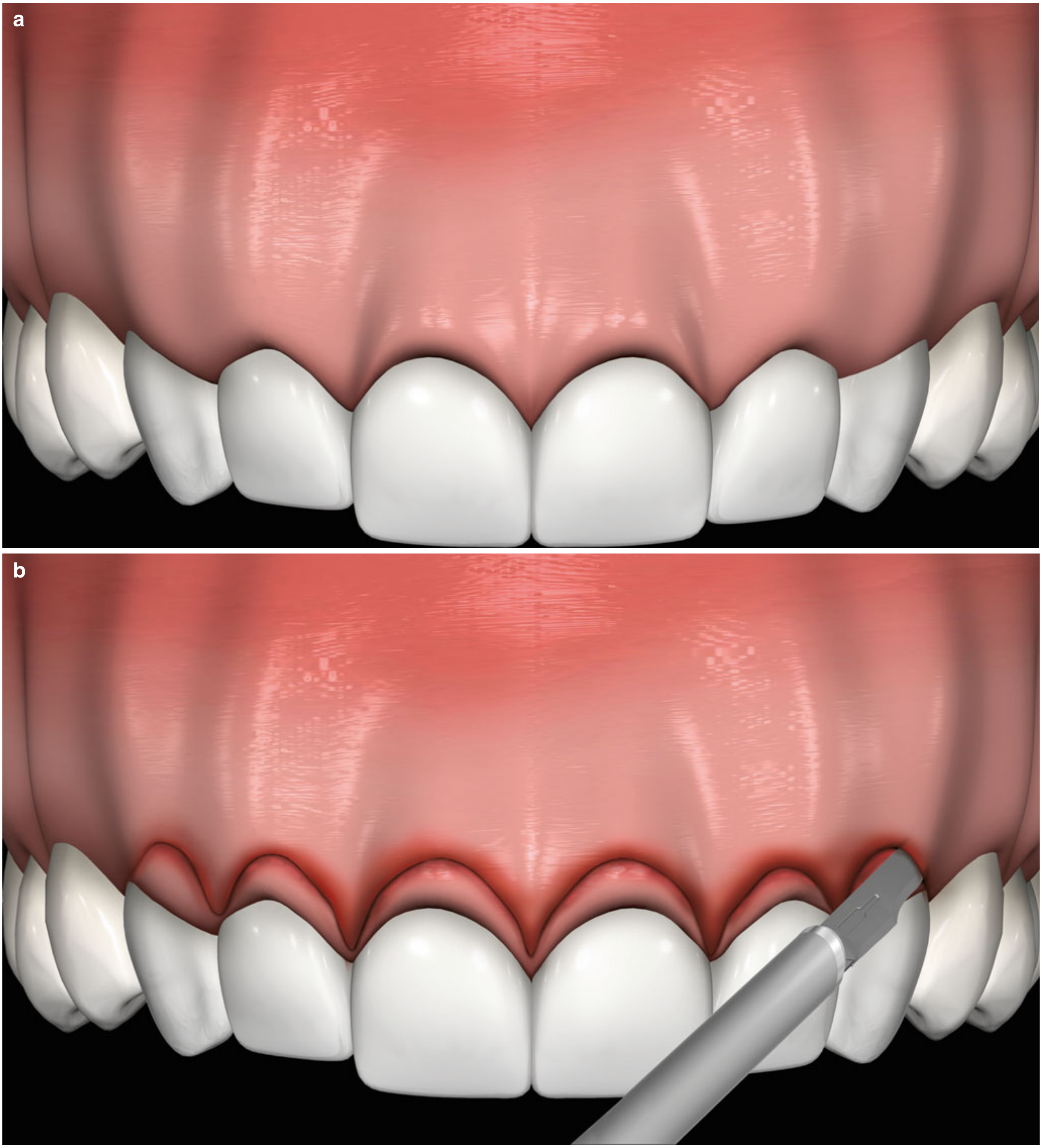

Fig. 5.4 (**a**–**h**) Baseline (**a**), external beveled incision (**b**) Intrasulcular incisions (**c**). Gingival collar removal (**d**). Full-thickness flap raised (**e**). Osteotomy and osteoplasty (**f**). Checking the distance of the alveolar crest to the cementoenamel junction (**g**). Flap positioned and sutures apically (**h**)

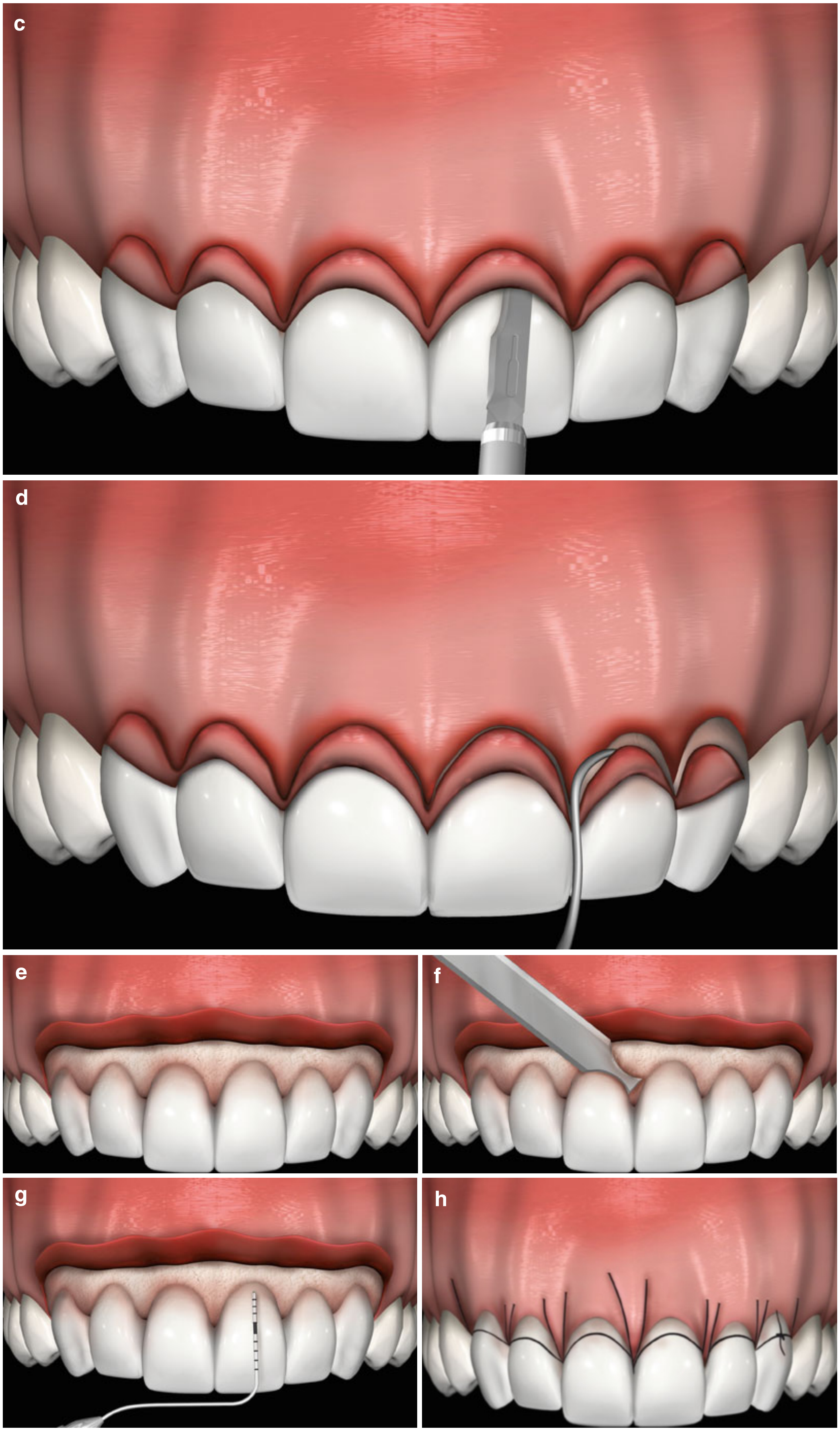

Fig. 5.4 (continued)

5.1.7 Orthodontic Tooth Extrusion: "Can Orthodontics Act as a Coadjuvant to the Use of Periodontal Plastic Surgery Procedure?"

Orthodontic extrusion associated with periodontal flap surgery or fiberotomy, during or immediately after extrusion, may be considered an additional resource for single tooth requiring esthetical clinical crown lengthening [20]. Fiberotomy has the advantage of preventing the return of the dental structure to its original position or the concomitant extrusion of both soft and hard tissues, which may lead to the need of additional plastic periodontal surgical procedures [20]. However, in sites lacking interpapillary gingiva, orthodontic extrusion without fiberotomy may provide superior esthetical gains (Figs. 5.5 and 5.6).

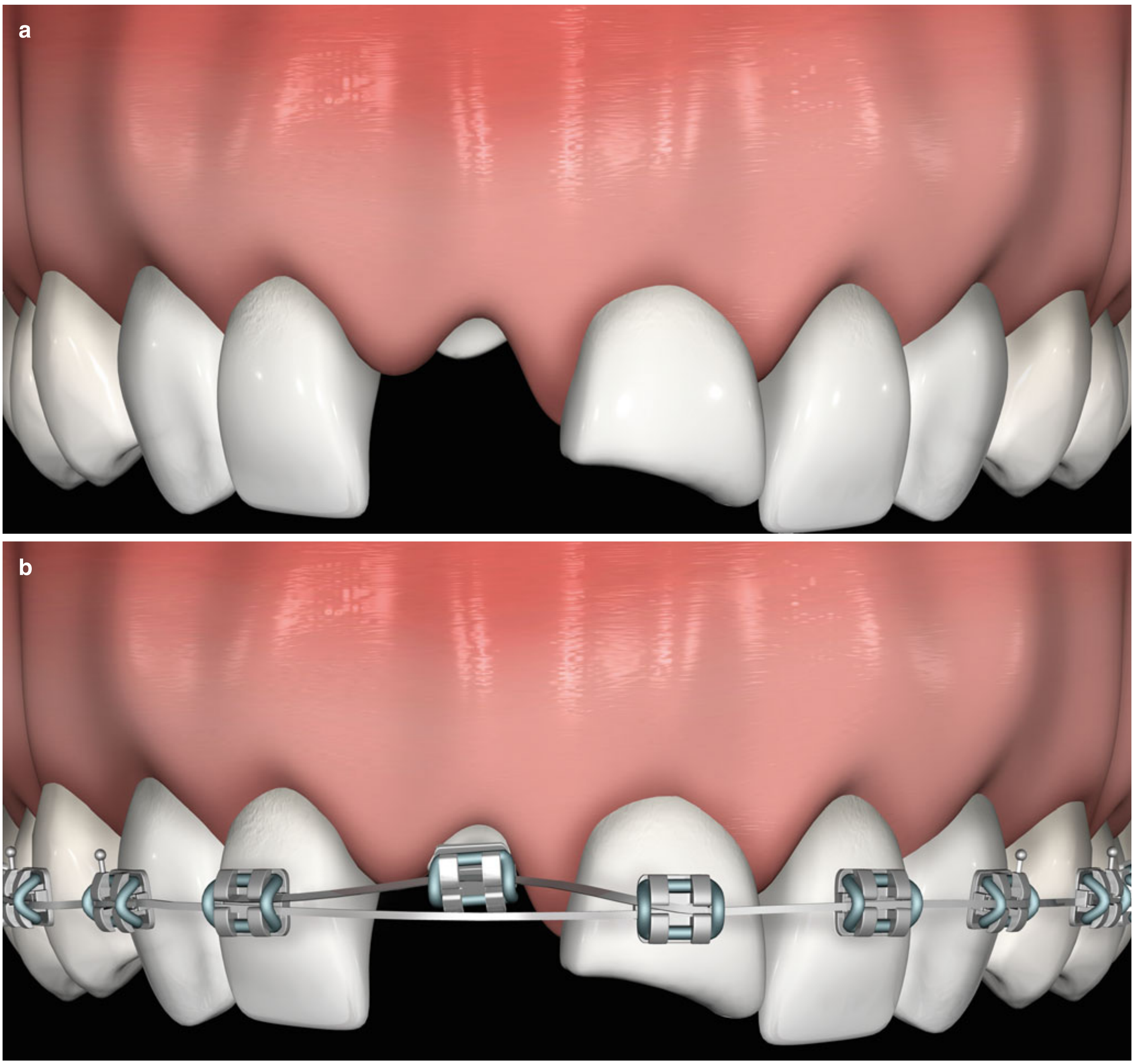

Fig. 5.5 Orthodontic tooth extrusion associated to fiberotomy in esthetic areas. Baseline – one or more teeth presenting fractures or caries invading the biological width (**a**). Use of partial fixed orthodontic appliance – passive bonding (in the same horizontal plane) of 0.022-in. brackets from the first right bicuspid to the first left bicuspid (on the tooth to be extruded, the bracket is positioned more apically to provide an extrusive component), placement of a 0.014-in. nickel–titanium arch wire and a 0.019 × 0.025 in. stainless steel auxiliary arch used to stabilize the segmented wire (**b**)

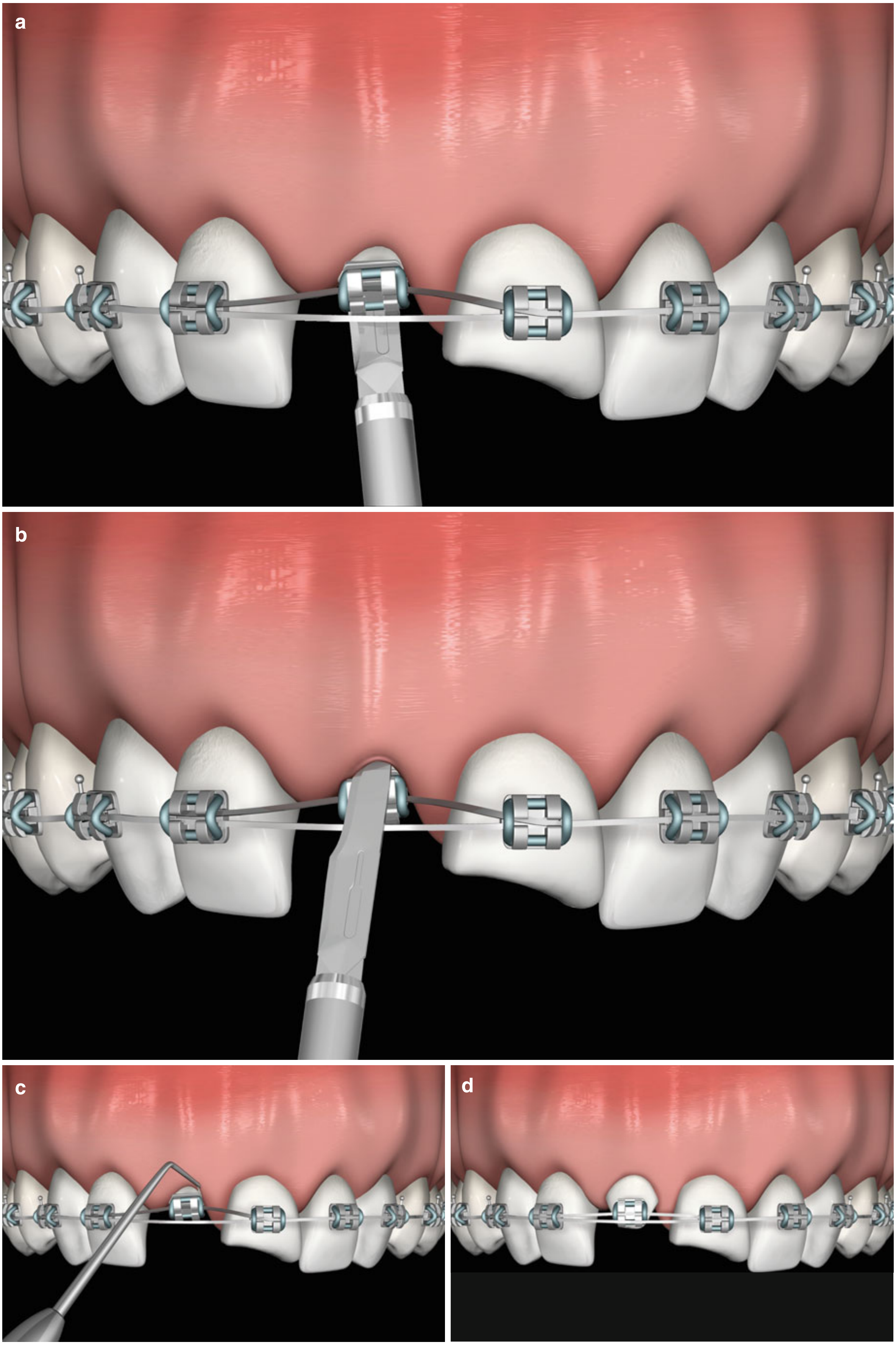

Fig. 5.6 Palatal intrasulcular incision (**a**). Buccal intra sulcular incision (**b**). Scaling and removal of supracrestal gingival fibers (**c**). Orthodontic extrusion without changes in the gingival margin (**d**)

5.1.8 Clinical Remarks: Implications for Practice and Clinical Decision-Making on Esthetical Clinical Crown Lengthening

Most of the data on crown lengthening procedures regard to studies on teeth requiring restorative approaches. Indeed, just one randomized trial on the treatment of anterior teeth exclusively due to esthetical purposes (on multiple teeth) was published up to now [13]. Overall, the outcomes accomplished by the use of esthetical clinical crown lengthening procedures, in clinical terms, may improve patients' esthetics because of the harmonization of the gingival tissues and teeth and the concomitant improved balance between lips, gingiva, and facial profiles [13]. These favorable conditions will result in more stable outcomes that may be maintained for long-term periods when the patients' full-mouth plaque score is less than 20 % [16].

The use of flapless approaches may decrease gingival height and volume, as well as lead to a minimal injury to the blood vessels and tissues, a reduced surgical morbidity, a more uniform healing process, and prevent the formation of scars [12, 13, 16]. Additionally, multidisciplinary treatment plans based on a diagnostic wax-up and a mock-up may guide the surgical procedure, reduce the gingival trauma, and assist posterior prosthetic treatment planning with restorative/prosthetic laminate veneers or full crowns. For such cases, the locations of the future biological width should be anticipated. However, information on the long-term maintenance of results have not been established yet, thus the potential of tissue regrowth (specially within patients presenting a thick periodontal biotype) should be assessed during wound healing in order to establish the best time for the subsequent definitive restorative treatment when intrasulcular prosthetic margins are planned to complete the case [9, 11].

Additionally, when multidisciplinary approaches were indicated for teeth presenting color alterations, shape deformities, irregular positioning in the dental arch, inadequate contact points, cervical lesions, and excessive occlusal wear, these should be carefully planned. The establishment of a proper crown length/width ratio may improve the outcomes of surgical procedure (i.e., central incisors > canines > lateral incisors) as it may provide an improved balance between teeth and gingiva during a smile (a better distribution of the six teeth of the anterior maxillary sextant) [7]. Within treatment planning involving ceramic crowns or laminated veneers, these should present smooth and precise margins located no more than 0.5 mm into the gingival sulcus, as well as a minimum of 3 mm distance of the margins of the restorations to the alveolar bone crest should be respected to prevent gingival inflammation and periodontal attachment loss [22, 23]. Provisional dental preparations and restorations (for porcelain veneers or full crowns) may be performed approximately 30 days after surgery, whereas definitive prosthetic restorations may be fabricated after full healing of periodontal tissue (i.e., 6 months postsurgery) [6]. As a general rule, the stability of the soft tissues surrounding ceramic crowns or laminated veneers will be directly linked to the health of periodontal tissues (e.g., lack of plaque-induced periodontal diseases), to the minimum trauma during intrasulcular margin placement and gingival displacement procedures, to the quality of provisional restorations, to the complete removal of excess of temporary and final cements, and the wait for the proper follow-up healing period after surgery before installing the definitive restorations [22].

Finally, the orthodontic extrusion may improve the esthetic crown lengthening as well. It should be performed based on clinical and radiographic data obtained at initial examinations, as well as it should be kept in mind that these may not provide an exact measurement of the amount of tooth/root to be extruded. When orthodontic extrusion was associated to circumferential fiberotomy, it does not lead to significant changes in the gingival and osseous tissues' anatomy. Conversely, conventional orthodontic extrusion (without fiberotomy) may improve the amount of soft tissue in interproximal areas and favor the achievement of better gingival contours when associated to crown lengthening surgery (Figs. 5.7, 5.8, 5.9, 5.10, 5.11, 5.12, 5.13, and 5.14).

Fig. 5.7 Case I – 8 (**a**–**n**) Esthetical clinical crown lengthening of maxillary anterior segment. Baseline – gingiva–anatomic crown relationship type I (**a**, **b**). Checking crown length on central incisors (**c**). Checking crown length of lateral incisor (**d**). Rechecking of clinical length of central incisors after removal of gingival collar (**e**). Rechecking of clinical length of lateral incisors after removal of gingival collar (**f**), alveolar crest–cementoenamel junction relationship subtype B (**g**). Osseous contour after osteotomy and osteoplasty procedures (**h**). Flap positioned and sutured apically (**i**). Flap positioned and sutured apically (**j**). Smile appearance before (**k**) and after treatment (**l**) 3 months follow-up (**m**, **n**)

Fig. 5.7 (continued)

Fig. 5.8 Case II (**a**–**l**) Esthetical clinical crown lengthening of maxillary anterior segment. Baseline – gingiva–anatomic crown relationship type I (**a**, **b**). Osseous contour before osteotomy and osteoplasty procedures (**c**). Alveolar crest–cementoenamel junction relationship subtype B (**d**). Osseous contour after osteotomy and osteoplasty procedures (**e**). Change of alveolar crest–cementoenamel junction relationship to subtype A (**f**). Two weeks follow-up – immediately after suture removal (**g**). Three months follow-up (**h**). Baseline smile appearance (**i**). Final smile appearance (**j**). Gingival anatomy adjacent to upper incisors at 4 months follow-up (**k**), 4 months follow-up (**l**)

Fig. 5.8 (continued)

Fig. 5.9 Case III 10 (**a**–**j**) – Esthetical clinical crown lengthening of maxillary anterior segment. Baseline – gingiva–anatomic crown relationship type I (**a**, **b**). Incisions performed and gingival collar delimited (**c**). Clinical aspect during osteotomy and osteoplasty procedures (**d**). Flap positioned and sutured apically (**e**). Flap positioned and sutured apically(**f**). Smile appearance before surgery (**g**). Smile appearance after surgery – last follow-up (**h**). Four months follow-up (**i**, **j**)

Fig. 5.10 Case IV 11 (**a**–**h**) – Esthetical clinical crown lengthening of maxillary anterior segment. Baseline (**a**). After intrasulcular incision – no internal beveled incision was performed (**b**). Osseous contour at the central incisions (**c**). Osseous contour at the left lateral incisor (**d**). Osseous contour at the right lateral incisor (**e**). Flap sutured (**f**). Three months follow-up (**g**, **h**)

Fig. 5.11 Case V – Esthetical clinical crown lengthening of maxillary anterior segment. Baseline (**a**). Osseous contour after osteotomy and osteoplasty (**b**). Flap positioned and sutured apically (**c**). Fifteen days follow-up (**d**). Three months follow-up (**e**). Six months follow-up (**f**–**h**)

Fig. 5.12 Case VI – Esthetical clinical crown lengthening of maxillary incisors, baseline (**a**, **b**). Gingival collar delimited by the incisions (**c**). Gingival collar removed (**d**). Osseous contour before osteotomy and osteoplasty procedures (**e**). Osseous contour after osteotomy and osteoplasty procedures (**f**). Flap apically positioned and sutured (**g**). Fifteen days follow-up (**h**). Smile appearance 3 months after surgery (**i**)

Fig. 5.13 Case VIII 14 (**a**–**l**) – Esthetical clinical crown lengthening of anterior maxillary teeth (**a**). Crown length: right canine (**b**); right lateral incisor (**c**), right central incisor (**d**), left central incisor (**e**), left lateral incisor and (**f**) left canine (**g**). Flap positioned and sutured apically (**h**), 6 weeks follow-up (**i**–**k**), 5 years follow-up (**l**)

Fig. 5.13 (continued)

Fig. 5.14 Case VIII – Esthetical clinical crown lengthening of anterior teeth to the end of orthodontic treatment. Gingiva–anatomic crown relationship type I (**a**). Estimation of the amount of soft tissue overgrowth formed (**b**). Inadequate gingival contour (**c**). Assessment of the amount of soft tissue to be removed (**d**). Amount of soft tissue removed with gingivectomy – external beveled incision (**e**). Clinical aspect after gingivectomy (**f**). Gingival contour after osteotomy and osteoplasty (**g**). One month follow-up (**h**). Before gingivectomy with external beveled incision (**i**) one week follow-up (**j**), 15 days follow up - lower arch (**k**), baseline smile (**l**), 45 days follow-up (**m**, **n**), 15 days follo-up (**o**)

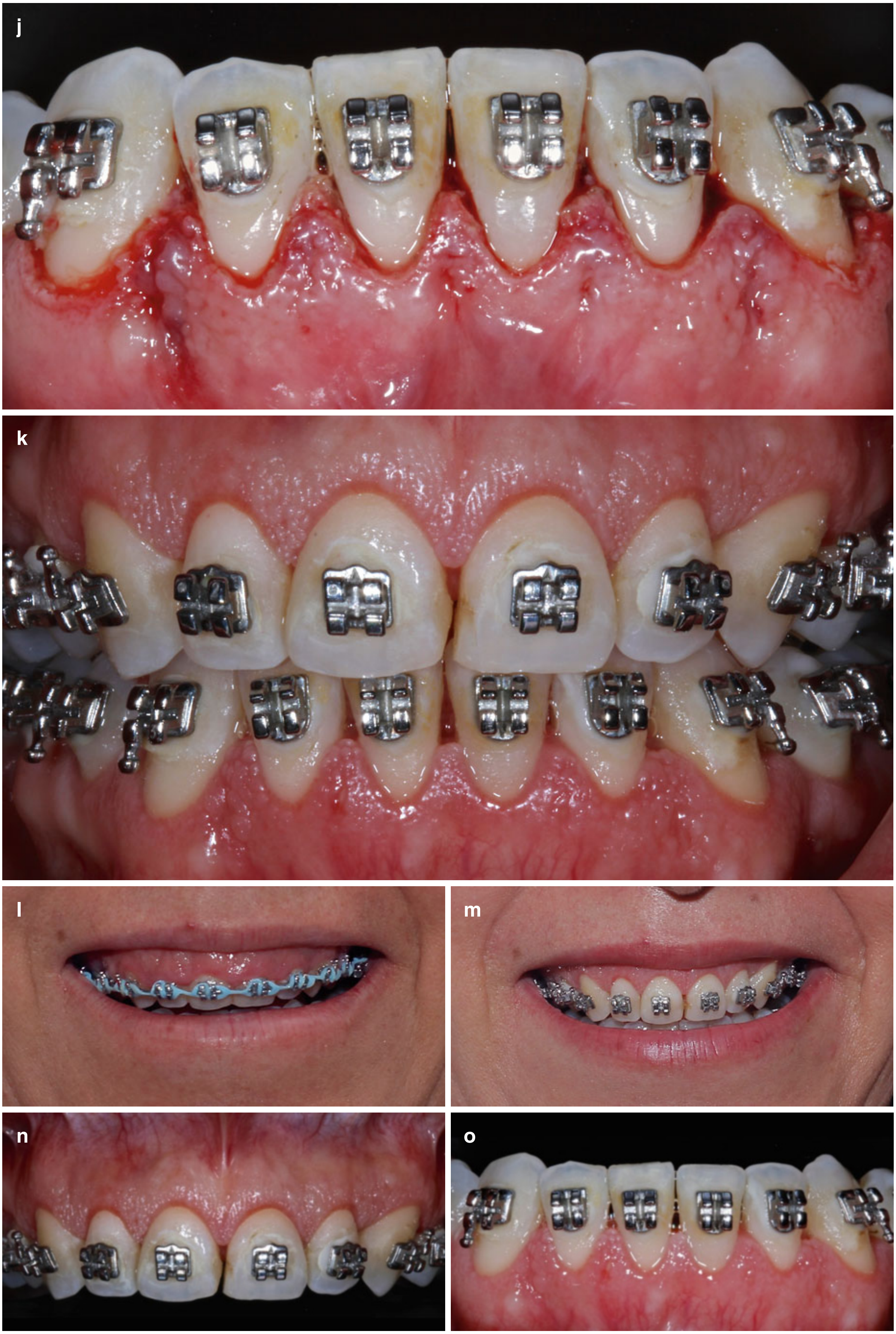

Fig. 5.14 (continued)

Critical Summary of the Results of Systematic Reviews

Systematic review conclusions: There is no information of systematic reviews concerning the use/effects of esthetical clinical lengthening procedures.

Summary of the review and critical remarks: Most of the literature on this topic is derived from case reports/series [12, 16]. In fact, only one randomized clinical trial is reported in the base of evidence:

Ribeiro et al. [13] – The use of open flap or flapless procedures for esthetical clinical crown lengthening provided similar and stable clinical outcomes 12 months postsurgery.

Evidence quality rating/strength of recommendation (ADA 2013) [21]: Expert opinion for – the single RCT available favors providing this intervention, but evidence is lacking, and expert opinion guides this recommendation.

5.2 Lip Repositioning

5.2.1 Historical Notes and Introductory Remarks

Several periodontal, restorative, and maxillofacial procedures have been associated to the treatment of excessive gingival display or "gummy smile" based on the etiologic origin of the condition [24]:

- Delayed tooth eruption – treatment is based on crown lengthening procedures such as gingivectomy and apically positioned flap associated to osteotomy/osteoplasty. [24]
- Compensatory tooth eruption of the upper incisors and canines due to excessive incisal wear/attrition associated to coronal migration of the soft and hard periodontal tissues – improvements in the smile may be achieved by orthodontic intrusion of the upper anterior teeth [24].
- Excessive vertical growth of the maxilla leading to an enlargement of the vertical dimensions of the mid face – usually, treatment involves orthognathic surgery via maxillary impaction (Le Fort I osteotomy) [24].
- Maxillary lip moving in an apical direction upon smile that leads to upper teeth exposure and excessive gingival display – achievement of a normal gingival display may be achieved by lip reposition surgery [24].

With respect to the last etiologic origin, the use of lip repositioning techniques was first described in 1973 by Rubinstein and Kostianovsky [25]. This procedures is based on the removal of a mucosal strip from the upper buccal vestibule in order to limit the retraction of the upper lip elevator muscles, such as the *levator labii superioris*, *levator anguli oris*, *orbicularis oris*, and the *zygomaticus minor* [26]. The clinical application of this plastic approach as part of periodontal treatment has been recently described in the literature mostly by series of case reports and case series [1, 24, 26–30].

5.2.2 Type of Condition to Be Indicated

Excessive gingival display caused by hyperactive upper lip moving

5.2.3 Type of Condition Not to Be Indicated

Presence of a narrow width of keratinized attached gingiva or excessive vertical growth of the maxilla. The use of this procedure in patients lacking attached gingiva may create a shallower and narrower vestibule, as well as it may hinder maxillary dental biofilm control [29, 30].

5.2.4 Basics of the Surgical Sequence

The surgical sequences depicted below are based on the modified protocol proposed by Silva et al. [29]. After local infiltrative anesthesia of the area is reached, a partial-thickness horizontal incision is performed 1 mm coronally to the mucogingival line, from the first molar region to the midline frenum of the upper lip. At the ends of hat incision, 10–12 mm vertical incisions should be performed in an apical direction and connected by another incision parallel to the first horizontal incision made. The band (strip) of tissue outlined should be removed using a superficial partial-thickness dissection. In the contralateral side, the sequence should be repeated. After that, the margins of the area of exposed connective tissue should be sutured with 5-0 or 6-0

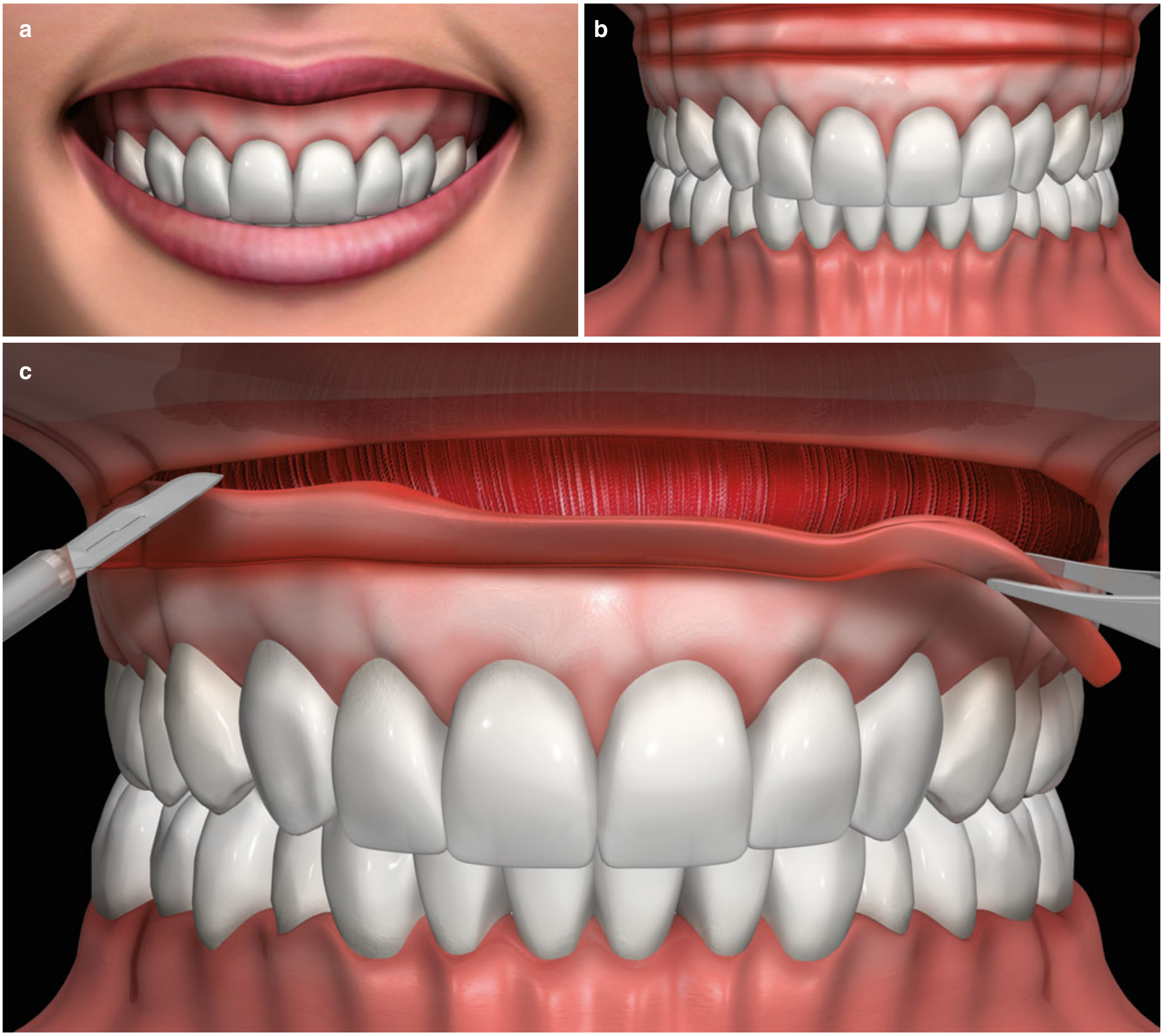

Fig. 5.15 (**a**–**c**) Schematic representation of the lip repositioning technique. Gummy smile (**a**). Incision outline of the epithelial layer to be removed (**b**). Removal of the epithelial layer by a partial-thickness flap (**c**)

Teflon or nylon sutures (Figs. 5.15 and 5.16). The sutures are removed 14 days after surgery.

In addition, patients should be prescribed 0.12 % chlorhexidine gluconate and instructed to rinse gently twice a day for 1 week and to "minimize lip movement when smiling or talking during the first 2 weeks postoperatively" [29]. Overall, like all other periodontal plastic surgery procedures, analgesics, anti-inflammatory drugs, and/or systemic antibiotics are prescribed if needed, as well as no adverse effects are expected in the treated sites.

Fig. 5.16 (**a**–**c**) Expected aspect after removal of the epithelial layer (**a**). Surgical wound suture (**b**). Expected final outcome (**c**)

5.2.5 Clinical Remarks: Implication for Practice and Decision-Making on Lip Repositioning

Like any other esthetical procedure, it is important to note that lip repositioning should be performed only in patients concerned with their smile and seeking for treatment. In the short term, it has demonstrated satisfactory outcomes when performed within patients presenting a "gummy smile." It is important to note that the percentage of success related to the use of this procedure seems directly associated to its correct indication/prescription (only for patients with excessive gingival display caused by hyperactive upper lip), as well as surgical/restorative approaches may be used concomitantly to improve the final esthetical outcomes (Figs. 5.17, 5.18, 5.19, and 5.20).

Fig. 5.17 Case I 18 (**a**–**i**) – Lip repositioning procedure for treating gummy smile. Baseline (**a**). Presence of a wide band of keratinized width (**b**). Delimitation of the epithelial layer to be removed (**c**). Surgical site after removal of the partial-thickness epithelial layer (**d**). Surgical site after removal of the partial-thickness epithelial layer (**e**). Surgical site ready for lip suture (**f**). Upper marginal connective tissue margin sutured to the lower margin (**g**). Upper marginal connective tissue margin sutured to the lower margin – frontal view (**h**). Final result after wound healing (**i**)

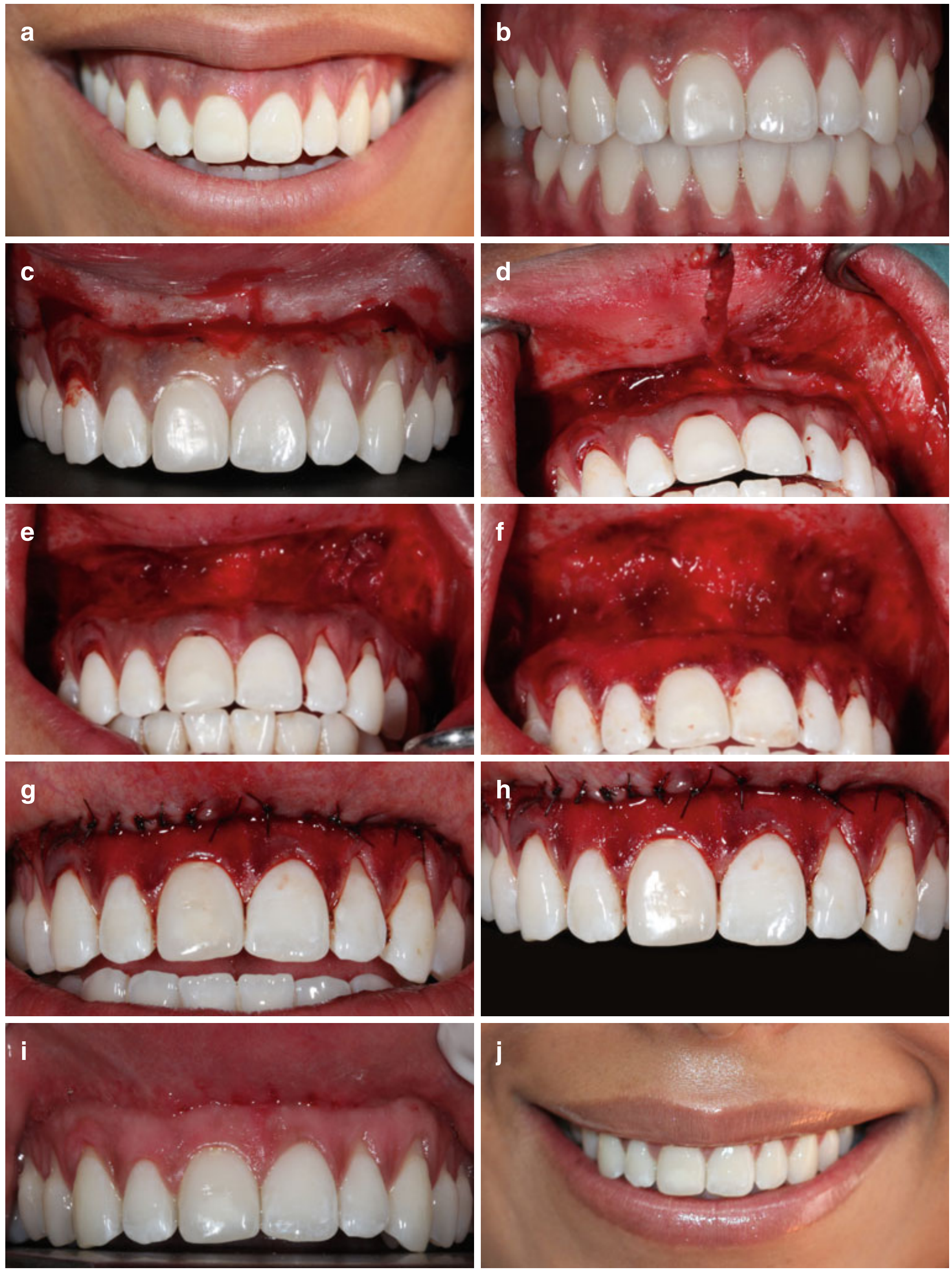

Fig. 5.18 Case II 19 (**a**–**j**) – Lip repositioning procedure for treating gummy smile. Baseline (**a**). Identification of the area to be treated (**b**). First horizontal incision 1 mm apical to the mucogingival junction (**c**). Removal of the partial-thickness epithelial layer (**d**). Epithelial layer removed (**e**). Surgical site ready to be sutured (**f**). Upper connective tissue margin sutured to the lower one (**g**). Assessment of lip tension (**h**). Clinical aspect after suture removal (**i**). Final result after wound healing (**j**)

Fig. 5.19 Case III 20 (**a**–**f**) – Lip repositioning procedure for treating gummy smile. Baseline (**a**). Partial-thickness epithelial layer removed (**b**). Extension of the epithelial layer removed (**c**). Upper connective tissue margin sutured to the lower one (**d**). Assessment of lip tension (**e**). Final outcome after healing of the surgical wound (**f**)

Fig. 5.20 Case IV 21 (**a**–**d**) – Lip repositioning procedure for treating gummy smile. Baseline (**a**). Partial-thickness epithelial layer removed (**b**). Connective tissue margins sutured (**c**). final result after healing of the surgical wound (**d**)

Critical Summary of the Results of Systematic Reviews

Systematic review conclusions: There is no information of systematic reviews concerning the use/effects lip repositioning surgery.

Summary of the review and critical remarks: Most of the literature on this topic is derived from case reports/series [1, 24, 26–28, 30]. There is only one prospective, single-arm study in the base of evidence:

Silva et al. [29] – The use of the modified lip repositioning procedure provided in high levels of patient satisfaction as a result of the reduction of the amount of gingival display caused by hyperactive upper lip.

Evidence quality rating/strength of recommendation (ADA 2013) [21]: Expert opinion for – the single prospective study available favors providing this intervention, but evidence is lacking, and expert opinion guides this recommendation.

5.3 Gingival Depigmentation

5.3.1 The Issue of "Darkened Gingiva" or "Black Gums"

As previously described in Chap. 2, the oral epithelium is formed by four layers (i.e., basal, spinous, granular, and cornea), and within each one of them, different cells such as keratinocytes, melanocytes, as well as Langerhans, Merkel, and inflammatory cells are present [31]. Within the basal cell layer, the activity of melanocytes in transforming tyrosine (i.e., a proteinogenic amino acid) [32] to melanin regulates the amount of this pigment produced and stored in the melanosomes [33–35].

Despite not considered the unique source of gingival pigmentation, melanin is certainly the most prevalent and relevant [35, 36]. Complementary, more or less genetic predisposition/expression of this pigment [37], and its effect on the color of the gingival tissues (especially the gingiva), is certainly not associated to a health or disease status [35].

5.3.2 The Depigmentation of the Gingiva: "Why and How"?

The totality of patients' complaints concerning "darkened gingiva" or "black guns" relates to esthetic concerns, mainly among subjects presenting high smile lines [35]. Outcomes reported in base of evidence showed that gingival depigmentation may be reached by procedures based on scalpel surgery, electrosurgery, cryosurgery, gingival grafts as well as mechanical, chemical, or laser epithelial abrasion [35].

Just as a historical timeline, the following procedures have been proposed over the last decades for gingival depigmentation:

- Hirschfeld and Hirschfeld [38] – chemical abrasion
- Dummett and Bolden [39] – scalpel surgery
- Tal et al. [40] – cryosurgery
- Farnoosh [41] – mechanical abrasion ("deepithelialization") using high-speed handpiece and diamond burs
- Deepak et al. [42] – electrosurgery
- Trelles et al. [43] – Lasers
- Tamizi et al. [44] – gingival grafts

5.3.3 Type of Condition to Be Indicated

Treatment of melanotic spots/clinical melanin pigmentation of soft periodontal tissues (gingiva) in patients with esthetic demands

5.3.4 Type of Condition Not to Be Indicated

None/lack of esthetic concern

5.3.5 Basics of the Surgical Sequence Using Scalpel Surgery or Mechanical/Laser Abrasion

Following local anesthesia, the epithelium over the pigmented area is removed by means of a partial-thickness flap that should be raised and excised, or via mechanical abrasion (with cutting hand instruments or diamond burs and handpieces) or surgical lasers (Fig. 5.21). For both procedures, bleeding may be controlled using pressure pack with sterile gauze, and the area cleaned with sterile saline solution as well. After bleeding control, the exposed depigmented surface should be covered with periodontal dressing for 1 week since suture is not performed. In addition, patients should be instructed to avoid mechanical contact/trauma with area and dressing removal before the period established. Patients should be prescribed 0.12 % chlorhexidine gluconate and instructed to rinse gently twice a day for 2–3 weeks, or until safe and comfortable toothbrushing can be performed. Overall, analgesics and anti-inflammatory drugs are prescribed to control pain, as well as antibiotics may be used due to the great area of connective tissue exposure. Except for pain, no adverse effects are expected in the treated sites, but bleeding caused by trauma/contact may occur if the dressing is removed earlier than recommended.

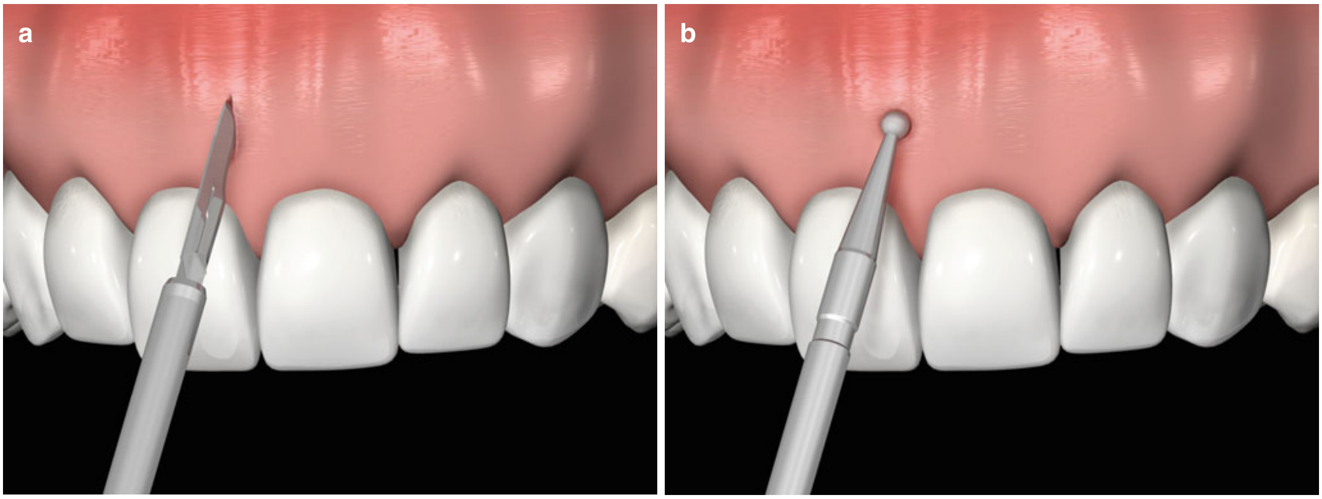

Fig. 5.21 (**a**, **b**) Gingival depigmentation by mechanical abrasion. Scraping using a surgical blade (**a**). Scraping using a handpiece and bur (**b**)

5.3.6 Clinical Remarks: Implications for Practice and Clinical Decision-Making on Gingival Depigmentation

The use of gingival depigmentation procedures may be safely applied within patients seeking for improvements in gingival color. Most of the melanotic spots/melanin pigmentation of the gingiva may be eliminated, but repigmentation may occur specially at sites treated with bur abrasion (9.0 % of recurrence ratio) or by scalpel surgery (4.2 %) [35]. For the other approaches, the rates of recurrence were of 2.0 % for gingival grafts, 1.2 % for laser surgery, 0.7 % for electrosurgery, and 0.3 % for cryosurgery [35]. Because of the nonfunctional nature of this treatment modality, it should be interesting to define the approach of choice/treatment modality based on the clinicians' skills and the cost-benefit for the patient (Figs. 5.22, 5.23, 5.24, 5.25, 5.26, and 5.27).

Fig. 5.22 Case I – Gingival depigmentation by laser (in collaboration with Dr. Alberto Blay). Baseline (**a, b**). Surgical laser application (**c**, **d**). Six months follow (**e**, **f**)

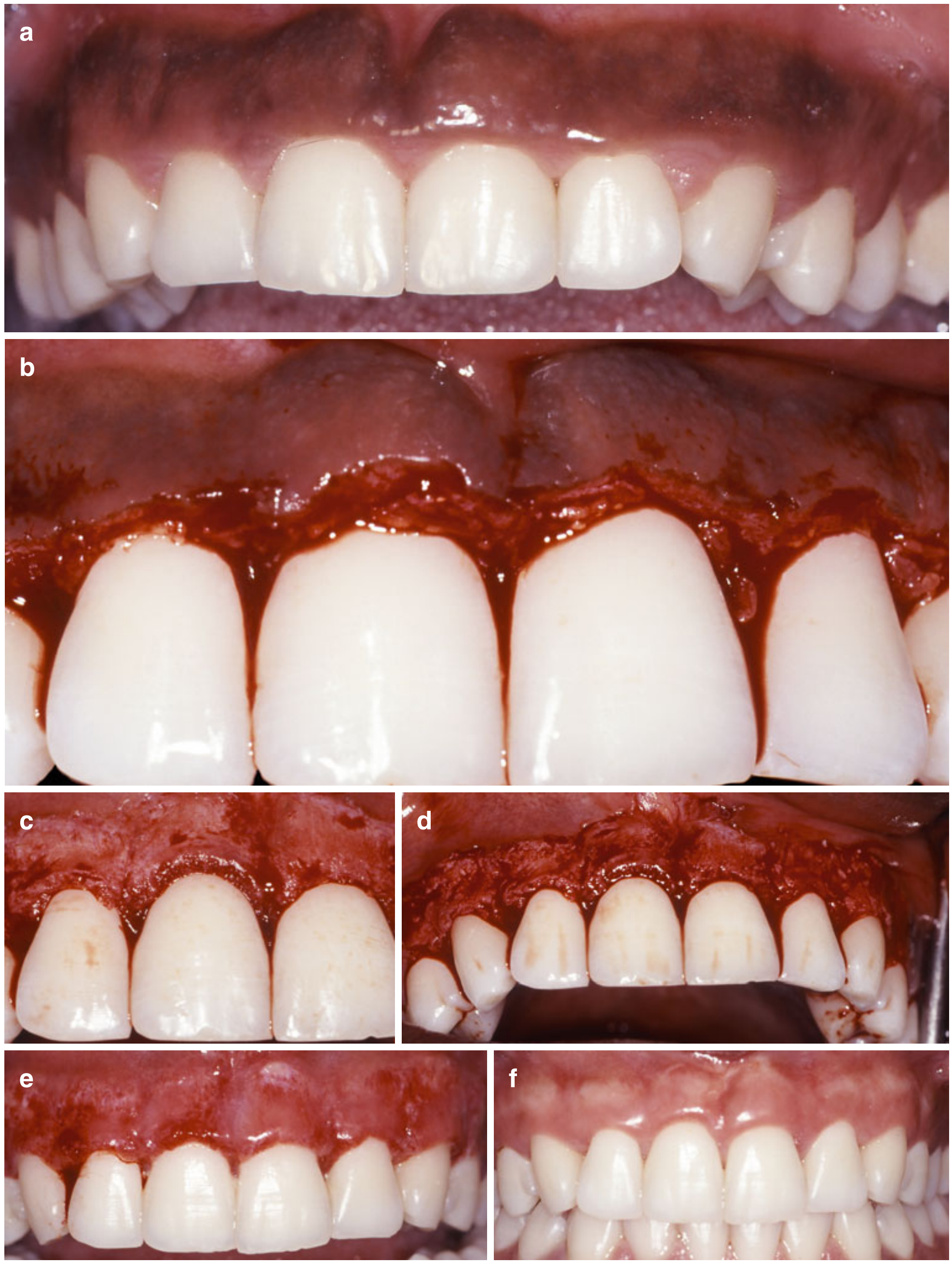

Fig. 5.23 Case II 24 (**a**–**f**) – Gingival depigmentation by scalpel surgery (epithelial removal via a partial-thickness flap). Baseline (**a**). Removal of some areas of gingival hyperplasia (**b**). Flap raising (**c**). Flap raised before the removal of the epithelial layer (**d**). One week follow-up (**e**). Six months follow-up (**f**)

Fig. 5.24 Case III 25 (**a**–**g**) – Gingival depigmentation by scalpel surgery (epithelial removal by partial-thickness flap) in a heavy smoker (>20 cigarettes a day). Baseline (**a**). Epithelial layer removed (**b**). Three weeks follow-up – moment of the second surgical procedure in the left side of the maxilla (**c**). Two months follow-up of the second surgical procedures (**d**). One year follow-up (**e**). Twenty-five years follow-up (**f**). Degree of keratinization observed at the last follow-up (**g**)

Fig. 5.25 Case IV 26 (**a**–**d**) – Gingival depigmentation via mechanical abrasion of the epithelial layer. Baseline (**a**). Mechanical abrasion performed by scrapping of the surgical blade (**b**, **c**). Three months follow-up (**d**)

Fig. 5.26 Case V 27 (**a**–**g**) – Gingival depigmentation via soft tissue grafting. Baseline (**a**). Amalgam tattoo in buccal gingiva around tooth 21 (**b**). Removal of the affected soft tissue – partial-thickness flap (**c**). Free gingival graft sutured at the area (**d**, **e**). Four months follow-up (**f**, **g**)

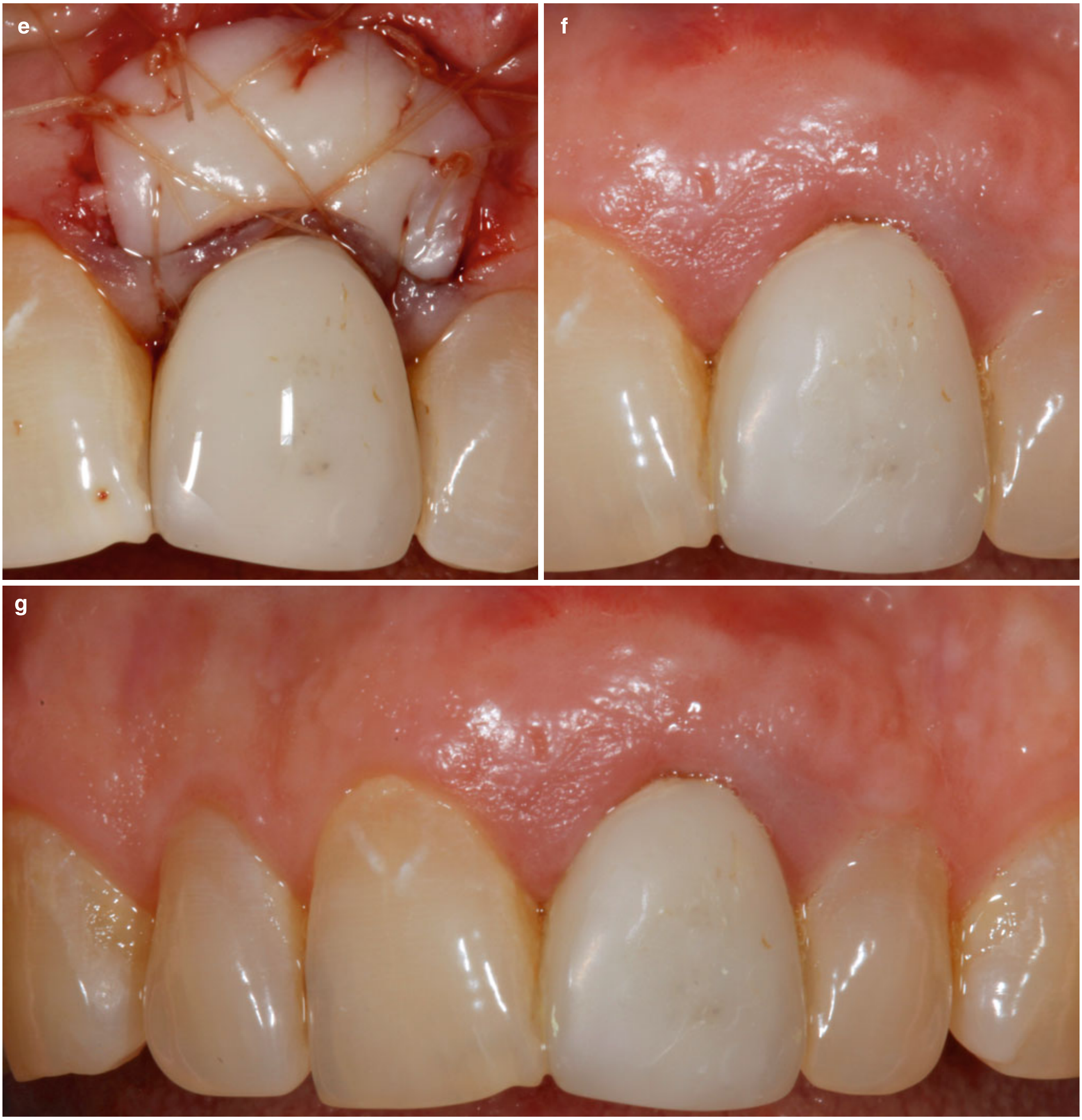

Fig. 5.26 (continued)

Fig. 5.27 Case VI 28 (**a**–**d**) – Gingival depigmentation via soft tissue grafting. Baseline (**a**). Amalgam tattoo in the gingival tissue among teeth 12 and 13 (**b**). Removal of the soft tissue containing the tattoo and suture of a subepithelial connective tissue graft (**c**). Two months follow-up (**d**)

Critical Summary of the Results of Systematic Reviews

Systematic reviews conclusions: All methods for treating gingival melanin pigmentation may be associated to some percentage of recurrence [35].

Summary of the reviews and critical remarks: The base of efficacy studies is scarce. Most of the data included in the unique SR available regard case reports/case series [35]. Regarding the repigmentation of treated sites, the outcomes of some of these studies are depicted below:

Kaur et al. [45] – 15 of the 20 patients treated with scalpel surgery presented some repigmentation of the treated sites at 9 months postsurgery.

Pontes et al. [46] – 1 of 15 and 10 of 15 sites treated with scalpel surgery + acellular dermal matrix graft or bur abrasion, respectively, presented repigmentation after 6 months. At 12 months, 8 and 15 (100 %) presented the outcome, respectively, in this RCT.

Singh et al. [47] – In this randomized study, 1 (10 %) out of the 10 treated patients presented repigmentation independently with treated sites with diode laser or cryosurgery 18 months after therapy.

Famoosh [41] – 2 (10 %) of 20 patients treated with bur abrasions presented repigmentation 20 months after treatment.

Evidence quality rating/strength of recommendation (ADA 2013) [21]: Expert opinion for – the single SRs available favors providing this intervention, but adequate evidence is lacking, and expert opinion guides this recommendation.

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Peri-implant Plastic Surgery

6

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6.1 Historical Note and Definitions

As reported in Chap. 3, two main terms may be used when planning gingival soft tissue procedures around natural teeth: mucogingival surgery and periodontal plastic surgery. However, such soft tissue augmentation or reduction procedures may be applied at implant sites as well. As a result, the term "peri-implant plastic surgery (PiPS)" appears as the application/translation of the concepts, surgical procedures, and main indications developed for the treatment of tooth soft tissue deformities to dental implants. Consequently, PiPS could be defined as the group of procedures aimed to correct aesthetical and/or functional, peri-implant soft and hard tissue deformities of acquired or pathological origin.

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6.2 Peri-implant Mucosa: "The Gingival Unit Around a Dental Implant"

Similar to the concepts established for the treatment planning of gingival tissue, there is a strong need for a solid knowledge on the peri-implant tissues. These, altogether with other local factors, such as smile line, occlusion, patient's compliance to oral hygiene, systemic factors, and professional skills/experience, will create the "roadmap" to the better prognosis of treatment available for each specific condition.

In anatomic terms, the peri-implant mucosa presents a microstructure that is similar to the gingiva around natural teeth, basically formed by oral, crevicular, and junctional epitheliums, and a connective tissue attachment (i.e., the peri-implant biologic width). As explained in Chap. 2, the biologic width (BW) is a physiologically formed and established vertical element of the dentogingival unit that comprised the sulcular and the junctional epitheliums and connective tissue attachment [1]. In comparison to gingiva surrounding natural teeth, dental implants present alike peri-implant soft tissue structures [2–4], but these may vary in length according to the implant macrostructure [4] (Fig. 6.1). For instance, two-piece implants present a microgap placed at the crestal bone level, whereas one-piece implants have no gap at this region [5].

It has been shown by studies conducted from the early 1990s to the early 2000s with external hex design that the mucosal barrier surrounding dental implants is formed by a crevicular oral epithelium ranging in mean 1.5–2 mm (but it may reach up to 4 mm) and a connective tissue barrier in mean ranging 1–2 mm [6–8]. Moreover, the oral epithelium presents an extension with a thin junctional epithelium facing the implant surface and extending about 1.64–2.35 mm from the mucosal margin (Fig. 6.1, 6.2, and 6.3) [6–8]. In general terms, the length from the marginal portion of the peri-implant mucosa to the first bone-to-implant contact has been found to be approximately 3 mm [6–8].

In addition, it was demonstrated that a 2 mm height saucer-shaped crestal bone resorption occurs (a phenomenon called as "saucerization") when submerged, 2-piece implants are used based on the location of the microgap, whereas for non-submerged, 1-piece implants, none or minimal loss may occur (Fig. 6.4) [9, 10]. It is also important to note for the 2-piece implants that such a bone change only occurs after the period of osseointegration/healing (submerged healing phase), within the first month following the placement of abutments [10]. The specific mechanisms linked to this crestal bone remodeling in 2-piece implants are not completely known [5], but these have been related in some animal model studies to microbial colonization of the microgap, micro-movements of the abutment, or an interruption of the blood supply when implants and abutments are placed transmucosally [10–12].

Around dental implants, BW determines the minimum dimensions to ensure junctional epithelium and connective tissue to attain an ideal seal and to provide protection from mechanical and external biological agents [13]. Also, an external agent invading the BW would induce a response from the epithelium that migrates beyond this agent trying to isolate it [2, 3, 13]. The resulting bone resorption produces a reestablishment of the BW dimension.

In humans, recent data showed that the biologic width around one- and two-piece retrieved implants is formed by (1) a crevicular epithelium composed of 4–6 layers of parakeratinized epithelial cells; (2) a junctional epithelium formed by 5–10 layers of epithelial cells, where the middle and apical portion of the JE consisted of 3–5 cells layers; and (3) a connective tissue (at the abutment area) containing few blood vessels (only from the supraperiosteal plexus), dense collagen fibers, and reduced number of fibroblasts (when compared to the *lamina propria* of the gingiva) oriented parallel to the longitudinal axis of the abutment [14]. Regarding to the dimensions of the biologic width around these implants, the following can be expected (Fig. 6.5):

- Mean overall dimension of the biologic width: 2.5 mm for one- and 3.3 mm for two-piece implants, where this difference was influenced by the connective tissue attachment [14].
- Sulcus depth (SD): 0.3 mm for both one- and two-piece implants [14].
- Junctional epithelium: 1.0 mm for both one- and two-piece implants [14], but it may range up to 3.4 mm [4, 15].
- Connective attachment: 1.2 mm for one- and 1.9 mm for two-piece implants [14], but it may also range to 3.4 mm [4, 15].

In addition, the biologic width formation and maturation around dental implants take place between 6 and 8 weeks of wound healing, and the connective tissue of the implant mucosa is similar in composition (cells, fiber orientation, and vascularization) to a scar tissue [16].

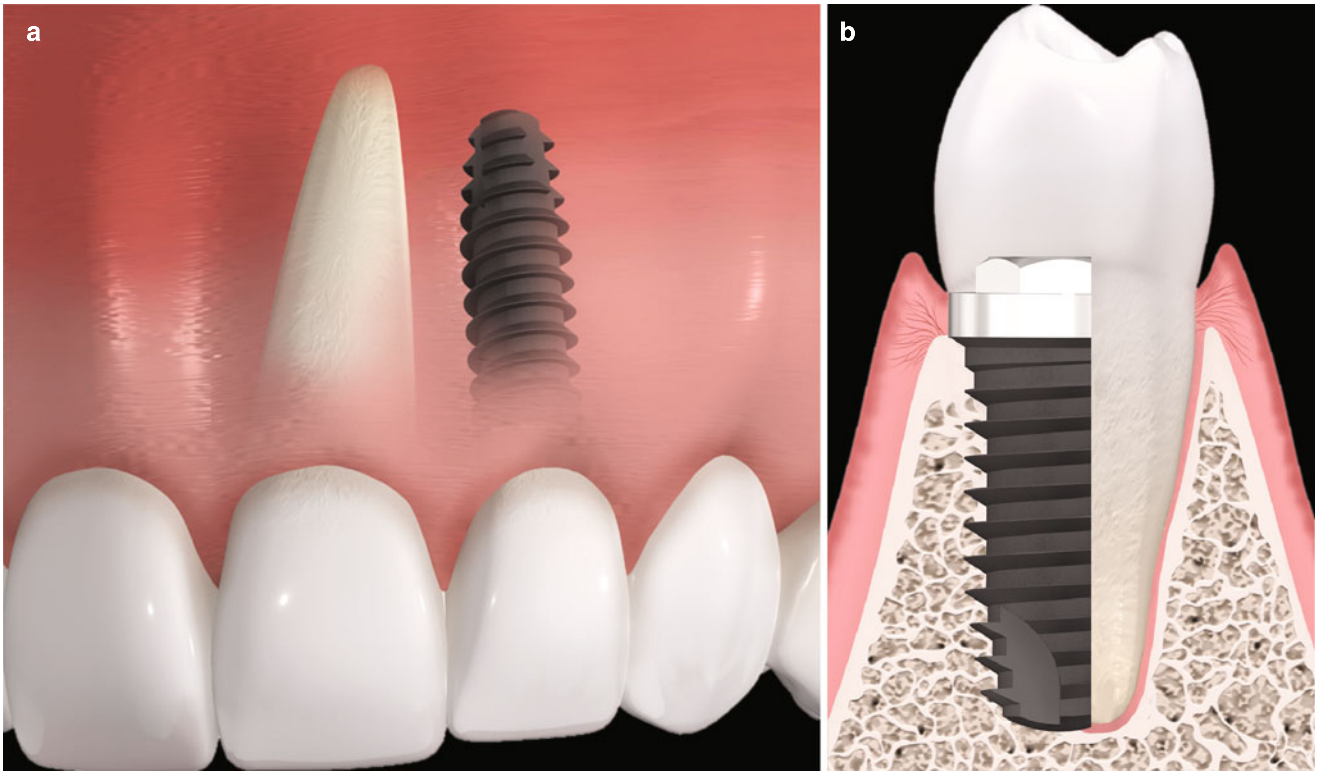

Fig. 6.1 (**a**, **b**) Biologic width – tooth versus implant: diagrammatic schematics of microscopical aspect of the peri-implant tissue in relation to the periodontal tissues

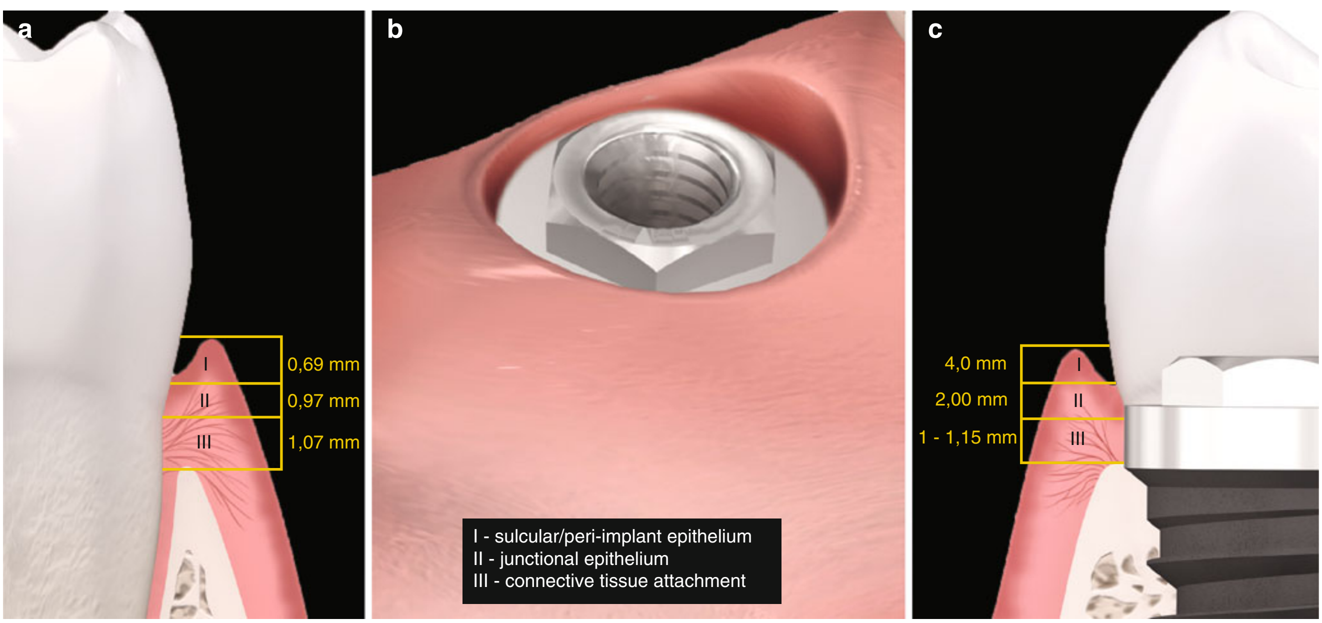

Fig. 6.2 (**a**–**c**) Biologic width of implants compared to natural teeth

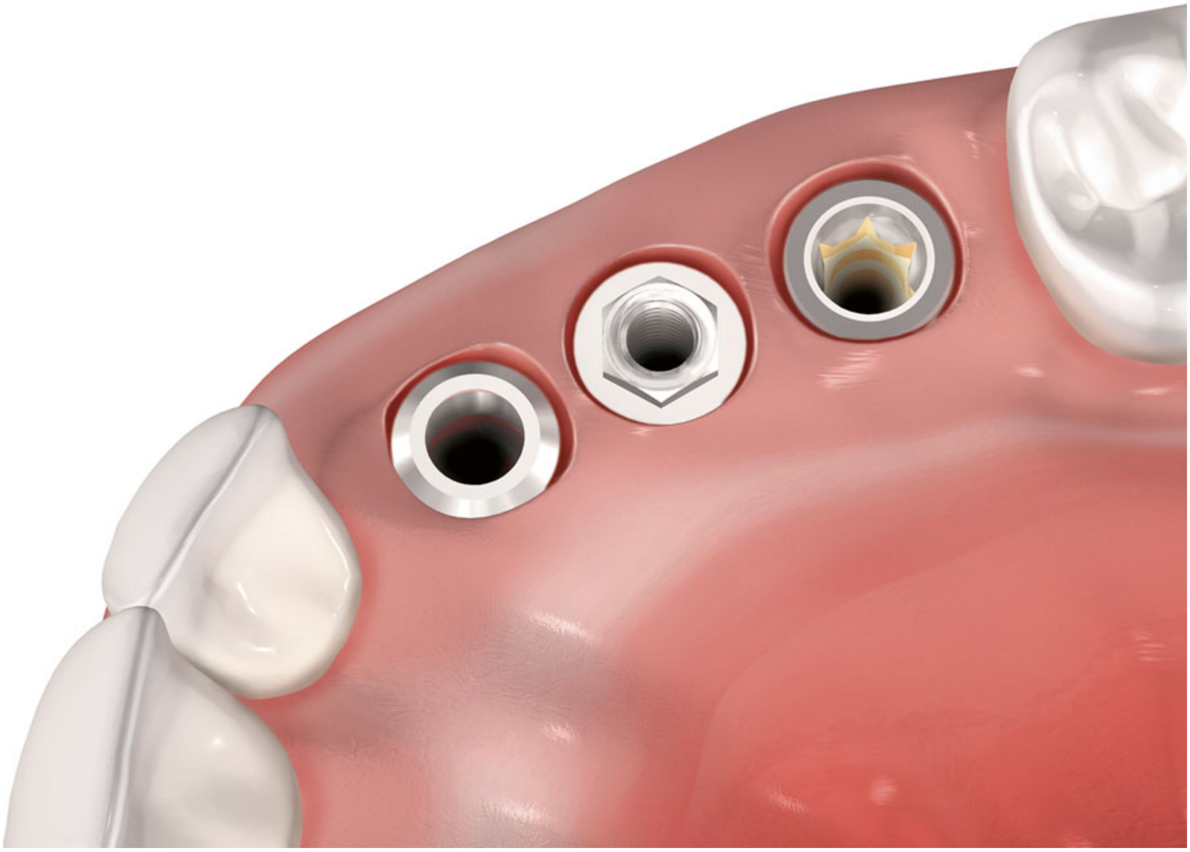

Fig. 6.3 Profile of the soft tissue mucosa at different types of implants

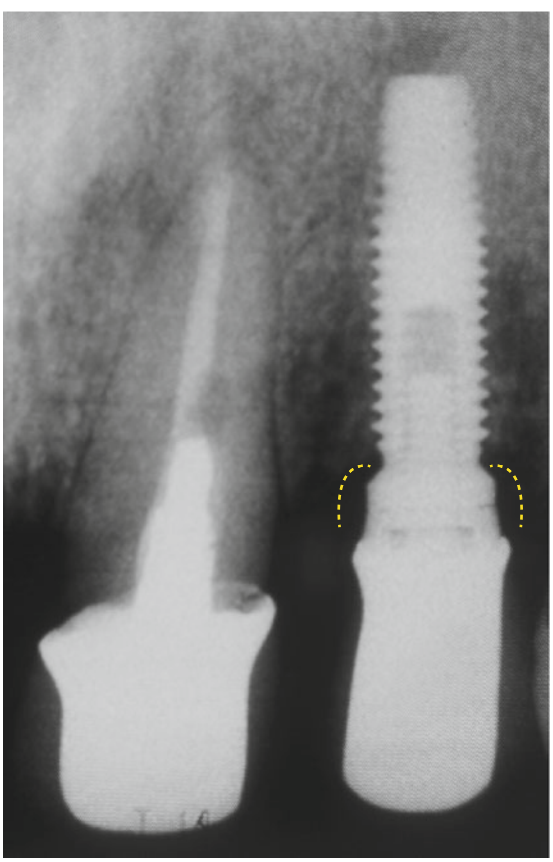

Fig. 6.4 Saucerization around an external hex implant

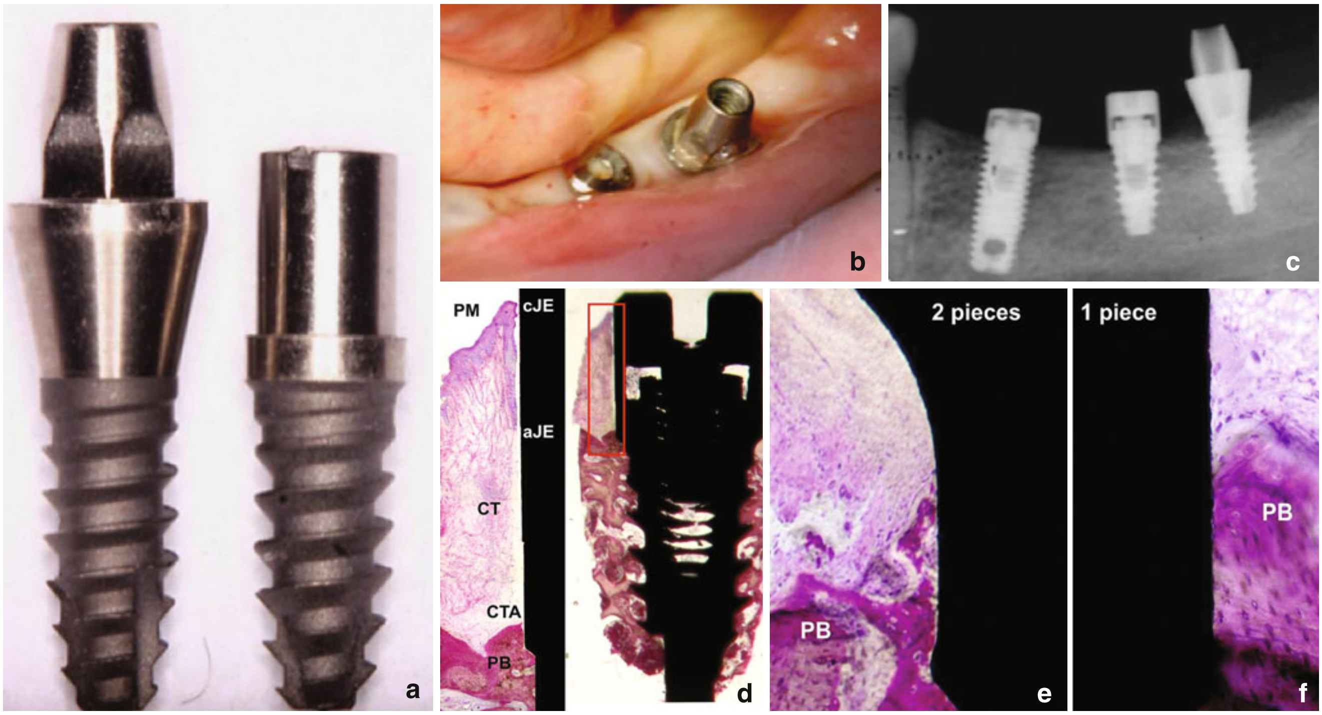

Fig. 6.5 Clinical, radiographic, and photomicrograph view of the biologic width around implants installed in human jaw: (**a**) one- and two-piece implants, (**b**) clinical, (**c**) radiographic, (**d**) photomicrograph of the ground section of the two-piece implant (20×) and the high magnification of the biologic width (100×), and (**e**, **f**) photomicrographs of the one- and two-piece implant (200×) near to the first bone to implant contact. Note the disorganization around the peri-implant bone close to the microgap on the two-piece implant. *PM* perimplant mucosa, *PB* perimplant bone, *CTA* connective tissue attachment, *CT* connective tissue, *CJE* most coronal point of junctional epithelium, *AJE* most apical point of junctional epithelium (Figure originally published at Judgar et al. [14])

6.3 Type of Defect to Be Indicated

Peri-implant sites requiring keratinized tissue width and thickness gain due to aesthetical and/or functional purposes, aesthetical treatment of alveolar ridges presenting osseous concavities or deformities, treatment of peri-implant mucosa recession, and alveolar ridge preservation (in association to bone graft materials) (Figs. 6.6, 6.7, 6.8, 6.9, 6.10, 6.11, and 6.12).

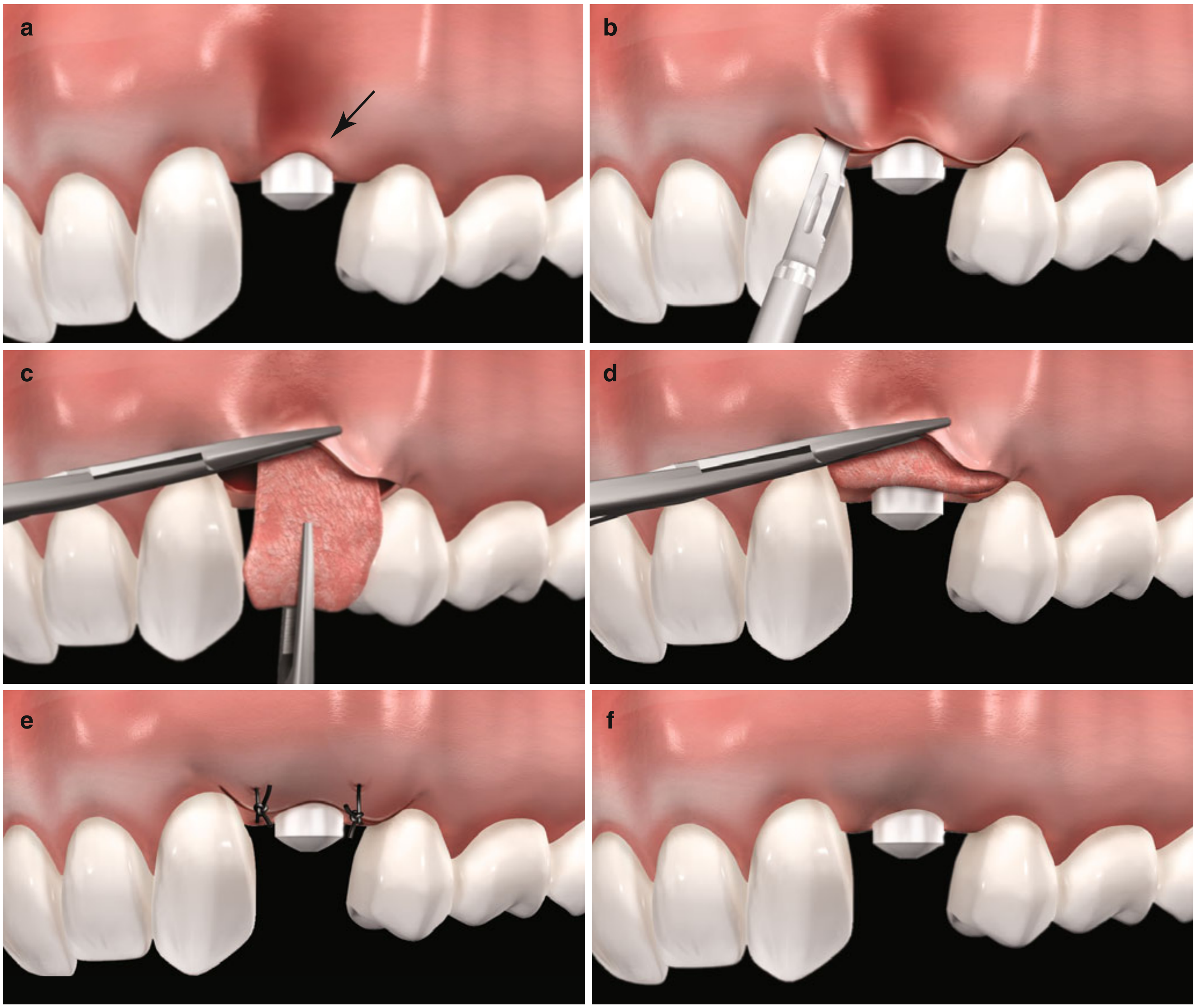

Fig. 6.6 Schematic representation of the use of subepithelial connective tissue graft in alveolar ridges previously treated with dental implants. Note the alveolar defect associated to the buccal resorption of the ridge subsequent to tooth extraction, (**a**) intrasulcular incision and rising of a partial-thickness flap, (**b**) placement of the graft through the envelope flap, (**c**) graft positioning 1–2 mm coronary to the peri-implant osseous ridge, (**d**) flap sutured covering completely the graft (**e**) expect outcome (**f**)

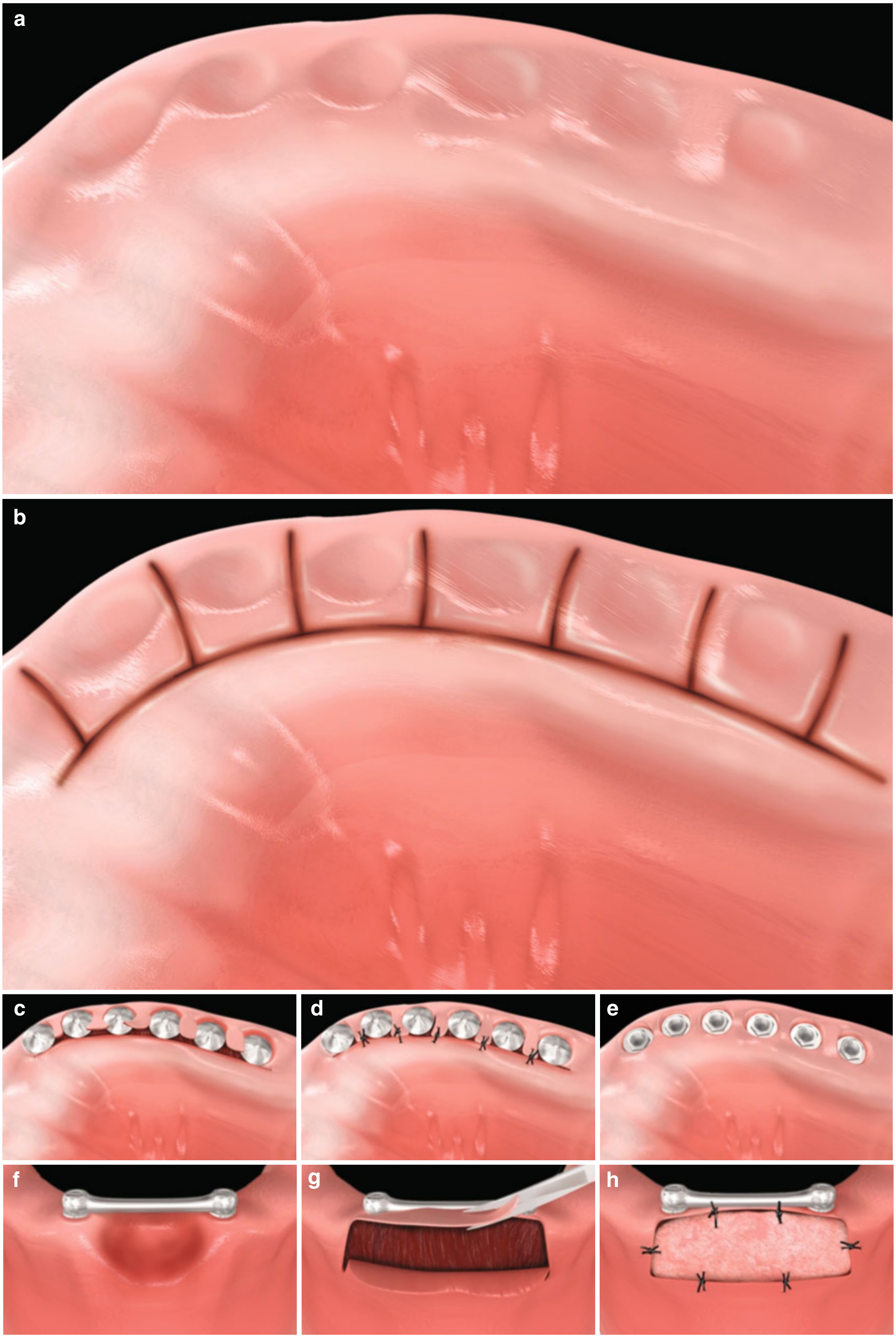

Fig. 6.7 Reopening procedures (**a**–**e**). Alveolar ridge with submerged implants (**a**). Palatal and interproximal incisions (**b**). Lateral positioning of the pedicle flaps (**c**). Suture of the pedicle flaps (**d**). Expected outcome (**e**). Removal of a soft tissue hyperplasia and gain in the keratinized tissue with free gingival graft around dental implants supporting overdentures (**f**–**h**). Excision of the hyperplasia and preparation of the recipient site for free gingival grafting (**f**, **g**). Free gingival sutured at the recipient site (**h**)

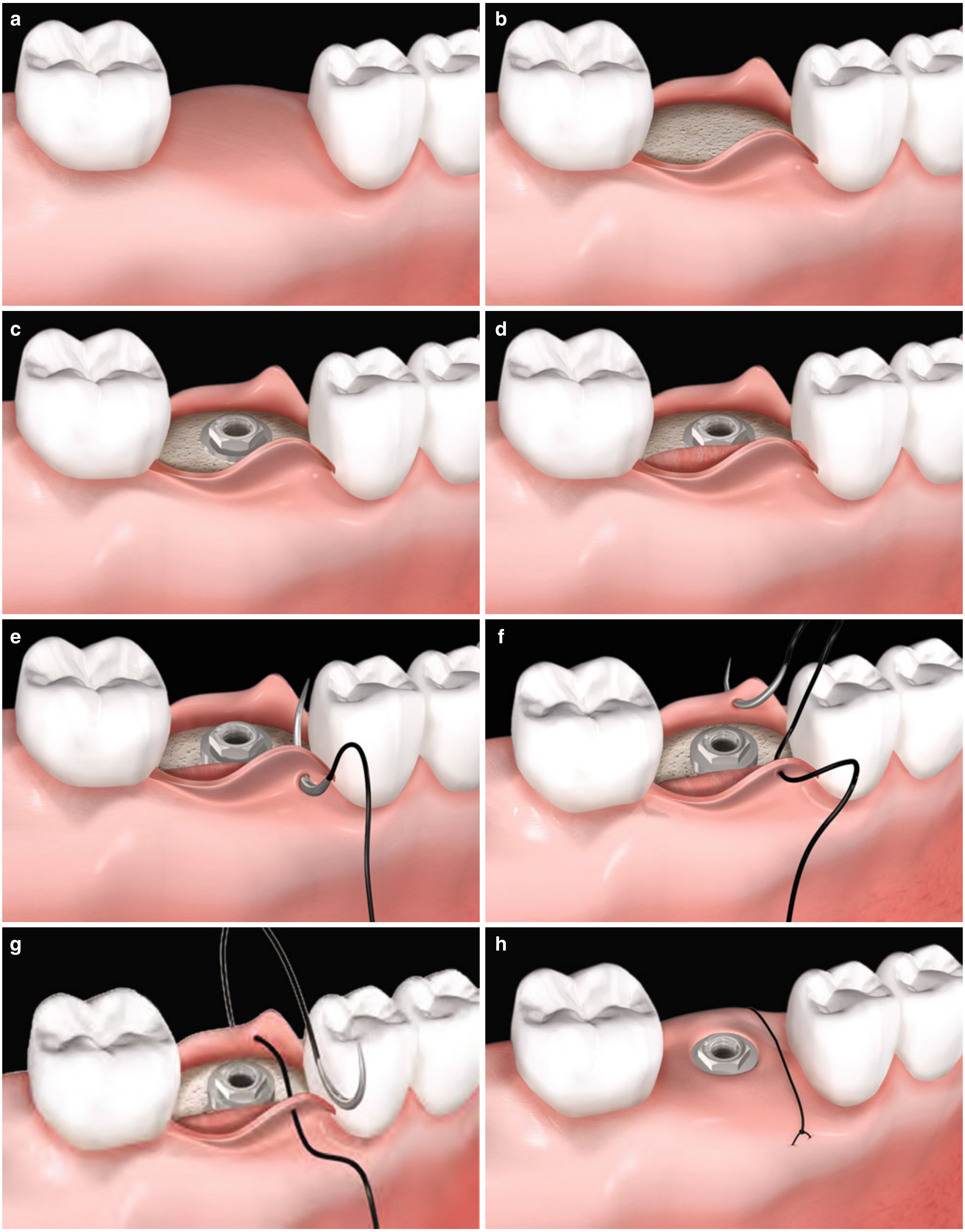

Fig. 6.8 (**a**–**h**) Soft tissue grafting concomitant to implant placement. Edentulous alveolar ridge prior to implant placement (**a**). Full-thickness flap rising (**b**). Implant installation (**c**). Placement of a soft tissue graft (**d**). Sequence of suture (**e**–**h**)

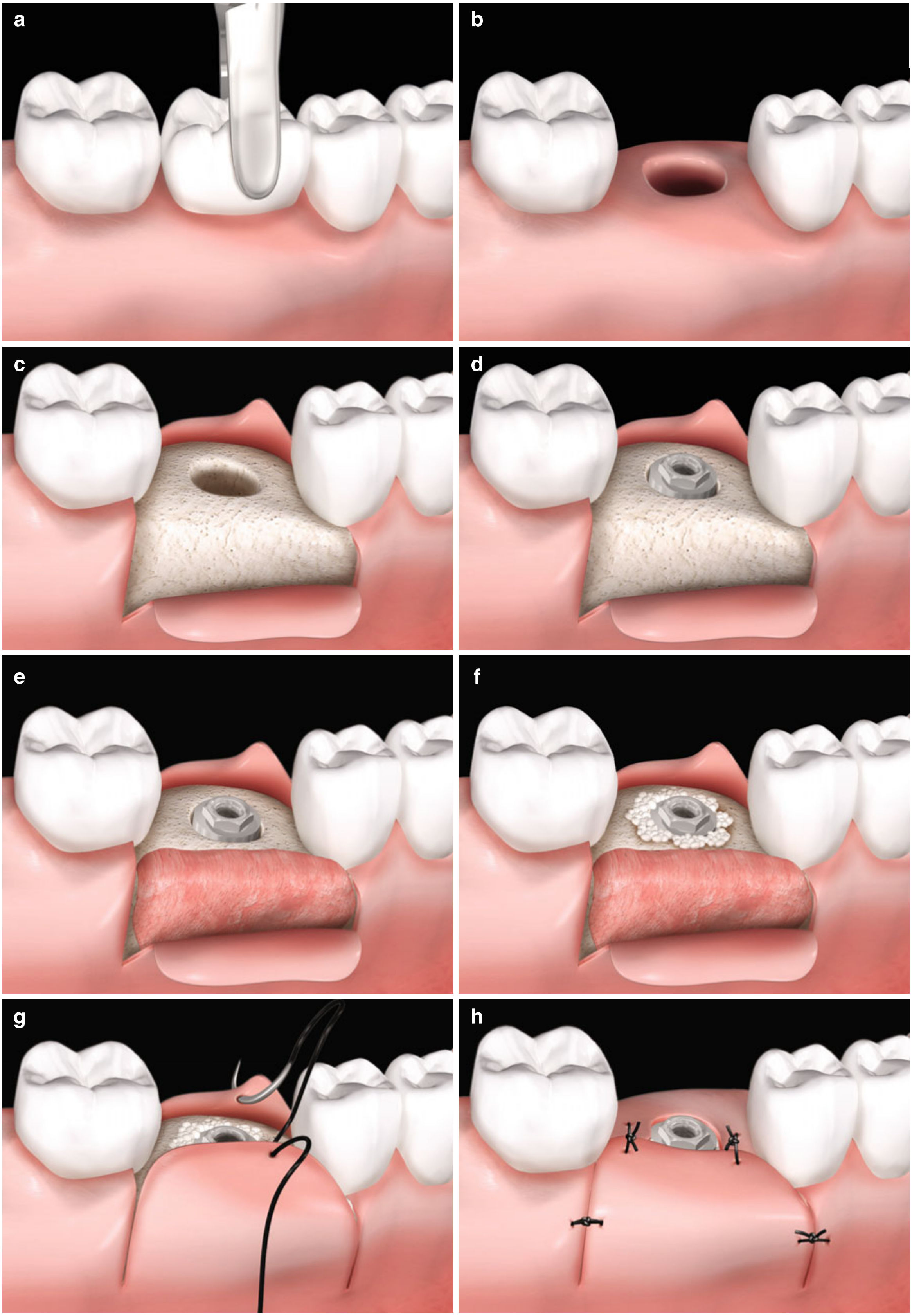

Fig. 6.9 (**a**–**h**) Soft tissue grafting concomitantly to implant placement – fresh extraction site. Tooth to be removed (**a**). Osseous cavity after tooth extraction (**b**). Full-thickness flap rising (**c**). Implant placement (**d**). Positioning of a soft tissue graft (**e**). Placement of bone substitute filling the gap between the implant surface and the bone walls at the extraction site (**f**). Suture sequence (**e**–**h**)

Fig. 6.10 **(a–d)** Other potential indications for peri-implant plastic surgery

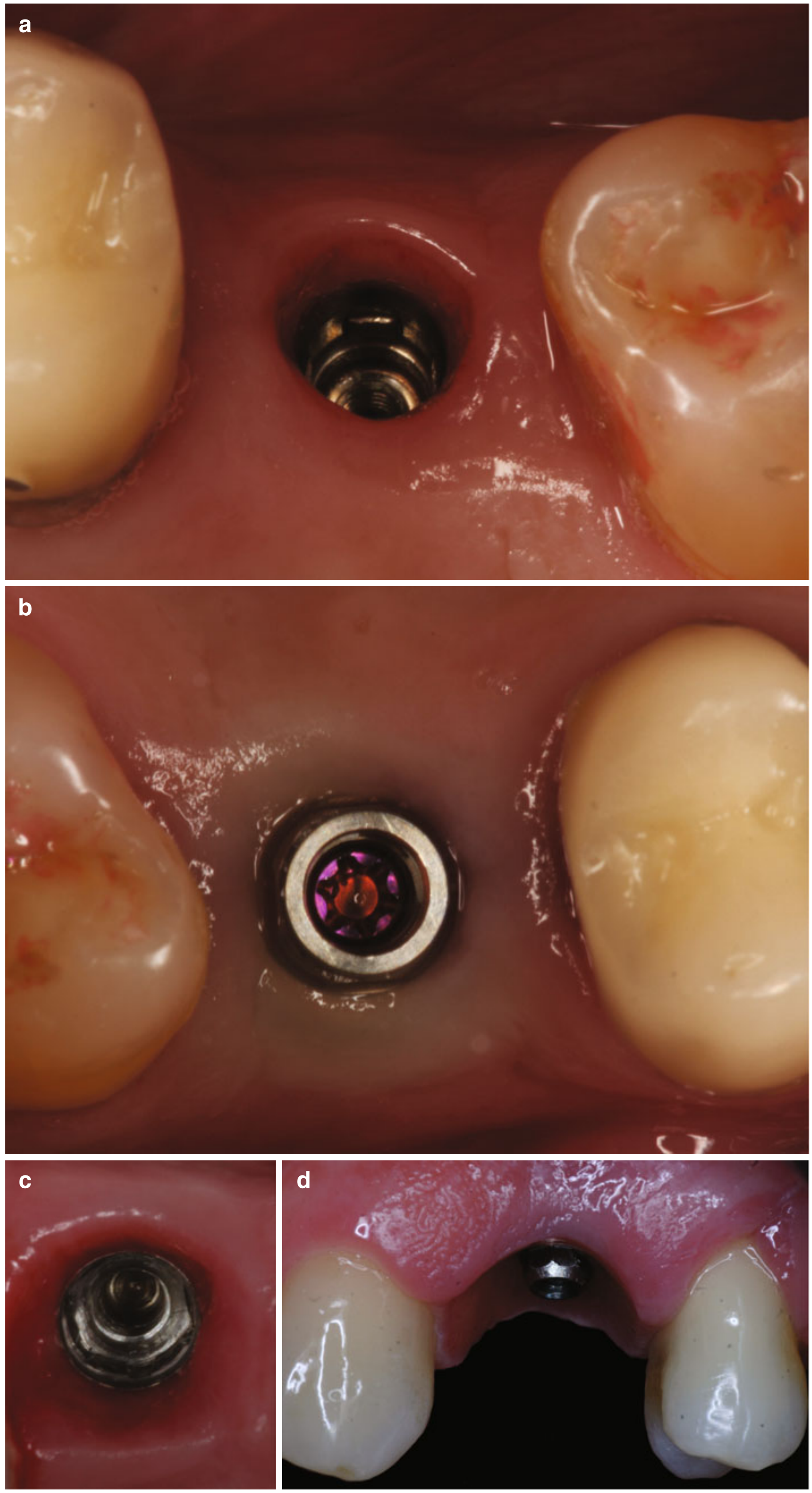

Fig. 6.11 (**a**–**d**) Healthy peri-implant mucosa

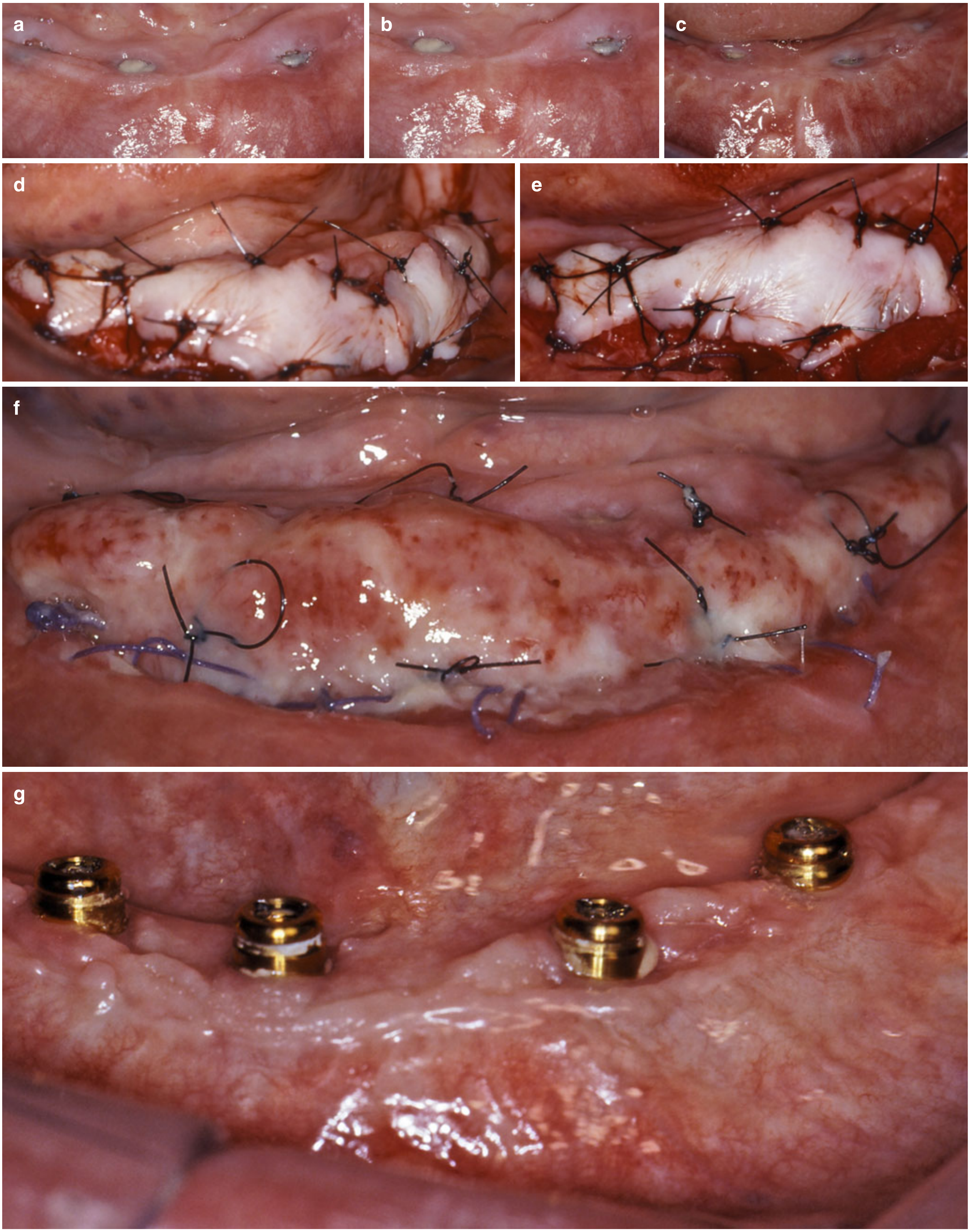

Fig. 6.12 Keratinized tissue gain with free gingival grafts prior the fabrication of overdenture. Lack of keratinized tissue around implants (**a**–**c**). Free gingival graft sutured (**d**, **e**). Ten-day follow-up (**f**). Two-year follow-up (**g**)

6.4 Type of Defect Not to Be Indicated

None, but predictability may vary according to the severity of the defect/deformity, as well as the biomaterial used.

6.5 Clinical Remarks: Implications for Practice and Clinical Decision-Making of Peri-implant Defects and Conditions

Similar to natural teeth, gingival recession may occur on the buccal aspect of implants leading to aesthetic and functional (dental biofilm retention) concerns. In cases where there is no loss of interproximal tissue and no exposure of implant threads, soft tissue augmentation procedures may be used to improve the "peri-implant mucosa phenotype" [17, 18]. Moreover, the gain of KT in areas of elastic peri-implant mucosa may decrease potential discomforts associated to toothbrushing, since it can provide a mechanical barrier of the site. Despite of the lack of reviews focusing on patient-centered outcomes, for example, using a VAS scale (Visual Analog Scale) to measure the discomfort and pain during toothbrushing of implants in areas lacking KT, clinician's knowledge and expertise demonstrate that patients attended and private periodontal practices demonstrate less discomfort when a firm band of KT is present around the implant.

The use of FGG can improve the amount of KT, but these may be better indicated in areas previously treated with implants and in "nonaesthetic" sites, while the use of SCTG may be better indicated concomitantly to implant placement or reopening procedures and in aesthetic areas. Moreover, apically positioned flaps may be used to improve KT. In general, the keratinized epithelium acts as an effective physical and biological barrier that protects the periodontal and peri-implant structures due to the production of antimicrobial peptides and cytokine in response to local/environmental aggression (e.g., dental biofilm, mechanical trauma). In general terms, peri-implant plastic surgery may be used to improve patient-centered outcomes, such aesthetics and soft tissue "comfort" during toothbrushing. The limited base of randomized studies may limit additional "evidence-based comments" at this moment in time; however, clinical expertise clearly indicates that most of the knowledge achieved with soft tissue augmentation outcomes on natural teeth may be applied for implant sites. Such issues per se seem to have proven the feasibility (in aesthetical/functional terms) of peri-implant plastic surgery in daily clinical practice.

6.6 Cases (Figs. 6.13, 6.14, 6.15, 6.16, 6.17, 6.18, 6.19, 6.20, 6.21, 6.22, 6.23, and 6.24.)

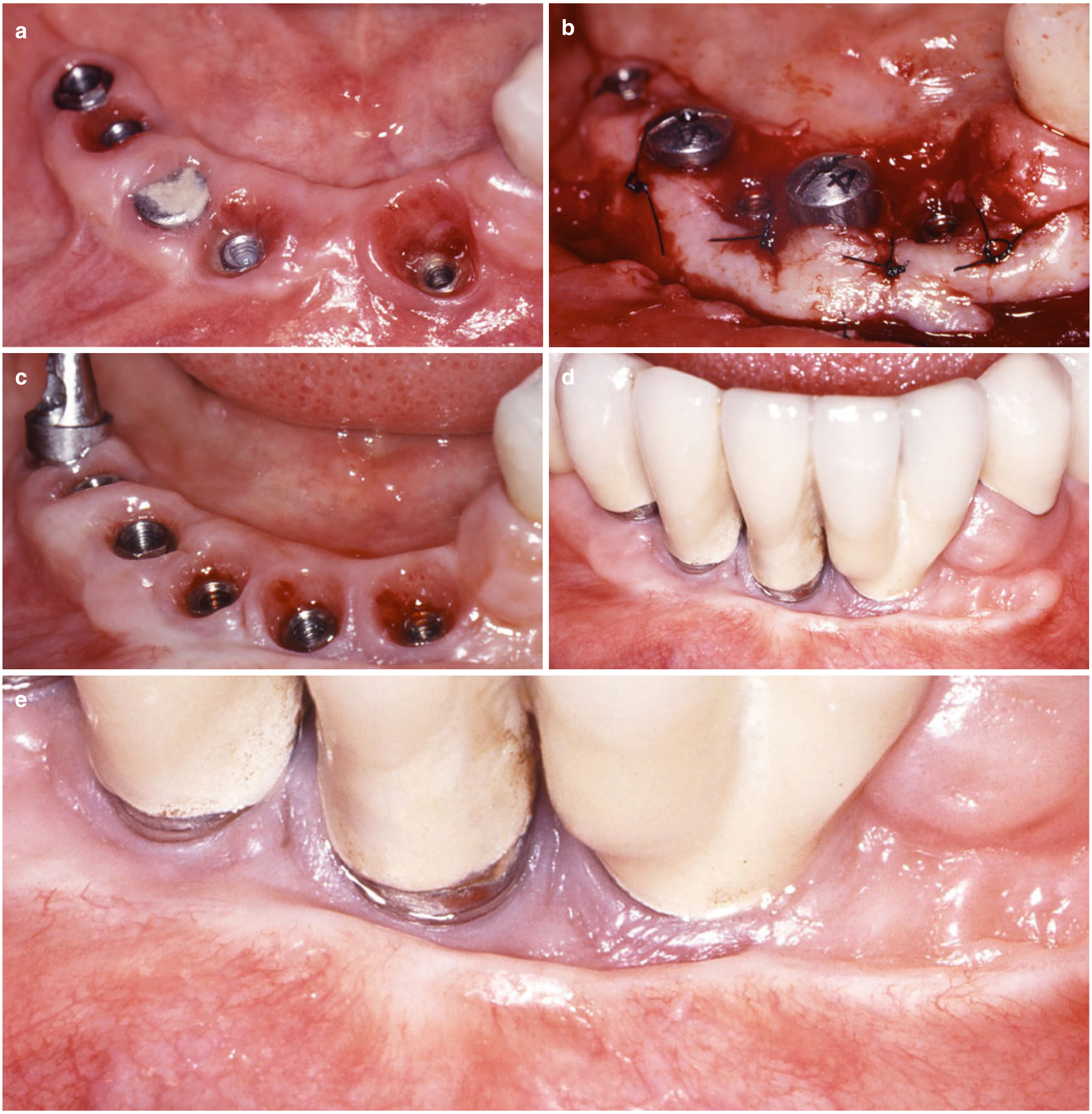

Fig. 6.13 Case I 13 (**a**–**e**). Keratinized tissue gain with free gingival graft prior implant-supported fixed partial denture. Lack of keratinized tissue (**a**). Graft sutured to the recipient site (**b**). Transitional inflammation of the soft tissue associated to the provisional restoration (**c**). Four-year follow-up (**d**). Four-year follow-up – presence of a healthy peri-implant mucosa (**e**)

Fig. 6.14 Case II 14 (**a**–**c**). Keratinized tissue gain with free gingival graft around implants installed in unfavorable position as an auxiliary condition for achieving proper implant hygiene. Graft sutured at the implant site (**a**). Two-month follow-up (**b**). Six-month follow-up (**c**)

Fig. 6.15 Case III 15 (**a**–**f**). Keratinized tissue gain by apically positioned flap during reopening implant procedure. Implant installation (**a**). Flap positioned slightly coronally to allow complete coverage of implants (**b**). During reopening procedures, the keratinized tissue was present, thus, an apically positioned flap was planned to improve the site (C). Three months after reopening – an adequate band of keratinized tissue was present, with evident peri-implant tissue health (**d**). Six months after reopening (**e**). Clinical condition of normality (**f**)

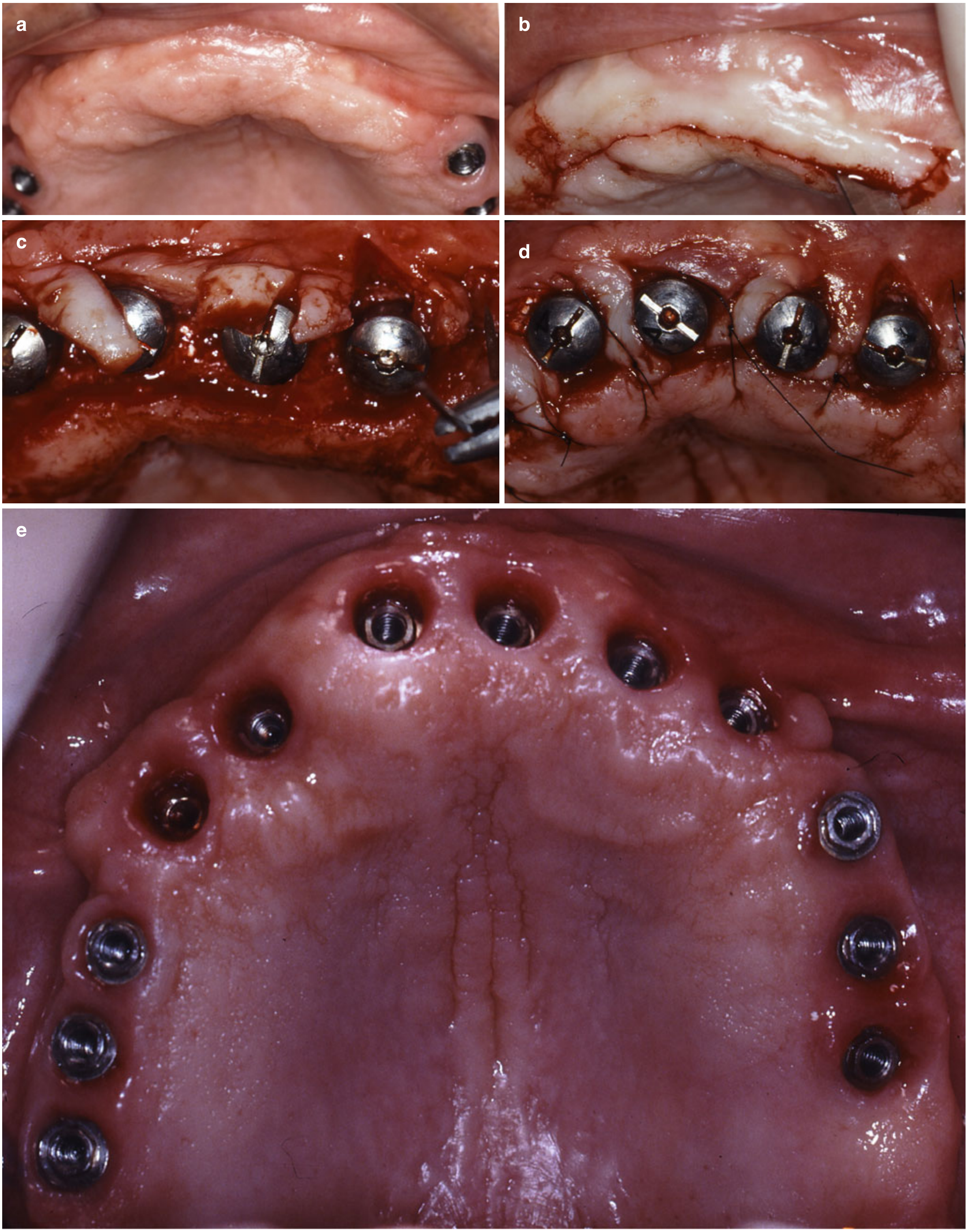

Fig. 6.16 Case IV 16 (**a**–**e**). Reopening procedure using the soft tissue covering submerged implants – lateral rotation of mini pedicle flaps. Baseline (**a**). Palatal linear incision (horizontal) (**b**). Mini pedicle flaps rotated and being sutured (**c**). Mini pedicle flaps sutured (**d**). Three-month follow-up (**e**)

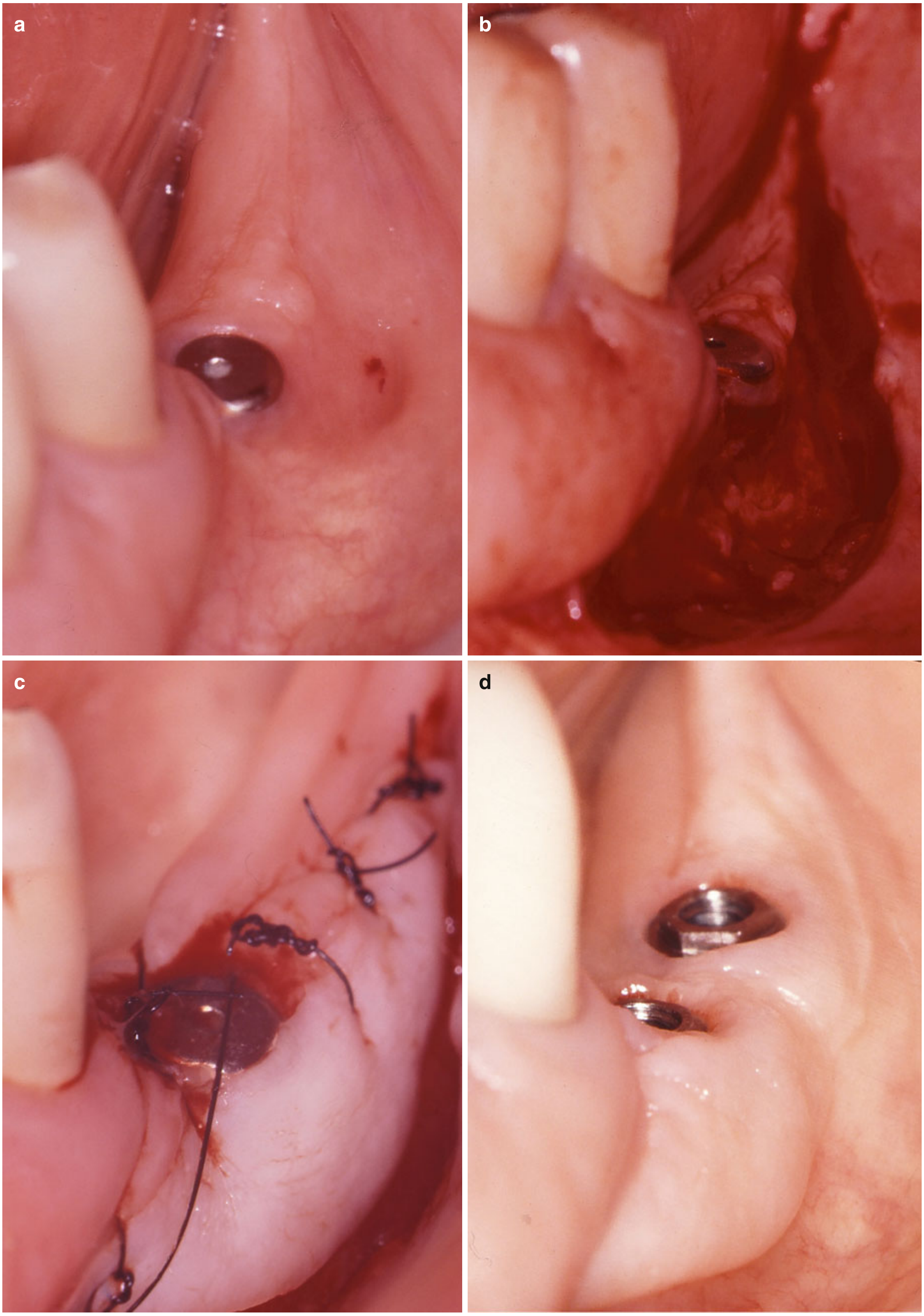

Fig. 6.17 Case V 17 (**a**–**d**). Keratinized tissue width gain by free gingival graft in the posterior region of mandible. Baseline (**a**). Removal of the buccal epithelial wall via partial-thickness flap (**b**). Graft sutured to the implant site (**c**). One-year follow-up – the amount of keratinized tissue formed allowed a comfortable toothbrushing, as well as the placement of an additional implant (**d**)

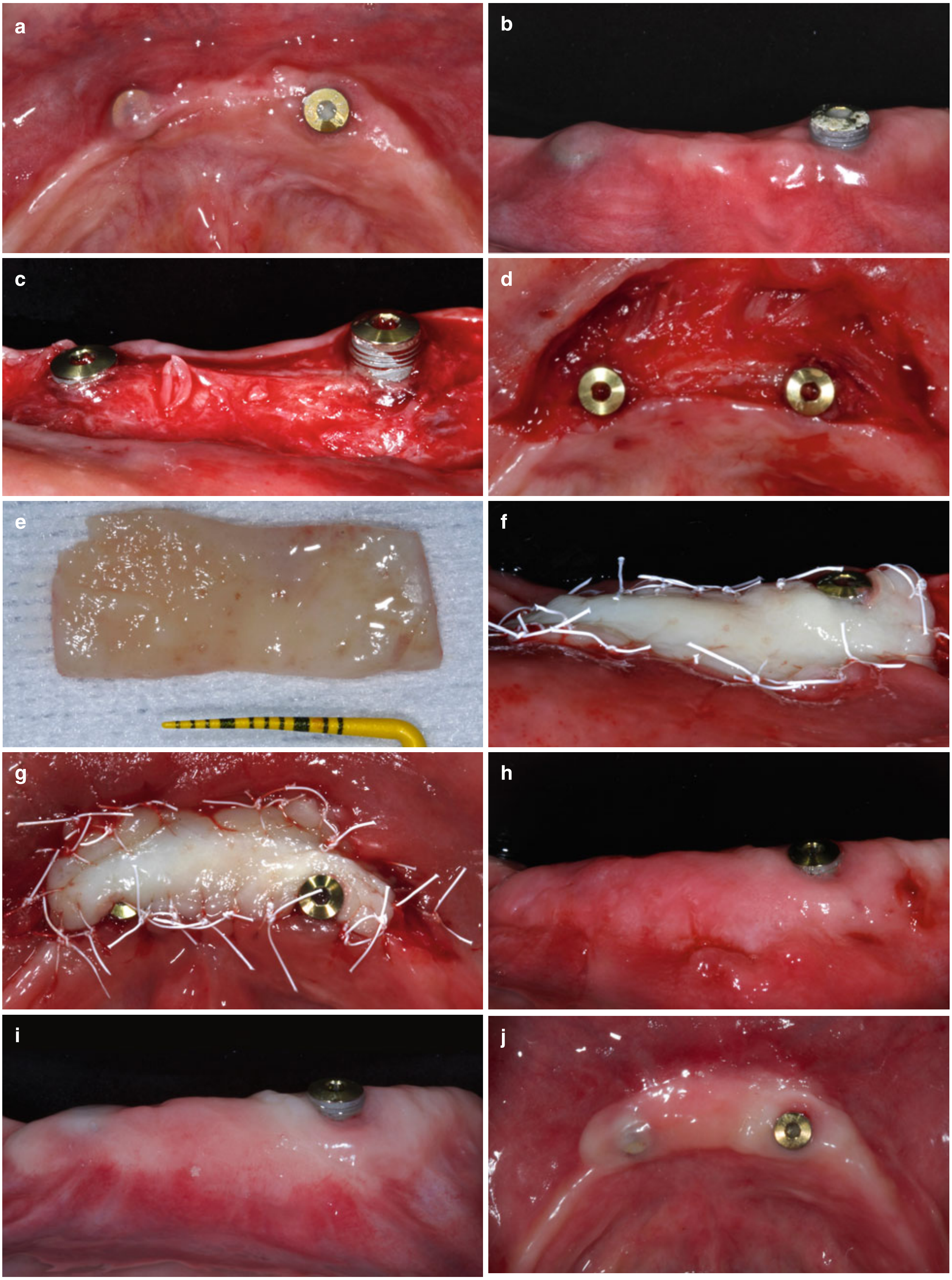

Fig. 6.18 Case VI 18 (**a**–**j**). Keratinized tissue gain by free gingival graft around implants with exposed threads planned to support mandibular overdenture. Baseline – lack of keratinized tissue (**a**, **b**). Recipient site prepared to accommodate the graft (**c**, **d**). Graft harvested (**e**). Graft sutured (**f**, **g**). Two-month follow-up (**h**–**j**)

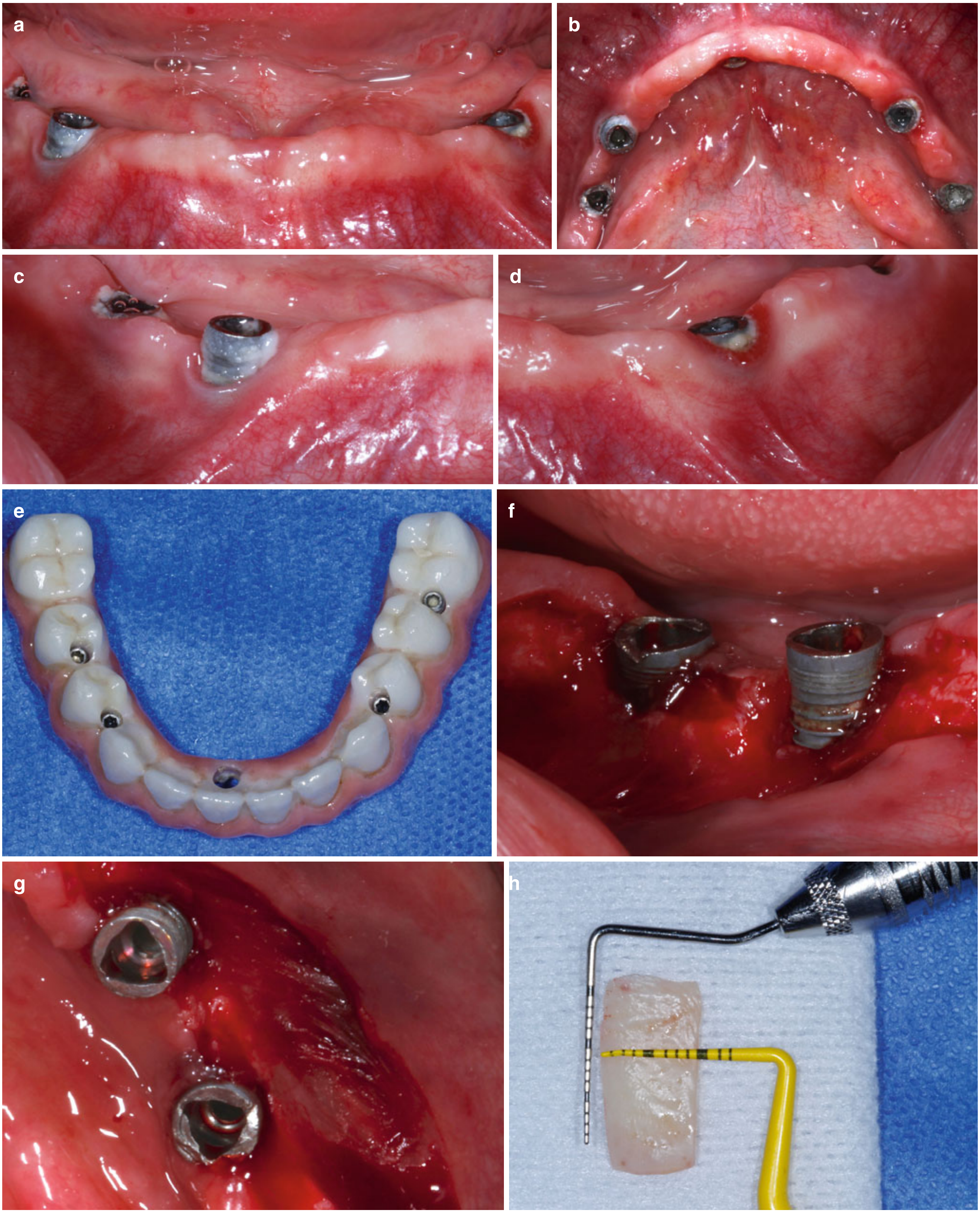

Fig. 6.19 Case VII 19 (**a**–**p**). Keratinized tissue gain by free gingival grafts around implants with mucositis and peri-implantitis that are supporting fixed dentures. Baseline (**a**, **b**). Abundant quantity of dental biofilm over the exposed threads of the anterior right implant (**c**). Abundant biofilm accumulation and mucositis around the left side implants (**d**). Prosthesis used by the patient (**e**). Debridement of the implant surface and recipient site preparation (right side) (**f**, **g**). Dimensions of the graft (**h**). Graft sutured (*right side*) (**i**, **j**). Recipient site prepared (*left side*) (**k**). The graft was expanded to fit the recipient site (**l**). Graft sutured (left side) (**m**). Final result (**n**, **p**)

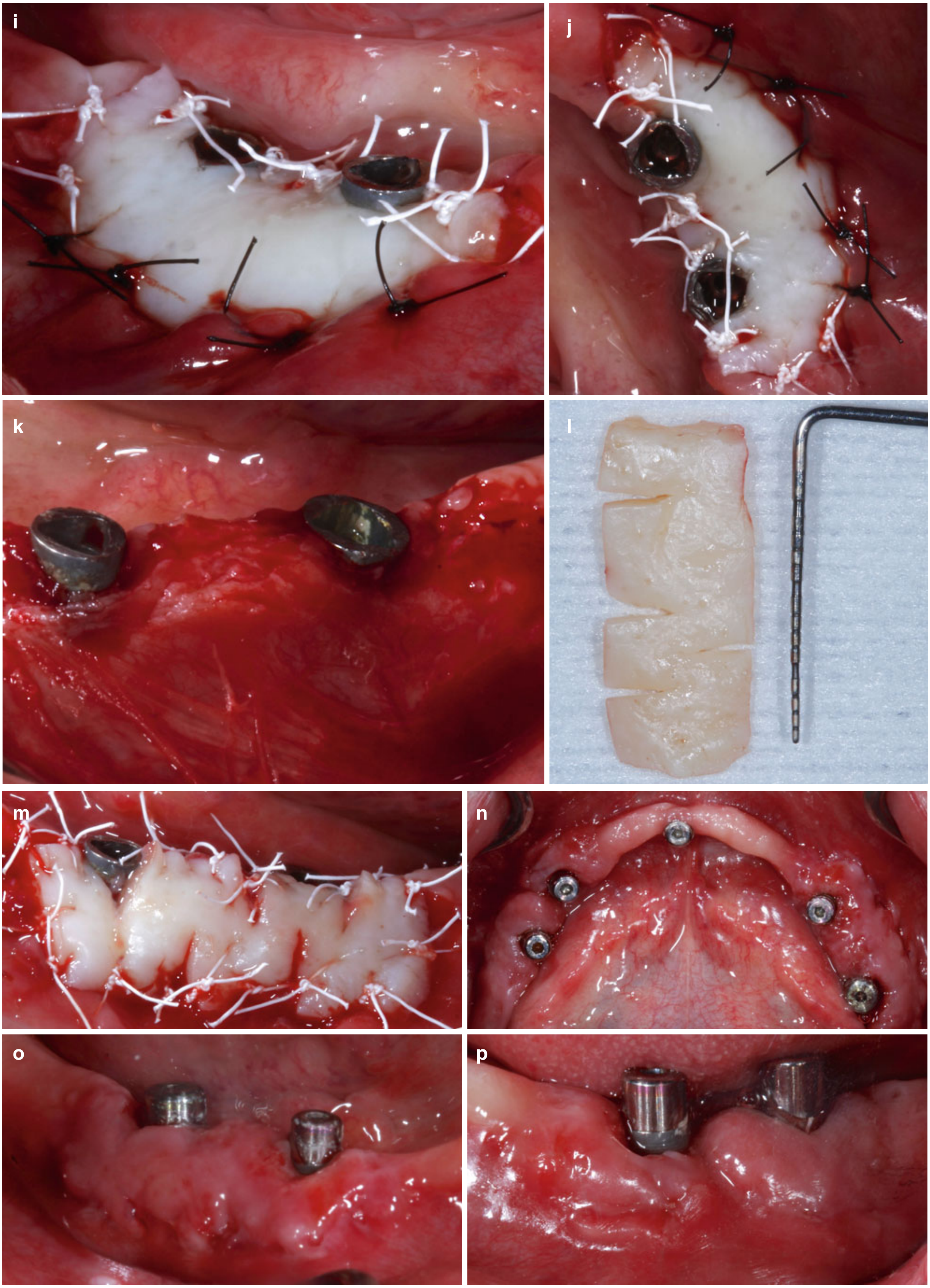

Fig. 6.19 (continued)

Fig. 6.20 Case VIII 20 (**a**–**e**). Keratinized tissue gain by free gingival graft around implants with peri-implantitis that are supporting fixed partial denture. Baseline (**a**). Graft length (**b**). Graft width (**c**). Expanded graft sutured at the implant's site – the exposed implant surfaces were debrided and not covered (**d**). Six-month follow-up (**e**)

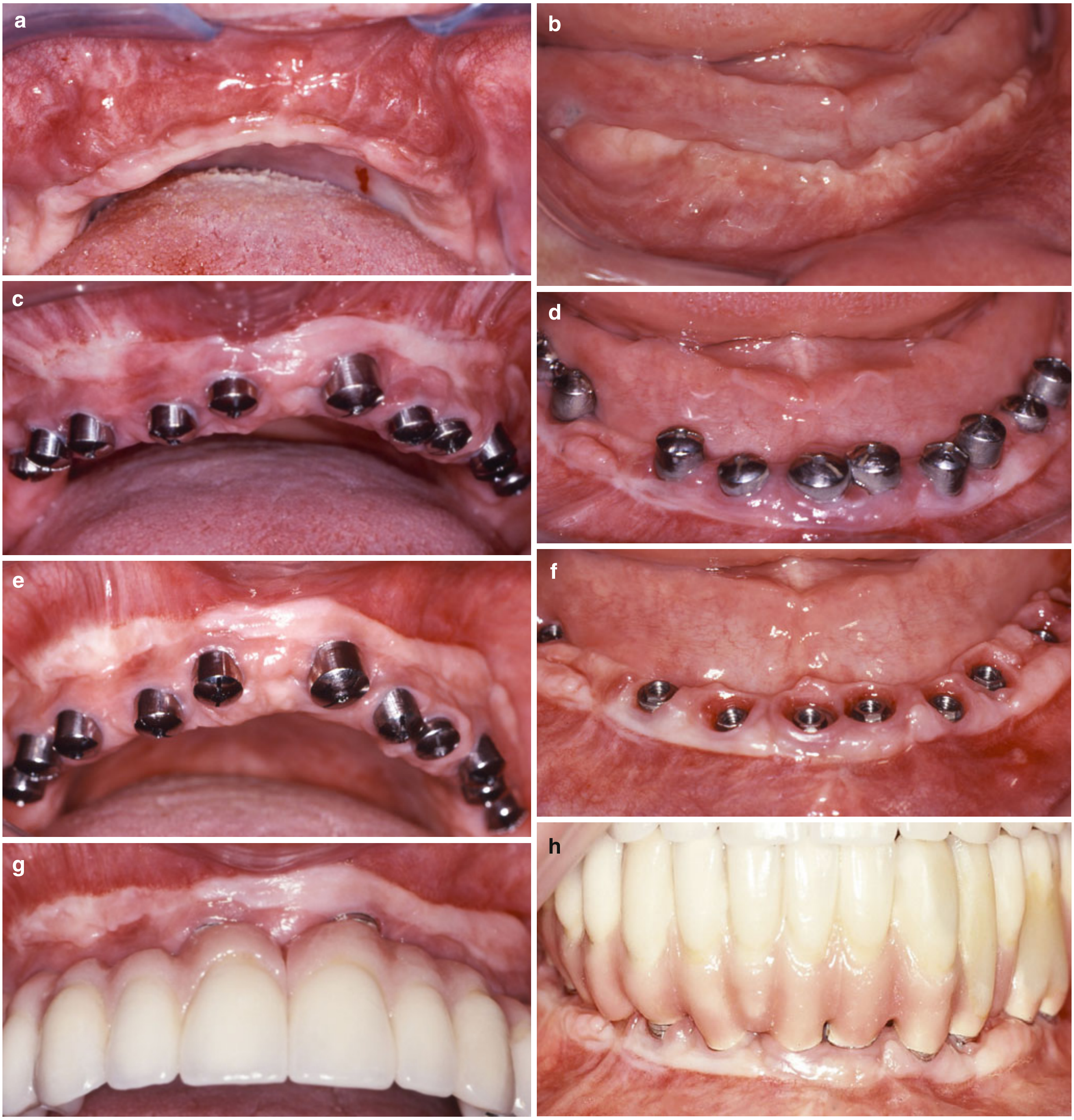

Fig. 6.21 Case IX 21 (**a**–**h**). Keratinized tissue gain for fixed full-mouth reconstruction following extra-oral bone grafting and implants installation. Clinical condition after extra-bucal bone grafting and implant placement (**a**, **b**). One-month follow-up after free gingival grafts (**c**, **d**). Six-month follow-up after soft tissue grafting (**e**, **f**). Three-year follow-up after soft tissue grafting (**g**, **h**)

Fig. 6.22 Case X 22 (**a–i**). Alveolar ridge preservation with subepithelial connective tissue graft concomitant to implant placement. * Note to the readers – just one case employing this type of graft is present in this chapter, because within most of our cases, this procedure is always associated to other treatment approaches (additional cases are presented in Chap. 7). Baseline – tooth 11 (root) referred for extraction and implant placement (**a**, **b**). Implant installed after atraumatic root extraction (**c**). The use of soft tissue to preserve the buccal soft tissue profile and to improve the vertical amount of soft tissue (**d**, **e**). Provisional restoration installed immediately after surgery (**f**). Three-month follow-up (**g–i**)

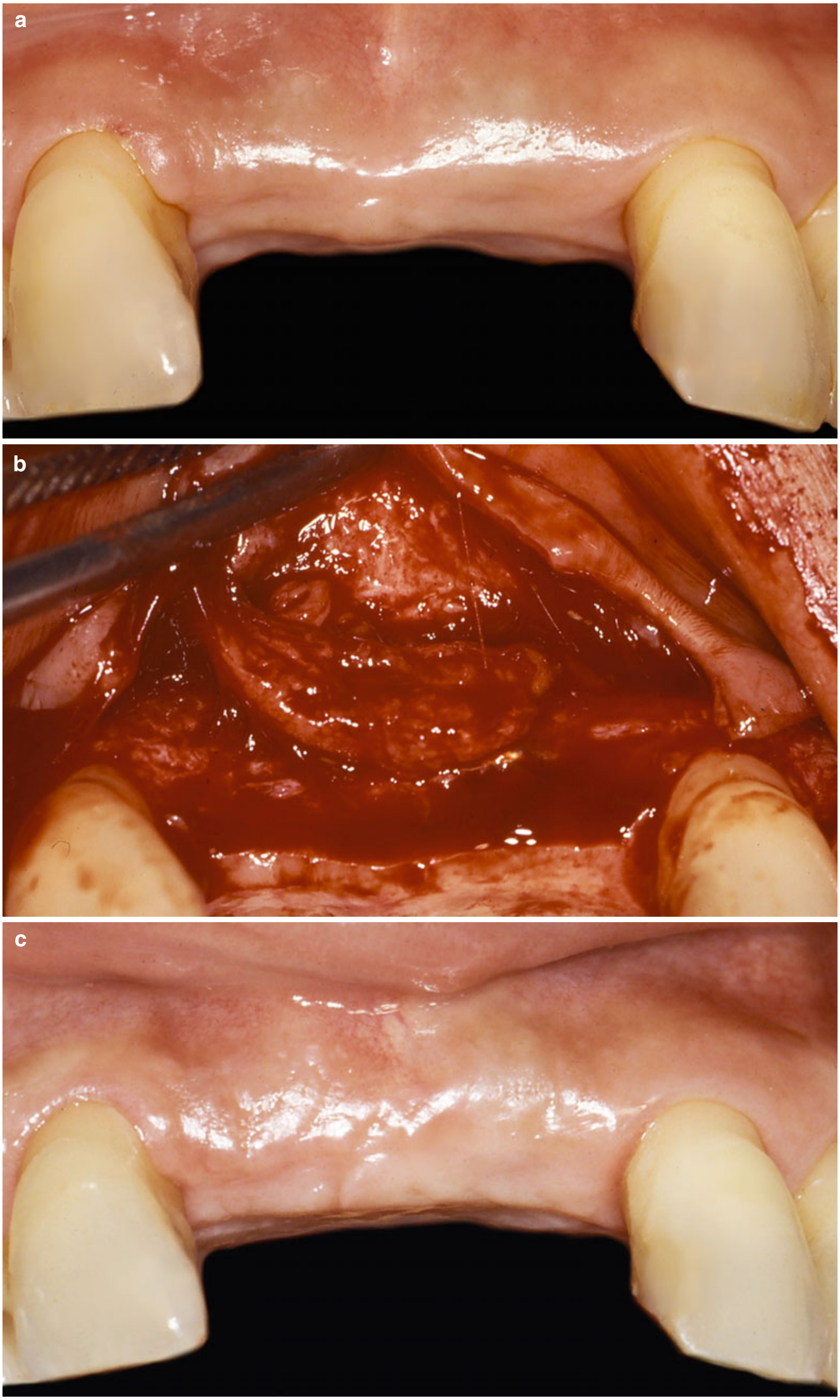

Fig. 6.23 Case XI – 23 (**a**–**c**). Correction of aesthetic deformities of the alveolar ridge with subepithelial connective tissue graft prior to implant placement. Baseline – presence of buccal concavity at the alveolar ridge due to the previous extraction of the central incisors (**a**). Partial-thickness flap raised and graft positioned (**b**). Six-month follow-up 0 increase in the width of soft tissue (**c**)

Fig. 6.24 Case XII – 24 (**a**–**e**). Treatment of peri-implant recession-type defects involving tooth and implant by subepithelial connective tissue graft. Baseline – after the removal of the gingival margin around tooth 23 (**a**). Partial-thickness flap raised (**b**). Graft being harvested (**c**). Graft positioned over the exposed root surface (**d**). Six-year follow-up (**e**)

Critical Summary of the Results of Systematic Reviews

Systematic reviews conclusions: The combined use of apically positioned flaps/vestibuloplasty in combination with SCTG, FGG, ADMG, or XCM leads to keratinized tissue gain, with the SCTG being considered the "gold standard" at implant sites and in partially edentulous ridges [19].

Summary of the reviews and critical remarks: The reduced base of evidence available included data up to 4 years of follow-up, and most of the studies are nonrandomized trials. Some degree of shrinkage after grafting procedures may be expected, which in clinical terms may lead to a reduction of at least of half of original width of the graft sutured during healing (i.e., at 60-day follow-up) [19]. Superior aesthetic outcomes can be expected (i.e., papilla height and level of the marginal mucosa) when soft tissue grafting is performed concomitantly with immediate implant placement, as well as there is a lack of data for soft tissue substitutes [19]. Overall, Yoshino et al. [20] reported that immediate implant placement and provisionalization with an SCTG presented less change of the level of the buccal peri-implant mucosa when compared to sites that did not undergo an SCTG.

Evidence quality rating/strength of recommendation (*ADA 2013*) [21]: Expert opinion for – the single SR available favors providing this intervention, but evidence is lacking for some graft materials and expert opinion guides this recommendation. (Authors' note: clinicians may guide their decision based on the outcomes of procedures performed around natural teeth.)

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7 Multidisciplinary Decision-Making: The "Real-World" Clinical Scenarios

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7.1 Potential Clinical Scenarios: Treatment Approaches for Natural Teeth Requiring Periodontal Plastic Surgery

Fig. 7.1 Case I – 1 (**a**–**h**). *Treatment planning*: nonsurgical periodontal therapy (supra- and subgingival scaling) and conventional gingivectomy at the anterior sextant of the mandible via external beveled incision. Baseline (**a**). After basic procedures (**b**). Identification of the remaining pseudo-pockets (**c**, **d**). Pseudo-pockets surgically removed (**e**). One-week follow-up (**f**). Four-month follow-up (**g**). Achievement of a normal probing depth (**h**)

Fig. 7.2 Case II – 2 (**a**–**c**). *Treatment planning*: nonsurgical periodontal treatment (supra- and subgingival scaling and root planing) and frenectomy (with periosteal fenestration) at the anterior sextant. Baseline – Class III gingival recessions anterior of the mandible (**a**). After basic procedures – frenum surgically removed (**b**). Six-month follow-up – significant reduction of the gingival recession on tooth 41 (**c**)

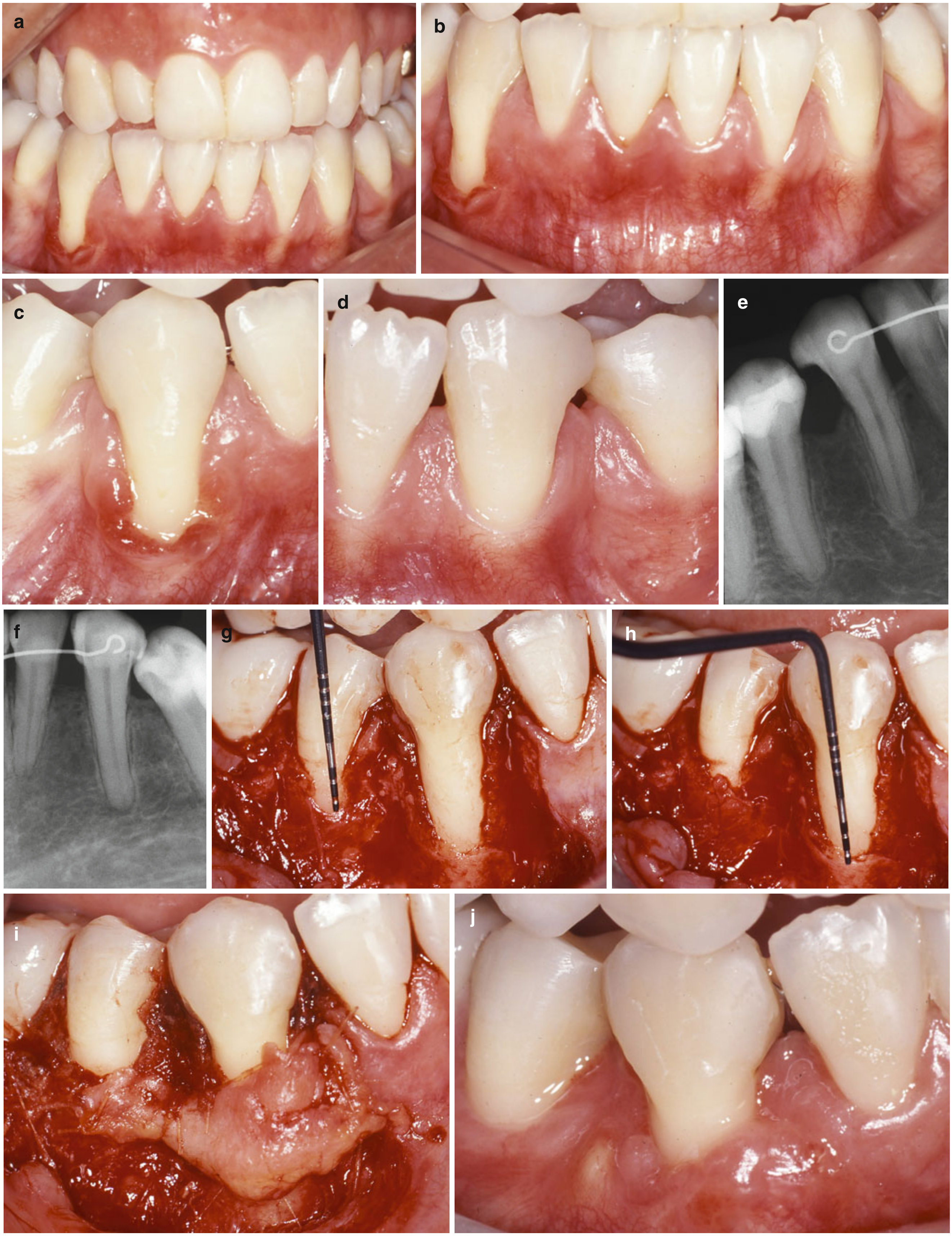
Fig. 7.3 Case III – 3 (**a**–**v**). *Treatment planning*: nonsurgical periodontal therapy (supra- and subgingival scaling and root planing), periodontal regeneration with bone substitute (infra-osseous defect between teeth 14 and 15), and root coverage (subepithelial connective tissue graft-based procedures) at mandibular gingival recessions. Baseline (**a**). Diagnosis of localized aggressive periodontitis (**b**, **c**). Presence of deep pockets (**d**). Infrabony defect after debridement (**e**). Occlusal view of the osseous defect (**f**). Defect – filled with bone substitute (**g**). Flap repositioned and sutured (**h**). Baseline – recession on teeth 44 and 45 (**i**). Baseline – closer view of the Class I and II recessions (**j**). Horizontal incision (**k**). Flap raised and graft sutured over recessions (**l**). Flap coronally advanced and sutured (**m**). Baseline – Class I gingival recession on tooth 34 (**n**). Tunnel flap raised (**o**). Graft interposed and sutured between the root surface and the tunnel flap (**p**). Donor site sutured (**q**). One-year follow-up after the last surgical procedure (**r**). One-year follow-up – right side (**s**). One-year follow-up – left side (**t**). One-year follow-up – teeth 44 and 45 (**u**). One-year follow-up – tooth 34 (**v**)

Fig. 7.3 (continued)

Fig. 7.4 Case IV – 4 (**a**–**k**). *Treatment planning*: nonsurgical periodontal therapy (supragingival scaling) and root coverage (subepithelial connective tissue graft+coronally advanced flap and modified coronally advanced flap) on the right side of the maxilla. Baseline (**a**). Baseline – after basic procedures (**b**). Realizing incisions performed adjacent to a Class II recession defect on tooth 13 (**c**). Flap raised by sharp dissection (**d**). Root planing (**e**). Soft tissue graft being sutured over the recession (**f**). Three-month follow-up (**g**). Shallow Class I recessions present at teeth 11 and 12 (**h**). Double semilunar coronally advanced flap (**i**). One-month follow-up (**j**). Six-month follow-up (tooth 13), and 3-month follow-up (teeth 11 and 12) (**k**)

Fig. 7.5 Case V – 5 (**a–d**). *Treatment planning*: nonsurgical periodontal therapy (supragingival scaling) and removal of the pyogenic granuloma associated to a free gingival graft (*note of the authors – this lesion was diagnosed in a pregnant woman with gingivitis, and the surgical phase of treatment was conducted after the baby's birth). Baseline – presence of a pyogenic granuloma adjacent to tooth 46 (**a**). Lesion removed and recipient site prepared to be grafted (**b**). Graft sutured to the recipient site (**c**). Four-month follow-up (**d**)

Fig. 7.6 Case VI 6 (**a–r**). Treatment planning: nonsurgical periodontal therapy (supra- and subgingival scaling), root coverage (subepithelial connective tissue graft + coronally advanced flap), and biotype modification (free gingival graft) at multiple sites of the mandible. Baseline (**a**, **b**). Class III gingival recession – tooth 43 (**c**). Class III gingival recession – tooth 33 (**d**). Radiographic interproximal bone loss associated to orthodontic extraction of the first mandibular bicuspids (**e**, **f**). Extension of bone dehiscence over the root surface of tooth 45 (**g**). Extension of bone dehiscence over the root surface of tooth 43 (**h**). Graft sutured over the root surface of teeth 43 and 45 (**i**). Two-month follow-up (**j**). Recipient site being prepared to accommodate the graft (**k**). Graft positioned (**l**). Graft coronally advanced and sutured (**m**). Baseline probing depth on tooth 41 (**n**). First surgical procedure at the mandibular incisors – submerged graft (**o**). Five months after the connective graft procedure, a free gingival graft was used to increase the thickness of keratinized tissue (**p**). Four-month follow-up after the last surgical procedure (**q**, **r**)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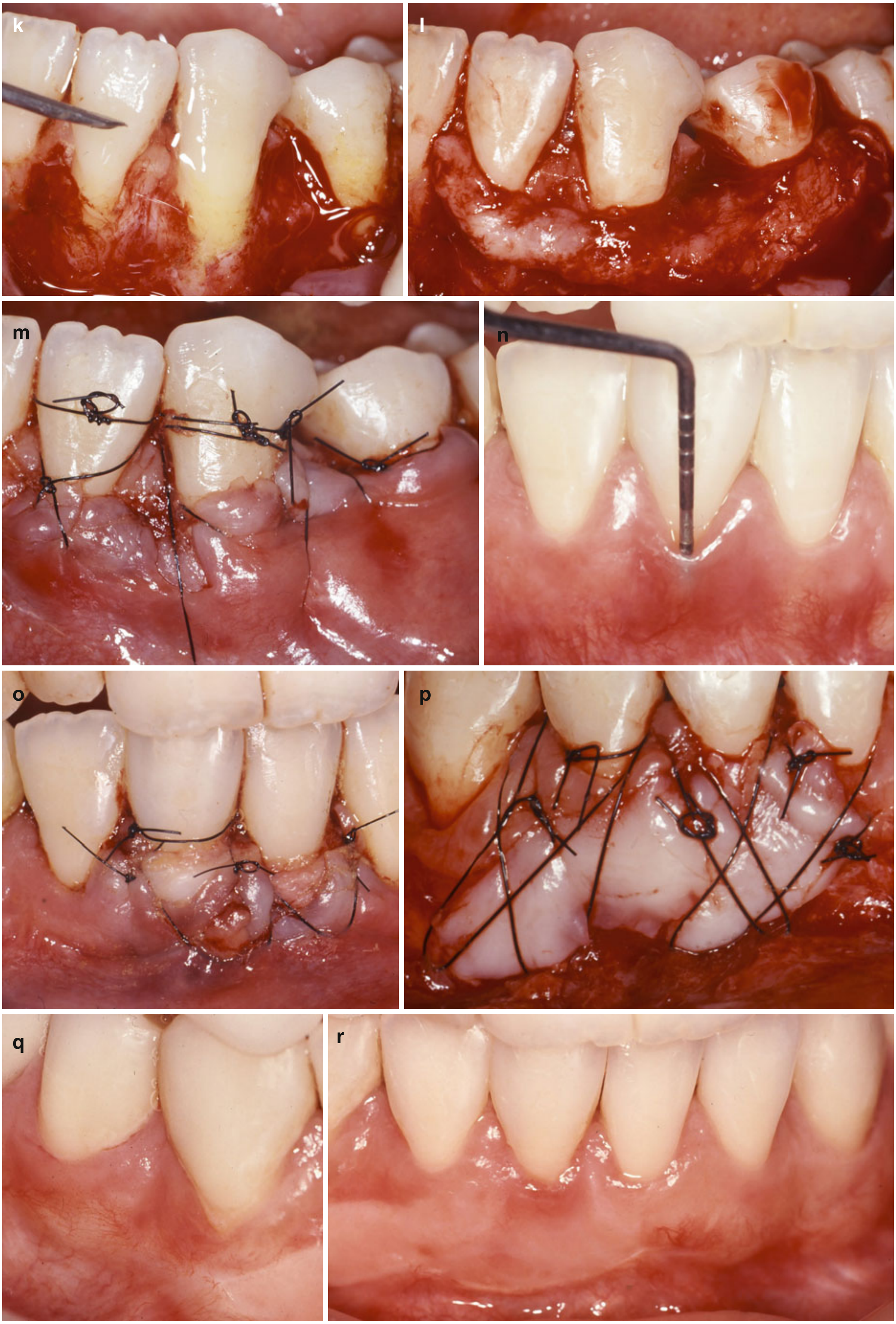


Fig. 7.6 (continued)

Fig. 7.7 Case VII – 7 (**a**–**e**). Treatment planning: nonsurgical periodontal therapy (supra- and subgingival scaling and root planning), frenectomy, and biotype modification concomitant orthodontic treatment. Baseline – Class IV gingival recession on teeth 31 and 41 developed during the orthodontic treatment associated to dental biofilm accumulation and high muscle insert close to the gingival margin (**a**). Frenum removed and osseous defect debrided (**b**). Length of the graft harvested from the palate (**c**). Graft sutured at the recipient site (**d**). Six-month follow-up (**e**)

Fig. 7.8 Case VIII – 8 (**a**–**h**). *Treatment planning*: nonsurgical periodontal therapy (supragingival scaling), frenectomy, and biotype modification concomitant orthodontic treatment. Baseline – single Class II recession defect on tooth 41 associated to dental biofilm accumulation and a high lip frenum (**a**, **b**). Frenum and epithelial layer of the gingiva removed (**c**). Graft harvested from the palate (**d**). Graft sutured to the recipient site covering the recession (**e**). Three-month follow-up (**f**). One-year follow-up (**g**, **h**)

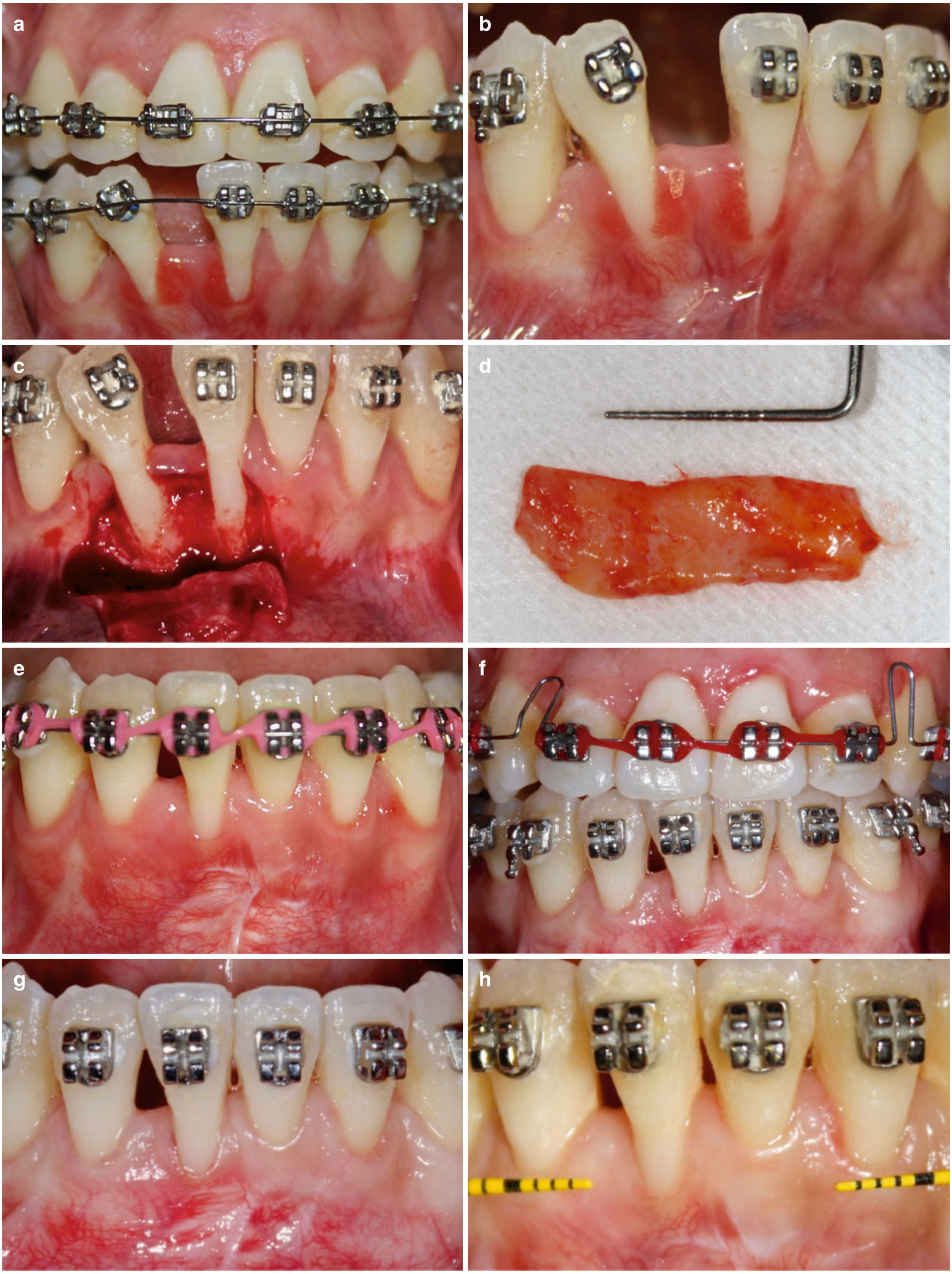


Fig. 7.9 Case IX – 9 (**a**–**m**). *Treatment planning*: nonsurgical periodontal therapy (supra- and subgingival scaling), root coverage (subepithelial connective tissue graft+coronally advanced flap), and biotype modification (free gingival graft) concomitant orthodontic treatment. Baseline – aggressive periodontitis patient periodontally treated and submitted to fixed orthodontics (**a**). Class III recession on teeth 31 and 41 associated gingival margin inflammation (**b**). Flap raised (**c**). Connective graft harvested from palate (**d**). Six-month follow-up (**e**). Six-month follow-up – baseline of the second surgical procedure (**f**). Baseline – second surgical procedure (**g**). Checking some gingival dimensions (**h**). Recipient site prepared to accommodate the second graft (**i**). Graft sutured to the recipient site (**j**). Three-month follow-up – second surgical procedure (**k**, **l**). Six-month follow-up – second surgical procedure (**m**)

Fig. 7.9 (continued)

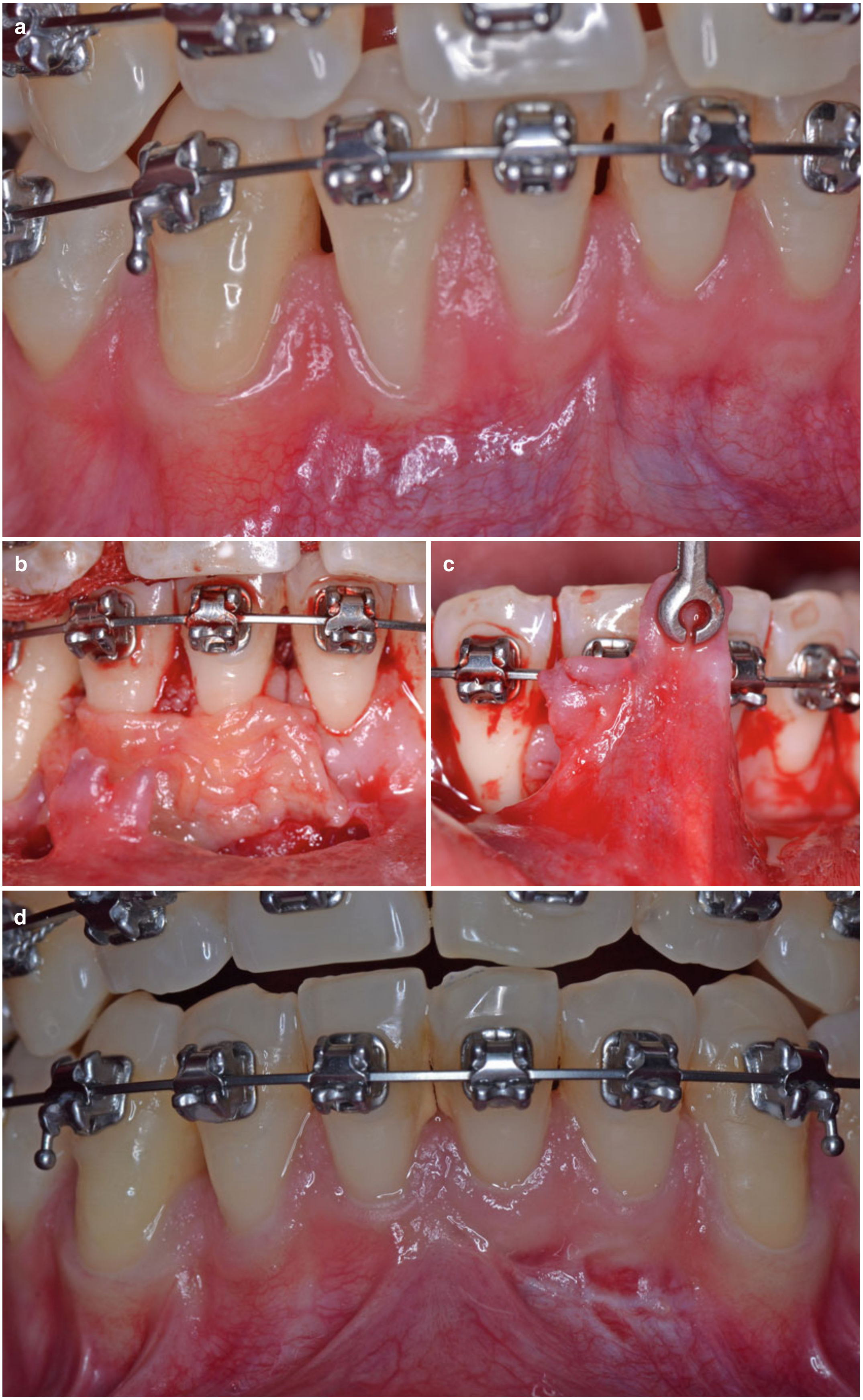


Fig. 7.10 Case X – 10 (**a**–**d**). *Treatment planning*: nonsurgical periodontal therapy (supragingival scaling) and root coverage (subepithelial connective tissue graft + coronally advanced flap) concomitant orthodontic treatment. Baseline – Class III gingival recessions on teeth 41 and 41 (**a**). Graft sutured at the recipient site (**b**). Checking flap tension (**c**). Six-month follow-up (imediately before periodontal maintenance) (**d**)

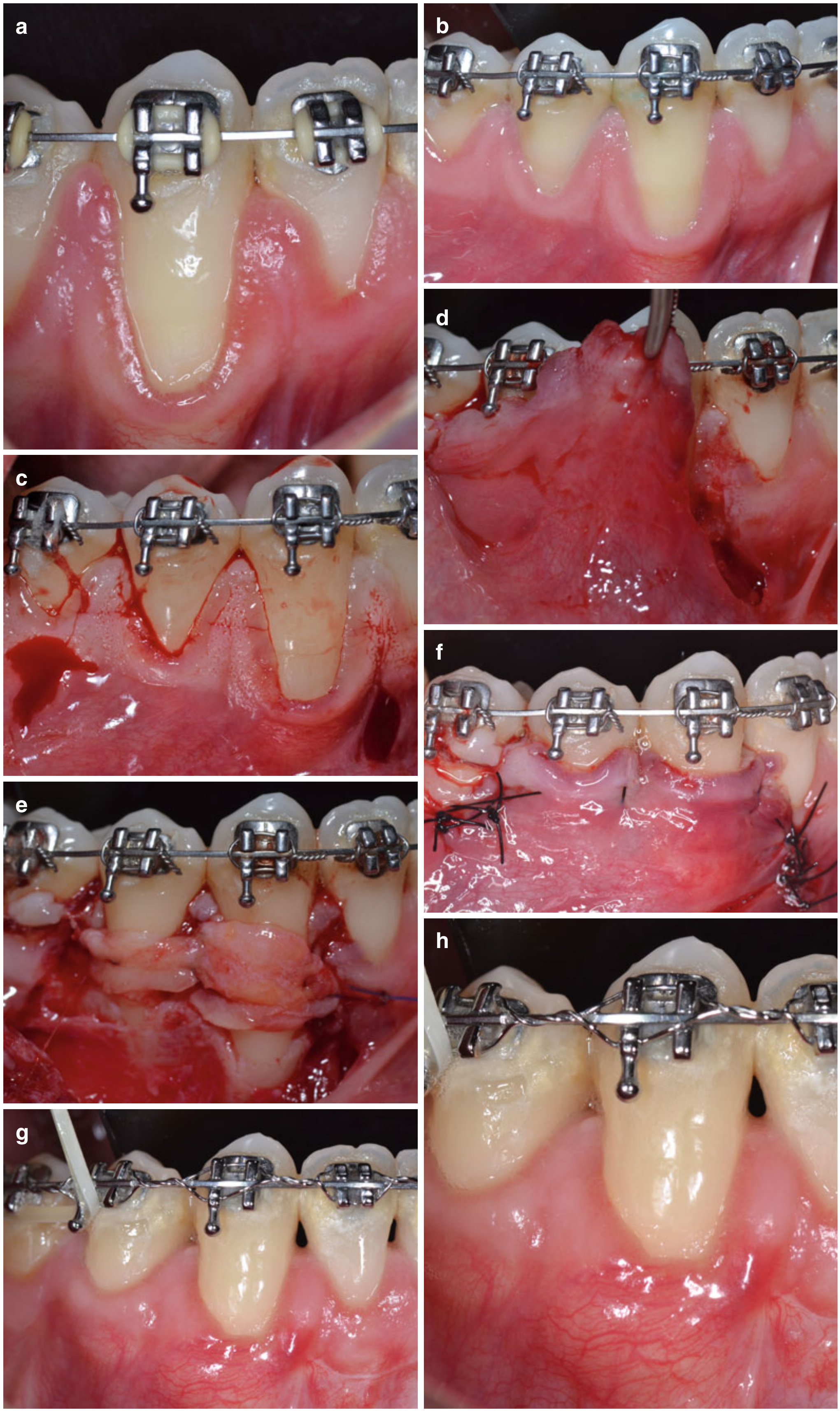


Fig. 7.11 Case X1 – 11 (**a**–**h**). *Treatment planning*: nonsurgical periodontal therapy (supragingival scaling) and root coverage (subepithelial connective tissue graft + coronally advanced flap) concomitant orthodontic treatment. Baseline (**a**). After basic procedures – Class I and II recession defects on teeth 44 and 43 (**b**). Horizontal and vertical incisions performed (**c**). Graft sutured over the recessions (**d**). Checking flap tension (**e**). Flap coronally advanced and sutured (**f**). One-year follow-up (**g**, **h**)

Fig. 7.12 Case XII – 12 (**a**–**j**). *Treatment planning*: aesthetical clinical crown lengthening of the anterior maxillary teeth after orthodontics and installation of porcelain veneers. Baseline (**a**, **b**). Gingival collar removal (**c**). Crown lengthening was achieved only with gingivectomy – external beveled incisions (**d**). Smile 3 months after surgery (**e**). Gingival contour around central incisors (**f**). Three-month follow-up (**g**). Three-month follow-up – lateral view (**h**). Six-month follow-up – porcelain veneer crowns were installed to improve anterior upper teeth's aesthetics (**i**). Six-month follow-up lateral view (**j**)

Fig. 7.12 (continued)

Fig. 7.13 Case XIII – 13 (**a**–**e**). Periodontal biotype modification (subepithelial connective tissue grafts) and installation of porcelain full-crown restorations. Baseline – smile (**a**). Baseline – lateral view (**b**). Baseline – clinical conditions (**c**, **d**). One year after grafting – full-crown restoration installed (**e**)

Fig. 7.14 Case XIV – 14 (**a**–**f**). *Treatment planning*: nonsurgical periodontal therapy (supra- and subgingival scaling and root planning), biotype modification (free gingival graft), and orthodontic teeth alignment (mandible). Baseline – frontal view of two Class IV gingival recessions on teeth 31 and 41 (**a**). Baseline – lateral view (**b**). Removal of the epithelial layer of the gingival adjacent to the recessions (**c**). Graft sutured to the recipient site (**d**). Obtaining of adequate space for central incisors alignment (**e**). Central incisors correctly aligned to in the mandibular arch approximately 6 months after surgery (**f**)

Fig. 7.15 Case XV 15 (**a**–**l**). *Treatment planning*: nonsurgical periodontal therapy (supra- and subgingival scaling), clinical crown lengthening, and installation of porcelain veneers. Baseline (**a**–**c**). External beveled incisions (**d**). Gingival collars being removed (**e**). Gingival collars removed (**f**). Following flap raising and osseous recontour (**g**). Flap apically positioned and sutured (**h**). Two-week follow-up (**i**). Four months after the surgical procedure – restorations installation (**j**, **k**). One year after the surgical procedure (**l**)

Fig. 7.15 (continued)

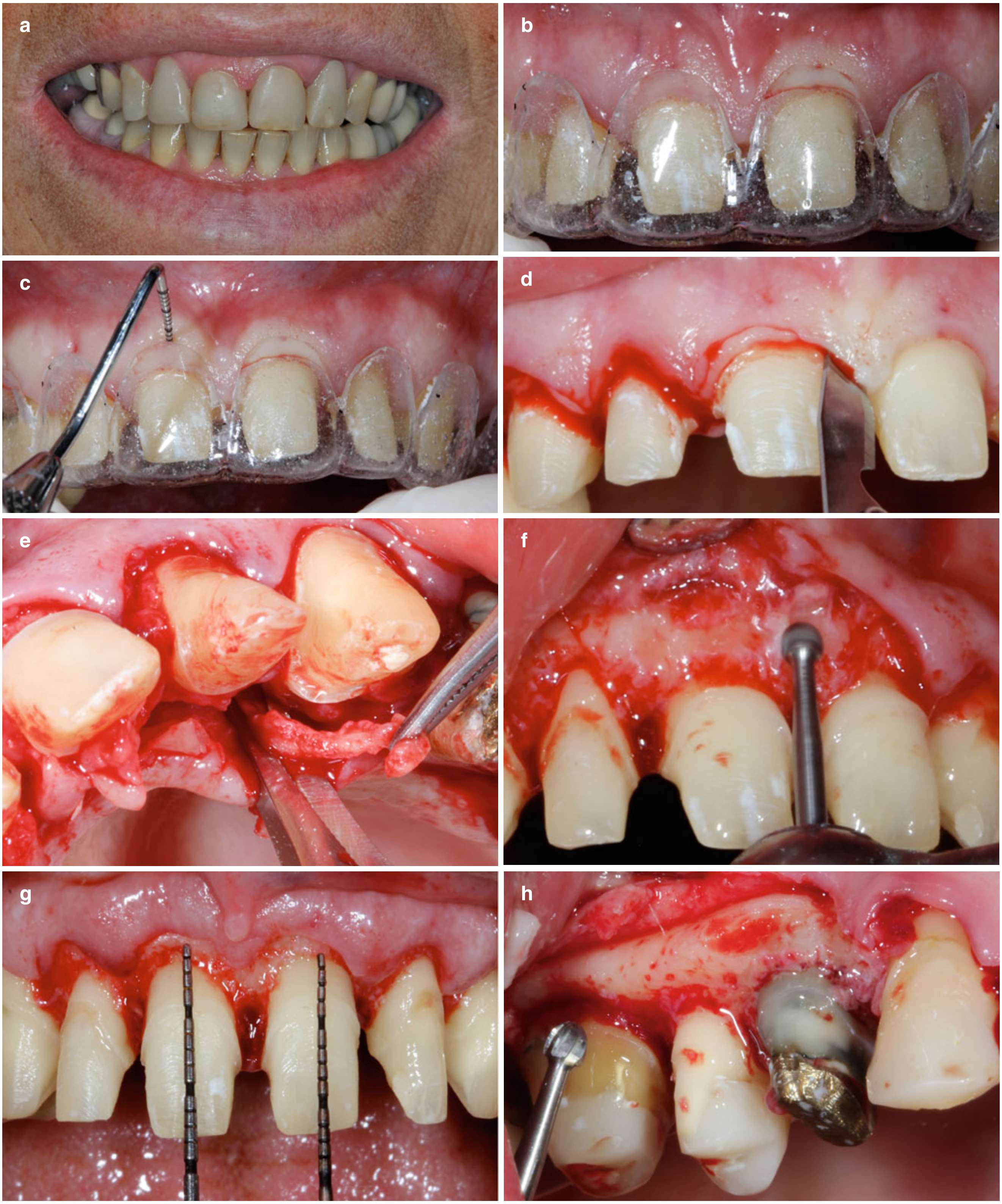


Fig. 7.16 Case XVI – 16 (**a**–**p**). *Treatment planning*: nonsurgical periodontal therapy (supra- and subgingival scaling), clinical crown lengthening, and installation of full-crown porcelain restorations. Baseline–smile (**a**). Clinical mock-up in positions (**b**). Delimitations of the new position of the gingival margin (**c**). Internal beveled incision (**d, e**). Osteotomy (**f**). Checking the distance between the bone crest and the margins of the future restorations (**g**). Osteotomy – posterior region of the maxilla (**h**). Checking the distance between the bone crest and the margins of the future restorations (**i**). Surgical site ready for suture (**j**). Occlusal view of the surgical sites before suture (**k**). Flap positioned apically and sutured (**l**). Six-month follow-up – restorations installed (**m**). Final result (**n**). Final result – smile (**o**). Final result – improved aesthetics and clinical gingival health (**p**)

Fig. 7.16 (continued)

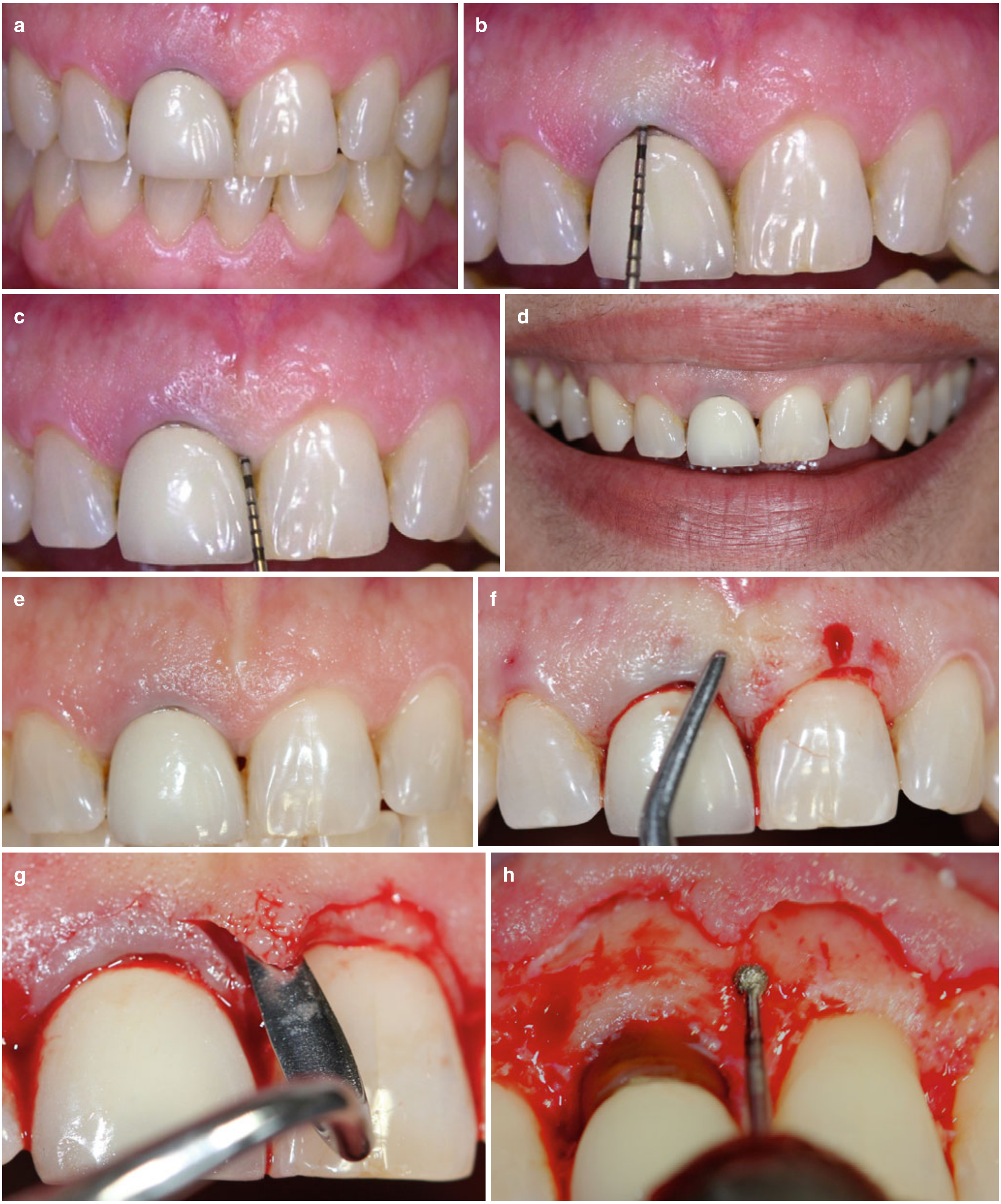


Fig. 7.17 Case XVII 17 (**a**–**p**). *Treatment planning*: clinical crown lengthening of the maxillary incisors and single-crown restoration (tooth 11). Baseline (**a**). Baseline – probing depth (**b**, **c**). Baseline – smile (**d**). Baseline (**e**). Delimitation of the new gingival margins (**f**). Removing the gingival collar (**g**). Osteotomy (**h**). Assessment of the distance between the bone crest and the cementoenamel junction – tooth 21 (**i**). Checking the height of the bone crest on both central incisors (**j**). Additional osteotomy with chisels (**k**). Final level of the bone crests (**l**). Flap positioned apically and sutured (**m**). Full-crown restoration installed in tooth 21 (**n**). Final result – smile (**o**). Final result (**p**)

Fig. 7.17 (continued)

Fig. 7.18 Case XVIII – 18 (**a**–**m**). *Treatment planning*: clinical crown lengthening and change of full-crown restorations invading the biologic width by a new set of porcelain crowns. Baseline – inflamed gingival tissue surrounding teeth 12, 11, and 21 due to the improper position of the full-crown margins (**a**–**e**). Gingival collars excised – teeth 12, 11, and 21 (**f**). Full-thickness flap raised (**g**). Bone crest remodeled (**h**). Flap positioned apically and sutured (**i**). Three-week follow-up (**j**). One-month follow-up (**k**). Old crowns removed (**l**). Provisional restorations installed (**m**). Smile – provisional restoration (**n**). Provisional restoration – smile lateral view (**o**). Two-month follow-up (**p**). Two-month follow-up – smile (**q**). Two-month follow-up – smile lateral view (**r**). Two-month follow-up – smile lateral view (**s**). Definitive crowns – 4-month follow-up (**t**–**x**)

Fig. 7.18 (continued)

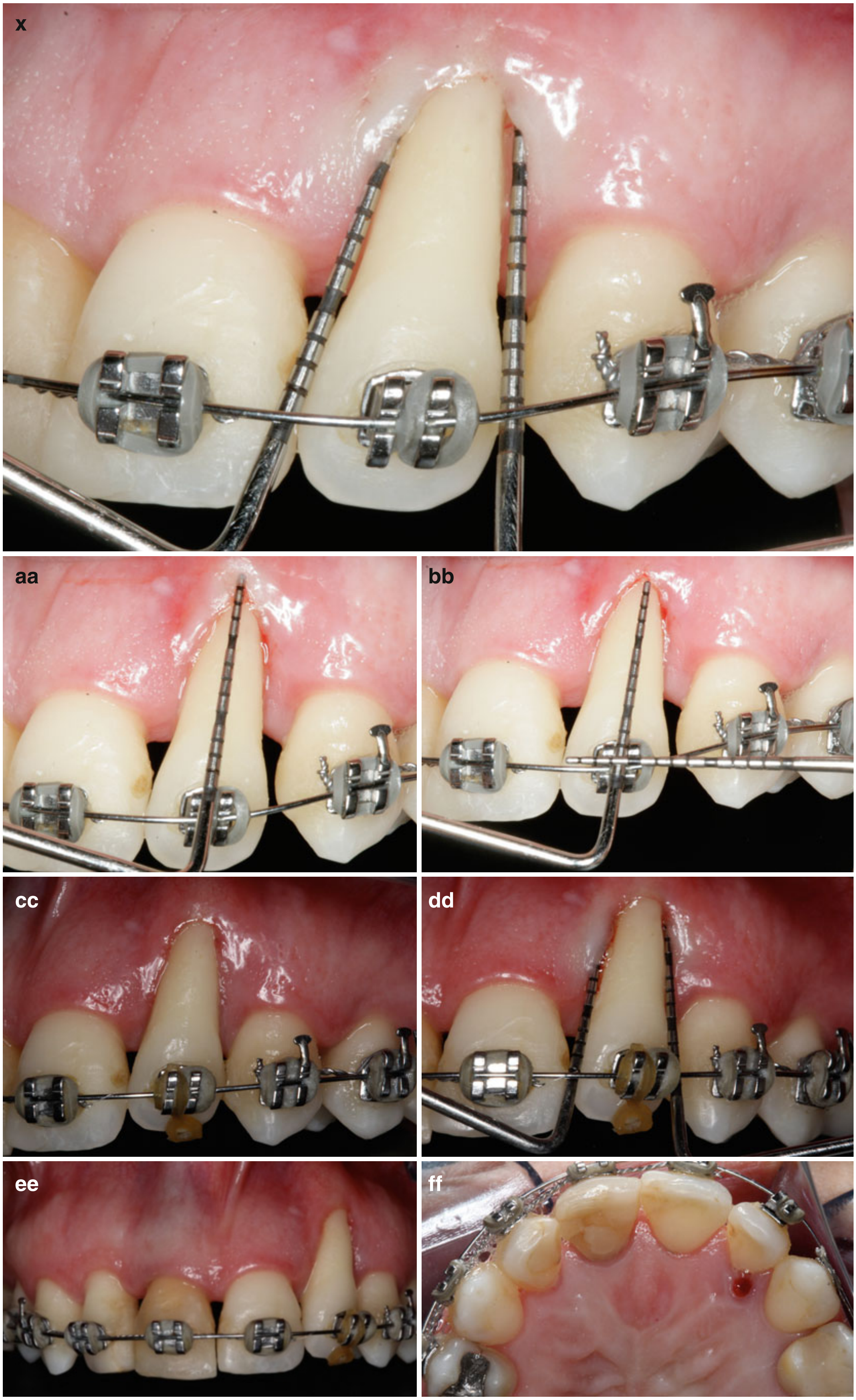
Fig. 7.18 (continued)

Fig. 7.18 (continued)

Fig. 7.19 Case XIX – 19 (**a**–**p**). *Treatment planning*: nonsurgical periodontal therapy (scaling and root planning), orthodontic treatment of the upper arch (intrusion and repositioning of tooth 23), and root coverage (subepithelial connective tissue graft + enamel derivative protein + coronally advanced flap). Baseline (**a**). Baseline – lateral view (**b**). Baseline – right side (**c**). Baseline – left side (**d**). Baseline – closer view of the positioning of tooth 23 (**e**). Before basic procedures (**f**). Probing depth before basic procedures (**g**). Probing depth before basic procedures (**h**). Probing depth before basic procedures (**i**). Location of the contact points (**j**). After basic procedures (**k**). Probing depths after basic procedures (**l**). Orthodontic appliance being prepared (**m**). Orthodontic appliance – lateral view (**n**). Mini implants used for tooth intrusion (**o**). Mini implants used for tooth intrusion – buccal view (**p**). Mini implants used for tooth intrusion – occlusal view (**q**). Mini implants used for tooth intrusion – lateral view (**r**). Partial intrusion of tooth 23 – frontal view (**s**). Partial intrusion of tooth 23 – close frontal view (**t**). Partial intrusion of tooth 23 – buccal view (**u**). Partial intrusion of tooth 23 – lateral view (**v**). Partial intrusion of tooth 23 – occlusal view (**w**). Regular checking of probing depths during orthodontic treatment (**x**). Regular checking of probing depths during orthodontic treatment (**aa**). Regular checking of recession depth during orthodontic treatment (**bb**). Final result after orthodontic treatment – buccal view (**cc**). Probing depths after orthodontic treatment (**dd**). Final result after orthodontic treatment – frontal view (**ee**). Final result after orthodontic treatment – occlusal view (**ff**). Final result after orthodontic treatment – occlusal view (**gg**). Flap raised (**hh**). Mechanical root preparation (**ii**). Graft being harvested from palate (**jj**, **kk**). Dimensions of the harvested graft (**ll**). Root surface after mechanical treatment (**mm**). Chemical preparation of the root surface (**nn**). Graft sutured over the recession (**oo**). Enamel matrix derivative (**pp**). Enamel matrix protein being applied between the root surface and the graft (**qq**). Clinical aspect after the application of the protein (**rr**). Flap being positioned (**ss**). Flap coronally advanced and sutured (**tt**). Final result – 4-month follow-up (**uu**, **vv**). Probing depth – 4-month follow-up (**ww**, **xx**, **aaa**)

Fig. 7.19 (continued)

Fig. 7.19 (continued)



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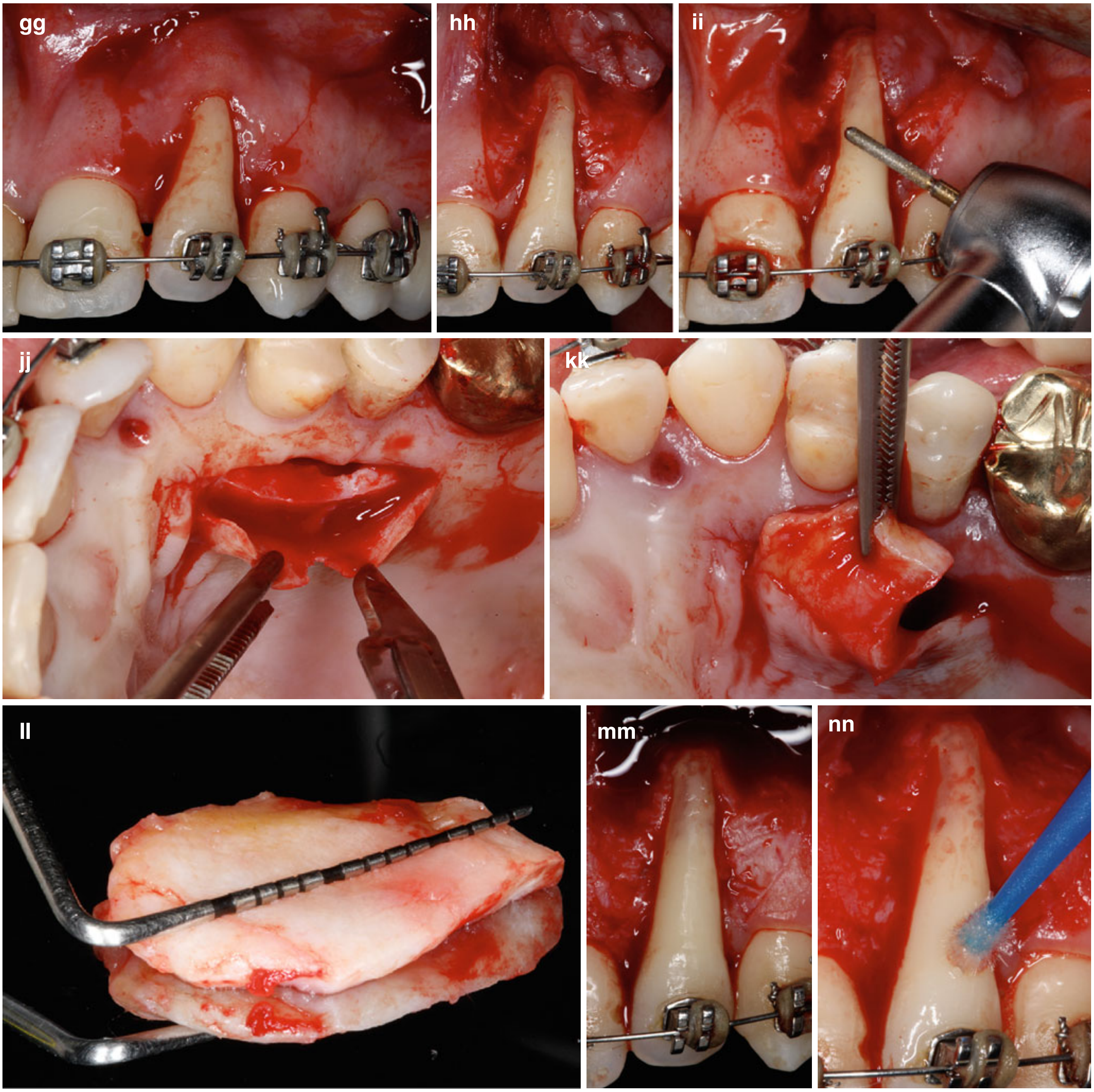

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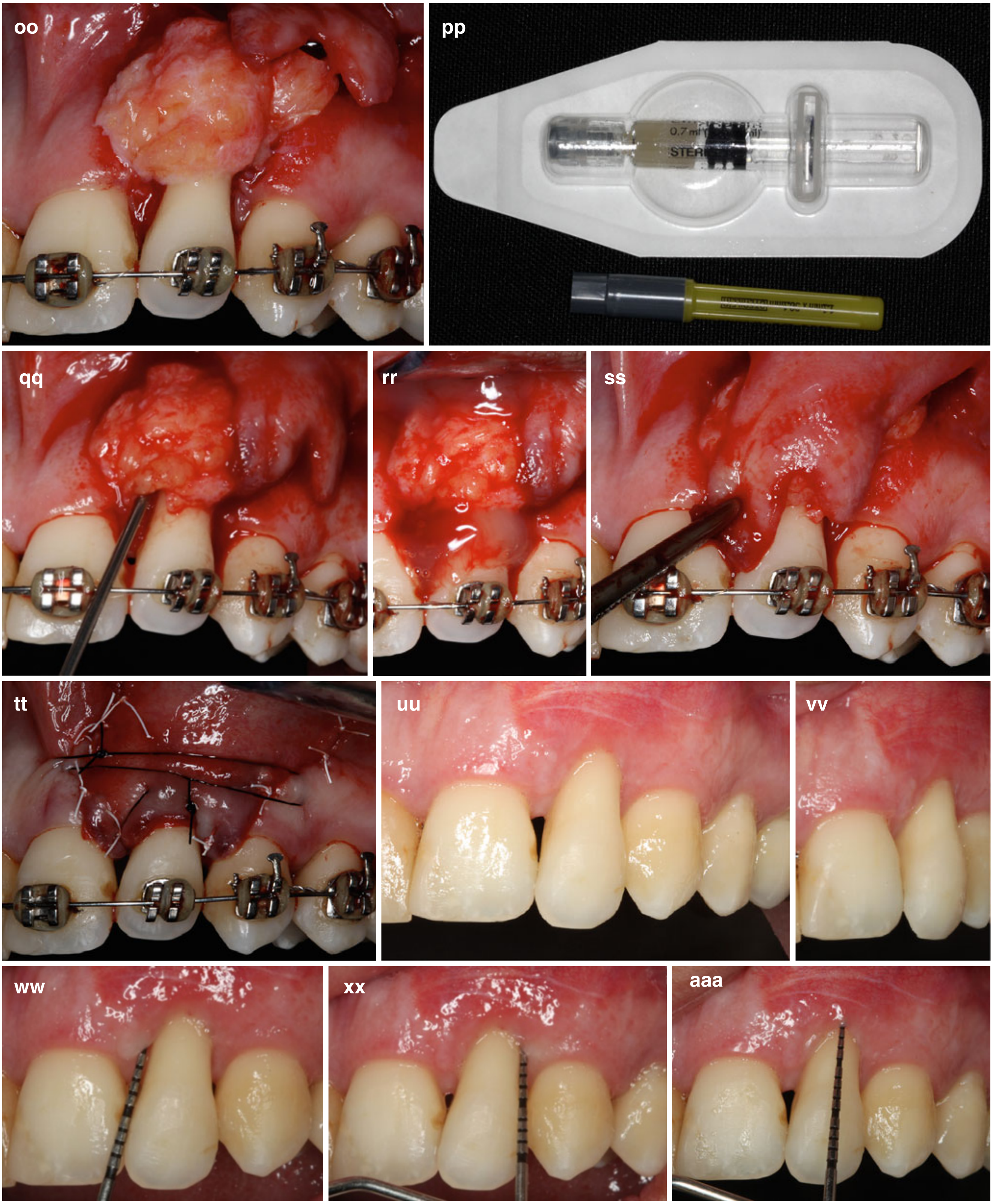


Fig. 7.19 (continued)

Fig. 7.20 Case XX – 20 (**a**–**s**). *Treatment planning*: orthodontic tooth extrusion (with fiberotomy) and clinical crown lengthening of maxillary incisors (case conducted with the participation of Dr. Rodrigo Carlos Nahas de Castro Pinto). Baseline (**a**–**d**). Orthodontic appliance being prepared (**e**). Orthodontic appliance activated (**f**). Buccal intrasulcular incision (**g**). Palatal intrasulcular incision (**h**). Scaling and root planning – buccal site (**i**). Scaling and root planing – palatal site (**j**). Two weeks after the beginning of treatment (**k**). Final orthodontic result – 6 weeks of activation followed by 16 weeks of wait (**l**). Final orthodontic result – occlusal view (**m**). Final result after the removal of orthodontic appliance (**n**). Baseline radiograph (**o**). Final radiograph – evident positive changes in the interproximal bone may be seen (**p**). Gingival collar removal around central incisors (**q**). Osteoplasty (**r**). Final results (**s**)

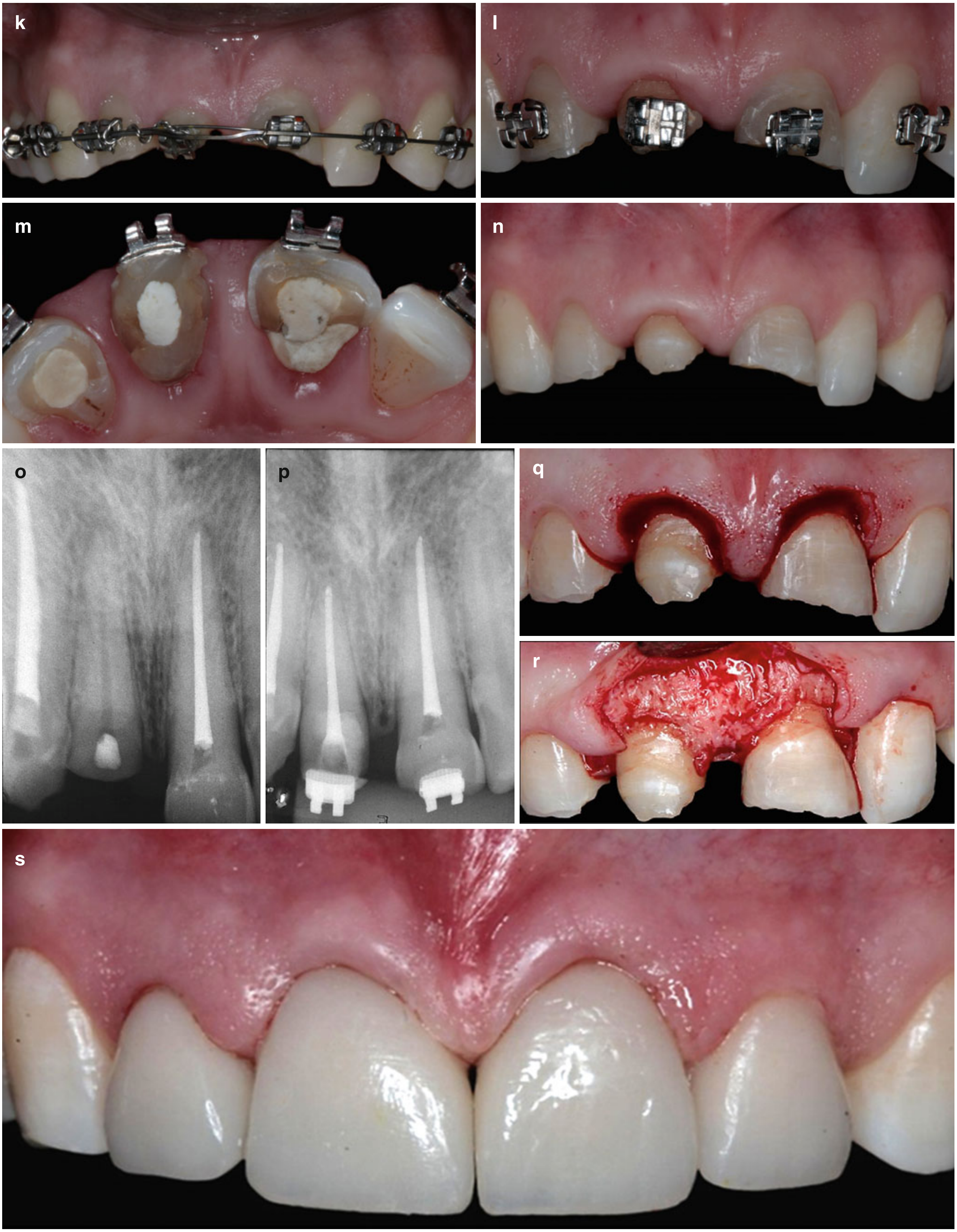


Fig. 7.20 (continued)

7.2 Potential Clinical Scenarios: Treatment Approaches for Implant Sites Requiring Perimplant Plastic Surgery

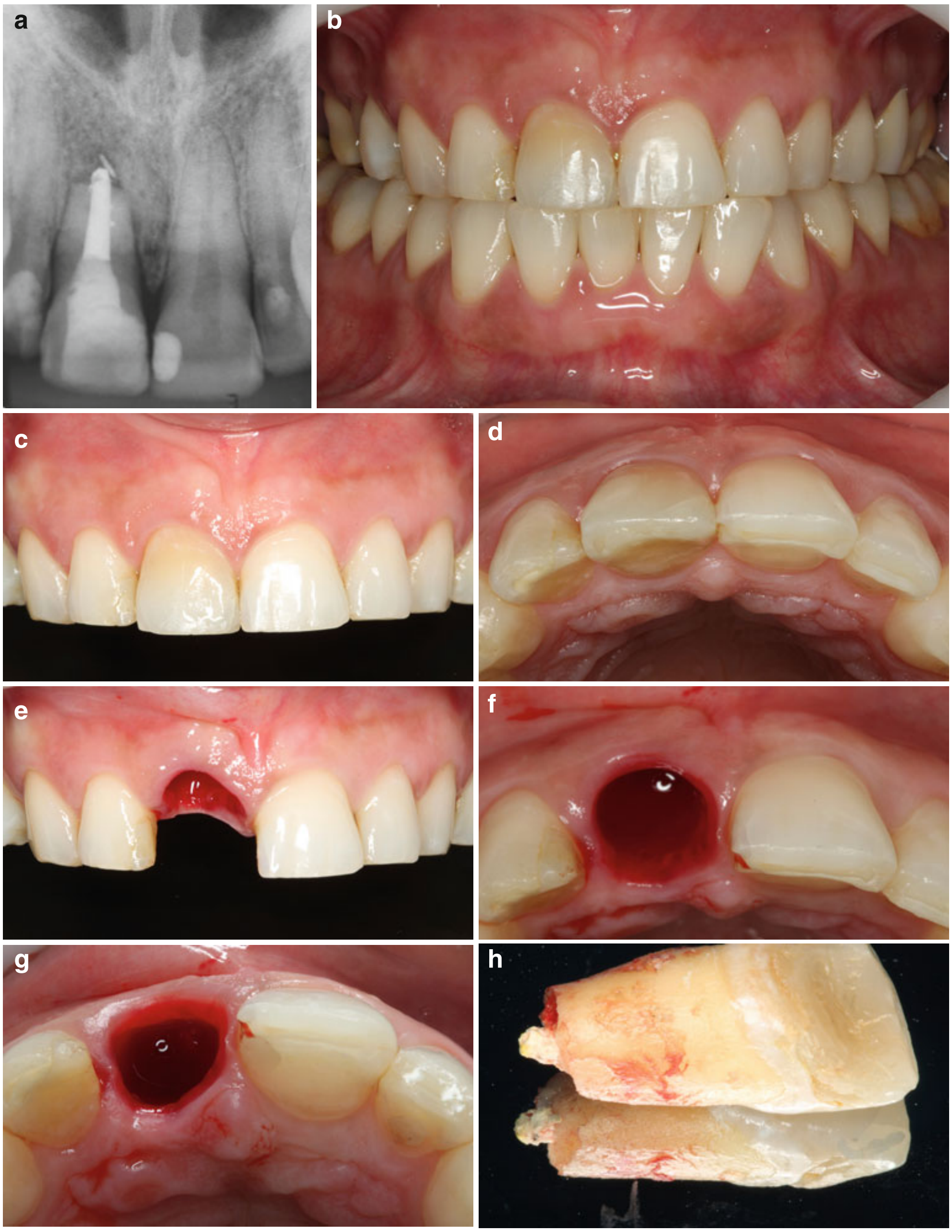


Fig. 7.21 Case XXI – 21 (**a–h**). Treatment planning: atraumatic tooth extraction of tooth 11 due to external root resorption, immediate implant placement, soft tissue augmentation with subepithelial connective tissue graft, socket filling/provision preservation with alloplastic bone substitute, immediate provisional restoration (without occlusal contact), and definitive porcelain cemented single-crown restoration 6 months after surgical procedures. Baseline – external resorption at the root apex (**a**). Baseline – clinical aspect (**b**, **c**). Baseline (occlusal view) (**d**). Atraumatic tooth extraction (**e**). Post-extraction ridge – occlusal view (**f**, **g**). Extracted tooth – external resorption. Case XXI–21 (**i–x**). Extracted tooth – external resorption (**i**). Immediate implant placement (**j**, **k**). Partial-thickness flap dissection (**m**). Checking the position of the buccal bone crest (**l**). Checking the dissected site (**n**). Soft tissue graft being positioned (**o**). Bone substitute being placed (**p**). Grafts accommodation (**q–s**). Soft tissue graft sutured (**t**). Sequence of provisional implant restoration (**u**, **v**). Tooth crown adapted as provisional restoration (**w**). Case XXI–21 (**x–oo**). Radiograph after implant installation (**x**). Tooth crown adapted as provisional restoration – occlusal view (**aa**). Six-month follow-up – occlusal view (**cc**). Six-month follow-up (**bb**). Amount of alveolar ridge thickness preserved (**dd**). Prosthetic component and porcelain crown prepared (**ee–gg**). Prosthetic component screwed to the implant (**hh**, **ii**). Definitive porcelain crown (**jj**). Definitive restoration being cemented (**kk**). Radiograph exam with definitive restoration installed (**ll**). Final result (**mm–oo**)

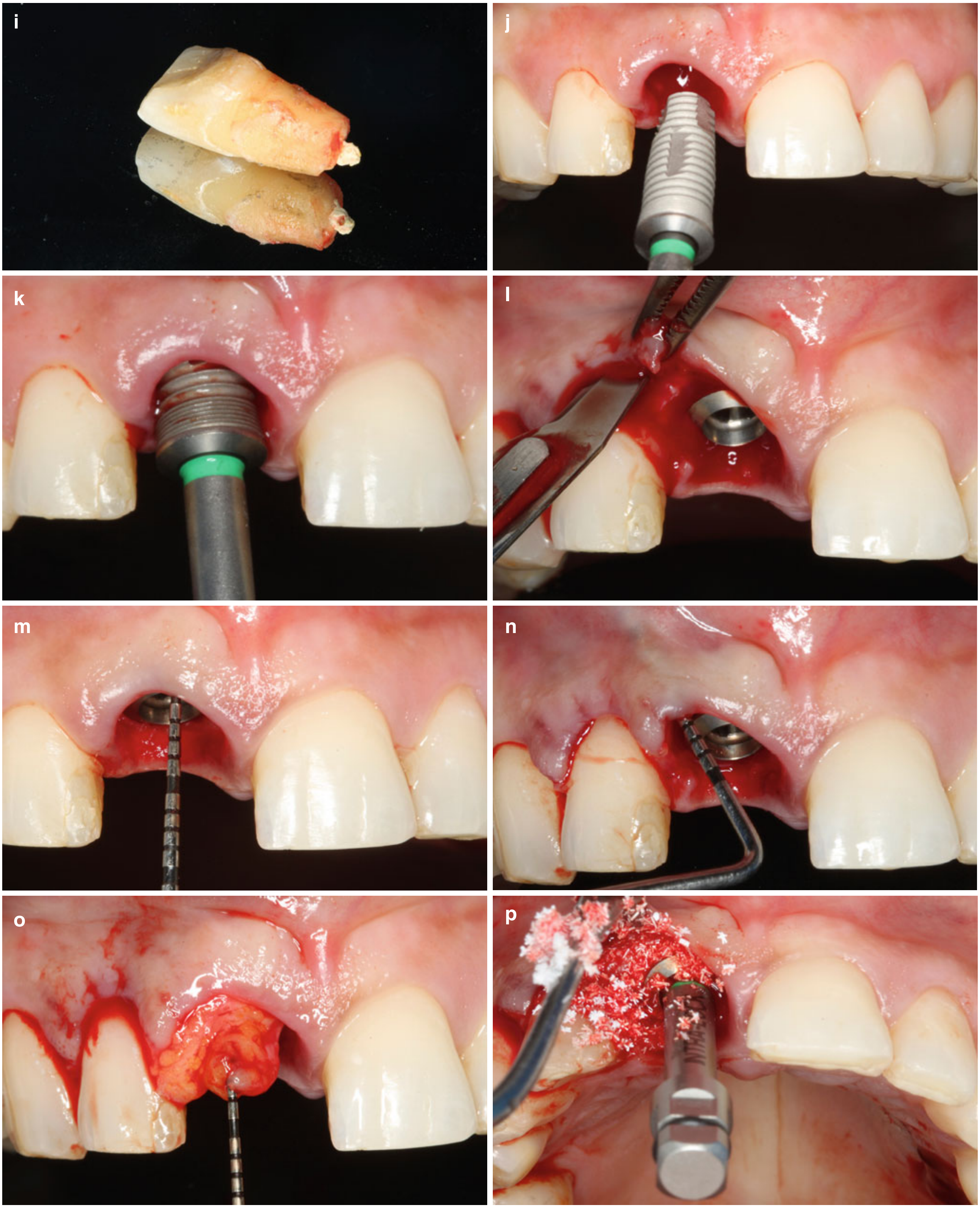
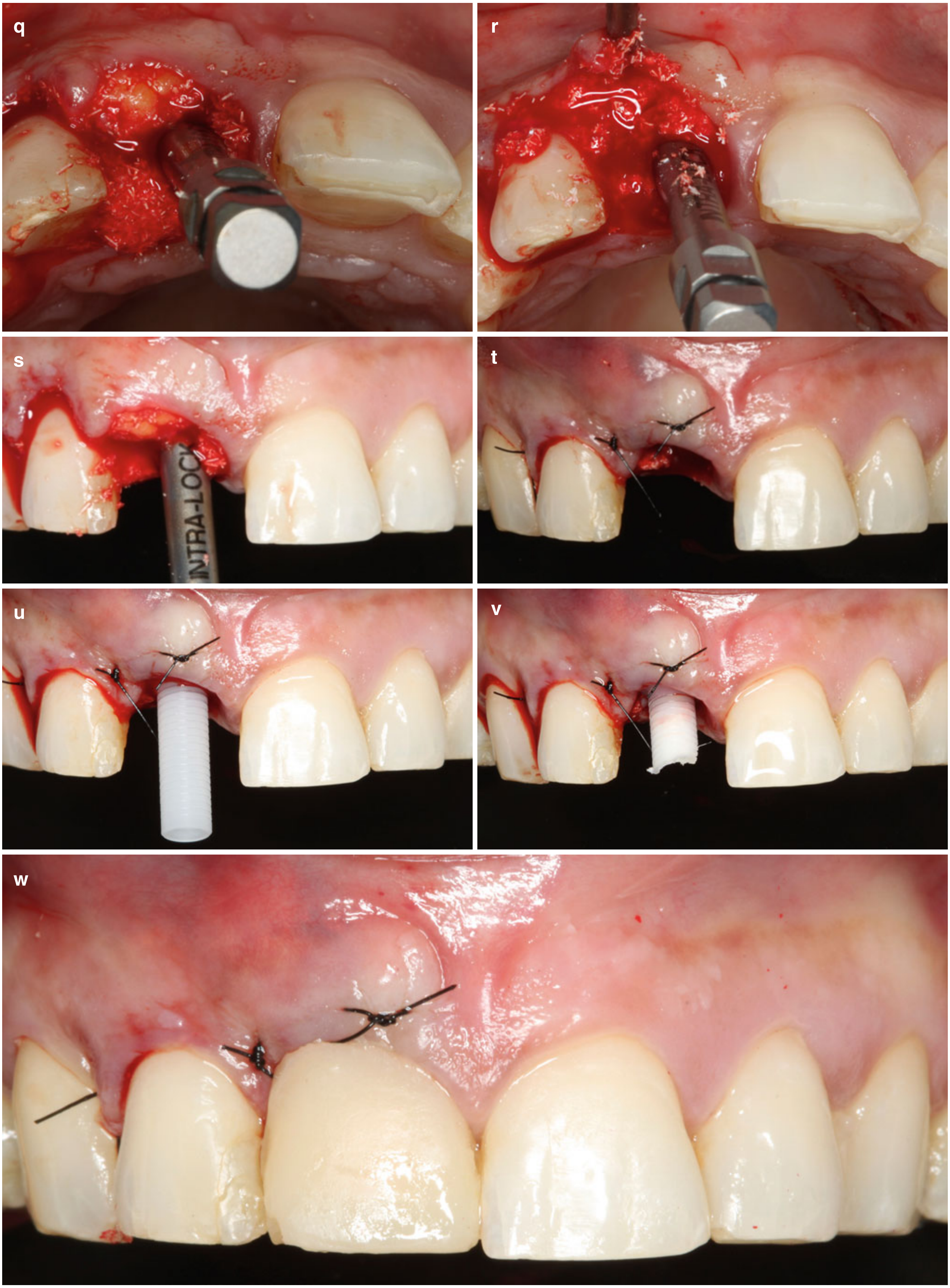


Fig. 7.21 (continued)



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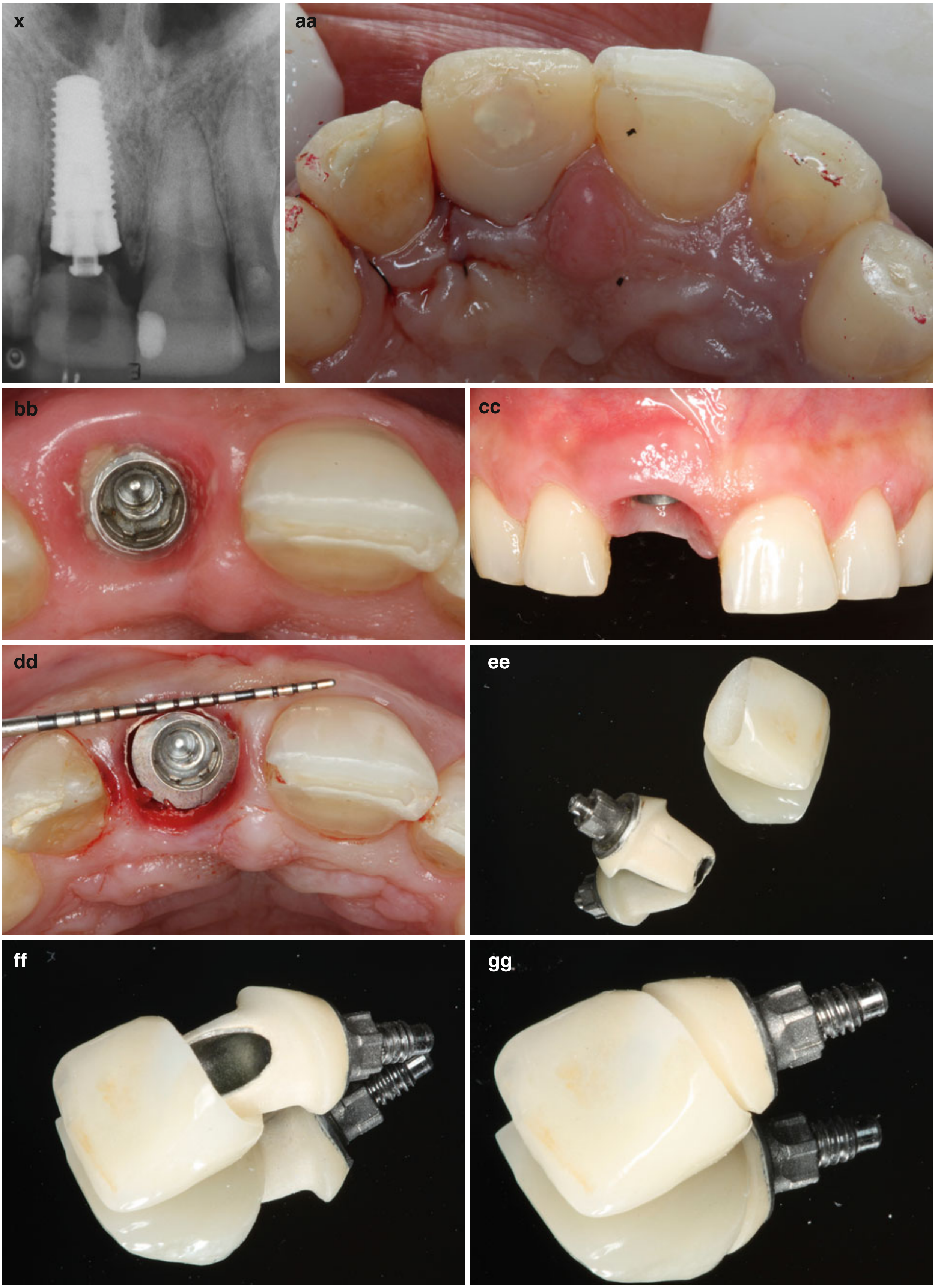

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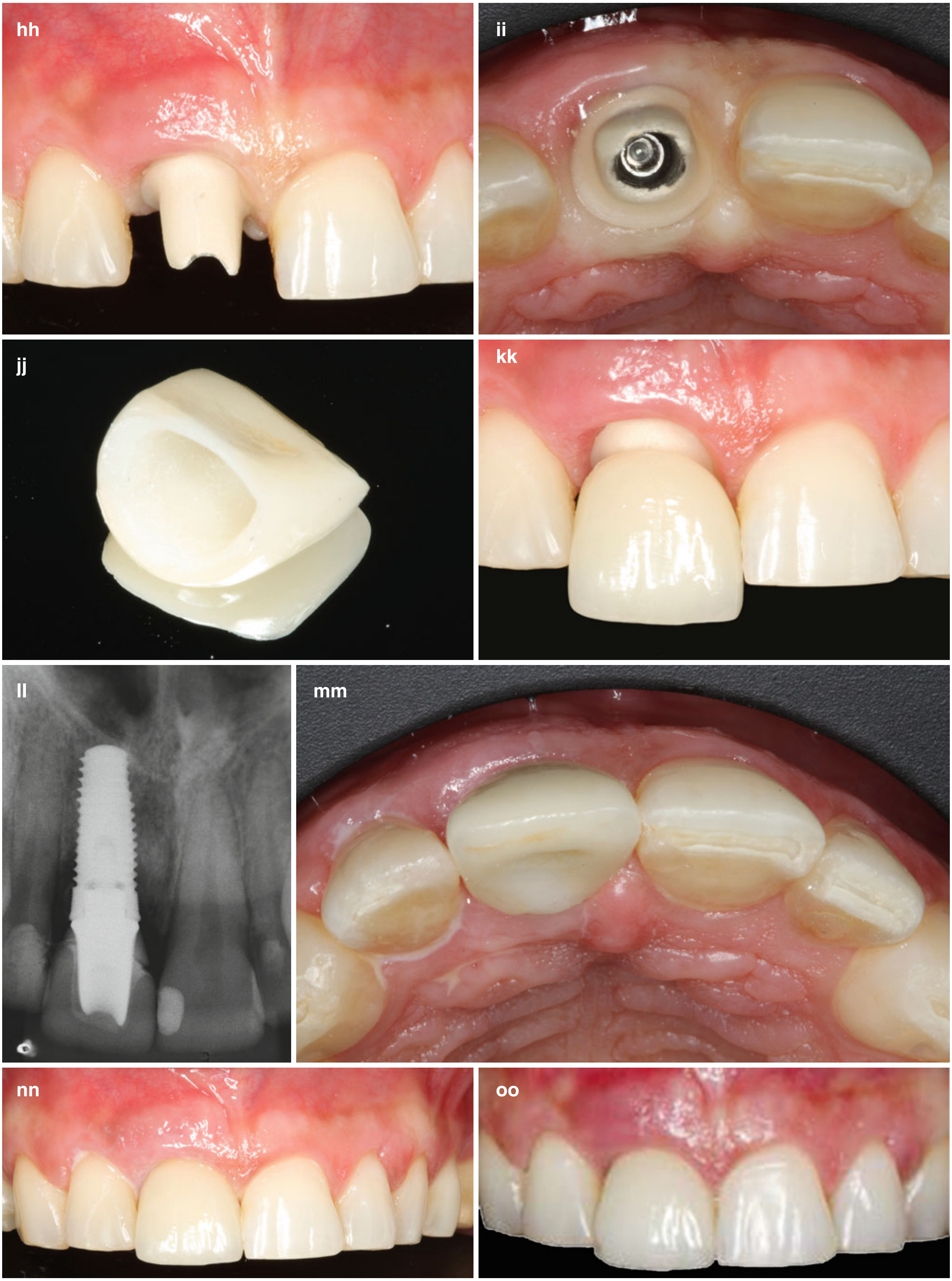
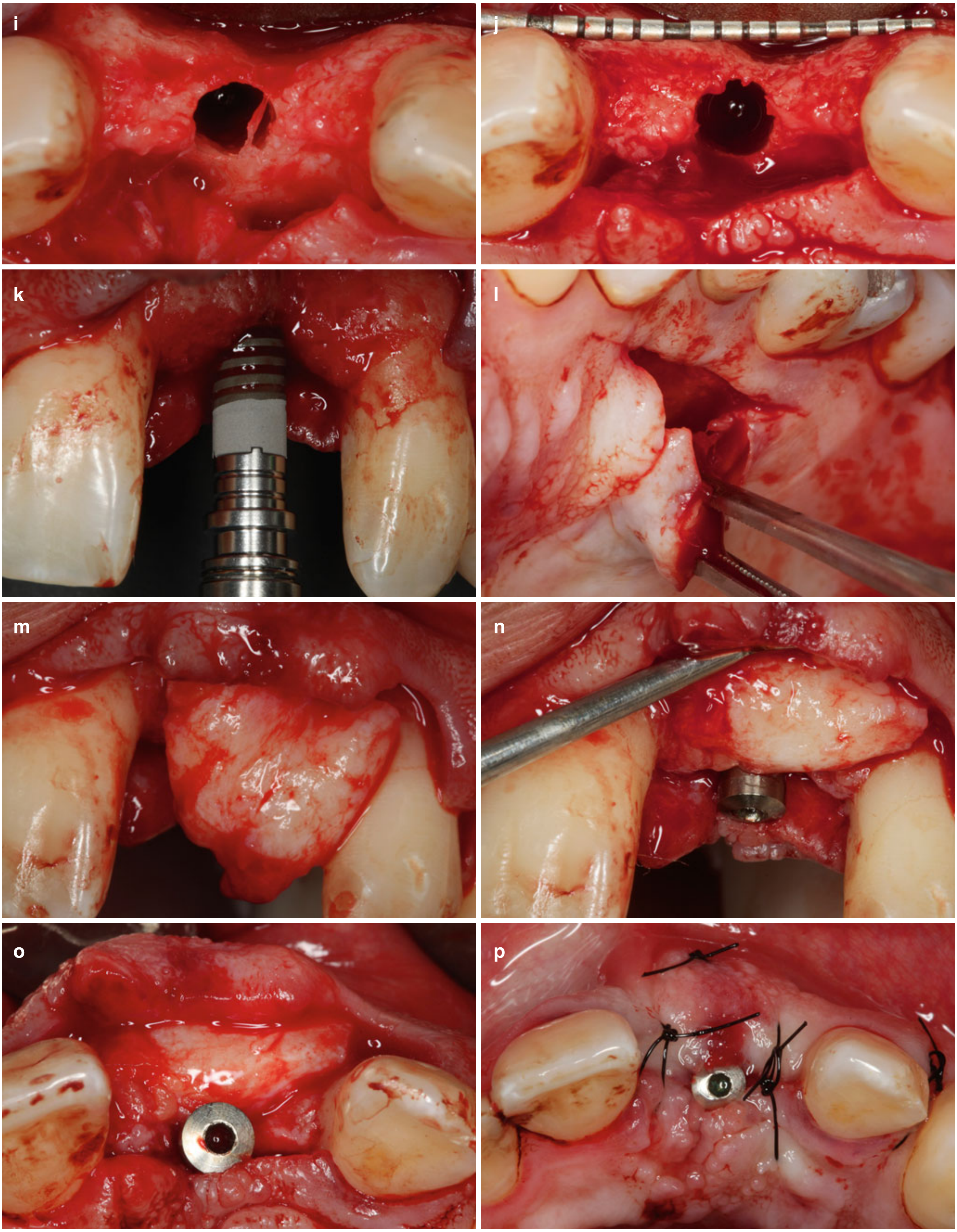


Fig. 7.21 (continued)

Fig. 7.22 Case XXII–22. Treatment planning: implant placement, soft tissue augmentation with subepithelial connective tissue graft, provisional restoration, and porcelain cemented single-crown restoration 6 months after surgical procedures. Baseline (**a**–**e**). Horizontal incision over the alveolar ridge connecting the intrasulcular incisions performed at teeth 11 and 22 (**f**). Full-thickness flap raised (**g**). Delimitation of the tooth-implant-tooth distance (**h**). Alveolar ridge after drilling the recipient site to receive the implant (**i**). Assessment of the osseous deformity formed due to ridge resorption following tooth 21 extraction (**j**). Implant being installed (**k**). Graft being harvested (**l**). Graft being positioned between the alveolar ridge and the internal side of the full-thickness flap (**m**). Graft in position (**n**). Graft in position – occlusal view (**o**). Flap sutured (**p**). Provisional restoration fixed to adjacent teeth (**q**). One-week follow-up (**r**–**t**). One-month follow-up (**u**, **v**). Prosthetic components (**w**–**bb**). Provisional cemented crown installed (**cc**). Radiograph of the provisional crown installed (**dd**). Six months after implant installation – frontal view (**ee**–**hh**). Assessment of the alveolar ridge (**ii**). Peri-implant sulcular epithelium (**jj**). Vascularization and anatomy of the peri-implant mucosa (**kk**, **ll**). Definitive porcelain crown being installed (**mm**). Definitive porcelain crown installed (**nn**, **oo**). Final radiograph (**pp**)



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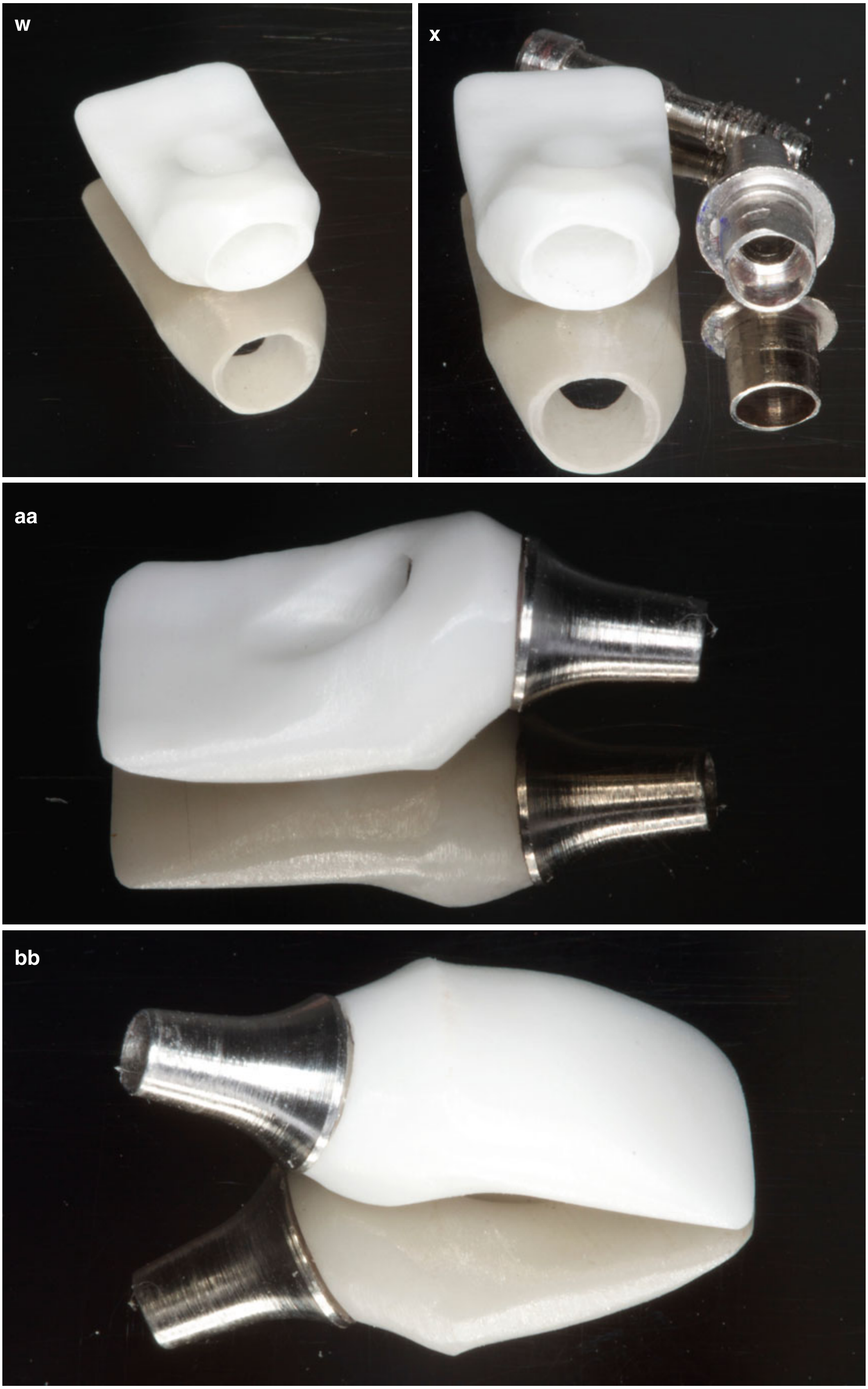

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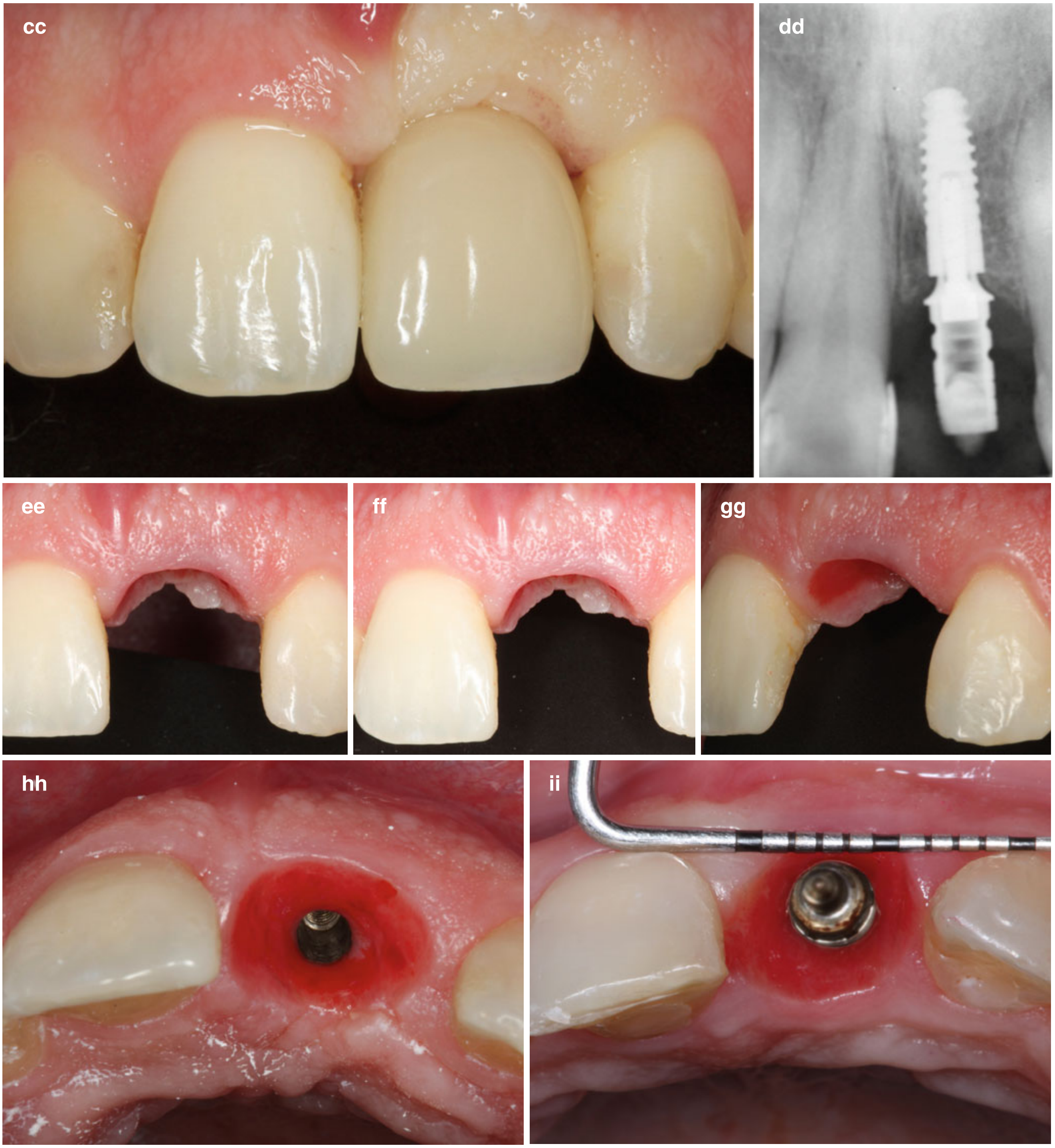

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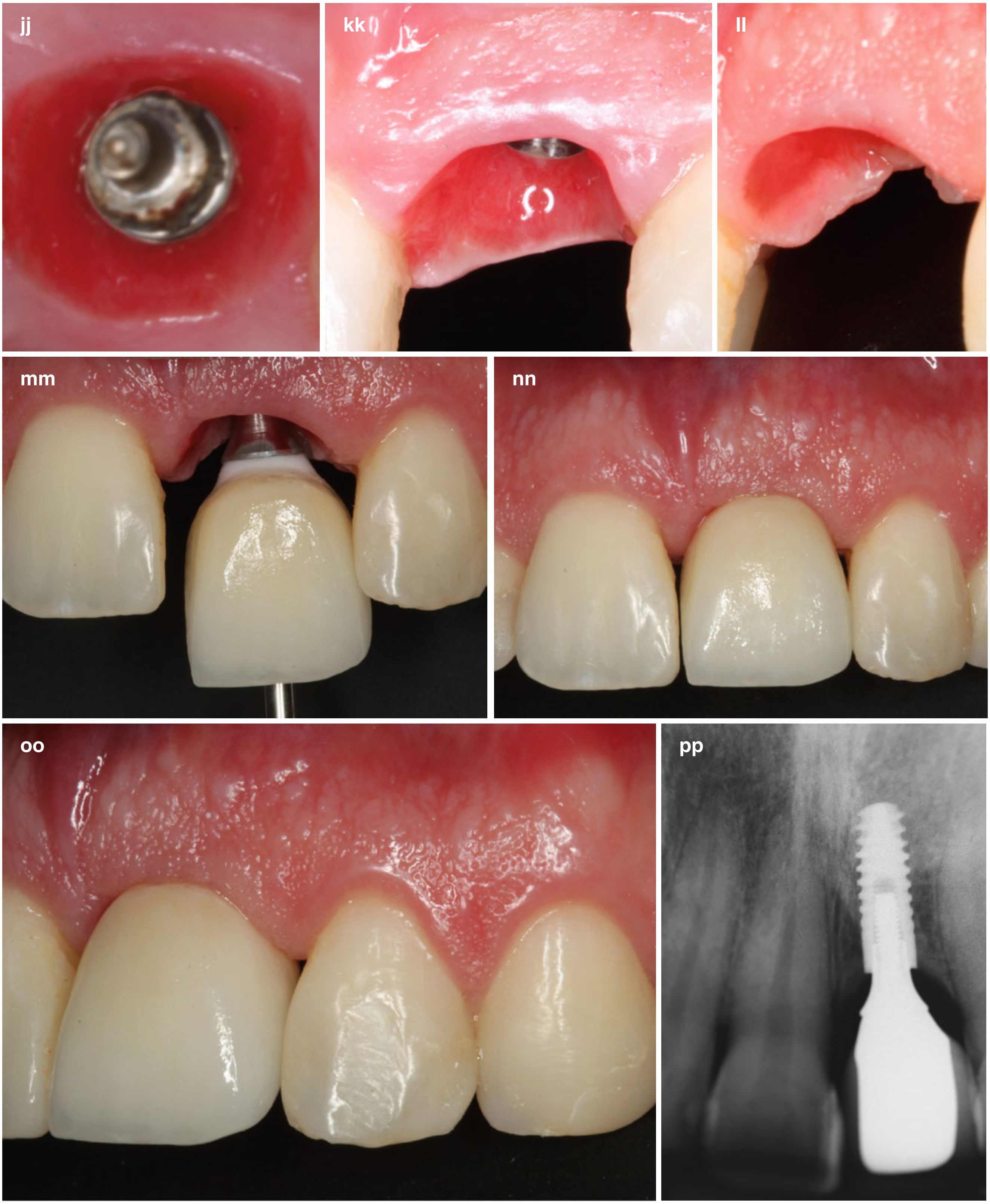

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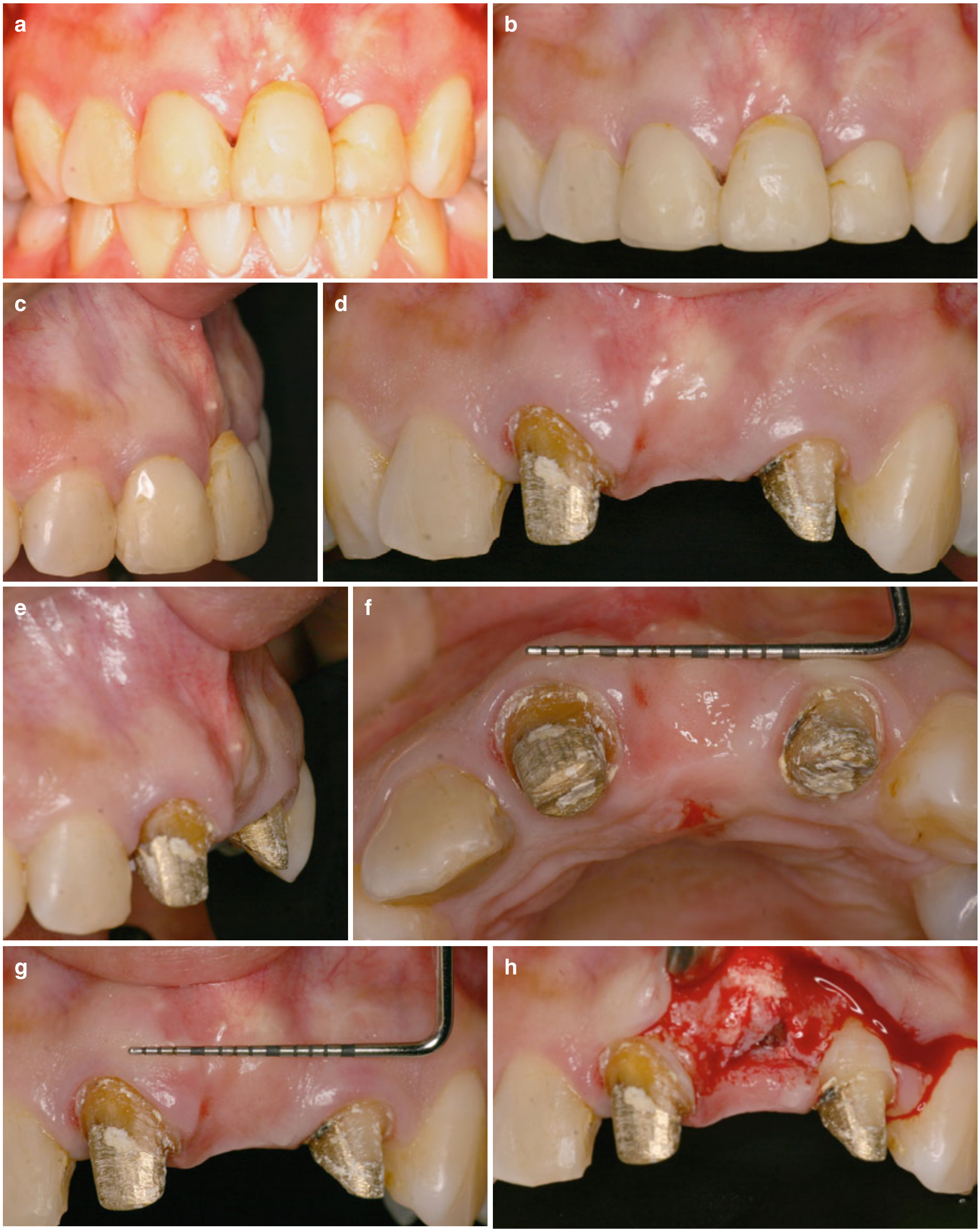
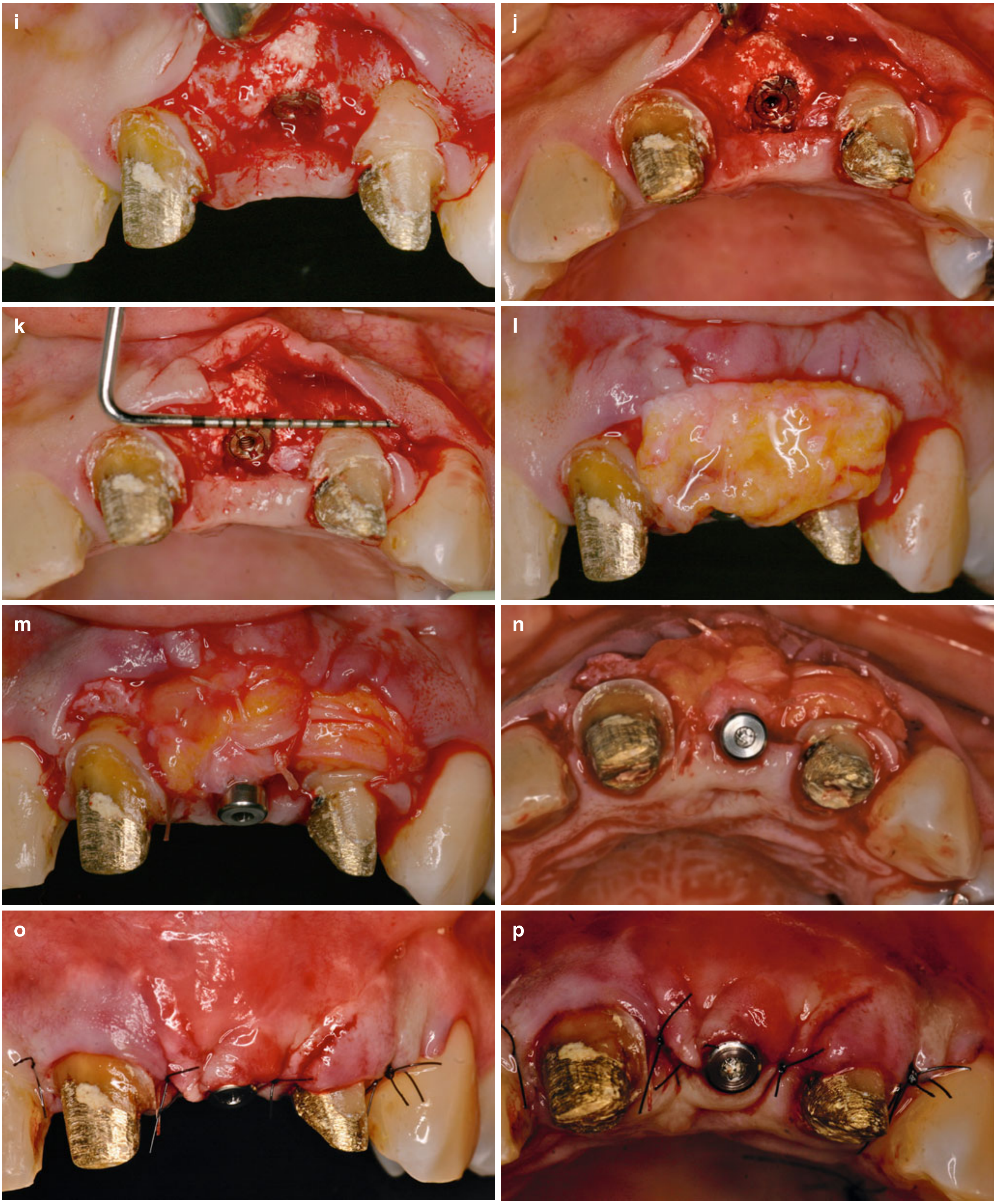


Fig. 7.23 Case XXIII – 23 (**a**–**p**). Treatment planning: implant reopening, soft tissue augmentation with subepithelial connective, and porcelain single-crown restorations. Baseline (**a**–**c**). Clinical aspect of the soft tissues following provisional restoration removal (**d**). Clinical aspect of the soft tissues following provisional restoration removal (**e**, **f**). Assessment of the area/perimplant site to be grafted (**g**). Full-thickness flap raised (**h**–**j**). Trans-surgical assessment of the area to be grafted (**k**). Graft being positioned (**l**). Graft sutured to the recipient site (**m**, **n**). Flap repositioned and sutured (**o**, **p**). Assessment of the soft tissue contour of the alveolar ridge (**q**–**s**). Provisional restorations replaced (**t**, **u**). Clinical condition of the soft tissues at the day of new provisional restoration cementation (**v**, **w**). Interproximal soft tissue tooth/implant (**x**). New provisional crowns cemented (**aa**, **bb**). Clinical condition of the soft tissues at the day of definitive restorations cementation (**cc**–**ee**). Definitive porcelain crowns (**ff**, **gg**). Definitive crowns cemented (**hh**, **ii**, **jj**). Adequate lip-crown relationship (**kk**). Radiograph – just before crown's cementation (**ll**). Final result (**mm**–**oo**)



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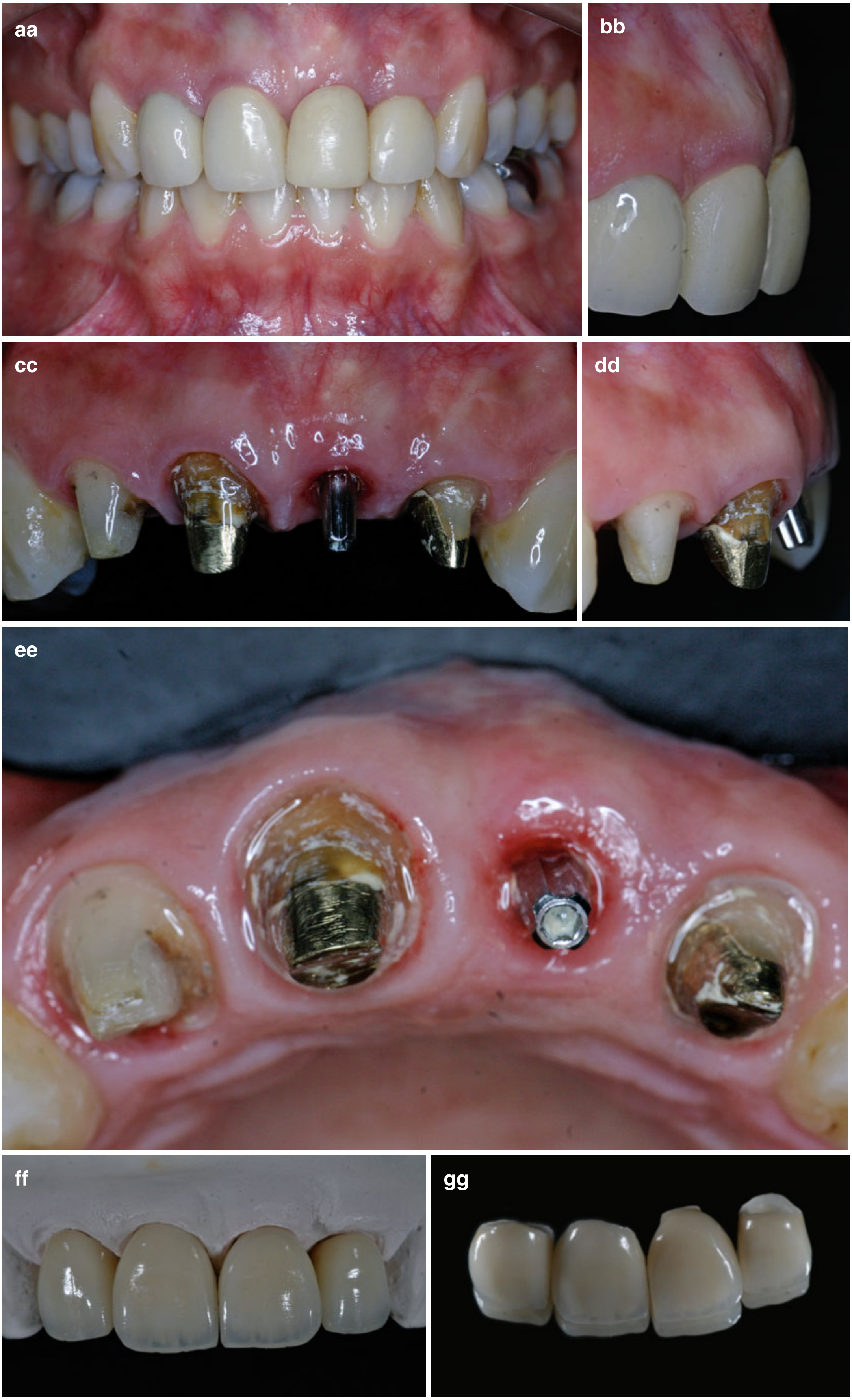

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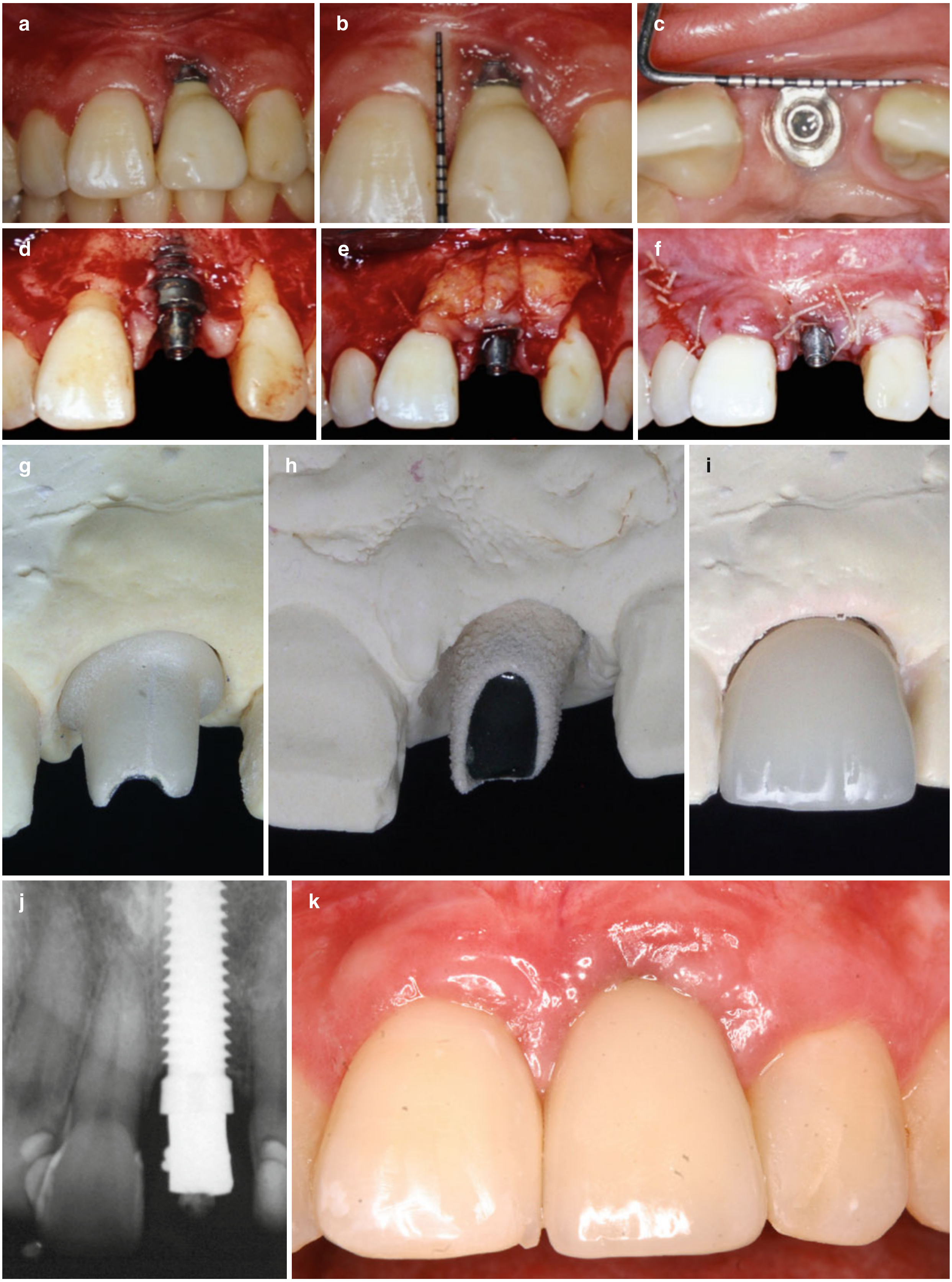

Fig. 7.24 Case XXIV – 24 (**a**–**n**). Treatment planning: implant surface decontamination, implant thread coverage (subepithelial connective tissue graft), and new porcelain cemented single-crown restoration 6 months after the surgical procedure. Baseline (**a**). Assessment of the vertical peri-implant mucosa needed to recover the implant (**b**). Assessment of the amount of horizontal peri-implant mucosa needed to recover the implant (**c**). Full-thickness flap raised (**d**). Graft sutured over the implant after thread decontamination (**e**). Flap coronally advanced covering completely the graft (**f**). New implant components (**g**–**i**). Radiography showing the peri-implant conditions before new crown installation (**j**). New crown installed 6 months after surgery (**k**). Assessment of probing depths 6 months after surgery (**l**–**n**).

Fig. 7.24 (continued)

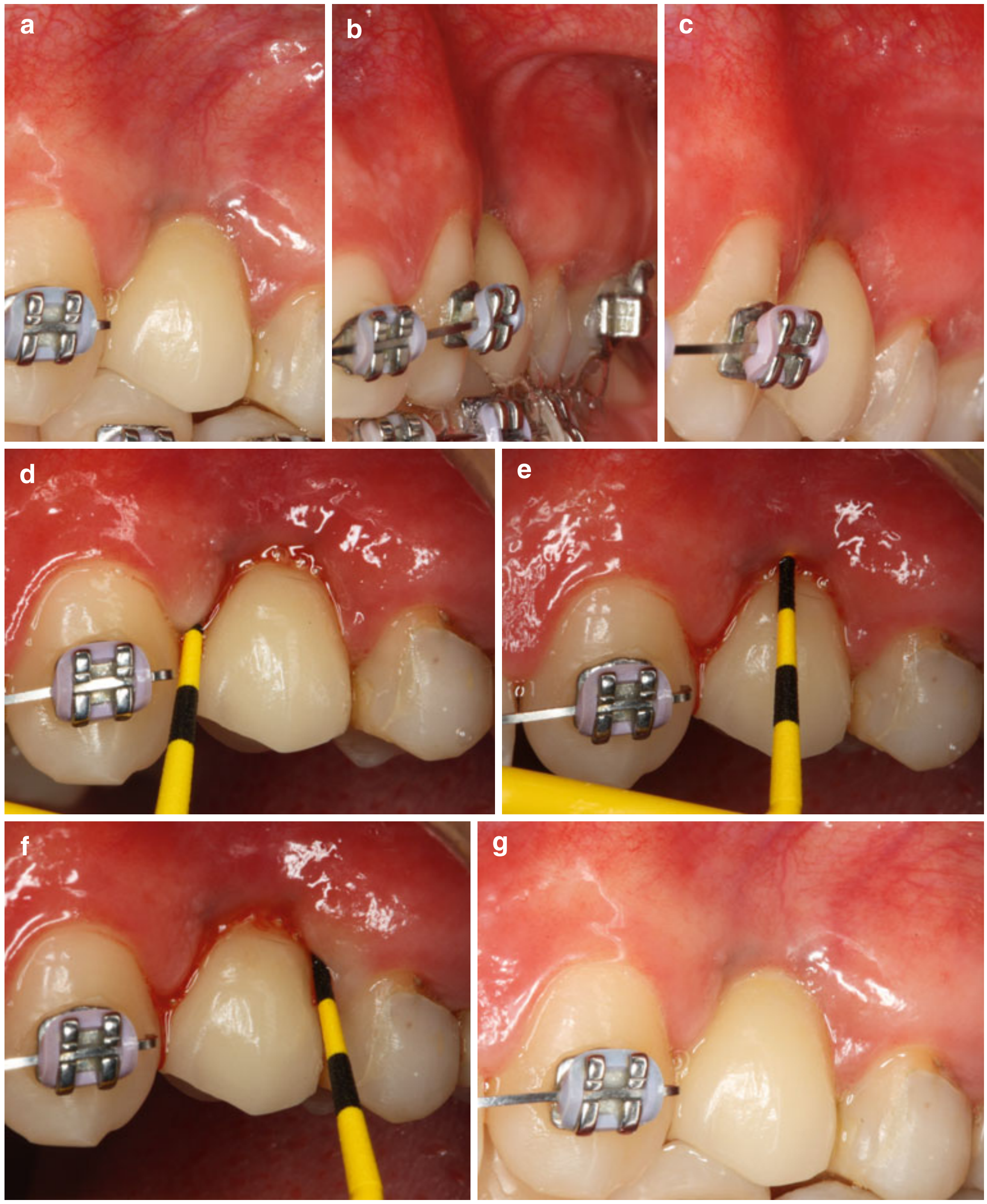

Fig. 7.25 Case XXV – 25 (**a**–**m**). Treatment planning: treatment of mucositis, laser decontamination, and soft and hard tissue augmentation with subepithelial connective tissue graft and synthetic bone graft material. Baseline (**a**–**c**). Probing depths at baseline – detection of mucositis (**d**–**f**). Baseline – day of surgery (**g**). Intrasulcular incisions performed (**h**). Full-thickness flap being raised (**i**). Flap raised (**j**, **k**). Identification of an osseous fenestration over the implant surface (**l**). Pigment applied before laser application (**m**) Laser application (**n**, **o**). Bone substitute placed (**p**, **q**). Soft tissue being harvested (**r**). Resorbable membrane being placed over the bone substitute (**s**). Soft tissue graft sutured at the recipient site (**t**). Flap repositioned and sutured (**u**). 45-day follow-up (**v**, **w**). Three-month follow-up (**x**, **aa**)

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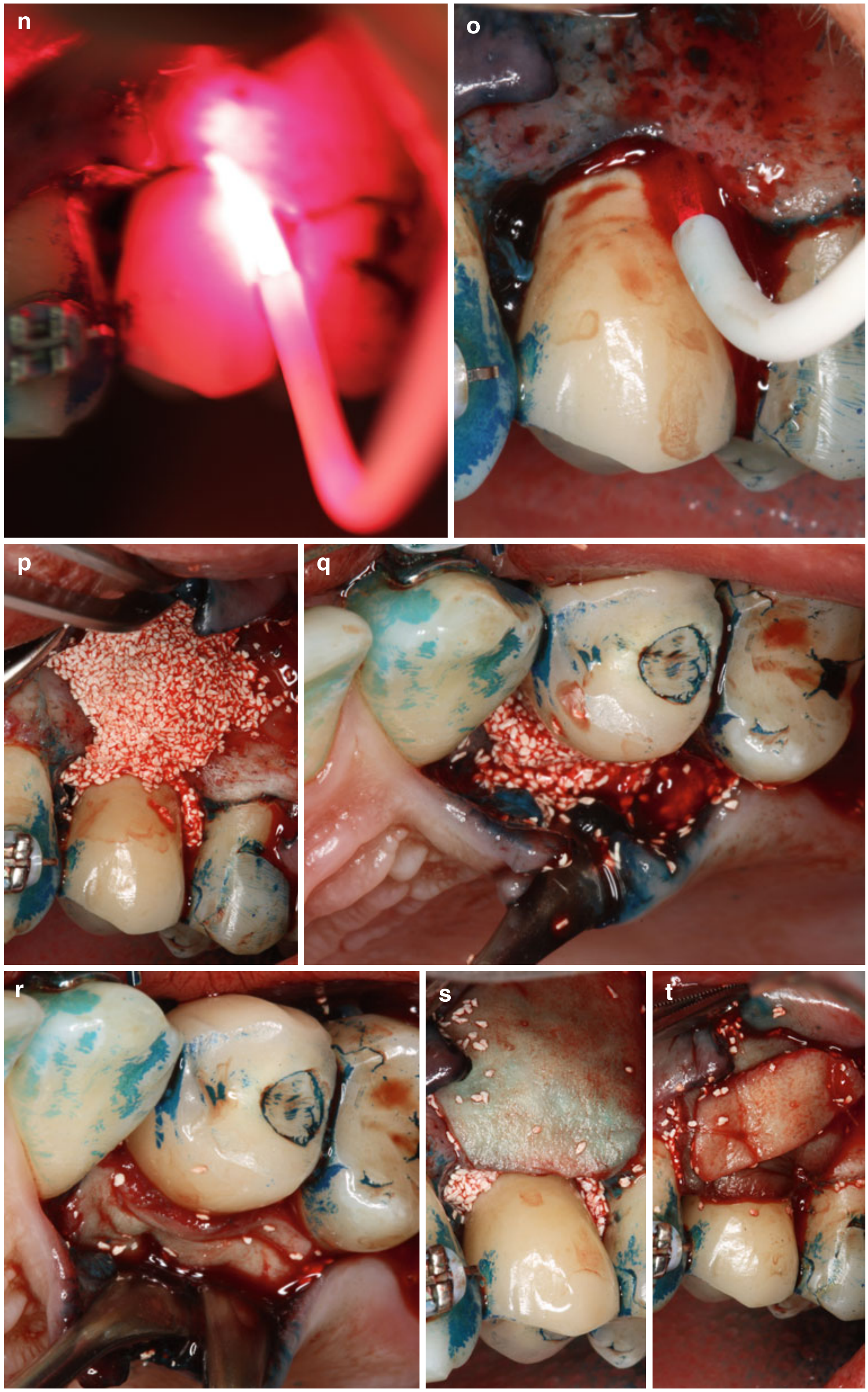

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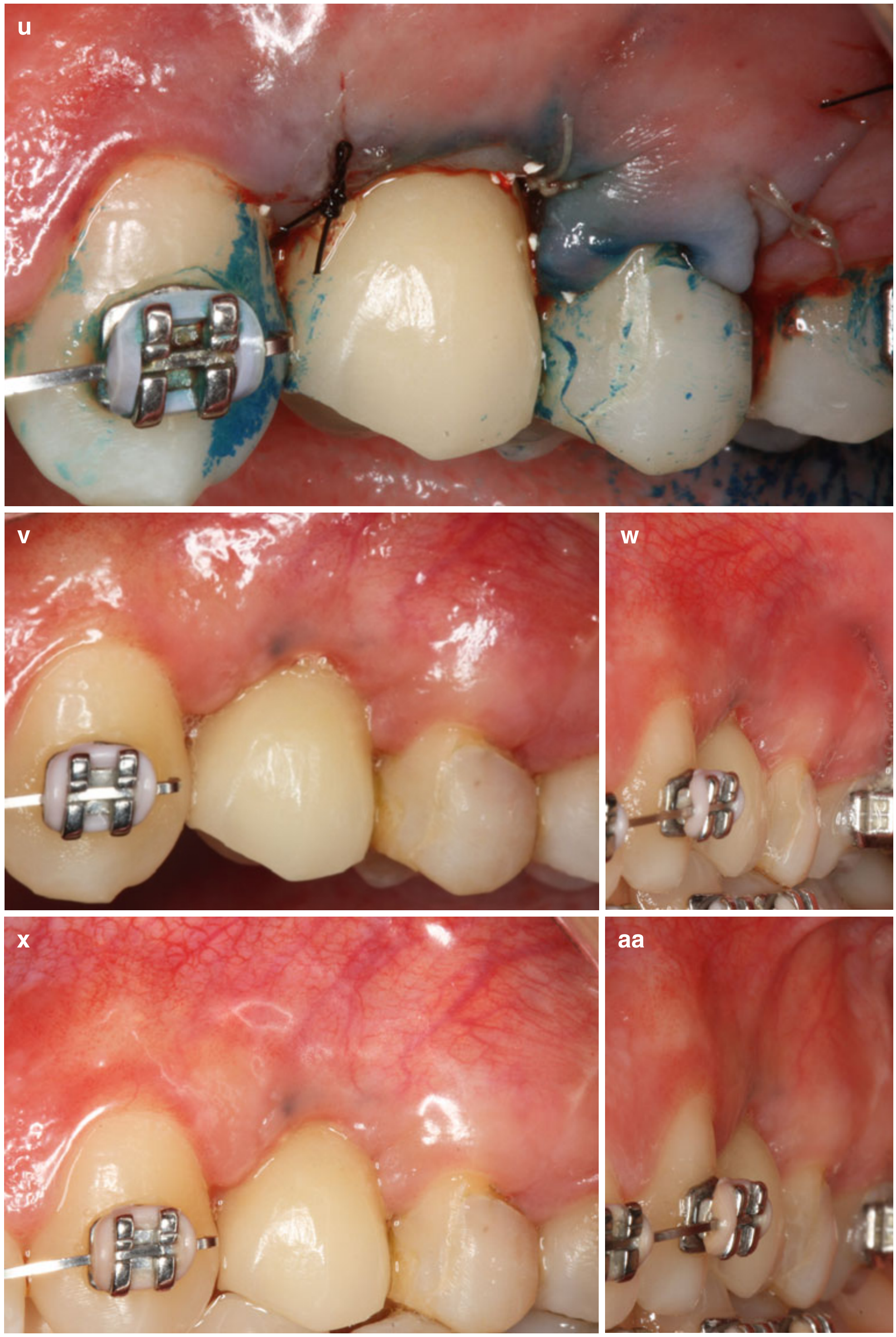


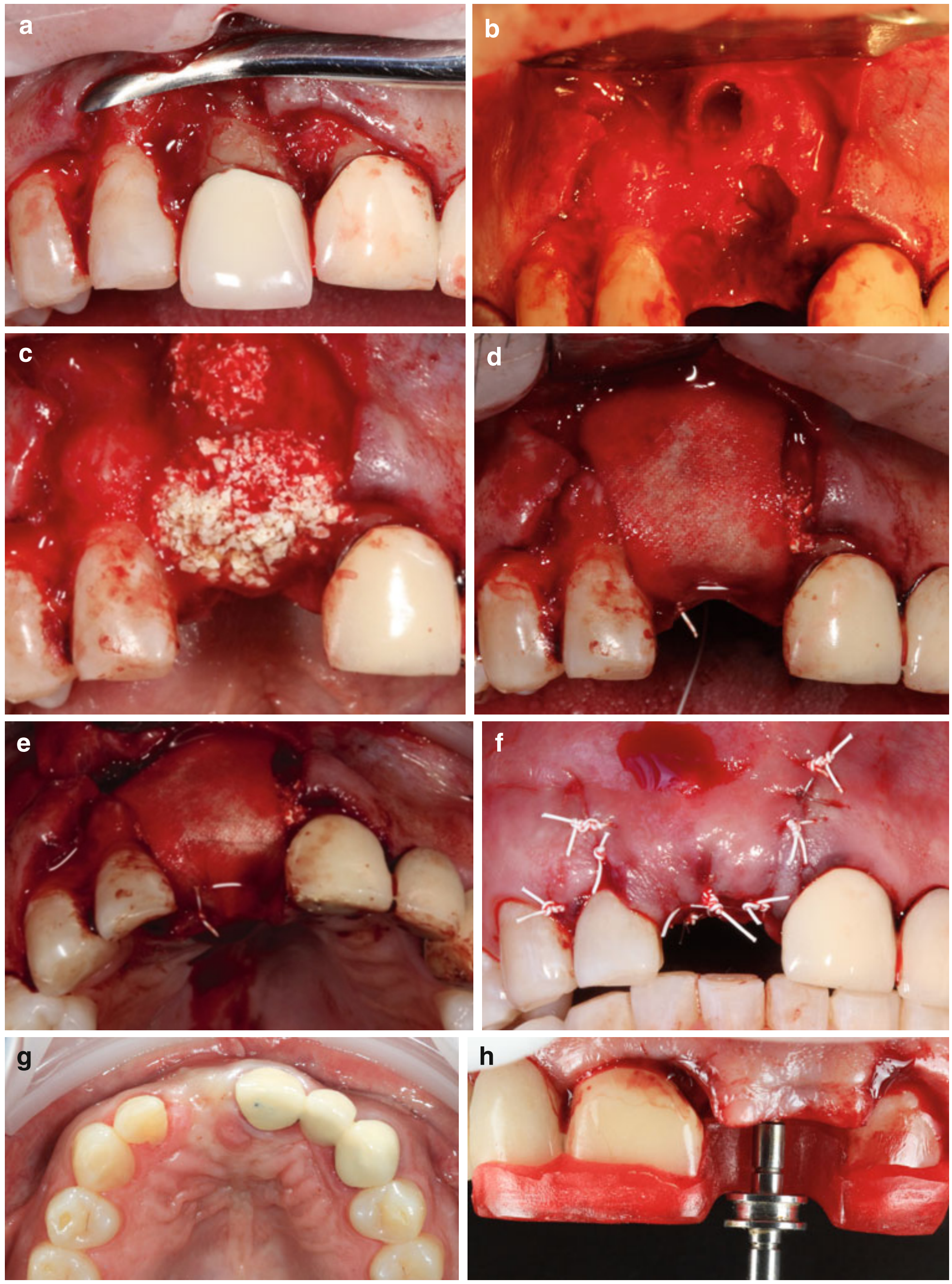
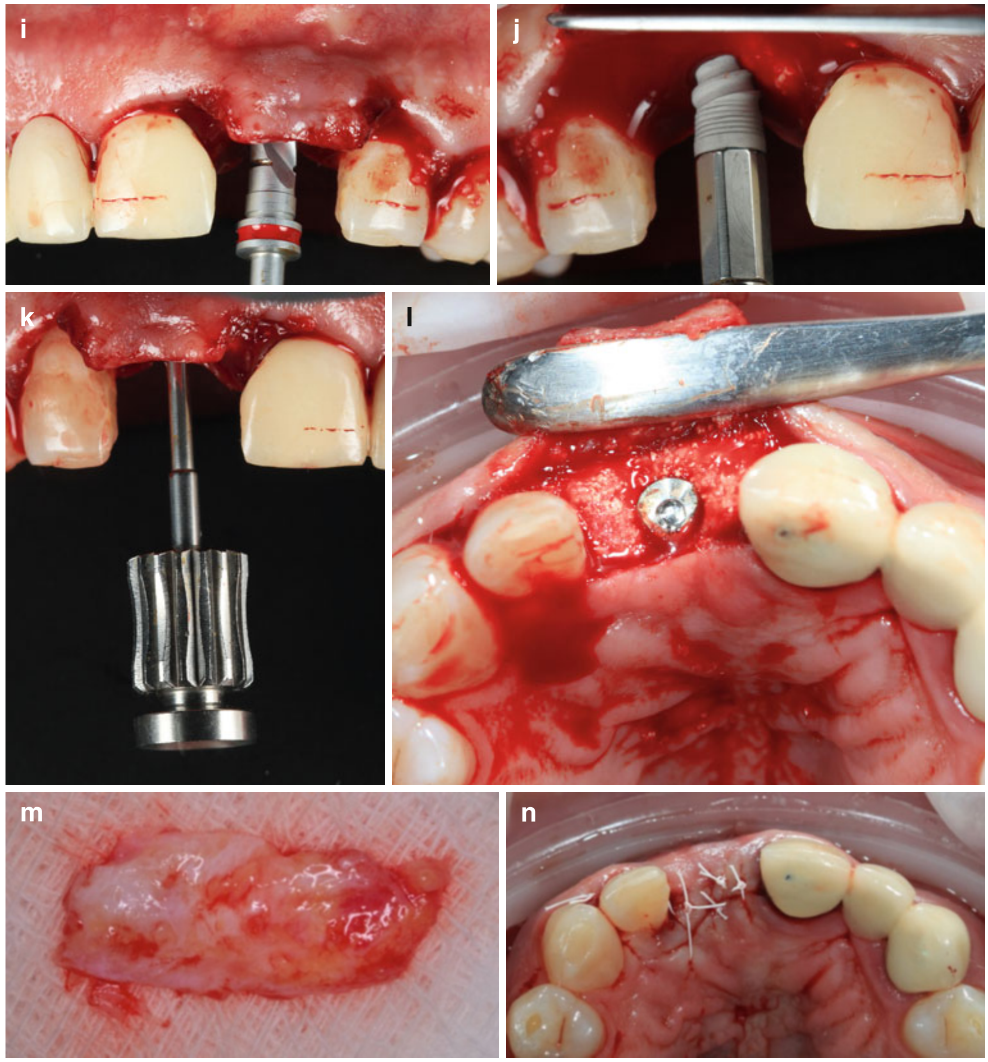


Fig. 7.26 Case XXVI – 26 (**a**–**n**). Treatment planning: extraction of tooth 11 due to root fracture, guided osseous regeneration (bone substitute + absorbable membrane), implant placement, soft tissue augmentation with subepithelial connective tissue graft, and provisional restoration after osseointegration. Flap raised exposing a root fracture of tooth 11 (**a**). Condition of the alveolar ridge after tooth extraction (**b**). Bone substitute placed on the alveolar ridge (**c**). Absorbable membrane placed over the graft (**d**). Membrane sutured to the recipient site (**e**). Flap coronally advanced and sutured (**f**). Six-month follow-up – day of implant installation (**g**). Implant site preparation (**h**). Implant being placed (**i**, **j**). Placement of cover screw (**k**). Cover screw placed (**l**). Soft tissue graft harvested (**m**). Flap repositioned and sutured after soft tissue graft placement (**n**). Flap coronally positioned and sutured after soft tissue graft placement (**o**). Provisional crown (**p**, **q**). Provisional crown installed 4 months after implant placement (**r**). Provisional crown being installed 4 months after implant placement (**s**). Probing depths after crown installation (**t**, **u**). Provisional crown installed 4 months after implant placement (**v**). Condition of the peri-implant mucosa 6 months after implant placement (**w**). Definitive crown cemented (**x**)

Fig. 7.26 (continued)



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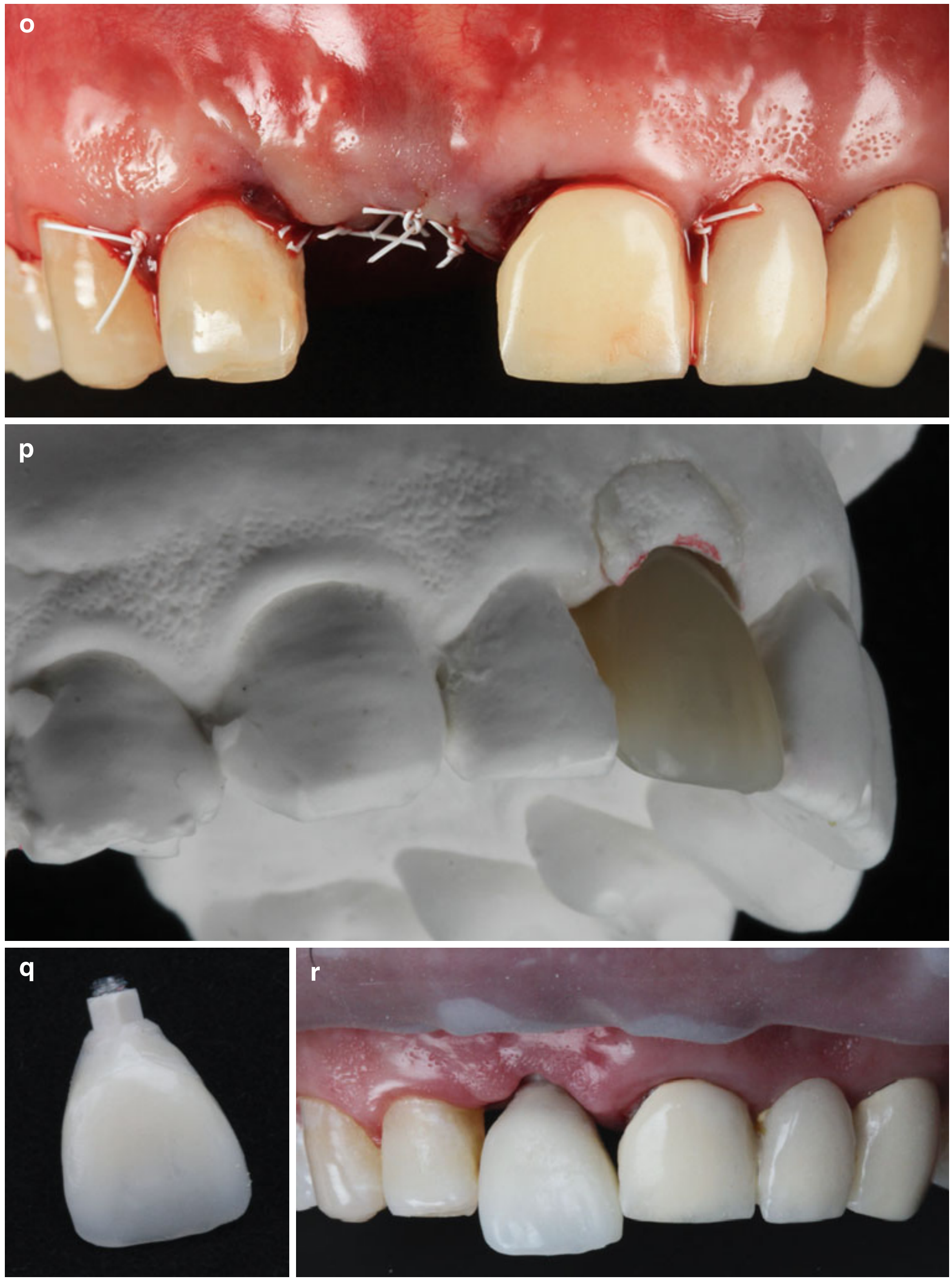

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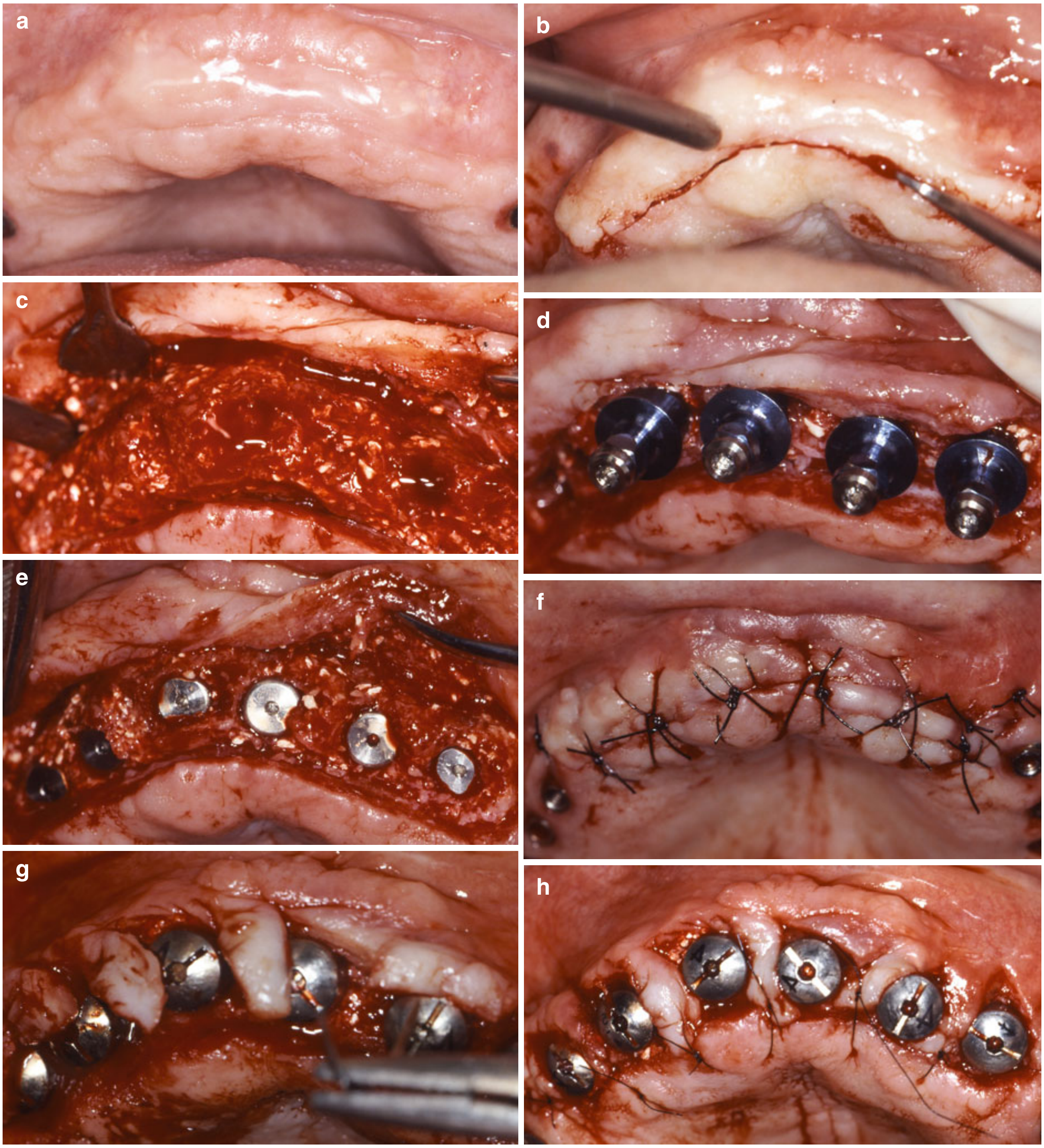
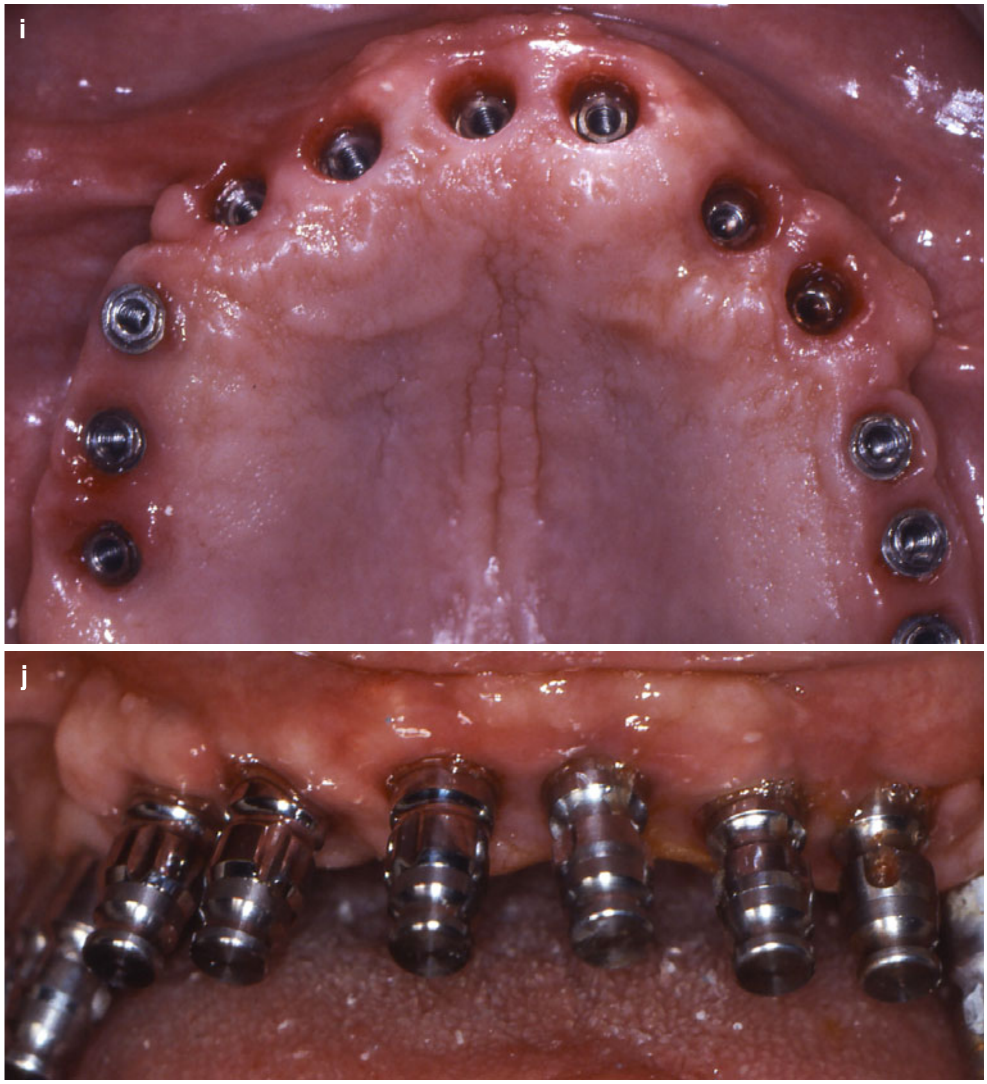


Fig. 7.27 Case XXVII – 27 (**a**–**j**). *Treatment planning*: placement of multiple implants at a previously grafted site (allogenous bone graft + absorbable membrane), the use of mini-pedicle flaps during reopening, soft tissue augmentation with free gingival grafts, and cemented porcelain crown bridges. Baseline (**a**). Crestal incision (**b**). Full-thickness flap elevated showing the results achieved with guided osseous regeneration (**c**). Implants being installed (**d**). Implants installed (**e**). Flap repositioned and sutured (**f**). Reopening 6 months later – mini-pedicle flaps designed to improved interproximal tissue around implants (**g**). Mini-pedicle flap rotated and sutured at the interproximal sites of the implants (**h**). Three-month follow-up (**i**). Parallelism of all implants – between 3 and 12 months after reopening of the anterior implants, free gingival grafts were performed to improve the width of keratinized tissue before the installation of the definitive restorations (**j**). Clinical aspect of soft tissue grafted sites (**k**–**o**). Titanium structure of the prosthesis (**p**). Final fixed prosthesis (**q**, **r**). Ten-year follow-up – definitive restorations (**s**, **t**). Twelve-year follow-up – definitive restorations – the lower arch received similar treatment 2 years earlier to the upper arch (**u**). Ten-year follow-up – definitive restorations (**v**–**cc**)



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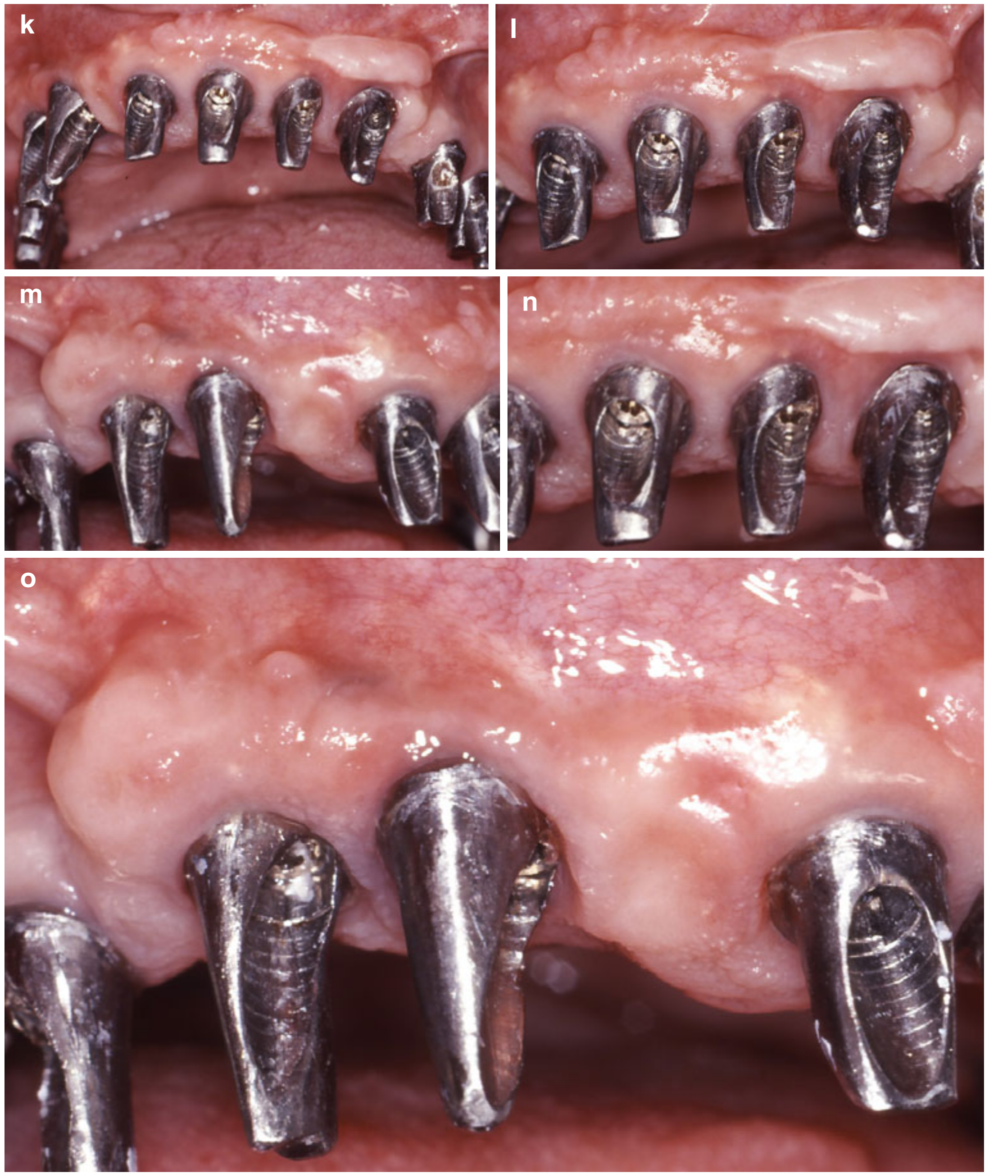

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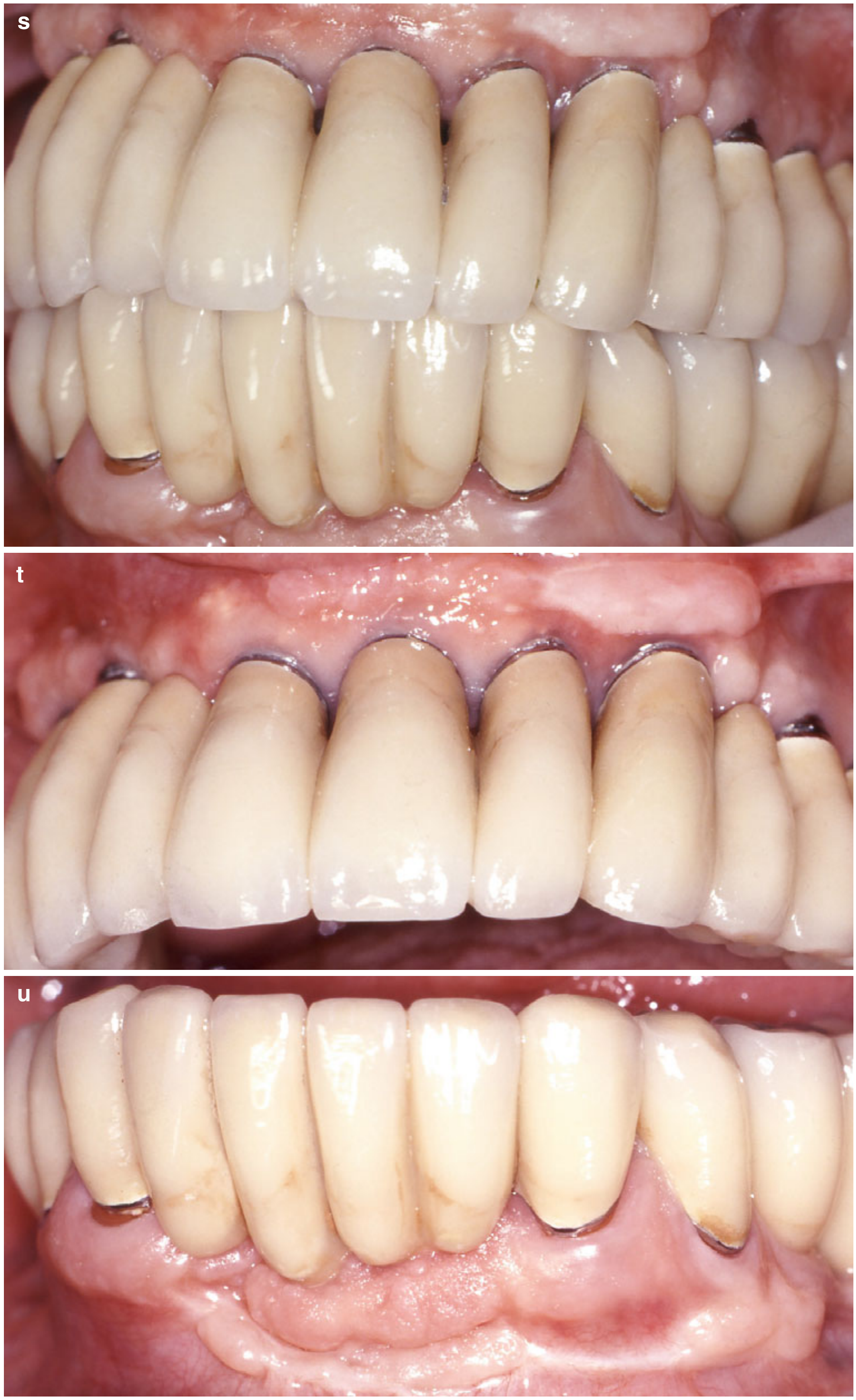

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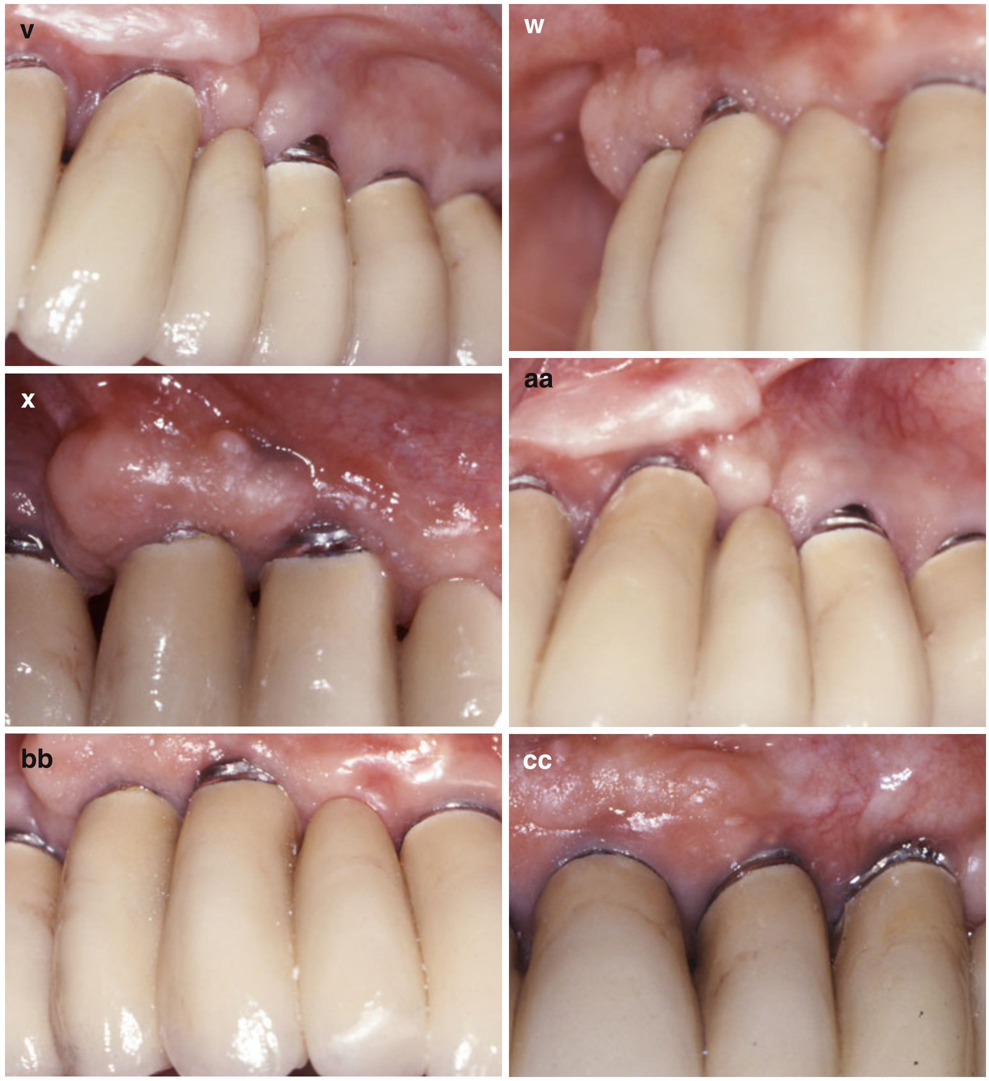

Fig. 7.27 (continued)

8 Decision Trees for Soft Tissue Augmentation Procedures Proposed by the American Academy of Periodontology

Leandro Chambrone

8.1 Decision Trees for Soft Tissue Root Coverage and Keratinized Tissue Augmentation in Sites Not Requiring Root Coverage

As part of the efforts of the recent AAP workshop on *Enhancing Periodontal Health Through Regenerative Approaches*, systematic reviews and consensus reports prepared (published at the *Journal of Periodontology*), the *Practical Applications* paper (published at *Clinical Advances in Periodontics*), as well as, decision trees for the different surgical clinical scenarios were developed to assist clinicians in understanding of periodontal regenerative approaches. But why?

During the daily practice, clinicians are required to deal with diverse clinical scenarios, as well as to provide the most adequate treatment options for each particular condition, based on the best evidence available, on clinician's skills and patients' desires. For instance, "which treatment options are available for the management of sites lacking keratinized tissue? And why are they important?"

Two of these state-of-the-science trees condense the existing information in the field of soft tissue root coverage and keratinized tissue augmentation in sites not requiring root coverage. More than simplistic schematics of procedures, these assessed clinical applications of the science, identified priorities for future research, and provided practical clinical translation of current evidence (i.e., clear summaries of evidence and multiple approaches to clinical translation through scenario-based interpretations of the systematic reviews) – in other words, "to build on existing knowledge to determine the best, practical way to treat patients with periodontal regeneration, as well as to prepare solid guidelines and treatment rationale to support decision-making for specific clinical scenarios."

These trees aim to guide clinicians during the decision-making process.

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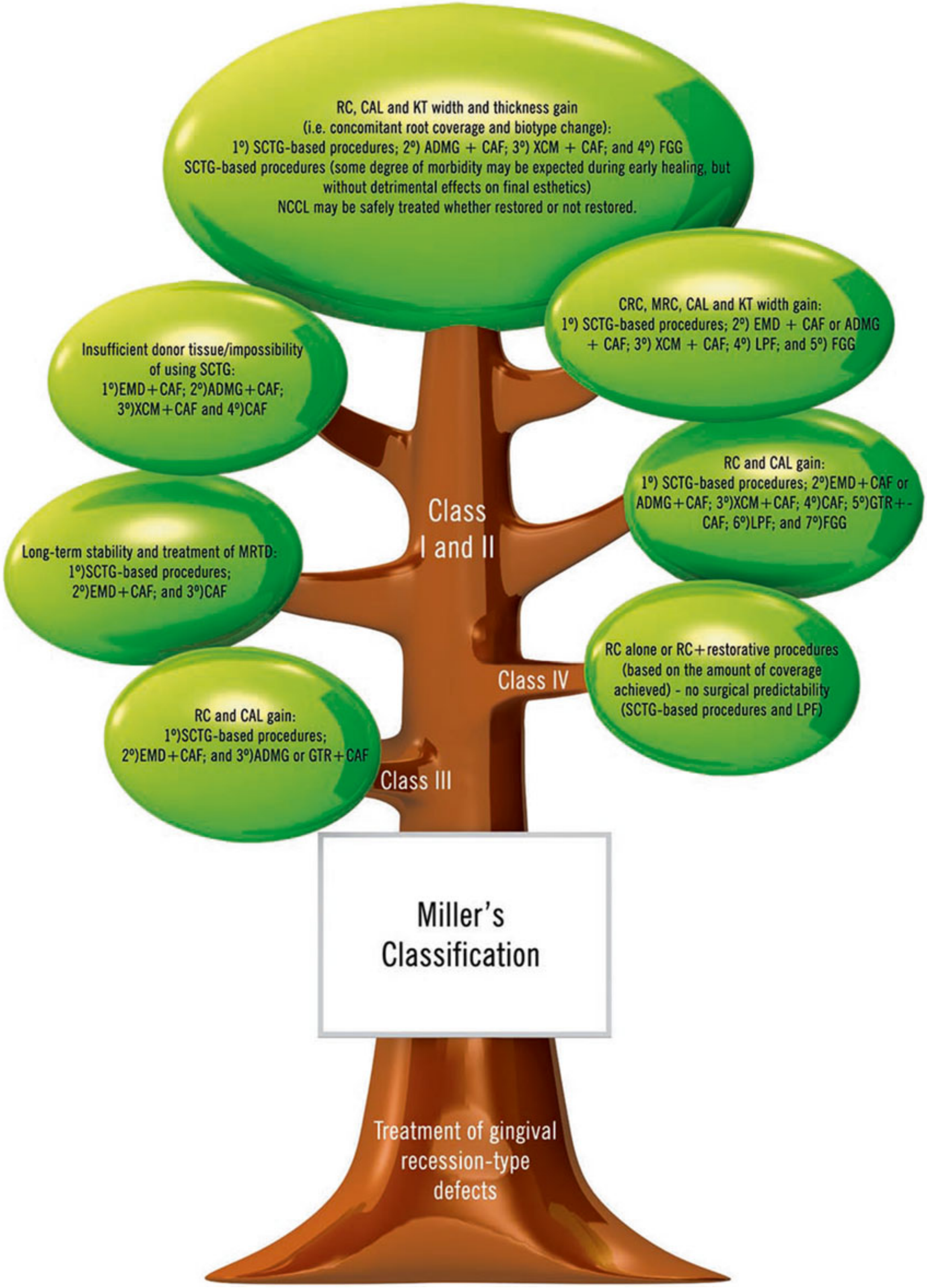

Fig. 8.1 Decision tree for the treatment of Miller's [1] recession-type defects by Chambrone and Tatakis [2] (the thicker the "branch," the stronger the base of evidence). It is expected that there is wound healing consisting of long junctional epithelium and connective tissue attachment (with fibers parallel to the root surface), but some degree of tissue regeneration may occur (mainly for EMD and GTR-based procedures). Since the majority of the publications included in the study evaluated single tooth recession sites, the decision tree seems better designed for determining appropriate treatment for single tooth sites, but it may guide the treatment of multiple recession-type defects as well. The use of root modification agents does not promote positive or negative clinical modifications. *ADMG* acellular dermal matrix graft, *CAF* coronally advanced flap, *CAL* clinical attachment level, *EMD* enamel matrix derivative, *FGG* free gingival graft, *GTR* guided tissue regeneration, *KT* keratinized tissue, *LPF* laterally positioned flap, *MRTD* multiple recession-type defects, *NCCL* non-carious cervical lesion, *RC* root coverage, *SCTG* subepithelial connective tissue graft, *XCM* xenogeneic collagen matrix

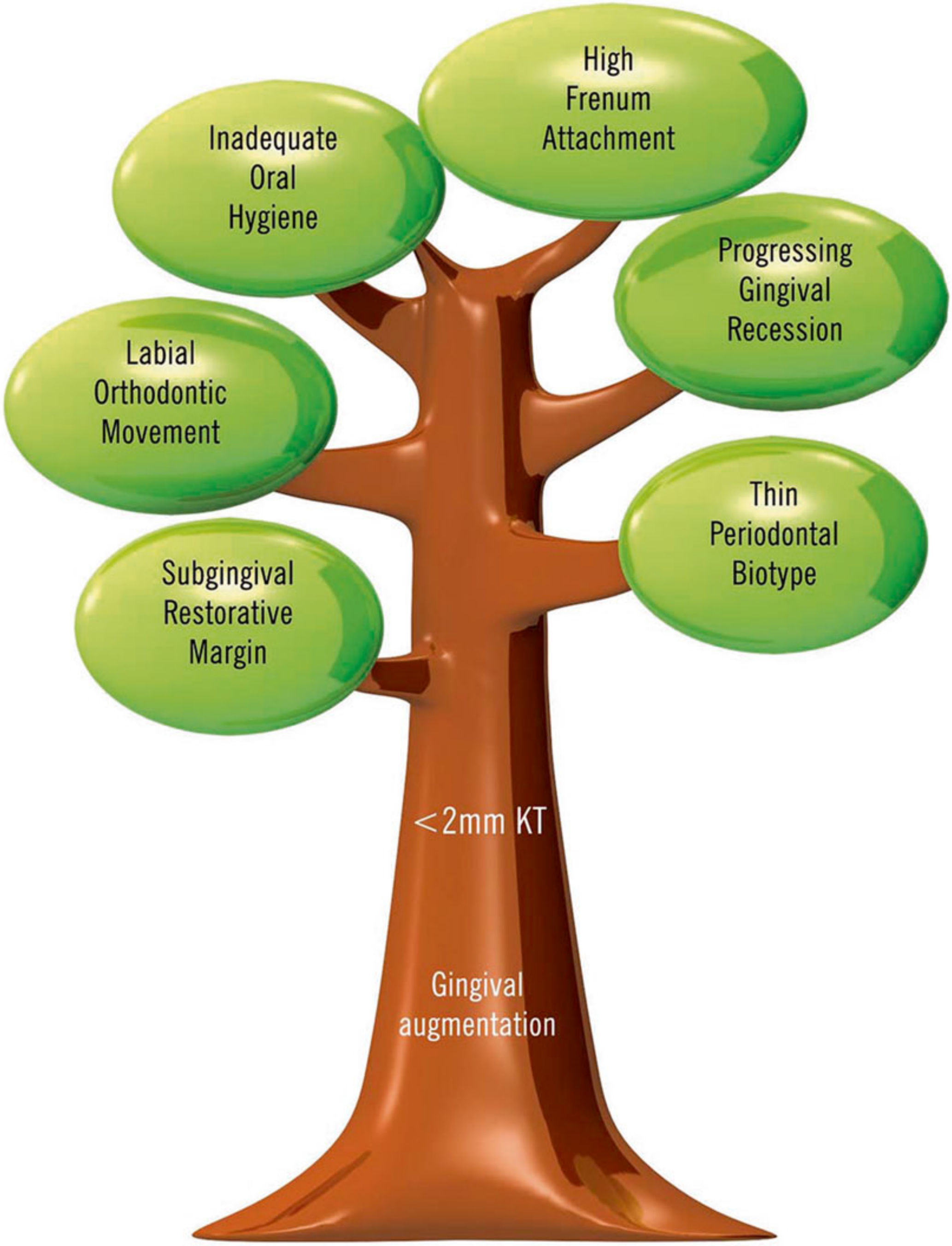

Fig. 8.2 Decision tree for soft tissue augmentation in sites not requiring root coverage (Based on the study by Kim and Neiva [3])

8.2 Concluding Remarks on the Decision-Making Process Involving the Use of Evidence-Based Periodontal and Peri-implantar Surgery

The bunch of procedures and variations of techniques of periodontal plastic surgery may definitely improve the results of treatment of most patients and individual conditions. On the other hand, the achievement of a state of clinical health before executing any “plastic surgery” is extremely necessary. The key of success is linked to the capacity of the patient on performing an adequate dental biofilm control, the lack of clinical inflammation of the periodontal tissues, and the rational use of procedures (the simplicity of how things are). These three “mimetic” elements will create the roadmap for good functional and esthetical prognoses.

Fig. 8.3 Periodontal health and adequate biofilm control

Fig. 8.4 (**a**, **b**) Periodontal health and adequate dental biofilm control

Fig. 8.5 (**a**, **b**) Rational use of procedures – decrease of recession depth solely achieved by a frenectomy

References

1. Miller Jr PD. A classification of marginal tissue recession. Int J Periodontics Restorative Dent. 1985;5:9–13.
2. Chambrone L, Tatakis DN. Periodontal soft tissue root coverage procedures: a systematic review from the AAP Regeneration Workshop. J Periodontol 2015;86(2 Suppl):S8–51.
3. Kim DM, Neiva R. Periodontal soft tissue non-root coverage procedures: a systematic review from the AAP regeneration workshop. J Periodontol 2015;86(2 Suppl):S56–72.

Erratum to: Evidence-Based Periodontal and Peri-Implant Plastic Surgery

Leandro Chambrone

Erratum to:
Leandro Chambrone (ed.), *Evidence-Based Periodontal and Peri-Implant Plastic Surgery: A Clinical Roadmap from Function to Aesthetics*,
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