Otto Zuhr Marc Hürzeler

Decision-Making at the Crossroads between Periodontology and Implant Dentistry

A Call for Personalized Oral Medicine

Volume 1

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DEFINITION OF "EBD," "IOM," AND "POM"

In order to avoid any confusion and ensure terminological clarity, it should be noted that in this book the terms *"evidence-based dentistry (EBD)," "individualized oral medicine (IOM),"* and *"personalized oral medicine (POM)"* are used as defined by Pokorska-Bocci et al in 2014. EBD, accordingly, refers to the focus on the best available scientific evidence in a given situation, combined with the clinical expertise of the treating physician and the individual needs of the patient in question. IOM focuses on the individual risk profile of affected patients, potentially taking into account individual molecular and genetic structures, for example, to more precisely predict and assess the long-term prognosis of complex tooth-preserving measures or implant treatments. Finally, POM-based therapy decisions are made with an emphasis on patient autonomy and individual needs, under the premise of shared decision-making. POM is an umbrella term that encompasses elements of both EBD and IOM.

PREFACE

This book was written to tell a story, and therefore, like any good story, it has a beginning and an end. It is a story in which the results of scientific research are of pivotal importance, but in the end are not always decisive. A story in which medical progress and clinical practice take center stage, but where the main characters rarely wear white coats – it is a story about patients!

It has only been 12 years since our first book was published, but times have changed significantly since then. Not only is my little girl Emma now an adult – the proud holder of a driver's license, with a steady boyfriend and little or no interest in the color of a dental textbook. The breakneck pace of the digital revolution in almost every aspect of life, paired with the increasing complexity of our economic and work environments, including rising costs and regulatory requirements, has also left an unmistakable mark on medical research and patient care. Despite the exponentially growing body of knowledge and the rapidly improving therapeutic possibilities, one of the key challenges facing dental practices today is ensuring that the focus on the individual patient is not lost!

Against this background, despite the progress associated with the introduction of evidence-based dentistry (EBD), the current trend toward customized treatment plans tailored to the individual patient, with clinical decision-making guided by the concept of personalized oral medicine (POM), is particularly important now and will be of great significance in the future.

The transfer of factual knowledge through clinical decision-making into actual patient treatment is certainly an essential aspect in ensuring that as many patients as possible can benefit optimally from science and medical progress today. But at the same time, under the premise of shared decision-making (SDM), based on current scientific evidence, it must also be a priority to recognize patients as equal partners and to provide them with all relevant information and facts on an equal footing. Ultimately, this aims to align treatment outcomes as closely as possible with patients' individual oral health-related quality of life (OHRQoL) requirements – patients as experts of their own treatment expectations!

In order to achieve this goal on a large scale, it will be necessary in the future to systematically incorporate the fundamentals of POM into the undergraduate and postgraduate education of prospective dentists. For this reason, this book is aimed not only at recognized experts and experienced specialists in periodontology and implant therapy, but also and especially at dental students and young professionals:

"Harry, I owe you an explanation of an old man's mistakes. Youth cannot know how age thinks and feels. But old men are guilty if they forget what it was to be young...," said Dumbledore.

Die-hard Harry Potter fans will remember these words from Albus Dumbledore in Joanne K. Rowling's Harry Potter and the Order of the Phoenix, the fifth book in the series. This quote kept running through my mind while I was writing this book, trying to put myself in the shoes of my younger self who, like most of us, set out many years ago with the goal of becoming the best dentist possible. Reflecting on what advice I would have given to my younger self back then, I can confidently offer the following advice to every young colleague today: Be uncompromising in putting patients at the center of your efforts from the very beginning; live critical thinking as a mindset for sound clinical decisions; embrace lifelong learning as a principle; and view manual skills not as a "God-given talent," but as a set of motor skills that can be developed and improved at any time, regardless of one's current situation – it is worth it in every way!

Otto Zuhr, Uffing, February 2025

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1.3.1 Theory and practical implementation

Vital to ensuring that as many patients as possible benefit optimally from advances in science and medicine, the transfer of factual knowledge from research to clinical decision-making to daily patient care has become one of the central challenges of the future, not only for the individual physician but for the entire field of medicine.[35] Touted as a milestone and a step in the right direction, the concept of evidence-based medicine (EBM) was introduced for this purpose in the 1990s,[36] followed by evidence-based dentistry (EBD).[37] The aim was to make systematically processed scientific data available to clinicians to support their decision-making processes and enable them to provide patient care based on the latest knowledge, with a manageable investment of time and effort. Like EBM, EBD has gained acceptance over the past two decades, not only as a globally recognized concept in medicine, but also as the standard for clinical decision-making, characterized by the integration of current *best available scientific evidence* with the *clinical expertise of the practitioner* and *individual patient needs*[38] (Fig 1-5).

Evidence-based decisions in accordance with EBD guidelines involve five basic steps:[39]

- Translation of the clinical problem into a researchable question
- Systematic literature search for the best available evidence
- Critical appraisal of evidence quality, significance, and clinical relevance of the selected research studies
- Application of the knowledge gained to clinical decision-making after reconciling it with one's own clinical expertise and with individual patient requirements
- Critical self-evaluation of treatment outcome and modification of the approach as needed for future use

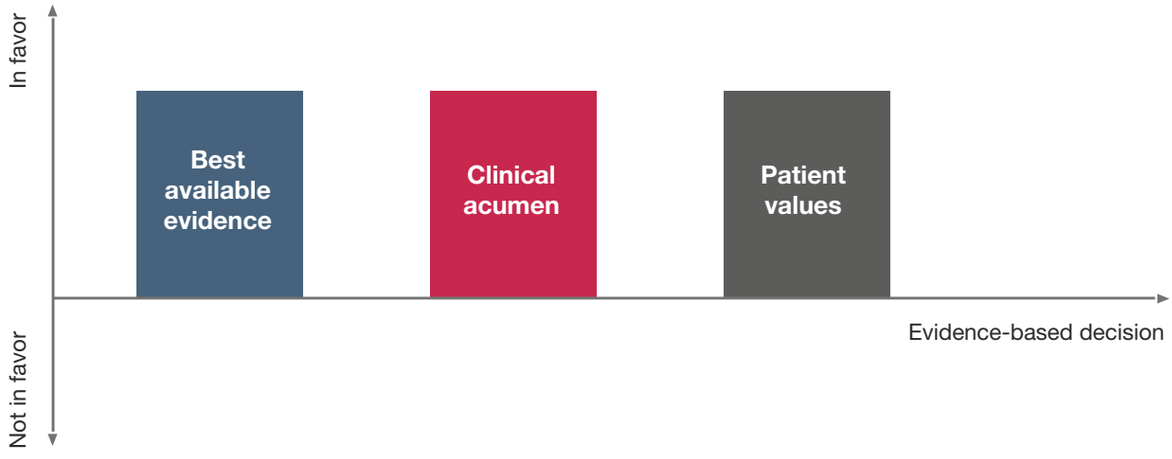


Fig 1-5 The three pillars of evidence-based medicine (EBM) are research evidence, clinical expertise of the practitioner, and individual patient needs. Evidence-based practice requires equal integration of all three pillars into the decision-making process with the aim of selecting a treatment modality that is scientifically sound, safe, effective, and cost-efficient at a given point in time.[36]

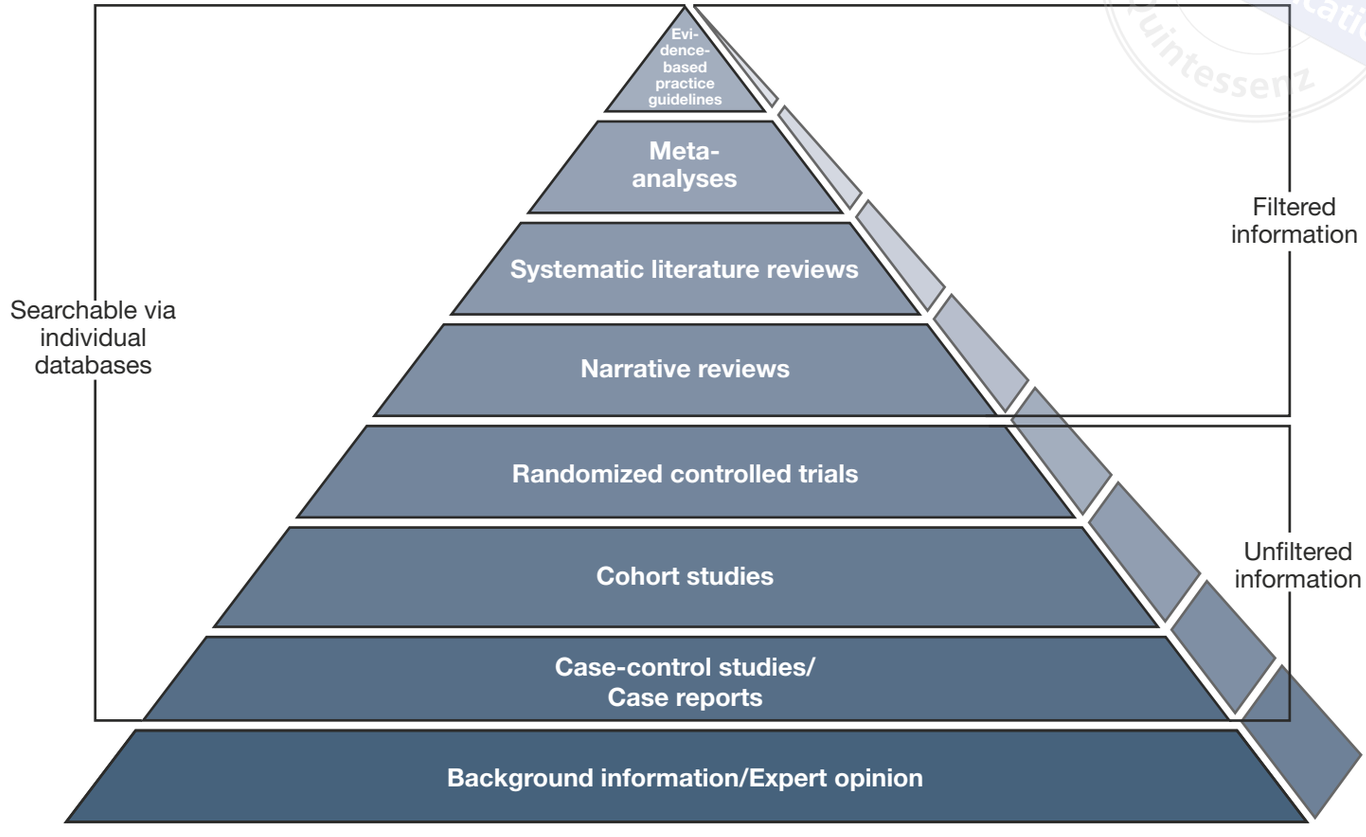


Fig 1-6 Evidence-based decisions in accordance with evidence-based dentistry (EBD) guidelines follow five consecutive steps, the most central being a systematic literature search (step 2). The best available evidence for decision-making in a given case is gathered in a critical, unbiased, and systematic manner and ranked according to a pyramidal hierarchy of evidence quality, as shown here.

The main difference between EBD and the concepts used in the pre-EBD era is that the best available evidence for decision-making in a given individual case is gathered in a critical, unbiased, and systematic manner using state-of-the-art literature search methods, and is then ranked according to a hierarchy of evidence quality. Meta-analyses and practice guidelines based on studies with a high level of evidence quality such as systematic literature reviews and randomized controlled trials are excellent sources of filtered and summarized research data, assuming that the authors have given due consideration to the underlying principles of EBD. Conversely, it may be necessary to use case studies in situations where studies with a high evidence level are not available (Fig 1-6).

The evidence-based decision-making process described above requires adequate training and is difficult to accomplish during routine daily practice. However, with a little practice the process becomes progressively easier, and a data archive is naturally built up over time, requiring only regular updates in accordance with recent research developments. Sharing the work with like-minded colleagues, including through the exchange of systematically gathered research data, can greatly facilitate the implementation of EBD principles into the daily practice routine.[40]

1.3.2 Aspiration and reality

Since its inception, EBM has been touted as the new paradigm for improving medical care; yet, to this day, there is still no evidence proving that it has achieved this goal. The engine driving the systematic application of EBM toward the successive implementation of scientific evidence in patient care practice seems to have stalled during the last several years.[41,42] The search for possible causes has revealed problems in the areas of knowledge creation, clinical decision-making, and clinical action.

Knowledge creation

Although multiple studies have shown that the outcomes and conclusions of industry-funded studies differ from those of independently conducted research, *industry sponsorship* of research projects is the rule rather than the exception today.[43,44] *Publication bias* through the selective and faster publication of studies with "positive results" in high-impact journals is also skewing the scientific evidence base.[45,46] This bias is further undermining clinicians' trust in research studies.[47] Although the quality of evidence in the dental literature is steadily improving for various reasons such as an increasing number of systematic literature reviews, missing *clinical relevance* is still a problem because available publications often fail to provide concrete practical recommendations and there are insufficient scientific data available to answer many clinical questions.[48]

Clinical decision-making

Barriers to applying existing knowledge to clinical decision-making also play a role in preventing the adoption of EBM practices. In the field of dentistry, the integration of new research findings into everyday practice seems to be happening only very slowly.[49] Studies have shown that most clinicians are basically aware of the existence of EBD and have a positive attitude toward it, yet they implement the principles of evidence-based decision-making in a very fragmented manner, if at all.[50–52] *Insufficient time*, *lack of knowledge* of basic medical statistics, inadequate training in EBM, and *lack of clinical relevance* of the available evidence to their practice are some of the main reasons why clinicians, to this day, tend to rely more on information from textbooks, internet platforms, or trusted colleagues than from scientific publications.[52] *Cognitive bias* related to physicians' inflated self-assessments, overconfidence, and overestimation of their knowledge and abilities may also be responsible for many incorrect choices in clinical decision-making.[53–55] It is probably not least due to human nature that it is difficult to *change from old patient care practices*, which one has *established as routine over the years*, to innovative methods with a higher level of evidence base, and this requires a great deal of willingness and willpower on the part of the practitioner.[56]

Clinical action

If the decision in favor of a particular treatment option has finally been made, there may still be barriers to clinical action regarding its implementation in daily patient care. This is especially true in the case of challenging procedures whose success depends on *sufficient experience* and a *high degree of manual dexterity* on the part of the clinician. These problems often manifest as "center effects" in multicenter randomized controlled trials of complex procedures such as periodontal regeneration or root coverage procedures related to gingival recessions. Although the clinicians selected to participate in these studies are chosen for their expertise in the investigated procedures and receive special training and calibration before the start of the study, a wide range of operator-dependent variability of clinical outcomes can be observed[57,58] (Fig 1-7).

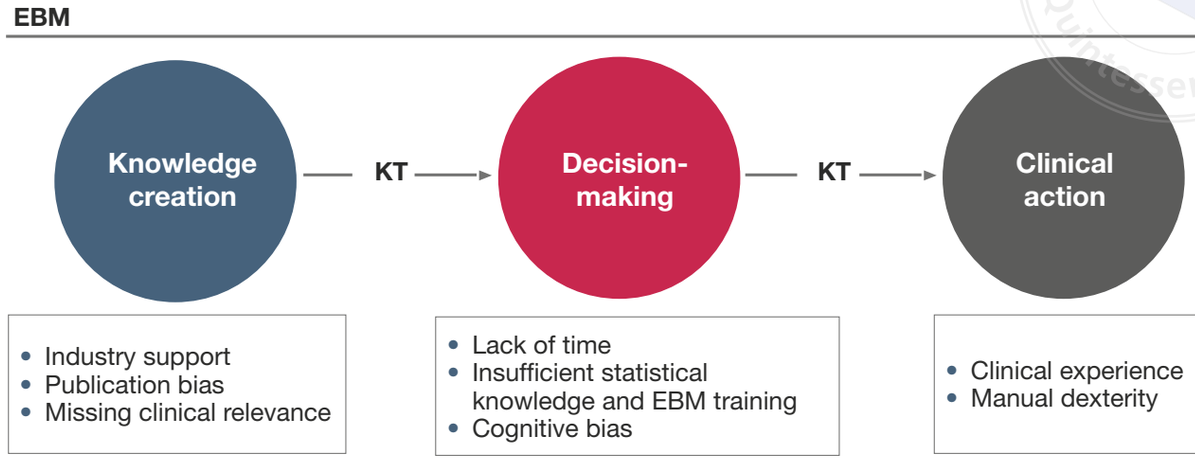


Fig 1-7 The engine driving the systematic application of EBM toward the successive implementation of scientific evidence in daily patient care has obviously stalled during the last several years. The progress of knowledge transfer from researchers to clinicians to the patients who are supposed to benefit from the scientific advances seems to be very slow and bumpy. Possible causes can be found in three main areas: knowledge creation, clinical decision-making, and clinical action.

EBM = evidence-based medicine; KT = knowledge transfer

1.3.3 Potential strategies for future improvement

Without a doubt, the introduction of EBD has significantly changed clinical decision-making for the better for all parties involved, and EBD will probably continue to be a major force in ensuring that even more patients benefit from advances in medicine and technology on a broader basis in the foreseeable future. If improvements are to be made in the future, many more dentists must learn not only to base their clinical actions on their personal positive or negative experiences with different therapeutic procedures, but also to integrate the latest scientific evidence into their clinical decision-making processes. To realize this goal, EBD principles must be systematically integrated into the educational curricula for prospective dentists. Knowledge creation is another key area in need of improvement. Clarkson and Worthington therefore urge academics in the field of dentistry to refrain from producing "scientific garbage" in the future by focusing on fewer yet more innovative and high-quality research projects addressing questions that are important from the patient perspective.[59] Dentists often find it difficult to filter through the plethora of evidence to find research that is truly clinically relevant. To improve this situation, Sellars suggests that the current focus on quantitative research using randomized controlled trials for the collection of pure facts and the production of statistically significant results should be somewhat shifted in favor of qualitative research methods such as case studies and expert interviews.[48] In this context, future study protocols must reflect the current emphasis on patient-reported outcome measures (PROMs) more strongly than ever to achieve even better integration of individual pa-

tient circumstances and expectations regarding treatment outcomes with clinical decision-making and treatment-planning processes.[60] The increasing number of published non-inferiority trials in the field of periodontal plastic and esthetic surgery also attests to the high significance of this development. In non-inferiority trials compared with conventional superiority trials, test procedures that are worse but, at most, irrelevantly worse than the standard treatment can also prove to be superior under certain conditions if the difference between the test and control groups is less than a predefined margin of non-inferiority. Tonetti et al, for example, conducted a multicenter non-inferiority randomized controlled trial of modified coronally advanced flaps in combination with xenogeneic collagen matrix as a test procedure versus autologous connective tissue grafts (CTGs) harvested from the hard palate as the comparator for multiple recession coverage in patients with 485 multiple gingival recessions at 14 different centers in Europe.[61] In addition to the usual clinical outcomes for gingival recession coverage such as the amount of root coverage or recession reduction, patient-reported outcomes were measured using standardized, validated questionnaires, particularly with regard to postoperative pain and morbidity, with and without connective tissue grafting. According to the study protocol, non-inferiority of the test to the standard procedure could have been considered confirmed if, under the condition of statistically significantly better PROMs, the results of recession coverage had not proved worse than the irrelevance range, which was defined in advance with a recession reduction of 0.25 mm. The 6-month follow-up assessment showed clear superiority of the test procedure with regard to patient-reported outcomes. However, the difference in recession reduction at 6 months, an average of 0.44 mm in favor of the comparator, was higher than the non-inferiority margin. Therefore, the non-inferiority hypothesis of xenogeneic collagen matrix with respect to a CTG in terms of root coverage had to be rejected. Due to the lack of non-inferiority, the authors concluded that although the use of soft tissue replacement grafts or the avoidance of graft harvesting from the palate significantly reduced postoperative morbidity, the test procedure could only be recommended in cases where patients want as little postoperative pain and inconvenience as possible and are willing to accept an inferior root coverage outcome as a tradeoff for this.[61] The design of the abovementioned study is exemplary of the current trend toward treatment planning in a manner tailored to the individual patient. With a view to the future, it clearly shows that, in individual cases, a decision made in accordance with EBD criteria may well turn out to be against a treatment with a higher level of evidence (option A) in favor of a treatment with a lower level of evidence (option B), which, although inferior to a certain extent with regard to the expected outcome, can be better reconciled with the individual patient's preferences and requirements regarding oral health-related quality of life (OHRQoL) (Fig 1-8).

Finally, it is obvious that systematic translation and synthesis of new research findings into evidence-based practice guidelines would make it much easier for practitioners to routinely apply EBD in their everyday practice.[62] In this context, the consensus conferences that have been held regularly by the European Federation of Periodontology (EFP) for many years and the resulting publications such as the recently developed guidelines for the systematic treatment of periodontal and peri-implant diseases can be cited as forward-looking examples (see Chapters 5 and 6).

1.3.4 "Understand – Decide – Act" as a guiding principle and treatment concept

In summary, the impression of many scientists and clinicians that evidence-based decisions in the sense originally intended by the founding fathers already shape everyday practice with patients seems to be deceptive. Instead, it is more likely that still only a fraction of patients benefit optimally from advances in science and medicine. As previously mentioned, there is a glaring gap between what we know and what we actually do for patients, and there are a variety of reasons for this gap.[63] All in all, progress in the systematic translation of new research findings into the language of clinicians, and thus the transfer of knowledge from researchers to the patients who are supposed to benefit from the scientific advances, has been slow and bumpy.[41] Even those dentists who are applying research findings to their daily patient care and engaging in clinical decision-making aligned with EBD principles are rarely able to obtain the relevant information needed to automatically make correct decisions with minimal effort. Though the goal of these dentists is to consistently provide patients with the best possible tailored care, they are often challenged – even in the age of EBD. In this context, it is important for practitioners to understand that while a high degree of manual dexterity and fine motor skills is essential to achieving successful treatment outcomes in a discipline such as dentistry, they are not in themselves a

CHAPTER 4

INCISIONS, FLAP DESIGNS, AND SUTURING TECHNIQUES

4.4 Suture Closure for Flap Stabilization

Because complication-free wound healing is the key to surgical success, as outlined in Chapter 3, it has become a main focus of clinical and scientific attention in contemporary periodontal and implant surgery. The central goal is the consistent achievement of primary wound healing in most cases. Evidence has shown that clinicians have control over two of the main factors that influence the healing process: blood supply to the surgical area and postoperative wound stability. The surgical suture plays a crucial role in this context, aiming to achieve adequate wound stabilization while avoiding any negative impact on the healing process due to unnecessary tissue trauma or excessive tension on the wound edges. It is important to remember that wound healing after surgical procedures in the oral cavity takes place under suboptimal conditions. In addition to being a moist and microbiologically contaminated environment, it is virtually impossible to completely immobilize wounds in the oral cavity during the early stages of healing. The sutures must therefore ensure *passive fixation of the surgical flaps* in the intraoperatively established position, provide *close approximation of the wound margins* – especially when grafts initially dependent on diffusion for nutrition are used – and *stabilize the wound* during the first postoperative days. Appropriate suture materials and suturing techniques must be selected to ensure that suture loosening does not occur, and that the sutures and soft tissue will be able to withstand the mechanical stresses exerted on them in the early stages of wound healing. All of these conditions must be met in order to consistently achieve primary healing and optimal treatment outcomes without postoperative scarring (Fig 4-24).

To facilitate precise suture closure, incisions should be made in *keratinized tissue* whenever possible. The incision design and flap design should ideally be chosen so that the flap ends lie in the desired position *without tension* and can be fixed together during suturing without excessive tension. This is the only way to ensure the required stability of the wound after suture closure. If mobile and fixed tissue flaps are to be connected, suturing should always be performed *from mobile to fixed tissue* to reduce the risk of the sutures tearing through the margin of the fixed tissue flap. Gentle mobilization of the fixed flap with a microsurgical scalpel blade or papilla elevator can further facilitate precise suture placement. Because a *moist environment* facilitates the use of microsurgical suture materials, frequent irrigation of the surgical area is recommended.

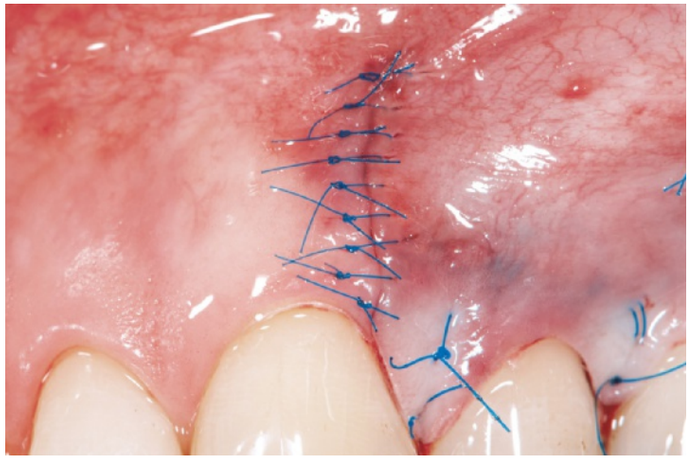


Fig 4-24 View after closure of a vertical releasing incision in the maxillary anterior region. Suturing plays a particularly important role in periodontal and implant surgery. The goal of suturing is to ensure passive fixation of flaps, intimate contact of the wound margins, and adequate wound stability during the early stages of healing.

4.4.1 Suturing techniques

Suturing techniques can be classified according to their functions and are applied in various forms within the surgical techniques presented in this book. Those that are most commonly used in periodontal and implant surgery are detailed in the following sections. Attaining the greatest possible wound stability without significantly impairing blood supply to the surgical area is the central factor to consider when selecting a suturing technique. For obvious reasons, it is impossible to achieve adequate wound stability if only movable flap portions are included in the suture line. The question of which suturing technique can provide optimal wound stability and is thus appropriate for a given clinical situation is largely determined by the type and availability of suitable *mechanical anchor points*. Both natural structures (eg, the teeth, gingiva, masticatory mucosa of the palate, and periosteum) and artificial structures (eg, implant-supported or made of composite retentions) may be used for suture anchorage.

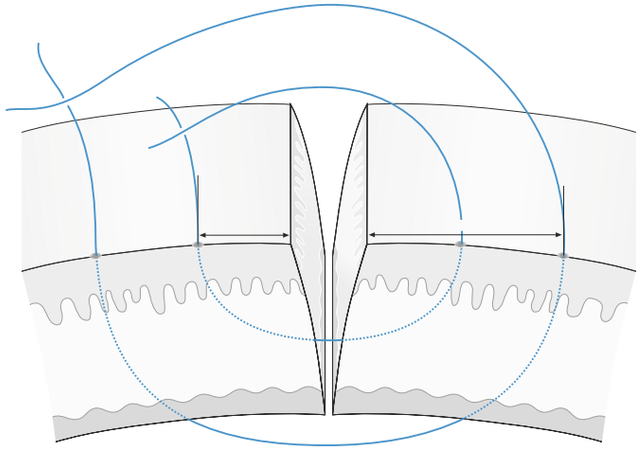


Fig 4-25 Schematic representation of "bite size." For an interrupted suture, the distance between the insertion point of the needle and the incision line should be as close as possible to that of the exit point – the "bite size" should be the same.

The following sections aim to provide clinicians with guidance on the indication-based selection and proper application of surgical sutures in daily practice. The focus is primarily on the fundamental aspects of the areas of application and the function of different suture techniques. Detailed descriptions of the individual sutures and suturing techniques will be explained later within the descriptions of the respective clinical procedures for which they are used.

Wound closure sutures

Because wound closure sutures function to ensure the optimal adaptation of two flap margins, they are critical for achieving primary wound healing in many cases. Ideally, fine suture materials of size 7-0 or 8-0 should be used, and surgical knots should be loosely tied.

Interrupted sutures

Uniform "bite size" is crucial for achieving precise approximation of wound edges with interrupted sutures. In other words, the *distance between the needle entry and exit points on either side of the incision line must be equal*. The thinner the flap or the more superficially the needle is to be passed through the tissue, the smaller the "bite size" can be (Fig 4-25).

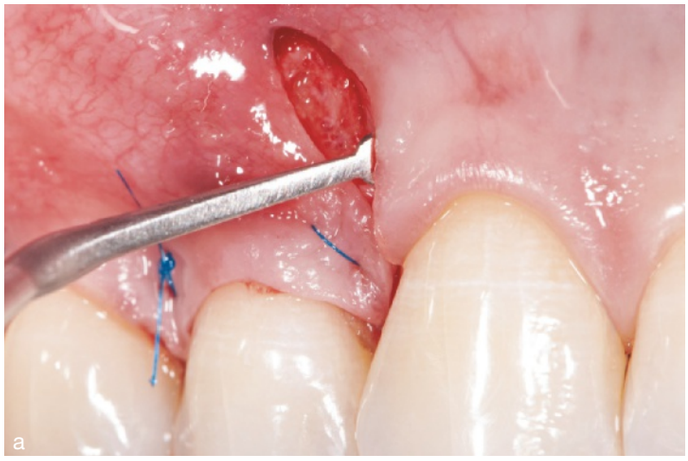
To prevent the suture from tearing during knotting or healing, the *soft tissue* should also be *securely grasped*. The "bite size" should decrease with decreasing flap thickness but should never be significantly smaller than 2 mm. The stitch may end within the flap or penetrate the entire flap.

The needle may enter and exit the tissue in one or two passes, depending on the access and the width of the wound. The needle should enter the tissue at an angle of *90 degrees to the flap*. After the needle has passed into the tissue as far as possible, the needle holder is opened to release the needle. At the exit site, the needle holder is used to grasp the central part of the needle and pull it through the tissue completely (Fig 4-26). To minimize soft tissue trauma while suturing, force should always be applied *in the direction of the needle curvature*. Furthermore, the needle must be sharp. For this reason, a needle holder should never grasp the needle at its tip. If the needle tip is damaged or dulled during suturing, new suture material should be used. If forceps held in the nondominant hand are used to grasp the margins of the flap while suturing, this should be done gently to avoid unnecessary trauma to the soft tissue. As a general rule, the needle should always be aligned *perpendicular to the incision line* when suturing. However, when suturing displaced flaps with mobile and fixed components, an angled needle path can be helpful in the case of coronally advanced or apically repositioned flaps.

The fewer stitches required for perfect adaptation of the flap, the better for postoperative wound healing. The advantage of interrupted sutures over continuous sutures is that the loosening of one knot does not jeopardize the integrity of the entire row of sutures. The disadvantage is that interrupted sutures are more time-consuming to place.

Continuous sutures

A continuous suture is like a series of interrupted sutures that do not have to be tied individually. Continuous sutures are not only easier and less time-consuming to place than an equivalent number of interrupted



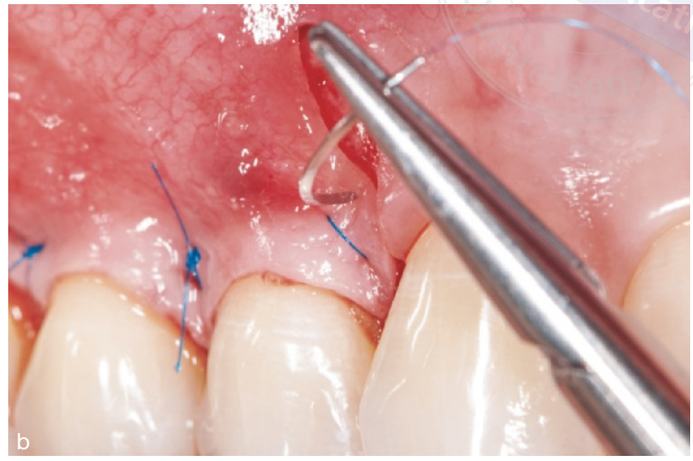
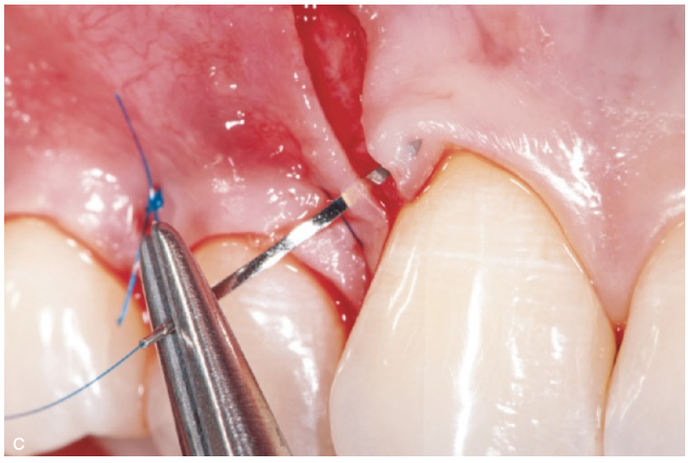


Fig 4-26a and b Clinical example of an interrupted suture used to close a vertical incision. As a preparatory measure, a papilla elevator is used to gently lift the fixed tissue component of the flap from the underlying bone. The needle is inserted into the flap perpendicular to the tissue surface.



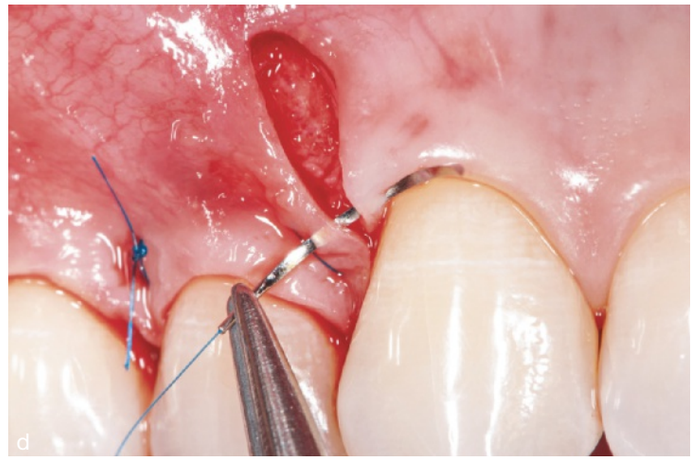
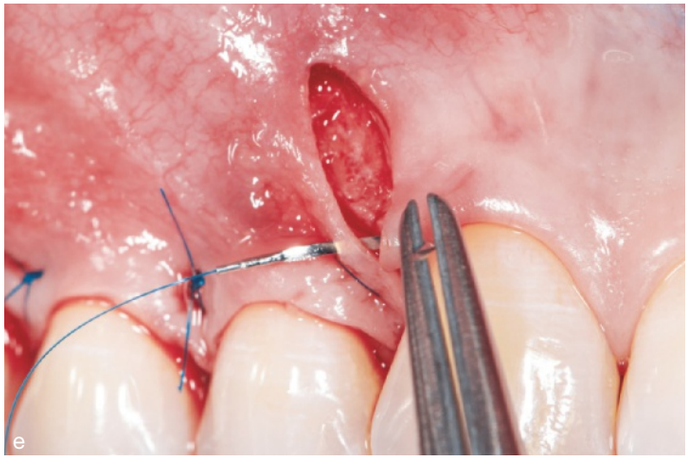


Fig 4-26c and d Ideally, clinicians should always suture from mobile to fixed tissue while holding the needle perpendicular to the incision line. To prevent the sutures from cutting through the tissue, the needle entry point should never be less than 2 mm from the wound edge. Because uniform "bite size" is crucial for optimal approximation of the wound margins, the distances between the incision line and the needle entry and exit sites on either side of the incision line must be as uniform as possible.



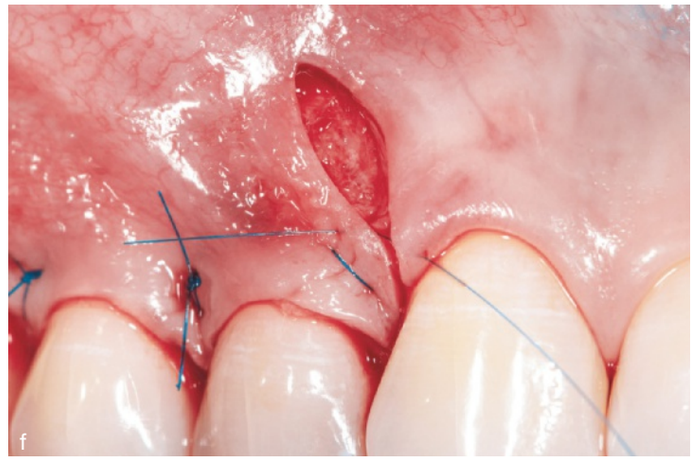
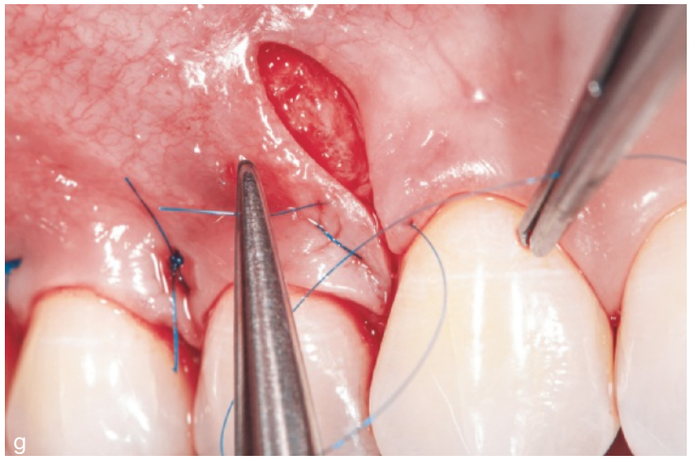
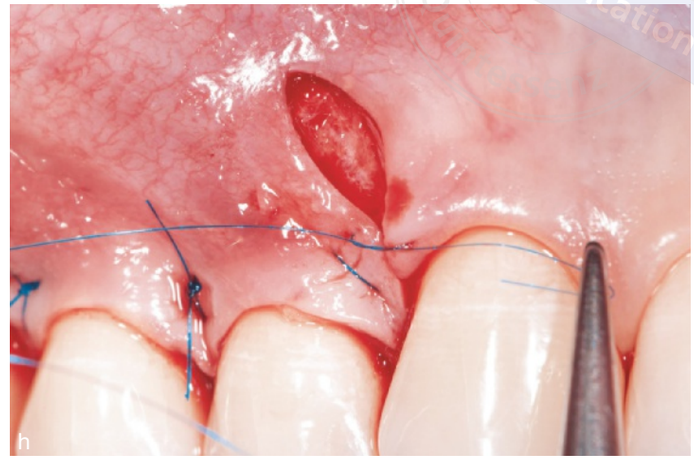
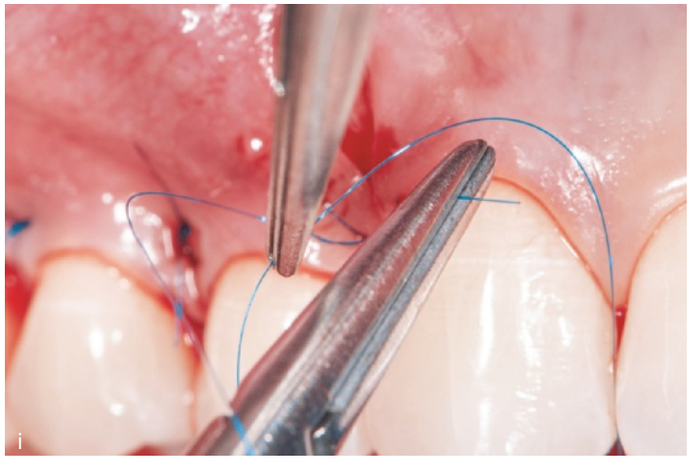
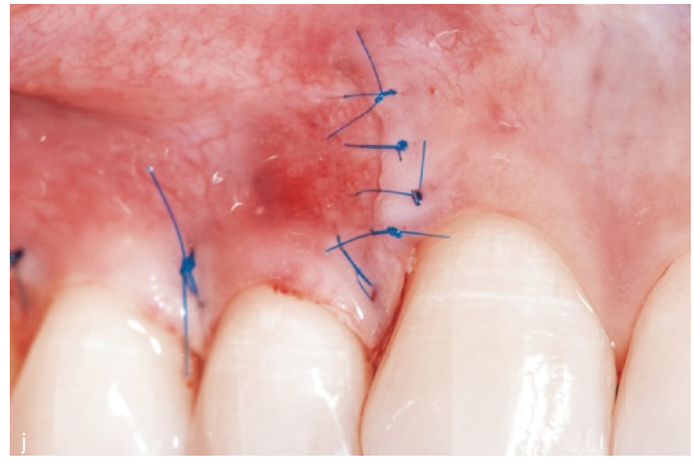


Fig 4-26e to j Once the needle has been pushed through the tissue to the opposite side as far as possible, the needle holder is opened. The needle is then grasped centrally, the thread is pulled through the tissue, and a knot is tied.









sutures, but are also easier to remove. The disadvantage of continuous sutures is that if a single knot loosens, the integrity of the entire row of stitches may be lost.

The *continuous locking suture with interlocking loops* has proved to be suitable for periodontal and implant surgery due to its "interlocking" effect. In this technique, a simple interrupted suture is first placed at the distal end of the incision, but only the short end of the thread is cut. As the second stitch is placed more mesially, the surgeon grasps the thread with the nondominant hand, forming a "loop." After the needle emerges at the exit site, it is not initially pulled out of the tissue completely. First, the needle holder is passed through the loop and the thread is pulled to "lock" the suture. The loop can also be turned 180 degrees to additionally stabilize the individual sutures. The suture is tied after the last stitch has been completed at the mesial end of the incision. To place the knot, the needle and thread are pulled through the tissue until all that remains is a small loop, which is used like the short end of the suture (Fig 4-27). The fewer number of stitches needed to achieve perfect flap adaptation, the better for postoperative wound healing.

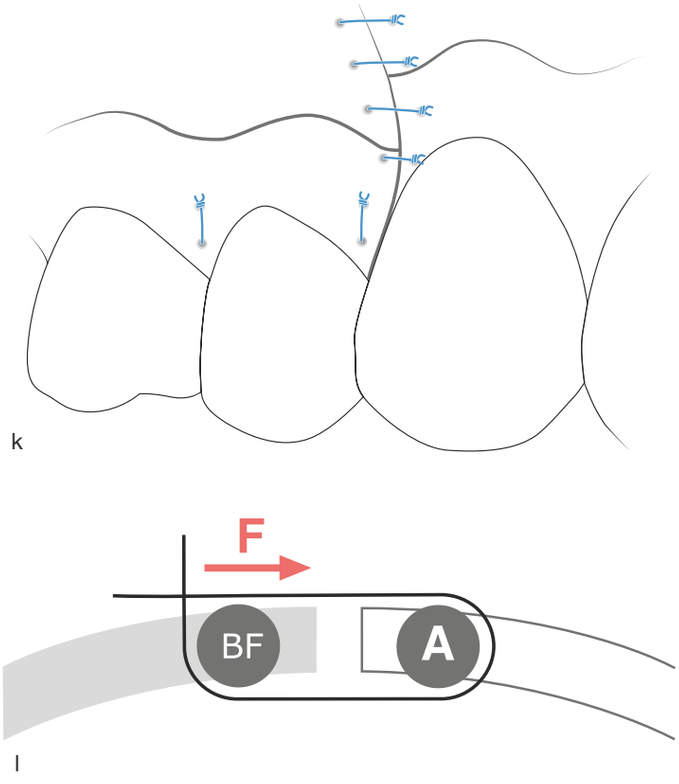


Fig 4-26k and l Schematic representations of the postoperative status. In this case, the gingiva of the fixed component of the flap is used as the mechanical anchor point for interrupted size 7-0 sutures. Placement of the sutures at right angles to the incision line results in force vectors after the sutures are tied that not only lead to the precise adaptation of the flap margin along the incision line, but also result in optimal stabilization of the wound.

A = suture anchor/point of application of the force vector;
BF = buccal flap; F = line of action of the force vector

Tension-relieving sutures

In the case of larger wounds with two movable flap components, and in situations where, despite a fixed flap component, there are no sufficiently stable anchors available for the sole use of closure sutures, relief sutures must be placed in order to ensure adequate wound stabilization. Suturing with wound closure sutures alone leads to narrow contact points between the flaps. Combining wound closure sutures with tension-relieving sutures results in broader and more intimate contact between the flap margins, even in deeper tissue layers. Tension-relieving sutures improve the precision and mechanical stability of suture closure, which is of particular importance if postoperative edema increases tension on the flap margins.

Tension-relieving sutures are placed and tied before closure sutures. They relieve tension on the incision line to enable precise flap positioning during the actual process of suture closure. These sutures are strategically placed to precisely control the direction of pressure on the flap to selectively invert or evert the flap margins as needed. Moreover, tension-relieving sutures reduce the risk of sutures cutting through the tissue when tied because they distribute the force over a broad area.

The *mattress suture* is the most common type of tension-relieving suture in periodontal and implant surgery. It may run horizontal or vertical to the incision line and may be located internally or externally. Internal mattress sutures are best for reducing force on the wound edges. The placement of internal mattress sutures results in eversion of the wound edges. Eversion facilitates wound closure with interrupted sutures or one continuous suture. External mattress sutures, on the other hand, frequently result in inversion of the wound edges. Inversion complicates suture closure and promotes postoperative scar development. Inverted wound edges are also disadvantageous if scar correction is needed later.

Therefore, the *internal horizontal mattress suture* has proven to be the most suitable tension-relieving suture for periodontal and implant surgery. First, the needle is inserted 2 to 4 mm from the flap margin and passed through the two flap segments. At the appropriate horizontal distance – which varies depending on the clinical situation – it is then passed back in the opposite direction, parallel or crosswise, to the same side as the first insertion site and is tied there after the last stitch has been made. In contrast to wound closure sutures, tension-relieving sutures must be tied more tightly to provide adequate wound stability. Very fine sutures will quickly tear if too much tensile force is used, but thicker sutures are more prone to compromise the blood supply to the wound edges if too much tension is exerted when they are tied. Thus, the routine use of size 6-0 tension-relieving sutures seems wise. This seems to be an ideal compromise because a suture of this size will withstand the amount of tensile stress needed for suture tying but will tear before overly tightened knots can cause damage to the flap (see Chapter 3). The number of mattress sutures needed varies depending on the length of the incision to be closed. Wound closure sutures are tied after tension-relieving sutures (Fig 4-28).

CHAPTER 7

AUTOLOGOUS MUCOSAL GRAFTS AND THE HARD PALATE AS THE DONOR SITE OF CHOICE

7.3 Donor Site Selection and Graft Harvesting Techniques

For the intraoral harvesting of mucosal grafts from the hard palate, only regions with a sufficient supply of tissue are suitable. The graft should be harvested from an area where there is minimal risk of serious complications associated with graft harvesting, including postoperative morbidity or discomfort for the patient.

7.3.1 Tissue availability on the hard palate

The thickness of the palatal masticatory mucosa varies widely from individual to individual and from one region of the hard palate to another, as has been demonstrated in several studies.[75] Ultrasound measurement data have shown that the soft tissue thickness of the palatal masticatory mucosa is greatest at the maxillary tuberosities, where it is more than 4 mm, followed by the area level with the second molars and premolars, where it is on average 3 mm. In addition, the palatal masticatory mucosa is generally thicker in males than in females.[96,97] An analysis of computed tomography measurement data showed that the mean thickness of the palatal masticatory mucosa is 3.83 ± 0.58 mm overall, is thinner in females (3.66 ± 0.52 mm) than in males (3.95 ± 0.60 mm), and increases with age. The same study showed that the thickness of the palatal masticatory mucosa increases from the canine to the second premolar region, decreases in the first molar region, and increases again in the second molar region. It also showed that the palatal masticatory mucosa is thickest in the second premolar region at 3.81 ± 0.75 mm and thinnest in the first molar region at 3.13 ± 0.69 mm, and that the thickness of the palatal masticatory mucosa increases from the gingival margin of the maxillary posterior teeth toward the median raphe palatina.[98] In a cadaver study, a palatal masticatory mucosal thickness of 2.5 to 4 mm was measured at the maxillary tuberosity[99] (Fig 7-10).

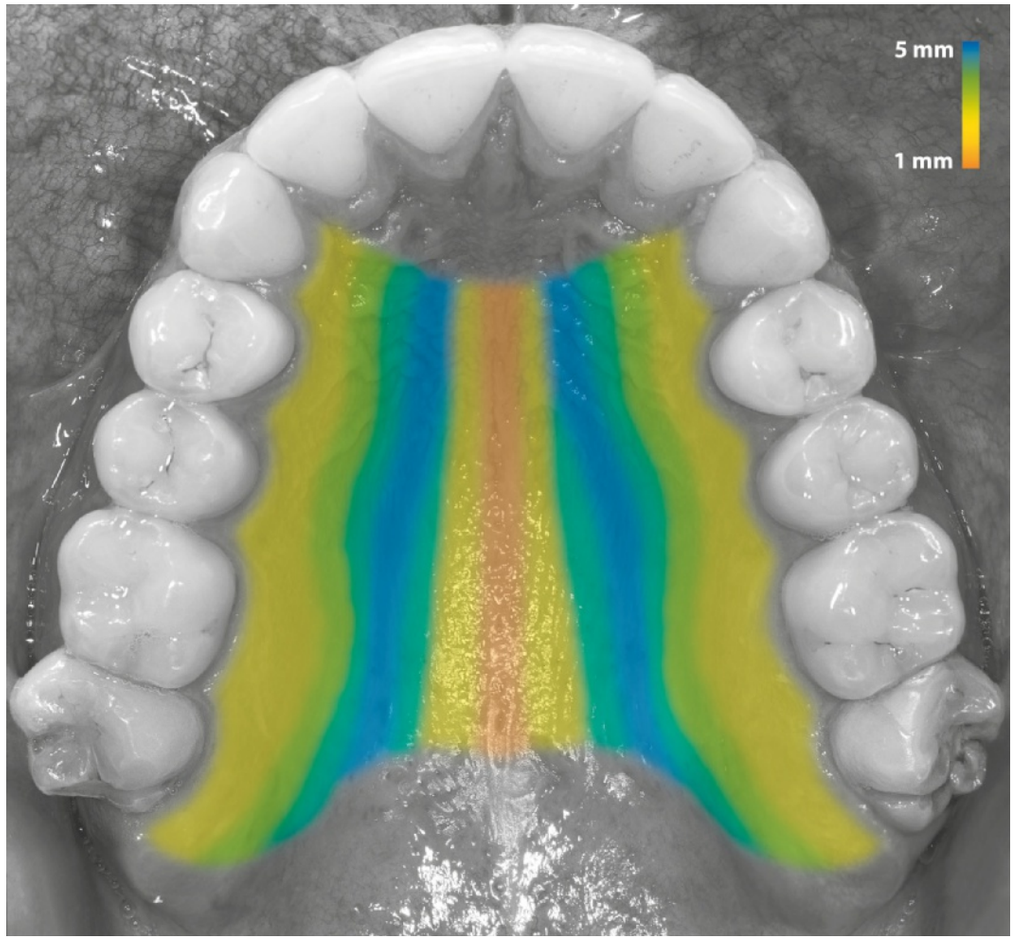


Fig 7-10 In the hard palate, the greatest volume of soft tissue for grafting can be expected at the level of the two premolars and second molar as well as in the tuberosity area. The thickness of the palatal masticatory mucosa increases from the gingival margin of the maxillary posterior teeth toward the median raphe palatina.

Table 7-1

Thickness of the overlying epithelium and lamina propria,[101] and thickness of the overlying epithelium, including the epithelial walls and the underlying lamina propria without papillae.[102]

Thickness of lamina propria including epithelium in mm

Distance below AC	CD	P1D	P2D	M1D	M2D
3 mm	1.83 ± 0.38	1.90 ± 0.27	2.20 ± 0.51	2.39 ± 0.76	1.80 ± 1.04
4 mm	1.57 ± 0.39	1.42 ± 0.23	1.68 ± 0.51	1.76 ± 0.47	1.18 ± 0.47
8 mm	1.24 ± 0.27	1.01 ± 0.21	1.38 ± 0.47	1.62 ± 0.49	0.98 ± 0.36

Thickness of epithelium including the epithelial walls in mm

Distance below AC	CD	P1D	P2D	M1D
3 mm	0.46 ± 0.15	0.43 ± 0.11	0.35 ± 0.09	0.33 ± 0.06
6 mm	0.44 ± 0.13	0.34 ± 0.09	0.31 ± 0.09	0.30 ± 0.06
9 mm	0.35 ± 0.11	0.32 ± 0.08	0.30 ± 0.09	0.28 ± 0.05

Thickness of lamina propria without papillae in mm

Distance below AC	CD	P1D	P2D	M1D
3 mm	1.78 ± 0.91	1.31 ± 0.50	1.40 ± 0.39	1.47 ± 0.53
6 mm	1.26 ± 0.65	1.06 ± 0.24	1.04 ± 0.31	0.89 ± 0.19
9 mm	1.04 ± 0.47	0.88 ± 0.16	0.83 ± 0.26	0.79 ± 0.25

C = canine; D = distal surface; Distance below AC = distance from the most coronal point of the alveolar crest; M1 = first molar; M2 = second molar; P1 = first premolar; P2 = second premolar

The results of a cadaver study in which the thickness of the palatal masticatory mucosa was measured at 24 standard measuring points largely confirm the above values.[100] However, the thickness of the lamina propria and overlying epithelium does not appear to be proportional to that of the masticatory mucosa as a whole: the epithelial thickness decreases from anterior to posterior as well as from coronal to apical. The thickness of the lamina propria also decreases from coronal to apical.[101] It is thickest in the canine region, decreases in thickness as it extends toward the first premolar, and then remains largely constant in thickness as it continues posteriorly.[102] Regardless, the varying values for mucosal thickness in different regions of the hard palate are primarily due to the differing layer thicknesses of the submucosa (Table 7-1).

7.3.2 Safe and unsafe donor sites

Although rare, intraoperative bleeding and sensory dysfunction are the most common complications of mucosal graft harvesting from the palate.[103–105] Against this

background, the palatal neurovascular bundle, consisting of the greater palatine nerve and the greater palatine artery, is an important anatomical structure. It is imperative to avoid injury to the neurovascular bundle when harvesting soft tissue grafts from the hard palate. Therefore, a thorough knowledge of the course of the palatal neurovascular bundle in a given case is very important and of high clinical relevance.

An anatomical study of the bony structures of the hard palate in 41 cadavers showed that the greater palatine foramen is located at the level of the interproximal space between the second and third molars, at the junction of the vertical and horizontal plates of the palatine bone, and that it is located slightly more anteriorly in males than in females.[106] A cone beam computed tomography study showed that in 92 out of 100 cases, the greater palatine foramen was located in the third molar region at a mean distance of 7.9 mm from the alveolar ridge.[107] In this context, the results of a systematic literature review and meta-analysis suggest that the greater palatine foramen is most commonly located at the level of the third molar, approximately 11 mm from the cementoenamel junction.[108]

The distance of the gingival margin of the maxillary posterior teeth to the main branch of the greater palatine artery was examined on plaster cast models from 198 patients without periodontal disease. It was shown that the mean distance between the gingival margin and the greater palatine artery was approximately 12 mm in the canine region and about 14 mm in the second molar region. Therefore, it would have been possible to harvest an 8-mm-wide subepithelial CTG in 93% of cases, and one of at least 5-mm wide in all cases, without damaging the greater palatine artery.[109] However, cadaver studies have shown that the techniques used to locate the greater palatine artery on plaster casts are subject to error and tend to underestimate the distance of the greater palatine artery from the cementoenamel junction of the first molars and premolars.[110] This is consistent with findings that the mean distance between the greater palatine artery and the first molar gingival margin is 12 mm (range: 9 to 16 mm).[92] The course of the greater palatine artery also appears to be related to the height of the palatal vault. Studies suggest that the shallower the palatal vault, the closer the greater palatine artery is to the palatal gingival margin as it extends anteriorly.[111,112] In this context, it is important to note that the course of the greater palatine artery can obviously be subject to anatomical variations. On its path from posterior to anterior, its larger lateral branches generally diverge medially in the direction of the median raphe and laterally at the level of the first premolar to the gingiva of the canine. However, in approximately 16% of cases, the lateral branches give off to the gingiva at the canine level immediately after the greater palatine artery emerges from the greater palatine foramen. In these situations, the main and lateral branches of the greater palatine artery not only run alongside each other, but also closer to the maxillary posterior teeth[93] (Fig 7-11).

Intraoperative perforation of the palatine artery or one of its larger lateral branches is a serious intraoperative complication that is difficult to manage even for experienced clinicians. Therefore, care must be taken to ensure that autologous mucosal grafts are harvested from the lateral palate without risk and with due consideration of the specific anatomical conditions.

When thin- or medium-thickness FGGs are harvested, intraoperative bleeding typically occurs only from relatively small terminal vessels, which is usually easy to control.[113] Conversely, harvesting thick FGGs or subepithelial CTGs, obtained through flap elevation, can result in more severe bleeding. A systematic literature review by investigators attempting to define a safety zone for harvesting free mucosal grafts from the lateral palate provides valuable information on how to safely avoid perforation of the main branch or one of the larger lateral branches of the greater palatine artery. After analyzing all available data in this regard, the authors determined that the mean distance from the greater palatine artery to the cementoenamel junction of the maxillary teeth was 13.9 ± 1 mm for the second molar, 13.0 ± 2.4 mm for the first molar, 13.8 ± 2.1 mm for the second premolar, 11.8 ± 2.2 mm for the first premolar, and 9.9 ± 2.9 mm for the canine. To safely exclude the possibility of injury to the greater palatine artery, the graft width must not exceed this distance minus the sum of the 2-mm safety distance to the gingival margin plus the standard deviation in the respective areas measured.[114] The scalpel blade used for harvesting the graft can serve as a valuable guide in this context (Fig 7-12).

Against this background, thin- and medium-thickness FGGs can generally be harvested virtually anywhere on the posterior hard palate or the distal portion of the anterior hard palate, possibly also from the tuberosity or edentulous areas. For thick FGGs and subepithelial CTGs obtained after flap elevation, the hard palate within the safety zone adjacent to the two premolars and the second molar as well as the tuberosity region are primarily considered as donor sites (Fig 7-13).

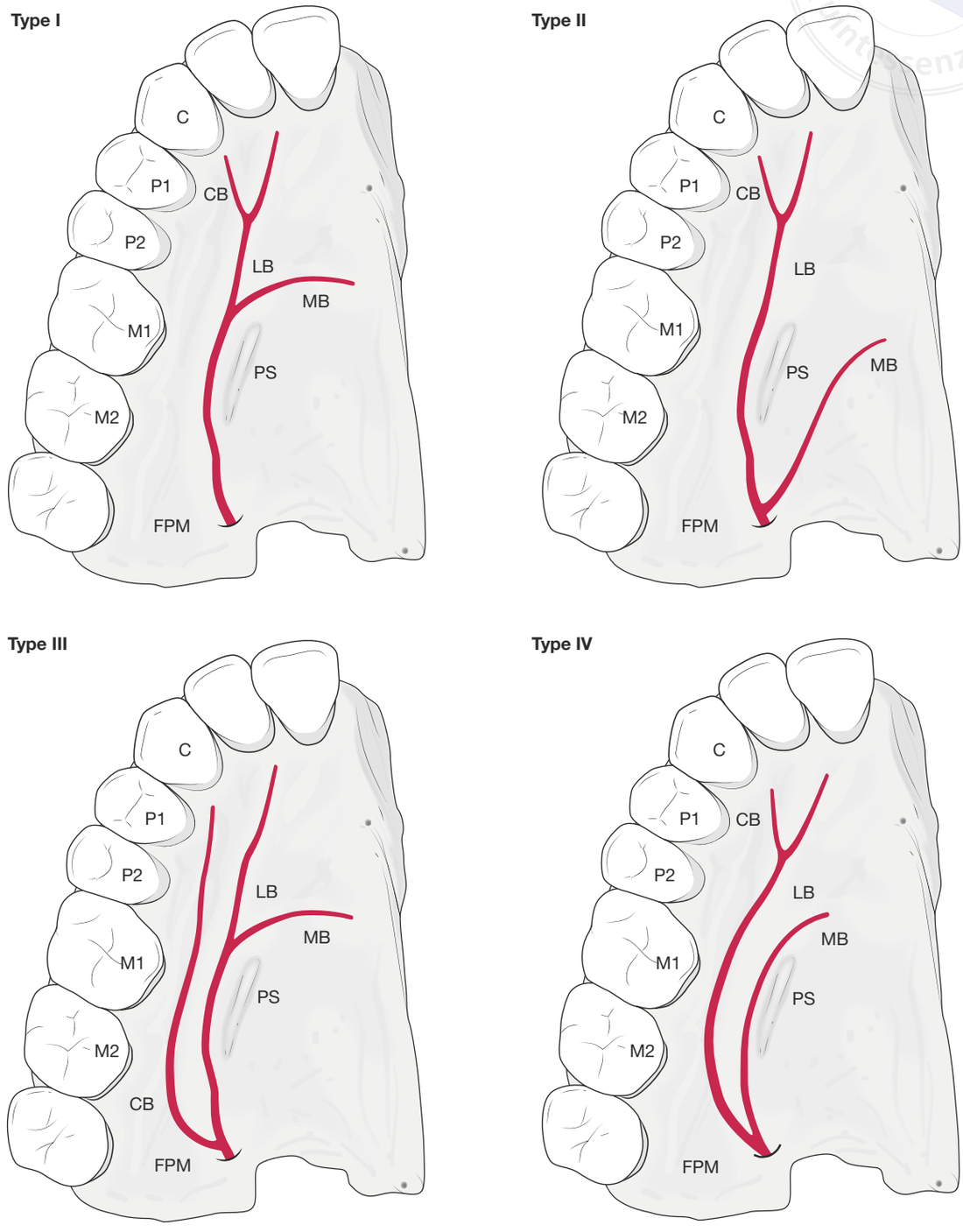


Fig 7-11 The posterior-to-anterior course of the greater palatine artery is subject to anatomical variation. In the type I branching pattern (41.7%), the greater palatine artery runs in the lateral groove of the palatal spine and, after emerging from the greater palatine foramen, runs anteriorly and gives off a larger medial branch toward the median palatal raphe as well as a lateral canine branch. In the type II pattern (33.3%), the greater palatine artery gives off a medial branch before the palatal spine and runs anteriorly in the medial palatal groove. In types III and IV, the greater palatine artery gives off a canine branch immediately after emerging from the greater palatine foramen. In the type III pattern (16.7%), it runs lateral to the main branch and courses anteriorly, whereas in the type IV pattern (8.3%), it runs medial to the main branch.[93]

C = canine; CB = canine branch of the greater palatine artery; FPM = greater palatine foramen; LB = main branch of the greater palatine artery; M1 = first molar; M2 = second molar; MB = medial branch of the greater palatine artery; P1 = first premolar; P2 = second premolar; PS = palatal spine

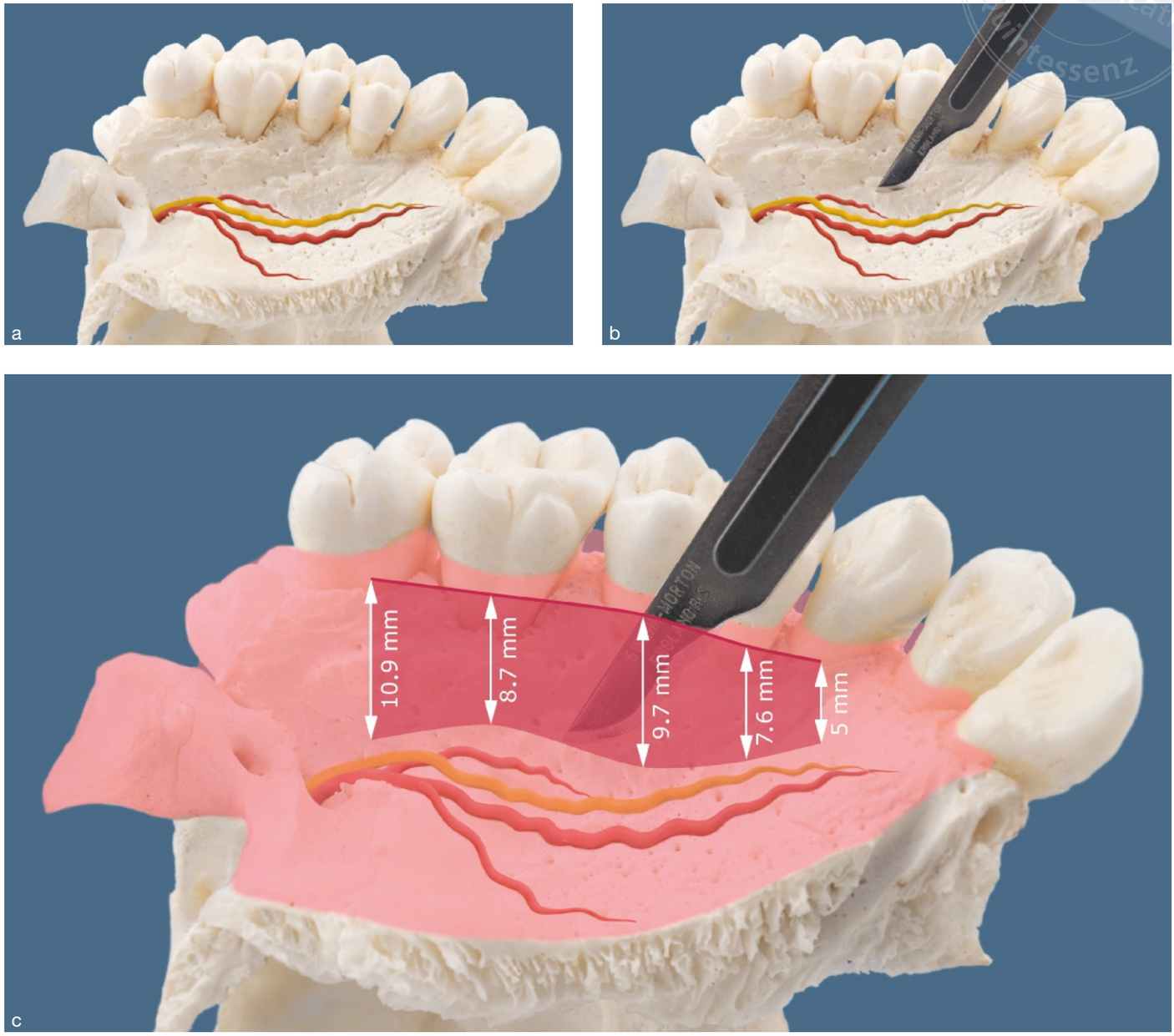


Fig 7-12a to c The results of a systematic literature review suggest that it is virtually impossible to injure the main branch or any of the larger lateral branches of the greater palatine artery in the posterior region when harvesting subepithelial CTGs from the lateral palate, provided the graft is harvested no more than 8 mm apical to the initial incision, and this surface incision is made approximately 2 mm from the gingival margin or cementoenamel junction of the maxillary posterior teeth.[114] The cutting portion of a No. 15 macroblade is approximately 8-mm wide. Therefore, the scalpel blade can serve as a valuable width reference for safe graft harvesting.

VOLUME 2

TECHNIQUES I

CHAPTER 10

SURGICAL TECHNIQUES FOR ACHIEVING HEALTHY AND STABLE GINGIVAL CONDITIONS

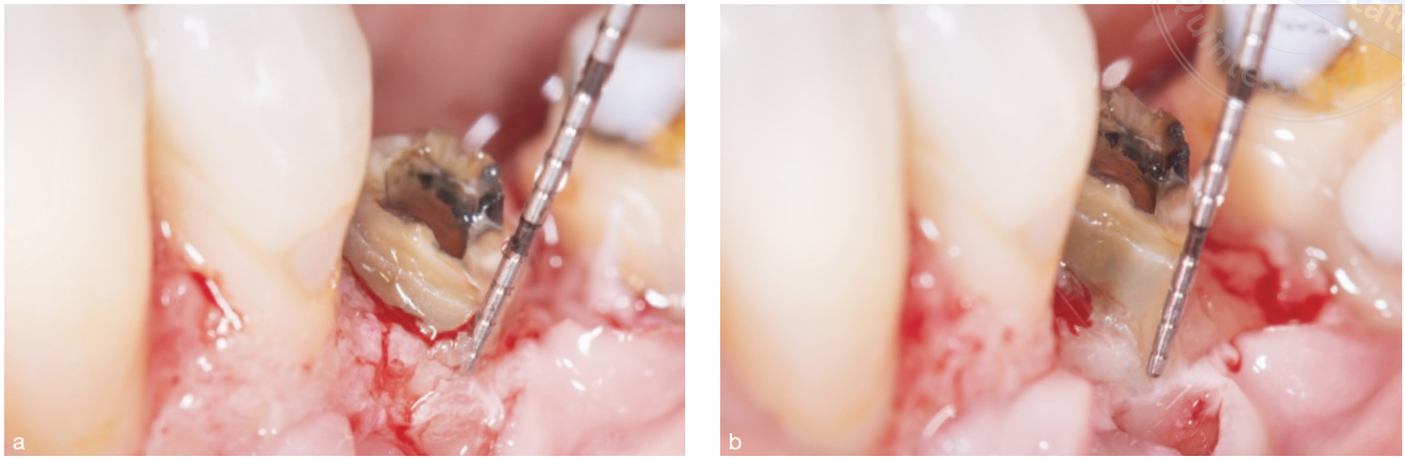
10.1 Resective Periodontal Surgery for Establishing Healthy Gingival Conditions

Resective periodontal surgical procedures for the elimination of subgingival restoration margins are often performed in the scope of restorative treatments and are designed to prevent further periodontal problems and enable accurate and error-free work. They are also indicated in cases where chronic gingivitis caused by subgingival restoration margins persists despite good oral hygiene by patients. If periodontal surgery is to result in predictable apical repositioning of the gingival margin, then the supracrestal tissue attachment is a constant dimension that must be taken into account. Whenever supracrestal soft tissue is completely or partially removed during the course of external gingivectomy or is moved to a more apical position in the context of apically repositioned flap surgery, regrowth of the lost epithelial and connective tissue attachment always occurs during the postoperative healing period – in order to maintain the microbiologic and mechanical protective function of the gingiva for the underlying anatomical structures – resulting in regeneration of the dentogingival complex (see Chapter 2). Thus, after completion of the healing in these cases, buccal and lingual soft tissue with a height of approximately 3 mm and interproximal sites of approximately 4 mm above bone level can be expected.[15,31,32] Because the supracrestal tissue attachment may be reestablished by either coronal growth of the gingiva or apical development of the soft tissue in conjunction with marginal alveolar bone resorption, or a combination of these two processes, it is difficult to predict the final position of the gingival margin. Therefore, the key to successful and predictable surgical crown lengthening is to carefully adapt the technique to the specific anatomical conditions present at baseline (Fig 10-6).

In a prospective clinical study relevant to this context, Pontoriero et al performed preprosthetic surgical crown lengthening in 30 periodontally healthy patients.[32] After mucosal flap elevation, the bone course was modeled according to the later restoration margins, the supracrestal fiber apparatus was thoroughly removed from the root surfaces, and the flaps were immobilized at bone level using periosteal sutures. Twelve months postoperatively, they observed vertical soft tissue regeneration amounting to a mean postsurgical soft tissue regrowth of 3.2 and 2.9 mm at interproximal and buccal sites, respectively. The extent of coronal growth of the gingival margin was statistically significantly higher in patients with thick gingival phenotypes than in those with normal or thin gingival phenotypes.[32] These results were confirmed by other clinical studies[34,35] (Fig 10-7).

The reference values established in this manner can be very useful for implementing predictable and at the same time minimally invasive resective periodontal surgical procedures for the elimination of subgingival restoration margins. Clinical experience has shown that if the marginal alveolar bone height is contoured to a level of approximately 3 mm from the planned gingival margin, the intended crown lengthening can be predictably achieved. However, this applies only if thorough intraoperative removal of residual periodontal fibers inserting into the root cementum from the root surface down to the level of the bone is performed. Based on the results of animal and clinical studies, it can be assumed that the reestablishment of the supracrestal tissue attachment takes place partly in the apical direction in this manner, in conjunction with resorption of the most marginal parts of the alveolar bone.[34,36–38] Apparently, this prevents postoperative coronal migration of the soft tissue margin beyond the planned level to a certain degree (Fig 10-8).

The main differences between apically repositioned flap techniques used in the surgical treatment of periodontitis versus those used in restorative dentistry for the elimination or prevention of subgingival restoration margins lie in the *contouring of alveolar bone* and the handling of *periodontal fibers* inserting into the root cementum coronal to the bone. In particular, the "fiber retention" technique aims to reduce osteoplasty and ostectomy to the absolutely necessary minimum and to achieve the goals of periodontal pocket elimination and simultaneous best possible clinical attachment gain by making every effort to preserve intact, undamaged periodontal fibers still present coronal to the alveolar bone and in the area of the bony defect. Conversely, apically repositioned flap procedures for the elimination of subgingival restoration margins always include alveolar bone contouring to the extent needed to create the desired gingival margin contour and the thorough removal of periodontal fibers inserting into the root cementum coronal to the contoured bone. All other aspects of surgery relating to incision design, flap preparation, flap mobilization, and flap stabilization on the buccal and oral aspects of the maxilla and mandible, including possibly



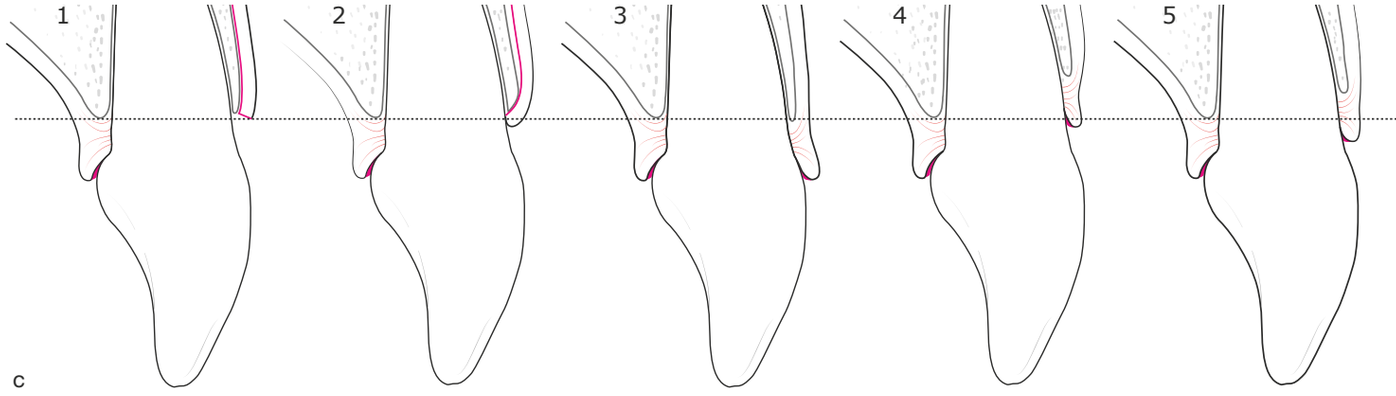
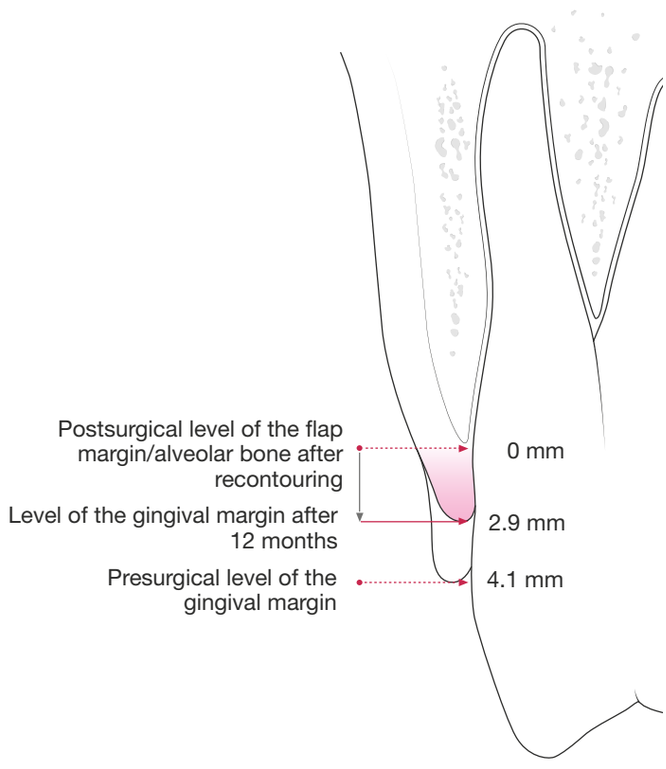
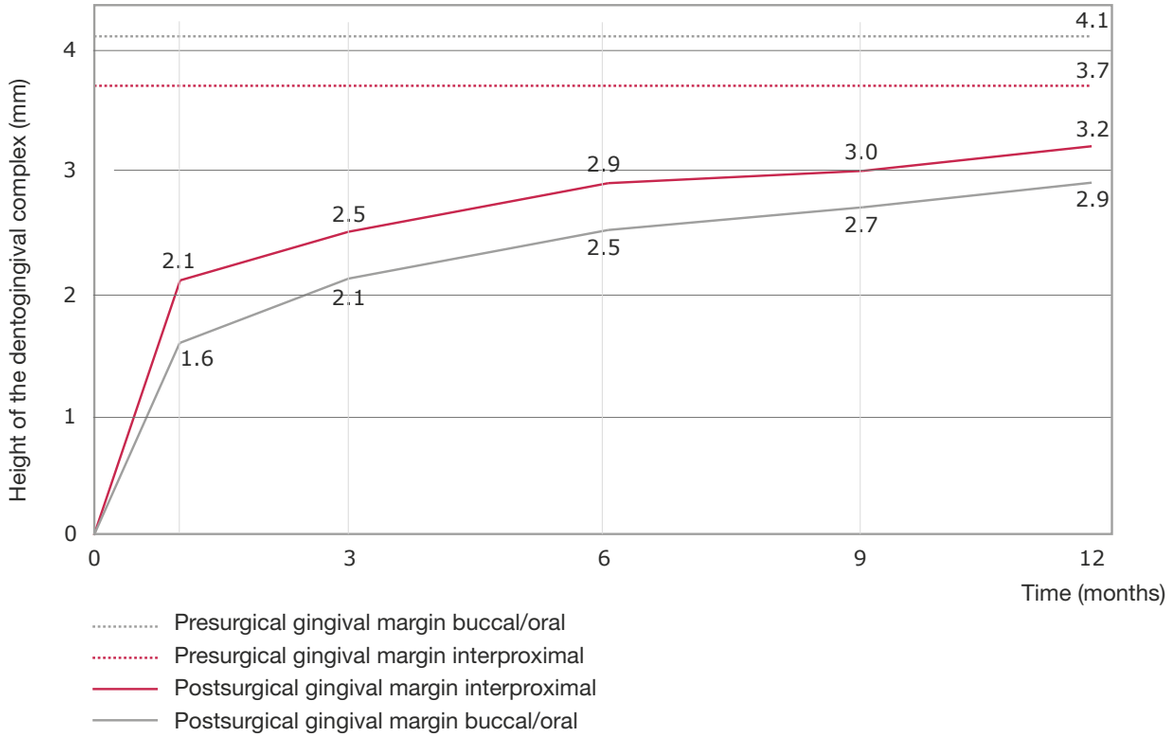


Fig 10-6a to c Whenever supracrestal soft tissue is removed during the course of external gingivectomy (1) or apically repositioned during flap surgery, as in this case example (2), supracrestal tissue attachment growth can occur in the coronal direction (3), in the apical direction in association with a loss of marginal alveolar bone (4), or in both directions (5) during the postoperative healing period, depending on the type of surgical approach adopted.



a

Fig 10-7a and b Twelve months after surgical crown lengthening with complete removal of the supracrestal fiber apparatus from the affected root surfaces, vertical soft tissue regeneration amounting to a mean postsurgical soft tissue regrowth of 3.2 and 2.9 mm at interproximal and buccal sites, respectively, can be expected.[32]



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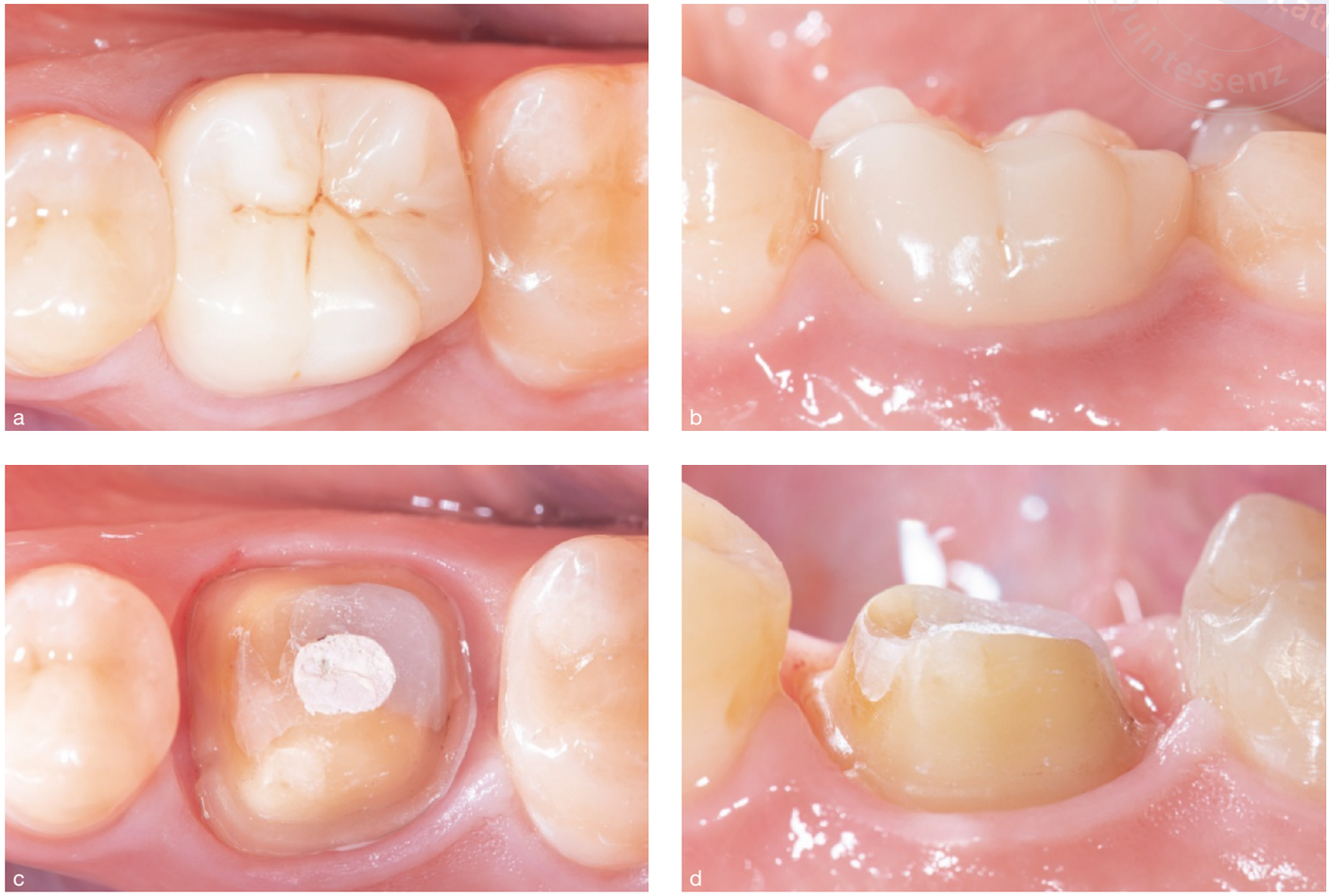


Fig 10-8a to d Clinical case example in which a deep subgingival margin on the mesial aspect of tooth 36 is eliminated by resective periodontal surgery in the scope of a prosthetic restoration. Fig 10-8a to d show the tooth with and without a long-term temporary before surgery.

Video 10-1 Osseous resection in conjunction with apically repositioned flaps for the elimination of subgingival restoration margins in the case example described above.

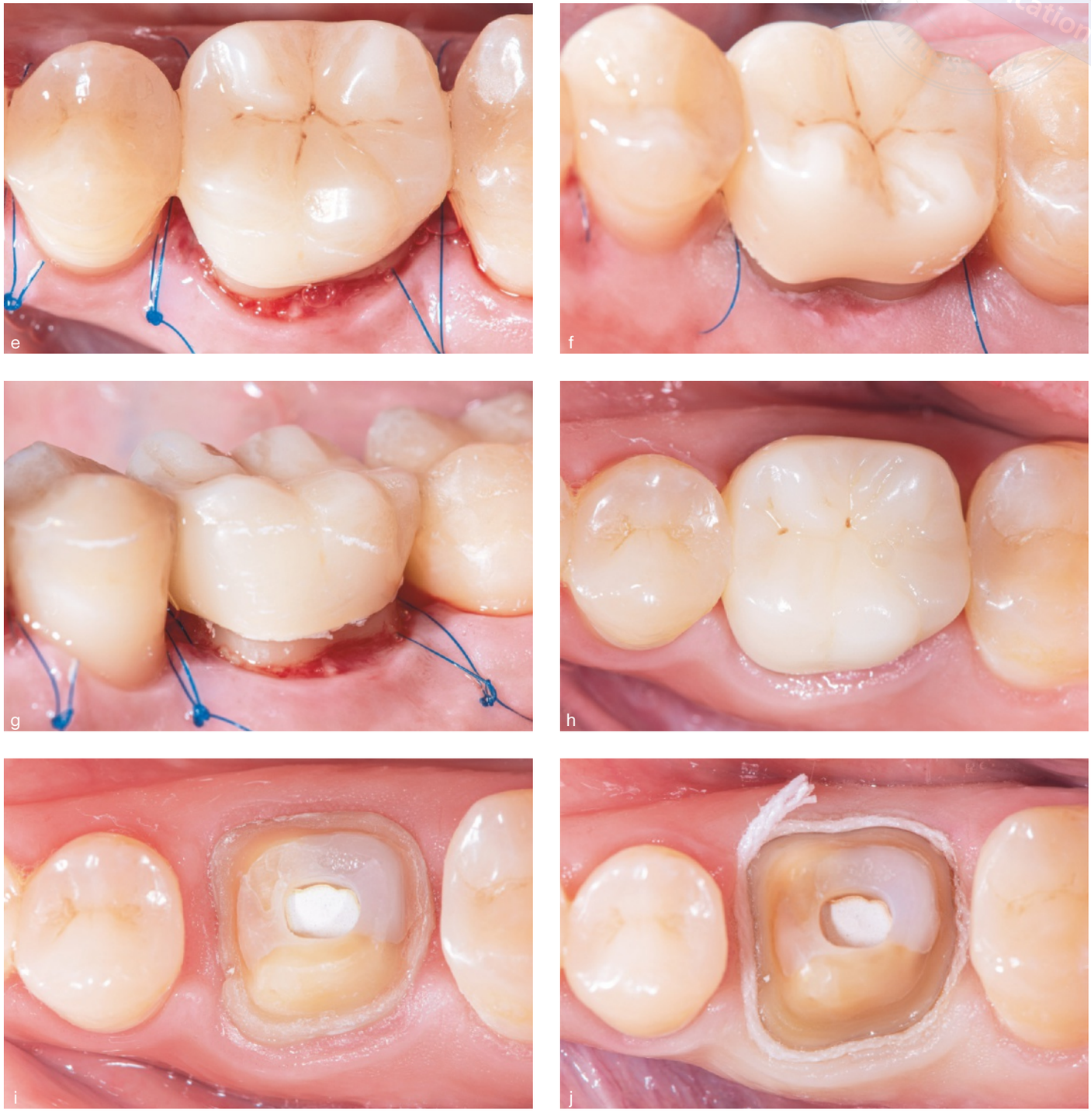
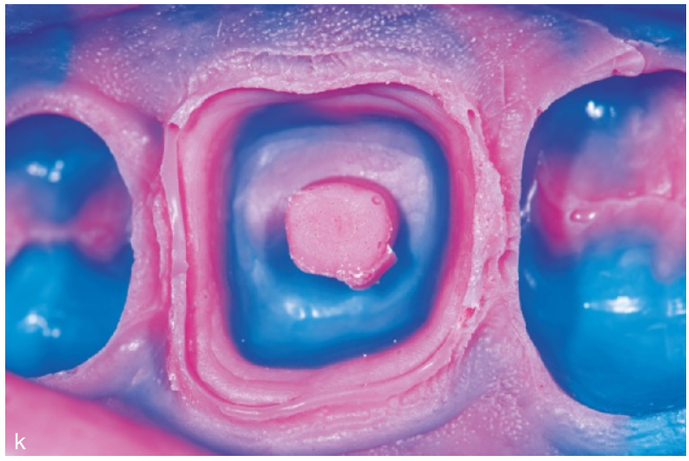


Fig 10-8e to m The situation immediately before suture removal, 1 week after the apically repositioned flap procedure. The distance between the flap margin and the preparation margin is approximately 2 mm at this time (e to g). Six-month postoperative healing outcome, highlighting the almost exactly epigingival position of the restoration margin. Intraoperative bone contouring to adjust the marginal alveolar bone height to a level approximately 3 mm from the planned gingival margin and thorough removal of the residual periodontal fibers inserting into the root cementum from the root surface to the bone enable the predictable establishment of the desired gingival margin (h and i). Because of the epigingival location of the restoration margin, finalization of the prosthetic work can be carried out in a simple and precise manner (j and k). After the completion of treatment, the periodontium is in a healthy and easy-to-clean state (l and m).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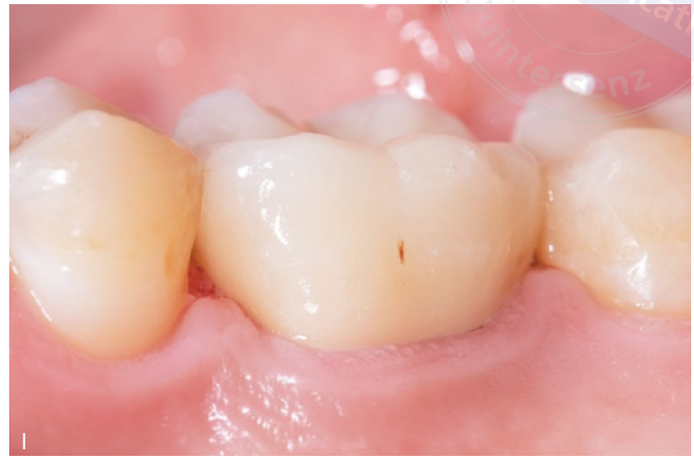
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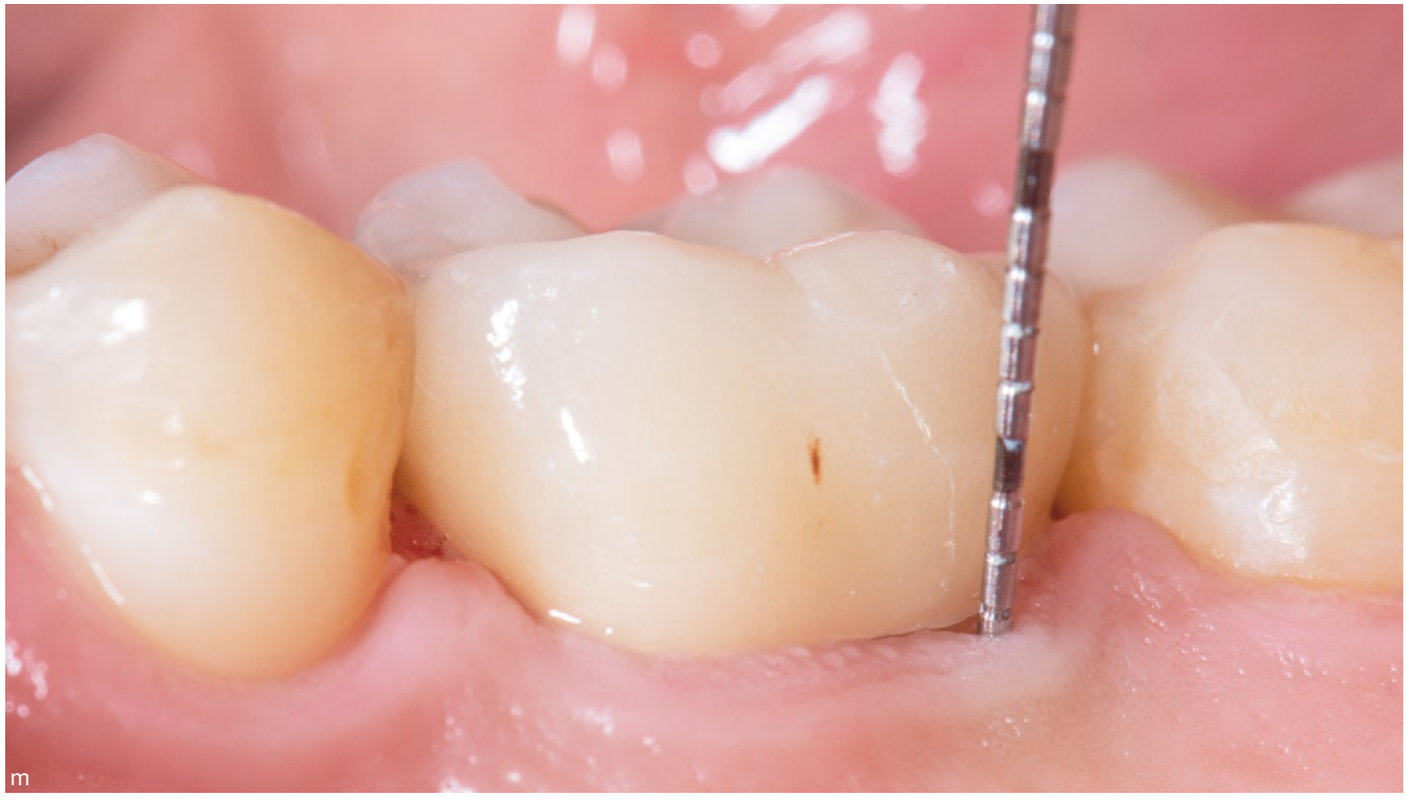

m

required distal wedge excisions, are completely analogous to the methods described in detail in Chapter 11 on resective surgical treatment of periodontitis. A detailed explanation of the surgical procedure for apically repositioned flaps will therefore not be provided here, and reference will be made to Chapter 11 for more detailed information about the techniques mentioned below (Fig 10-9).

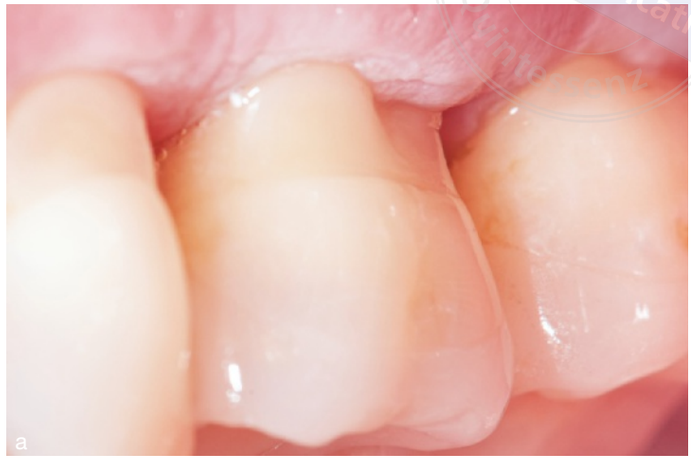
CHAPTER 12

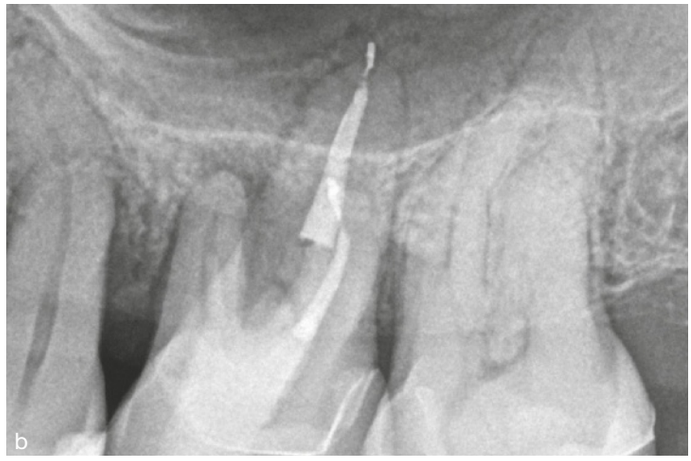
TOOTH-PRESERVING DENTAL SURGERY AT THE LIMITS

12.2 Resective Periodontal Surgery for the Treatment of Molars with Class II and III Furcation Involvement or Individual Non-Salvageable Roots

The use of resective periodontal surgical techniques can still be considered for the treatment of molars with furcation involvement today in cases where anti-infective periodontal therapy has failed to restore periodontal health, and periodontal regeneration procedures are not indicated such as in class III furcation involvement, or class II furcation involvement with subclass B in the maxilla, or subclass C in the mandible (see also Chapter 11.2). While access flap procedures can be used successfully to treat these cases in the presence of less severe class II furcation defects,[24] resective periodontal surgery is often the only available treatment option when more severe furcation defects are present. Even in such situations – due to the heterogeneity of available studies – it does not appear to be scientifically justified at the present time to conclude that resective measures are superior to nonsurgical procedures and flapless approaches, based on, for example, the survival rate of affected teeth. However, under these conditions, resective periodontal surgery is often the only predictable way to restore periodontally healthy conditions.[25] Regardless of their range of indications for systematic periodontal therapy, it is also crucial in this context that resective periodontal surgical procedures in cases in which individual roots are compromised by untreatable vertical fractures, caries lesions, or even root resorption, serve as a treatment of last resort to prevent the premature extraction of a tooth (Fig 12-84).

The available resective periodontal surgical techniques for the treatment of molars with class II and III furcation involvement or individual nonsalvageable roots include tunnel preparation, root amputation, root separation, and root resection[26] (Table 12-4).





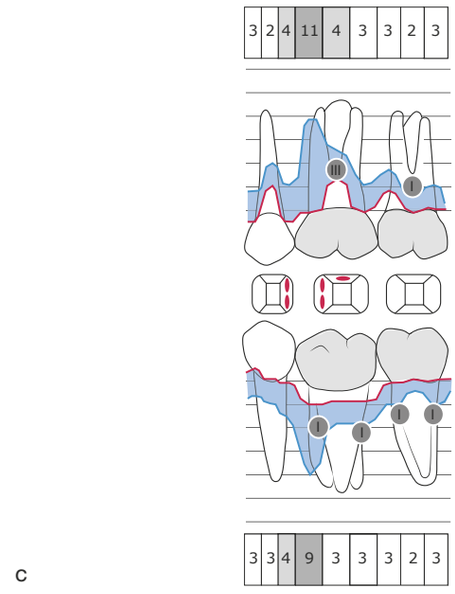
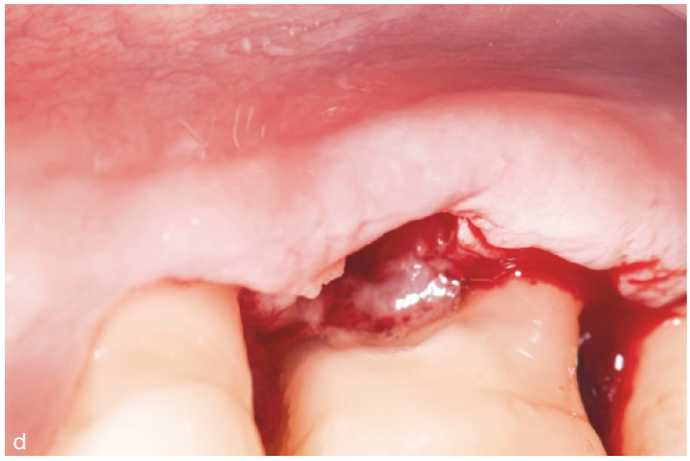


Fig 12-84a to i Clinical case example: 44-year-old female with a vertically fractured mesiobuccal root of vital tooth 26 before surgery (a to c), during and immediately after surgery (d to f), and 7 years after root amputation (g to i). In this case, resective periodontal surgery is the only treatment option that can be used to prevent premature extraction of the tooth.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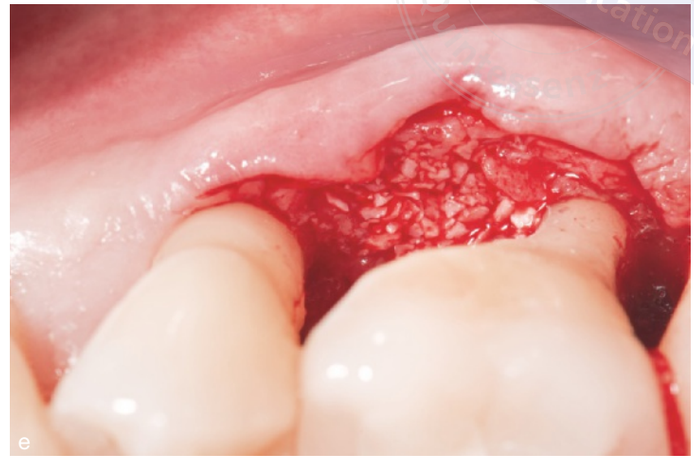
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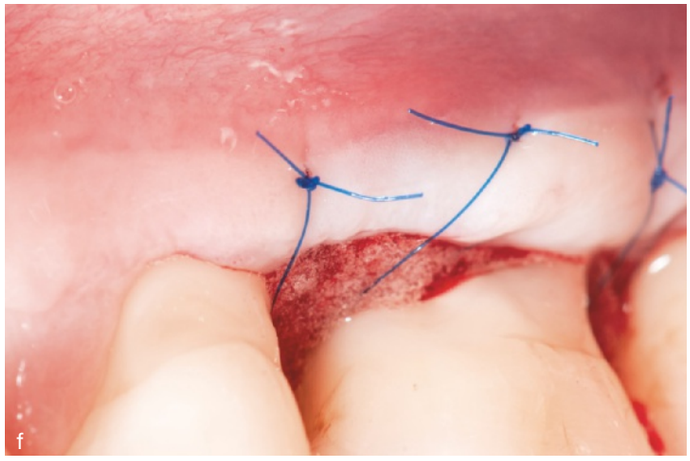
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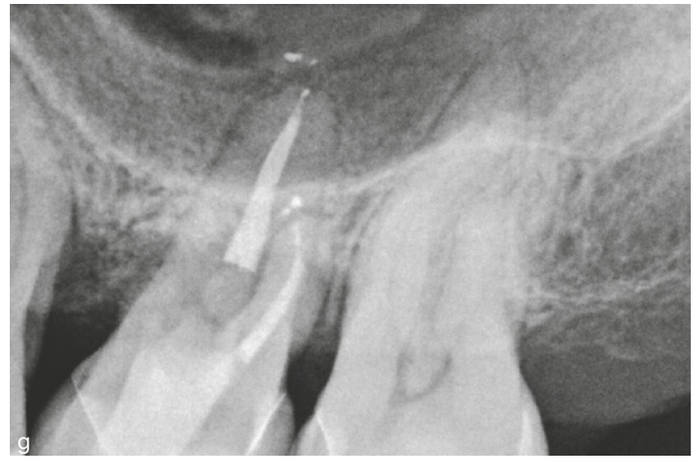
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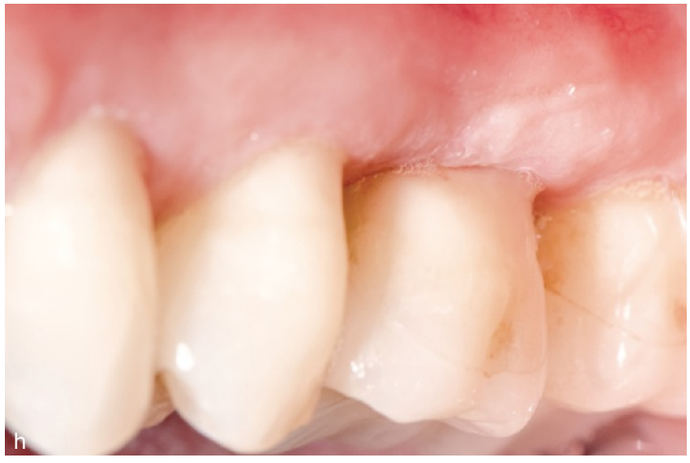
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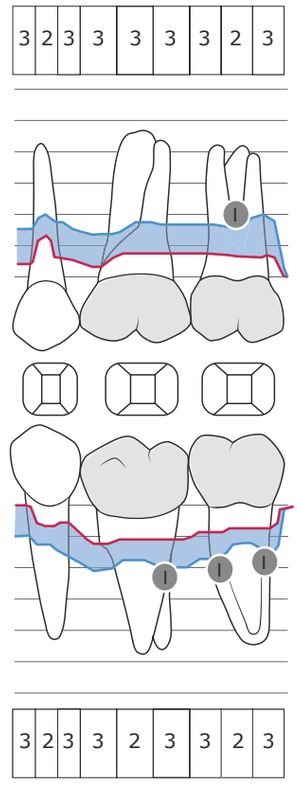


i

Table 12-4

Resective periodontal surgical techniques used for the treatment of molars with class II and III furcation involvement or individual non-salvagable roots as defined by Carnevale et al.[26]

Tunnel preparation	Resective periodontal surgical procedure used to surgically enlarge class III or regeneratively untreatable class II furcation involvements to ensure that the furcation area is conducive to good oral hygiene
Root amputation	Resective periodontal surgical procedure used to surgically remove one or more roots of a multirooted tooth while leaving the associated portion of the clinical crown in place
Root separation	Resective periodontal surgical procedure used to surgically separate one or more roots of a multirooted tooth, including their associated portion of the root trunk and clinical crown, without their subsequent removal
Root resection	Root separation with subsequent surgical removal of one or more roots of a multirooted tooth, including their associated portion of the root trunk and clinical crown

Tunnel preparation

Tunnel preparation is primarily used to treat deep class II and III furcation involvements in mandibular molars when both roots are salvageable. The aim here is usually to completely open the furcation area by removing alveolar bone in the area of the furcation entrances and between the roots to allow the affected patients to optimally clean the furcation area with interdental brushes and thus keep it free of inflammation. A major advantage is that tunnel preparation requires comparatively little treatment effort as no endodontic or restorative treatment of the affected molars is necessary. Because tunnel preparation requires a short root trunk and a high degree of root separation, the procedure is most commonly indicated on mandibular first molars[27] (Fig 12-85).

The tunnel preparation technique is similar to the apically repositioned flap procedure used in surgical periodontitis therapy, which is described in detail in Chapter 11. The recommendation to keep the treated furcation area sites open during the early healing phase, eg, by placing rubber dam cords or applying periodontal dressings, appears to have limited predictability in establishing a soft tissue surface morphology around furcation areas that are easy to clean for the patient later. Especially when there are large differences between the interdental and interradicular attachment levels, elevating a mucosal flap and leaving the periosteum on the alveolar bone for stable anchorage of the flap in the desired apical position when tunneling is therefore of great importance (Fig 12-86).

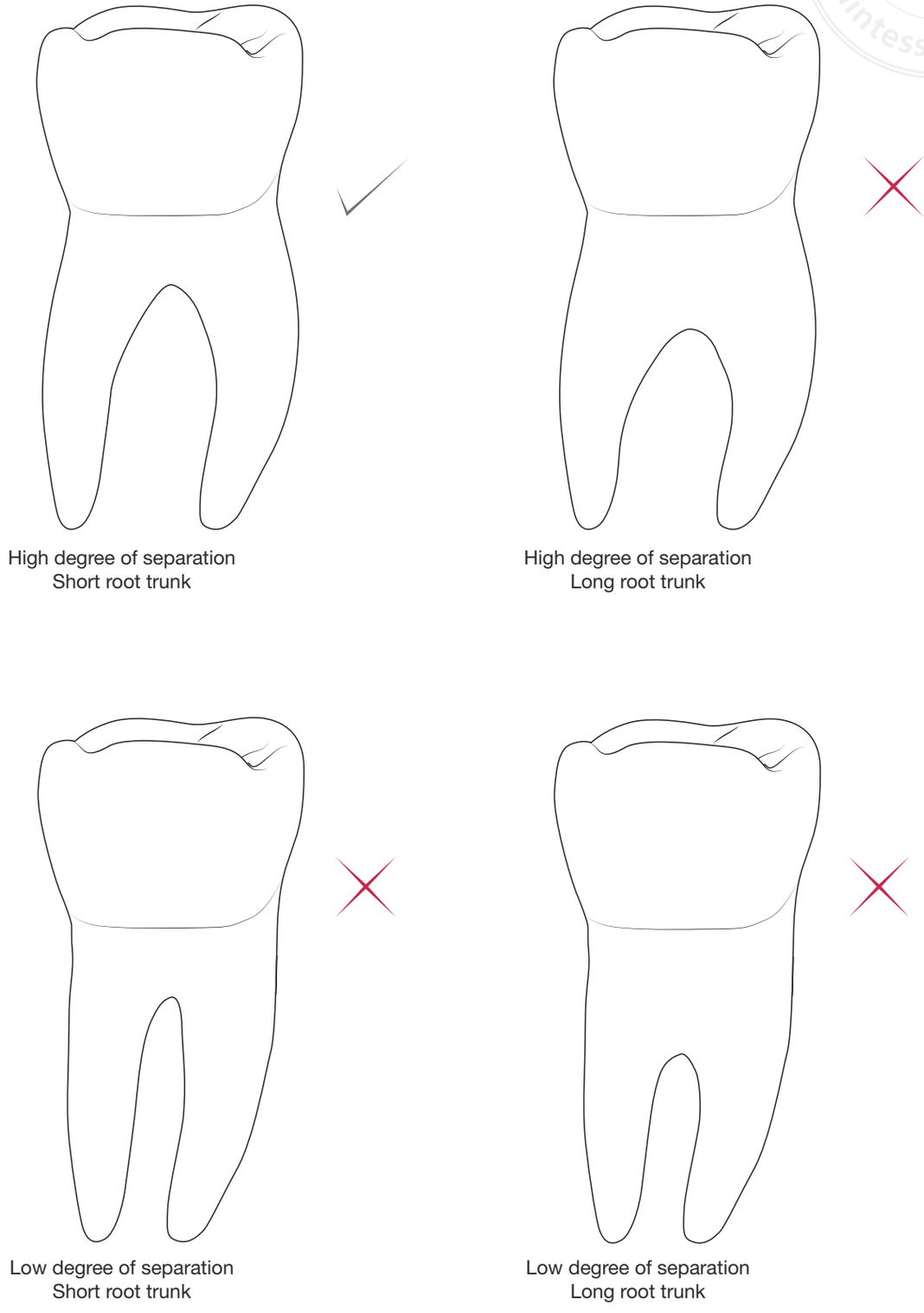


Fig 12-85 Because tunnel preparation requires a short root trunk and a high degree of root separation, the procedure is most commonly performed on mandibular first molars (✓ = Dos; ✗ = Don'ts).

12.2.3 Apically repositioned flap with distal wedge exision and root resection using the “fiber retention” technique in the maxilla

CASE PRESENTATION

Clinical history

General medical history

- 61-year-old female
- Married, one child
- Civil registrar
- No known general medical conditions, no relevant medication intake

Special anamnesis

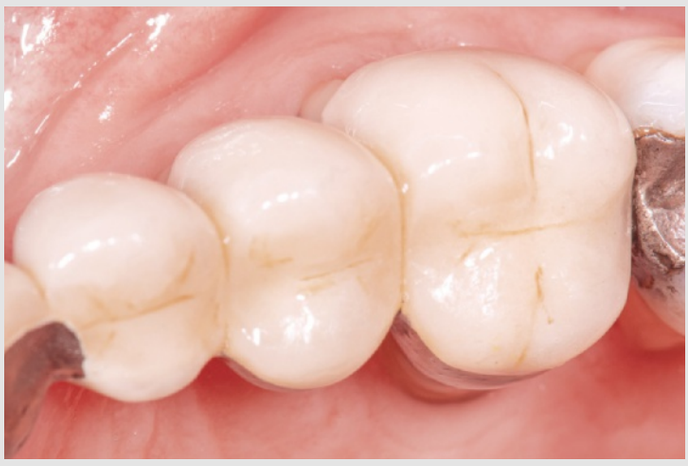
- The periodontitis treatments performed several times over the past few years have not led to any significant improvement. Inflammation is still present and has recently led to the extraction of two mandibular teeth

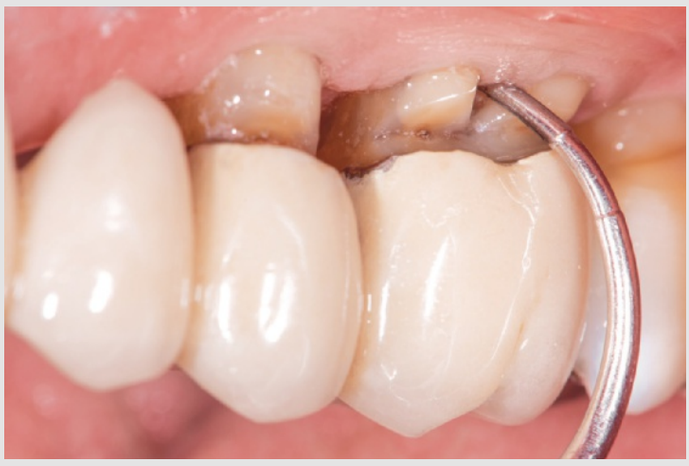
Main concern

“Although I see my dentist frequently and have had several gum treatments, two of my teeth had to be extracted last month and I’m afraid of losing more teeth.”

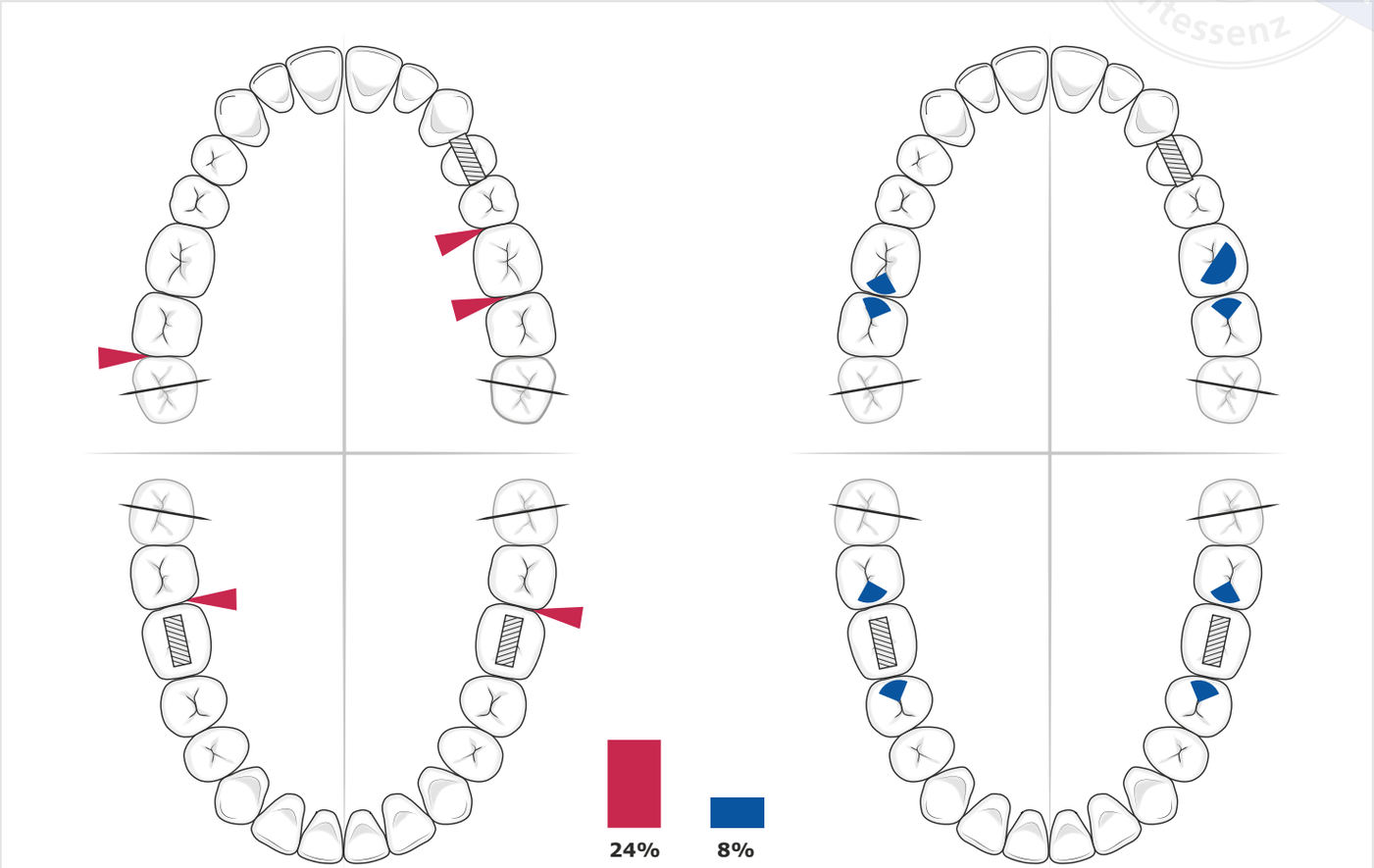
Findings at the time of reevaluation after systemic and anti-infective periodontal therapy

Intraoral findings





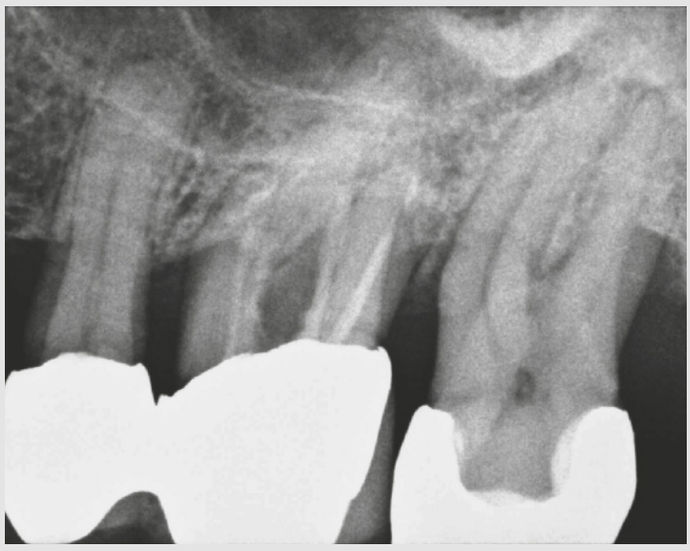
Oral hygiene findings



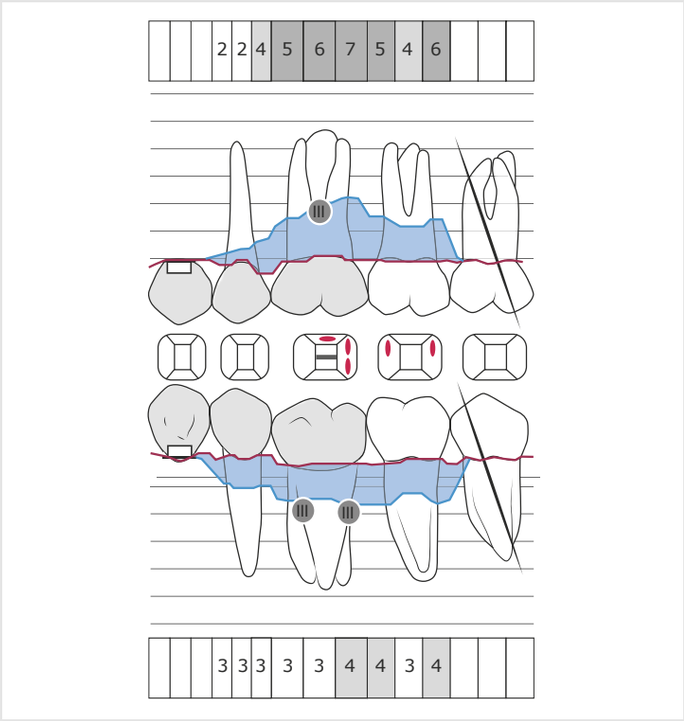
Modified Sulcus Bleeding Index
(Lange, 1977)

Plaque Control Record
(O'Leary et al, 1972)

Radiographic findings



Periodontal findings



Diagnosis

- Periodontitis, generalized stage III, grade B

Clinical decision-making – rationale for selecting the technique described in this case

- The patient wants to exhaust all options to prevent further tooth loss
- Regardless of the periodontal problems, the prostheses for the teeth affected by periodontitis need to be replaced
- Due to the presence of through-and-through furcation involvement with predominantly suprabony and only slightly pronounced infrabony defects, regenerative periodontal surgery does not appear to be a promising therapeutic option
- The short root trunk and high degree of root separation provide favorable conditions for successful execution of a resective periodontal surgical furcation treatment
- Sufficient oral hygiene cannot be achieved with root separation
- Because the patient will be able to carry out oral hygiene more easily and the treatment effort is minimally higher in this case, the decision is made against a root amputation and in favor of a root resection

Prognosis

+ Medically healthy patient, good oral hygiene, nonsmoker
+ Area without esthetic relevance
+ Short root trunk
+ High degree of root separation
– Class III furcation involvement
– Extensive removal of periodontal tissue required
– Increased tooth mobility
– Demanding surgical procedure
– Magnification aids and microsurgical instruments are required

KEY POINTS IN BRIEF

01. Fabrication of a long-term temporary restoration to create *conditions conducive to good oral hygiene* and *endodontic revision treatment* of the furcation-involved tooth prior to the planned surgical procedure

02. Decision-making regarding specific parameters of the surgical procedure based on *periodontal and radiographic findings* and *bone defect morphology* as determined by bone sounding

03. *Incision design:*
Intrasulcular incision:
- Along the *buccal* aspect of the affected teeth *without cutting the periosteum*

Paramarginal incision:
- Along the *palatal aspect* of the affected teeth. The *distance from the gingival margin* is determined by the *height of the palatal vault* and the *expected bone contour* after intraoperative osseous surgery. Care must be taken to ensure that the scalpel blade is held *perpendicular* to the surface of the palatal masticatory mucosa when making the incision

Surface incisions for the "distal wedge" technique:
- *Distal to the terminal molar*, on the *buccal* and *palatal* sides. Care must be taken to ensure that the scalpel blade is held perpendicular to the soft tissue surface when making the incisions

Interdental incisions to create the surgical papillae:
- Extended from *buccal* and *palatal*, *perpendicular* to the surface, as far into the *interdental or interradicular space* as technically feasible

Releasing incision:
- On the *palatal aspect, vertical releasing incision* starting from the distal line angle of the second premolar. Care must be taken to ensure that the scalpel blade is held *perpendicular* to the soft tissue surface when making the incision

04. *Mucosal flap* preparation:
Buccal:
- Extended apically, mesially, and distally as far as necessary to allow flap displacement to the desired apical position *without tension*

Palatal:
- In the coronal part: *Parallel* to the surface of the palatal masticatory mucosa, and then *to the bone* in the area of the flap base. Mesially, another internal *vertical incision* is made on the bone

Distal to the terminal molar:
- On the *buccal* and *palatal* aspects. First *parallel* to the mucosal surface, and then at the base of the flap, *to the bone*

05. Removal of the *tissue wedge* created by the incision on the *palatal* side and *distal to the terminal tooth*, and sharp removal of the *remaining interdental soft tissue*

06. *Visualization of the furcation entrances* with a Nabers Furcation Probe, *root separation* using a flame-shaped diamond bur, and *extraction* of the distobuccal root as *atraumatically* as possible. The root to be removed must always be selected with the goal of creating *optimal conditions for good oral hygiene*

07. *Intraoperative preparation* of the mesiobuccal and palatal root. In addition to *parallel preparation* of the abutment teeth, care must be taken to ensure *adequate distance* between the two roots and to *remove undercut areas*

08. *Careful removal* of soft tissue from the defect areas, leaving intact the supracrestal periodontal fibers attached to the root surfaces

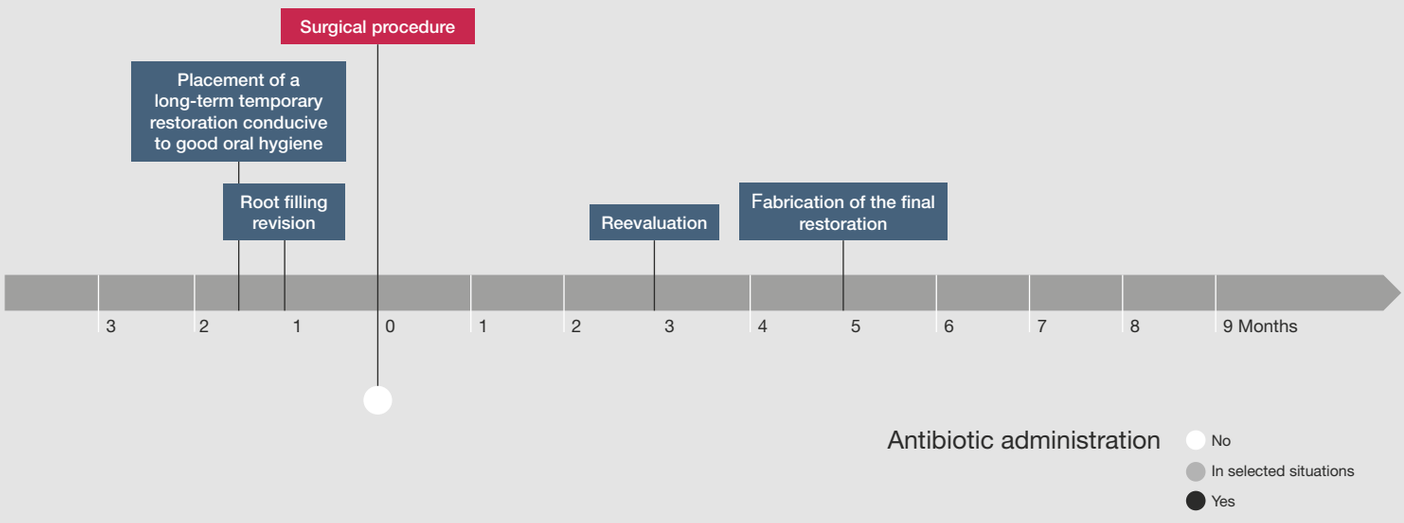
09. Thorough *instrumentation of the root surface*, *bone contouring* with the goal of creating a thin and harmonious alveolar bone margin based on the *"fiber retention" technique*

10. Apical *flap stabilization* with 6-0 *mattress sutures* anchored to the periosteum on the buccal side and onto the palatal masticatory mucosa on the palatal side, followed by *flap adaptation* with 7-0 *interrupted sutures* in the distal wedge area

11. Placement of the lined long-term temporary restoration with temporary cement and application of a *periodontal dressing* coated with chlorhexidine powder to cover the wound areas left to heal by secondary intention in the interdental areas

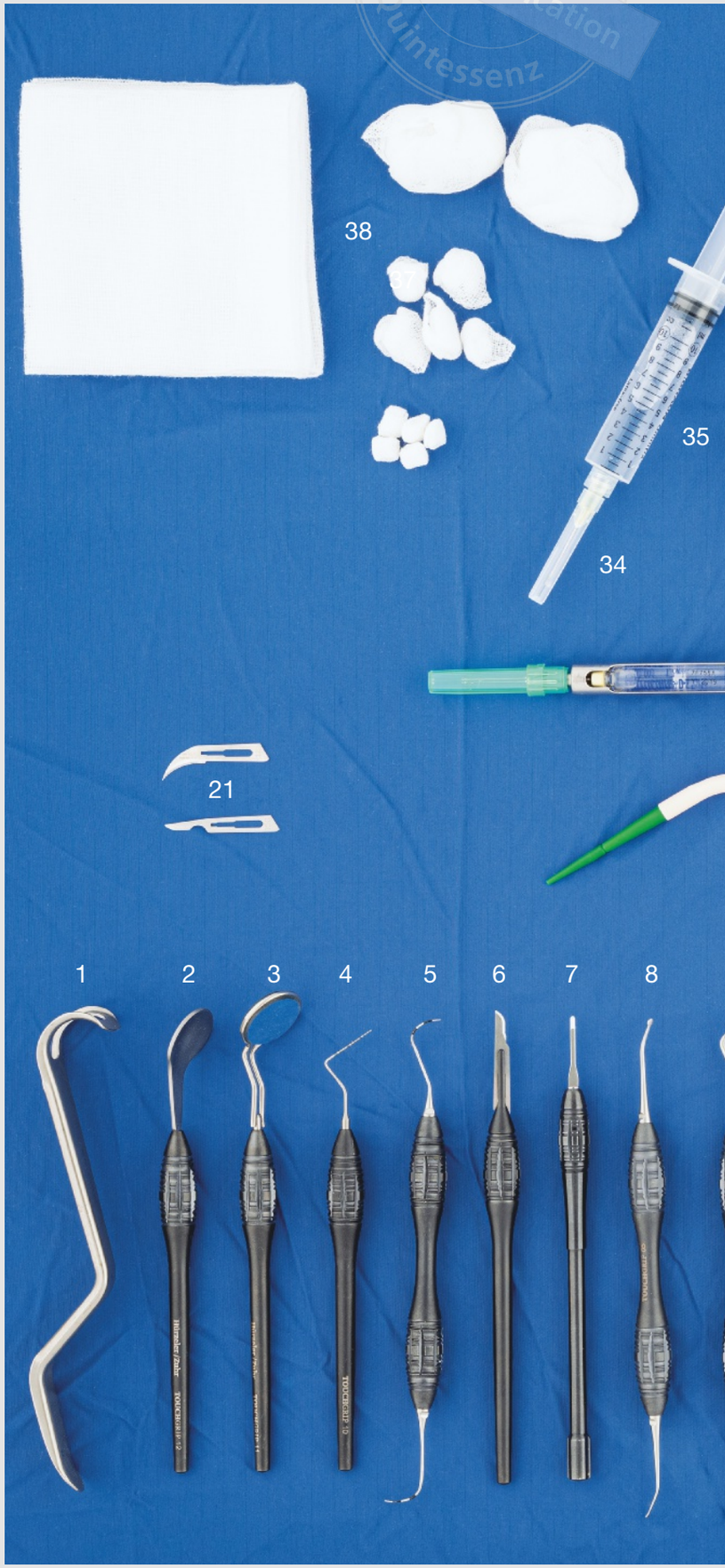
12. Comprehensive and complete *patient instructions*

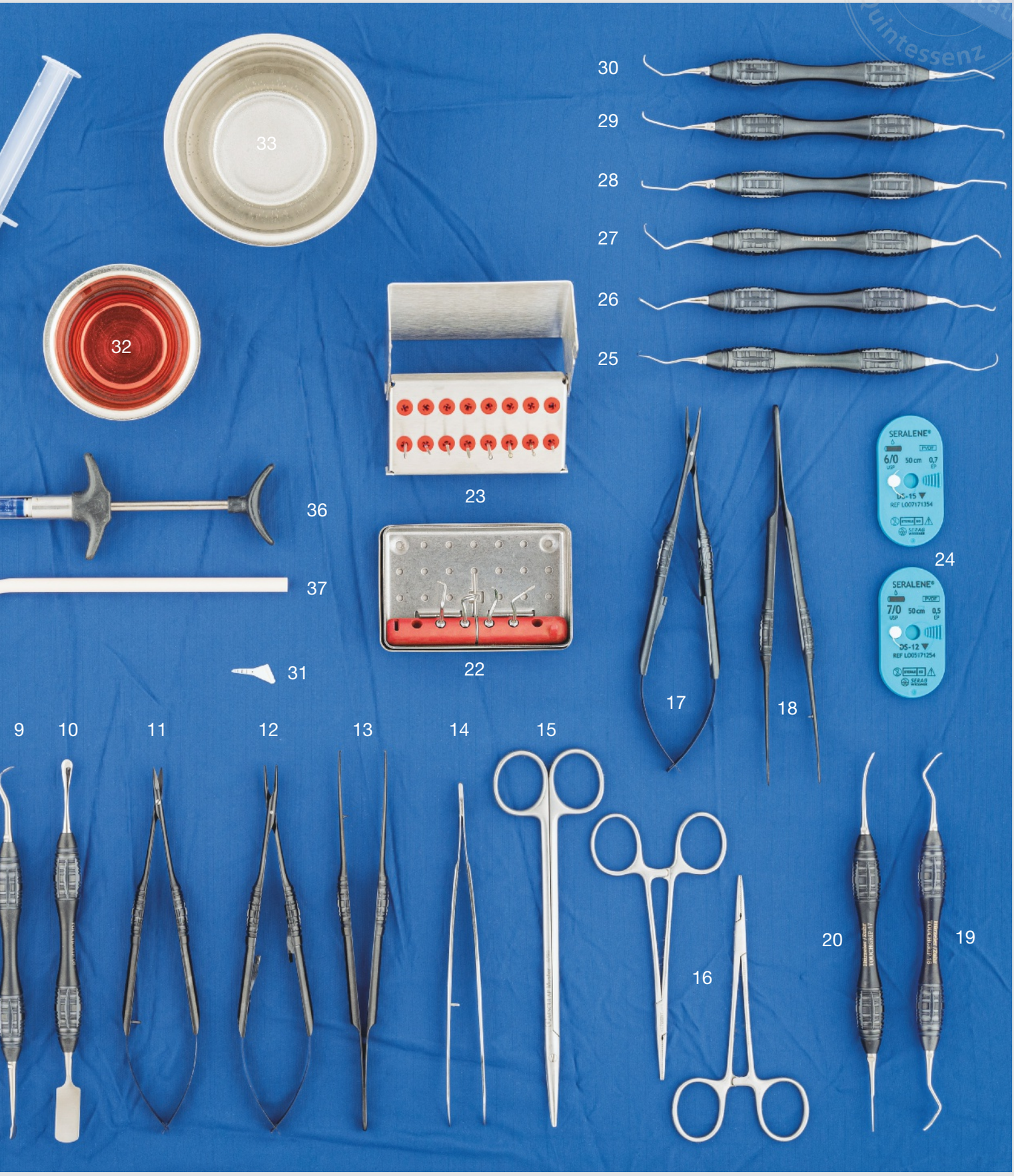
TIME MANAGEMENT



WORKPLACE PREPARATION CHECKLIST

1 Cawood-Minnesota Retractor
2 Hilger Retractor
3 Mirror with Lip Holder
4 Perio Probe, straight
5 Nabers Furcation Probe
6 Scalpel handle for macroblades with No. 15 scalpel blade
7 Scalpel handle for microblades with Micro Blade SR
8 Papilla Elevator, double-ended
9 Raspatory with one straight and one angled working end
10 Raspatory with Prichard Retractor
11 Spring scissors
12 Needle holder, corrugated
13 Anatomical–surgical combination forceps
14 Dental tweezers
15 Metzenbaum scissors, curved
16 Artery clamps, straight
17 Needle holder smooth, extra fine
18 Anatomical forceps, smooth, extra fine
19 Back Action Chisel
20 Fedi Bone Chisel
21 Scalpel blades: Nos. 12d, 15c
22 SONICflex™ rootplaner tips: Nos. 24, 25, 26, and 27
23 Tray with surgical burs
24 Suture materials: SERALENE® DS-15 6-0, SERALENE® DS-12 7-0
25 Explorer
26 Universal curette Mini-Langer ¾
27 Excavator, fine, angled
28 Gracey curette 5/6
29 Gracey curette 11/12
30 Gracey curette 13/14
31 PERIOFLOW® Nozzle
32 Chlorhexidine irrigation solution 0.1% in metal bowl
33 Sterile water in metal bowl
34 Blunt cannula, ø 0.90 x 40 mm
35 Syringe, 10 mL
36 Local anesthesia, Ultracain® D-S forte 1:100,000 1.7 mL
37 Microsurgical Aspirator, Surgitip-micro
38 Large and small swabs





VOLUME 3

TECHNIQUES II

CHAPTER 13

ALTERNATIVE TOOTH REPLACEMENT OPTIONS TO DELAY OR AVOID IMPLANT TREATMENTS

13.3 Prosthetic Space Closure

Conventional bridges, resin-bonded fixed partial dentures, and, in selected cases, palatal implant-supported pontics are predictable alternatives to implants for replacing missing or unsalvageable teeth when orthodontic space closure and autotransplantation are contraindicated or not used for other reasons. The case examples presented in detail below for the three different options of prosthetic space closure were selected to also highlight frequently indicated periodontal surgical procedures aimed at optimizing the soft tissue around bridge units.

Free gingival grafts to increase the width and thickness of the masticatory mucosa

In addition to static requirements, pontics placed in areas without esthetic relevance must be designed in such a way that adequate oral hygiene is ensured and the occurrence of food retention is prevented as far as possible.[87] The shape and mucosal condition of the edentulous area must allow for the fabrication of a pontic that can easily be cleaned proximally with interdental brushes and basally with dental floss, ideally with its base positioned in the masticatory mucosa.[119] Complete reconstruction of tissue defects in edentulous areas is rarely necessary for site preparation. However, resective periodontal surgery is required in rare cases in order to place a sufficiently dimensioned pontic that meets the mechanical requirements. Furthermore, to create conditions conducive to good oral hygiene in cases where the junction of the lining mucosa and the masticatory mucosa is displaced toward the center of the alveolar ridge, it may be advisable to use free gingival grafts (FGGs) to increase the width of the keratinized mucosa.[120] The surgical principles here follow the previously described procedure for increasing the width of gingival tissue by placing thin (1 to 1.5 mm) FGGs on vascularized surfaces apical to the gingival margin (see Chapter 10.2). A well-vascularized wound bed as well as tight adaptation and immobilization of the graft to the wound bed are also critical success factors in this indication. Medium-thickness (1.5 to 2 mm) and thick (> 2 mm) FGGs are used as "onlay" grafts in individual cases where it is necessary to increase not only the width but also the thickness of the masticatory mucosa in the defect area[121] (Fig 13-131).

Connective tissue grafting to augment edentulous sites using a combination of the modified "pouch" and "saloon door" techniques

In addition to biologic, mechanical, functional, and hygienic requirements, bridge restorations in esthetic areas must also meet esthetic criteria of success. They must imitate the missing teeth, including their surrounding soft tissue, as perfectly as possible. In addition to an appropriate pontic design, the reconstruction of the alveolar ridge defects also plays a decisive role in achieving a soft tissue contour in edentulous areas that closely resembles the gingival architecture around natural teeth. Esthetic success requires more than just complete reconstruction of the defects (quantitative criteria). It also requires techniques to ensure that the augmented tissue does not differ from the surrounding natural periodontal structures in terms of surface texture, color, and absence of scarring (qualitative criteria). In this context, tunneling techniques have gained popularity among clinicians in recent years. The basic idea is to avoid any surface incisions on the buccal aspect of the teeth to achieve optimal blood supply and maximal postoperative wound stability, thus minimizing the risk of postoperative scarring in esthetically relevant areas. The disadvantage of tunnel flaps is their limited mobility compared with flaps prepared with releasing incisions. Depending on the indication, buccal horizontal or vertical releasing incisions distant to the defect or palatal releasing incisions, palatal peninsula flaps, or completely detached palatal peninsula flaps can be used to increase the mobility of tunnel flaps (see Chapter 4).

The *modified "pouch" technique* for soft tissue augmentation around pontics is based on the tunneling flap procedure. It allows for alveolar ridge reconstruction and prosthetic tissue conditioning to be performed in a single step, thereby significantly simplifying and shortening the conventional clinical procedure.[74] To allow for correct intraoperative positioning of the provisional pontic, an area of the affected alveolar ridge to be reconstructed is deepithelialized at the beginning of the procedure. The position and size of the selected area should correspond to the root cross-section of the missing tooth and the base of the temporary pontic, respectively. The interproximal and buccal soft tissue in the defect area is then undermined to create a partial-thickness flap. To achieve sufficient flap mobility, the pouch must be extended laterally to the adjacent teeth and apically well beyond the mucogingival junction,

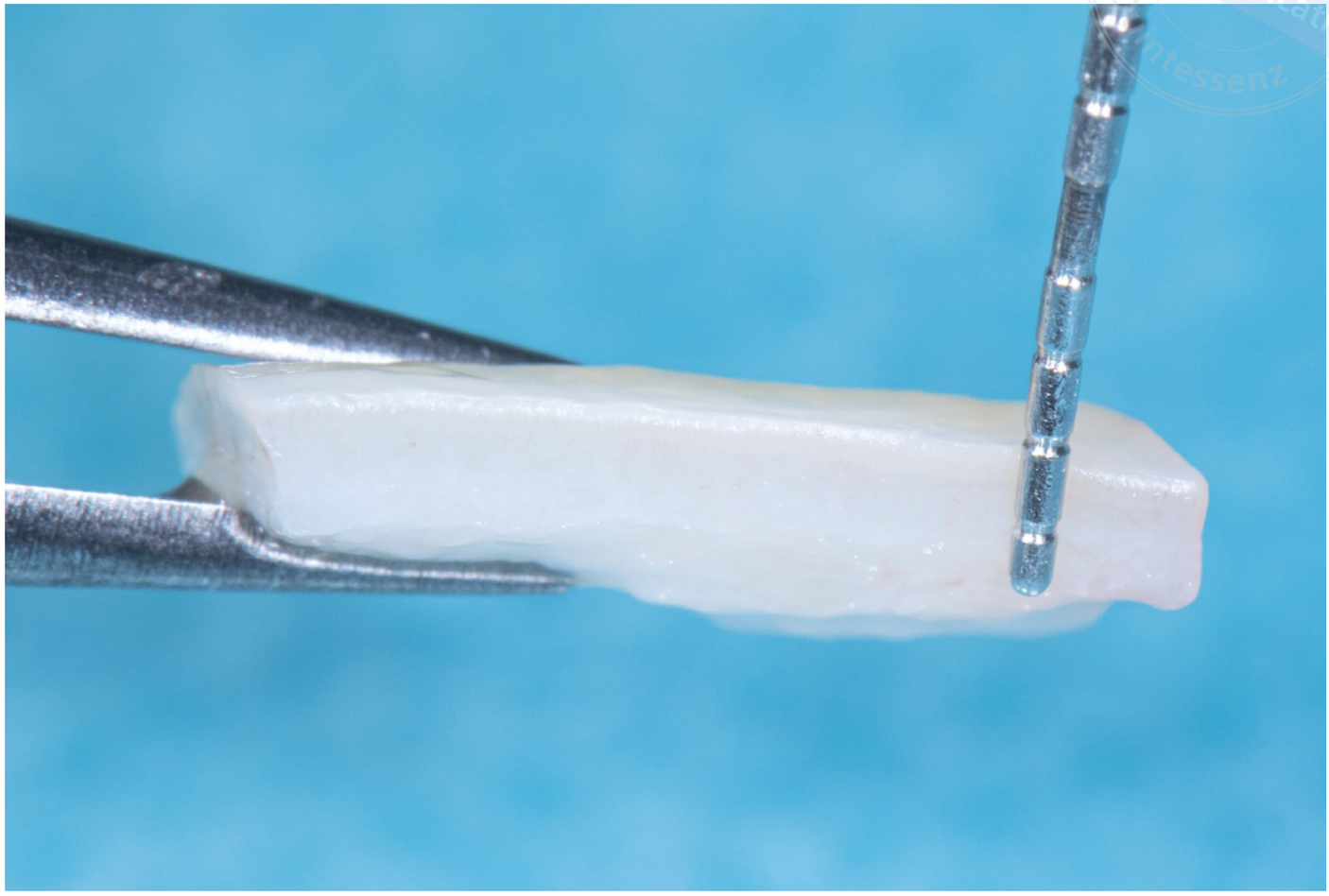


Fig 13-131 Periodontal surgery to increase the width of the masticatory mucosa in edentulous areas is similar to the procedure for increasing the width of gingival tissue by placing thin free gingival grafts (FGGs) on vascularized surfaces (see Chapter 10.2). Thicker FGGs are used as "onlay" grafts in cases where it is necessary to increase not only the width but also the thickness of the masticatory mucosa.

in accordance with the combined coronally advanced tunneling technique proven effective in the treatment of gingival recessions.[74] Depending on the mobility of the resulting mucosal–mucoperiosteal–mucosal flap relative to the size of the defect to be reconstructed, it may, as previously described, be necessary to increase flap mobility. This can involve making defect-distant releasing incisions on the buccal side or extending the flap preparation to the palatal side by creating an additional palatal peninsula flap or a fully detached palatal peninsula flap, to provide a sufficiently mobile soft tissue collar around the base of the temporary pontic. Using positioning sutures, the CTG is subsequently drawn into the tunnel and placed in the desired position. Prior to definitive suturing, the pontic is placed in the soft tissue opening, and the provisional bridge is temporarily cemented. Since the graft is positioned exclusively on the buccal side of the pontic in this approach, there is no risk of pressure necrosis caused by postoperative swelling.

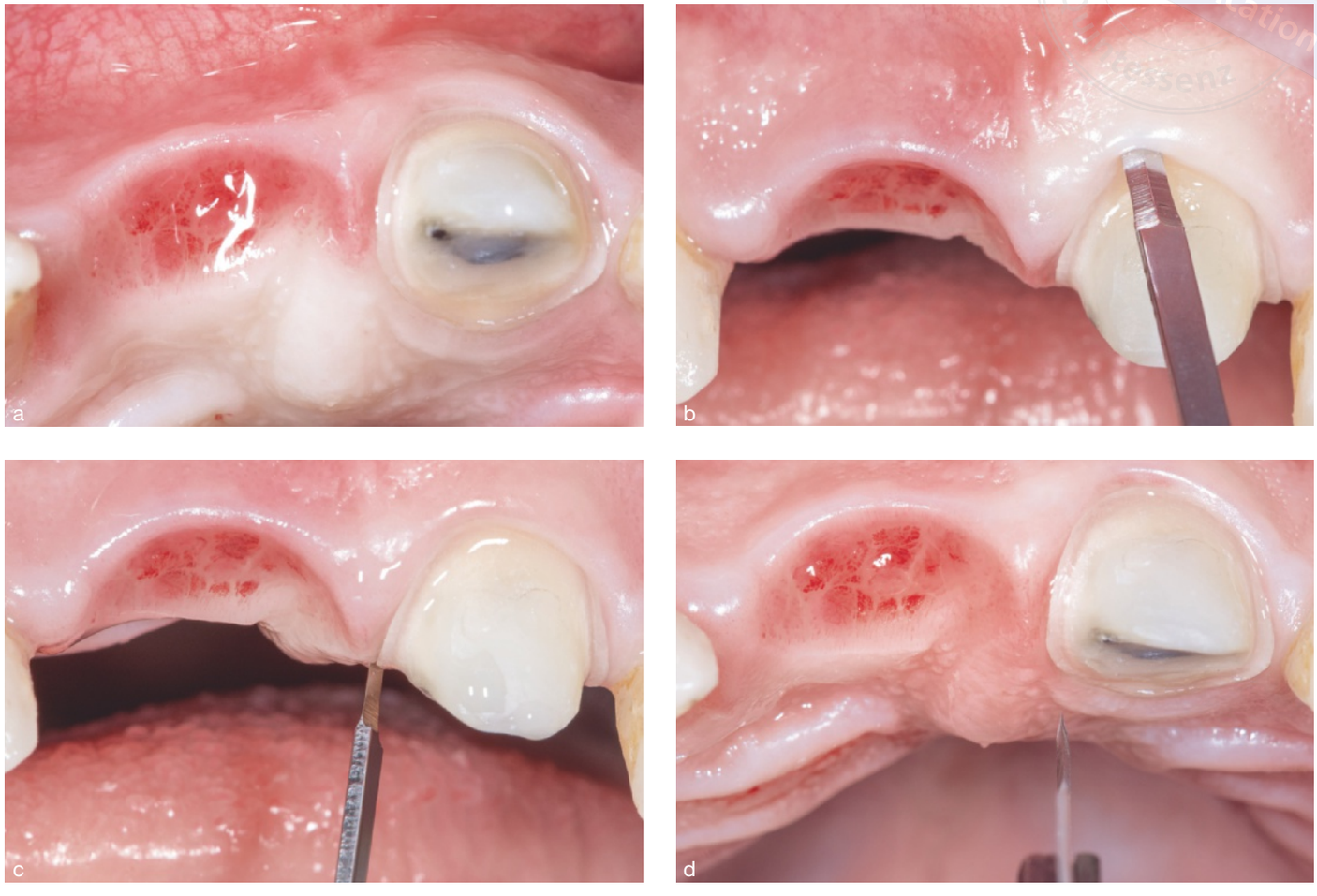


Fig 13-132a to d Clinical case example of a prosthetic space closure for the replacement of missing tooth 11 with reconstruction of the alveolar ridge defect through a combination of the modified "pouch" technique and "saloon door" technique. To achieve sufficient flap mobility, the papillae between the teeth immediately adjacent to the gap and the neighboring teeth are included in the buccal intrasulcular incision. For additional flap mobility, the intrasulcular incisions along the teeth adjacent to the edentulous site are extended to the palatal line angles of the teeth, after which incisions are made to create a palatal peninsula flap.

The modified "pouch" technique can be used in combination with the *"saloon door" technique* to simultaneously reconstruct the buccal soft tissue and augment the papillae between the pontic and the adjacent teeth or between two adjacent pontics in single- or multi-tooth edentulous spaces. In principle, this is very similar to the modified roll flap technique used during implant uncoverage to compensate for buccal tissue deficits.[122] With this technique, after deepithelization of the mucosa in the edentulous area, a U-shaped incision is made perpendicular to the tissue surface close to the bone, leaving the periosteum intact. The flap is then mobilized

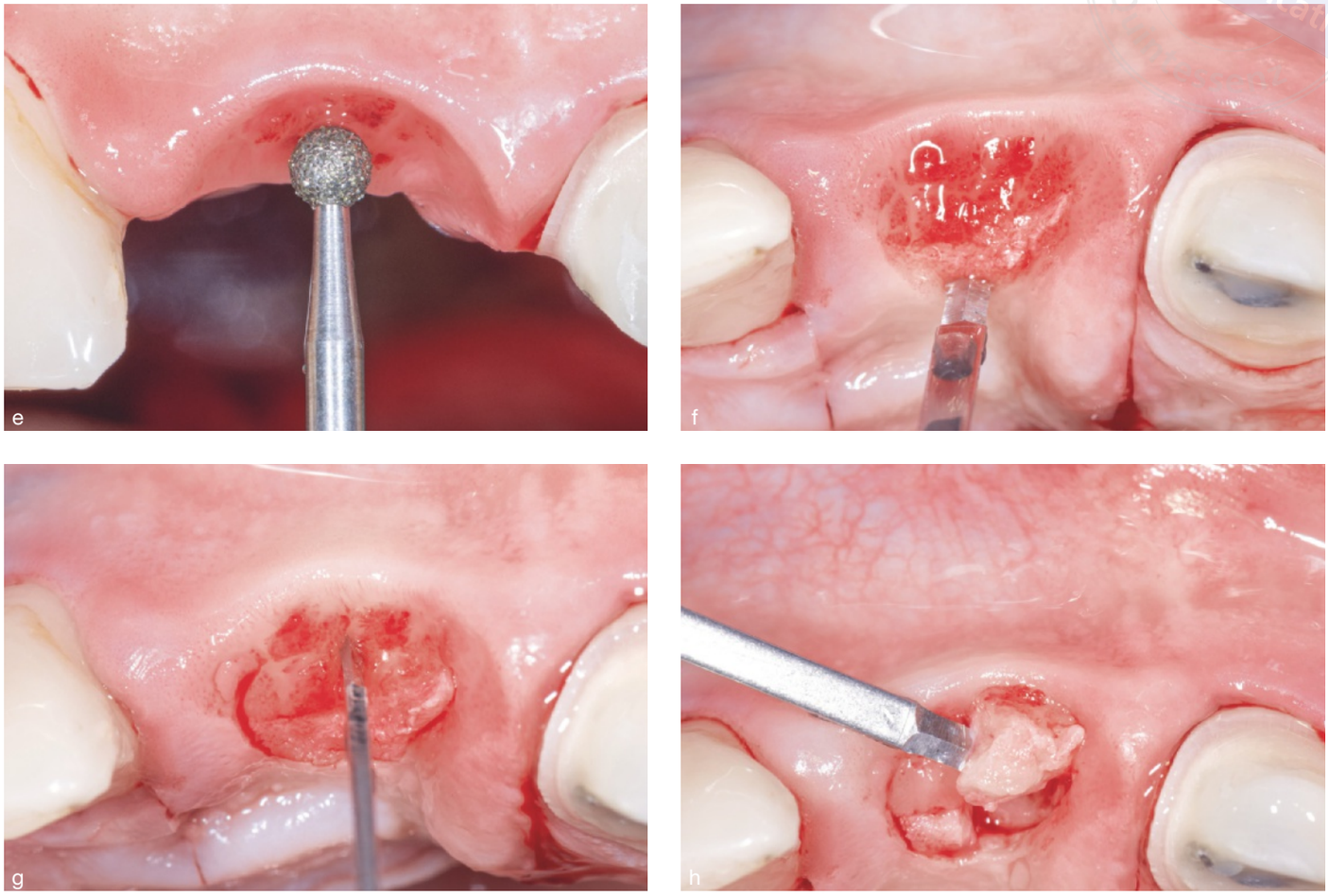


Fig 13-132e to h A round diamond bur is used to deepithelialize an area corresponding to the diameter of the tooth to be replaced. Subsequently, the deepithelialized area is carefully incised laterally and palatally with a microscalpel blade, close to the underlying bone, and then bisected along the median plane in the bucco-oral direction – the scalpel is oriented perpendicular to the surface. The exposed connective tissue is then sharply detached from its bony base with the microscalpel blade while preserving the periosteum, until two small, buccally pedicled, and independently movable CTGs are created.

from the palatal side, and rolled into the prepared buccal tunnel as a buccal pedicle CTG. With the "saloon door" technique, the corresponding connective tissue is additionally bisected along the median plane with a buccolingual incision. In this way, two small, buccally pedicled, and independently movable soft tissue grafts are created, which, after the placement of the CTG from the hard palate for the reconstruction of the buccal tissue defect, can be rotated mesially and distally under the buccally prepared tunnel to build up the papillae between the pontic and the adjacent teeth, or between two adjacent pontics (Fig 13-132).

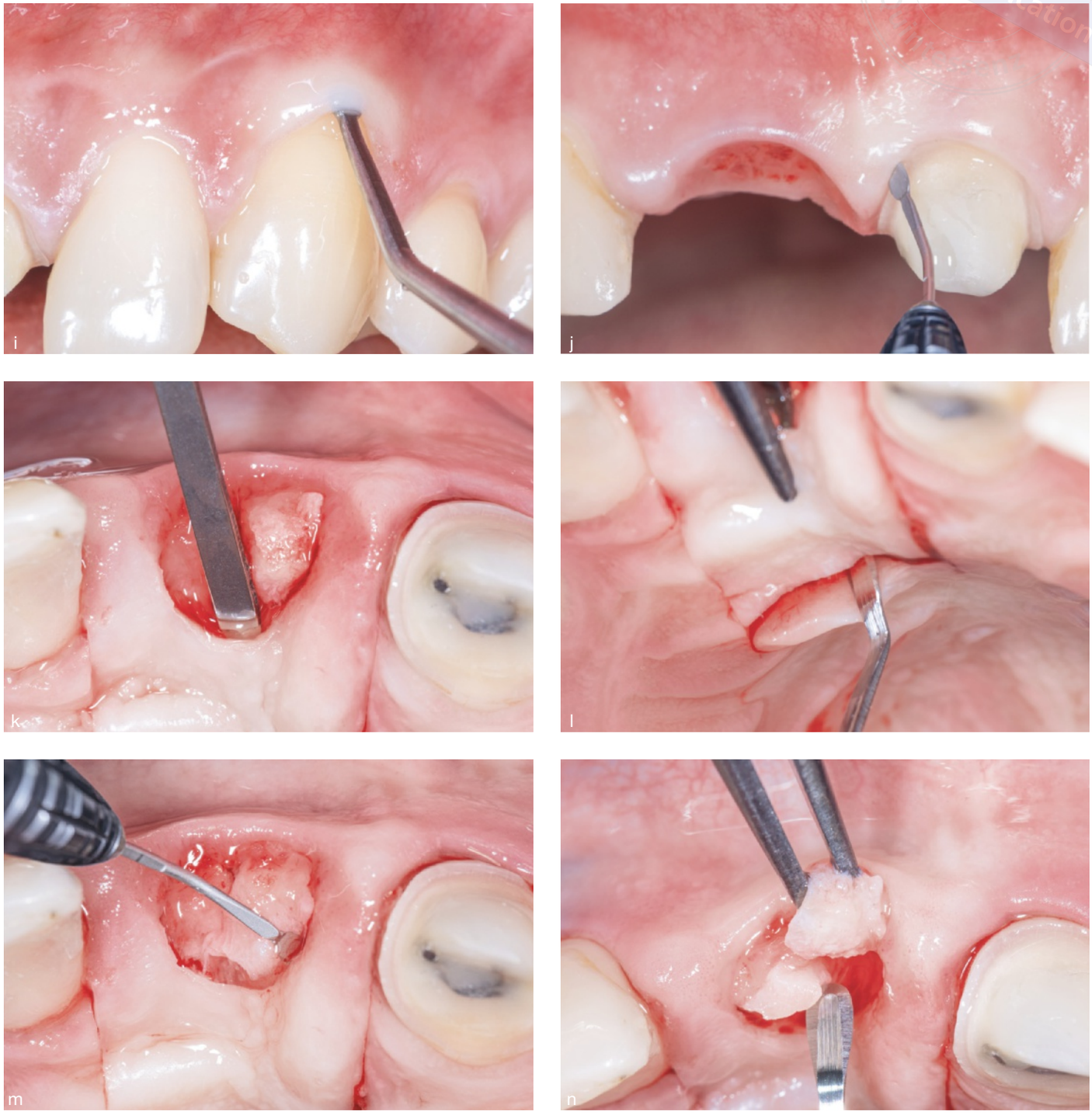
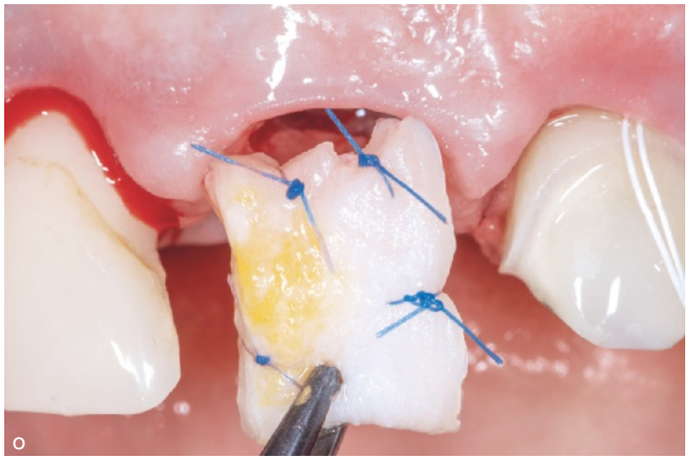
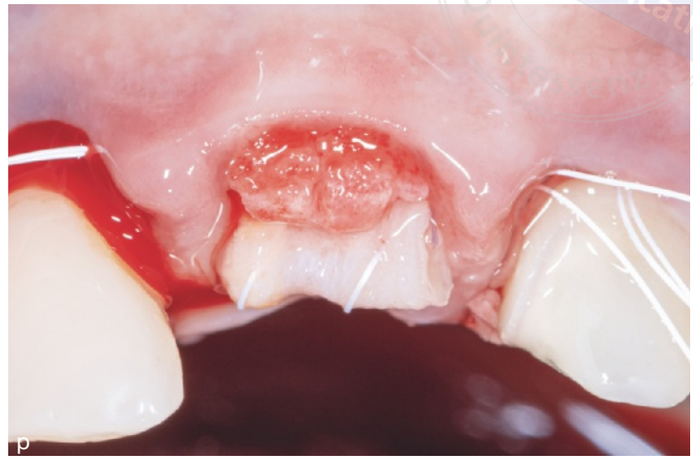
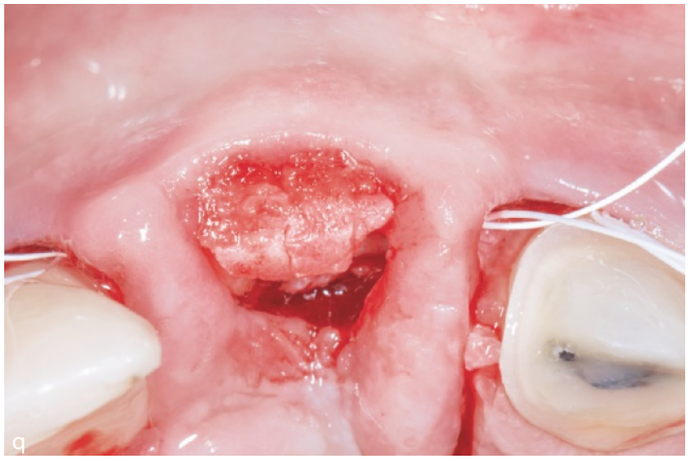
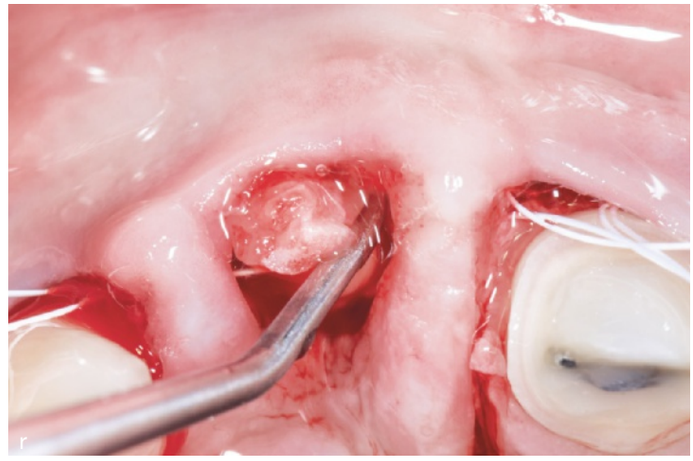


Fig 13-132i to n The buccal and palatal flaps are then elevated using the combined coronally advanced tunnel technique on the buccal side and the palatal peninsula flap technique on the palatal side. To achieve the desired flap mobility, the buccal and palatal flaps are joined in the correct plane through a sharp incision in the mucosa remaining on the alveolar ridge mesial and distal to the soft tissue opening.









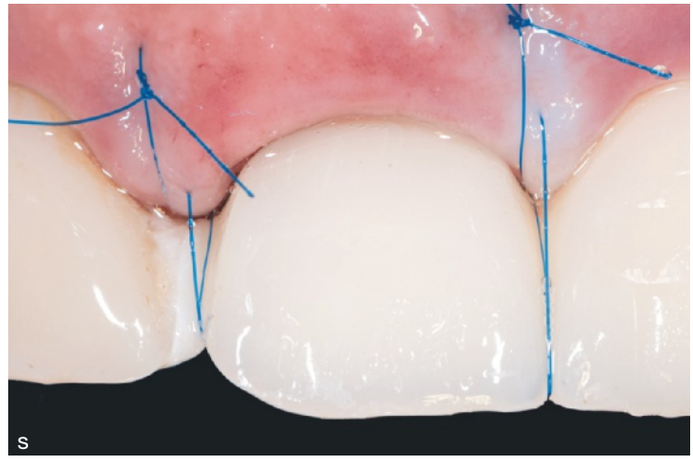


Fig 13-132o to s Positioning sutures are used to pull the free palatal CTG into the prepared tunnel to reconstruct the horizontal tissue defect. The two soft tissue pedicle grafts are then rotated mesially and distally under the buccal tunnel flap to augment the papillae between the pontic and the teeth. After temporary bonding of the provisional bridge, whose pontic base is designed as a "modified ovate pontic," all three grafts are sutured in the desired position with two double-crossed sutures.

CHAPTER 16

NEW APPROACHES TO IMMEDIATE IMPLANT PLACEMENT

16.1.2 "Through the tooth" technique in the maxilla with orthograde sinus floor elevation and a digital workflow

CASE PRESENTATION

Clinical history

General medical history

- 61-year-old female
- Married, one daughter
- Camerawoman
- No known general medical conditions, no relevant medication intake

Special anamnesis

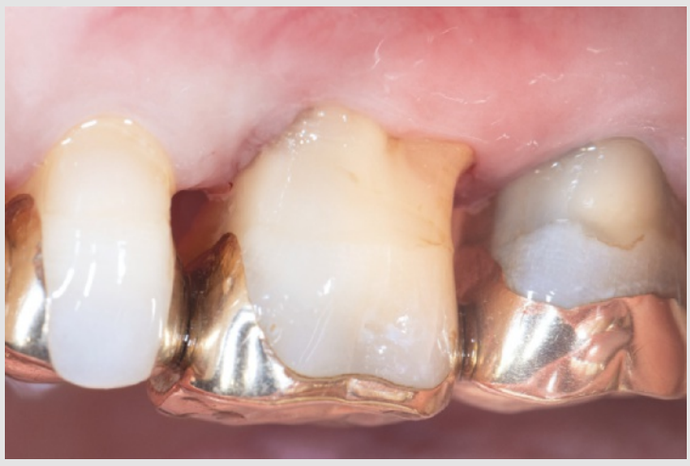
- Despite an otherwise excellent treatment outcome, tooth 26 has not responded well to systemic and anti-infective periodontal therapy. The tooth has had recurrent periodontal abscesses in the past and is severely periodontally destroyed with class III furcation involvement

Main concern

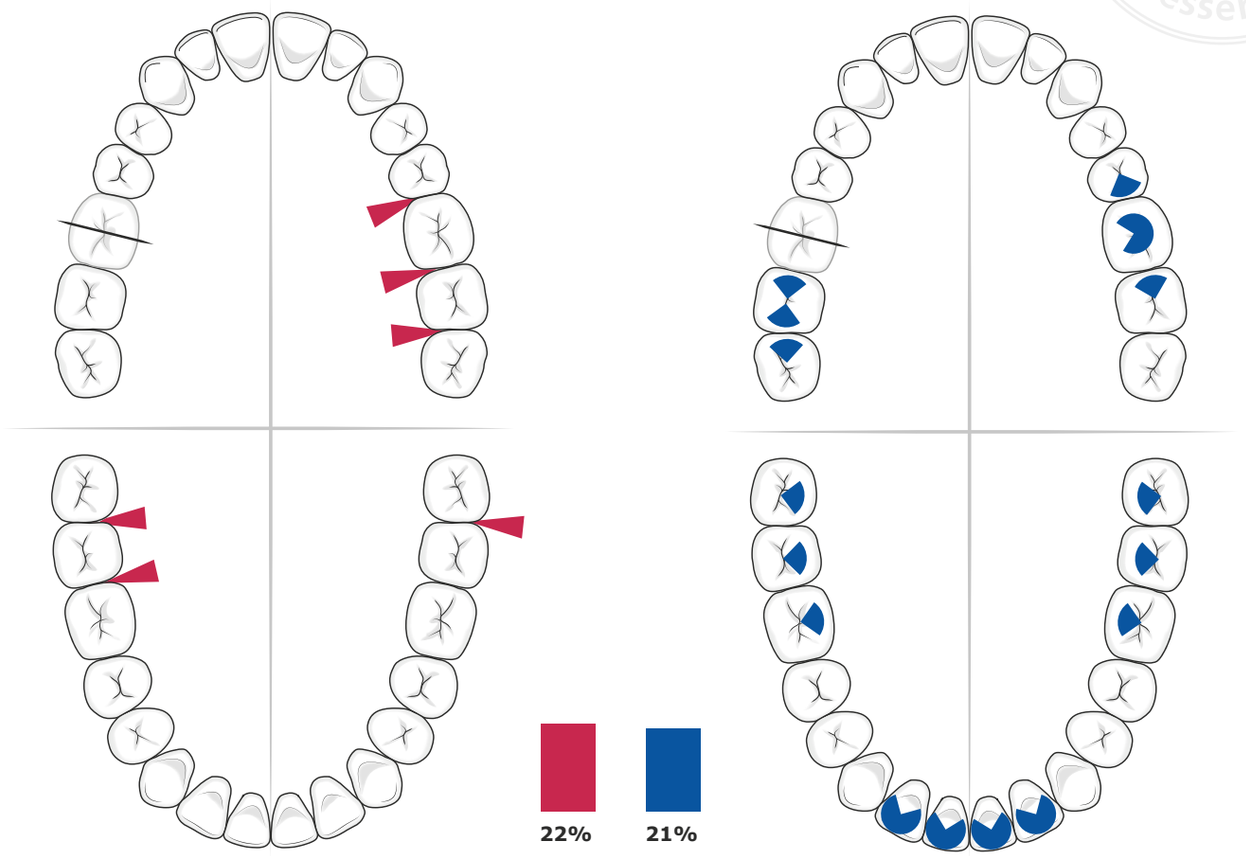
"My upper left molar still doesn't feel right. It is sensitive when chewing and it still bleeds when I clean it with an interdental brush"

Initial situation

Intraoral findings



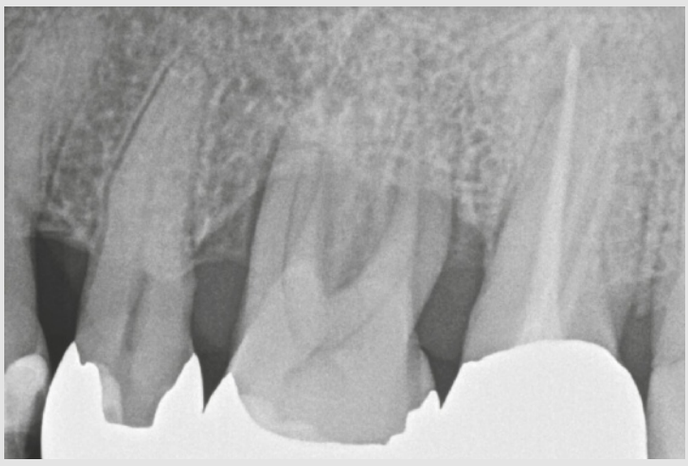
Oral hygiene findings



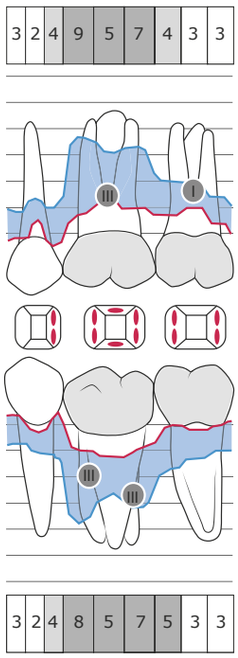
Modified Sulcus Bleeding Index
(Lange, 1977)

Plaque Control Record
(O'Leary et al, 1972)

Radiographic findings



Periodontal findings



Diagnosis

- Periodontitis, localized stage III, grade B

Clinical decision-making – rationale for selecting the technique described in this case

- The affected region is of little esthetic relevance
- Due to the high treatment effort required for tooth preservation, for example, through a resective periodontal surgical procedure with root resection, the decision is made to extract the tooth
- To avoid the incorporation of the prognostically questionable tooth 27 as a bridge anchor from a treatment strategy perspective, and considering the patient's age, the decision is made against the fabrication of a conventional bridge and in favor of an implant-supported restoration
- Due to the presence of the buccal bone wall and adequate alveolar bone dimensions apical to the tooth to be extracted, it can be assumed that an immediate implant placement with non-submerged healing can be performed
- In order to minimize the treatment effort and duration for the patient, it is decided to take digital impressions for the fabrication of the final implant-supported crown immediately after flapless immediate implant placement
- To simplify the surgical procedure, the implant bed is prepared using the "through the tooth" technique through the root complex remaining in the alveolus

Prognosis

+ Good oral hygiene on the part of the patient
+ Little esthetic relevance of the site
+ No need for extensive bone reconstruction
– Technically difficult implant bed preparation, the tooth to be replaced with an immediate implant has multiple roots
– Need for sinus floor elevation
– Magnification aids and microsurgical instruments are required

KEY POINTS IN BRIEF

01. *Decision-making* for immediate implant placement based on the clinical findings and the available bone in the correct 3D implant position – the implant is the apical extension of the restoration to be made later, and not the other way around

02. *Decoronation* of the non-salvageable tooth and *access cavity* preparation in the center of the root trunk for the implant drills

03. *Implant bed preparation*, if necessary, using a surgical guide according to the procedure recommended by the implant manufacturer

04. *Root trunk sectioning* along the furcations, *intrasulcular incision*, and *removal of the root segments* still present in the extraction socket along with any *inflammatory tissue*

05. *Orthograde sinus floor elevation* without autologous bone or particulate bone substitute material

06. *Implant placement* in the correct 3D position – check the insertion torque and primary stability during this process!

07. *Digital impression* for the final implant-supported crown after screwing on a scan abutment

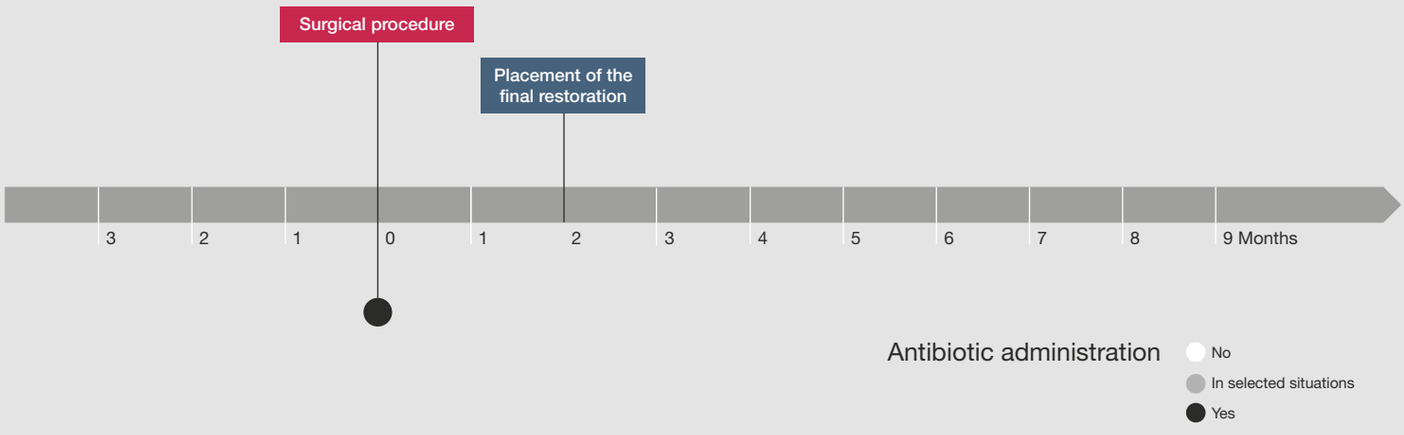
08. *Filling of the gaps* between the implant and extraction socket using autologous bone particles or particulate bone substitute material

09. *Fabrication of a customized healing abutment* to secure the position of the augmentation material and support the peri-implant soft tissue

10. Placement of a *long-term temporary restoration* fabricated in advance to prevent the adjacent teeth from shifting toward the edentulous space during the implant healing period

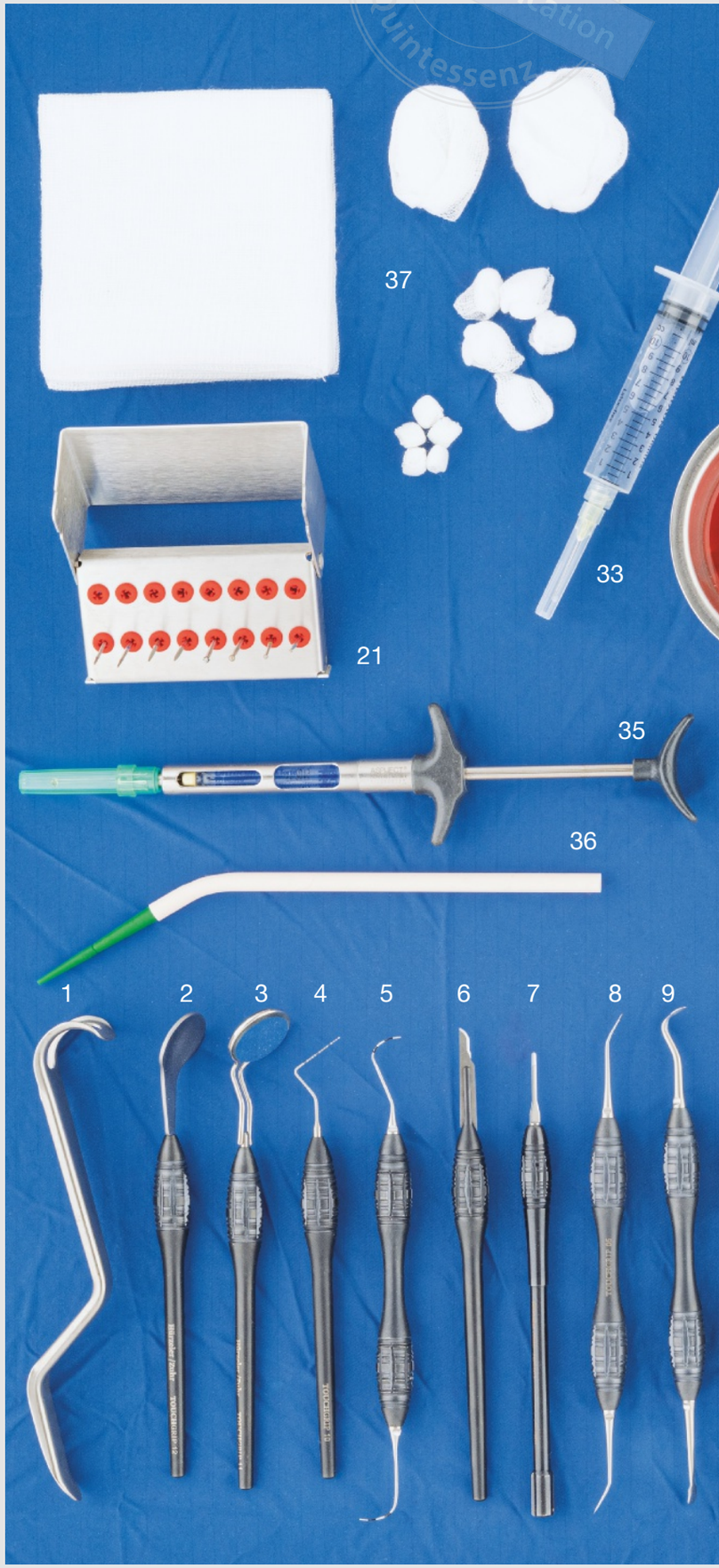
11. Comprehensive and complete *patient instructions*

TIME MANAGEMENT



WORKPLACE PREPARATION CHECKLIST

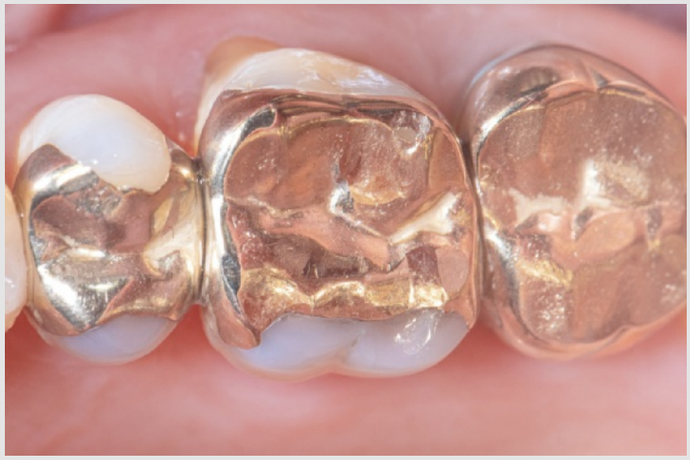
1 Cawood-Minnesota Retractor
2 Hilger Retractor
3 Mirror with Lip Holder
4 Perio Probe, straight
5 Nabers Furcation Probe
6 Scalpel handle for macroblades with No. 15 scalpel blade
7 Scalpel handle for microblades with Micro Blade SR
8 Papilla Elevator, double-ended
9 Raspatory with one straight and one angled working end
10 Raspatory with Prichard Retractor
11 Spring scissors
12 Needle holder, corrugated
13 Anatomical–surgical combination forceps
14 Dental tweezers
15 Metzenbaum scissors, curved
16 Artery clamps, straight
17 Desmotome, straight
18 Sharp spoon
19 Gap Plugger
20 Root Elevator
21 Tray with surgical burs
22 Surgical guide
23 Osteotome, Ø 3.0 and Ø 4.0, concave, parallel-walled with hammer
24 Surgical cassette for implant placement
25 Implant including titanium base for the fabrication of a customized healing abutment
26 Scan abutment, screw for impression coping
27 Abutment screw
28 Bio-Oss®
29 Removable long-term temporary restoration
30 Syringe, 1 mL
31 Chlorhexidine irrigation solution 0.1% in metal bowl
32 Sterile water in metal bowl
33 Blunt cannula, ø 0.90 x 40 mm
34 Syringe, 10 mL
35 Local anesthesia, Ultracain® D-S forte 1:100,000 1.7 mL
36 Microsurgical Aspirator, Surgitip-micro
37 Large and small swabs

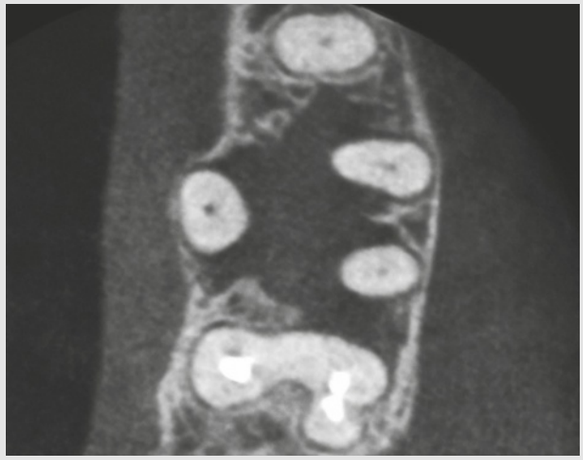


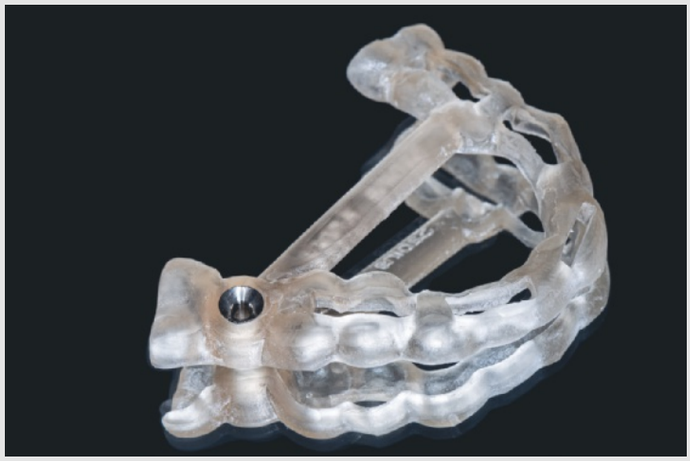
LEARNING TARGETS

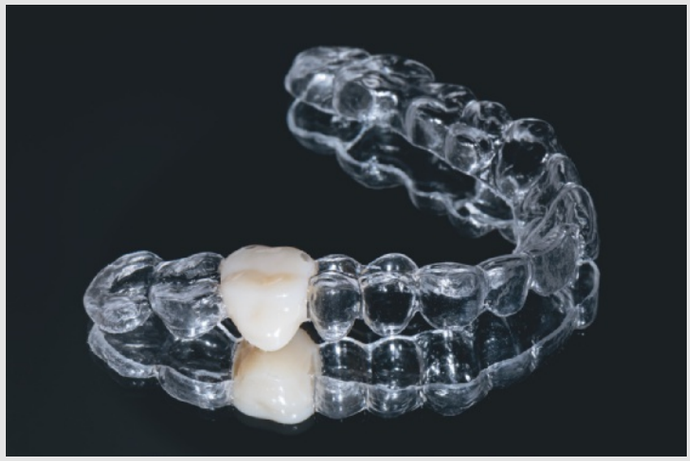
Implant bed preparation with orthograde sinus floor elevation through the molar roots still remaining in the alveolus using the *"through the tooth" technique in the maxilla – Fabrication of customized healing abutments* to hold the augmentation material in place and preserve the peri-implant soft tissue around the implant during the healing phase

STEP-BY-STEP PROCEDURE

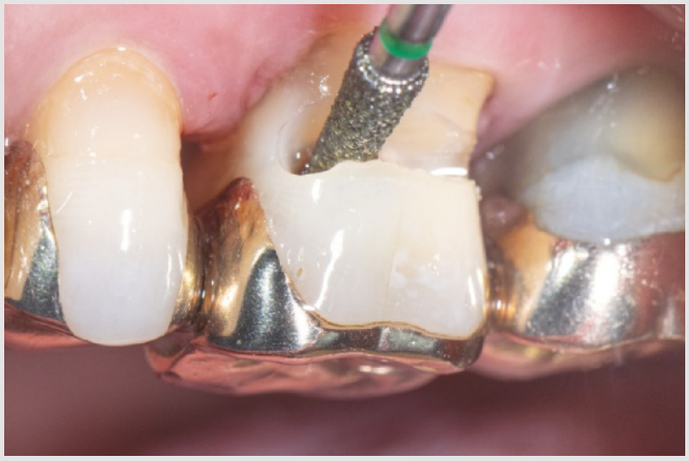


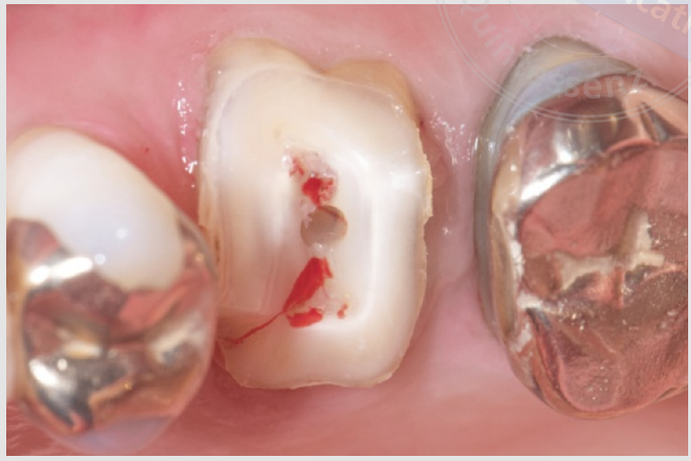




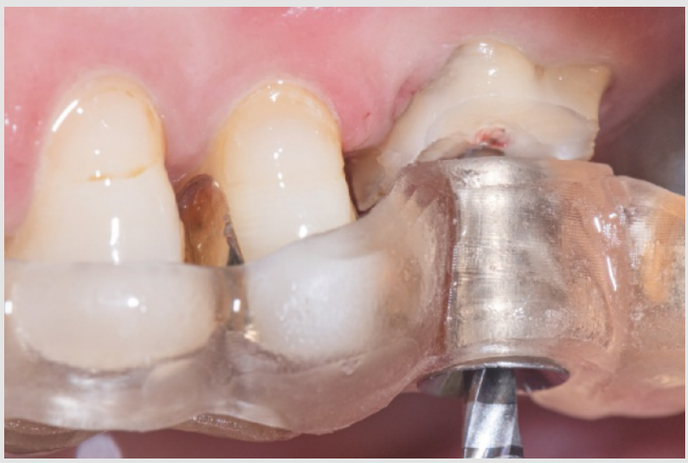


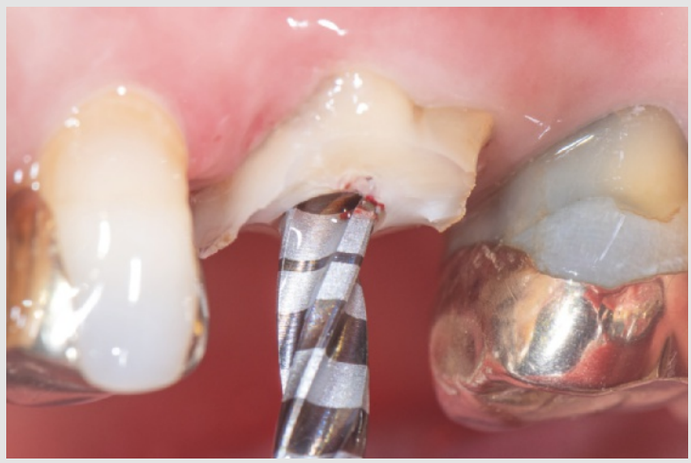
Figs 16-56 to 16-59 Initial clinical situation: The periodontally compromised tooth 26 is to be extracted and replaced with a single-tooth implant. Despite severe periodontal destruction with class III furcation involvement, the buccal bone wall is still present as seen on the CBCT image. Therefore, immediate implant placement could be performed using a flapless approach. A digitally designed surgical guide and removable provisional prosthesis are fabricated prior to surgery.



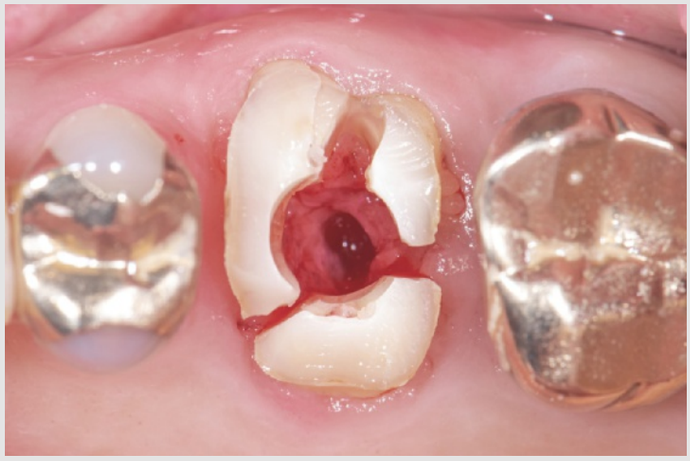


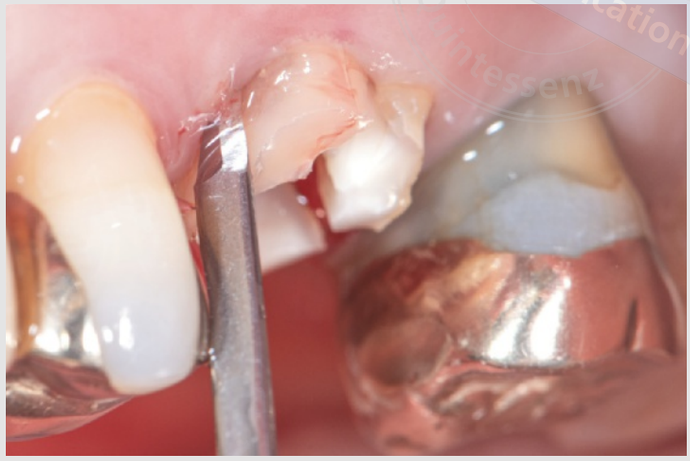
Figs 16-60 and 16-61 First, the compromised tooth is decoronated slightly coronal to the gingival margin. A small cavity is then created in the center of the root trunk to ensure drill guidance and safety during the subsequent implant bed preparation.



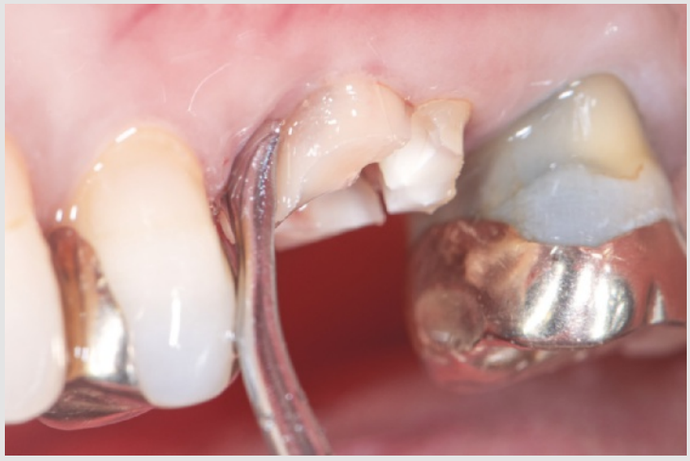


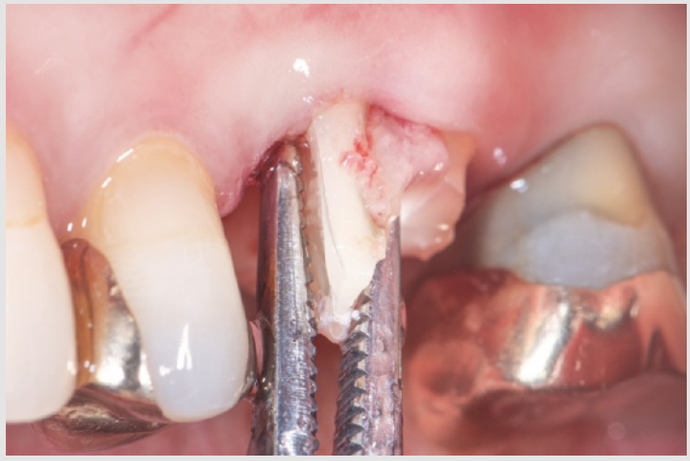
Figs 16-62 and 16-63 Implant bed preparation is now performed down to the floor of the maxillary sinus with a surgical guide using the drilling protocol recommended by the implant manufacturer. To facilitate the technical execution of the immediate implantation, the required implant drillings are performed with support from the remaining tooth root complex. The drills used can be stabilized and guided safely during the drilling process through the root complex still located in the alveolus. In this way, they are not at risk of slipping off the walls of the extraction socket, allowing for precise positioning of the implant in the desired 3D position. Since the retained root complex provides optimal orientation for the ideal implant position during the implant bed preparation, in situations like this, the use of a surgical template can often be omitted.





Figs 16-64 and 16-65 After sectioning the root trunk along the furcations with a diamond bur, an intrasulcular incision is made using a Micro Blade SR.





Figs 16-66 and 16-67 A microscalpel blade, desmotome, root elevator, artery clamps, and sharp spoon are used to carefully remove the root segments still present in the extraction socket, along with any inflammatory tissue.

APPENDIX

MATERIALS AND INSTRUMENTS

1. AIRFLOW® Plus powder, AIRFLOW® MAX, PERIO-FLOW® Nozzle; E.M.S. Electro Medical Systems S.A., Nyon, Switzerland
2. Bending pliers; American Dental Systems GmbH, Vaterstetten, Germany
3. Bio-Oss®, Bio-Gide®, Bio-Gide® Perio, Fibro-Gide®, Mucograft® Seal; Geistlich Pharma AG, Wolhusen, Switzerland
4. COE-PAK™ periodontal dressing; GC International AG, Lucerne, Switzerland
5. Desmotome VT1; Deppeler SA, Rolle, Switzerland
6. Diamond and carbide burs (LD3195/LD3196); Gebr. Brasseler GmbH & Co. KG, Lemgo, Germany
7. Emdogain®/PrefGel®; Straumann Holding AG, Basel, Switzerland
8. GINGI-PAK® Pellets; Gingi-Pak, Camarillo, USA
9. Glass plate; Alfred Becht GmbH, Offenburg, Germany
10. Hammer; HELMUT ZEPF Medinzintechnik GmbH, Seitingen-Oberflacht, Germany
11. Implant system; Thommen Medical AG, Grenchen, Switzerland
12. Keydent Micro Blade SR microblade; American Dental Systems GmbH, Vaterstetten, Germany
13. Keydent Micro Blade Tunnel microblade; American Dental Systems GmbH, Vaterstetten, Germany
14. Keydent PTFE Dental Sutures; American Dental Systems GmbH, Vaterstetten, Germany
15. Keydent Spin Blade 360 microblade; American Dental Systems GmbH, Vaterstetten, Germany
16. Leibinger Bone chisel; OTTO LEIBINGER GmbH, Mühlheim an der Donau, Germany
17. Ligosan® Slow Release; Kulzer GmbH, Hanau, Germany
18. Local anesthesia, Ultracain® D-S forte 1:100,000 1.7 mL; Sanofi-Aventis Deutschland GmbH, Frankfurt am Main, Germany
19. Macroblades Nos. 15, 15c, 12d; Swann-Morton Limited, Sheffield, UK
20. Microsurgical aspirator Surgitip-micro; Coltène/Whaledent AG, Altstätten, Switzerland
21. Mini Friedmann bone rongeur forceps, Aesculap FO409R; B. Braun SE, Melsungen, Germany
22. NiTi Brush Nano/Pocket; HANS KOREA Co., Ltd., Paju, South Korea
23. ProRoot® mineral trioxide aggregate (MTA); Dentsply Sirona Deutschland GmbH, Bensheim, Germany
24. SERAFIT® suture material; SERAG-WIESSNER GmbH & Co. KG, Naila, Germany
25. SERALENE® suture material; SERAG-WIESSNER GmbH & Co. KG, Naila, Germany
26. SONICflex™ rootplaner tips; KaVo Dental GmbH, Biberach, Germany
27. TABOTAMP®; Johnson & Johnson Medical GmbH, Norderstedt, Germany
28. Titanium Trauma Splint; Medartis AG, Basel, Switzerland
29. TOUCHGRIP Gap Plugger; American Dental Systems GmbH, Vaterstetten, Germany
30. TOUCHGRIP Instrument Set; American Dental Systems GmbH, Vaterstetten, Germany
31. TOUCHGRIP Osteotome, Ø 3.0 and 4.0, concave, parallel-wanded; American Dental Systems GmbH, Vaterstetten, Germany
32. TOUCHGRIP Root Instrumentation Set; American Dental Systems GmbH, Vaterstetten, Germany
33. TOUCHGRIP Sharp Spoon; American Dental Systems GmbH, Vaterstetten, Germany
34. TOUCHGRIP Suture Removal Set; American Dental Systems GmbH, Vaterstetten, Germany
35. Zalex® Axial Tooth Extraction System; Hohenwarthe, Germany

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