

Otto Zuhr

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Decision- Making at the Crossroads between Periodontology and Implant Dentistry

A Call for
Personalized
Oral Medicine

Volume 1

With the support of Sophia M. Abraha and Erdem Gülnergiz

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Title of original issue: *Entscheidungsfindung im Spannungsfeld von Parodontologie und Implantattherapie – Zeit für personalisierte Oralmedizin*

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A CIP record for this book is available from the British Library.

ISBN 978-1-78698-126-4

 **QUINTESSENCE PUBLISHING
DEUTSCHLAND**

Quintessenz Verlags-GmbH
Ifenpfad 2–4
12107 Berlin, Germany
www.quintessence-publishing.com

Quintessence Publishing Co Ltd
Grafton Road, New Malden
Surrey KT3 3AB, United Kingdom
www.quintessence-publishing.com

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Translation: Suzyon O’Neal Wandrey, Berlin, Germany
Illustrations: Angelika Kramer, Stuttgart, Germany
Layout, production, and reproduction:
Quintessenz Verlags-GmbH, Berlin, Germany

ISBN 978-1-78698-126-4
Printed in Croatia by GZH



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 post-graduate 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



TABLE OF CONTENTS

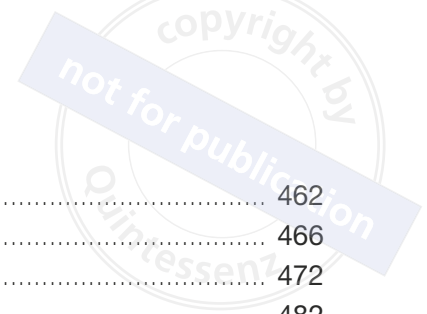
Definition of “EBD,” “IOM,” and “POM”	vii
Preface	ix
Team	x
Acknowledgments	xi
Authors	xiii

VOLUME 1: FUNDAMENTALS, STRATEGIES, AND CONCEPTS

1	The Patient at the Center of Evidence-Based Medicine	3
1.1	Demographic Changes, Oral Health, and Tooth Loss: The Current State of Research	4
1.2	The Success Story of Dental Implants	6
1.3	Evidence-Based Dentistry: Between Scientific Progress and Everyday Clinical Practice	9
1.3.1	Theory and practical implementation	9
1.3.2	Aspiration and reality	11
1.3.3	Potential strategies for future improvement	12
1.3.4	“Understand – Decide – Act” as a guiding principle and treatment concept	13
1.4	Shared Decision-Making at the Limits of Tooth Preservation	21
1.5	Tooth Preservation and Implant Replacement over the Course of a Patient’s Life: Decision Criteria with the Future in Mind	29
	References	59
2	Anatomy and Structural Biology of Periodontal and Peri-Implant Tissues	61
2.1	Anatomy of Periodontal Structures	62
2.1.1	Gingiva	62
2.1.2	Periodontal fiber apparatus and cementum	67
2.1.3	Alveolar process	70
2.1.4	Blood supply and innervation	72
2.2	Anatomy of Peri-Implant Structures	74
2.3	Structural Biologic Relationships and their Clinical Relevance	77
2.3.1	Supracrestal tissue attachment	77
2.3.2	Dentogingival complex	79
2.3.3	Gingival phenotypes	81
	References	84
3	Focus on Healing: Influencing Factors, Manual Skills, and the Clinical Relevance of Microsurgery	87
3.1	Physiology of Wound Healing	88
3.1.1	Primary and secondary wound healing	88
3.1.2	Chronological sequence of wound healing	90
3.1.3	Clinical assessment of wound healing	94

3.2	Identifying and Controlling Factors that Affect Wound Healing	96
3.2.1	Patient-related factors	96
3.2.2	Defect-related factors	97
3.2.3	Technique-related factors	97
3.3	Wound Healing and Microsurgery: A New Paradigm	102
3.3.1	Scientific findings and their clinical relevance	102
3.3.2	Optical magnification systems	108
3.3.3	Surgical instruments	113
3.3.4	Surgical suture materials	125
3.3.5	Microsurgical training as a prerequisite for clinical practice	130
3.4	Pre- and Postoperative Measures to Promote Wound Healing	137
3.4.1	Preoperative management	137
3.4.2	Postoperative management	139
	References	148
4	Incisions, Flap Designs, and Suturing Techniques	151
4.1	Incisions for Flap Surgeries	152
4.1.1	Incisions in the mucosal margin area	152
4.1.2	Releasing incisions	155
4.2	Flap Designs	156
4.2.1	Full-thickness mucoperiosteal flap	156
4.2.2	Partial-thickness mucosal flap	156
4.2.3	Combined flaps	159
4.3	Flap Mobilization	165
4.3.1	Flap designs for flap mobilization	165
4.3.2	Releasing incisions for flap mobilization	165
4.3.3	Tunnel surgery for flap mobilization without releasing incisions	166
4.3.4	Mobilization of tunnel flaps	171
4.4	Suture Closure for Flap Stabilization	189
4.4.1	Suturing techniques	189
4.4.2	Throws and knots	202
	References	209
5	Periodontitis, Life Expectancy, and Quality of Life – Healthy Teeth for a Lifetime!	211
5.1	Periodontal Diseases and their Global Impacts on Oral and General Health of Affected Patients	212
5.2	The Oral Biofilm	215
5.3	Etiopathogenesis of Periodontal Diseases	219
5.3.1	Symbiosis	221
5.3.2	Incipient dysbiosis	221
5.3.3	Frank dysbiosis	222
5.4	Prevention of Periodontal Diseases	224
5.5	Diagnosis of Periodontal Diseases	226
5.6	Treatment of Periodontal Diseases	237
5.6.1	The systemic phase of periodontal therapy (phase I)	238
5.6.2	The anti-infective phase of periodontal therapy (phase II)	238
5.6.3	The corrective phase of periodontal therapy (phase III)	241
5.6.4	The supportive phase of periodontal therapy (phase IV)	255

5.7	Periodontal Wound Healing	256
5.8	Long-Term Prognosis after Periodontitis Treatment	261
5.9	Individualized Periodontal Medicine, Personalized Oral Medicine, and the Limits of Tooth Preservation ...	262
5.10	The Esthetic Dilemma of Periodontal Disease	266
5.11	Case Example	293
	References	312
6	Peri-Implantitis – When even the “Third Set of Teeth” is at Risk of Being Lost	317
6.1	Etiopathogenesis of Peri-Implant Diseases	319
6.1.1	Symbiosis	320
6.1.2	Incipient dysbiosis	320
6.1.3	Frank dysbiosis	321
6.2	Prevention of Peri-Implant Diseases	323
6.2.1	Patient-related risk factors	324
6.2.2	Implant-related risk factors	325
6.2.3	Technique-related risk factors	326
6.3	Diagnosis of Peri-Implant Diseases	349
6.4	Treatment of Peri-Implant Diseases	356
6.4.1	Systemic phase of peri-implantitis treatment	356
6.4.2	Anti-infective phase of peri-implantitis treatment	356
6.4.3	Corrective phase of peri-implantitis treatment	359
6.4.4	Supportive phase of peri-implantitis treatment	360
6.5	Wound Healing after Peri-Implantitis Treatment	361
6.6	Long-Term Outcome after Peri-Implantitis Treatment	363
6.7	Limits of Implant Preservation	364
6.8	Case Example	365
	References	374
7	Autologous Mucosal Grafts and the Hard Palate as the Donor Site of Choice	379
7.1	Historical Perspective and Biologic Foundations	380
7.2	Anatomical Characteristics of the Hard Palate	389
7.2.1	Macroscopic anatomy	389
7.2.2	Microscopic anatomy	390
7.2.3	Blood vessels and nerves	391
7.3	Donor Site Selection and Graft Harvesting Techniques	393
7.3.1	Tissue availability on the hard palate	393
7.3.2	Safe and unsafe donor sites	394
7.3.3	Comparing different mucosal grafts	398
7.3.4	Clinical decision-making – which graft to use and when?	416
7.4	The Harvesting Techniques Step by Step	439
7.4.1	Harvesting free gingival grafts – with or without subsequent deepithelialization	440
7.4.2	“Single incision” technique for harvesting connective tissue grafts after flap elevation on the lateral palate	444
7.4.3	“Trap-door” technique for harvesting connective tissue grafts after flap elevation on the lateral palate	448
7.4.4	“Distal wedge” procedure for harvesting connective tissue grafts after flap elevation in the tuberosity area ..	453
7.5	Management of Complications	458
7.6	Healing of Free Mucosal Grafts	462



7.6.1	Healing of free gingival grafts	462
7.6.2	Healing of connective tissue grafts	466
7.7	Soft Tissue Substitutes – A Look into the Future	472
	References	482
8	Gingival Recessions, Peri-Implant Mucosal Recessions, and the Pivotal Question of whether their Treatment is Required	489
8.1	Prevalence	490
8.1.1	Gingival recessions	490
8.1.2	Peri-implant mucosal recessions	491
8.2	Etiology	492
8.2.1	Gingival recessions	492
8.2.2	Peri-implant mucosal recessions	495
8.3	Pathogenesis	503
8.3.1	Gingival recessions	503
8.3.2	Peri-implant mucosal recessions	504
8.4	Indications and Goals	504
8.4.1	Gingival recessions	504
8.4.2	Peri-implant mucosal recessions	547
8.5	Prognosis	558
8.5.1	Gingival recessions	558
8.5.2	Peri-implant mucosal recessions	574
	References	582
9	Implant Dentistry in the 21st Century – Where is the Journey Heading?	589
9.1	Healing after Tooth Extraction	591
9.2	Alveolar Ridge Preservation Techniques	599
9.3	Immediate Implant Placement	604
9.3.1	“Orthodontic extraction”	609
9.3.2	Implant bed preparation with the “through the tooth” technique	617
9.3.3	Reconstruction of missing buccal bone walls with the “immediate dentoalveolar restoration” technique ..	622
9.3.4	The “socket shield” technique	626
	References	640

VOLUME 2: TECHNIQUES I

10	Surgical Techniques for Achieving Healthy and Stable Gingival Conditions	645
10.1	Resective Periodontal Surgery for Establishing Healthy Gingival Conditions	652
	▶ <i>Video 10-1 Osseous resection in conjunction with apically repositioned flaps for the elimination of subgingival restoration margins</i>	<i>655</i>
10.1.1	Apically repositioned flap to establish hygiene-conducive conditions prior to restorative therapy in the maxilla	661
10.1.2	Apically repositioned flap to establish hygiene-conducive conditions prior to restorative therapy in the mandible	686
	▶ <i>Video 10-2 Mucosal flap design for the apically repositioned flap procedure on the buccal aspect of the mandibular arch</i>	<i>697</i>

10.2	Mucogingival Surgery for Establishing Gingival Stability	711
10.2.1	Free gingival graft to establish stable gingival conditions in the mandibular anterior region	724
	▶ <i>Video 10-3 Stabilizing suture for immobilization of a free gingival graft</i>	741
10.2.2	Deepithelialized free gingival graft to establish stable gingival conditions in the mandibular anterior region	747
	▶ <i>Video 10-4 Positioning suture used in the combined coronally advanced tunnel technique</i>	760
	▶ <i>Video 10-5 Double-crossed suture used in the combined coronally advanced tunnel technique</i>	761
	References	777
11	Surgical Treatment of Periodontitis	779
11.1	Regenerative Periodontal Surgery for the Treatment of Intrabony Defects	832
	▶ <i>Video 11-1 Microsurgical access flap in the maxilla: Buccal one-sided flap preparation ending coronal to the mucogingival junction – 1f_loc</i>	835
	▶ <i>Video 11-2 Microsurgical access flap in the maxilla: Buccal two-sided flap preparation ending coronal to the mucogingival junction – 2f_loc</i>	835
	▶ <i>Video 11-3 Microsurgical access flap in the maxilla: Buccal two-sided flap preparation extending beyond the mucogingival junction – 2f_ext</i>	835
11.1.1	Regenerative treatment of an intrabony defect – <i>MAF_bucHE_1f_loc</i>	839
	▶ <i>Video 11-4 Double sling suture for microsurgical access flap closure</i>	850
11.1.2	Regenerative treatment of an intrabony defect – <i>MAF_bucOC_1f_loc</i>	857
	▶ <i>Video 11-5 Vertical mattress suture with a loop for closure of a microsurgical access flap</i>	868
11.1.3	Regenerative treatment of an intrabony defect – <i>MAF_palHE_2f_loc</i>	873
11.1.4	Regenerative treatment of an intrabony defect – <i>MAF_palPEN_loc</i>	897
11.1.5	Regenerative treatment of intrabony defects – <i>MAF_palHE_2f_ext</i>	917
	▶ <i>Video 11-6 Horizontally crossed internally running mattress suture for microsurgical access flap closure</i>	931
11.1.6	Regenerative treatment of an intrabony defect – <i>MAF_palPENcut_MCAT/MCAF_CTG</i>	937
11.2	Regenerative Periodontal Surgery for the Treatment of Interradicular Defects	960
11.2.1	Microsurgical access flap for the treatment of a mesial class II maxillary furcation defect – <i>MAF_bucHE_2f_loc</i>	969
11.2.2	Modified coronally advanced flap for the treatment of a buccal class II mandibular furcation defect – <i>MCAF</i>	987
	▶ <i>Video 11-7 Modified coronally advanced flap for the surgical regenerative treatment of a furcation defect</i>	996
	▶ <i>Video 11-8 Fixation suture and double-crossed suture used in the regenerative surgical treatment of a furcation defect</i>	999
11.2.3	Modified coronally advanced flap with autologous connective tissue graft for the treatment of a buccal class II furcation defect in the mandible – <i>MCAF_CTG</i>	1005
11.3	Resective Periodontal Surgery for the Treatment of Moderate Intrabony and Suprabony Defects	1027
11.3.1	Apically repositioned flap with distal wedge excision using the “fiber retention” technique in the maxilla	1033
	▶ <i>Video 11-9 Stabilization suture used for the anchorage of apically repositioned flaps in the maxilla</i>	1051
11.3.2	Apically repositioned flap with distal wedge excision using the “fiber retention” technique in the mandible	1057
	▶ <i>Video 11-10 Stabilization suture for the anchorage of apically repositioned flaps in the mandible</i>	1075
	References	1083

12	Tooth-Preserving Dental Surgery at the Limits	1087
12.1	Regenerative Periodontal Surgery for the Treatment of Presumably “Hopeless” Teeth	1093
12.1.1	Regenerative treatment of a periodontal defect extending to the apex in the maxillary anterior region – <i>MAF_palHE_2f_ext_CTG</i>	1095
12.1.2	Regenerative treatment of a periodontal defect extending to the apex with furcation involvement in the mandibular posterior region – <i>MAF_bucHE_1f_loc</i>	1115
12.2	Resective Periodontal Surgery for the Treatment of Molars with Class II and III Furcation Involvement or Individual Non-Salvageable Roots	1135
	▶ <i>Video 12-1 Intraoperative abutment preparation for apically repositioned flap with root resection in the maxilla</i>	1151
12.2.1	Apically repositioned flap with tunnel preparation in the mandible	1167
12.2.2	Root amputation with alveolar ridge preservation in the maxilla	1186
12.2.3	Apically repositioned flap with distal wedge excision and root resection using the “fiber retention” technique in the maxilla	1205
12.3	Periodontal Surgical Techniques for the Treatment of External Root Resorption	1227
12.3.1	Microsurgical access flap with intraoperative treatment of a hyperplastic invasive external cervical root resorption in the maxillary anterior region	1272
12.3.2	Intentional replantation of a maxillary premolar with extraoral treatment of hyperplastic invasive external cervical root resorption	1291
12.3.3	Preprosthetic decoronation of a maxillary anterior tooth with untreatable trauma-induced replacement resorption	1309
12.4	Orthodontic Extrusion to Restore Teeth with Deep Subgingival Defects	1329
12.4.1	Orthodontic extrusion with fibrotomy and root instrumentation to treat a deep subgingivally fractured maxillary anterior tooth	1333
	References	1347

VOLUME 3: TECHNIQUES II

13	Alternative Tooth Replacement Options to Delay or Avoid Implant Treatments	1353
13.1	Orthodontic Space Closure	1405
13.1.1	Orthodontic space closure for congenital absence of both maxillary lateral incisors	1407
13.2	Autotransplantation of Permanent Teeth	1423
	▶ <i>Video 13-1 Case presentation of tooth autotransplantation using an impacted and displaced canine to replace an unsalvageable maxillary central incisor</i>	1427
13.2.1	Autotransplantation of a mandibular second premolar with incomplete root development in the position of an unsalvageable maxillary central incisor	1431
13.3	Prosthetic Space Closure	1454
13.3.1	Conventional bridge to replace a mandibular first molar: free gingival grafting to facilitate oral hygiene ..	1463
13.3.2	Resin-bonded fixed partial denture to replace a maxillary lateral incisor: modified “pouch” technique, “saloon door” technique, and palatal peninsula flap	1481
13.3.3	Palatal implant-supported pontic to replace a maxillary central incisor: “immediate pontic” with alveolar ridge preservation and a completely detached palatal peninsula flap	1501
	References	1525



14	Surgical Techniques for Achieving Healthy and Stable Peri-Implant Conditions	1529
14.1	Resective Surgical Measures to Establish Hygienic Peri-Implant Conditions	1536
14.1.1	Apically repositioned flap for thinning the palatal mucosa and pedicled free gingival graft for thickening and widening the buccal keratinized mucosa in the posterior maxilla during implant uncoverage	1541
14.2	Augmentative Surgical Measures to Establish Hygienic and Stable Peri-Implant Conditions	1559
14.2.1	Free gingival graft for increasing the thickness and width of the keratinized peri-implant mucosa in the buccal posterior mandible at the time of implant placement	1569
14.2.2	Connective tissue graft for increasing the thickness of the peri-implant mucosa in the buccal posterior mandible at the time of implant uncoverage	1589
14.2.3	Free gingival graft for increasing the thickness and width of the keratinized peri-implant mucosa in the buccal posterior maxilla during maintenance therapy	1605
	References	1625
15	Surgical Treatment of Peri-Implantitis	1627
15.1	Regenerative Surgery for the Treatment of Infrabony Peri-Implant Defects	1638
15.1.1	Regenerative treatment of an infrabony defect in the anterior maxilla – <i>MAF_palHE_2f_loc_CTG</i>	1647
15.1.2	Regenerative treatment of an infrabony defect in the posterior mandible – <i>MAF_HC_2f_ext</i>	1667
15.2	Regenerative–Resective Surgery for the Treatment of Suprabony–Infrabony Peri-Implant Defects	1683
15.2.1	Regenerative–resective treatment of a combined suprabony–infrabony defect in the posterior maxilla – <i>MAF/ARF_HC_2f_ext</i>	1689
	References	1708
16	New Approaches to Immediate Implant Placement	1709
16.1	Immediate Implant Placement with Tooth-Supported Implant Bed Preparation	1718
	▶ <i>Video 16-1 Tooth-supported implant bed preparation with orthograde sinus floor elevation</i>	1719
16.1.1	“Through the tooth” technique in the mandible using a digital workflow	1721
16.1.2	“Through the tooth” technique in the maxilla with orthograde sinus floor elevation and a digital workflow	1740
16.2	Immediate Implant Placement using the “Immediate Dentoalveolar Restoration” Technique	1757
16.2.1	“Immediate dentoalveolar restoration” technique for the replacement of a maxillary central incisor	1763
16.3	Immediate Implant Placement with Partial Extraction	1780
16.3.1	“Socket shield” technique for the replacement of a maxillary central incisor	1792
16.3.2	“Orthodontic extraction” and “socket shield” technique for the replacement of a maxillary central incisor	1810
16.3.3	“Socket shield” technique for the replacement of two maxillary central incisors	1828
	▶ <i>Video 16-2 Video demonstration of the use of the “socket shield” technique to replace two maxillary central incisors</i>	1835
	References	1843
	Afterword	I
	Appendix	III
	Materials and instruments	IV
	Index	V

VOLUME 1

FUNDAMENTALS, STRATEGIES, AND CONCEPTS



1.3 Evidence-Based Dentistry: Between Scientific Progress and Everyday Clinical Practice

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

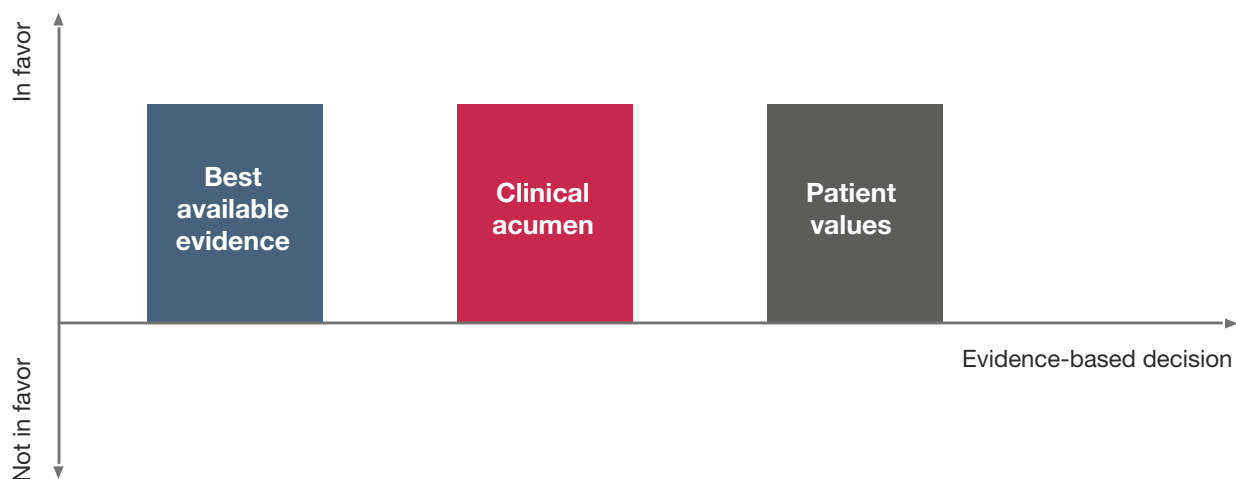


Fig 1-5 The three pillars of evidence-based medicine (EBM) are research evidence, clinical expertise of the practitioner, and individual patient needs. Evidence-based practice requires equal integration of all three pillars into the decision-making process with the aim of selecting a treatment modality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

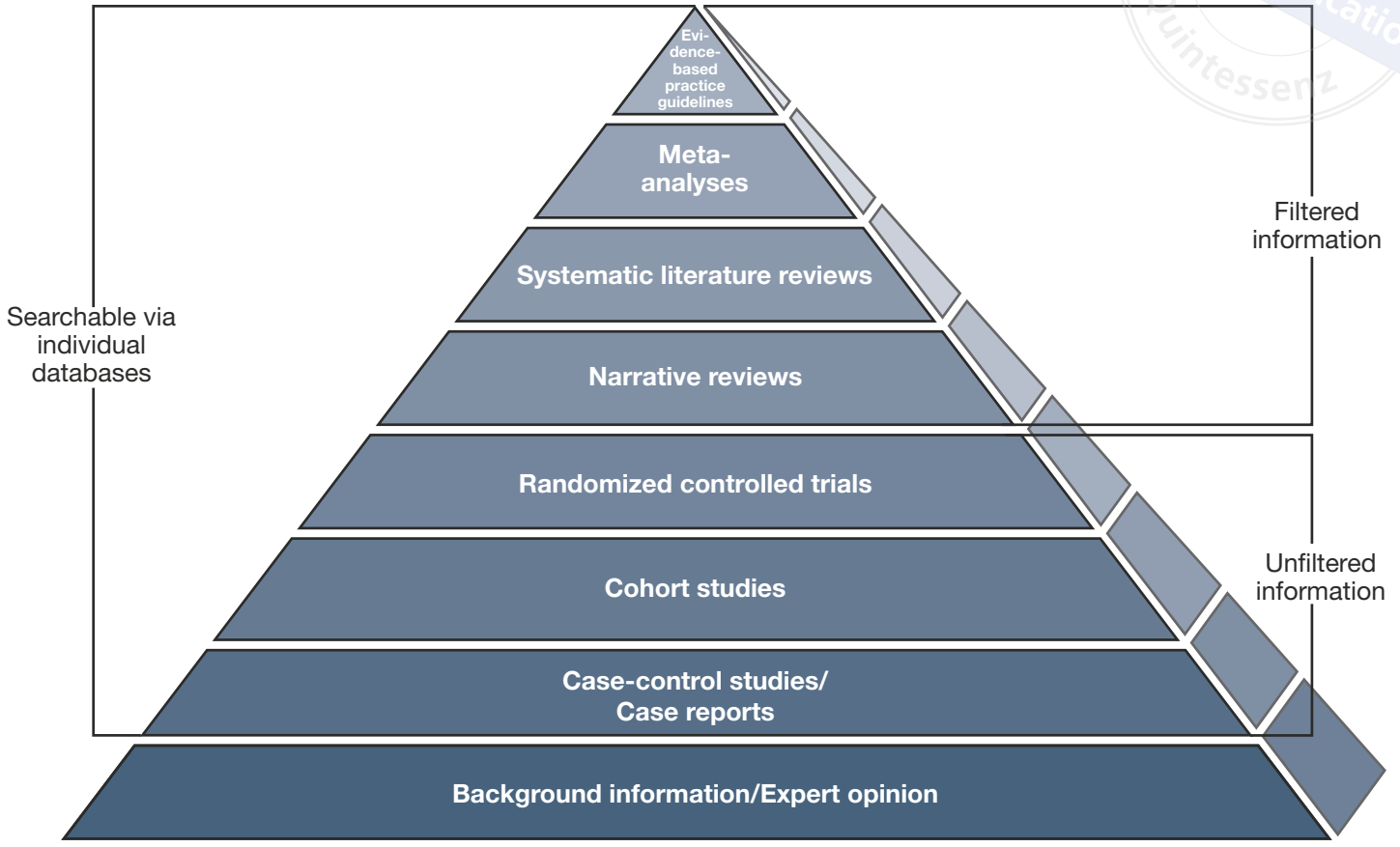


Fig 1-6 Evidence-based decisions in accordance with evidence-based dentistry (EBD) guidelines follow five consecutive steps, the most central being a systematic literature search (step 2). The best available evidence for decision-making in a given case is gathered in a critical, unbiased, and systematic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

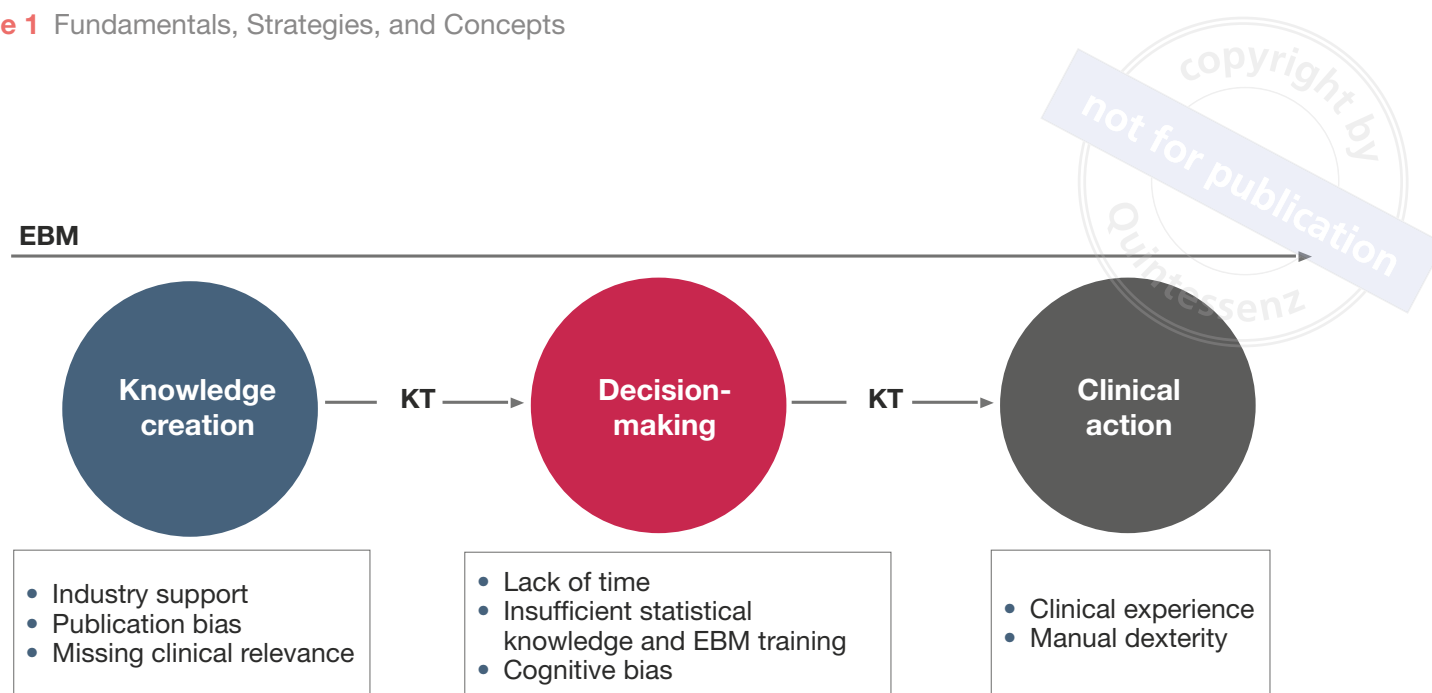


Fig 1-7 The engine driving the systematic application of EBM toward the successive implementation of scientific evidence in daily patient care has obviously stalled during the last several years. The progress of knowledge transfer from researchers to clinicians to the patients who are supposed to benefit 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 indi-

vidual 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.

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.

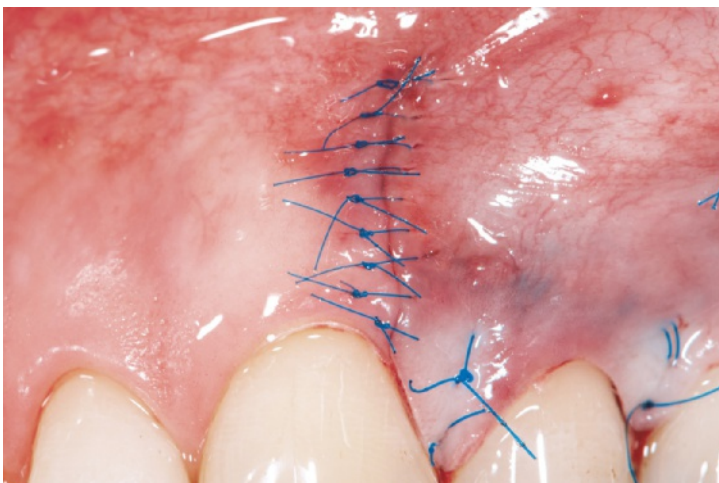


Fig 4-24 View after closure of a vertical releasing incision in the maxillary anterior region. Suturing plays a particularly important role in periodontal and implant surgery. The goal of suturing is to ensure passive fixation of flaps, intimate contact of the wound margins, and adequate wound stability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

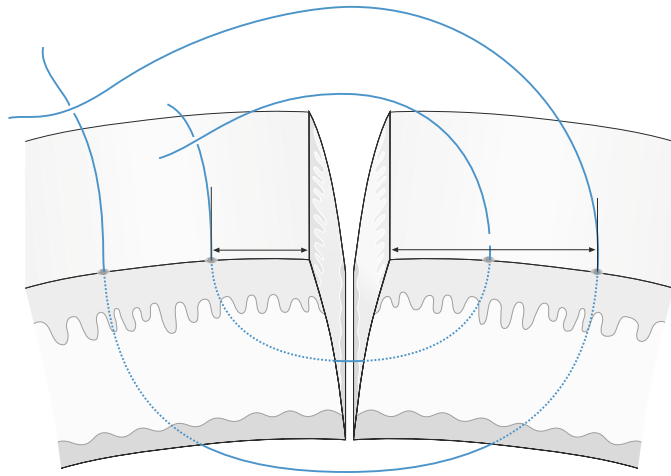


Fig 4-25 Schematic representation of “bite size.” For an interrupted suture, the distance between the insertion point of the needle and the incision line should be as close as possible to that of the exit point – the “bite size” should be the same.

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

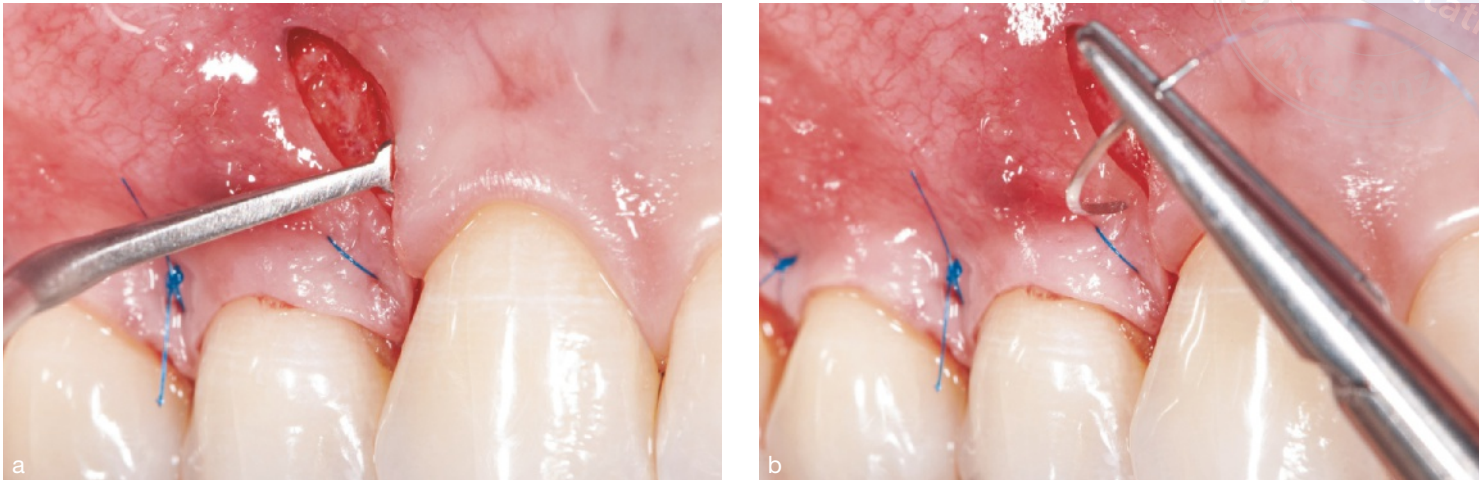


Fig 4-26a and b Clinical example of an interrupted suture used to close a vertical incision. As a preparatory measure, a papilla elevator is used to gently lift the fixed tissue component of the flap from the underlying bone. The needle is inserted into the flap perpendicular to the tissue surface.

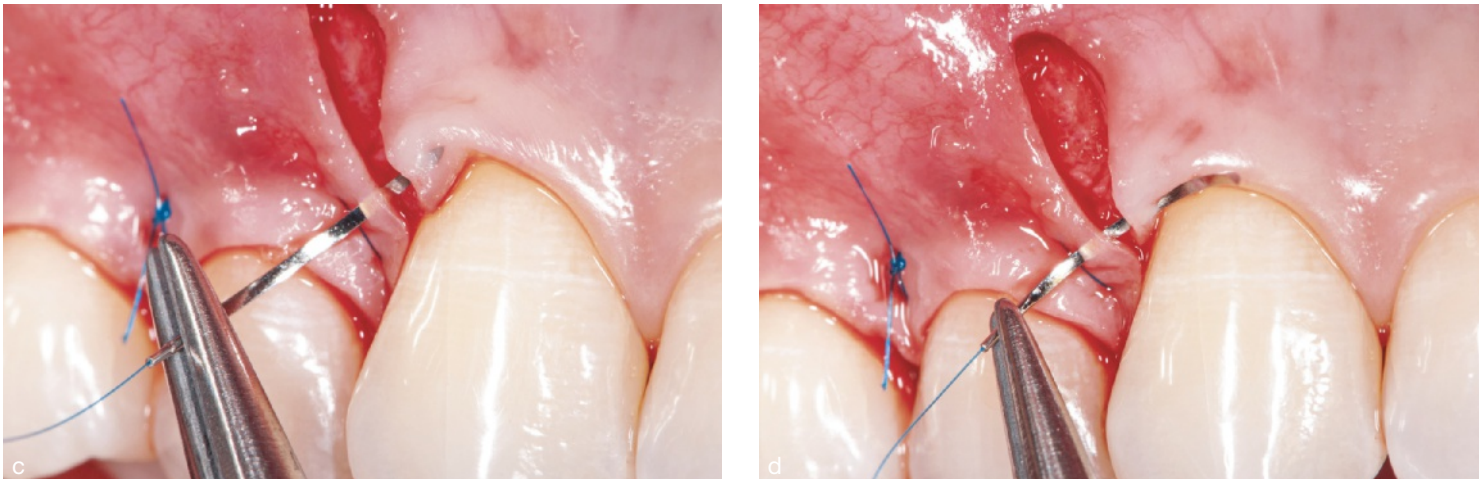


Fig 4-26c and d Ideally, clinicians should always suture from mobile to fixed tissue while holding the needle perpendicular to the incision line. To prevent the sutures from cutting through the tissue, the needle entry point should never be less than 2 mm from the wound edge. Because uniform “bite size” 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.

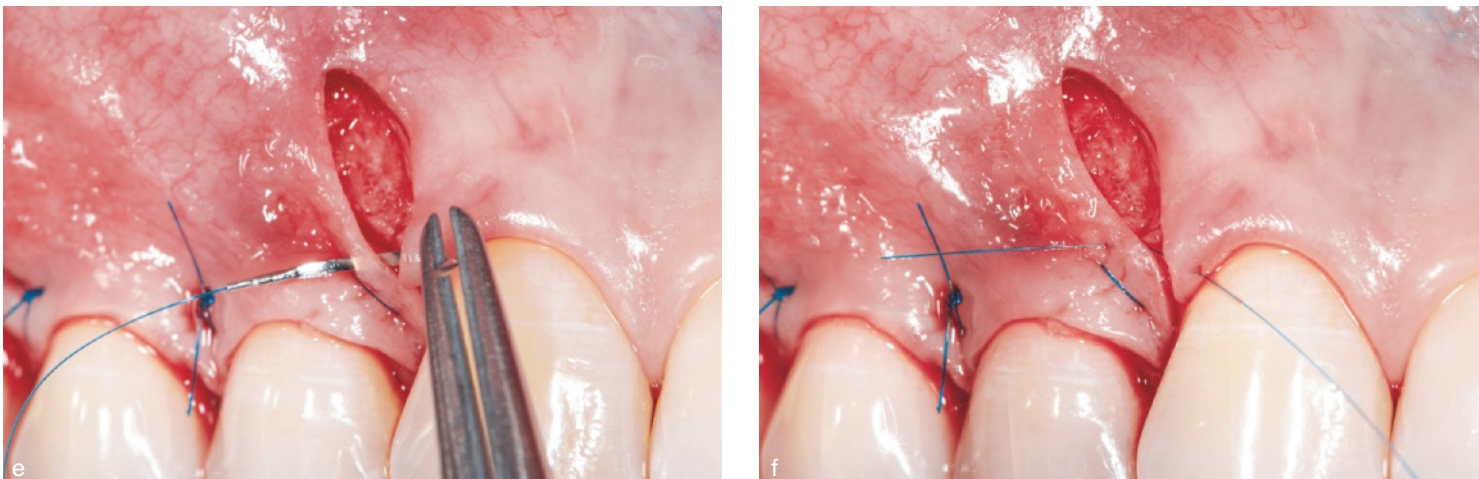
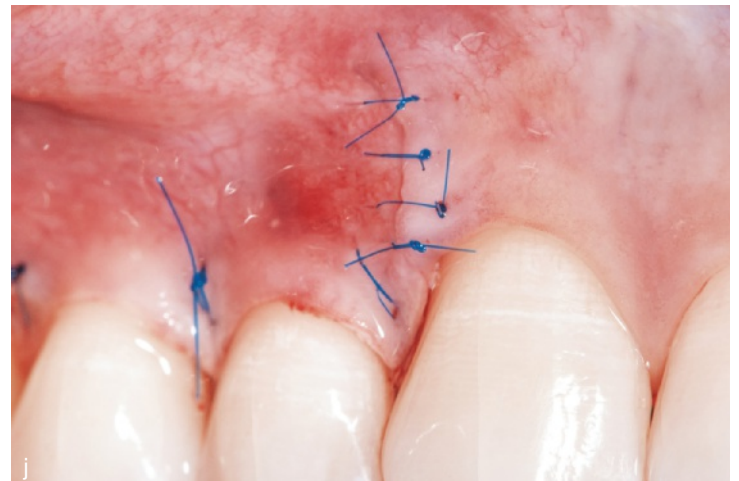
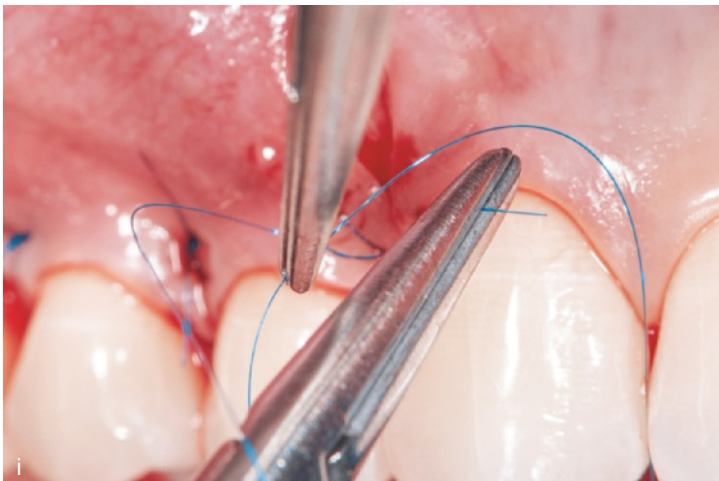
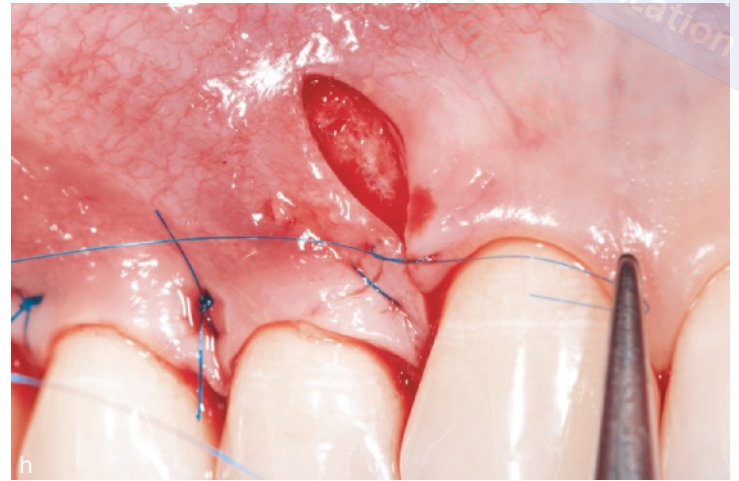
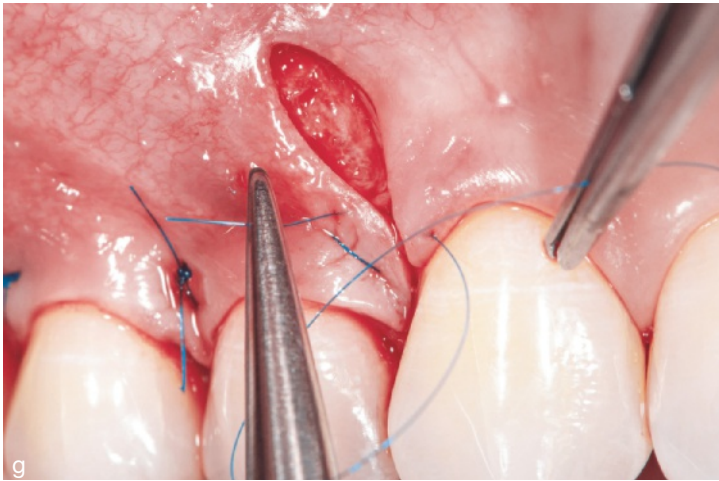


Fig 4-26e to j Once the needle has been pushed through the tissue to the opposite side as far as possible, the needle holder is opened. The needle is then grasped centrally, the thread is pulled through the tissue, and a knot is tied.



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.

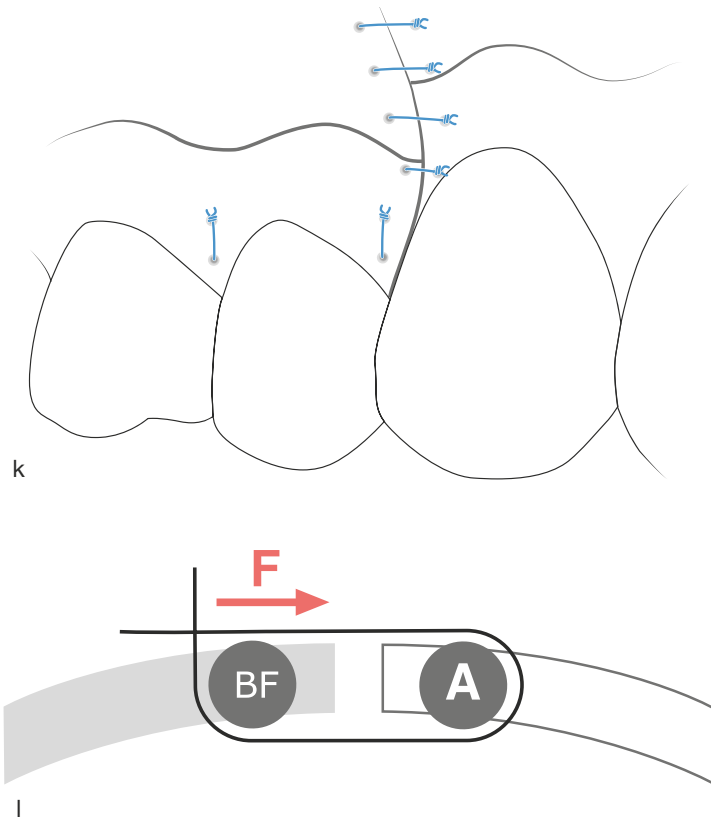
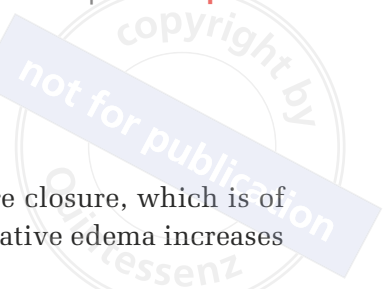


Fig 4-26k and l Schematic representations of the postoperative status. In this case, the gingiva of the fixed component of the flap is used as the mechanical anchor point for interrupted size 7-0 sutures. Placement of the sutures at right angles to the incision line results in force vectors after the 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).

**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 tuberosity⁹⁹ (Fig 7-10).

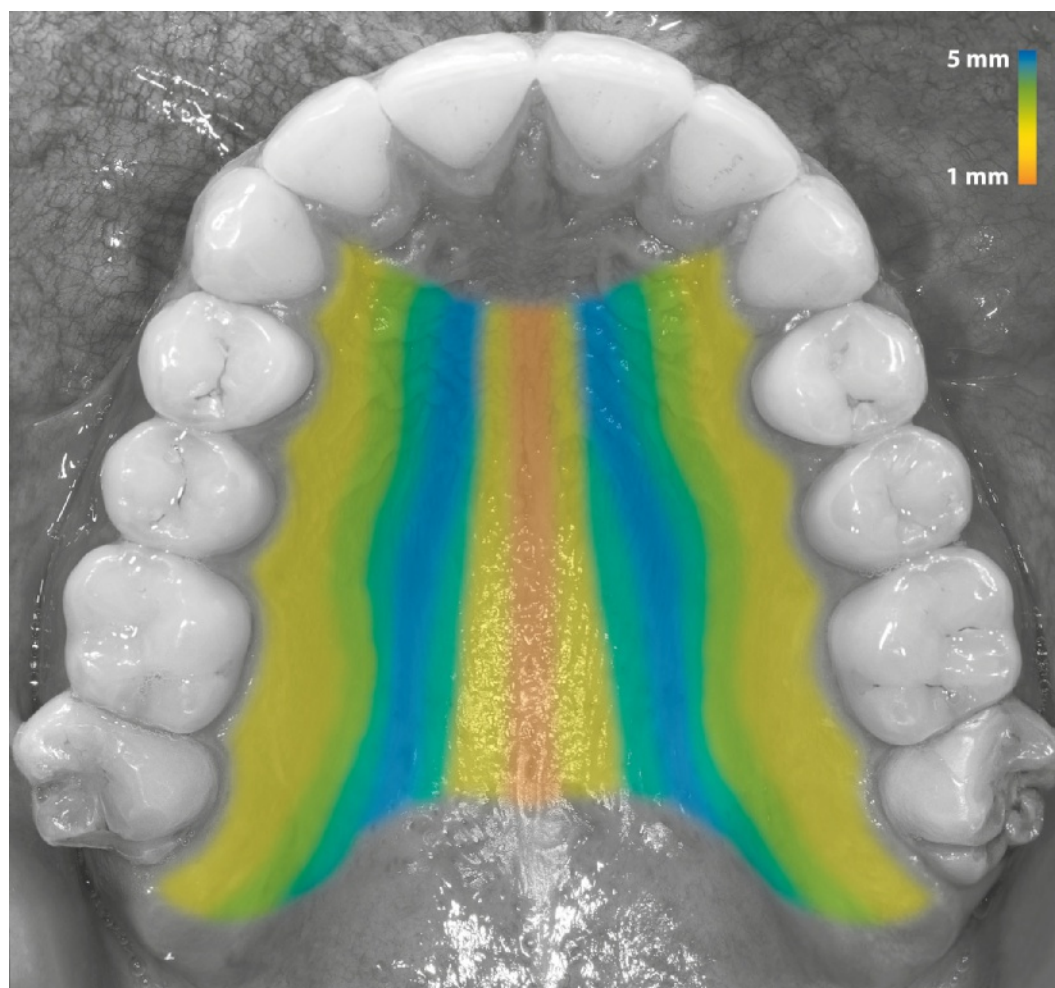


Fig 7-10 In the hard palate, the greatest volume of soft tissue for grafting can be expected at the level of the two premolars and second molar as well as in the tuberosity area. The thickness of the palatal masticatory mucosa increases from the gingival margin of the maxillary posterior teeth toward 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 cemento-enamel 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 cemento-enamel 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 teeth⁹³ (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 cemento-enamel 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).

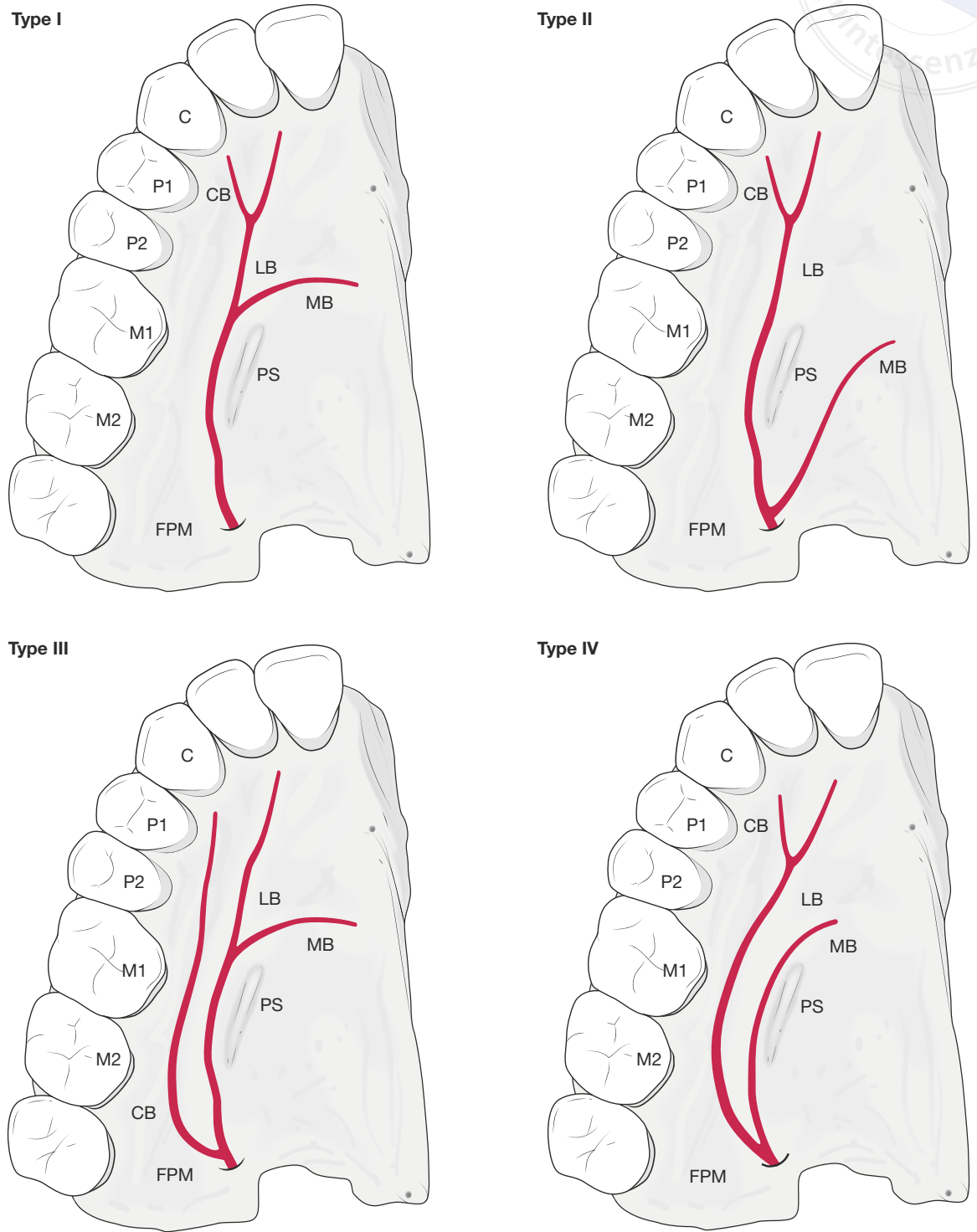


Fig 7-11 The posterior-to-anterior course of the greater palatine artery is subject to anatomical variation. In the type I branching pattern (41.7%), the greater palatine artery runs in the lateral groove of the palatal spine and, after emerging from the greater palatine foramen, runs anteriorly and 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

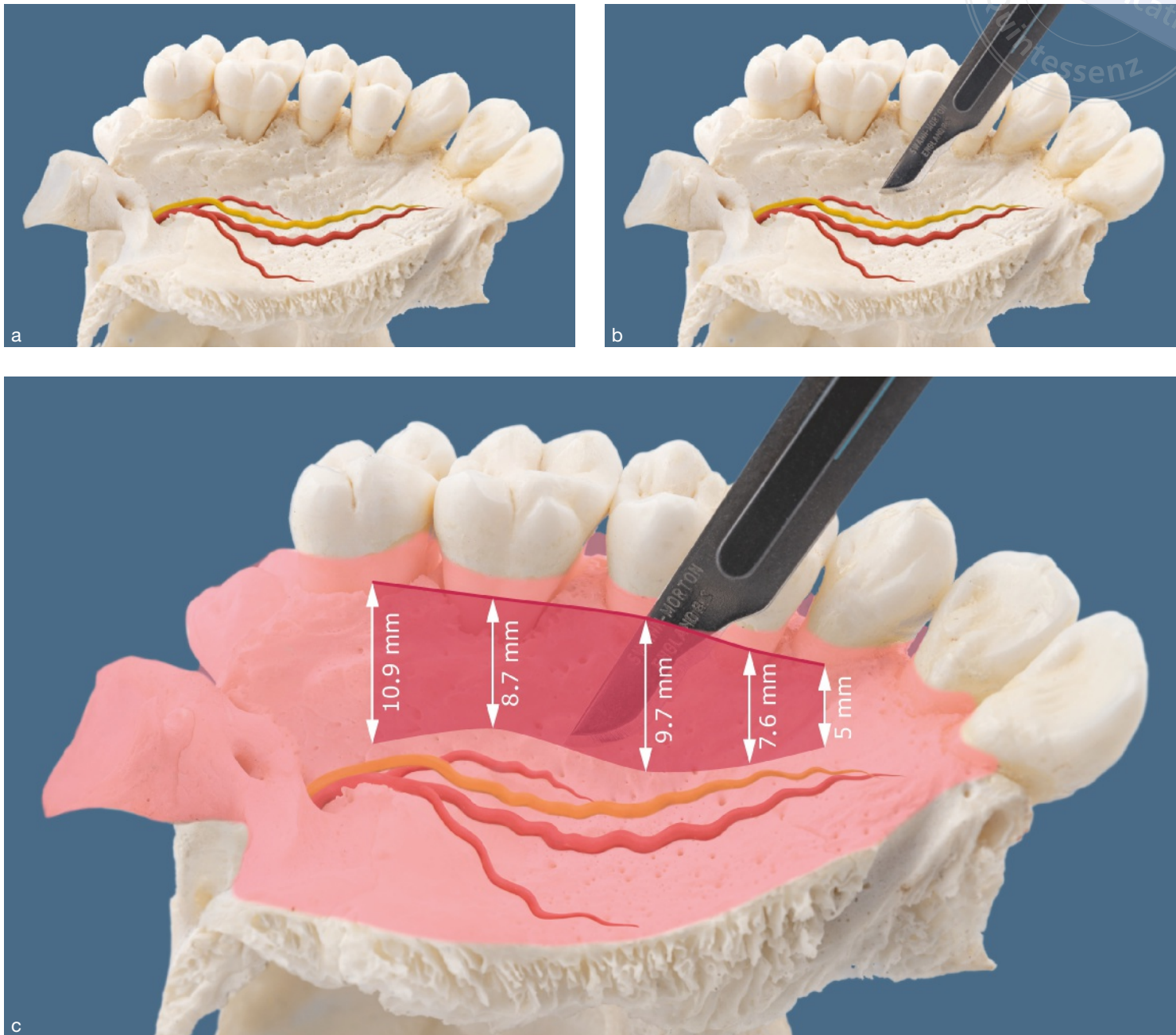


Fig 7-12a to c The results of a systematic literature review suggest that it is virtually impossible to injure the main branch or any of the larger lateral branches of the greater palatine artery in the posterior region when harvesting subepithelial CTGs from the lateral palate, provided the graft is 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 cemento-enamel 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 osteotomy 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

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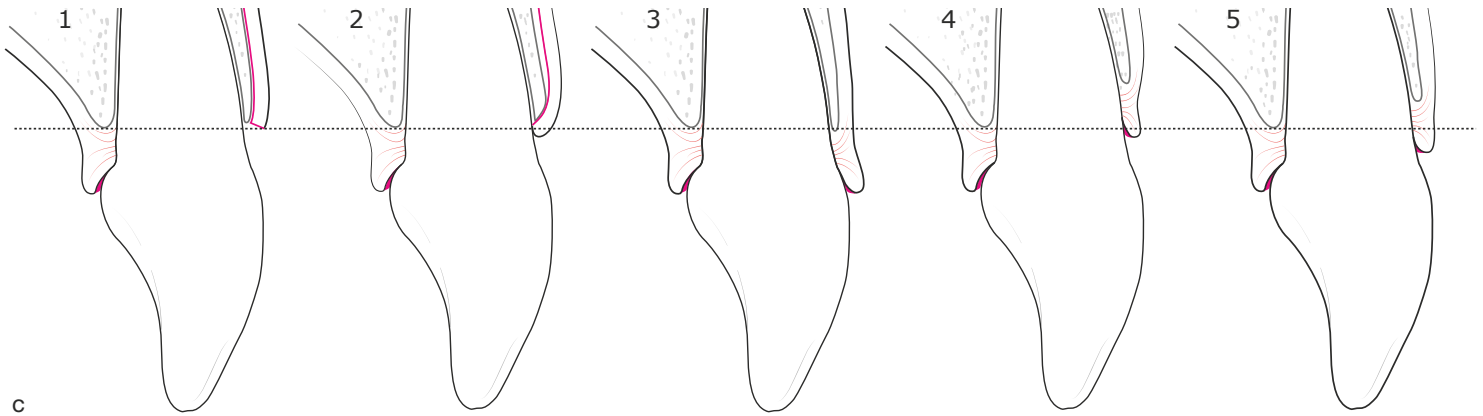
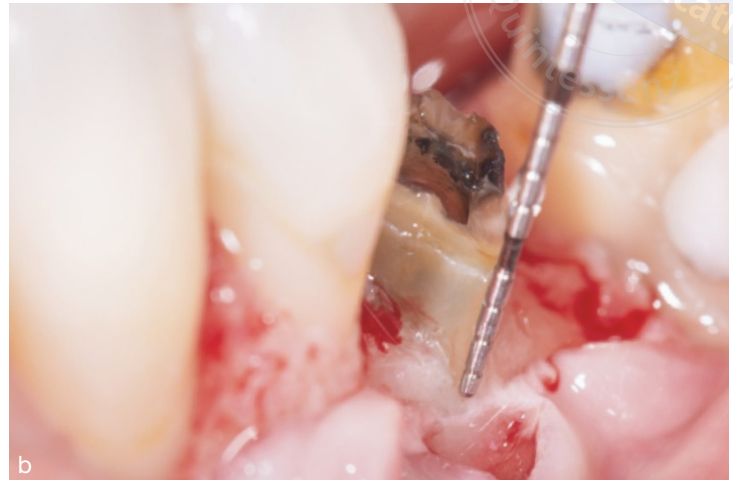
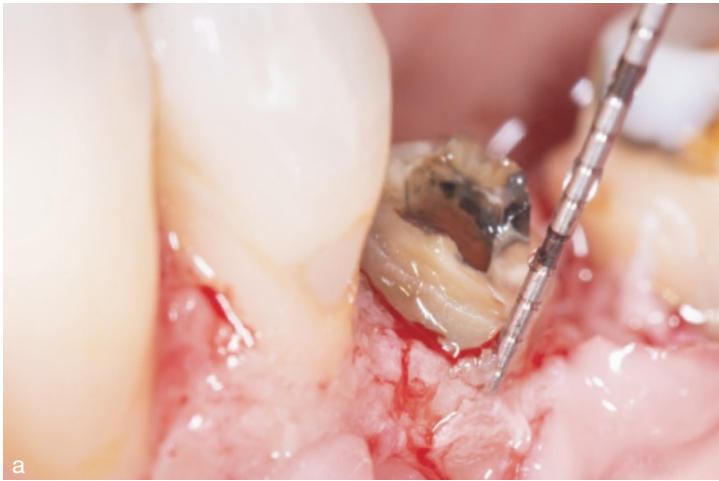


Fig 10-6a to c Whenever supracrestal soft tissue is removed during the course of external gingivectomy (1) or apically repositioned during flap surgery, as in this case example (2), supracrestal tissue attachment growth can occur in the coronal direction (3), in the apical direction in association with 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.

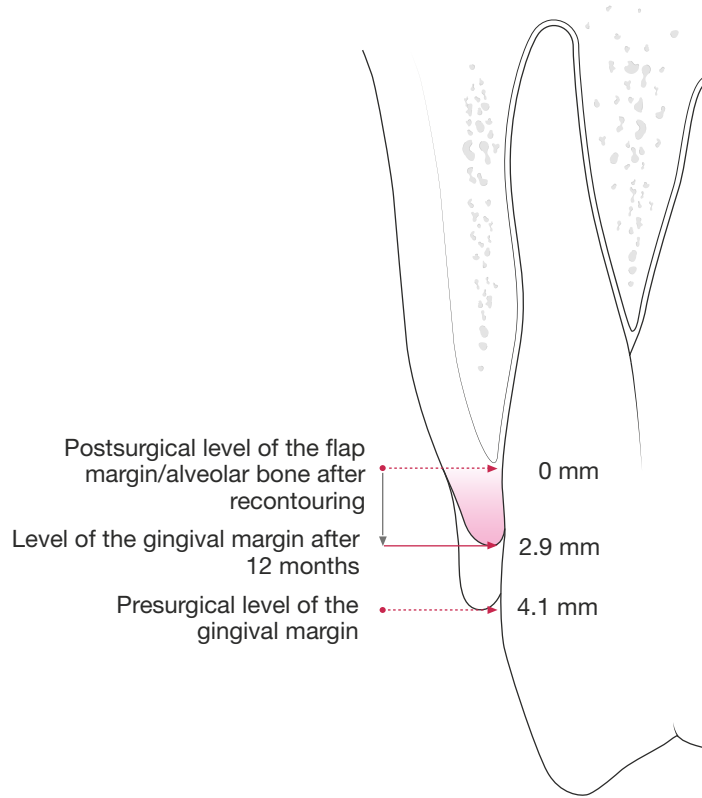
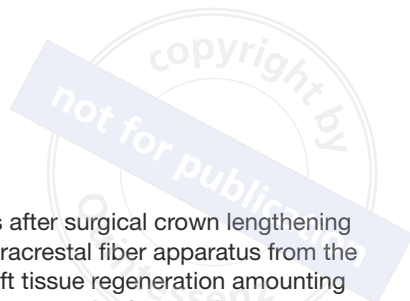
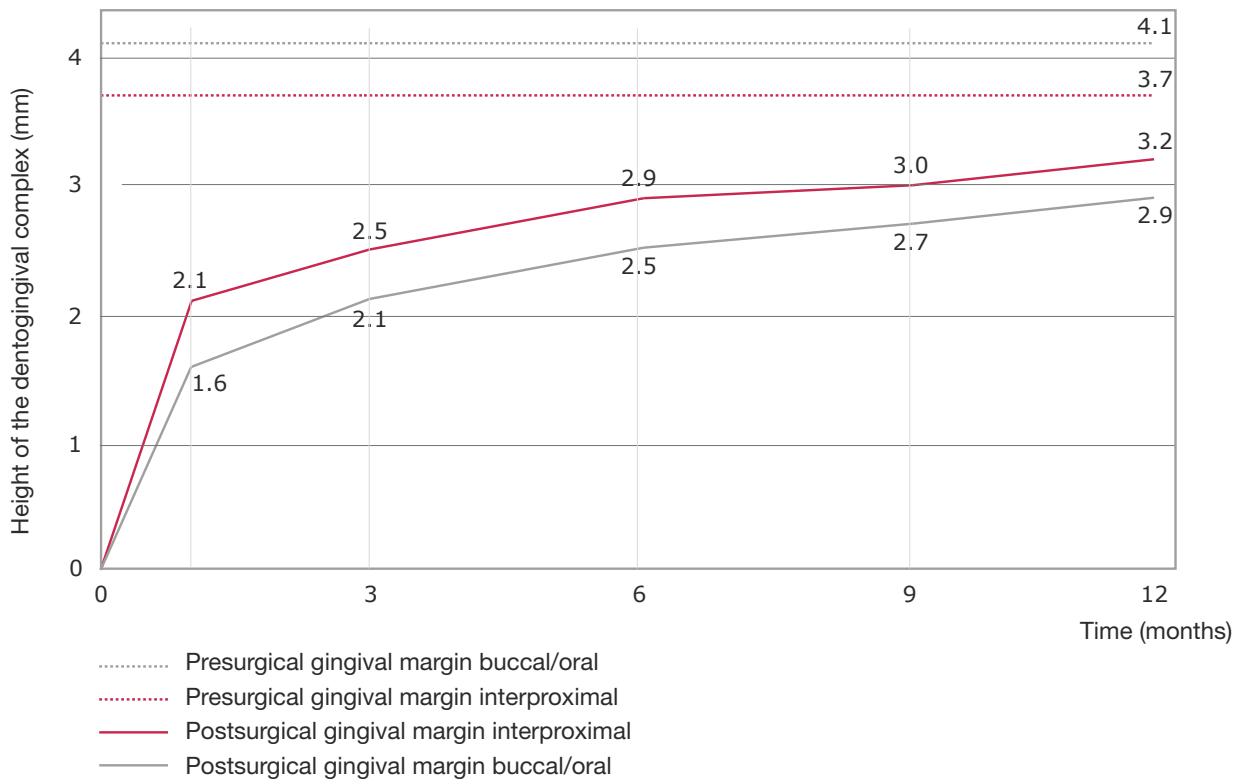


Fig 10-7a and b Twelve months after surgical crown lengthening with complete removal of the supracrestal fiber apparatus from the affected root surfaces, vertical soft tissue regeneration amounting to a mean postsurgical soft tissue regrowth of 3.2 and 2.9 mm at interproximal and buccal sites, respectively,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

a



b

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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.

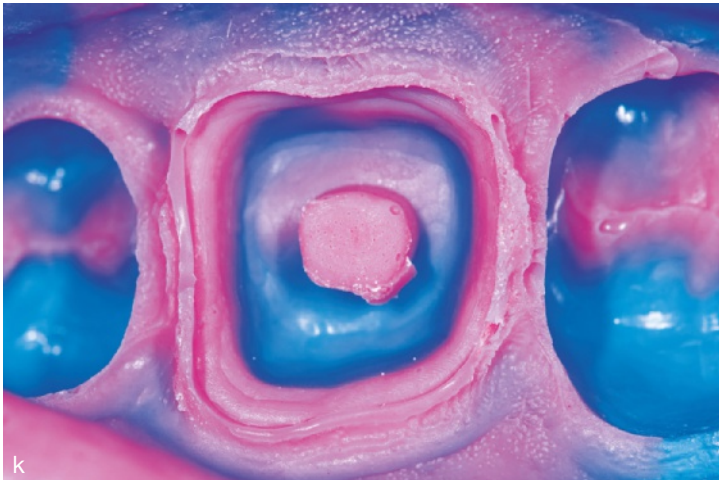


Video 10-1 Osseous resection in conjunction with apically repositioned flaps for the elimination of subgingival restoration margins in the case example described above.



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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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).



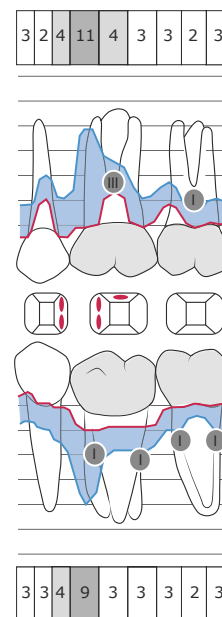
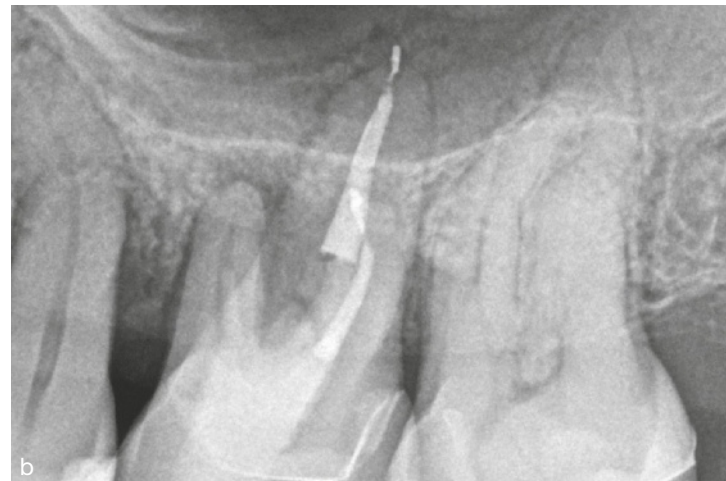
CHAPTER 12

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).

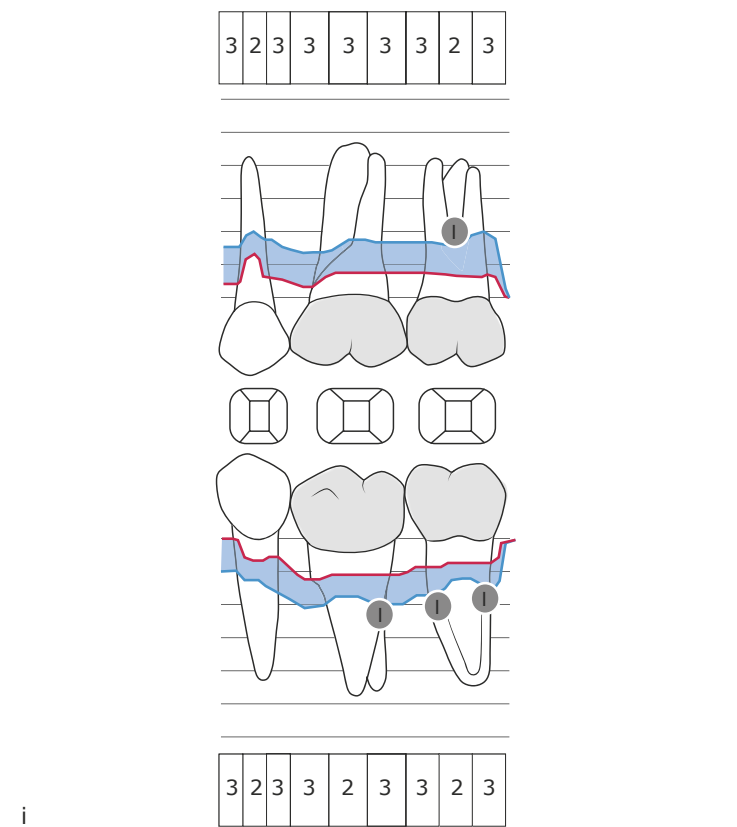
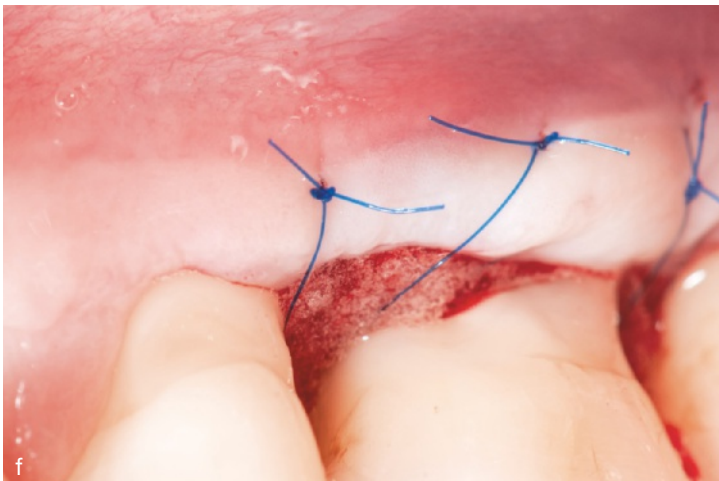
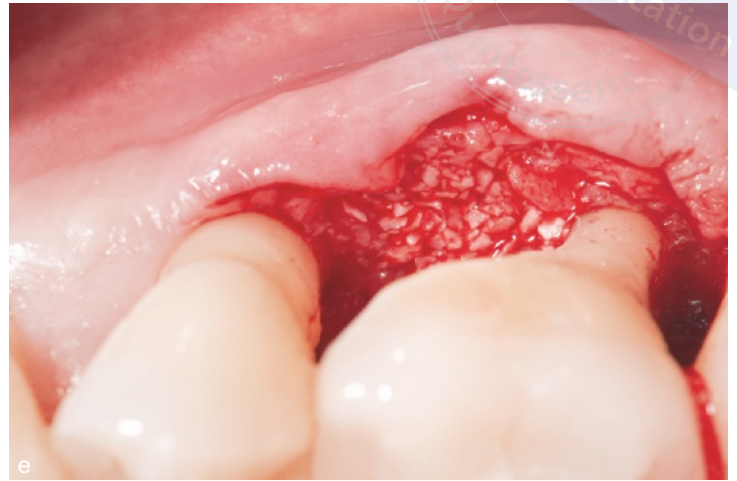
The available resective periodontal surgical techniques for the treatment of molars with class II and III furcation involvement or individual nonsalvageable roots include tunnel preparation, root amputation, root separation, and root resection²⁶ (Table 12-4).

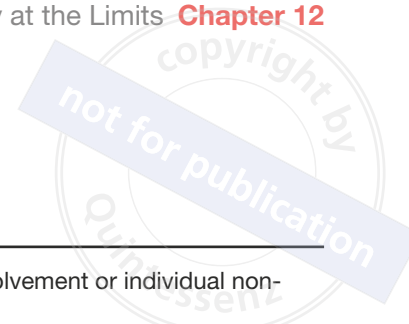


c

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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**Table 12-4**

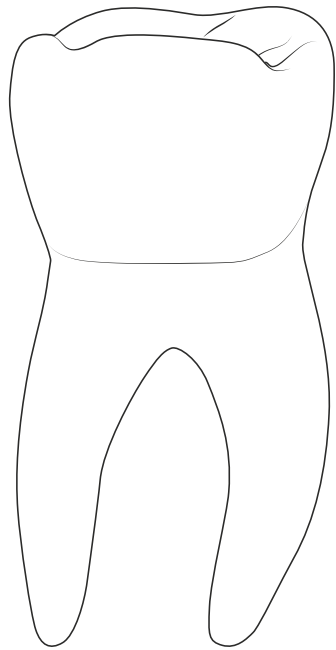
Resective periodontal surgical techniques used for the treatment of molars with class II and III furcation involvement or individual non-salvageable roots as defined by Carnevale et al.²⁶

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

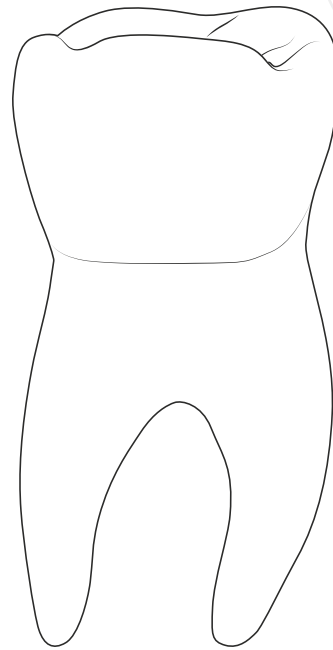
Tunnel preparation

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 molars²⁷ (Fig 12-85).

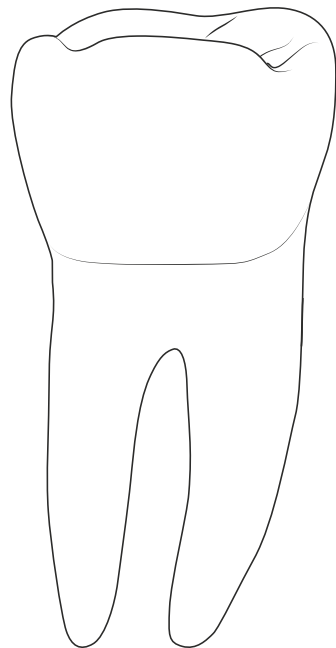
The tunnel preparation technique is similar to the apically repositioned flap procedure used in surgical periodontitis therapy, which is described in detail in Chapter 11. The recommendation to keep the treated furcation area sites open during the early healing phase, eg, by placing rubber dam cords 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).



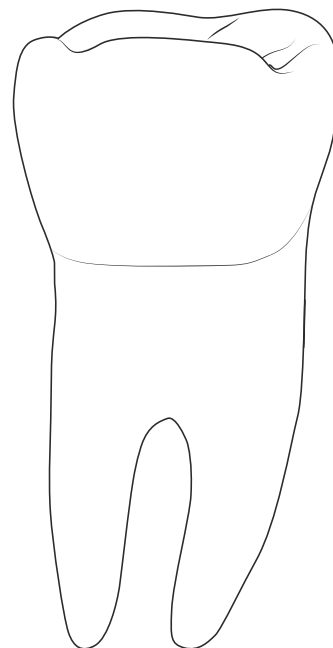
High degree of separation
Short root trunk



High degree of separation
Long root trunk



Low degree of separation
Short root trunk



Low degree of separation
Long root trunk



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.”

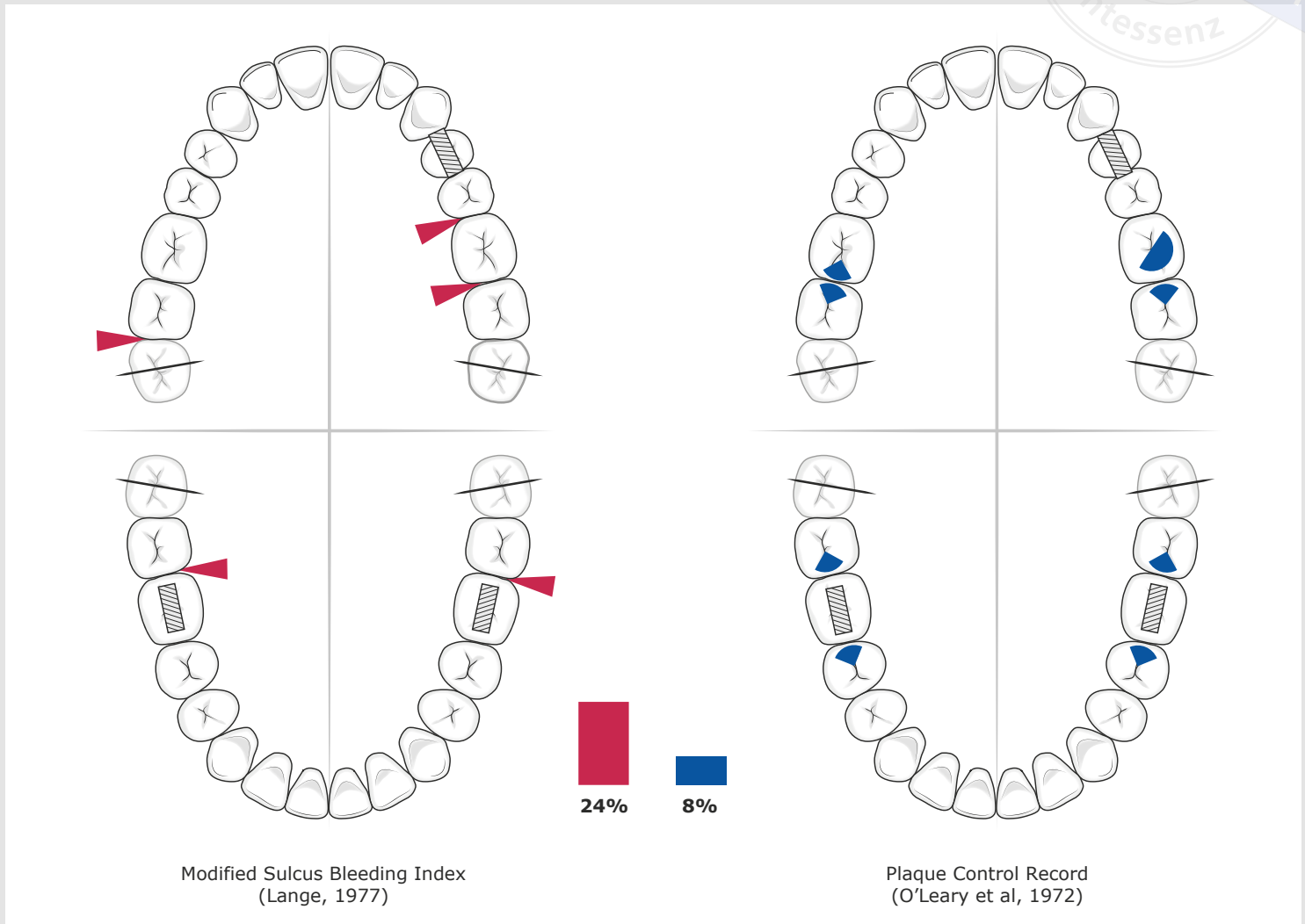
Findings at the time of reevaluation after systemic and anti-infective periodontal therapy

Intraoral findings





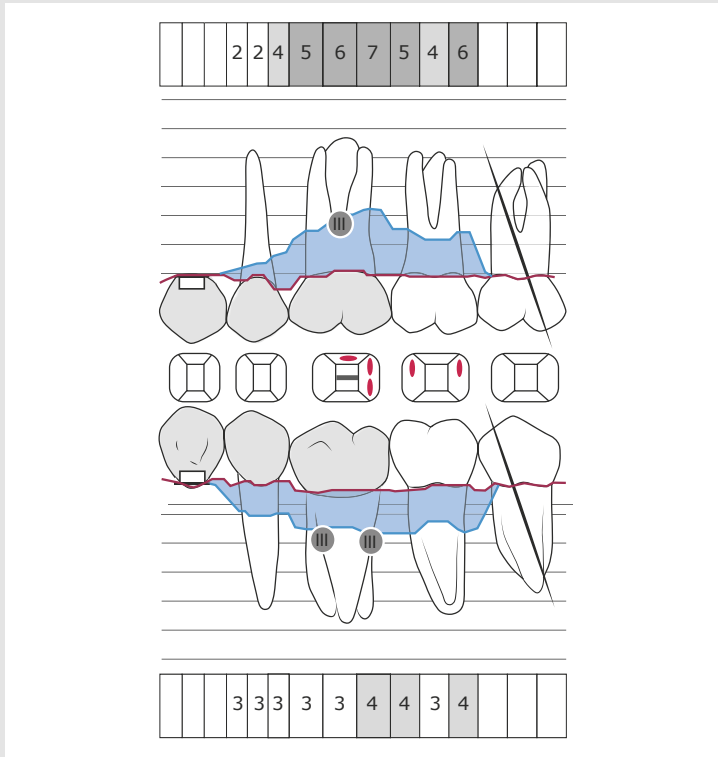
Oral hygiene findings



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

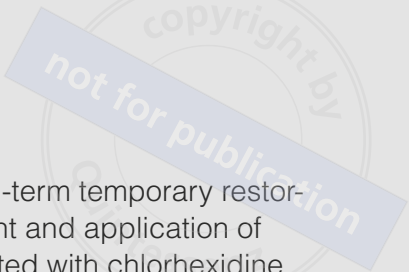
Prognosis

- + 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



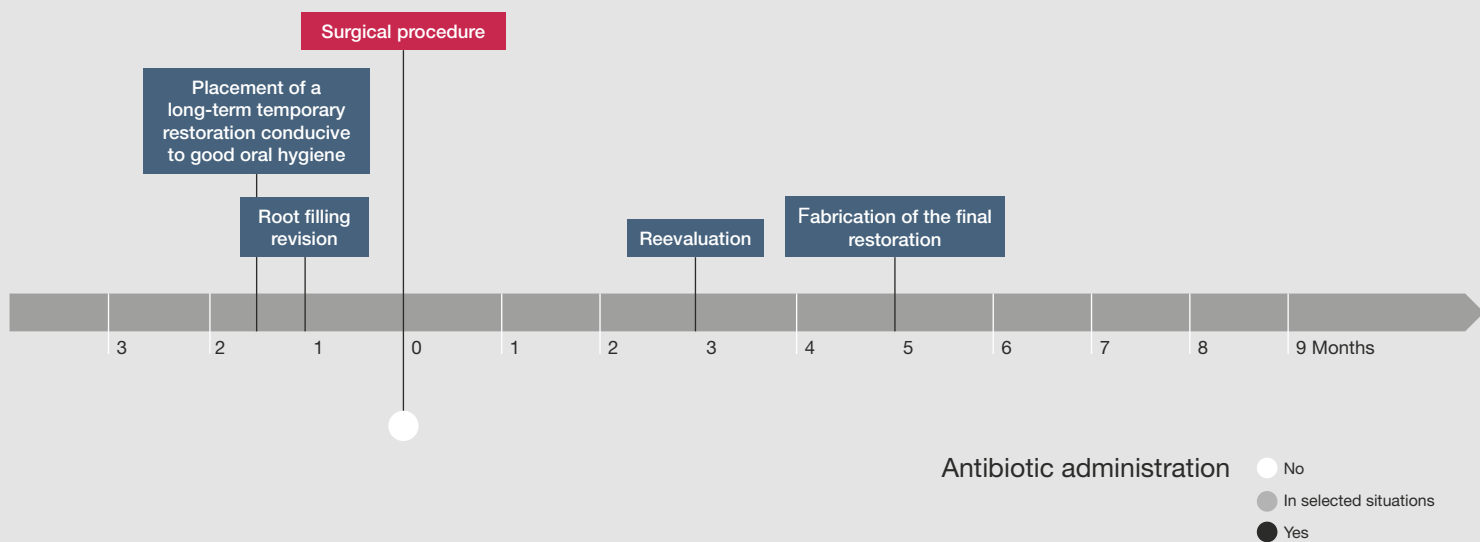
KEY POINTS IN BRIEF

- 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

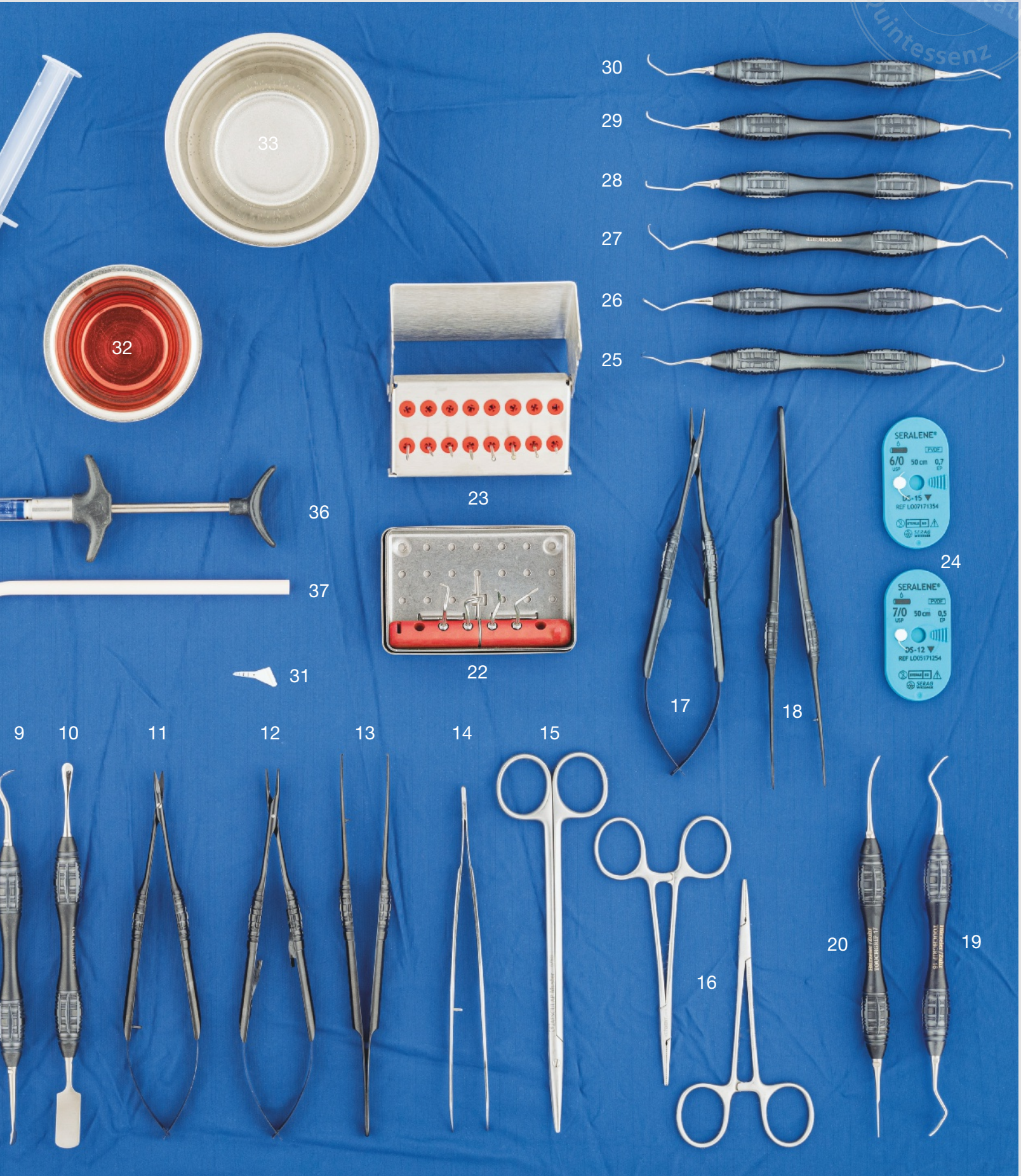
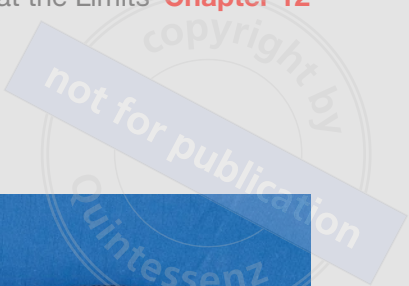




WORKPLACE PREPARATION CHECKLIST

- 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

**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 area¹²¹ (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,

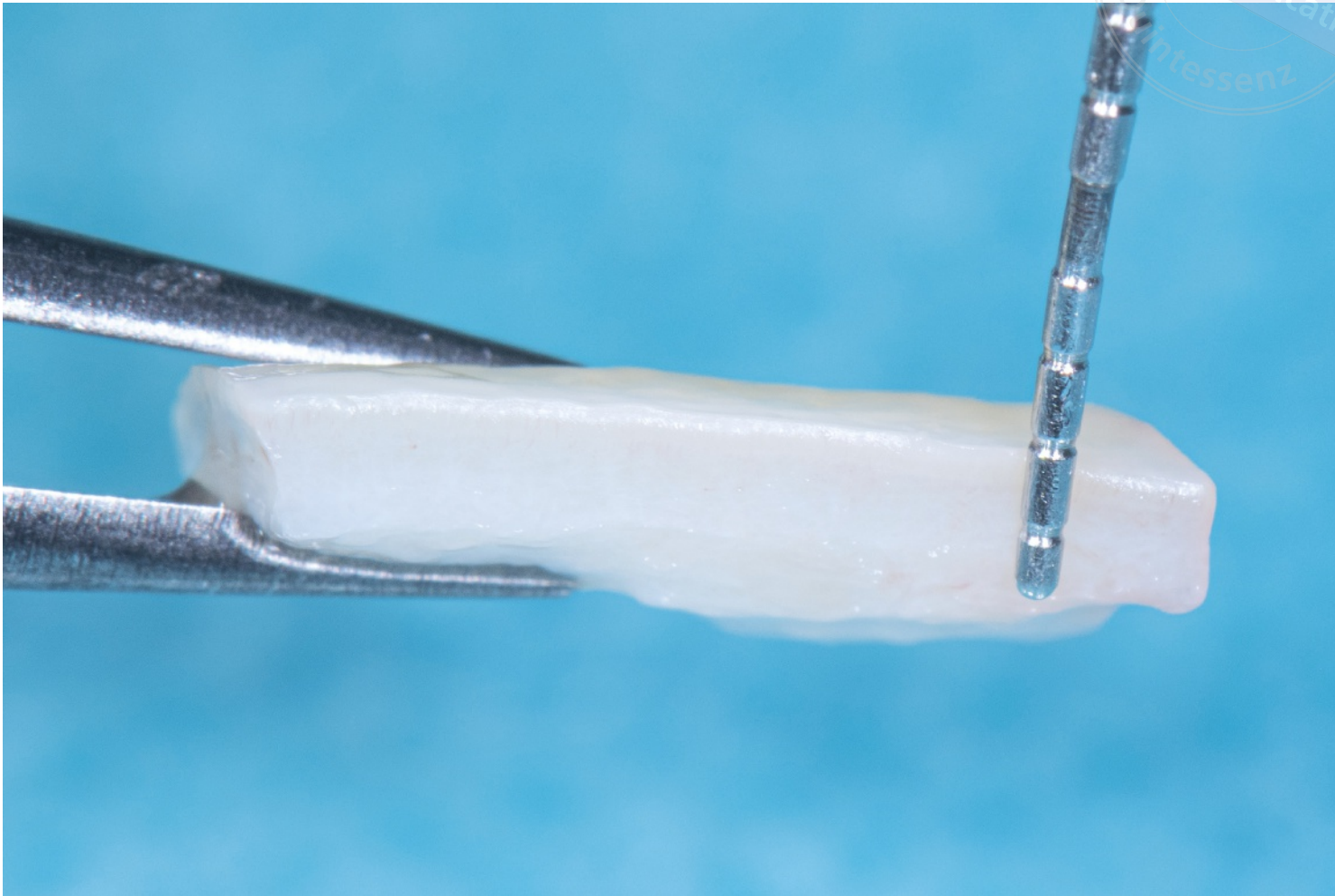


Fig 13-131 Periodontal surgery to increase the width of the masticatory mucosa in edentulous areas is similar to the procedure for increasing the width of gingival tissue by placing thin free gingival grafts (FGGs) on vascularized surfaces (see Chapter 10.2). Thicker FGGs are used as “onlay” grafts in 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.

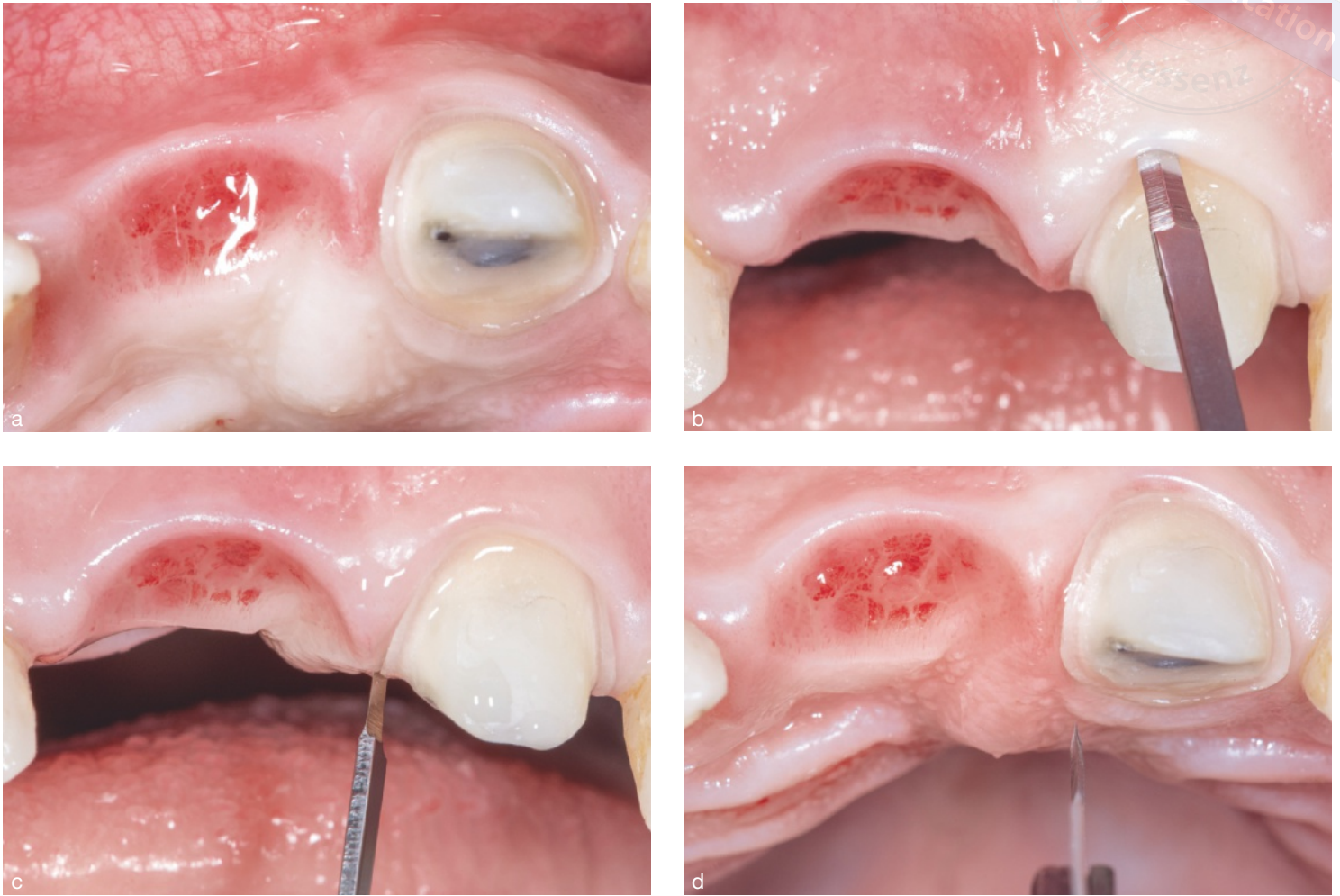


Fig 13-132a to d Clinical case example of a prosthetic space closure for the replacement of missing tooth 11 with reconstruction of the alveolar ridge defect through a combination of the modified “pouch” technique and “saloon door” technique. To achieve sufficient flap mobility, the papillae between 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

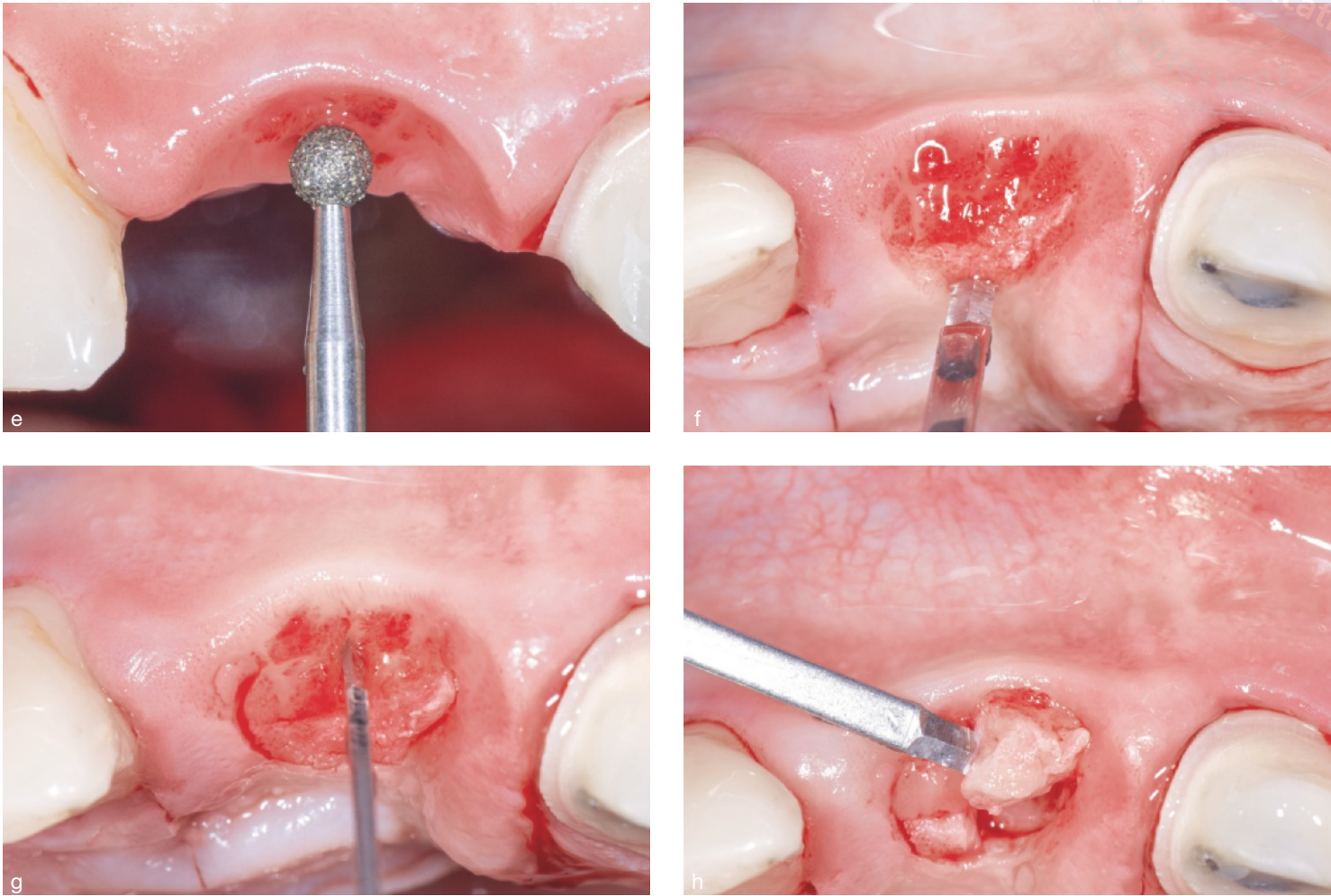


Fig 13-132e to h A round diamond bur is used to deepithelialize an area corresponding to the diameter of the tooth to be replaced. Subsequently, the deepithelialized area is carefully incised laterally and palatally with a microscalpel blade, close to the underlying bone, and then bisected along the 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).

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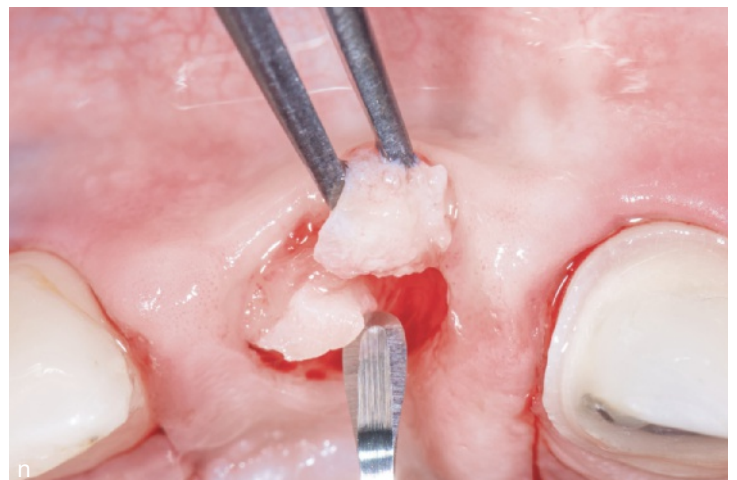
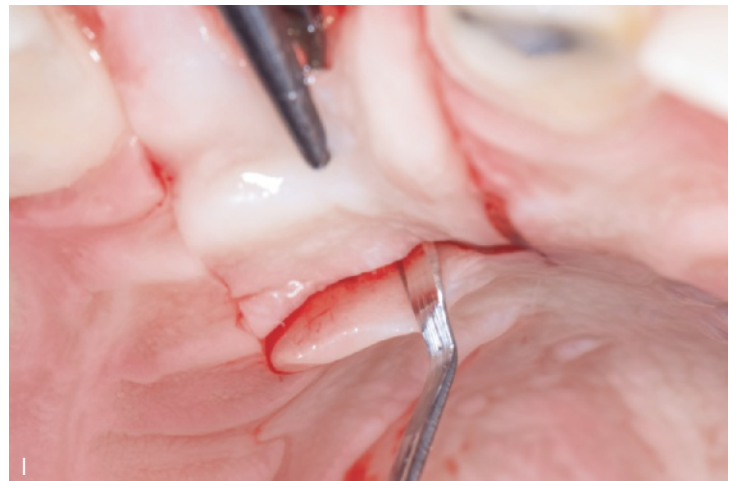
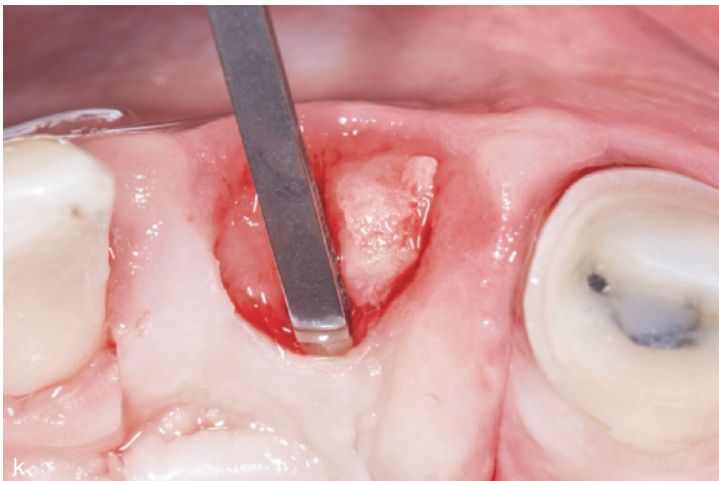


Fig 13-132i to n The buccal and palatal flaps are then elevated using the combined coronally advanced tunnel technique on the buccal side and the palatal peninsula flap technique on the palatal side. To achieve the desired flap mobility, the buccal and palatal flaps are joined in the correct plane through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

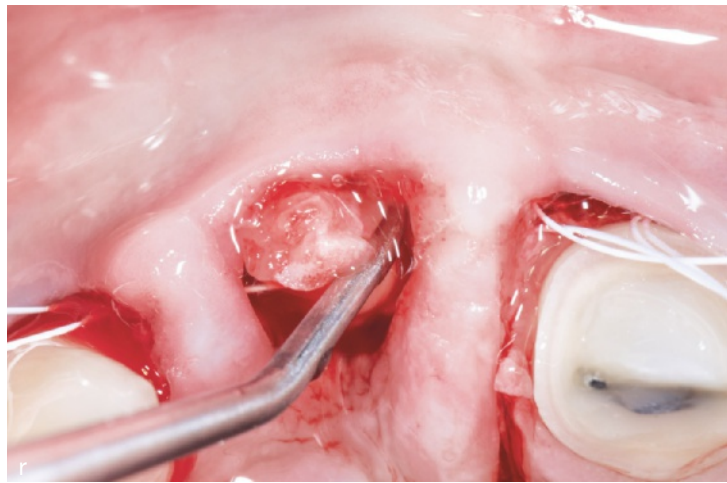


Fig 13-132o to s Positioning sutures are used to pull the free palatal CTG into the prepared tunnel to reconstruct the horizontal tissue defect. The two soft tissue pedicle grafts are then rotated mesially and distally under the buccal tunnel flap to augment the papillae between the pontic and the teeth. 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”

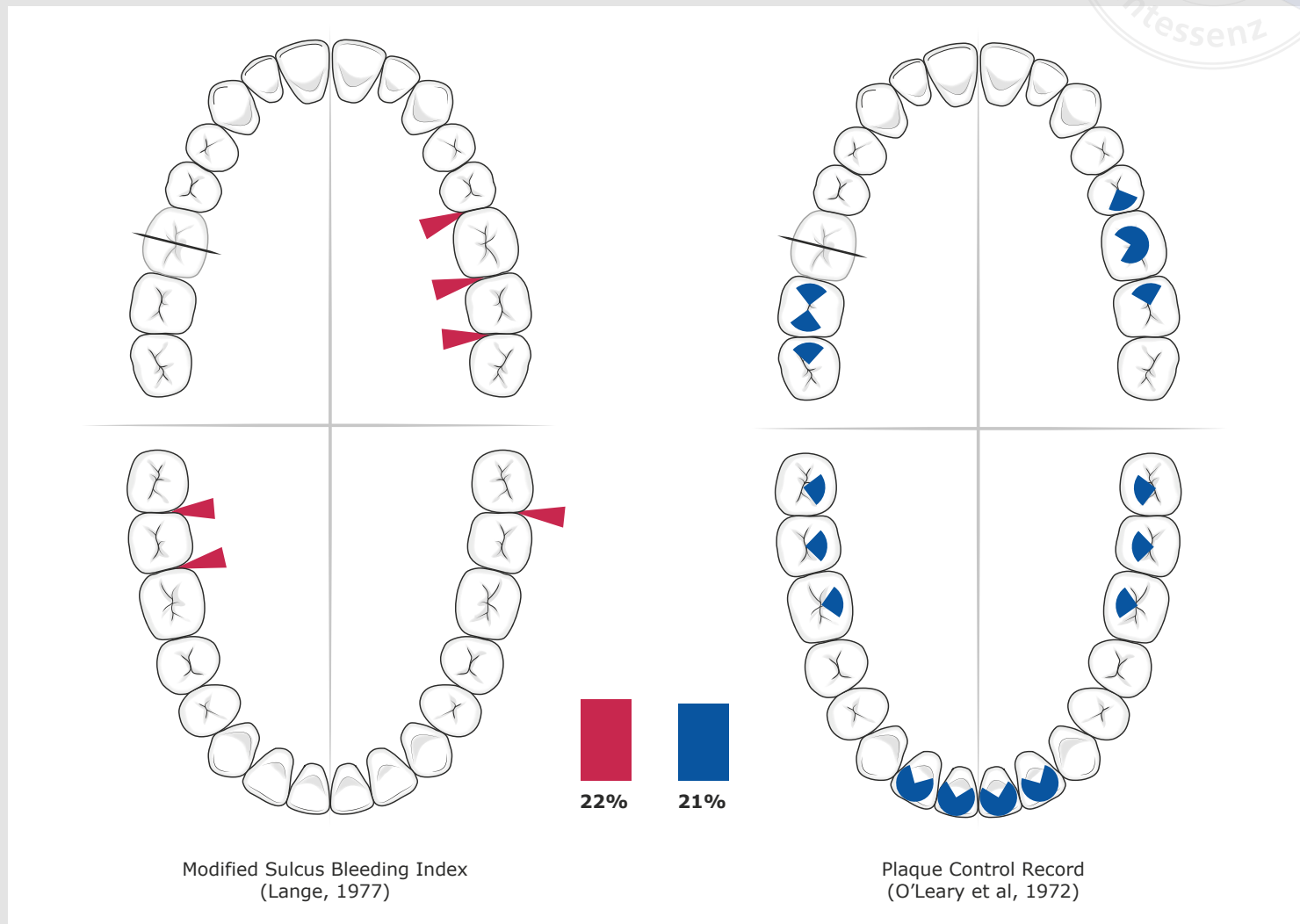
Initial situation

Intraoral findings



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Oral hygiene findings

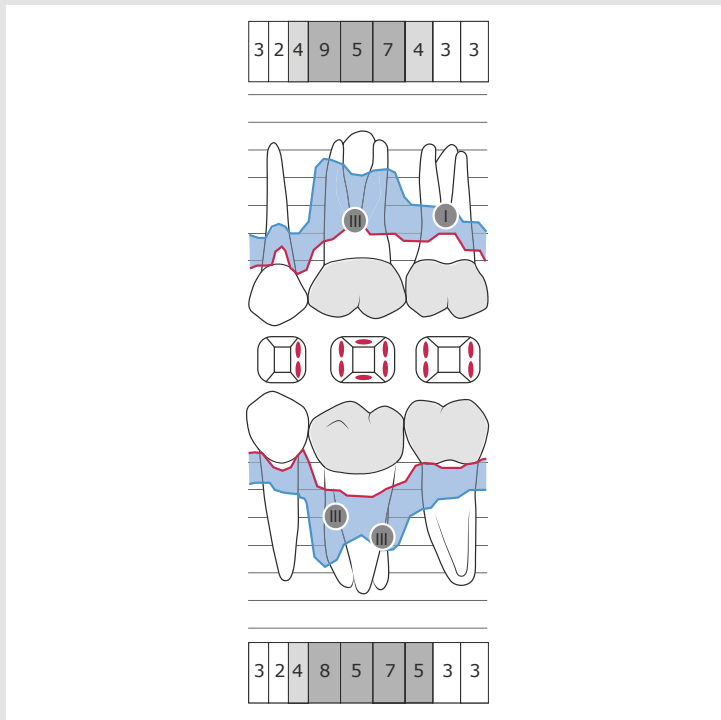


Radiographic findings





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

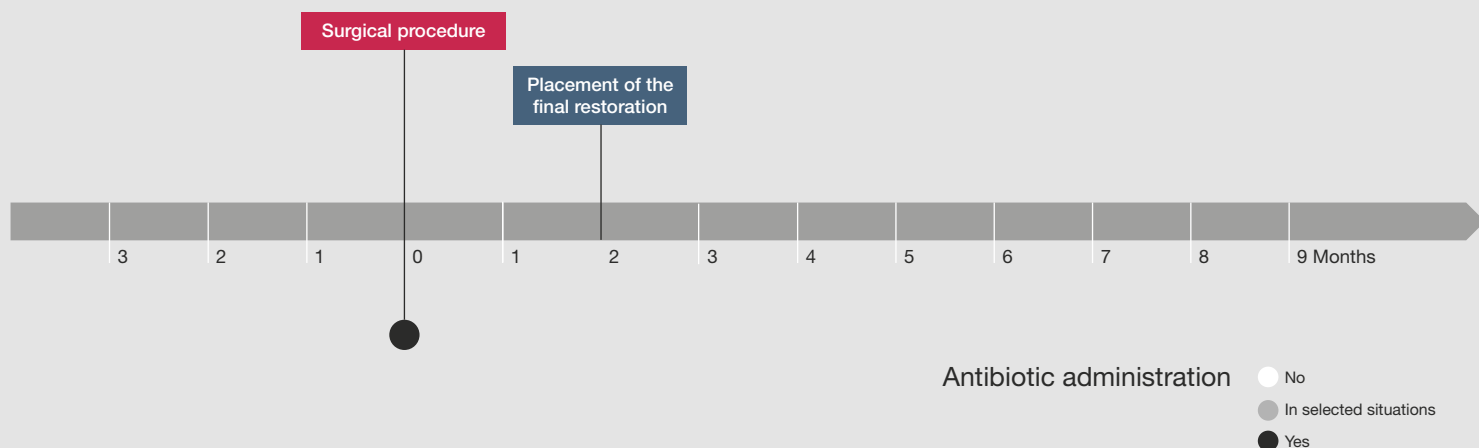
Prognosis

- + 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, *intra-sulcular 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



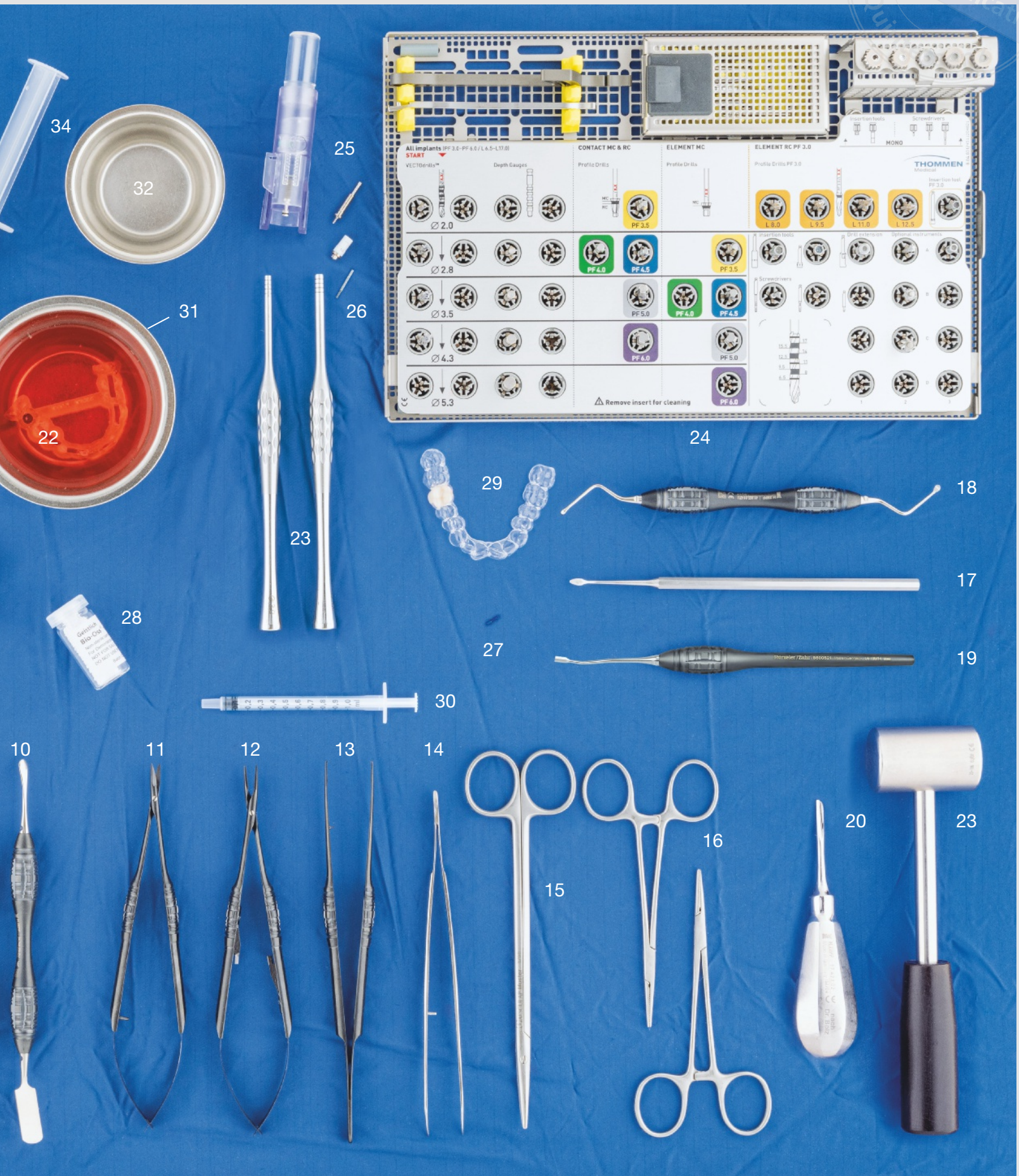


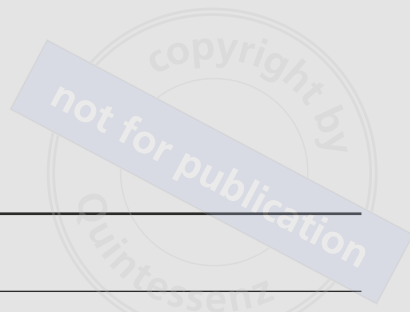
WORKPLACE PREPARATION CHECKLIST

- 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



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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 – Fab-

rication 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.

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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, PERIOFLOW® 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

INDEX

A

access flap techniques 247, 257, 260, 364, 406–415, 428–435, 444, 448, 453, 717, 781–784, 786, 831, 832–837, 850, 868, 931, 1630, 1636

alternatives to dental implants 1354–1404

autotransplantation 1354, 1361–1368, 1423–1430, 1431

maxillary growth 1354–1357

orthodontic space closure 1356–1361, 1405–1406, 1407

palatal implants 1369, 1388–1403, 1498

pontics 1368–1403

prosthetic space closure and periodontal surgery 1454–1462

alveolar process 70–72

bundle bone 70

cancellous bone 70, 71

cortical bone 70

cribriform plate 70

endosteum 71

Haversian canal 70

lamina dura 70

osteon 70

periosteum 71

Volkman's canals 71

alveolar bone 70–72

alveolar crest types 79–81

dehiscence, *bony* 79

fenestration, bony 79, 81

alveolar ridge

preservation 599–603

attachment, connective tissue 65, 78

attachment loss, periodontal 30, 649, 1089

autotransplantation 1354, 1361–1368, 1423–1430, 1431

of permanent teeth 1423–1430

B

biofilm, oral 215–218

“blood clot stabilization” 788

blood supply and innervation 72–73

anterior superior alveolar arteries 72

buccal arteries 72

buccal nerve 73

facial arteries 72

greater and lesser palatine arteries 72, 392, 395, 459

incisive artery 72

inferior alveolar arteries 72

inferior alveolar nerves 73

infraorbital arteries 72

infraorbital nerve 72

mental arteries 72

mental nerve 72, 769

posterior superior alveolar arteries 72

sublingual arteries 72, 775

sublingual nerve 73

superior alveolar nerves 73

bone architecture 811

bony dehiscence 79, 81, 352–353, 492, 495

bony fenestration 79, 81

C

“center effects” 11, 805–806

cementoenamel junction 63, 65–67, 80, 395, 537–542, 558–563

cementum 67–69

acellular afibrillar 68

acellular extrinsic fiber 68

cellular intrinsic fiber 68

cellular mixed fiber 69

combined flaps 159–164

connective tissue fibers, peri-implant 75

connective tissue, gingival 62–66

connective tissue graft *see* “mucosal grafts”

“creeping attachment” 563–564

D

decontamination 1628–1629, 1639, 1641, 1644

defect morphology 781

defects, bony 227, 781, 783

infrabony 227, 781, 783

interradicular 227, 781, 783

suprabony 227, 781, 783

defects, interradicular 781, 802–803, 838, 960–968

defect analysis 960–961

flap preparation 963–965

flap mobilization 966

flap stabilization 966–968

incision design 962

defects, intrabony 781, 783, 800–805

dehiscence, *bony* 79, 81, 352–353, 492, 495

demographic changes 4–5

dentogingival complex 78–80

“distal wedge” procedure 409, 453, 809

E

EBD *see* “evidence-based dentistry”

EBM *see* “evidence-based medicine”

edentulism 5

EMD *see* “enamel matrix derivative”

EMPs *see* “enamel matrix proteins”

enamel matrix derivative (EMD) 562–563, 788–789, 799, 806

enamel matrix proteins (EMPs) 102, 259, 562–563, 789–790, 799, 806

epidemiology 4–5

epithelium, oral gingival 62–63

ePTFE *see* “suture materials, surgical”

- evidence-based dentistry (EBD) 9–14, 16, 32
 “center effects” 11, 805–806
clinical relevance 11
cognitive bias 11
 guidelines 9
 level of evidence 10
manual dexterity 11
 patient-reported outcome measures (PROMs) 12–13, 237, 590
 PICO model 16
publication bias 11
- evidence-based medicine (EBM) 9, 11–12
- explantation* 364
- extraction 591–598
 healing 591–598
 “orthodontic” 609–616
- extrusion, orthodontic 1329–1332, 1333
- F**
- fenestration* 79, 81
- fiber apparatus 67–69
 alveolar 67
 periodontal 67–69
 supraalveolar 65, 67
- “*fiber retention*” technique 652, 818, 821–831, 1027, 1033, 1057, 1205
- flap, apically repositioned* 152, 200–201, 257–258, 260, 658, 661, 686, 780–783, 806–831, 1027–1032, 1033, 1057, 1167, 1205, 1541
- flap design, surgical 156–164
 combined flaps 159–164
 mucoperiosteal flap 156, 159
 mucosal flap 157–159
- flap mobilization 165–188
 combined tunnel flap techniques 182–188
 palatal peninsula flaps 172–181
 releasing incisions 165–166, 172
 tunnel surgery 166–188
- flap preparation 1027–1032
 buccal 1027–1028
- lingual 1028–1029
 palatal 1028–1032
- free gingival grafts 380–388, 395, 398–399, 402–407, 410, 418–439, 440–443, 714–717, 1454–1455
- deepithelialized 398–400, 402–406, 410, 418, 420, 424–438
- deepithelialized free 747
- foundations 380–388
- free 381, 462–465, 649–650, 724, 1463, 1569, 1605
- healing 462–466
- indications 420–421
- furcation defect 227–236
- G**
- GBR *see* “guided bone regeneration”
- “*guided bone regeneration*” (GBR) 599, 604
- gingiva 62–67, 380
 attached 65
 free 63–65
 interdental 67
- gingival connective tissue 62–66
- gingival margin* 63
- gingival phenotypes 81–83
- gingival recessions 492–495, 503–546, 558–573
 etiology 492–495
 pathogenesis 503
 prevalence 490–491
 prognosis 558–567
- gingival recessions, treatment 504–546
 around prosthetically restored teeth 545
 around teeth with noncarious cervical lesions 537–544
 in areas with esthetic relevance 507–525
 in areas without esthetic relevance 526–536
 in children and adolescents 545
- gingivectomy 409, 652, 653, 780–781, 809
- gingivitis 646–648
- GTR *see* “guided tissue regeneration”
- “guided tissue regeneration” (GTR) 98, 563, 787–791
- I**
- “immediate dentoalveolar restoration” technique 622–625, 1757–1762, 1763
- immediate implant placement* 591, 604–609, 1710–1717
- implants 6–8, 590–591
digital workflow 591, 1711–1713, 1721
- “immediate dentoalveolar restoration” technique 622–625, 1757–1762, 1763
- immediate implant placement 591, 604–609, 1710–1717
- long-term survival rates 590
- orthodontic extrusion* with partial extraction 609–616
- “socket shield” technique 626–639, 1780–1784, 1792, 1810, 1828
- “through the tooth” technique 617–621, 1718, 1721, 1740
- implants preservation, limits 364–365
- incisions, in the mucosal margin area 152–154
 intrasulcular 152
 marginal 152–154
 paramarginal 152–154
- individualized oral medicine (IOM) 31–32, 262–265
- individualized periodontal medicine* 29–32, 97, 262–264
- instruments 113–124
 anatomical forceps, smooth, extra fine 122
 anatomical–surgical combination forceps 117
 Instrument Set 114–124
microsurgical scalpel blade 117
microsurgical tunneling blade 117
 needle holder, corrugated 122
 needle holder, smooth, extra fine 122
 papilla elevator 122

- Root Instrumentation Set 116
 scalpel handle for microblades 117
Spin Blade 360 microblade 117
 spring scissors 122
 Suture Removal Set 117
intentional replantation 1261–1262
 IOM *see* “individualized oral medicine”
- J**
- JE *see* “junctional epithelium”
junctional epithelium 62, 63–66, 74–75, 77, 78
- L**
- loops and knots 133–136, 202–208
instrumentally tying 133–134, 202
semi-instrumentally tying 133, 202
 suture removal 142, 206
 loupes 109, 111–113
- M**
- McCall’s festoon 491
 microsurgery 102–136
 loupes 109, 111–113
 microsurgical training 130–136
 operating microscope 110–112
 optical magnification systems 108–113
 scientific findings 102–108
mucogingival junction 63, 65
mucosa, masticatory 62, 65, 73
 mucosa, peri-implant 74–76
 mucosal grafts 380–388, 398–415, 1559
 autologous 399, 439, 462, 472–475, 478
 combined 436–438
 deepithelialized free gingival grafts 398–400, 402–406, 410, 418, 420, 424–426
 free 439, 462–471
 subepithelial connective tissue grafts 105, 160, 384–388, 395, 397, 406, 408, 418
 mucosal grafts, clinical decision-making 416–439
 mucosal grafts, complications 458–461
 mucosal grafts, donor site 393–397
 greater palatine artery 395–397, 417
 lateral palate 393–395, 400, 410–413, 428–429
 tuberosity 393–396, 400, 409–413
 mucosal grafts, harvesting technique 393–397, 439, 440, 444, 448, 453
 “*distal wedge*” procedure 409, 453, 809
 free gingival grafts 440
 “single incision” technique 444
 “trap-door” technique 448
 mucosal grafts, healing 462–471
 connective tissue grafts 466–471
 free gingival grafts 462–466
mucositis, peri-implant 318–319, 321, 355–356
 multirooted teeth, anatomy 229
- N**
- needles, surgical 127–128
- O**
- operating microscope 110–112
 oral biofilm 215–218
 oral gingival epithelium 62–63
 orthodontic extrusion 1329–1332, 1333
 orthodontic space closure 1356–1361, 1405–1406, 1407
- P**
- palate, hard 380, 389–392, 393–395, 398–400
 blood vessels and nerves 391–392
 macroscopic anatomy 389
 microscopic anatomy 390–391
palatal implants 1369, 1388–1403, 1498
 “palatal ramping” 811
 “patient-reported outcome measures” (PROMs) 12–14, 237, 262, 265–266, 590
 peri-implant diseases, classification 354–355
 peri-implant diseases, diagnosis 349–355
 peri-implant diseases, epidemiology 318
 peri-implant diseases, etiopathogenesis 319–322
 frank dysbiosis 321–322
 incipient dysbiosis 320–321
 symbiosis 320
 peri-implant diseases, long-term outcome 363–364
 peri-implant diseases, prevention 323–348, 1531, 1533
 implant-related risk factors 325
 patient-related risk factors 324–325
 technique-related risk factors 326–348
 peri-implant diseases, treatment 356–360
 anti-infective phase 356–358
 corrective phase 359
 supportive phase 360–361
 systemic phase 356
 peri-implant diseases, wound healing 361–362
 peri-implant mucosa 74–76
 augmentative surgical measures 1559–1568
 resective surgical measures 1536–1540
 peri-implant mucosal recessions 491, 495–502, 504, 547–557, 574–581
 etiology 495–502
 pathogenesis 504
 prevalence 491
 prognosis 574–575
 peri-implant mucosal recessions, treatment 547–557
 in areas with esthetic relevance 547–552
 in areas without esthetic relevance 553–557

- peri-implant mucositis* 318–319, 321, 355–356
- peri-implant structure 74–76
- peri-implantitis 6, 318
- periodontal diseases, biofilm 219–220
- periodontal diseases, diagnosis 226–236
- classification 235
- periodontitis progression rate 234, 236
- periodontitis stages 234, 236
- periodontal diseases, epidemiology 212
- periodontal diseases, etiopathogenesis 219–223
- frank dysbiosis 222–223
- incipient dysbiosis 221–222
- symbiosis 221
- periodontal diseases, prevention 224–225
- periodontal diseases, treatment 237–256
- anti-infective phase 238–240
- corrective phase 241–254
- supportive phase 255–256
- systemic phase 238
- periodontal surgery, of external root resorptions 1227–1271
- hyperplastic invasive 1230, 1248–1259
- infection-induced 1230, 1247–1248
- trauma-induced 1230–1246
- periodontal surgery, regenerative* 242, 782, 784–806
- “blood clot stabilization” 788
- enamel matrix proteins 789–790, 799, 806
- “guided tissue regeneration” (GTR) 787
- patient-related factors* 800
- primary wound healing* 784–791
- prognosis* 800–801, 804
- reevaluation 799
- technique-related factors* 801
- tooth- and defect-related factors* 800–801
- periodontal surgery, regenerative* for interradicular defects 960–968
- defect analysis 960–962
- flap mobilization 966
- flap preparation 963–965
- flap stabilization 966–968
- incision design 962–963
- periodontal surgery, regenerative* for intrabony defects 832–838
- defect analysis 832
- flap mobilization 835–837
- flap preparation 835
- flap stabilization 838
- incision design 832–834
- periodontal surgery, regenerative* for presumably “hopeless” teeth 801, 1088–1092, 1093–1094, 1095, 1115
- periodontal surgery, resective* 242–254, 652–659, 806–831, 1027–1032, 1135–1166
- apically repositioned flap* 811–819, 821–824, 831, 1027–1032, 1033, 1057
- bone architecture* 811
- “distal wedge” procedure 409, 453, 809
- “fiber retention” technique 652, 818, 821–831, 1027, 1033, 1057, 1205
- gingivectomy 409, 652, 653, 780–781, 809
- historical development 806
- “palatal ramping” 811
- periodontal surgery, resective* for class II and III furcations or nonsalvageable roots 1135–1166
- root amputations 1137, 1144–1145, 1151, 1186
- root resections 1137, 1144, 1149, 1151, 1152, 1154, 1158–1160
- root separations 1137, 1144, 1148–1149, 1151, 1158–1159
- tunnel preparation 1137–1142
- periodontal surgery, resective* for moderate intrabony and suprabony defects 1027–1032
- defect analysis 1027–1028
- flap preparation, buccal 1027–1028
- flap preparation, lingual 1028–1029
- flap preparation, palatal 1028–1030
- periodontal wound healing 256–260
- periodontitis 5, 234–236, 646–649
- grades 234–236
- stages 234, 236
- personalized oral medicine (POM)* 31–32, 262–265
- phenotypes, gingival 81–83
- PICO model 16
- POM *see* “personalized oral medicine”
- primary wound healing* 88–90, 784
- prosthetic space closure 1454–1462
- PROMs *see* “patient-reported outcome measures”
- R**
- releasing incisions 155–156
- horizontal 155
- vertical 155–156
- restoration margin 646–649
- root amputations 1137, 1144–1145, 1151, 1186
- root resections 1137, 1144, 1149, 1151, 1152, 1154, 1158–1160
- root resorptions 1135, 1149, 1227–1271, 1272
- classification 1230
- external* 565, 1227–1271, 1272
- hyperplastic invasive 1230, 1248–1254
- infection-induced 1230, 1247–1250
- internal* 1228, 1230, 1246–1250, 1271
- trauma-induced 1230–1231, 1239, 1246, 1248
- root separations 1137, 1144, 1148–1149, 1151, 1158–1159
- S**
- SDM *see* “shared decision-making”
- secondary wound healing 88–90
- “shared decision-making” (SDM) 21–22, 31–32, 262

- individualized periodontal medicine* 31–32, 97, 262–265
- personalized oral medicine (POM)* 31–32, 262–265
- Sharpey fibers* 67–69
- “single incision” technique 202–203, 384, 402, 406, 428, 444
- “socket shield” technique 626–639, 1780–1784, 1790, 1792, 1810, 1828
- soft tissue substitutes 472–481
- allogeneic 472–473
 - alloplastic 472
 - leukocyte- and platelet-rich fibrin (L-PRF) 474
 - “recombinant human platelet-derived growth factor” (rhPDGF) 474
 - requirements 478
 - tissue engineering 472, 478
 - xenogeneic 472–478
- space closure, orthodontic 1356–1362, 1405–1406, 1407
- space closure, prosthetic 1454–1462
- Stillman’s cleft 491
- subgingival restoration margin 54–55, 492, 539–541, 545, 1329–1330
- sulcular epithelium, oral 63
- sulcus*, depth 63
- “supracrestal tissue attachment” 74–79
- surgery, augmentative 1559–1568
- surgery, regenerative *see* “treatment of peri-implantitis, surgical”
- surgery, regenerative–resective *see* “treatment of peri-implantitis, surgical”
- surgery, resective* 1536–1540, 1630
- suture closure, principles 189
- suture material 125–127
- suture materials, surgical 125–130
- expanded polytetrafluorethylene (ePTFE) 125–127, 202, 787
 - nonresorbable 125–126, 129
 - polyglycolic acid 125, 129
 - polyvinylidene fluoride 125, 129
 - resorbable 125, 129
- suture removal 142, 206
- suture size 127, 129
- suture techniques, combined
- sutures 196–199, 202
 - double-sling sutures 196–197, 202
 - vertical mattress sutures with loop 198–199, 202
- suture techniques, stabilization
- sutures 200–202
 - horizontal sling sutures 202–203
 - periosteal sutures 200–202
 - vertical sling sutures 202, 204–205
- suture techniques, tension-relieving
- sutures 193–195
 - mattress sutures* 193, 195
- suture techniques, wound closure
- sutures 190–194
 - continuous sutures 190–192, 194
 - interrupted sutures 190–191
- T**
- “through the tooth” technique 617–621, 1718, 1721, 1740
- tissue engineering 472, 478
- tooth loss 5
- tooth preservation, limits 262–265
- tooth-preserving dental surgery at the limits 1088–1092
- “trap-door” technique 160, 202, 384, 400, 406, 428, 448
- treatment of peri-implantitis, surgical 1628–1637
- access flap techniques* 1630, 1636–1637
 - combined regenerative–resective surgery* 1630, 1635, 1683–1688, 1689
 - decontamination 1628–1629
 - indications 1630
 - regenerative surgery 1630, 1638–1646, 1647, 1667
 - resective surgery* 1630–1633
- treatment of periodontitis, surgical 780–831
- defect morphology 781–782
 - historical development 781
 - indications 781–783
- tunnel preparation 1137–1142
- tunnel surgery, combined 715–723
- tunnel surgery, mobilization 166–171
- combinations of tunnel flaps, palatal flaps, and buccal releasing incisions 182–188
 - completely detached palatal peninsula flaps 178–181
 - palatal peninsula flaps 172–177
 - palatal releasing incisions 172–173
- W**
- workflow, digital 591, 1711–1713, 1721
- wound healing, aftercare 144–147
- wound healing, clinical assessment 94–95
- wound healing, influencing factors 96–101
- defect-related* 97, 101
 - patient-related* 96–97, 101
 - technique-related* 97–101
- wound healing, measures 137–147
- postoperative 139–147
 - preoperative 137–140
- wound healing, *oral hygiene* 96–97, 101, 139–144, 147
- wound healing, periodontal 256–260
- wound healing, phases 90–93
- inflammatory 92
 - restorative 92–93
- wound healing, physiology 88–90
- primary* 88–90, 784, 789–791
 - secondary* 88–90, 92–94