PRACTICAL ADVANCED PERIODONTAL SURGERY

Second Edition

Edited by
Serge Dibart, DMD
Professor and Chair
Department of Periodontology
Director Advanced Specialty Program in Periodontics
Boston University Henry M. Goldman School of Dental Medicine
Boston, MA, USA

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Ziedonis (Zie) Skobe, PhD

29 April 1941–5 August 2018

Known as a “gentle giant” who had “a remarkable life and career,” Zie guided and supported hundreds of projects and grants, and countless young scientists, during his 40 plus years career at the former Forsyth Dental Institute.

Always proud of his immigrant background, he arrived in the USA from Latvia as a refugee during World War II, overcoming language barriers while learning English then working in the construction industry as a laborer while studying for his PhD

Throughout his long career, he always had a welcoming smile and encouraging words for the young scientists whom he mentored. His early experience with learning English prepared him to enthusiastically help those for whom English was not a first language. He is remembered by all those whose lives he touched for being a great friend, scientist, and mentor with a kind and generous heart. You will not be forgotten, Zie. Rest In Peace.

Contents

List of Contributors

Nawaf J. Al-Dousari, DDS, MSD
Practice Limited to Prosthodontics
Armed Forces Hospital
Ministry of Defense
Shamiya, Kuwait City, Kuwait

Haneen N. Bokhadoor, DDS, MSD
Practice Limited to Periodontics and Dental Implants
Bneid Al Gar Specialty Dental Center
Ministry of Health
Shamiya, Kuwait City, Kuwait

Rokas Borusevičius, DDS
Division of Periodontology, Institute of Odontology
Faculty of Medicine
Vilnius University, Vilnius, Lithuania

Jean-Pierre Dibart, MD
Rheumatology and Sport Medicine
Marseilles, France

Serge Dibart, DMD
Professor and Chair
Department of Periodontology
Director Advanced Specialty Program in Periodontics
Boston University Henry M. Goldman School of
Dental Medicine
Boston, MA, USA

Thomas Van Dyke, DDS, PhD
Vice President and Senior Member of Staff
Forsyth Institute
Professor of Oral Medicine, Infection and Immunity
Faculty of Medicine, Harvard University
Boston, MA, USA

Agnė Gečiauskaitė, DDS
Division of Prosthodontics, Institute of Odontology,
Faculty of Medicine
Vilnius University, Vilnius, Lithuania

Sadru Kabani, DMD, MS
Co-Director of Oral Pathology
STRATADX
Lexington, MA, USA

Elif Keser, DDS, PhD
Private Practice, London, UK
Adjunct Assistant Professor, Department of
Orthodontics & Dentofacial Orthopedics
Boston University Henry M. Goldman School of
Dental Medicine
Boston, MA, USA

Jess Liu, DDS, MSD
Clinical Assistant Professor
Department of Periodontology
Boston University School of Dental Medicine
Boston, MA, USA

Lorenzo Montesani, DDS
Practice Limited to Prosthodontics and
Implant Dentistry
Rome, Italy

Luigi Montesani, MD, DDS
Practice Limited to Periodontology, Prosthodontics,
and Implant Dentistry
Rome, Italy

Steven Morgano, DMD
Professor and Chair
Department of Restorative Dentistry
Rutgers University School of Dental Medicine
Newark, NJ, USA

Mani Moulazadeh, DMD
Assistant Clinical Professor
Department of Endodontics
Boston University School of Dental Medicine
Boston, MA, USA

Donald Nelson, DMD
Assistant Clinical Professor
Department of Orthodontics
Harvard School of Dental Medicine
Boston, MA, USA

Vikki Noonan, DMD, DMSc
Director and Associate Professor, Division of Oral
Pathology
Boston University Henry M. Goldman School
of Dental Medicine
Boston, MA, USA

Justinas Pletkus, DDS
Division of Prosthodontics, Institute of Odontology
Faculty of Medicine
Vilnius University, Vilnius, Lithuania

Albert Price, DMD, MS
Clinical Professor
Department of Periodontology and Oral Biology
Boston University School of Dental Medicine
Boston, MA, USA

Vygandas Rutkūnas, DDS, PhD
Associate Professor
Division of Prosthodontics, Institute of Odontology
Faculty of Medicine
Vilnius University, Vilnius, Lithuania
ProDentum Clinic, Vilnius, Lithuania

Sherif Said, DDS, MSD
Clinical Assistant Professor
Department of Periodontology
Boston University School of Dental Medicine
Boston, MA, USA

Ulrike Schulze-Späte, DMD, PhD
Diplomate, American Board of Periodontology
Director, Section of Geriodontics
Department of Conservative Dentistry
and Periodontology
Center of Dental Medicine
University Hospital Jena
Jena, Germany

Peyman Shahidi, DDS, MScD
Practice Limited to Periodontology and
Implant Dentistry
Toronto, Ontario, Canada

Ming Fang Su, DMD, MS
Clinical Professor
Department of Periodontology and Oral Biology
Boston University School of Dental Medicine
Boston, MA, USA

Yun Po Zhang, PhD, DDS(hon)
Director
Clinical Dental Research
Colgate-Palmolive Company
Piscataway, NJ, USA

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About the Companion Website

This book is accompanied by a companion website:

www.wiley.com/go/dibart/advanced

The website includes 2 videos from Chapter 4.

Introduction

Thomas Van Dyke

As reflected in this Second Edition, the surgical techniques that span the scope of dentistry have continued to evolve. Predictable implant placement and bone augmentation techniques have become a common part of the repertoire of the periodontist. Importantly, these technical developments and the research on which they are based have impacted other specialties, including orthodontics, endodontics, oral and maxillofacial surgery, and prosthodontics.

In *Practical Advanced Periodontal Surgery, Second Edition,* Dr. Serge Dibart has updated, expanded, and improved on the landmark First Edition with a team of experts who have played a major role in the development of these concepts, in some cases, and their implementation, in all cases. It is arranged into 13 chapters that range from a review of the science leading up to new technologies to their implementation and the evidence backing their veracity. The contribution of periodontal concepts to orthodontics and endodontics is just an example of how modern periodontology adds to the armamentarium of all aspects of the dental profession.

The focus of this book is bone – the biology of bone and how an understanding of the basic principles of biology can be used to enhance treatment. The book begins with a review of bone biology and current understanding of wound healing. The discovery that surgically injured bone becomes rapidly osteopenic followed by increased turnover has been updated to include new clinical techniques for rapid tooth movement through *Piezocision*.

Notably, there are three new chapters in the Second Edition. The topics are vital to modern practice, including IV sedation by Dr. Jess Liu, Digital Technologies in Clinical Restorative Dentistry by Dr. Vygandas Rutkūnas and colleagues, and Extraction Site Management in the Esthetic Zone: Hard and Soft Tissue Reconstruction by Dr. Sherif Said. The final five chapters of the book are devoted to exploring the specialized needs of complex cases. The problems of inadequate vertical bone height and soft tissue defects can now be predictably addressed in most cases. In particular, the esthetic issues of lack of papillary redevelopment between adjacent implants are addressed by established investigators in the field. Distraction osteogenesis and papilla regeneration techniques now provide a means to enhance the esthetics of the most complicated cases.

Periodontal medicine has its roots in oral pathology/oral medicine. The forefathers of periodontics, physicians such as Gottlieb, Orban, and Goldman, were oral pathologists first. No book of advanced periodontal techniques would be complete without a review of the most common oral lesions that face the periodontist and their treatment, along with proper biopsy techniques.

The look to the future has also changed between the First and Second Editions. The future of periodontology is bright; we are provided an exciting glimpse of what is next.

Dr. Dibart has again brought together the subject, the team, and the expertise to produce a most valuable compilation of advanced techniques of modern periodontics. The content is based in science and is well-balanced, providing a reference work and guide for the practitioner of advanced dentistry.

Practical Advanced Periodontal Surgery, Second Edition. Edited by Serge Dibart.

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Chapter 1 Conscious IV Sedation Utilizing Midazolam

Jess Liu

INTRODUCTION

Dental fear and anxiety are the common reasons why patients avoid seeking proper dental care. A survey conducted in the US has reported up to 30.5% of both US adults and adolescents experience a moderate to high dental fear (Gatchel 1989). Therefore, it is important for dentists to understand the management of dental fear and anxiety as an integral component of the overall treatment.

As defined by the American Society of Anesthesiologists (see Table 1.1), the continuums of depth of sedation are:

- Minimal Sedation: Normal response to verbal stimulation.
- Moderate Sedation: Purposeful response to verbal or tactile stimulation.
- Deep Sedation: Purposeful response following repeated or painful stimulation.
- General Anesthesia: Unarousable even with painful stimulus.

According to the American Society of Anesthesiologists moderate sedation is also known as "Conscious Sedation," and by definition, conscious sedation is "a drug-induced depression of consciousness during which patients respond purposefully to verbal commands, either alone or accompanied by light tactile stimulation. No interventions are required to maintain a patent airway, and spontaneous ventilation is adequate. Cardiovascular function is usually maintained."

Conscious sedation can be achieved by different routes of administration such as enteral or parenteral administration. For the purpose of this chapter, parenteral administration of conscious sedation limited to intravenous administration of Midazolam (Versed) will be reviewed.

Training in Intravenous Conscious Sedation

While IV conscious sedation is relatively safe to practice, only a qualified and well-trained healthcare provider who is able to manage emergency complications should perform the practice. Dentists who practice IV conscious sedation are mandated by all states to be certified by an approved continuing education program. Furthermore, each state is governed by its own rules and regulations for the administration of conscious sedation, therefore it is important to verify with the individual state dental board for the proper requirements to obtain a permit to practice IV conscious sedation.

MIDAZOLAM (VERSED)

Midazolam is a water soluble, short acting benzodiazepine central nervous system (CNS) depressant. Pharmacologically, it produces anxiolytic, hypnotic, anterograde amnestic, muscle relaxation, and anticonvulsant effects (Reves et al. 1985). Metabolized in the liver by cytochrome P450 enzymes, its mechanism of action is through binding of the $GABA_A$ receptors, (causing an influx of chloride ion which causes hyperpolarization of the neuron's membrane potential) creating a neural inhibition effect.

The onset of intravenous administration of midazolam is relatively fast with a short acting duration. Intravenous administration of 5 mg of midazolam in healthy adults has shown to take effect one to two minutes after administration and has a half-life of approximately one to three hours (Smith et al. 1981).

It is important to understand that the use of midazolam is to produce conscious sedative effects and does not replace the need for proper local anesthesia. Therefore proper anesthetic should be administered prior to the starting of the dental procedure.

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Table 1.1 Continuum of sedation: definition and levels (2004).

Continuum of depth of sedation: definition of general anesthesia and levels of sedation/analgesia				
	Minimal sedation (Anxiolysis)	**Moderate sedation/analgesia (Conscious sedation)**	**Deep sedation/Analgesia**	**General anesthesia**
Responsiveness	Normal response to verbal stimulation	Purposeful[a] response to verbal stimulation	Purposeful[a] response following repeated or painful stimulation	Unarousable even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous Ventilation	Unaffected	Adequate	May be inadequate	Frequently inadequate
Cardiovascular Function	Unaffected	Usually maintained	Usually maintained	May be impaired

[a] Reflex withdrawal from a painful stimulus is NOT considered a purposeful response.

ARMAMENTARIUM

Monitoring equipment for:

- Non-invasive Blood Pressure (NIBP)
- Electrocardiogram (EKG)
- Pulse Oximetry
- Capnography

IV Supplies:

- 0.9% Sodium Chloride Injection 250 ml bag
- Primary IV set (100″)
- 22 Gauge × 1″ Introcan Safety® IV Catheter
- 24 Gauge × ¾″ Introcan Safety IV Catheter

Basic Supplies:

- 1 ml Insulin Syringe
- Blunt Plastic Cannula
- Nasal Cannula
- Supplemental Oxygen
- 1″ Latex free Tourniquet
- 3M Tegaderm Film Transparent Film Dressing
- 3M Transpore Tape
- Gauze
- Band-Aids
- Alcohol Wipes

Basic Medications:

- Midazolam 5 mg/1 cc
- Flumazenil 5 cc
- ACLS Emergency Medical Kit (HealthFirst)

Please see Figure 1.1.

STEPS IN IV SEDATION

Patient pre-op evaluation: As with all dental procedures, a thorough review of the patient's medical history is essential to ensure safe and successful treatment. Review of the patient's medical history with complete review of the system, current medications, as well as drug allergies will provide you the necessary information to assess the patient utilizing the ASA Physical Status Classification System (see Table 1.2). The authors recommend limiting the administration of conscious sedation with patients with ASA Physical status of 2 or less to reduce the chance of medical emergencies.

Contraindication:

- Hypersensitivity
- Acute narrow-angle glaucoma
- Hypotension
- Pregnancy
- Renal disease
- Critically ill patients

Pre-op instructions

- No food or drinks eight hours prior to procedure.
- Please wear comfortable loose-fitting clothing with short sleeves to allow for monitoring of your blood pressure.
- Must be accompanied by a person of legal age to escort you home.
- No sedatives for 24 hours before appointment.

Day of Procedure:

- Seat the patient
- Review medical history. *If patient has medical history of asthma instruct patient to take two puffs of asthma inhaler prior to starting of procedure.*

Figure 1.1 Armamentarium needed to provide sedation: monitor, drug, IV sedation set.

Table 1.2 ASA physical status classification (American Society of Anesthesiologists 2015).

ASA physical status classification system	
ASA Physical Status 1	A normal healthy patient
ASA Physical Status 2	A patient with mild systemic disease
ASA Physical Status 3	A patient with severe systemic disease
ASA Physical Status 4	A patient with severe systemic disease that is a constant threat to life
ASA Physical Status 5	A moribund patient who is not expected to survive without the operation
ASA Physical Status 6	A declared brain-dead patient whose organs are being removed for donor purposes

Figure 1.2 Pulse oximetry, oxygen cannula, blood pressure cuff.

- Attach patient monitors (See Figure 1.2) for:
  - Blood pressure
  - Electrocardiography (EKG)
  - Pulse oximetry (Oxygen saturation)
  - Capnography (CO2 partial pressure) Give earliest warning of respiratory distress
- Record pre-operatory vital signs: Blood pressure, pulse, respiratory rate, oxygen saturation, end tidal CO_2 level. If vital signs not within normal range re-evaluate patient for the procedure.

Pre-operative vital signs chart

Diagnosis	Systolic (mm Hg)	Diastolic (mm Hg)
Normal	Less than 120 and	Less than 80
Prehypertension	120–139 or	80–89
Hypertension Stage 1	140–159 or	90–99
Hypertension Stage 2	160 or higher or	100 or higher

	Average range
Pulse Rate	Adult 60–80 beats/min
Respiratory Rate	12–20 breaths/min
Oxygen Saturation	95–100%
End tidal CO_2	35–45 mm Hg

- Starting of IV:
  - Complete assemble of Primary IV infusion set with 0.9% Sodium Chloride Injection bag See Figure 1.3.
  - Exam and select visible superficial vein for venepuncture: Location: Dorsum of hand/wrist, Ventral Forearm, or Antecubital Fossa.
    - Contraindication for venepuncture site are:
      - Mastectomy
      - Cannulas
      - Scarring
      - Vein with valves or bifurcations

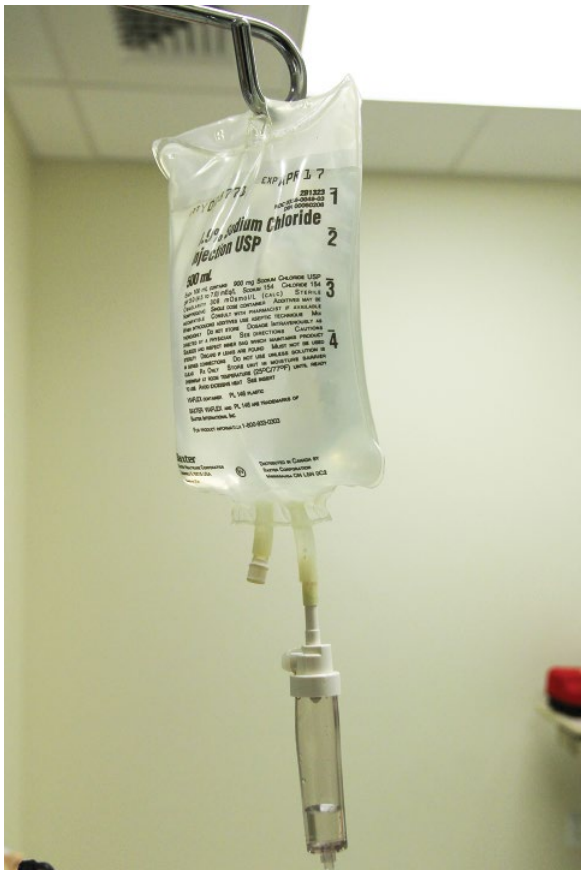

Figure 1.3 Saline bag used for IV sedation.

- Methods of venous distension to facilitate venepuncture.
  - Application of tourniquet 3–4 in. above collection area with appropriate compression
  - Opening and closing of hand
  - Hanging of the arm below heart
  - Light slapping or rubbing of the area with alcohol wipe
- Select appropriate Introcan Safety I.V. Catheter *(22/24 gauge is recommended)*. See Figures 1.4 and 1.5.
- Disinfect selected area of venepuncture with 70% isopropyl alcohol wipe
- Insertion of needle and observe for blood return in the flashback chamber
  - *Caution: At no time should venepuncture be performed on an artery*
- Remove tourniquet
- Attach infusion set to catheter adaptor
- Start IV drip, constant drip should be observed. See Figure 1.6.

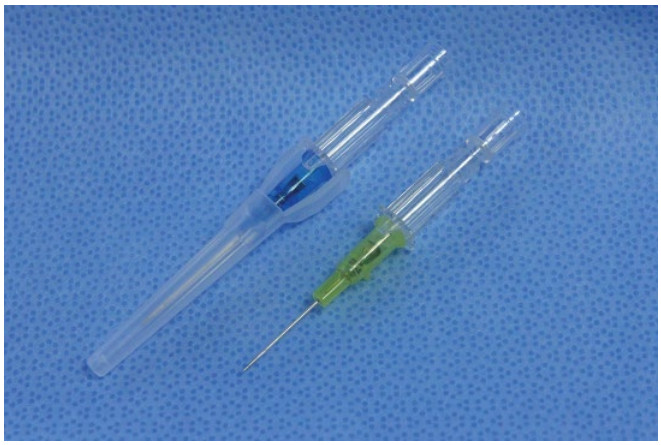

Figure 1.4 IV catheters of various size.

  - *Caution: Initially exam the area of venepuncture after starting IV drip for swelling to ensure proper venepuncture has been performed*
- Stabilize the catheter with 3M Tegaderm Film Transparent Film Dressing and 3M Transpore Tape. See Figure 1.7.

- **Dosage and Administration**
  - Use the 1 ml Insulin Syringe U-100 to draw up 1 ml of 5 mg/ml midazolam. See Figure 1.8.
  - Dosage and administration indicated for the intravenous administration of midazolam as provided by pharmaceutical company Hospira Inc. is as follows:
    - **Healthy Adults Below the Age of 60:** Titrate slowly to the desired effect (e.g. the initiation of slurred speech). Some patients may respond to as little as 1 mg. No more than 2.5 mg should be given over a period of at least two minutes. Wait an additional two or more minutes to fully evaluate the sedative effect. If further titration is necessary, continue to titrate, using small increments, to the appropriate level of sedation. Wait an additional two or more minutes after each increment to fully evaluate the sedative effect. A total dose greater than 5 mg is not usually necessary to reach the desired endpoint.
    - **Patients Age 60 or Older, and Debilitated or Chronically Ill Patients:** Because the danger of hypoventilation, airway obstruction, or apnea is greater in elderly patients and those with chronic disease states or decreased pulmonary reserve, and because the peak effect may take longer in these patients, increments should be smaller and the rate of injection slower. Titrate slowly to the desired effect (e.g. the initiation of slurred speech). Some patients may respond to as little as 1 mg. No more than 1.5 mg should be given over a period of no less than two minutes. Wait an additional two or

Figure 4.17 Forty two year old female patient intra oral view (notice the discoloration and white spots on the teeth).

Figure 4.18 Occlusal view of maxilla showing mild crowding.

Figure 4.19 Occlusal view of mandible showing mild crowding.

would not wear "braces." An alternative treatment was offered using clear aligners and the issue of time spent in orthodontics was addressed by suggesting Piezocision assisted orthodontics. Piezocision has been shown to cut orthodontic treatment time by approximately half (Charavet et al. 2016; Dibart et al. 2014; Keser and Dibart 2011). Once the teeth were put in an optimal position after short orthodontics, the stage was set for the restorative team to address the problem of teeth discoloration and white spots via prepless/minimally invasive Porcelain Laminate Veneers (PVL). After resolving the crowding, the amount of anterior teeth retraction was limited to 0.5mm which is approximately the thickness of the PLVs. By doing so, enough space was created to finish the case with minimal preps and without changing the lip support. After a week into wearing the first aligner, Piezocision was done (Figure 4.20). The patient wore the aligner immediately after the procedure and was asked to change her aligners every five days (this was at the time of the old Invisalign protocol when the recommended usage time was changing every two weeks, nowadays with the new Invisalign protocols one can change the aligners even sooner post Piezocision). At the end of her orthodontic treatment crowding was resolved and the anterior teeth had been "over retracted" by 0.5mm to accommodate the thickness of the restorative material (Figures 4.21–4.23).

Figure 4.20 The patient wears the aligners after the Piezocision procedure.

Figure 4.21 At the end of the orthodontic treatment. Treatment time was cut by approximately half after Piezocision.

Figure 5.1 Persistent inflammation associated with the mesial root of a mandibular molar with a separated instrument.

Figure 5.2 Surgery reveals a hand file extending 3–4 mm beyond the root tip.

Relentless Inflammation

Previously missed and untreated canals, bifurcations, fins, and extraradicular infections often harbor bacteria and present themselves as chronically and intermittently symptomatic teeth. Apical surgery can be performed to eradicate such factors (Figures 5.4–5.6).

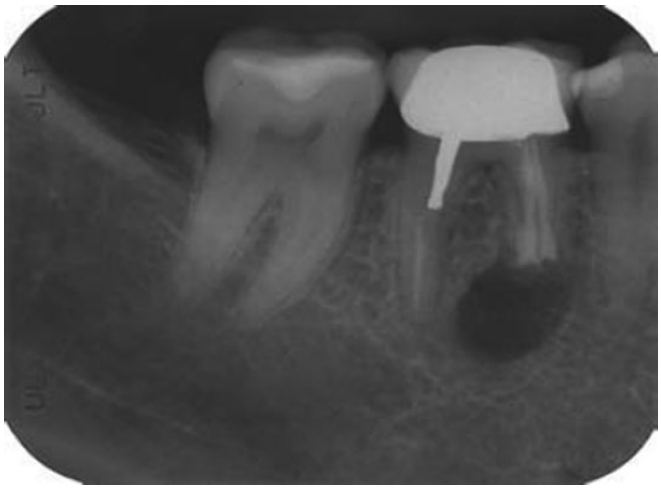

Figure 5.3 Instrument recovery, root resection, and retrograde obturation with MTA.

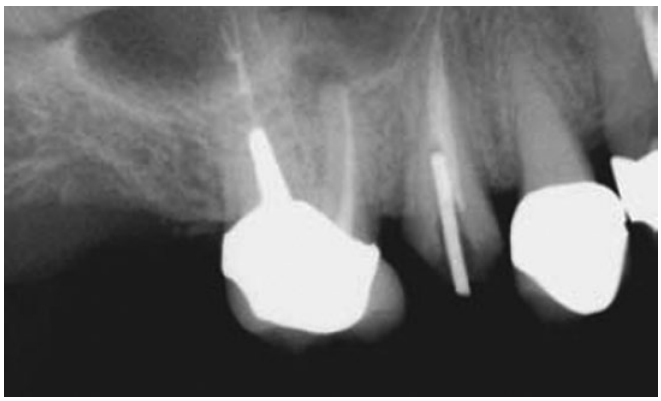

Figure 5.4 Persistent inflammation and symptoms associated with the mesial root of a maxillary molar due to the missed MB-2 canal.

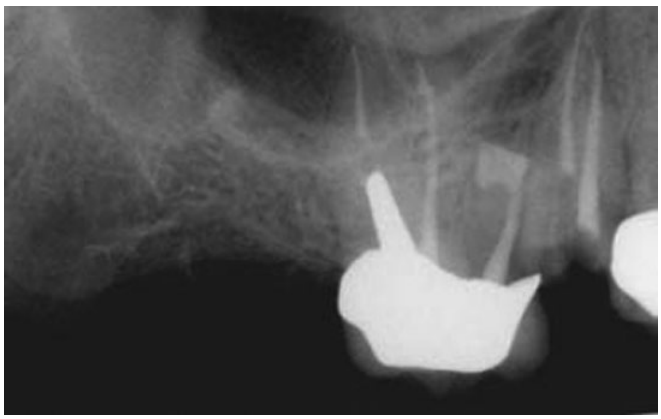

Figure 5.5 Apicoectomy performed in conjunction with finding and obturation of the additional canal and the isthmus between MB-1 and MB-2 canals.

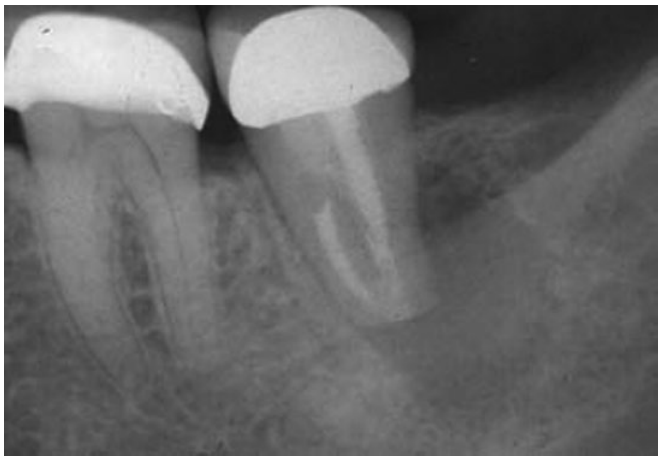

Figure 5.20 Radiograph immediately post reimplantation.

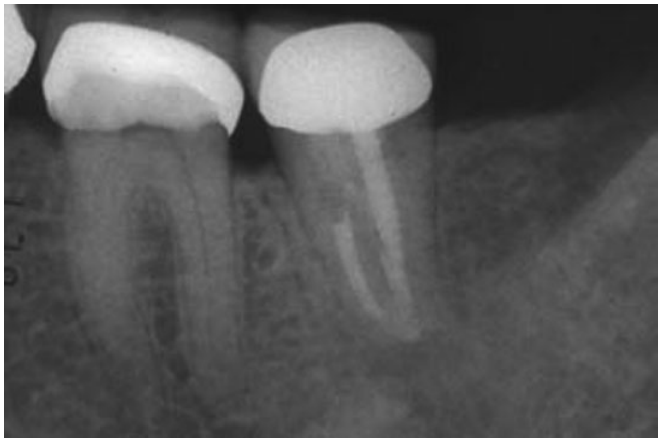

Figure 5.21 Two-year recall exhibits complete healing.

remainder of the day and to chew away from the side for about one week. Postoperative instructions are given, and the patient should be reappointed for follow-up visit in one week, at which time the sutures are removed if still intact. Pain management instructions are given as described earlier. Once regarded as a last resort before extraction, today intentional replantation in selected cases is a viable and logical mode of treatment. With the development of new protocols for intentional replantation, the procedure has become more predictable and should always be considered as a part of possible treatment planning (Figure 5.21).

PERIRADICULAR SURGERY

Periradicular surgeries, otherwise known as apicoectomy, constitute the bulk of endodontic surgeries. By definition, *apicoectomy* involves the reflection of a soft tissue flap, osteotomy of both cortical and cancellous bone, and resection of the root segment, which is suspected to be associated with a persistent inflammatory process. The preparation of a retrocavity and placement of a root-end filling material are not necessary requirements for an apicoectomy, although they are highly recommended. Apicoectomy is perceived to be technically more difficult than other endodontic surgeries due to difficulties in its accessibility, illumination, and small operating field. This is especially true with the case of posterior teeth, that the access more than the anatomy renders them more difficult to treat (Wang et al. 2004). However, since the addition of the SOM to our armamentarium, we have been able to overcome many of the challenges associated with apicoectomy.

Indications

Apicoectomy is indicated for treatment of teeth with persistent apical or periradicular pathosis due to anatomical challenges, iatrogenic factors, irretrievable dental material inside and outside of the canal, fractures, and repair of resorptions or perforations (Figures 5.22–5.25).

Figure 5.22 Sinus tract tracing and the location of the mid-root radiolucency is suggestive of a post perforation.

Figure 5.23 Upon the reflection of the soft tissue flap, an isolated endodontic fenestration is visible.

Figure 6.13 Microsurgical crown-lengthening procedure for the facial surfaces of Nos. 8 and 9 to correct gingival line discrepancy. (a) Preoperative view. (b) Vertical incisions at the line angles of Nos. 8 and 9 by using a microsurgical blade. (c) Full-thickness flap elevated. (d) Ostectomy completed. (e) Flaps sutured with 7-0 Vicryl sutures. (f) One week after surgery. (g) Two weeks after surgery.

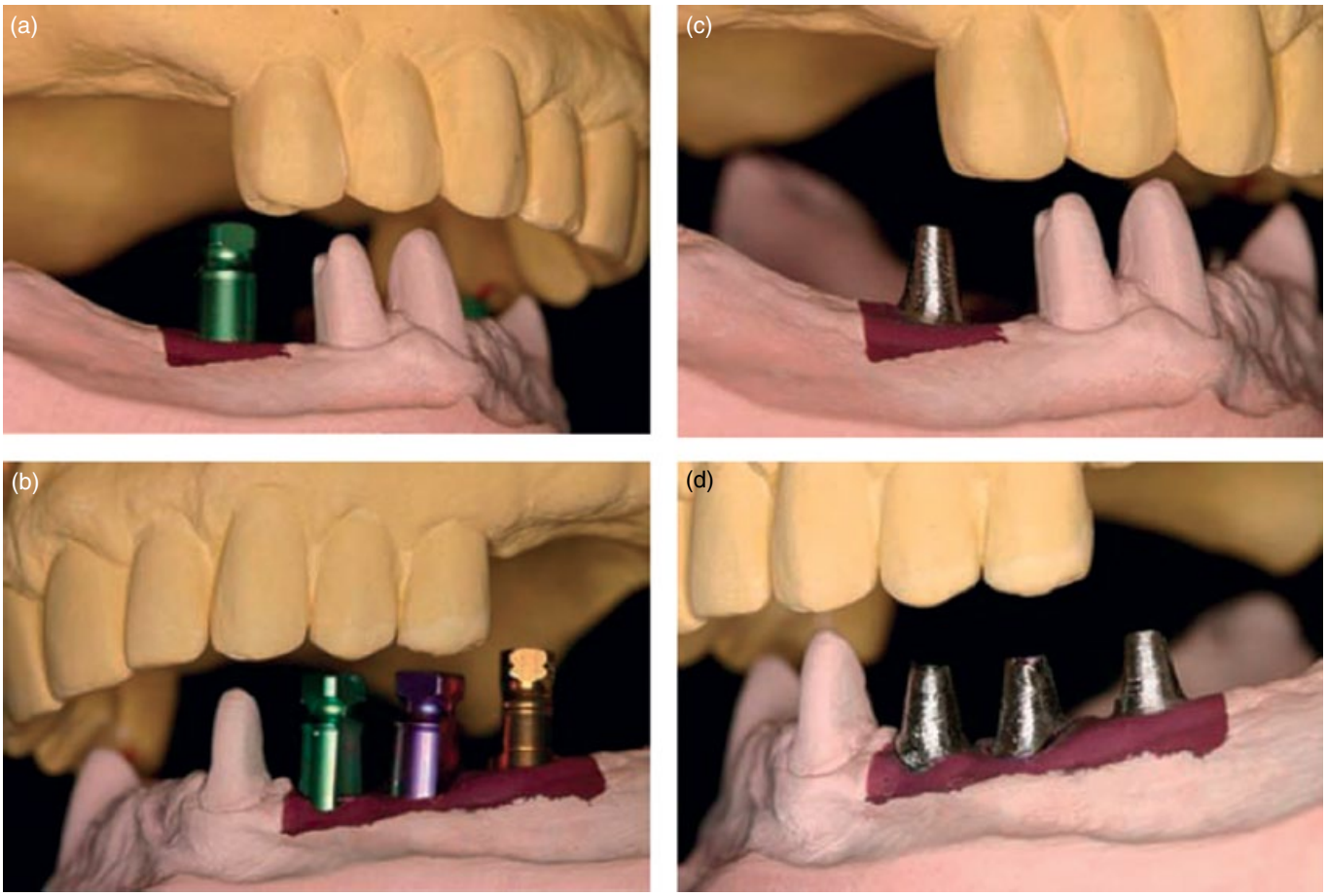

Figure 6.34 Surgical mounts (a and b) of the dental implants were prepared to be used as temporary abutments (c and d).

- Generalized redness, edema, and glazing of the gingiva, especially in the maxillary anterior sextant
- Missing, Nos. 1, 3, 5, 9, 13, 14, 17, 18, 19, 28, 30, and 32
- Multiple defective restorations, Nos. 2-x-4-x-6, Nos. 7-8-x-10, and Nos. x-29-x-31
- Endodontic therapy, Nos. 4, 7, 11, 29, and 31
- Periapical radiolucency, No. 29
- Inadequate endodontic therapy, No. 31
- Occlusal silver amalgam restoration, No. 16 with mesial and distobuccal carious lesions
- Mesial drift, Nos. 15 and 16
- Defective restorations, dental caries, and inadequate endodontic therapy, Nos. 20 and 21
- Distal carious lesions, Nos. 22 and 27
- Probing depths within the normal range (2–3 mm), except for teeth Nos. 4, 6, 10, 11, and 15, where probing depths ranged between 4 and 5 mm (Figure 6.49)
- Generalized bleeding upon probing
- No hypermobility or furcation invasions (Figure 6.49)
- Multiple defective FPDs
- Multiple teeth with inadequate endodontic therapy
- Localized bone loss (10–15%), distal surface of No. 15 and the mesial surface of No. 10 (Figure 6.48)

Impressions were made with alginate (Jeltrate). Her diagnostic casts were mounted in centric relation in a semi-adjustable articulator with a face-bow record (Figure 6.50).

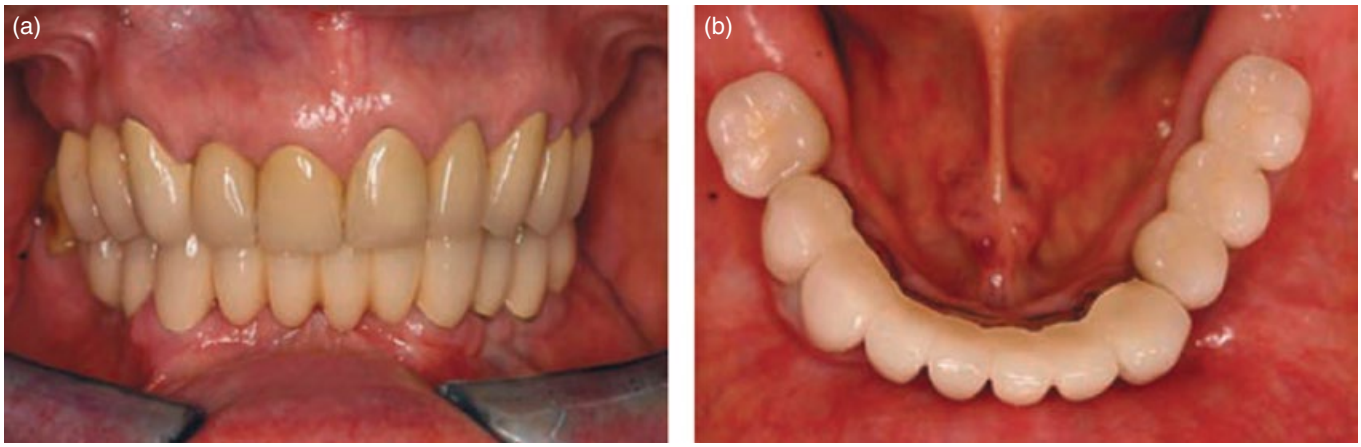

Figure 6.43 Clinical try-in (a) and final delivery (b).

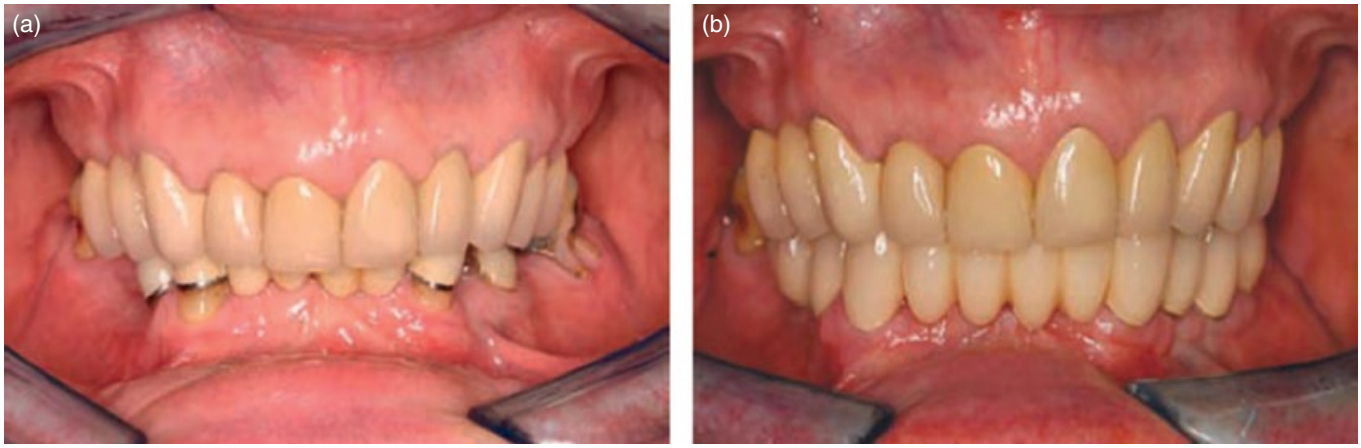

Figure 6.44 Intraoral view before (a) and after (b) treatment.

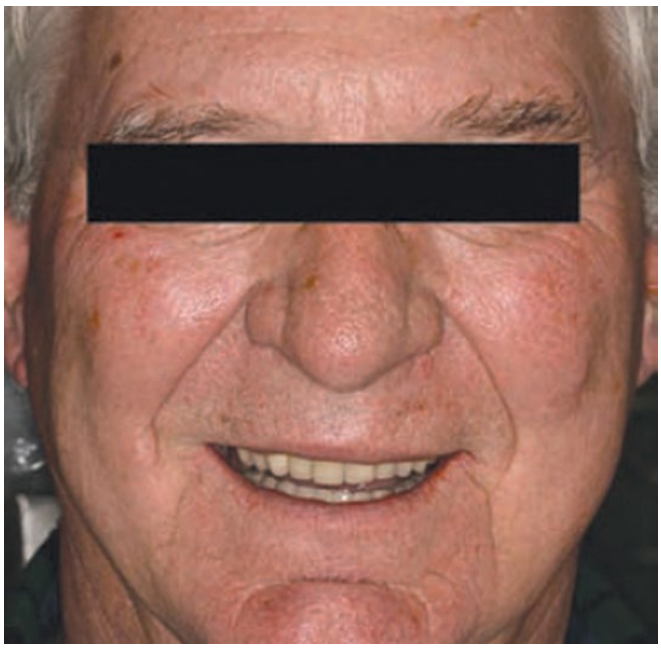

Figure 6.45 Patient's smile after treatment.

Figure 6.46 Full-face frontal view of patient.

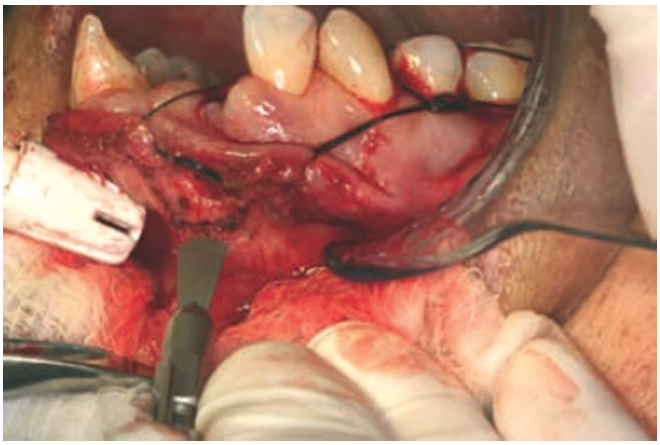

Figure 7.11 Using the oscillating microsaw (KLS Martin, Jacksonville, FL, USA), the osteotomy is started.

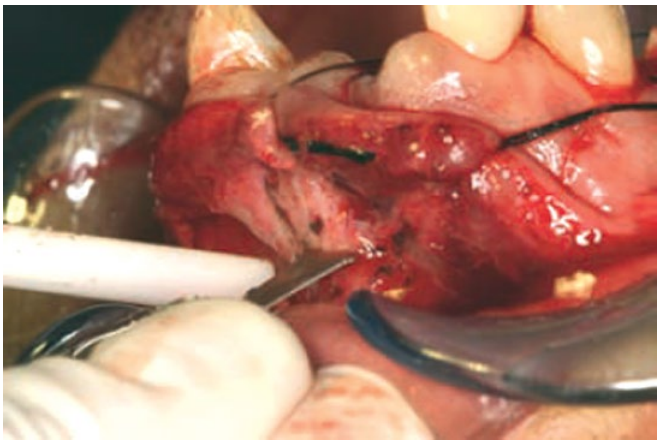

Figure 7.12 It is important to get as close as possible to the palatal/lingual cortical plate but not go through it with the sagittal microsaw, so as not to injure the palatal/lingual periosteum.

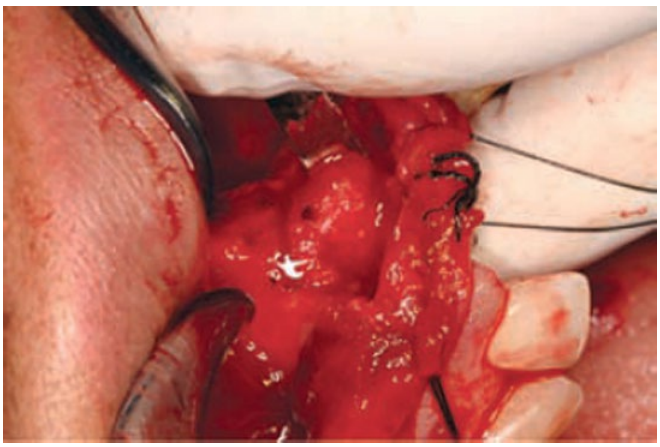

Figure 7.13 A fine osseous chisel (or modified spatula) is used very carefully with a mallet in order to detach the segment to be distracted. Notice the finger on the palate; it is used to counteract and control the force of the blow.

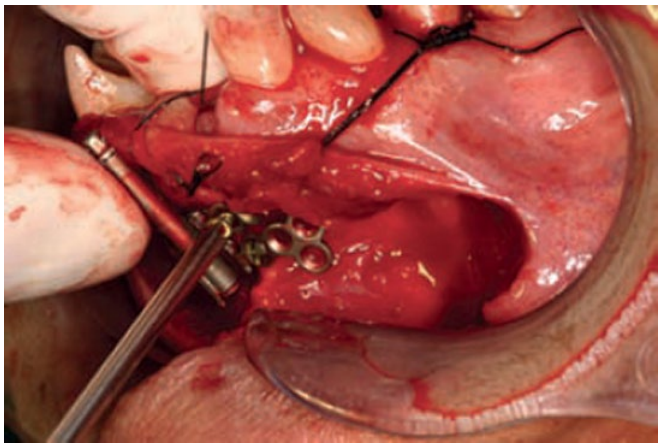

Figure 7.14 The distractor is repositioned very accurately due to the previously drilled holes and secured with the screws.

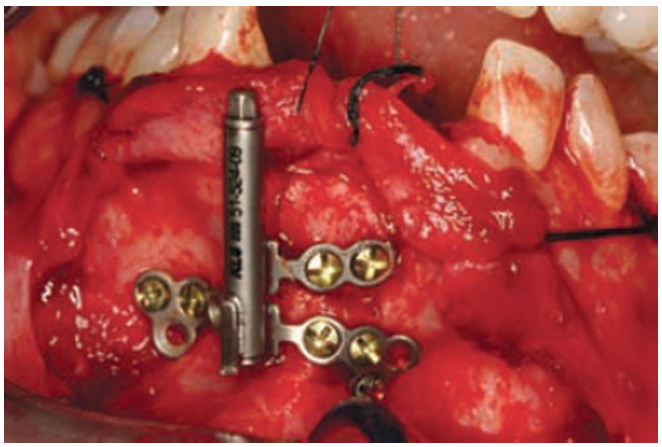

Figure 7.15 The distractor is securely in place.

recommended to secure the distractor (two screws for the upper segment and three screws for the lower segment).

These screws are self-drilling, but it is better to use the drill and predrill; this way, you will avoid running the risk of splitting the bony segment to be distracted. It is customary to use the 5-mm-length screws (Figure 7.15).

Once the distractor is securely in place, it is useful to activate it and see how the bony segment glides upward (Figure 7.16). This is critical because if there is an impediment to the smooth trajectory of the segment to be distracted, it should be corrected at this point. This is usually the case when the mesial and distal cuts are somewhat parallel to each other instead of being divergent. This can be corrected using a fine fissure bur. The distractor is put back in its inactive mode, and a small opening is made in the gingiva ("button hole") to allow for the passage of the distractor's arm (Figure 7.17). The suturing is done in two layers, using chromic gut sutures (Figures 7.18 and 7.19).

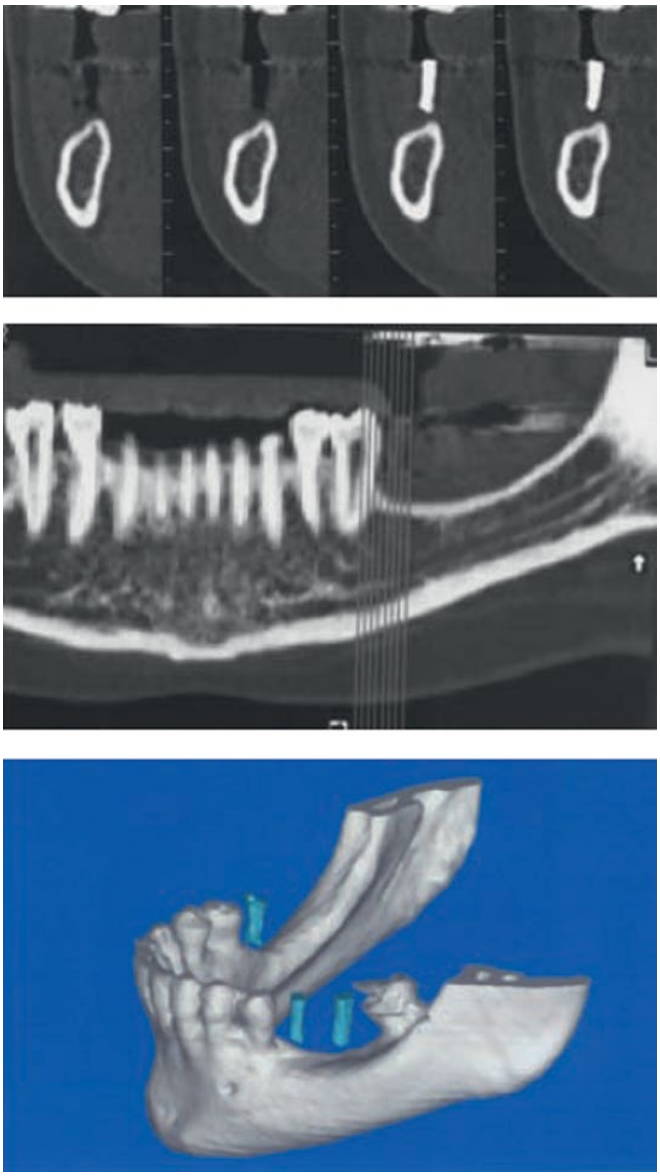

Figure 7.31 The segment to be distracted is drawn on the model and will be replicated in the mouth precisely during the surgery. The distractor arms are modified and bent prior to the surgery to fit the clinical situation. This will save a lot of time and aggravation during the surgery.

A Few Words of Caution

- Pay special attention to the direction of the vector in the lower anterior mandibular region (Figures 7.32 and 7.33).
- Make sure that the distractor does not interfere with the occlusion.
- Select patients who are reliable and compliant.
- Always "overdistract" by a couple of millimeters to ensure you will have enough bone.

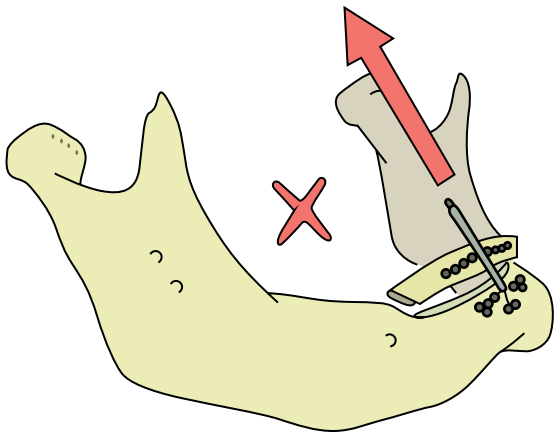

Figure 7.32 The *arrow* shows an incorrect vector of distraction. The bony segment will be too lingual and therefore could not be used for proper dental implant placement.

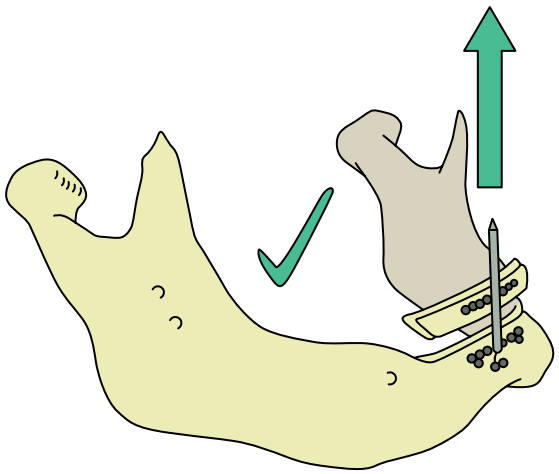

Figure 7.33 The *arrow* shows a correct vector of distraction. The bony segment will be distracted parallel with the long axis of the adjacent teeth. Dental implants can be placed in the proper alignment.

Preoperative Instructions

- Antibiotherapy (i.e. amoxicillin 500 mg three times a day starting the day of surgery and for seven days) is indicated.
- Mild oral sedation could be useful (i.e. diazepam 5 mg the night before and 5 mg one hour before the procedure).
- Analgesics are recommended (i.e. ibuprofen 600 mg one hour before the surgery).

Postoperative Instructions

- Corticosteroids for five days: dexamethasone 0.75 mg, five tablets the day of surgery, then four tablets the

Figure 8.4 The abutment and provisional restorations for Nos. 4 and 5 in place. Notice how the gingiva has been folded and maintained via the temporary restorations.

width of its crown. This is essential in gaining an adequate buccolingual/palatal papilla or col. width to cover the interproximal space.

4. Flaps are elevated by using the tip of the blade and the tip of an Orban knife. First, the soft tissues are reflected from the underlying implant; then each mini-flap is undermined by the No. 15 blade and the Orban knife, and the full- or partial-thickness mini-flap is extended to about 1 mm from the adjacent implant or tooth.

Flaps are mobilized and pushed in the mesial and distal directions to open a "window" and place the healing abutment. The application of gauze in the area for a few minutes facilitates the molding of the tissues while pushing the tissues to the sides. After removing the cover screw, a healing abutment with proper height, width, and shape is inserted into the implant with or without a provisional restoration. This shapes the future papilla by pushing the tissues to the sides and holding them upright (Figures 8.4 and 8.5). The same technique is repeated for implant(s) distal to the first implant. No sutures are applied, because healing abutments hold the tissues in the proper position.

The patient then receives postoperative instructions and is scheduled for a follow-up visit within 7–10 days.

POSTOPERATIVE INSTRUCTIONS

The patient is advised to rinse with chlorhexidine gluconate (PerioGard oral rinse; Colgate Palmolive) twice daily for one week and take ibuprofen (Advil) 200 mg in case of discomfort. Postsurgical care after the first week of healing

Figure 8.5 The palatal view. The U- and H-shaped flaps have been folded, creating papillae.

Figure 8.6 Two weeks postoperatively. The area has healed uneventfully.

involves regular brushing with a soft bristle toothbrush (Colgate 360-degree toothbrush) and rinsing for another week with chlorhexidine gluconate.

SURGICAL INDEXING

This should be considered to increase predictability and esthetic outcome.

POSSIBLE COMPLICATIONS

- Complications are very unusual due to the minimally invasive nature of the procedure.
- Infection is always a possibility and should be treated with local antibiotherapy and antiseptic mouth rinses.

HEALING

The results are very stable 1.5 years postsurgery (Figures 8.6–8.9).

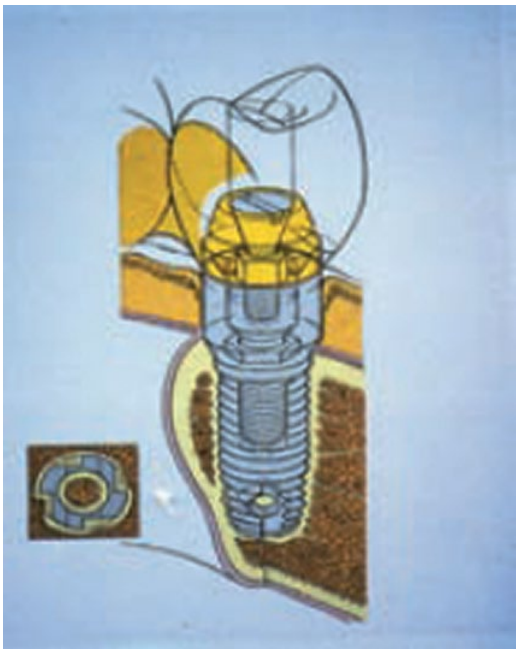

Figure 9.1 Image of a Branemark implant depicting design and surface structure. Source: Reprinted with permission from Branemark et al. (1985). *Tissue-Integrated Prostheses*. Quintessence, Chicago.

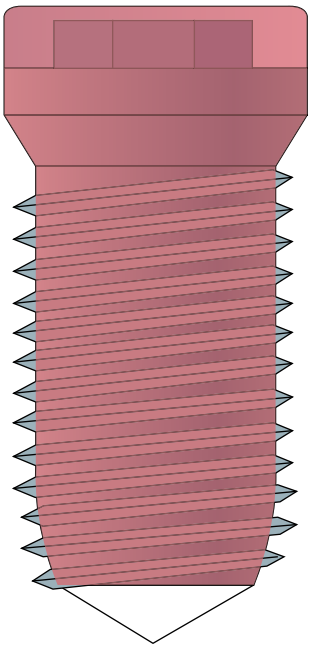

Figure 9.3 Implant fitted into the osteotomy site (cylindrical shape) Threads were pre-tapped or formed by self-tapping implant design upon insertion of implant.

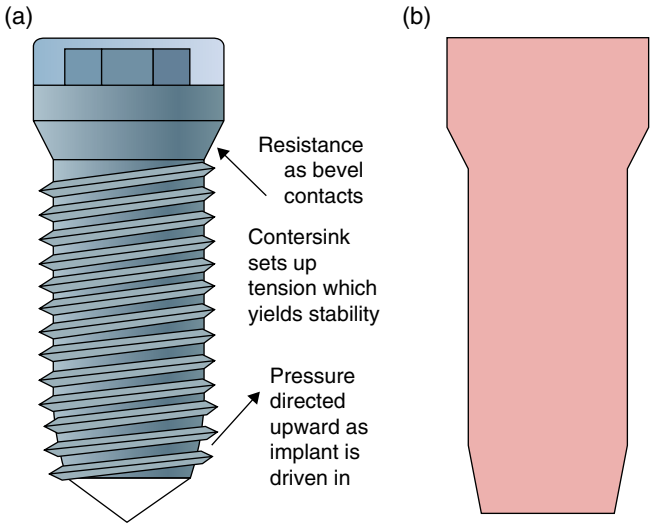

Figure 9.2 (a) Branemark's prototype implant geometry. (b) Osteotomy outline created by cylinder and countersink burs representing the flared neck and body shape plus allowance for the cover screw without thread tapping. This protocol resulted in the cover screw flush with existing bone surface.

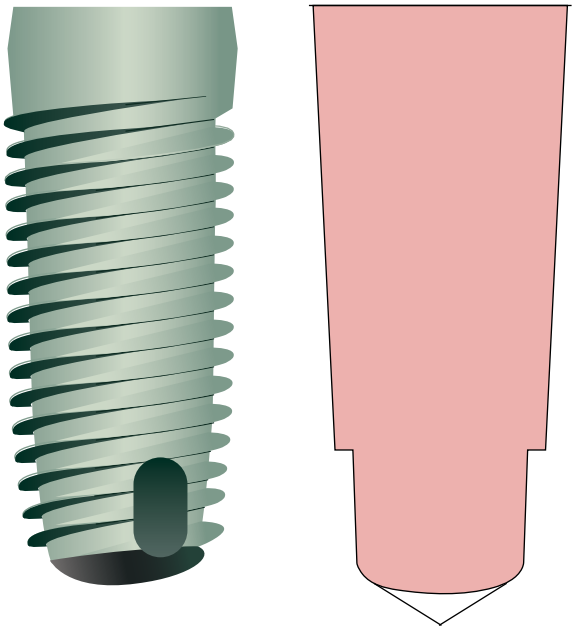

Figure 9.4 Tapered implant and outline of osteotomy site without thread tapping.

The current basic geometries include the cylinder with screw threads (Branemark's design), the tapered cylinder with threads (e.g. Zimmer [Figures 9.4 and 9.5]), and the plate form without threads, (e.g. Bicon [Figure 9.6] and Endopore). The microarchitecture of the bone influences the choice and effectiveness of these forms to gain the necessary stability at time of placement. (See bone microarchitecture in Figures 3.2, 3.4, 3.5, Chapter 3.)

Branemark stressed bicortical stabilization as essential to secure his implant system. The mechanical shape of his design created stability by the resistance of the countersink flare to the draw or pull of the threads into the bony preparation (Figure 9.2a and b); this requires heavy compact bone at each end of the osteotomy (the type of bone profile usually found in his test cases of severe

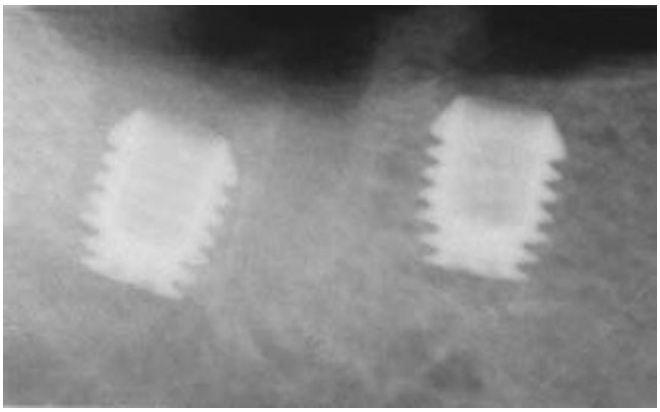

Figure 9.25 Short implants (Bicon, Boston, MA, USA) were placed to overcome vertical limitation.

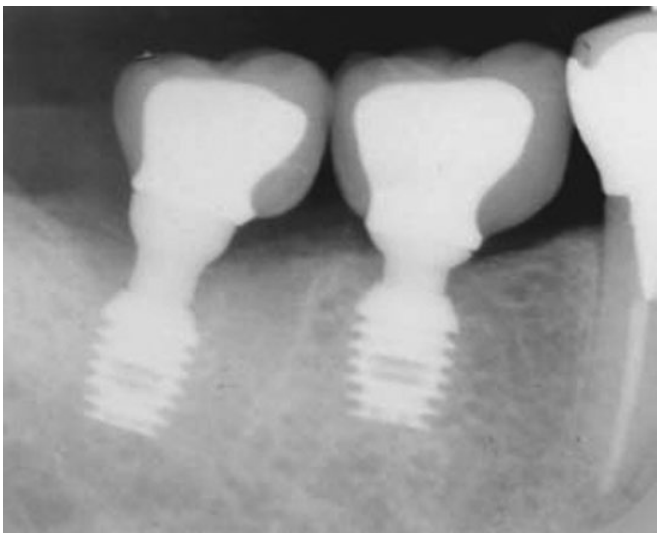

Figure 9.26 Periapical radiograph showing implants restored.

Figure 9.27 Clinical picture of restored short implants.

Figure 9.28 Short implants were used to overcome the anatomical limitations of sinus proximity (avoiding extensive sinus grafting).

Figure 9.29 Clinical picture of final implant-supported restoration.

around adjacent implants would overlap and drop interproximal bone and then the soft tissue above leaving the "black triangle." Other implant geometries may not present this problem. In addition, if one is dealing with narrow buccal–lingual but heavy compact bone such as found in the lower anterior, then placing implants too close endangers the endosseous vascular supply between them and there is the risk of bone necrosis between and loss of both implants and bone. (Branemark isolated this by trial and error – suggesting 7.0 mm on center to allow 3 mm of bone between the standard 4.1 mm implant head.)

Implants can be placed closer to teeth because they have an increased vascular net in their periodontal ligamnet (PDL), which is connected through numerous spaces to the adjacent marrow.

Figure 11.8 The material is placed in the centrifuge and the plasma is separated.

Figure 11.9 The stem cell-rich material is mixed with the xenograft (Bio-Oss).

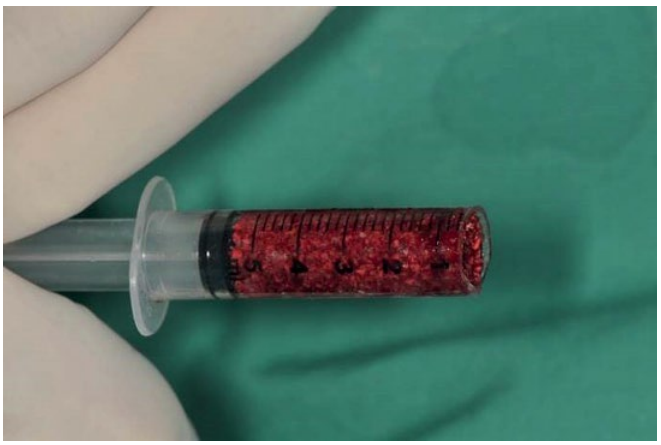

Figure 11.10 The graft mixture is loaded into the syringe.

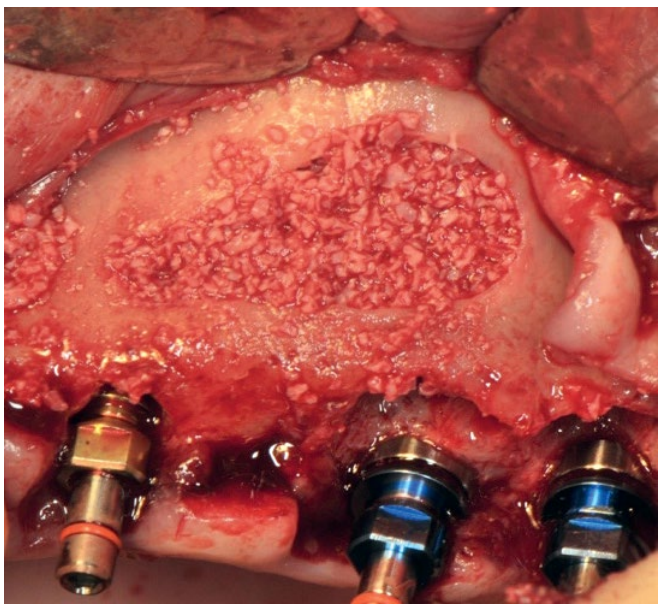

Figure 11.11 The bone graft is delivered into the sinus with simultaneous implant placement.

infection, prescription of antibiotics such as clindamycin with a loading dose of 600 mg followed by 300 mg four times daily is recommended. Metronidazole can be added for anaerobic coverage at 500 mg three times daily. Most of the time, a localized infection will respond to the treatment. However, in case of persistent symptomatology it is imperative to pursue aggressive treatment, which includes incision and drainage over the original incision line. In addition,

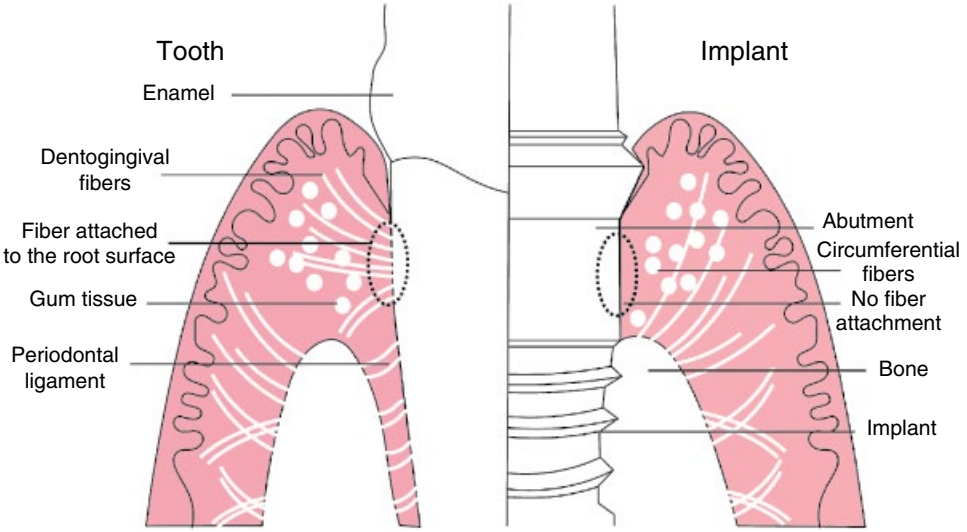

Figure 12.9 Schematic illustrating the differences between the peri-implant and periodontal attachment. Note the perpendicular orientation of the periodontal attachment which creates a protective barrier from physical and bacterial insults in addition to support of the supra-crestal tissue. The difference in fibers orientation histologically contributes to the difference in macroanatomy of the peri-implant papilla and gingiva.

but by the presence of the supra-crestal periodontal fibers on the adjacent teeth. It has been further shown in recent literature that the papillary height in sites of multiple adjacent missing teeth is significantly less than when the tooth is present. Therefore, the periodontal integrity and height of bone on the adjacent teeth become a key determinant in the final esthetics of the implant supported restoration. In the presence of periodontal pathology, or interproximal attachment loss on the adjacent teeth, interdisciplinary techniques such as orthodontic extrusion or changes to the tooth shape by restorative means may then be required to compensate for deficiencies in the interproximal papillary area (Figure 12.9).

Consequently, a comprehensive periodontal evaluation, radiographic analysis, and bone sounding are essential diagnostic factors prior to tooth extraction in order to anticipate the final outcome and diagnose any deficiencies that may be present. Furthermore, the clinician must be cognizant of any mesio-distal tooth mal-positioning and/or root proximity that may render the interdental bone more susceptible to resorption. The choice of flap reflection and design may also be modified in an attempt to avoid stripping of the periosteum and blood supply overlying thin (<1.5 mm) or compromised inter-radicular bone.

Integrity of the Buccal Plate of Bone

Conebeam CT scan, clinical periodontal evaluation, and bone sounding are combined to ascertain the integrity and level of the buccal plate prior to extraction (Figure 12.10). Compromise in the buccal plate integrity can ultimately yield to collapse of the tissue in the bucco-lingual aspect yielding to an unesthetic implant supported restoration and facial tissue recession exposing the underlying restorative components. If the level of the gingival margin in relation to the adjacent teeth and in relation to the final implant supported restoration is located apically to the contralateral tooth, it may be prudent for the clinician to consider soft tissue grafting either before tooth extraction or at any time point prior to finalization of the prosthetic procedures to compensate for these discrepancies (Figure 12.11).

Root Angulation/Inclination and its Relationship to the Apical Bone Topography

Kan (Kan et al. 2011) classified sagittal tooth positions on CT scans to evaluate the viability of immediate implant placement in fresh extraction sockets based on different tooth inclination patterns (Figure 12.12). Sagittal tooth position may facilitate or hinder implant placement in the correct three-dimensional restorative driven position. Since the objective is to place the implant in a more palatal position, a buccal tooth position may offer a more favorable situation due to the increased available palatal bone for implant anchorage. If the tooth occupies most of the socket as in class IV or if there is inadequate apical bone to engage the implant, this may dictate additional hard tissue augmentation prior to implant placement. The results of Kan studies have shown that most of the anterior teeth lie in the class II and III categories, meaning that the tooth is either in the center of the socket or the root apex is angled toward the palatal aspect. These positions consequently create difficulties in placement of immediate implants in a more palatal position to facilitate a palatal screw retained access. Consequently, an angled screw channel may be utilized should a screw retained restoration be desired or the

Figure 12.10 (a–d) Pre-operative assessment of the interproximal height of bone through bone sounding of the tooth to be extracted as well as adjacent dentition to determine the integrity of the periodontal attachment prior to flap reflection.

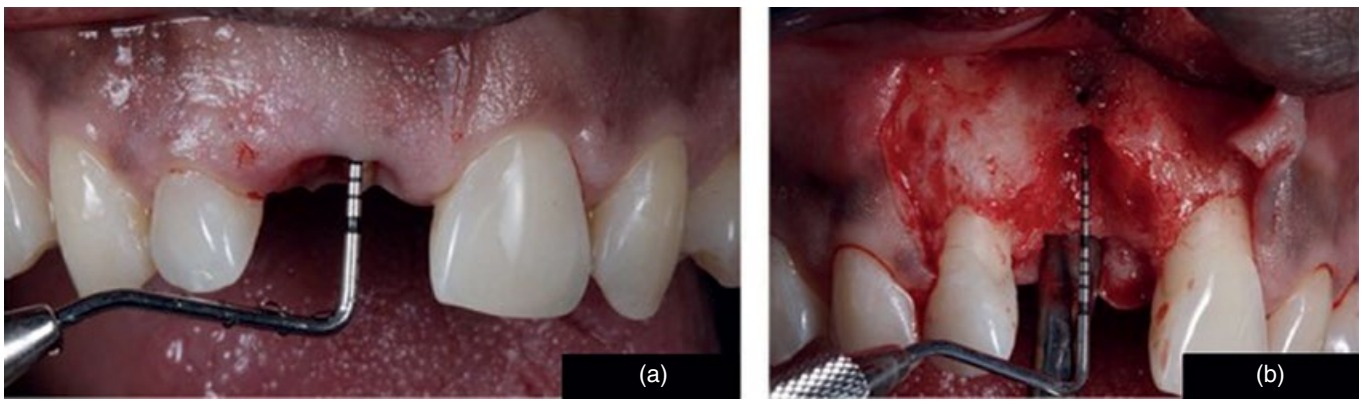

Figure 12.11 (a) Pre-operative bone sounding of the buccal plate reveals probing depths in excess of 10 mm. (b) Intra-surgical view showing complete absence of the buccal plate.

clinician may resort to a cement retained restoration with customized abutments.

It can therefore be established from the studies that the tooth position within the alveolar envelope determines the amount of apical bone to engage the implant if immediate implant therapy is considered as well as determining the need of augmentation procedures in lieu of immediate implant placement if the implant is not sufficiently encased within the alveolar envelope.

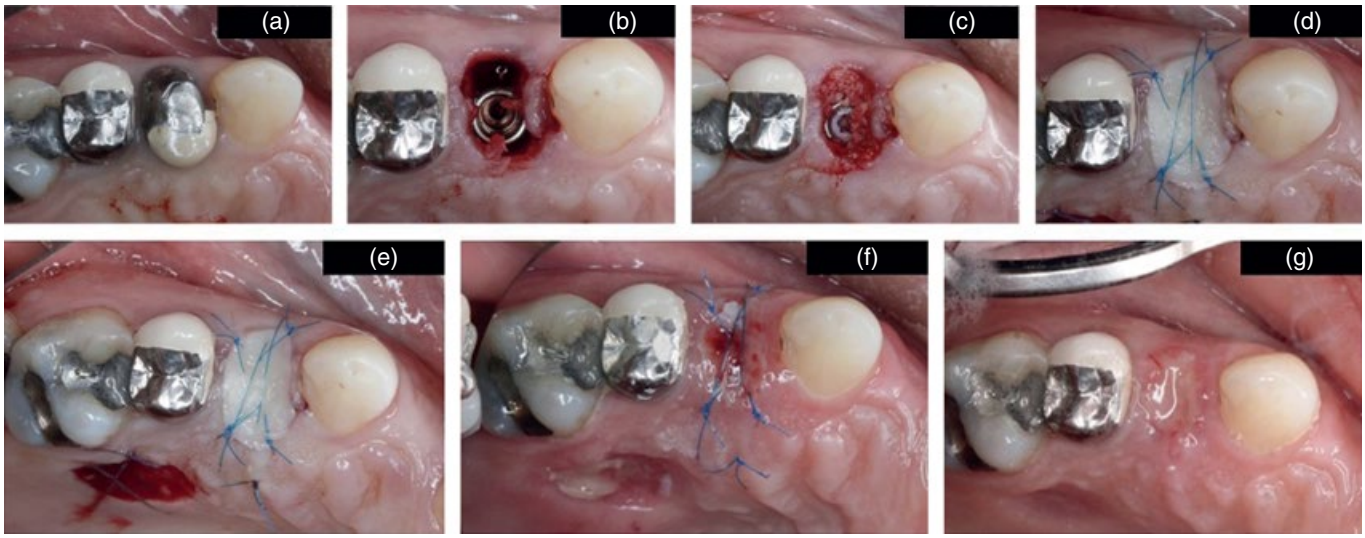

Figure 12.27 (a–d) Immediate implant placement was combined with bone grafting of the residual gap surrounding the implant. A socket seal approach was utilized to seal the extraction site. Note the adaptation of the graft to the surrounding soft tissue margins. Lower pictures show the donor and recipient sites at immediate post-op (e), one week (f) and two weeks (g) intervals.

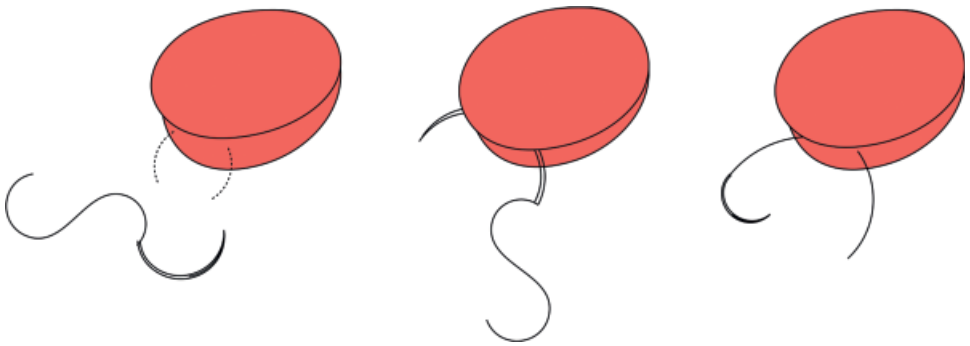

Figure 12.28 From left to right. Suture entry point: The needle is advanced within the thickness of the graft. This suture is an internal horizontal mattress suture that helps adapt the connective tissue aspects of the graft to the recipient site to enhance early revascularization.

The use of tissue adhesives may be used in lieu of multiple sutures to aid in graft stability while avoiding excessive trauma from the suture needle. N.B. tissue adhesives may not be used as the sole method of graft stabilization in this technique, but as a supplemental method to reduce the number of sutures needed to fixate the graft in place.

A compressive suture as demonstrated in Figure 12.27 offers the advantage of additional graft compression in both lateral and vertical directions. This suture is useful in cases where the graft is is too small or too thin, as stretching the graft in opposing directions may result in a dead space apical to the graft.

In addition to a compressive suture, utilizing an internal mattress suture aids in stabilization and adapting the graft to the internal socket lining (Figure 12.28).

Disadvantages of This Technique

The main disadvantage of the socket seal FGG is that there is no true augmentation of the buccal tissue volume which is critical around implants for esthetic purposes and long term stability of the underlying buccal bone. This issue may be overcome at the time of implant placement and/or second stage uncovering of the implant by either utilizing the tissue previously augmented on the occlusal aspect and introducing it onto the buccal aspect or by adding a connective tissue graft at the time of implant placement:

- The predictability of the graft taking is low
- Technique sensitive

To overcome these disadvantages a partially de-epithelialized free gingival graft or sub-epithelial connective tissue graft may be utilized (Figure 12.29). The following

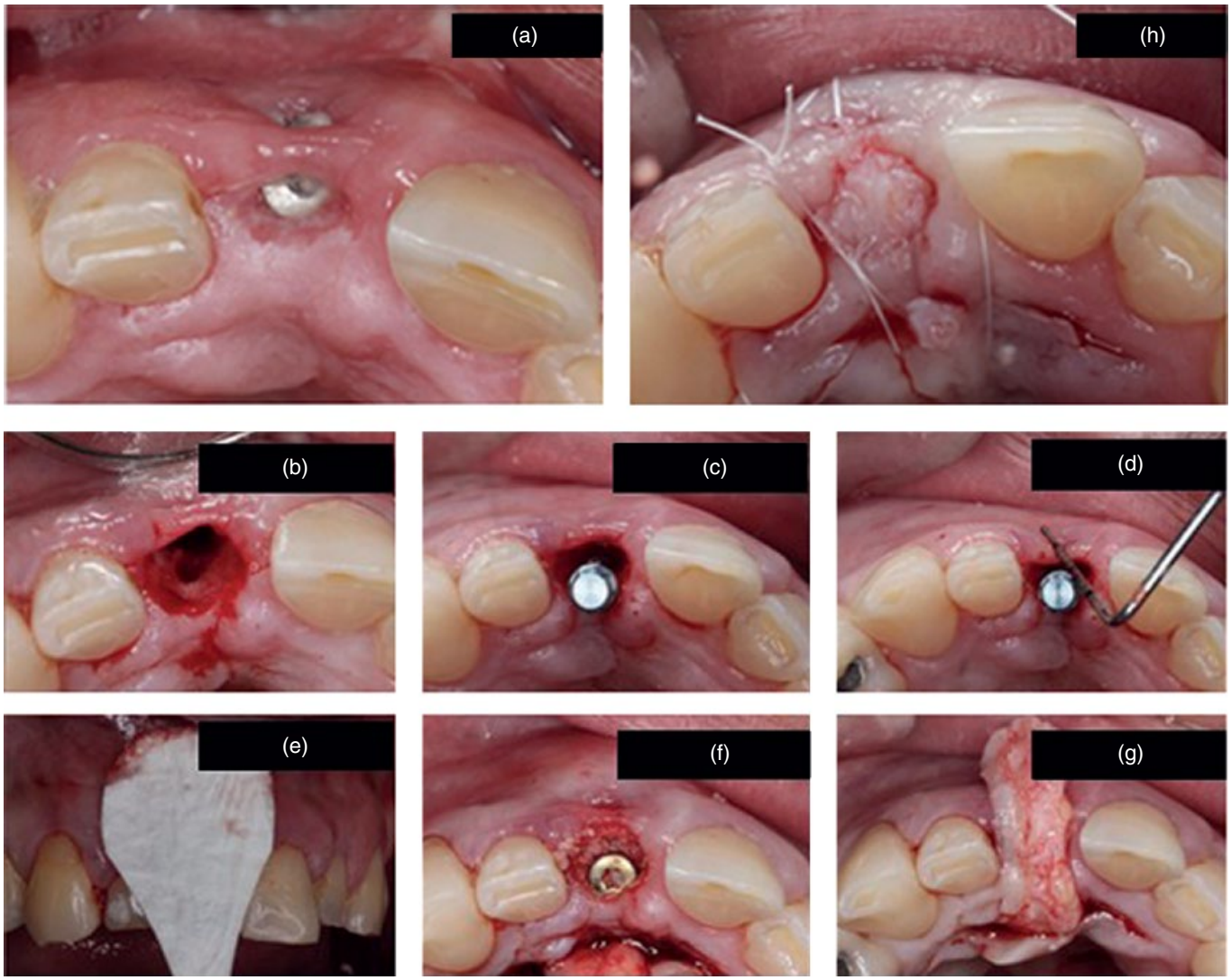

Figure 12.41 Sub-optimal implant placement correction. (a) Note the excessive labial positioning of the implant. (b–d) Implant removal is followed by replacement with a new implant in a more palatal position. (e–f) A resorbable collagen membrane is trimmed according to the defect shape combined with an allograft material and a rotated pedicle soft tissue graft to augment the labial contour of the site as well as seal over the socket (g).

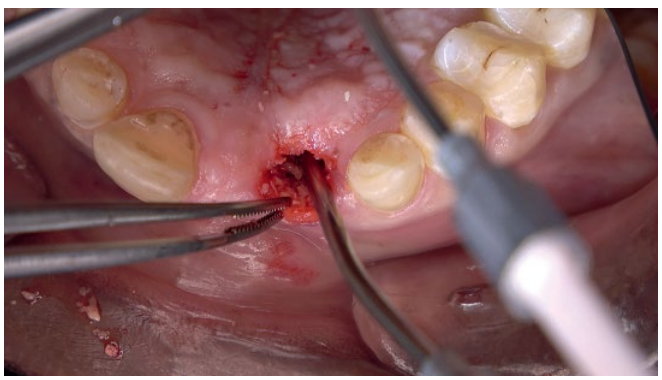

Figure 12.42 Flapless ridge preservation and implant replacement.

Rationale

Recombinant technology allows for the availability of synthetically engineered pure human growth factors. Recombinant human bone morphogenic protein-2 (rhBMP-2) has been extensively studied for extraction socket preservation and sinus elevation in multi-center randomized controlled trials (RCTs). (Fiorellini et al. 2005; Triplett et al. 2009). Recombinant human platelet-derived growth factor-BB (rhPDGF-BB) has been approved for periodontal regenerative procedures to enhance the periodontal attachment apparatus (Nevins et al. 2003a, 2005, 2013). Human histologic studies support the ability of rhPDGF-BB to induce periodontal regeneration (Nevins et al. 2003a, b). In addition, rhPDGF-BB has demonstrated

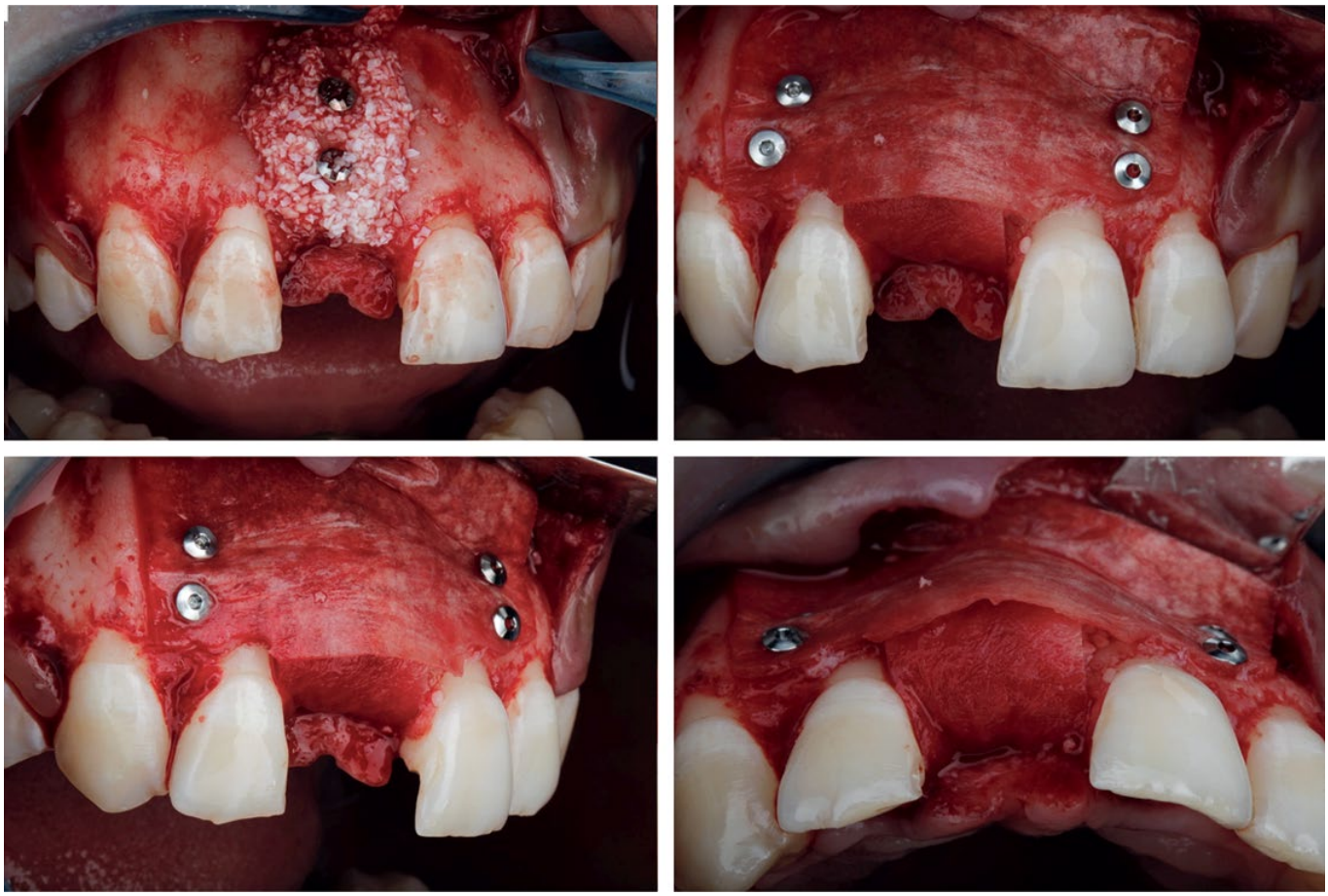

Figure 12.48 Example of membrane fixation with tacks placed to stabilize one horizontal membrane with a second membrane placed on the occlusal aspect to completely seal off the regenerative site.

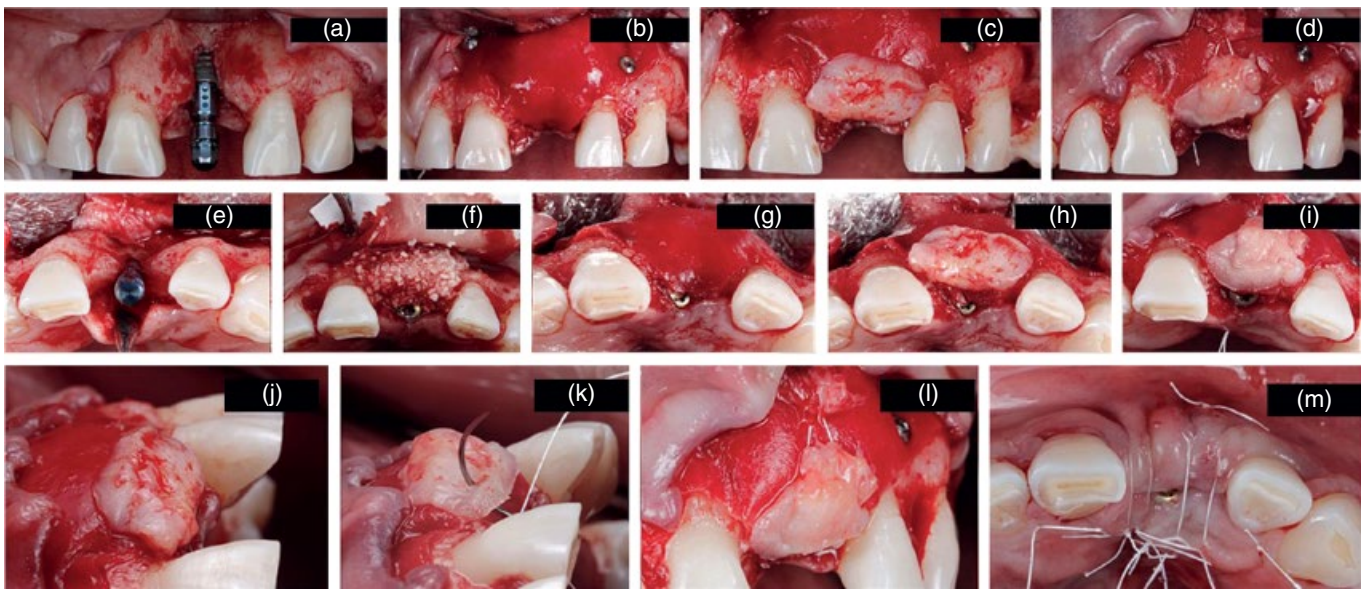

Figure 12.49 (a–d) (a) Frontal view implant placement, guided bone regeneration was performed on the buccal aspect, with fixation tacks for added membrane stability. A connective tissue graft was performed to further augment the tissue volume. The membrane and tissue graft were secured with a stabilizing periosteal suture. (e–h) occlusal view of the procedure. (j–m) Showing the graft being engaged prior to periosteal anchoring as well as the periosteal anchorage done with the same suture to stabilize the graft in place. Closure is done above the healing abutment.

incisor, width of the central incisors, etc.) (Figure 13.2.3). Based on the preferred esthetic landmarks and biological aspects the esthetic framework of the anterior teeth is defined and outline of the restorations is selected in frontal, occlusal and 12 o'clock projections (Figure 13.2.4). To facilitate the process, different libraries of the teeth shape can be used and adjusted based on the patient or dentist preferences. The simulation of the final result can also be done in order to better communicate the planned result to the patient (Figure 13.2.5). The concept of visagism is also used and allows clinicians to design the shape of the teeth that blends the patient's physical appearance, personality, and desires (Visagism: The Art of Dental Composition 2018). Patients can evaluate the planning and 2D dental after final adjustments, which can then be transferred to the lab for further procedures: wax-up (digital or analog), model or mock-up, or restoration fabrication (Figure 13.2.6).

However, it should be understood that such 2D planning should be taken as guidance, rather than a precise and final treatment plan. The shortcomings of such 2D planning are related to the fact that only static images are taken, under certain lighting conditions and projection. It has been shown that lighting conditions can affect the buccal corridor appearance on smile photography (Ritter et al. 2006). Another disadvantage is that planning is done based mainly on esthetic criteria and fails to address biological and functional circumstances. Despite these aspects, 2D digital design is a very informative tool enhancing communication between dentist, patient, and dental technician.

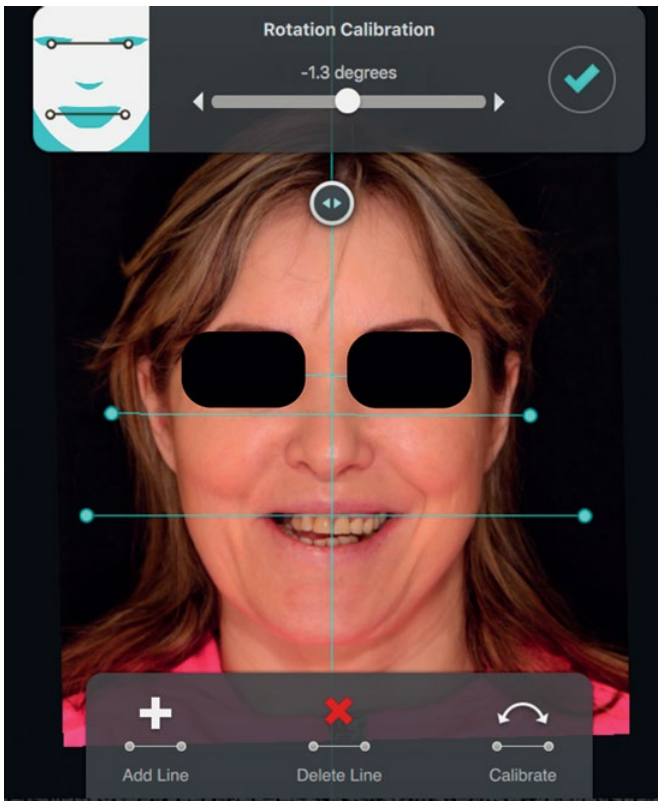

Figure 13.2.1 Rotational calibration of the face photo based on the facial horizontal and vertical lines.

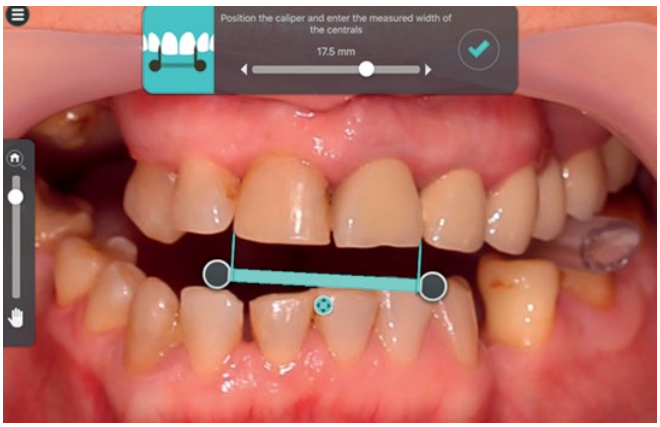

Figure 13.2.3 Calibration of the dimensions is done with the ruler, in order to indicate measurements on the final smile design version.

Figure 13.2.2 Photos of retracted and non-retracted smile are calibrated by selecting reference points.