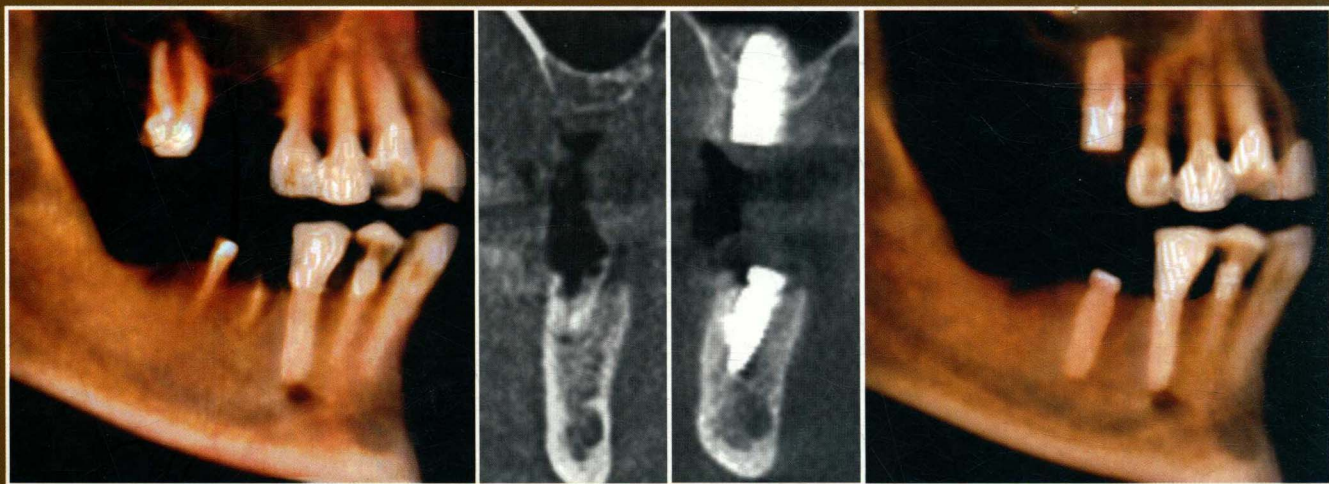


MINIMALLY INVASIVE DENTAL IMPLANT SURGERY



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WILEY Blackwell

Minimally Invasive Dental Implant Surgery

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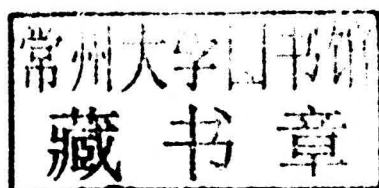
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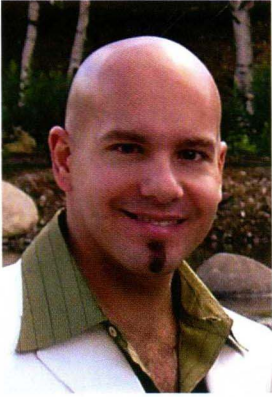
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Memorial to Jean-Francois Bedard



Remembering a great son, husband, father, and friend ... To Deanna and all the family, words cannot describe your loss and sorrow. Any time spent with this special man was both a joy and privilege. Jean was and will always be the unique fun-loving soul that we all loved to be with. His love for you and the kids was both obvious and spoken. He treasured you greatly in his heart, and when he was away you were always on his mind. We shared with Jean many outstanding moments on the mountain, at meetings, at great restaurants, even in the Starbucks' line ... that will not be forgotten. Jean was kind hearted, passionate, exacting, and highly skilled. He truly enjoyed life to the fullest! Please accept our deepest sympathies, you will remain in our thoughts and prayers as you move forward through this tragedy.

Dan and Spring Cullum

Foreword

It has been a joy and privilege to be asked to write a *Foreword* for this beautiful book *Minimally Invasive Dental Implant Surgery*, edited by two eminent, world-renowned colleagues, Drs. Cullum and Deporter.

In the past years there has been an exponential increase in scientific information in implant dentistry, and it is really important that what is learned from basic and clinical research should flow in a clear and direct way to the practicing professional. In the field of biomedicine there is an ever increasing demand for minimally invasive procedures (e.g. robotic surgery) in order to decrease the biological costs for patients. Professional communities must be kept up to date on the most current findings and developments in diverse scientific areas.

Drs. Cullum and Deporter together with many outstanding contributors have provided, in this first-rate book, a comprehensive update of knowledge on many different facets of implant dentistry. This book is sorely needed, and provides an important resource to

implant dentistry which covers the field thoroughly focusing on specific issues that confront the dental implant professional every day. All the most relevant aspects of today's implant dentistry have been covered in this book, and all the material is presented with a rigorous scientific approach. The information, such as the basic principles, the most recent advances, and practical applications, are presented in a well-integrated way. Beautiful illustrated case reports complete the book.

This book is a milestone contribution in implant dentistry, and will set a new standard for many years to come.

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Preface

Developing a minimally invasive mindset ...

A new paradigm in dentistry began with the introduction of osseointegration and the predictable replacement of teeth with dental implants. Innovation and research have helped to refine the associated techniques such that today with careful planning and execution we are able to provide predictable and pleasing esthetic and functional implant treatments for our patients. Minimally invasive surgery is the next step ... using the “least invasive” procedure, with the fewest number of steps and smallest cost. Surgery ... simple, fast, and clean ... **when less is more.**

Advances in technology now allow unprecedented diagnostic and planning capability. Following evidence-based protocols allows ideal implant placement even, where appropriate, with immediate implantation and immediate function. Choosing to utilize site preservation grafting at the time of tooth extraction lessens the later need for dedicated ridge augmentation grafting with its associated trauma and protracted treatment times. Combining or “stacking” multiple bone manipulation and soft tissue grafting procedures permits shorter treatment times, and using truly short implants helps to avoid complications in posterior jaw sites.

With surgery there is always risk. Flapless surgery can minimize surgical trauma, but comes with limited visibility and the potential for complications and unfavorable outcomes without adequate training and experience. Using computer-guided surgery also comes with risks and requires considerable time and investment to achieve competence. Technology is not a substitute for surgical training, experience or judgment, and significant perils often await its misapplication ... **when more is less.**

The focus of this book is to provide a reference for predictable and minimally invasive surgical techniques that can be progressively applied within a construct of advancing skills. The contributors were carefully chosen with the purpose of exploring the field from different perspectives but with a common philosophy. As in other surgical disciplines, developing a minimally invasive mindset in implant dentistry requires a clear understanding of bone and soft tissue biology, wound healing, dental implant design, and the required surgical and/or prosthodontic skills to achieve predictable and optimal treatment outcomes. It is our hope that this book helps the practicing clinician to achieve these lofty goals.

Thank you to the team at Wiley Blackwell for their efforts and assistance.

Daniel R. Cullum DDS

Acknowledgments

Undertaking a comprehensive textbook is an ominous project. The time demand is more than one could ever have imagined. To that end I wish to thank my family and friends for the time we missed together: my wife Spring in particular has been outstanding in her support and love, my parents for teaching me to work, my dad for instilling a love for dentistry, my office staff and manager Lincoln, for the extra demands of business and busyness. A special thank you to Doug for his contribution and interaction, and to all of the contributors for their efforts and expertise. I want to also thank the many teachers and mentors who have influenced my career and praise God for gifting me with the strength, energy and skill to complete this project! Minimally invasive surgery is more demanding in time, skill and judgment, however, it has changed the way I practice and we want to share the many benefits for our patients.

Dan Cullum

I would like to thank Dan for giving me the opportunity to participate in this project. For over 25 years, I have striven to deliver minimally invasive dental implant treatment using short implants and the OSFE and BAOSFE approaches to sinus floor elevation. This book has been a challenging project. In the end I enjoyed the work and interacting with Dan, contributed a bit myself, and learned a lot from the contributors. Producing a comprehensive book like this one is a group effort. I would like to express my appreciation to all who contributed and wish them continued success and good health in future.

Douglas Deporter

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SECTION I

Technology, Diagnosis, and Treatment Planning

Diagnosis and Treatment Planning for Minimally Invasive Dental Implant Treatment

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Introduction

While the recent trend in dental implantology has been toward less invasive surgical procedures, an argument can be made that the prosthetic phase has become more complex. Our desire to provide patients with minimally invasive treatment options requires that the diagnostic aspects be completed comprehensively. There is no “minimally invasive” diagnosis. Treatment options may be more or less invasive, but the diagnosis needs to be thorough and complete. Despite significant advances in dental implant technology, implants remain endosseous anchorage devices intended for prosthetic reconstruction of missing teeth.¹

Many diagnostic tools, including cone beam computed tomography (CBCT) imaging and dental implant planning software (see also Chapters 2 and 9), have been developed to provide clinicians with user-friendly and precise methodology to examine and virtually plan possible therapeutic interventions.² These technologies greatly facilitate communication with the patient and treatment team members.³ Clinicians should, however, use caution when applying these technologies and develop an understanding of their advantages and limitations. Restorative management of dental implants requires a clear understanding of the final restoration design, planning for the phases of treatment and anticipating contingency plans.⁴

In addition, it is important to realize that minimally invasive surgery does not imply less complexity or that less skill and judgment are necessary. On the contrary, often more skill and judgment are required with minimally invasive approaches, and clinicians should be trained and competent in both minimally invasive and traditional approaches. Clinicians providing surgical care also should be competent in anticipating, preventing, and managing potential surgical and prosthetic complications. Thus, the skills and judgments of the treatment team remain paramount.

For successful implant treatment outcomes, there must be sufficient quality and quantity of supporting hard and soft tissues, the implants must be in the proper number, location, and orientation, and the prosthesis must be fabricated with detailed attention to esthetics, phonetics, occlusal function, and access for oral hygiene.⁵ This chapter will address principles for the diagnosis and treatment planning for prosthetic reconstruction of commonly encountered clinical situations in the context of employing minimally invasive procedures.

The diagnostic process

Developing an accurate diagnosis is best achieved using a systematic process. Initial patient evaluation should begin with a subjective assessment, including chief complaint, history of the present illness or problem, and past dental and medical histories. A full discussion of the patient's immediate concern (chief complaint), expectations, goals, and desires (immediate, short and long term) regarding treatment can prevent misunderstandings and help to avoid disappointments. While it is important to pay attention to the chief complaint, it is equally important not to let the chief complaint prevent a comprehensive approach in the clinical decision-making process. For example, patients presenting for single tooth replacement may not appreciate the need for a full diagnostic work-up and any additional treatment that might be required to achieve an optimal result. Consultation or referral to a more experienced clinician or implant team may be indicated if there is any discrepancy between the alignment of treatment goals and expectations and the clinical reality.

Following a thorough subjective assessment, the collection of objective diagnostic data begins. A focused head and neck examination and dental/oral examination are completed, with special attention given to teeth opposing and adjacent to potential implant sites. A complete periodontal examination, including probing, should be a part of the diagnostic record. The periodontal evaluation also should include an esthetic evaluation of the gingiva, including gingival display, symmetry, and biotype. An occlusal evaluation is necessary, with special attention afforded to vertical space relationships, interdental spaces, attrition, deep bite, cross-bite, and any other issues that might potentially impact the prosthetic outcome.

Radiographic evaluation may include any or all of periapical radiography, panoramic radiography, and CBCT 3-D imaging of the affected jaw(s) and proposed implant site(s).² Following the initial diagnostic examination, more sophisticated planning may be required with the use of surgical guides or templates fabricated from diagnostic wax-ups and/or tooth set-ups and 3-D planning.⁶ A record of the bite relationship should be taken in wax or a suitable elastomeric material, and diagnostic casts prepared. Mounting of these casts with a facebow transfer is ideal, especially if a diagnostic wax-up is being done.

Digital photographs are an important aspect in diagnosis to help communicate clinical and technical information to patients, dental

colleagues, and laboratory technicians. Referring to a digital photograph will help to answer questions that can arise in the treatment after teeth have been removed or otherwise altered. Extraoral photographs should be taken from both lateral and frontal views with the lips in repose as well as during a full smile. Intraoral photographs should include an occlusal view of each arch, a frontal view with the teeth in full contact, and right and left lateral views. The camera system need not be elaborate or complex; however, a modern digital single-lens reflex camera with macro lens and a dedicated macro flash system will give the best results. In addition, it is suggested that a high-quality set of intraoral mirrors and lip retractors be available, and that both the dentist and clinical staff be trained in their proper use.

Following a thorough review of the findings and, if need be, consultation with specialists, a set of treatment options is developed. The clinician is required to put all the findings together and come up with possible solutions. As a part of the diagnosis, a risk assessment is completed, including the demands of the case and whether or not a minimally invasive treatment approach is appropriate and/or involvement of other experienced colleagues is indicated.

This process must be purposeful and lead to a plan with the patient's full understanding and support. A plan is rarely a single option, but rather a discussion encompassing multiple possibilities even though some options may be eliminated quickly based on a patient's desires (for example, a reluctance to accept a removable prosthesis). Some treatment options may require additions to the basic plan (for example, a patient requiring multiple implants to be placed in order to secure a prosthesis may require bone augmentation or reduction procedures prior to implant placement). The final plan should include an indication of advantages and disadvantages, expected prognosis, costs, and possible complications in order to adequately inform the patient prior to their consent.

Informed consent

Informed consent involves more than simply presenting a few treatment alternatives. The patient should fully understand the associated risks, benefits, and limitations, including possible complications and alternatives for any treatment proposal. The first treatment option should always be "no treatment," and the implications of that decision should be considered and discussed. Many patients will be concerned regarding the anticipated esthetic outcome, and this should be discussed and documented fully in advance. There is no substitute for a set of mounted models with a diagnostic wax-up to directly visualize the proposed treatment. Digital photographs, 3-D imaging and planning, and a wax try-in or mock-up of the proposed treatment are important aspects of planning and informed consent. Patients should have an opportunity to have all of their questions answered, preferably with a friend or loved one in attendance, and this will often require more than one interaction. Diligence at this phase of treatment is critical to developing trust and rapport with the patient for those inevitable challenges that can occur.

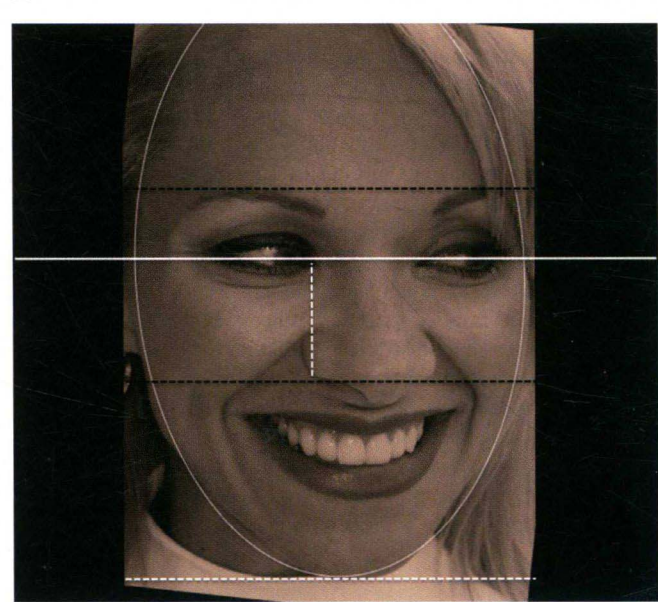
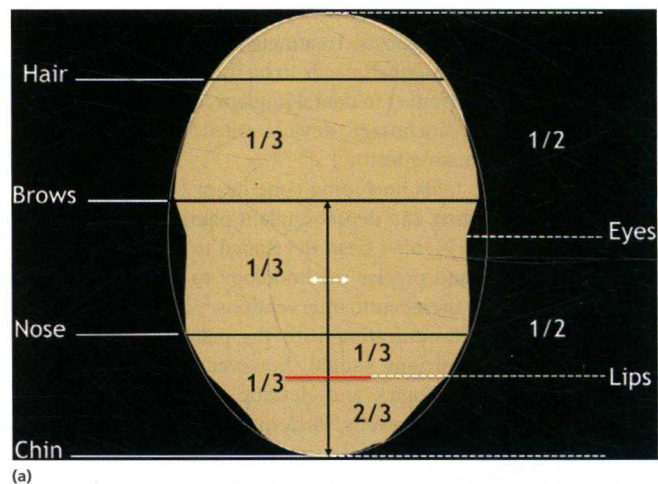
Comprehensive evaluation and risk assessment

Comprehensive examination begins before the patient is seated in the dental operator. Evaluation of the patient begins with interactions while standing and sitting upright during normal conversation. This is best facilitated in a consultation room with a home living room environment. Most patients begin adaptive responses

and compensations when placed in the dental operator and in a reclined position. The patient and clinician will benefit from a systematic approach and review of the findings.

Facial analysis

Evaluation of facial dimension includes inspection of facial symmetry from the frontal (Figure 1.1a), lateral, and three-quarter views. This inspection will allow confirmation that the facial thirds are harmonious (Figure 1.1b) and determination of the skeletal classification (Class I, II, or III).⁷ Diagnosis of the facial type (brachiocephalic versus dolicocephalic) can have significant implications with the amount of bite force generated on posterior teeth and the importance of anterior guidance (deep bite versus open bite). Further examination and palpation of the head and neck include the muscles of mastication to evaluate for hyperactivity or myospasm, temporomandibular joint disorders affecting mandibular range of motion or discomfort, and to rule out the presence of any masses, suspicious lymphadenopathies, or sinus issues.



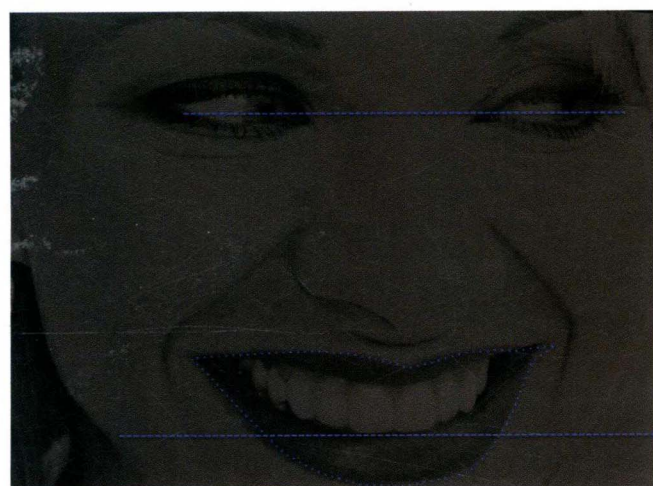
(b)

Figure 1.1 (a) Facial perspectives and proportions. (b) Facial perspectives and proportions projected over face.

Dento-facial analysis

Evaluation of the esthetic zone – *incisal plane, plane of occlusion, incisal edge position, dental/facial midlines, lip support, and gingival display* – is included in the dento-facial analysis⁸ (Figure 1.2a). Digital photography is indispensable for this pretreatment evaluation. Careful and systematic investigation of these features may change what appears initially to be a simple, single-tooth case into a complex interdisciplinary restorative challenge with increased treatment risk. On frontal evaluation, the anterior incisal plane should be parallel to the interpupillary plane and curve upwards in the canine region to follow the contours of the lower lip and the Frankfort horizontal plane⁹ (Figure 1.2b). The plane of occlusion should follow the interpupillary line, the curve of Spee, the curve of Wilson, and the curve of Monson¹⁰ (Figure 1.3).

Incisal edge position and tooth display at rest are patient-specific. Consideration of empirically determined norms can be helpful as the amount of display is age and gender dependent, excluding other variables such as lip length and lip movement on animation.¹¹ Accepted guidelines for the position of the maxillary central incisal edge at rest

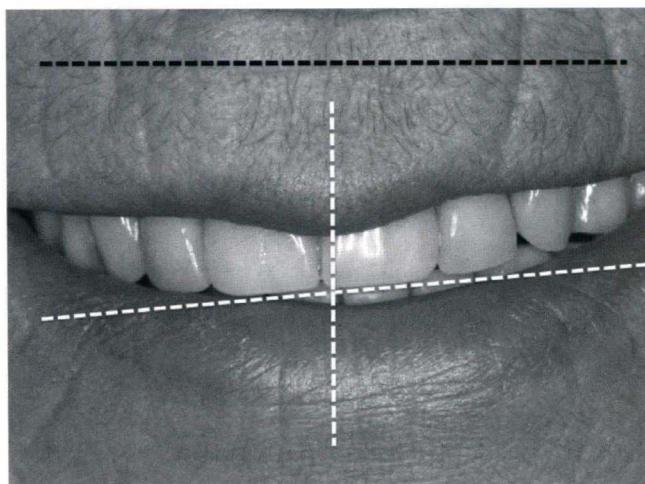


(a)

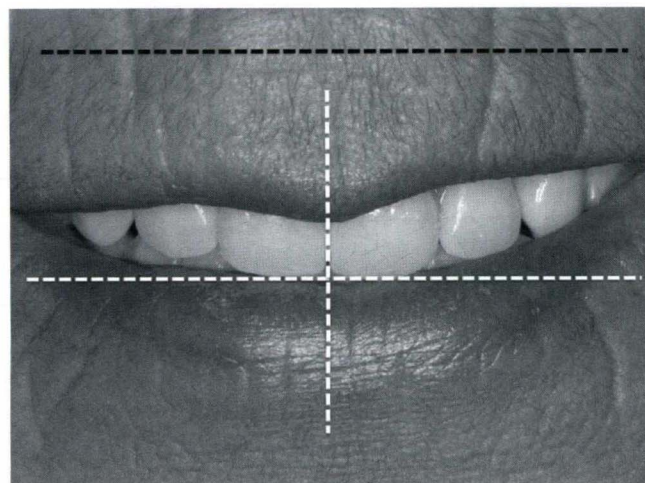


(b)

Figure 1.2 (a) Parallelism between interpupillary plane and overall anterior incisal plane. (b) Parallelism between Frankfort plane and posterior occlusal plane.



(a)



(b)

Figure 1.3 (a) Midline and anterior incisal plane discrepancies. (b) New midline and anterior incisal plane after correction.

is 3.4 mm in females and 1.9 mm in males “below the lip”. If the patient has a “short” upper lip, then exposure can be as much as 3.65 mm; with a “long” upper lip exposure can be as little as 0.59 mm.¹⁰ With aging, tooth exposure generally decreases due to lip laxity and decreased animation, and can be further reduced with incisal edge wear (see “Dento-gingival analysis” section). The accepted guidelines range from 3.37 mm of exposure for patients younger than 29 years of age to as little as 1.26 mm for those up to 50 years of age.

Assessment of the *facial and dento-facial midlines* for alignment will reveal any significant horizontal or vertical asymmetry, and any orthodontic, orthognathic, and/or facial plastic surgical treatment that may be indicated¹² (see Chapter 20). If significant dental asymmetry is found, orthodontic treatment (see Chapter 20) and/or prosthetic restoration of adjacent or opposing teeth may be required (Figure 1.4).

A key determinant of esthetic risk in implant therapy is the amount of *gingival display* exhibited during a full smile.⁷ If there is no exposure of the dento-gingival margin, the primary esthetic considerations are limited to tooth shade, tooth width, and incisal edge anatomy.¹³ Conversely, if there is full exposure of the gingival margin, then the entire dento-gingival complex must be considered, and the esthetic demands of the case will increase exponentially. If it is



(a)



(b)

Figure 1.4 (a) Anterior smile view of preoperative disharmony. (b) Anterior smile view after camouflage of disharmony.

determined that there is altered passive eruption, vertical maxillary excess, or excessive gingival display due to hypermobility of the lip, then periodontal crown lengthening, fixed prosthetic enhancement, surgical, or orthodontic treatment options are best addressed preoperatively along with anticipated limitations in treatment outcome.

Dento-gingival analysis

Gingival plane

Generally, a patient's maxillary anterior teeth display similar gingival length and proportions. The maxillary canines and central incisors may have slightly longer gingival contours than the lateral incisors with relatively more tooth exposure. (Figure 1.5a–c) The maxillary anterior teeth are progressively inclined to the distal, placing the gingival zeniths slightly distal to the midpoint of the tooth width. Tooth shape, tooth positions, and loss of bone or soft tissue support will cause discrepancies in gingival and/or papilla height. Generally, the closer to the midline these discrepancies occur, the more significant their impact will be. Facial angulation or positioning moves the gingival margin apically. Schematics representing tissue defects and gingival levels can aid diagnosis and risk assessment in treatment planning (Figure 1.5b–g) Options to manage gingival height discrepancy include orthodontic treatment, prosthetic soft tissue manipulation with long-term provisional restorations, and/or gingival surgery.

Modification of the gingival levels is often desirable and should be considered during the treatment planning process.¹⁴ Figure 1.6a and b shows a young female patient who presented with a significant asymmetry in the esthetic zone. On dento-facial and dento-gingival evaluation of her smile, the proportions of the maxillary right canines and lateral incisors became the focus of the treatment

objectives. Because the left canine and lateral incisor presented with pleasing proportions, a reasonable approach was to reproduce them to the degree possible on the right side (Figure 1.6c and d). The treatment plan in this case consisted of gingivoplasty to increase the length of the right crowns relative to the contralateral teeth. Restorative treatment included narrowing the width of the right lateral incisor and increasing the width of the cuspid to achieve more pleasing proportions (Figure 1.6e). These changes were first evaluated by digital superimposition of a mirror image of the left cuspid and lateral incisor teeth onto the right side. Thereafter, the teeth were prepared and restored with provisional restorations (Figure 1.6f).

Lip support

In addition to support from alveolar bone and soft tissue, the upper lip is mainly supported by the gingival two-thirds of the anterior maxillary teeth, not the incisal one-third. The shape and volume of the anterior maxillary alveolus (relative undercut and proclination) and the effects of aging with altered muscle tone also will effect labial position and mobility on animation.¹¹

Gingival biotype

Gingival biotype is another key determinant in esthetic risk.¹⁵ Patients exhibiting a thin, scalloped gingival biotype are more likely to have translucency of the underlying restorative material and/or buccal soft tissue recession over time and, as a result, may show exposed implant components.¹⁶ (See also Chapter 3.) The possible need for modification of the gingival biotype (see also Chapter 8), either preoperatively or following completion of the treatment, is best discussed before treatment begins.

Interdental papilla

Normal interdental papilla reformation following implant restoration is one of the most challenging outcomes in implant dentistry. The height and symmetry of interdental papillae following implant restoration are determined by the height of the interproximal bone crest of the adjacent tooth or implant.¹⁷ A single tooth implant placed between two healthy natural teeth has the best prognosis for reforming esthetically pleasing papillae. In such situations, papillae with 4.0–4.5 mm of soft tissue height can be anticipated (see further discussion in “Planning for ideal implant position” section). Tooth shape is also an important factor in predicting the presence or absence of esthetically pleasing interdental papillae. Square crown forms typically have shorter, thicker papillae and interproximal contacts, which may extend into the middle third of the clinical crown.¹³ Conversely, teeth with long, tapered crown shapes have thinner and more delicate papillae, and the interproximal contact zone may be limited to the incisal third of the crown. In this latter situation, when an extraction is done even in a minimally traumatic fashion, recession of papillae and incomplete soft tissue fill between crowns is a common finding.

Maxillary central incisor position

This is the key to anterior esthetics, and is the foundation for the diagnostic and treatment processes. Concepts such as dominance (relative size/shade), symmetry, proportions, and incisal edge position must be understood and applied if esthetic success is to be achieved.⁵

Tooth proportion

Tooth proportion may ultimately be influenced by factors beyond the control of the implant surgeon, such as orthodontic positioning and tooth migration. Guidelines for ideal proportions include a