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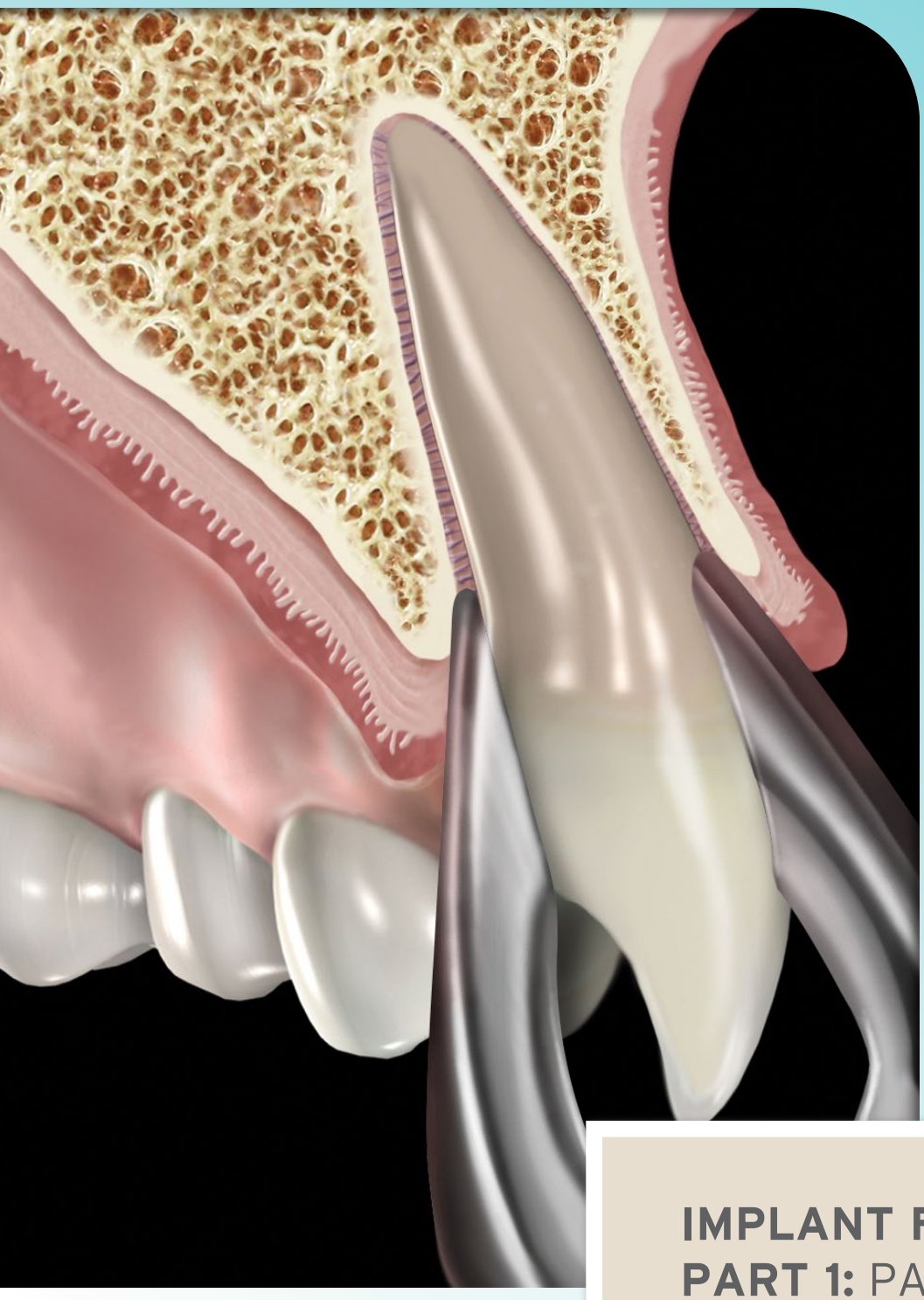

IMPLANT FUNDAMENTALS
PART 1: PATIENT ASSESSMENT AND EXTRACTION

A Peer Reviewed Publication
by Hu-Friedy

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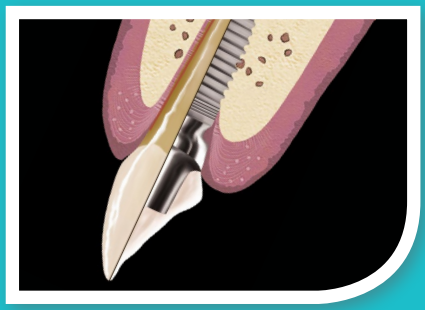

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ABSTRACT

In Part I of *Implantology Fundamentals*, participants will learn about how to best prepare for implant placement in order to achieve long term success. Key points of discussion include patient assessment and treatment planning as well as preservation of the implant site through atraumatic tooth extraction. The course also covers the use of surgical templates, grafting, and guided bone regeneration (GBR).

OBJECTIVES

At the conclusion of Part I, participants will be able to:

- List and describe the necessary steps of intraoral examination of tissue and bone
- Identify key considerations when placing implants (periodontal biotype, biologic width, and interproximal papillae)
- Understand the use of surgical guides and how they benefit implant positioning
- Identify atraumatic extraction goals and techniques
- Understand bone augmentation and regenerative techniques
- Know bone grafting materials & concepts

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This course was written for dentists and dental professionals from novice to skilled.

Educational Methods: This course is a self-instructional journal and web activity.

Requirements for Successful Completion: To obtain 1 CE credit for this educational activity you must review the material, complete the course evaluation and obtain a score of at least 70% on the examination. Upon attaining a passing score, you will receive an emailed copy of your certificate of completion for 1 CE or you may print it immediately. This course is provided at no charge.

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CHAPTER 1:
PATIENT ASSESSMENT AND TREATMENT PLANNING

The long-term success rates for dental implants have been well documented in the literature (Adell et al 1981; Lekholm et al 1999; Buser et al 1997). From the first Branemark procedures completed on fully edentulous, severely resorbed ridges (Branemark et al 1977), the indications for dental implants have expanded to include the replacement of single teeth and partially edentulous arches (**Figures 1.1** and **1.2**). Recent developments in the field have focused on the macro and microgeometry of dental implants and the use of digital diagnostics and computer-aided surgery to aid in treatment planning, fixture placement, primary stability, and healing for the edentulous site. As a result of these innovations, dental professionals today can provide predictable implant treatment for their edentulous patients.

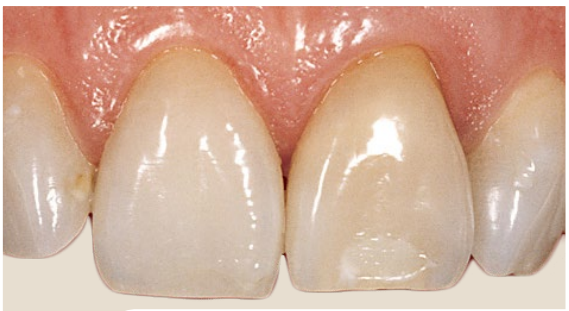

Figure 1.1 Preoperative view of patient requiring implant treatment on tooth #9 due to partial ankylosis and root resorption.

Keys to these successes, however, are due diligence in patient assessment and careful treatment planning. Each patient presents a unique set of circumstances that must be evaluated through a consistent, systematic approach in order to determine his or her candidacy for implant dentistry, and to permit the involved dental professionals (e.g., general practitioner, specialist, dental technician, supporting staff) to restore the patient to an optimal outcome.

PATIENT HISTORY AND PHYSICAL EXAMINATION

A detailed patient history should include not only dental disease but also the individual's potential medical problems and related medications, as multiple factors can affect one's suitability for an implant restoration (Ahmad 2012). Although patients with conditions such as irradiated mandibles, cardiovascular compromise, diabetes, or advanced age were once contraindicated for implant therapy, they too can benefit from this modality of treatment (Tanner 1997; Handelsman 1998; Weyent, Burt 1993).

The patient's use of nicotine, alcohol, or drugs, however, can have a negative effect on vascularity at the site and must be confidentially evaluated, discussed, and documented. The individual's psychological mindset is a factor to be carefully considered as well, as compliance is critical to the success of implant therapy.

All standard extraoral examinations should be performed for the potential implant patient. The soft tissue profile and support from the underlying alveolar bone are critical factors that influence the design of prosthesis. For example, if the desired final tooth position will be facial to the residual mandibular ridge, a hybrid-type prosthesis rather than a conventional crown and bridge restoration may be necessary to best restore the patient (Lazzara, Porter 2001). The status of the soft tissue in the edentulous arch (width and thickness of the attached gingiva) must be checked and the extension of the alveolar ridge must be evaluated for its suitability as a possible implant site.

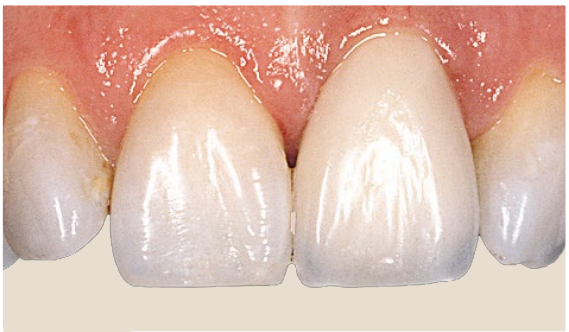

Figure 1.2 Postoperative view following successful implant restoration of tooth #9.

The intraoral examination aids in the interdisciplinary team's determination of which teeth can or cannot be saved. The endodontic and restorative status of the existing teeth should be recorded as well. Evaluating the periodontal health of the patient is mandatory and must be completed prior to placement of any dental implants. The patient's periodontal status also provides important information regarding his or her potential for compliance during treatment.

MULTIDISCIPLINARY COMMUNICATION

Implant dentistry encompasses three principal stages (e.g., implant placement, abutment connection, and restoration) and often the collaboration of multiple professionals in order to achieve the expectations of today's dental implant patient. This enables the pooling of experiences and expertise so that the implant placement can be determined not by the limitations of the existing hard and soft tissue support at the edentulous or extraction site, but rather by the desired final location as best to benefit the patient. Thus, important throughout this process is thorough documentation and exchange of all patient records.

ASSESSMENT OF PATIENT ANATOMY

Depending on the existing arch shape (e.g., narrow, crowded, posterior cross bite) of the patient, orthodontics may be necessary. Static and dynamic occlusion must be assessed prior to treatment (**Figure 1.3**), as should intra-alveolar distance and centric relations, to ensure occlusal stability (Lazzara, Porter 2001; Ahmad 2012). Any findings of elevated stress on the masticatory system such as bruxism or temporomandibular disorder must be documented and considered prior to treatment.

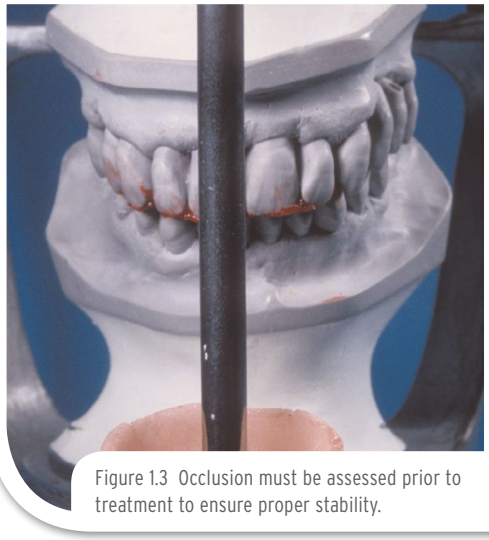

Figure 1.3 Occlusion must be assessed prior to treatment to ensure proper stability.

The location of the sinuses, the inferior dental nerve, and the position of the mental and incisal foramina, each a vital intraoral structure, must also be documented and shared among the members of the interdisciplinary team. Adjacent tooth roots play a similar role.

AVAILABLE BONE

Alveolar bone of sufficient dimension and quality (classified as type I to type IV) is a prerequisite for implant placement (Lekholm, Zarb 1985; Turkyilmaz et al 2007). (**Figure 1.4**). Its insufficiency or absence will dictate the need for bone reconstruction or augmentation prior to, or in conjunction with, implant placement (Touati et al 2008). Type I—highly dense cortical bone—is most desired for implant placement; type IV bone is often found in the posterior maxilla and is the least dense.

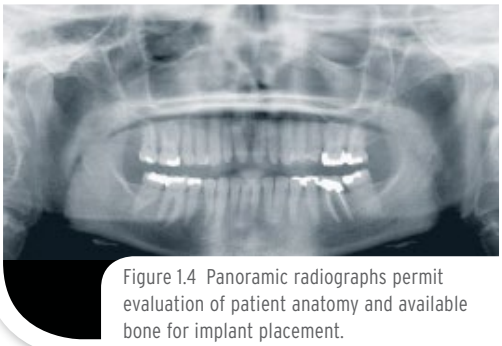

Figure 1.4 Panoramic radiographs permit evaluation of patient anatomy and available bone for implant placement.

Consequently, a detailed radiographic analysis is mandatory in each patient (**Figures 1.4** and **1.5**), allowing the members of the interdisciplinary team to coordinate the necessary implant position and angle (Lazzara, Porter 2001) in conjunction with mounted models. The condition of the bony ridge, any pattern of previous resorption, and the angulation of this bone, particularly in the anterior maxilla, should be considered during preoperative treatment planning. The thickness of the buccal plate should be assessed as well using the appropriate calipers and/or probes (a specialized implant probe) (**Figure 1.6**).

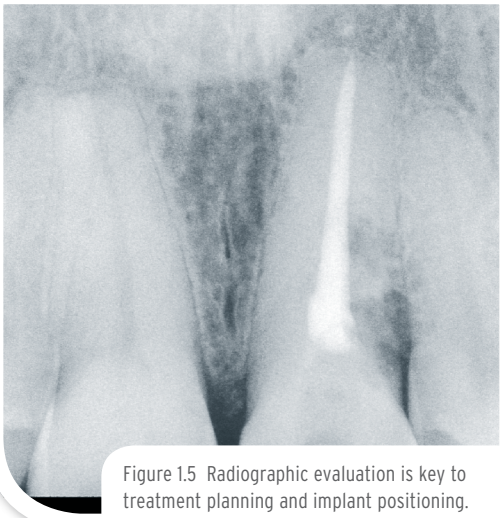

Figure 1.5 Radiographic evaluation is key to treatment planning and implant positioning.

Implants should be surrounded by 2mm of bone to prevent undesired bone resorption and to enable correct faciolingual implant placement and the development of proper peri-implant soft tissues (Saadoun 2004). This can dictate the type and size of the implants to be placed. Fistulas and fenestrations, like vertical and/or horizontal defects or similar pathologic conditions, must be corrected prior to implant treatment as well, due to the impact such defects can have on implant positioning in a prosthetically driven approach.

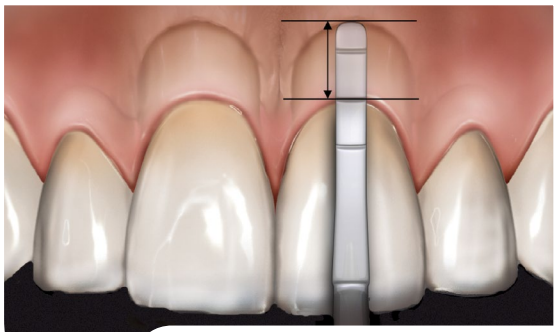

Figure 1.6 Assessment of alveolar bone is critical to evaluating the implant site.

Quantitatively, the available bone at the site should have a three-dimensional configuration that permits placement of a restoration-driven implant, be of optimal length and diameter, and have an optimal position and angulation (Saadoun 2004). It should also approximate, in the buccal position, the facial bone level on the adjacent and contralateral teeth adjacent to the edentulous area to support the formation of the interproximal papillae. The faciopalatal bone dimension should permit implant placement in a position and angulation that approaches that of a natural tooth. Furthermore, the facial contour of the restoration should correspond to the contours of the adjacent teeth (Smukler et al 2003).

In addition to periapical and panoramic radiographs, computed tomography (CT) scans and CBCT disclose bone dimension and the contours of the residual ridge and guide proper three-dimensional insertion of the implant at a given edentulous site (Ascheim Dale 2001) (**Figure 1.7**). Cross sections of such scans are particularly useful to the treatment team because they provide visibility of bone quantity buccolingually, and the location of vital structures. Digital scans, in addition to providing valuable radiological diagnostics, can also be integrated for computer-based implant planning. They permit evaluation of the site in three dimensions from its anatomical structures and can provide information about the density of the existing bone.

Bone Measurement

Accurate, finely designed instruments, such as bone calipers, should be used for precise measurement of intraoral structures.

- Bone sounding and determination of alveolar bone dimensions
- Easily measure for implant/prosthetic placement

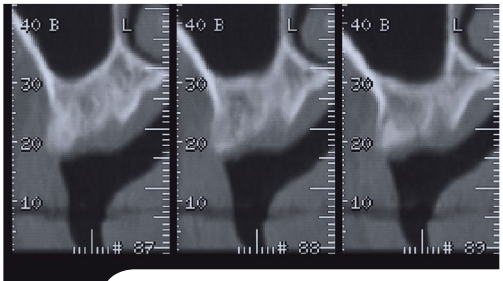

Figure 1.7 Computed tomography scans and CBCT imaging also facilitate patient assessment and treatment planning.

PERIODONTAL BIOTYPE

The patient's gingival biotype is an important consideration as well. Patients with thin, highly scalloped gingivae are prone to gingival recession (**Figure 1.8**); those with thick, flat biotypes can be predisposed to pocket formation or inflammation after implant surgery (**Figure 1.9**). Defects in thin biotype patients can also be produced as a byproduct of bone remodeling and should be accurately assessed and surgically treated to re-establish healthy peri-implant hard and soft tissues (Touati et al 2008).

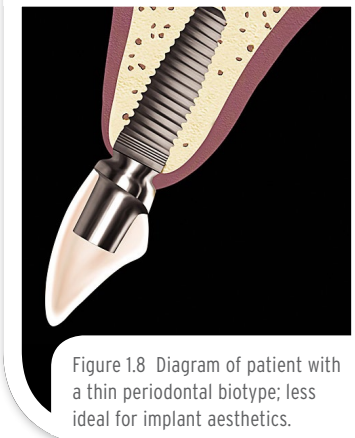

Figure 1.8 Diagram of patient with a thin periodontal biotype; less ideal for implant aesthetics.

BIOLOGIC WIDTH

On natural teeth, the "biologic width" is the term describing the supracrestal soft tissues (e.g., junctional epithelium and connective tissue) that seal the oral cavity and protect against inflammation. The dimension of the connective tissue (~1mm) around dental implants and natural teeth is relatively constant, but the junctional epithelium around an implant is much greater than it is around a natural tooth (2-2.5mm vs. 1mm, respectively) (Touati et al 2008). On natural teeth, the connective tissue is deeply inserted in the cementum through collagen fibers, which provides high mechanical strength. Around implants (**Figure 1.10**), however, the collagen fiber bundles are not really attached but instead adhere to the transmucosal components via glycoaminoglycosides. As a consequence, this adhesion has poor mechanical resistance (Touati et al 2008).

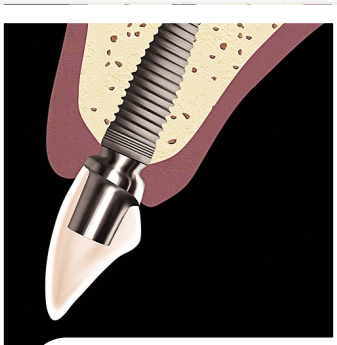

Figure 1.9 Patients with a thick biotype are less prone to gingival recession following implant treatment.

Consequently, the selection of transmucosal components must be biased toward biocompatibility; if the components are not biocompatible, the soft tissues will migrate apically until they reach the level of the implant. Titanium and aluminum oxide, for example, have been shown to be biocompatible enough to allow soft tissue adherence, (Domken et al 2003) whereas resin, gold, or porcelain at the transgingival level does not allow soft tissue adherence and may result in gingival recession and/or bone loss.

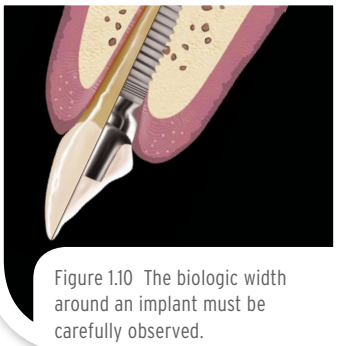

Figure 1.10 The biologic width around an implant must be carefully observed.

INTERPROXIMAL PAPILLAE

In order to achieve a natural appearance between two natural teeth, Tarnow et al determined that a distance less than 5mm is necessary between the contact point and the interproximal bone (Tarnow et al 1992) (**Figure 1.11**). To produce a similar aesthetic outcome for a papilla between two adjacent implants, this distance must be a minimum of 3.4mm (Tarnow et al 2000). These guidelines, however, must take into account the position of the crest of bone relative to the cementoenamel junction during treatement planning.

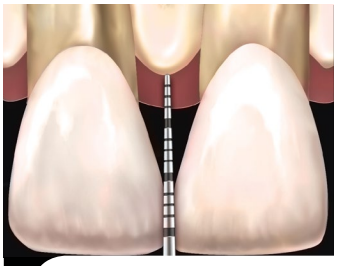

Figure 1.11 Diagram of contact point and relationship between bone and the interdental papilla.

PROSTHETICALLY DRIVEN TREATMENT PLANNING

Contemporary implant treatment is prosthetically rather than surgically driven, as various grafting techniques are available to support implant placement in areas where insufficient bone exists preoperatively (Ascheim Dale 2001). Restoration-driven implant placement must guide the harmonious peri-implant soft tissue profile with the contours of the restoration in order to ensure compatibility with the adjacent natural teeth (Saadoun 2004).

DIAGNOSTIC WAXUP

A diagnostic waxup must be mounted on a diagnostic cast in the dental laboratory to permit assessment of jaw relations, and to determine if a change in occlusal position is necessary (**Figure 1.12**). The articulator should be positioned to establish anterior-to-cuspid guidance with early disclusion of the posterior dentition ("freedom in centric" as possible).

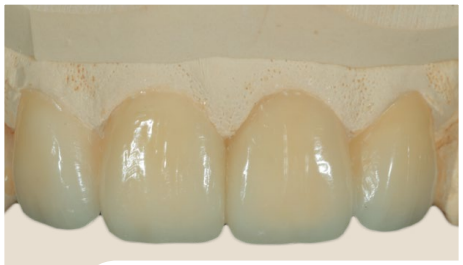

Figure 1.12 The diagnostic waxup permits assessment of ridge morphology, evaluation of GBR needs, and implant selection.

The diagnostic waxup also allows ridge morphology to be evaluated and allows planning of the number, position, angulation, and type of implants to be placed. Augmentation procedures necessary to support this prosthetically driven placement can also be determined at this phase if a discrepancy is noted between the current level of the crestal bone and the position required for the prosthetic crown.

Evaluation of the waxup enables the team to determine whether a fixed, removable, or cement-retained prosthetic is ideal for the restoration of the patient. It also provides a template for the fabrication of provisional restorations and a surgical guide that will determine implant positioning.

SURGICAL GUIDE

Planning and implementation of a successful implant-supported restoration is much simpler when surgical templates or guides are used to plan implant positions in the mouth (**Figure 1.13**). The template can be converted to a drilling guide later. In the planning phase, the guide should establish proper positioning that respects the following requisites:

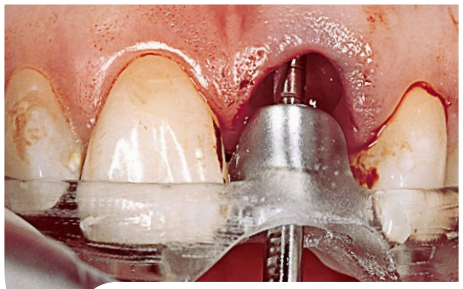

Figure 1.13 An accurate surgical guide aids the clinician in proper implant placement.

Mesio-distal plane

A distance of 1.5mm is necessary between an implant and natural tooth; the distance should be minimally 3mm-4mm between two adjacent implants.

Bucco-lingual plane

On both aspects a distance of 1mm (minimally) must be established.

Inciso-cervical plane

The head of the implant should be positioned apically by 3mm to the anticipated position of the gingival margin, with no apical impingement on nearby structures.

SUMMARY

Implant therapy is an important modality for the restoration of the edentulous patient, and is ideally performed by a cohesive team of dental professionals acting in concert to evaluate the specific medical, dental, and physical factors of the individual patient. Meticulous assessment and diagnostics enable implant placement to be prosthetically driven with success and predictability (**Figures 1.14** and **1.15**).

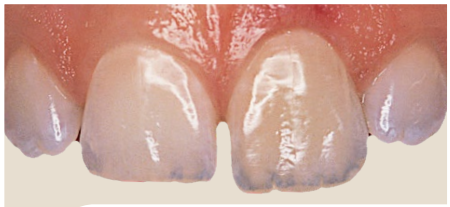

Figure 1.14 Pretreatment view of patient with failing maxillary left central incisor (tooth #9) due to horizontal fracture.

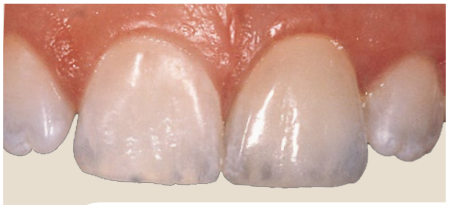

Figure 1.15 Note natural tissue integration and harmonious results achieved via implant treatment at site #9.

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CHAPTER 2:
TOOTH EXTRACTION AND IMPLANT SITE PRESERVATION

For years, practitioners have endeavored to eliminate contraindications to implant placement as a means of expanding access to care. Procedures such as sinus lifts, dental nerve repositioning, and guided bone regeneration (GBR) have been pioneered in order to improve control of the involved treatment site(s) and overcome limitations. These concepts have a considerable influence on treatment outcomes, particularly in addressing alveolar bone deficiencies that come to light during treatment planning and patient examination. Hard and soft tissue grafting at the surgical site enables functional, aesthetic implant placement, often with optimal fixture positioning or fewer procedural steps.

Proper Use of Extraction Forceps

Reduce the risk of root tip fracturing or crown crushing by using forceps to firmly grasp its roots in an apical direction.

- Use thin, tapered beaks that penetrate the PDL space.
- Secure multiple points of root contact below the cervical line.
- Longitudinal beak serrations provide additional grip to the crown and root surface.

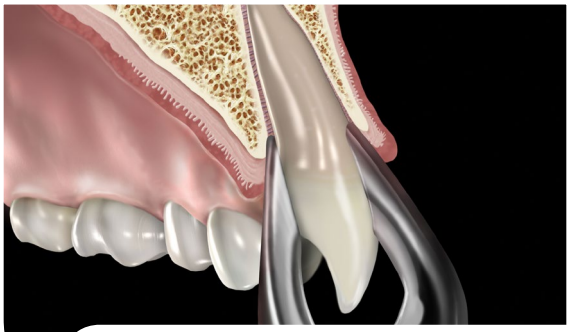


Figure 2.1 Atraumatic tooth extraction is key to preserve the alveolar bone at the implant site.

ATRAUMATIC TOOTH EXTRACTION

Tooth extraction and implant placement may be the treatment of choice for hopeless teeth, i.e., when the periodontal involvement of the tooth or root jeopardizes an adjacent tooth or there is an infrabony defect or caries extending apical to the osseous crest (Rosenthiel et al 2001; Genco et al 1990). Exodontia typically involves an expansion of the alveolar bone and severing of the periodontal ligament, as conducted with a combination of dental elevators, periotomes, and extraction forceps (Misch 2008) (**Figures 2.1** through **2.4**).

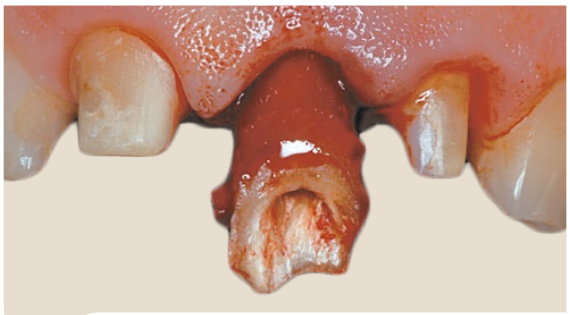


Figure 2.2 Exodontia with deference to preservation of hard and soft tissues at the site.

Traditional instrumentation uses principles like simple machines (e.g., levers, fulcrums, and wedges) to separate the attachment apparatus and create tooth mobility through a "prying" motion that is less desirable at the treatment site. Implant treatment today depends on the ability of the treatment team to ideally preserve or supplement the extraction site for implant placement, commonly referred to as "atraumatic extraction", which includes several important objectives:

Goals of Atraumatic Extraction:

- Preservation of buccal bone and cortical plate
- Maintenance of the periosteal envelope and vascularity at the site
- Generate less pressure on bony site
- Prevent root tip fractures

Figure 2.3 A periotome is used to sever the periodontal ligament and facilitate extraction.

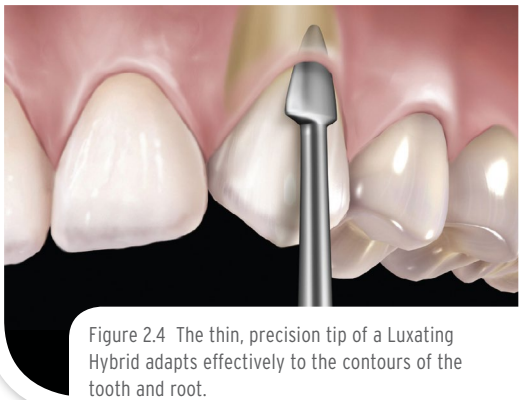


Figure 2.4 The thin, precision tip of a Luxating Hybrid adapts effectively to the contours of the tooth and root.

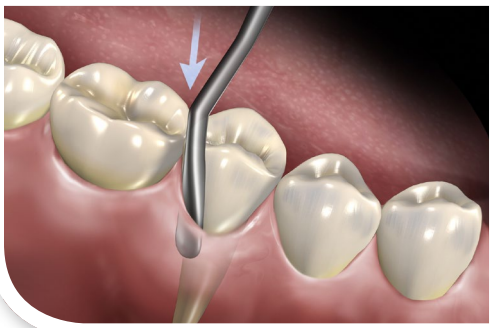
Advances in dental instrument design provide today's clinician with ideal options for achieving the goals of atraumatic extraction. Finely tuned instrumentation, e.g., luxating elevators and periotomes, is key to this process, both in the severing of the periodontal attachment and grasping of the failing tooth below the cervical margin with specially designed apical forceps. With the latter, a light yet constant apical pressure is applied onto the mesial and distal PDL space only until the tooth is slightly elevated and mobile for the proper use of atraumatic extraction forceps (Misch 2008; Horowitz and Mazor 2010; Feck). All granulation tissue is removed using specially designed curettes and the site is prepared for bone grafting, GBR, or implant placement according to the treatment plan.

CLASSIFICATION OF RIDGE DEFECTS

To simplify interprofessional communication regarding alveolar deficiencies, Seibert established a classification system as such (Siebert 1983):

- **Class I:** Buccolingual defects yet normal apicocoronal height.
- **Class II:** Apicocoronal loss of tissue with a normal buccolingual ridge width.
- **Class III:** Combination cases involving both a vertical and horizontal deficiency.

The vertical component of bone loss is generally more challenging to manage; horizontal deficiencies are more predictably restored (Touati et al 2008). In treating the former, the clinician must use tension-free flaps and ensure they completely cover the regenerative materials used at the treatment site—and both addressed using GBR.



Proper Use of a Periotome or Luxating Elevator

Avoid lifting and prying with a standard elevator for a less traumatic extraction.

- Reduce pressure on adjacent teeth during extraction.

PRINCIPLES FOR GUIDED BONE REGENERATION

After over four decades, a significant body of scientific evidence resulted in the development of a biological concept known as Guided Tissue Regeneration (GTR) (Quiñones et al 1996; Quiñones and Caffesse 1997). The clinical utilization of this concept revolutionized surgical therapy in all areas of dentistry, including periodontics, oral reconstructive surgery, and dental implantology. In the 1970s, Melcher (1976) presented the basic premises that formed the biological basis for GTR; he suggested that each of the four tissue groups found in the periodontium (i.e., gingival epithelium, gingival connective tissue, alveolar bone, and periodontal ligament) had the ability to express a unique cell phenotype. Melcher further postulated that the type of healing resulting following periodontal therapy depended on the phenotype of the cells that first re-populated the root surface, a concept that was ultimately validated in numerous research publications that led to the various clinical applications of GTR (Quiñones 1997). Therefore, in GTR, a barrier membrane is selectively placed during surgery to exclude undesirable tissues and cells from the wound area and to create a space into which progenitor cells with a regenerative potential can migrate.

The term Guided Bone Regeneration (GBR) was introduced by Buser et al (1993) to specifically describe those GTR procedures directed towards bone regeneration. Since that date, GBR has successfully been used clinically to facilitate bone regeneration in extraction sites, to augment deficient alveolar ridges, and in conjunction with dental implants (Hürzeler and Quiñones 1991).

Clinically, GBR involves the placement of a barrier membrane (Hürzeler and Quiñones 1991) (**Figure 2.5**) to:

1. Exclude undesirable gingival epithelium and gingival connective tissues and cells,
2. create a secluded wound area into which progenitor cells from the alveolar bone can migrate and facilitate bone regeneration,
3. protect the underlying blood supply, and
4. stabilize the wound area.

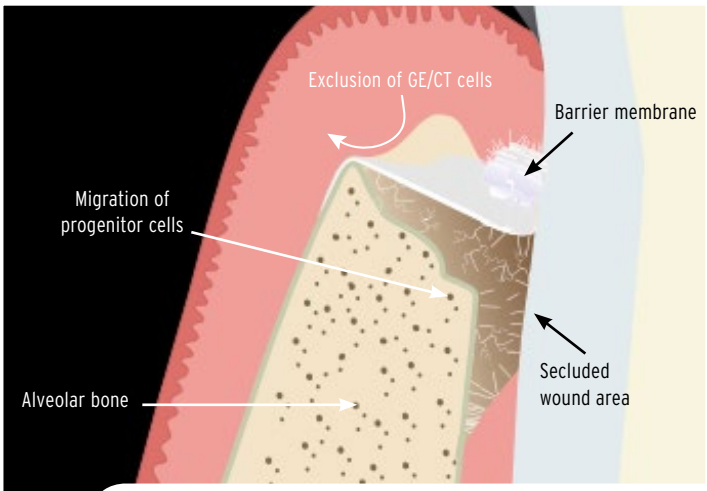


Figure 2.5 Diagram shows placement of a barrier membrane and biological processes at the defect site. The membrane excludes undesired gingival epithelial (GE) and connective tissue (CT) cells from the wound and establishes a protected space into which progenitor cells can migrate.

A barrier membrane is required for all four in order to promote bone regeneration. Adequate space is essential to provide an environment for blood vessel and bone growth. A viable bone graft material is often required to physically support the overlying membrane, thereby avoiding membrane collapse into the underlying space. Protection of the underlying blood clot and wound stabilization, required for bone regeneration, is assured by anchoring of the overlying membrane, which prevents micromovements from affecting the underlying space and the ingrowth of fibrous connective tissue (Buser et al 1996; Urban et al 2009).

In patients with moderate or severe resorption, or when preoperative treatment planning reveals an alveolar bone dimension unsuitable for implant placement at the desired location, then reconstructive surgery using GBR principles is warranted (Fuggazatto et al 1997; Cranin et al 1999; Mayfield et al 1997; Eilan et al 2007).

BONE GRAFTING MATERIALS

Numerous bone grafting materials have been utilized to augment deficient alveolar bone and support sinus lift procedures (American Academy of Periodontology 1992).

- **Autografts** – Involve the transfer of tissue from one site to a second site in the same individual (**Figure 2.6**). This autogenous bone is harvested from the iliac crest or oral cavity (e.g., maxillary tuberosity, mandibular symphysis, coronoid process) and is often considered the 'gold standard' in grafting because of obvious genetic compatibility and no risk of cross contamination (Anitua 1998).
- **Allografts** – A graft taken from an individual of the same species as the recipient but with a different genetic composition (e.g., freeze-dried bone; demineralized freeze-dried bone). Allografts eliminate the need for a second donor site.
- **Xenografts** – Bone graft materials harvested from another species (e.g., bovine or equine bone) for their osteoconductivity.
- **Alloplasts** – Synthetic bone substitutes such as porous and non-porous hydroxyapatite materials that can serve as a scaffold for new bone formation.

The graft material one selects should be biocompatible, without provoking an immunologic response at the treatment site. The chosen material should be readily available and easy to manipulate in the oral environment. In each clinical application, the grafting material should be manipulated as infrequently as possible and be maintained in a sterile environment (Anitua 1999; Anitua et al 2014).

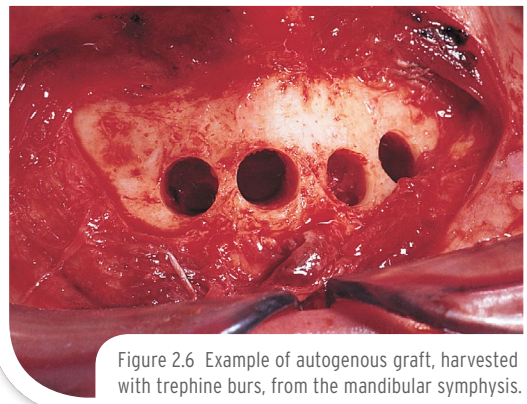


Figure 2.6 Example of autogenous graft, harvested with trephine burs, from the mandibular symphysis.

AVERAGE AMOUNT OF BONE GRAFTING MATERIAL REQUIRED FOR VARIOUS PROCEDURES (ANITUA 1999)

Single Tooth	1-2mL
Two - Three Teeth	2-5mL
Sinus Lift	
Unilateral	5-10mL
Bilateral	10-20mL
Severe pneumatized	20-30mL

Graft materials essentially provide osteoblasts and newly forming bone with a scaffold to guide and support the regenerative process. A barrier membrane should be placed over the graft site to protect the defect during healing and promote the desired selective cell repopulation, e.g., preventing gingival epithelial and connective tissue downgrowth and allowing the ingrowth of alveolar bone (Kay et al 1997; Quinones 1997; Anitua 1999).

GRAFTING CONCEPTS

The dental literature contains abundant information explaining in detail the grafting procedures required to preserve the postextraction site and ready it for implant placement, or ridge augmentation procedures. Following here are several common examples:

Post Extraction Socket Preservation

Following atraumatic extraction of a tooth, the use of an alveolar graft or GBR procedure is necessary to prevent the collapse of the alveolar bone. Possessing all surrounding walls, this site has favorable potential for regeneration (Anitua 1999).

In the post extraction socket preservation technique, full-thickness facial and lingual crevicular incisions—including the papillae and producing well-vascularized flaps of generous size—are made prior to tooth removal. Mucoperiosteal reflection is then performed down to but not beyond the vestibular level. The extractions are then performed, with the clinician taking care to preserve as much of the bony socket as possible.

The site is then inspected and all follicles, cysts, or granulomas are removed using periodontal and surgical curettes. (**Figure 2.7**). At this point, it is advisable to confirm primary flap closure will encompass the entire surgical site after completion of the grafting procedure.

The selected graft material is then prepared for delivery. Depending on the size of the socket, a syringe or bone scoop/placement instrument may be used to deliver the graft particulate to the site (**Figure 2.8**). The patient's blood (alternately saline) may be added to the particulate to help promote integration and contouring. The site is filled with the particulate slurry to the level just below the highest point of bone, and the graft is manipulated into place and covered with a resorbable membrane (Cranin 1999). Care should be taken to allow spacing for vascularity, angiogenesis, and cell migration.

Primary wound closure is then accomplished with an appropriate technique (e.g., continuous box-lock) and suture material (e.g., 4-0 dyed or undyed polyglycolic acid [PGA] sutures) (**Figure 2.9**). The patient is dismissed until the usual one-week postoperative follow-up appointment. The socket area is allowed to heal for a variable amount of time, typically ranging from two to six months, depending on the severity of the initial defect.

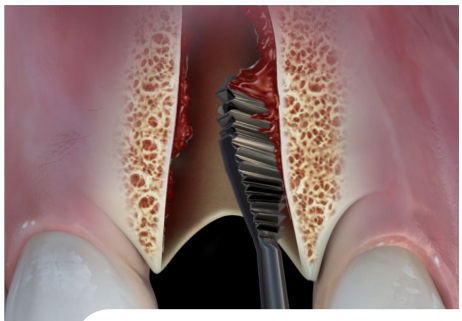


Figure 2.7 Diagram of debridement performed with a periodontal or surgical curette to ready the extraction site for implant placement.

Figure 2.8 Graft material is placed into the site to promote an environment suitable for optimal implant integration.

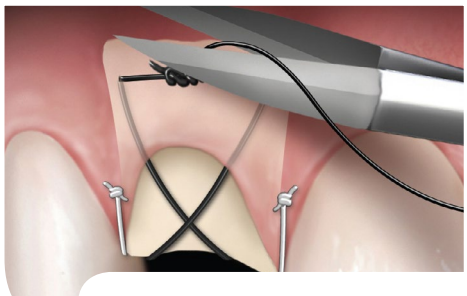


Figure 2.9 Closure is performed using the operator's technique of choice.

Particulate Bone Grafts

Many types of bone particulate can be used in support of GBR at a future implant site. This popular approach entails the mixing of particulate with either saline or the patient's own blood (**Figure 2.10**), placement of this "slurry", and then covering it with a barrier membrane to facilitate new bone growth. Indications for particulate bone grafts include horizontal defects, small vertical ridge defects, postextraction socket preservation, sinus lifts, and procedures that involve grafting simultaneously with implant placement (Ahmad 2012).

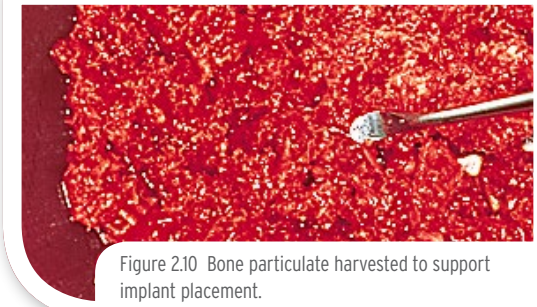


Figure 2.10 Bone particulate harvested to support implant placement.

Onlay Block Grafts

One approach for augmenting a deficient site in order to facilitate implant placement involves autogenous bone blocks that are affixed to residual bone via screws (**Figures 2.11** and **2.12**). Once removed from the symphysis or similar donor site (i.e., obtained with the Jovanovic chisel and grasped with a cortical bone clamp), the graft is prepared to accommodate the residual ridge, sitting atop this bone and fixed in place with mini screws. Block grafts are particularly valuable for making dramatic dimensional changes in ridges of insufficient height (Misch et al 2014); they are similarly indicated for augmentation of ridge width.

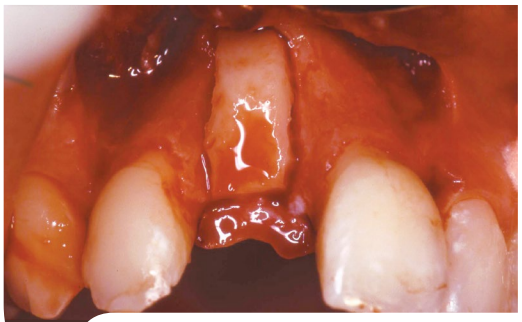


Figure 2.11 Implant site with severe buccal resorption and adaptation of an onlay graft prior to fixation.

Maxillary Sinus Augmentation

The rehabilitation of the partially or totally edentulous maxilla with osseointegrated dental implants has often presented a greater surgical and prosthetic challenge than that of the similarly edentulous mandible. This is due in part to a number of anatomical and physiologic differences between the two arches. A main difference is the presence of enlarged or pneumatized maxillary sinuses on the posterior areas of the maxilla which often result in quantitative and qualitative deficiencies of bone, thus preventing or limiting the placement of dental implants on these areas of the jaws. It is on these cases that a maxillary sinus augmentation procedure is warranted (Garg and Quiñones 1997).

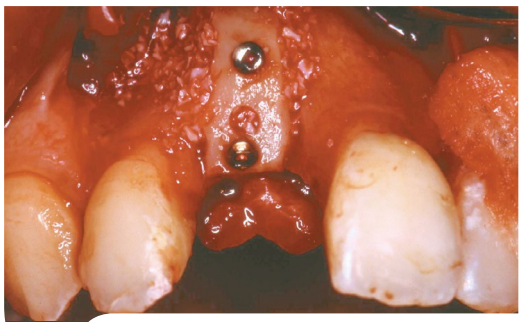


Figure 2.12 Onlay block graft affixed at the treatment site to improve its potential for implant placement.

Sinus Lift Procedure Crestal Approach

This technique elevates the maxillary sinus floor from an alveolar crest approach with the objective of being less invasive and using a minimally invasive flap design. After creating an osteotomy between teeth or along an edentulous ridge, osteotomes, specialized instruments with round or concave ends of varying diameters, are used to elevate the sinus floor **(Figure 2.13)**.

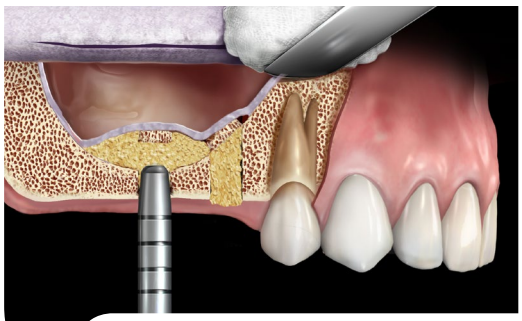


Figure 2.13 Diagram of the crestal approach used to elevate the sinus floor for implant placement.

Existing bone volume is augmented to prepare the hard tissues for placement of dental implants after ossification of the sinus graft. Steady water irrigation is important in such procedures to prevent overheating of bone and instruments alike (Cranin 1999; Summers 1994). The sinus lift procedure via a crestal approach using osteotomes is mostly warranted when limited or moderate bone atrophy of the maxillary sinus is present.

Sinus Lift Procedure Lateral Window Approach

When moderate to advanced pneumatization of the sinus is present, and a significant amount of bone augmentation is required, a sinus lift procedure using a lateral window approach is best indicated. The lateral approach to the maxillary sinus allows the Schneiderian membrane to be elevated with great visibility for the surgeon and augments the vertical amount of bone within the sinus cavity (**Figure 2.14**). Access to the Schneiderian membrane is made through the lateral wall of the maxillary sinus using surgical burs or piezo technology. The Schneiderian membrane can then be retracted using sinus elevation instruments. Compared to surgical curettes, sinus lift curettes have accentuated or prominent angles to gently separate the membrane from the bone. After successful retraction of the membrane, bone graft material is added using a bone syringe. Implants are placed after maturation of the bone graft (**Figures 2.15** and **2.16**) or, in certain circumstances, simultaneously.

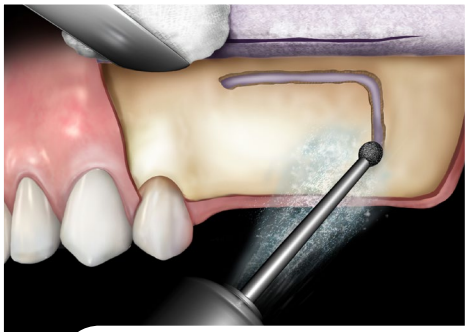


Figure 2.14 Diagram of osteotomy utilized to permit lateral approach to the maxillary sinus region.

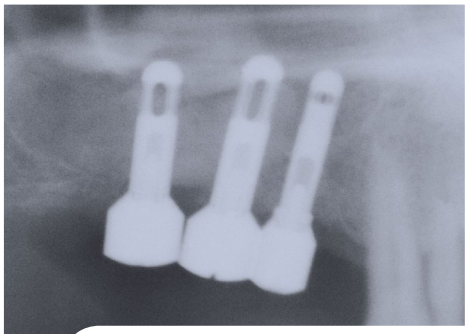


Figure 2.15 Radiograph of the augmented maxillary sinus with three implants after abutment connection.

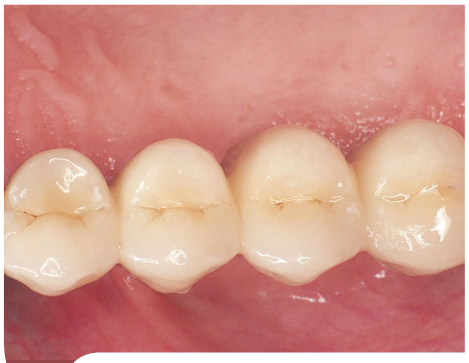
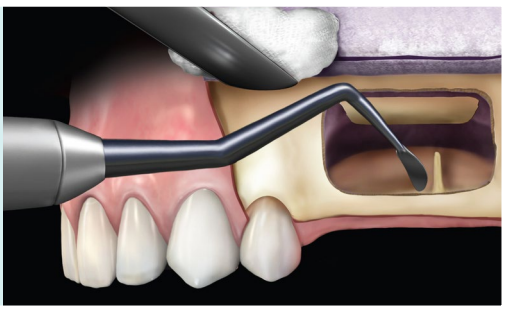


Figure 2.16 Postoperative occlusal view of the definitive implant restorations.

Elevate and Separate Schneiderian Membrane From Bone

Using sinus lift instruments, separate and reflect the Schneiderian membrane from the maxillary bone, and elevate the membrane during lateral sinus lifts for easy access.

- Delicate separation is essential to preserve the Schneiderian membrane
- Variety of sizes and working-end angles for optimal access



Connective Tissue Grafts

Connective tissue grafts (e.g., harvested from the palate or retromolar tuberosity [i.e., acellular dermal matrix]) are often utilized in an additive periodontal procedure such as recession coverage, ridge augmentation, or to alter gingival biotype. The quality of the graft tissues is important for the long-term stability of the regenerative site; the more fibrous the tissue, the better the long-term stability of the soft tissues (Touati et al 2008) (**Figures 2.17** through **2.20**).

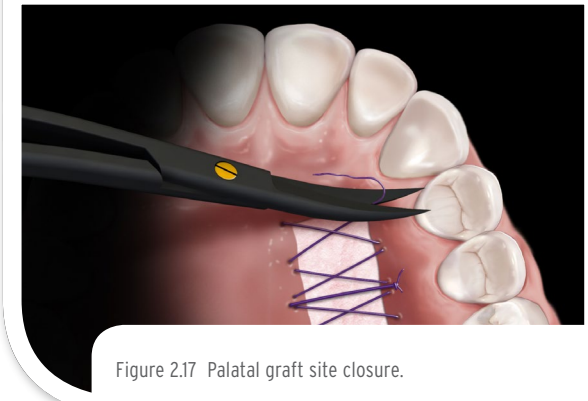


Figure 2.17 Palatal graft site closure.

SUMMARY

Today's bone augmentation concepts enable clinicians to overcome many anatomical barriers to implant placement. Regenerative procedures such as GBR, sinus lifts, and socket preservation improve treatment site(s) quality and allow for predictable healing. Used in combination with bone grafting materials, these concepts promote osteogenesis and completion of prosthetically driven implant placement.

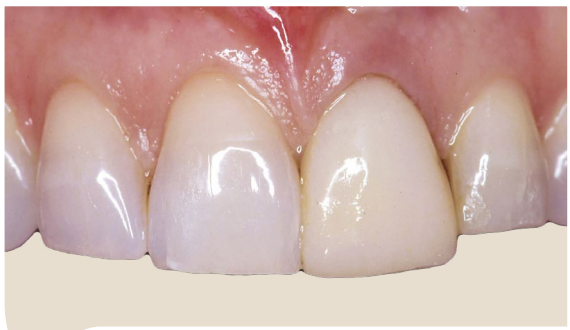


Figure 2.18 Preoperative facial view of implant candidate with thin biotype.

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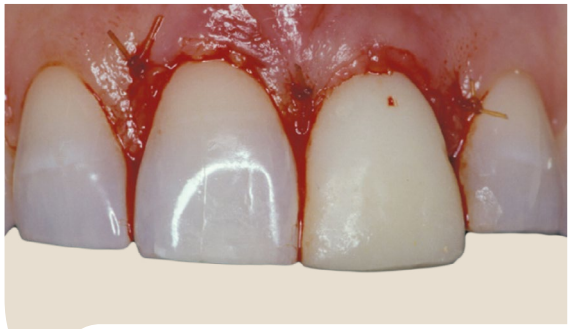

Figure 2.19 Connective tissue graft (CTG) is placed and secured with chromic gut sutures.

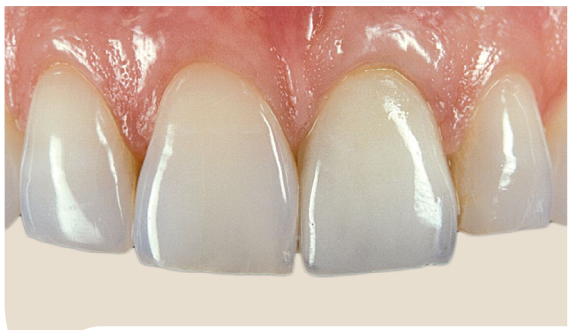

Figure 2.20 Postoperative result of aesthetics achieved with successful implant placement and CTG procedure.

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