Diagnosis & treatment planning for implants

Since implant therapy encompasses both surgical and prosthodontic procedures, integration of these two components of care is essential. The outcome of treatment is dependent upon a thorough understanding of the possibilities and limitations inherent in both the surgical and prosthodontic phases of treatment, a comprehensive evaluation of the patient, obtaining the required records, and developing and communicating a definitive treatment plan to the patient.

Implant prosthodontic treatment can be provided through single crowns (figures 1A, 1B & 1C), fixed partial dentures (figures 2A, 2B & 2C), overdentures (figures 3A, 3B, 3C, 3D & 3E), and fixed complete dentures (figures 4A, 4B, 4C & 4D). There are several factors which can limit conventional prosthodontic treatment and therefore may indicate the need for implant therapy. A knowledge of these factors serves as a foundation for the diagnosis and treatment planning of patients.

FACTORS WHICH LIMIT CONVENTIONAL PROSTHODONTIC TREATMENT

Anatomic Factors

Severe morphologic compromise (residual ridge resorption) of the denture supporting areas that significantly undermines denture stability and retention (figures 5A & 5B).
Sharp residual ridge (figure 6), mylohyoid ridge or prominent genial tubercle that compromises denture stability (figure 7).
Soft tissue ridges lacking a bony foundation (combination syndrome, hypermobile ridges (figure 8).
Pain in the area of the mental foramen or ridge crest of a severely resorbed ridge when palpated.
High frenal/muscle attachments which can be surgically corrected but the need for surgery makes implant therapy a viable treatment alternative in terms of cost and patient inconvenience/discomfort (figure 9).
Large tongue size which limits the neutral space available for removable prostheses (figure 10).
Unfavorable tongue positions that are not level with the mandibular denture occlusal plane and result in the tongue being actively retracted posteriorly (figures 11A & 11B).
Minimal attached mucosa, creating poor stability of a removable prosthesis.

Biologic Factors

Parafunctional habits that cause recurrent soreness and instability of a conventional prosthesis. However, parafunctional habits produce a hostile environment for both conventional and implant prostheses. Careful evaluation is required to determine which treatment modality will provide the most favorable outcome and still permit effective management of the complications that inherently accompany individuals with substantial parafunctional habits (figures 12A & 12B).
Tissue trauma from a prosthesis with accompanying residual ridge resorption (RRR) (figure 11B).
Loss of muscle tone and mass.
Lack of normal saliva quantity/quality (figure 13).
Poor oral musculature coordination which impacts the patient’s ability to wear a mandibular complete denture.
Thin, fragile oral mucosa. Low tolerance of the mucosal tissues as evidenced by sensitivity to palpation, burning sensation, or chronic soreness/need for adjustment of removable prostheses (figure 14).
Potential abutment teeth for a fixed partial denture are intact and their preparation is not desirable due to potential pulpal, periodontal or esthetic consequences (figures 15A & 15B).
Active or hyperactive gag reflex elicited by a removable prosthesis.

Mechanical Factors

Situations where conventional prosthodontics cannot be performed, will result in a substantial compromise or has proven to be inadequate (figure 16).
The patient does not feel their ability to chew is adequate. It has been determined that conventional complete denture wearers have decreased chewing efficiency.1 An extensive literature review of masticatory function has been published that permits a comparison of studies completed on both natural and artificial dentitions.47 When implants are placed and patients chew with implant supported prostheses, it has been determined that their oral function approaches that of a dentate person48 and their masticatory muscle function is equal to or approaches that of patients with natural teeth.49 It has also been determined that the maximal force is lower than the force developed by patients with natural teeth.50 In a 10 year follow-up of the bite force exerted following implant therapy, the findings indicate bite force was significantly higher after 10 years than it was at the baseline examination.51
The remaining natural abutments are inadequate in number, location, size or integrity (figures 17A & 17B). They cannot be successfully used to support a conventional fixed partial denture. The use of implants would permit a fixed prosthesis to be used.
There is a lack of existing prosthesis stability (figures 18A & 18B).
There is a need for greater prosthesis retention (figure 19).
There is a lack of support for conventional removable prostheses (figure 18A).

Esthetic Factors

The position of the teeth in a removable prosthesis does not provide an attractive appearance for the patient while maintaining adequate prosthesis stability and comfort (figures 20A & 20B). Clasps are visible on removable partial dentures (figures 21A & 21B). There have been changes in the occlusal vertical dimension (figure 22).
The need for facial support exceeds what can be accomplished when using conventional prostheses (figures 23A & 23B).

Behavioral Factors

Psychologic inability to wear a removable prosthesis, even if adequate denture retention/stability is present.
The expectations of the patient regarding stability and function will likely not be satisfied by conventional prostheses.
The patient prefers not to have a removable prosthesis.
The proposed abutments are intact and the patient does not want their teeth prepared.

MEDICAL HISTORY
Implant dentistry is an elective procedure and therefore should not usually be performed on patients with severe systemic disease (ASA Status IV patient). The ASA physical status classification serves as an excellent means of identifying patients that are not well suited for implants because of their systemic status (Table 1). The disease processes that will alter the delivery of dental treatment are usually cardiac or pulmonary in origin. Patients in all categories that are apprehensive should be evaluated to determine if they would benefit from a stress reduction protocol (Table 2).

ASA I

The ASA I ranking is reserved for “normal healthy patients,” a description that is easier to clinically recognize than to describe. The ASA I patient should not be limited in activity by any medical condition and should be able to exercise without limitation. Although not universal, some clinicians will increase to ASA II level any patient with a drug allergy. A patient can be elevated in ASA status by either the severity of a disease, the circumstances about his/her disease, or having several mild or controlled diseases.

ASA II

The ASA II patient is one that has a mild to moderate systemic disease that is under control. Some examples are patients with hypertension that is controlled with diet or medication. However, the controlled hypertensive that is taking multiple medications (3 or more) and has other risk factors (obesity, high cholesterol, current smoking, etc.) may need to be elevated to ASA III status. Although the process may appear complicated, the actual clinical stratification is not difficult.

ASA III

A patient is ranked at level ASA III by having a moderate (to severe) controlled (treated) systemic disease or by having multiple mild diseases.

ASA IV

The ASA IV patient is a patient with severe systemic disease that is a constant threat to life.

Physical Status Classification

One of the best indicators of physical status is the ability of the patient to exercise. The LLUSD Physical Status Classification (Tables 3, 4, 5 & 6) helps identify patients at risk. The benchmarks of this classification system and its rankings relate to the following capabilities:

- Climbing one flight of stairs without resting.
- Walk two level blocks at a normal pace.
- Mow the lawn for 5-10 minutes without having to stop.
- Patients who cannot perform such activities are considered to be at risk.
To some, this classification is considered to be overly generous and they prefer a more rigorous set of standards such as the Metabolic Equivalents (METS), an index used by cardiologists to measure cardiac risk (Table 7).

Factors such as fear/anxiety, pain, and vasoconstrictors can cause hypertension and tachycardia, both of which will increase cardiac work. The patient that is able to perform exercise without limitation (>6 METS) would most likely not be at additional risk under these circumstances.

Examples of Contraindications to Any Dental Treatment Because of ASA IV Status

Recent myocardial infarction (<6 months ago) Recent cerebrovascular accident (<6 months ago) Severe cardiac deficit resulting from MI or CVA Severe or uncontrolled angina pectoris

Angina pectoris at rest or after exercise (cardiac)
Severe pulmonary disease that results in:

Cyanosis at rest
The continuous use of oxygen
Cardiac and/or pulmonary disease resulting in limited ability to perform normal daily functions (i.e. the patient who becomes dysneic while washing dishes).
Severe or uncontrolled diabetes mellitus Severe or uncontrolled thyroid disease Severe bleeding disorder

Contraindications to Dental Implant Placement

Patients with compromised healing capacity

Uncontrolled diabetes
History of osteomyelitis in operative site
Debilitating or transmittable infection – hepatitis, HIV Pregnancy Chronic, severe alcoholism
Terminally ill patients

Relative Contraindications to Dental Implant Placement (depends on severity of conditions)

Malignancies with ongoing chemotherapy Head and neck radiation treatment Chemical dependency Recent heart transplant or artificial heart valve Smoking

SYSTEMIC CONSIDERATIONS IN THE DENTAL LITERATURE

There are several diseases, medical conditions, medications/treatments/habits that could affect implant success and they have been evaluated or reported in the dental literature. Some have been definitively correlated with increased implant failure rates, others have been evaluated and no correlation with increased failure has been noted, and data about other factors is limited and does not permit conclusions to be drawn. The factors have included smoking, radiation therapy,
diabetes, chemotherapy, osteoporosis, hormone replacement therapy, scleroderma, Sjogren’s syndrome, Parkinson’s disease, multiple myeloma, and an HIV-positive status.

ASA Status

One paper evaluated 104 consecutive patients who were treated with 313 implants. Forty-four of the patients were ASA Class I, 50 were ASA Class II, and 10 were ASA Class III patients. There did not appear to be an increased implant failure rate amongst the medically compromised patients in this sample.

Smoking

Multiple clinical studies assessed the effect of smoking on implant loss. In the combined data from all 9 studies, a total of 6187 implants were placed, 4645 in non-smokers and 1542 placed in smokers. Of the 4645 implants placed in non-smokers, 234 (5%) were lost. In smokers, 167 of 1542 implants were lost (11%). There were two studies that each evaluated over 2000 implants. PR2PR3 Another paper reported on the benefits of a smoking cessation protocol that improved implant success in smokers. PR4 A review on the interventions for tobacco cessation in the dental setting by Carr and Ebbert101 assessed the effectiveness of interventions for tobacco cessation offered to cigarette smokers and smokeless tobacco users in the dental office or community setting revealed interesting information. This study included six clinical trials after they met the inclusion criteria. The authors report that there is available evidence to suggest that behavioral interventions for tobacco use conducted by oral health professionals incorporating an oral examination component in the dental office and community setting may increase tobacco abstinence rates among smokeless tobacco users. However, there was insufficient evidence to make any conclusions about the effectiveness of these interventions for cigarette smokers.

Radiation Therapy

Eleven papers reported the effect of therapeutic doses of radiation (to the oral area) upon implant loss. In the 11 papers, a total of 157 maxillary and 1195 mandibular implants were placed in irradiated patients. Hyperbaric oxygen was used in three of the papers. Of the 157 maxillary implants, 40 (25%) were lost. Of the 1195 mandibular implants, 73 (6%) were lost. The four largest studies evaluated between 26 and 60 patients. PR5PR6PR7PR8

A systematic review that compared the effects of pre and post implantation radiotherapy reported that the failure rates were similar in these patients (5.4% vs 3.2%). This study also compared failure rates for the same patients by arch and reported that the failure rate in preimplantation radiotherapy was lower for mandible (4.4%) in comparison to the maxilla (17.5%).101

Another study evaluating implants in radiated fibula flaps concluded that acceptable long-term implant success rates may be achieved in the irradiated mandible with vascularized fibula flap reconstruction.102

A systematic review103 by Esposito et al published in The Cochrane Database of Systematic Reviews in 2008 compared success morbidity, patient satisfaction and cost effectiveness of dental implant treatment carried out with and without hyperbaric oxygen (HBO) therapy in
irradiated patients. Screening of eligible studies resulted in only one randomized controlled trial (RCT) by Schoen et al104 being selected. Based on this study the authors concluded that despite the limited amount of research available, it appears that HBO therapy in irradiated patients requiring dental implants may not offer any appreciable clinical benefits.

Diabetes

When the data from 5 papersPR9-PR13 were combined, a total of 1053 implants were placed in 507 diabetic patients. Ninety-three implants were lost in the combined data (9%).

Chemotherapy

There have been 5 publications that reported on patients who received chemotherapy. No adverse effects were reported with endosseous implants in 4 of the papers.PR14-PR17 In one paper, infections developed around subperiosteal/blade implants and there was trauma to the muscosa of one patient with root form implants.18

Osteoporosis

Two papers have reviewed the literature regarding the potential impact of osteoporosis upon dental implants. Neither publication provided scientific indications that osteoporosis alters the success of osseointegrated implants. A retrospective study was performed as apart of one of these papers and no evidence was found of a linkage.19 There are 2 reports of patients with osteoporosis who were taking medications associated with their osteoporosis/arthritis.PR20PR21

Bisphosphonates:

Drugs such as bisphosphonates (Zometa, Aredia, Fosamax, Boniva, Actonel are brand names of some bisphosphonates) have been associated with increased risk of osteonecrosis. An individual who has had current or previous treatment with bisphosphonates is considered to have bisphosphonate-related osteonecrosis of the jaw (BRONJ) if exposed necrotic bone in the maxillofacial region has persisted for more than 8 weeks with no history of radiation to the jaws. It should be noted that the initial and most reports on BIONJ have been related to patients that have been on intravenous bisphosphonates.106 Even though incidences of bisphosphonate related osteonecrosis related to dental implant placement is relatively low (Jeffcoat, 2006)107 implant treatment should still be considered as a potential risk factor for BRONJ. A blood test that reveals a high carboxy-terminal collagen crosslinks in serum has been associated with high bone turnover rate and a higher risk for developing BRONJ. However, this is still not considered very reliable as a predictor for BRONJ. With the limited data in the literature regarding BRONJ and dental/implant treatment, it is recommended to consider every patient on bisphosphonates ‘at risk’ for developing this disease. It is advisable that patients who are going to receive treatment with bisphosphonates receive a thorough dental examination and surgical procedures if required, be completed prior to administering the drug. The American Academy of Periodontology (AAP statement on bisphosphonates, 2011) recommends that invasive dental procedures should be avoided in patients taking IV bisphosphonates unless absolutely necessary. American Academy of Oral and Maxillofacial Surgeons (AAOMFS position paper 2009) recommends that placement of dental implants should be avoided in patients taking IV bisphosphonates on a frequent dosing schedule (4-12 times/year).
(ADA panel 2008) recommends that oral hygiene and regular dental care is the best way to lower risk and also suggests that routine dental treatment should not be modified based on the use of oral bisphosphonates. However, it is suggested that patients on oral bisphosphonates with risk factors may benefit from assessment by an expert in metabolic bone diseases. Individuals who have an increased risk of BRONJ include those, who are older than 65 years, with presence of periodontal disease, using oral steroids, who have been on prolonged bisphosphonate use (more than 3 years) and who are diabetic and smokers. If implants are being considered for patients who are ‘at risk’, information should be provided that discusses risks, benefits and alternatives to proposed treatment. A signed informed consent should be obtained as well, prior to proceeding with surgical procedure.

Hormone Replacement Therapy

The use of hormone replacement therapy in postmenopausal women has not been determined to positively or negatively affect implant success.PR22PR23PR24

Scleroderma

The effect of scleroderma on implant success has been reported in 4 papers that each presented findings related to one patient.PR25-PR28 It does not appear that scleroderma adversely affects implant success.

Sjögren’s Syndrome

Information on the effect of Sjögren’s syndrome is limited and there have been implant losses reported in the papers.PR29PR30

Parkinson’s Disease

Implants were found to be helpful and successful in the paper providing information about patients with Parkinson’s disease.PR31

Multiple Myeloma

One paper provided information about the successful use of implants in a patient with multiple myeloma.PR32

HIV-Positive Status

Implants have been successfully used in patients who were HIV-positive.PR33PR34

DENTAL HISTORY

Oral Hygiene

An evaluation of the patient's existing oral hygiene is essential when developing an understanding of the oral environment. The patient should possess both the dexterity and the desire to maintain oral health. When these attributes are present, knowledge regarding any
special oral hygiene procedures that may be required around dental implants will easily be put into action (figure 24).

Mucosal Characteristics

Mucosa that is too thick may need to be surgically thinned to develop sufficient interarch space, allow for development of appropriate esthetics in the prosthesis, or provide access for oral hygiene procedures.

Attached mucosa is preferable but unattached has been successfully used with implants when the patient’s oral hygiene is adequate.

Interarch Space

There needs to be adequate space available into which a prosthesis/crown can be placed that possesses the required esthetic and structural forms.

The distance from the occlusal plane to the edentulous mucosa at the crest of the ridge should meet the following criteria:

There should be 10-12 millimeters of vertical space for fixed complete dentures or overdentures (figures 25A & 25B). The minimum space required for overdentures is about 8 millimeters (includes retentive mechanism and overlying resin base. When a bar is used as the retentive mechanism, this dimension includes some space between the bar and soft tissue for oral hygiene access.

3-4 millimeters of minimum vertical space is required for structural integrity in fixed partial dentures and posterior single crowns (figures 26A, 26B & 26C). It should be noted that this minimal space may not produce the best esthetic result in terms of morphology and depth of color/translucency in procelain. All-metal crowns/prostheses may be required when minimal space conditions are present.

For anterior single crowns, there should be adequate space present between the opposing tooth and the implant abutment for the type of restoration being fabricated. One millimeter is the recommended minimal space for metal ceramic and all-ceramic crowns. If a maxillary metal ceramic crown will be fabricated with metal forming the lingual occluding surface, it is possible to occupy less than one millimeter of space.

The distance from the occlusal plane to the implant is important when planning fixed partial dentures and single crowns.

Prefabricated abutments range in height from 4-10 millimeters. When the available space is 3-4 millimeters, then custom fabricated abutments are required.

For fixed complete dentures and overdentures, a determination of the occlusal vertical dimension must be made using the established methods (closed speaking space, resting vertical dimension vs. occlusal vertical dimension, esthetics, phonetics, and facial contours). (figures 27A & 27B).

The vertical space between the edentulous area and the opposing teeth must be such that surgical instruments can be used. The vertical space between any implant component that is to be screwed into place and the opposing teeth should permit access with the required screwdriver. A minimum space of 35 millimeters has been recommended.52
Intra-Arch Space

At least 6-7 millimeters of mesiodistal space should be available between adjacent teeth for surgical access in placing an implant for a single crown (figure 1A).

With fixed partial dentures, it has been recommended that at least 17 millimeters of mesiodistal space be available when placing 2 implants and 24 millimeters of space when placing 3 implants.53

For fixed complete dentures, there should be adequate space between the mental foramina to place 4-6 implants with sufficient bone present between the implants (about 3 millimeters) (figure 28). The presence of sufficient space is rarely a problem since the average dimension between the 2 mental foramina has been identified as 47 millimeters.54

Arch Curvature

It is important to develop a uniform symmetric curvature of the multiple implants (usually 4-6 implants) that will be used with a fixed complete denture. The curvature should produce at least 10 millimeters of anteroposterior distance55 between the most anterior implant and a line drawn between the two most posterior implants (figures 28 & 29). The jaw size and morphology should permit the placement of an adequate number of properly positioned implants. Certain square-shaped mandibular residual ridges do not lend themselves to the placement of multiple implants with a substantial anteroposterior dimension. The implants tend to be located in a straight line that may lead to mechanical overload (figures 30A, 30B & 30C).

Jaw relationships

The maxillomandibular relationship can determine whether a fixed complete denture or overdenture should be used.56

A Class II jaw relationship (where the mandibular residual ridge is located posterior to the maxillary ridge) can present some challenges when designing fixed complete dentures. There may be a lack of anterior tooth contact and therefore interdigitation of all the posterior teeth (including second molars) may be required to provide the patient with an adequate number of chewing surfaces. Placing the required number of posterior teeth to permit effective chewing may produce a substantial distal cantilever on the mandibular fixed complete denture that cannot be offset by an appropriate anteroposterior dimension. When this situation is encountered, an overdenture may become the treatment of choice (figure 31).

When a Class II jaw relationship is corrected by anteriorly positioning the mandibular incisor prosthetic teeth, there can be a substantial anterior cantilever present on a fixed complete denture (figure 32).

A Class III jaw relationship may produce a larger than desired posterior cantilever on a mandibular fixed complete denture in order to provide an adequate number of posterior teeth that contact the opposing arch.
The interarch relationship of the maxillary and mandibular arches may produce a posterior reverse occlusal relationship (crossbite). If the desired treatment includes correction of this posterior relationship, mandibular implants would be placed into the buccally located bone and the prosthetic teeth would be lingually located. This relationship could necessitate the formation of holes through the buccal (perhaps visible) portions of the mandibular posterior teeth to provide access to the screws. In the maxilla, the palatal placement of implants due to resorption may affect patient comfort and chewing efficiency as a result of tongue crowding.56

Facial Support

To provide proper facial support due to decreased muscle tone in the area and resorptive bone changes, the bulk of material provided by a denture base (as present on an overdenture) may be needed.57 A fixed complete denture may not provide the required support. Bone Quantity

The occlusocervical height of the residual ridge should be at least 7 millimeters, since that is the shortest available implant length. It should also be remembered that short implants (7-10 millimeters) have a higher failure rate (Table 8).

Bone Quantity

The faciolingual ridge thickness should have a minimal dimension of 6-8 millimeters so the implants can be housed within bone. These minimal dimensions make the implant placement very critical to avoid fenestration/dehiscence of the implant. Minimal faciolingual dimensions do not permit changing the implant angulation in the bone.

Bone Quality

The quality of the bone (as determined radiographically) is an important factor to evaluate (figure 33) since implants that are placed into poor quality bone (Type IV bone) have a higher failure rate. When the data from 7 studies 59, 62-67 are combined (Table 9), the percent of implant loss in Type IV bone was much higher than the loss in Types I-III bone.

Smile Line

It is important to determine how much of the teeth and soft tissue is visible during a maximal smile. As with conventional single crowns and fixed partial dentures, the display of significant amounts of soft tissue increases the esthetic difficulty of implant single crowns and implant fixed partial dentures (figure 34). With fixed complete dentures, patients may smile in a manner that the border of the prosthesis would be visible, producing an undesirable esthetic result and necessitating the use of an implant overdenture.

Phonetics

Proper phonetics may require the use of an overdenture instead of a fixed complete denture.60 61 64 68 The larger base present with the overdenture may be necessary to restrict air passage and develop the prosthesis contours necessary for appropriate diction.

Tongue Size/Position
A large tongue or a tongue that retracts posteriorly and superiorly contributes to difficulty in wearing a conventional mandibular complete denture. When using implants, an overdenture usually provides the required prosthesis stability. However, some very challenging tongues may require the positional stability achievable only with the fixed complete denture that is screwed in place and not removable by the patient.

CLASSIFICATION SYSTEM FOR COMPLETE EDENTULISM

The American College of Prosthodontists has developed a classification system for complete edentulism that is a valuable guide to the diagnosis of difficulty and therefore serves as an aid in identifying those patients where implant therapy will be beneficial. While implants can be used with any of the classes of patients, they are most beneficial to Class III and Class IV patients. It may not be possible to successfully treat certain Class IV patients without the use of implants and prosthodontic techniques of a specialized nature are usually required in addition to the implants to achieve an appropriate treatment outcome.

A Systematic Review of Diagnostic Criteria for the Edentulous Patient

The diagnostic criteria are organized by their objective nature and not in their rank of significance. Because of variations in adaptive responses, certain criteria are more significant than others. However, objective criteria will allow for the most accurate application of the classification system and measurement of its efficacy.

Bone Height: Mandible Only

The identification and measurement of residual bone height is the most easily quantified objective criterion for the mandibular edentulous ridge. In addition, it represents a measurement of the chronic debilitation associated with complete edentulism in the mandible. Despite the lack of a known etiology, it has been established that the loss of denture-supporting structures does occur. Atwood’s description in 1971 of alveolar bone loss is still applicable today: “Chronic progressive, irreversible and disabling process probably of multifactoral origin. At the present time, the importance of various cofactors is unknown.”

The continued decrease in bone volume affects:

- Denture-bearing area
- Tissues remaining for reconstruction
- Facial muscle support/attachment
- Total facial height
- Ridge morphology.

The results of a radiographic survey of residual bone height measurement are affected by the variation in the radiographic techniques and magnification of panoramic machines of different manufacturers. To minimize variability in radiographic techniques, the measurement should be made on the radiograph at that portion of the mandible of the least vertical height. The values assigned to each of the four types listed below are averages that historically have been used in relation to preprosthetic surgical procedures. A measurement is made and the patient is classified as follows:
Type I: (most favorable): residual bone height of 21 mm or greater measured at the least vertical height of the mandible (figure 35)
Type II: residual bone height of 16 to 20 mm measured at the least vertical height of the mandible (figure 36)
Type III: residual alveolar bone height of 11 to 15 mm measured at the least vertical height of the mandible (figure 37)
Type IV: residual vertical bone height of 10 mm or less measured at the least vertical height of the mandible (figure 38).

Residual Ridge Morphology: Maxilla Only

Residual ridge morphology is the most objective criterion for the maxilla, because measurement of the maxillary residual bone height by panoramic radiography is not reliable. The classification system continues on a logical progression, describing the effects of residual ridge morphology and the influence of musculature on a maxillary denture.

Type A (most favorable) (figure 39)

Anterior labial and posterior buccal vestibular depth that resists vertical and horizontal movement of the denture base.
Palatal morphology resists vertical and horizontal movement of the denture base.
Sufficient tuberosity definition to resist vertical and horizontal movement of the denture base.
Hamular notch is well defined to establish the posterior extension of the denture base.
Absence of tori or exostoses.

Type B (figure 40)

Loss of posterior buccal vestibule.
Palatal vault morphology resists vertical and horizontal movement of the denture base.
Tuberosity and hamular notch are poorly defined, compromising delineation of the posterior extension of the denture base.
Maxillary and palatal tori and/or lateral exostoses are rounded and do not affect the posterior extension of the denture base.

Type C (figure 41)

Loss of anterior labial vestibule.
Palatal vault morphology offers minimal resistance to vertical and horizontal movement of the denture base.
Maxillary palatal tori and/or lateral exostoses with bony undercuts that do not affect the posterior extension of the denture base.
Hyperplastic, mobile anterior ridge offers minimum support and stability of the denture base.
Reduction of the post malar space by the coronoid process during mandibular opening and/or excursive movements.

Type D (figure 42)

Loss of anterior labial and posterior buccal vestibules.
Palatal vault morphology does not resist vertical or horizontal movement of the denture base.
Maxillary palatal tori and/or lateral exostoses (rounded or undercut) that interfere with the posterior border of the denture.
Hyperplastic, redundant anterior ridge.
Prominent anterior nasal spine.
Muscle Attachments: Mandible Only

The effects of muscle attachment and location are most important to the function of a mandibular denture. These characteristics are difficult to quantify. The classification system follows a logical progression to describe the effects of muscular influence on a mandibular denture. The clinician examines the patient and selects the category that is most descriptive of the mandibular muscle attachments.
Type A (most favorable) (figure 43)

Attached mucosal base without undue muscular impingment during normal function in all regions.
Type B (figure 44)

Attached mucosal base in all regions except labial vestibule.
Mentalis muscle attachment near crest of alveolar ridge.
Type C (figure 45)

Attached mucosal base in all regions except anterior buccal and lingual vestibules – canine to canine.
Genioglossus and mentalis muscle attachments near crest of alveolar ridge.
Type D (figure 46)

Attached mucosal base only in the posterior lingual region.
Mucosal base in all other regions is detached.
Type E (figure 47)

No attached mucosa in any region.
Maxillomandibular Relationship

The classification of the maxillomandibular relationship characterizes the position of the artificial teeth in relation to the residual ridge and/or to opposing dentition. Examine the patient and assign a class as follows:

Class I (most favorable): Maxillomandibular relation allows tooth position that has normal articulation with the teeth supported by the residual ridge.
Class II: Maxillomandibular relation requires tooth position outside the normal ridge relation to attain esthetics, phonetics, and articulation (eg, anterior or posterior tooth position is not supported by the residual ridge; anterior vertical and/or horizontal overlap exceeds the principles of fully, balanced articulation).
Class III: Maxillomandibular relation requires tooth position outside the normal ridge relation to attain esthetics, phonetics, and articulation (ie crossbite – anterior or posterior tooth position is not supported by the residual ridge).

Integration of Diagnostic Findings

The previous four subclassifications are important determinants in the overall diagnostic classification of complete edentulism. In addition, variables that can be expected to contribute to increased treatment difficulty are distributed across all classifications according to their significance.

Classification System for Complete Edentulism

Class I

This classification level characterizes the stage of edentulism that is most apt to be successfully treated with complete dentures using conventional prosthodontic techniques. All four of the diagnostic criteria are favorable (figures 48A, 48B, 48C, 48D, 48E, 48F, 48G & 48H).

- Residual bone height of 21 mm or greater measured at the least vertical height of the mandible on a panoramic radiograph.
- Residual ridge morphology resists horizontal and vertical movement of the denture base; Type A maxilla.
- Location of muscle attachments that are conducive to denture base stability and retention; Type A or B mandible.
- Class I maxillomandibular relationship.

Class II

This classification level distinguishes itself by the continued physical degradation of the denture-supporting anatomy, and, in addition, is characterized by the early onset of systemic disease interactions, patient management, and/or lifestyle considerations. Affects mostly the mandible (figures 49A, 49B, 49C, 49D, 49E, 49F, 49G & 49H).

- Residual bone height of 16 to 20 mm measured at the least vertical height of the mandible on a panoramic radiograph.
- Residual ridge morphology resists horizontal and vertical movement of the denture base; Type A or B maxilla.
- Location of muscle attachments with limited influence on denture base stability and retention; Type A or B mandible.
- Class I maxillomandibular relationship.

Class III

This classification level is characterized by the need for surgical revision of supporting structures to allow for adequate prosthodontic function. Additional factors now play a significant role in treatment outcomes (figures 50A, 50B, 50C, 50D, 50E, 50F, 50G & 50H).

- Residual bone height of 11 to 15 mm measured at the least vertical height of the mandible on a panoramic radiograph.
- Residual ridge morphology has minimal influence to resists horizontal and vertical movement of the denture base in the maxilla; Type C maxilla.
- Location of muscle attachments with moderated influence on denture base stability and retention; Type C mandible.
Class I, II, or III maxillomandibular relationship.

Conditions requiring preprosthetic surgery:
- Minor soft tissue procedures
- Minor hard tissue procedures including alveoloplasty
- Simple implant placement, no augmentation required
- Multiple extractions leading to complete edentulism for immediate denture placement
- Limited interarch space (18-20mm)
- Moderate psychosocial considerations, and/or moderate oral manifestation of systemic diseases or conditions such as xerostomia.
- TMD symptoms present.
- Large tongue (occludes interdental space) with or without hyperactivity.
- Hyperactive gag reflex.

Class IV

This classification level depicts the most debilitated edentulous condition. Surgical reconstruction is almost always indicated but cannot always be accomplished because of the patient’s health, preferences, dental history, and financial considerations. When surgical revision is not an option, prosthodontic techniques of a specialized nature must be used to achieve an adequate treatment outcome (figures 51A, 51B, 51C, 51D, 51E, 51F, 51G & 51H).

- Residual bone height of 10 mm or less measured at the least vertical height of the mandible on a panoramic radiograph.
- Residual ridge morphology offers no resistance to horizontal and vertical movement; Type D maxilla.
- Location of muscle attachment that can be expected to have significant influence on denture base stability and retention; Type D or E mandible.
- Class I, II, or III maxillomandibular relationship.
- Major conditions requiring preprosthetic surgery:
  - Complex implant placement, augmentation required
  - Surgical correction of dentofacial deformities
  - Hard tissue augmentation required
  - Major soft tissue revision required, ie, vestibular extensions with or without soft tissue grafting
  - History of paresthesia or dysesthesia
  - Insufficient interarch space with surgical correction required.
  - Acquired or congenital maxillofacial defects.
  - Severe oral manifestation of systemic disease or conditions such as sequelae from oncological treatment.
  - Maxillo-mandibular ataxia (incoordination)
  - Hyperactivity of tongue that can be associated with a retracted tongue position and/or its associated morphology.
  - Hyperactive gag reflex managed with medication.
  - Refractory patient (a patient who presents with chronic complaints following appropriate therapy).
  - Psychosocial conditions warranting professional intervention.

**ESTHETIC ASSESSMENT**

The word esthetic pertains to beauty and therefore an assessment of esthetics inevitably involves a comparison between what is perceived to be beautiful and what is actually present.
The esthetic perceptions of both the patient and the practitioner play a role in the evaluation of esthetics but ultimately the patient is the one that needs to be satisfied with the esthetic result achieved through implant therapy. Therefore, it is important to ascertain what the patient perceives to be beautiful and determine what they would like to see accomplished through the treatment.

A knowledge of facial/dental esthetics is valuable when evaluating the current status of the patient. It also permits esthetic norms to be discussed with the patient in order to elicit their feelings about what they would like to see when the treatment is complete.

Attractiveness

When the most important attractiveness characteristics were identified by 308 college age students, they indicated general appearance was the most important, followed by the face. The eyes and the mouth were the two facial features most commonly associated with facial attraction. The focus upon the eyes and mouth occurs because they are the moving parts of the face, they provide emotional expressions, and they play an important role in recognition.

Dentists have studied facial and dental esthetics for some time to determine the characteristics that are considered to be “normal” and to identify esthetic norms that can be used in evaluating the existing oral environment and planning dental treatment. Facial esthetics have been evaluated from both a frontal view and a profile view. The effect of racial variants has also been evaluated in multiple studies.

Facial Esthetics – Extraoral Frontal View

From a frontal view, the relationship between the eyes and the mouth has been a focus of attention. The orientation of the interpupillary line with the lips and mouth commissures during resting of the facial muscles (figure 52) and during smiling (figure 53) have been evaluated. Additionally, the relationship between the line bisecting the interpupillary line and the nose, upper lip, and the midline of the maxillary central incisors has received attention (figure 53). These factors have been evaluated in the dental literature and a comparison has been made between several races for both females and males. A prosthodontic evaluation of frontal esthetics has usually included an assessment of the support of the lips by the teeth, the support of the corner of the mouth, and the degree of lip eversion.

Facial Esthetics – Intraoral Frontal View

When a patient smiles, several frontal relationships between the teeth and the lips/cheeks have been studied. Based on a review of recent research on the esthetics of a smile, the preferences of patients have been compared with the esthetic norms present in the population.

Curvature of the Upper Lip During Smiling

The most common form found in the population was a straight upper lip where the two mouth commissures were at the same level as the center of the inferior border of the upper lip (figure 54). A nearly equivalent incidence was recorded for a lip curvature where the center of the lip
was located superior to the two commissures. The least common incidence was a lip curvature where the commissures were raised above the level of the center of the upper lip.

When the preferences of patients were determined by having the patients evaluate photographs, they preferred the form where the commissures were superior to the center of the upper lip which was the least commonly occurring form in the population studied. The least preferred form of lip curvature was the one where the center of the upper lip was raised above the level of the two commissures (figure 54). This is the only frontal view parameter where the patient preference differed from the esthetic norms measured in the population.

Amount of Visible Gingiva (Smile Line Height)

The most common relationship encountered in the population consisted of the entire clinical crowns of the incisors being visible during smiling along with the interdental papillae (very little or no gingival was visible apical to the center of the crowns). The next most common occurrence was the display of gingiva apical to the clinical crowns (a high smile line) followed by a low smile line (figure 55).

The patient preferences paralleled the relationships found in the population.

Incisal Edge Parallelism with the Superior Border of the Lower Lip

A parallel relationship between the incisal edges of the maxillary teeth and the superior border of the lower lip was the most common relationship found in the population and it was also the one preferred by most patients (figure 56). A mediolaterally straight alignment of the maxillary incisors was the second most commonly encountered form and that was the second most common form preferred by patients. A reverse curvature of the maxillary incisors was the least common arrangement and also had the lowest patient preference score.

Maxillary Incisal Edge Proximity to the Superior Border of the Lower Lip

The most common relationship found in the subjects was the presence of a slight space between the maxillary incisal edges and the lower lip. The next most common relationship was contact between the maxillary anterior teeth and the lower lip during smiling and the least common form was when the lower lip covered part of the maxillary anterior teeth (figure 57).

Equivalent patient preferences were recorded for the relationships that retained a space between the maxillary anterior teeth and the lower lip and the relationship where there was contact between the lower lip and the maxillary anterior teeth. The lowest patient preference score was recorded for the relationship where the lower lip covered some of the incisal aspects of the maxillary anterior teeth (figure 57).

Number of Maxillary Teeth Visible During Smiling

In the population, the most common display of maxillary teeth included the second premolars. The next common occurrence was equally divided between the first molars being visible during
smiling and only displaying the first premolars. The patients preferred smiles where the first molars were visible (figure 58).

Facial Esthetics – Extraoral Profile View

The following factors have been evaluated in the literature: profile convexity (figure 59), interlabial contour (figure 60), nasolabial angle (figure 61), the relationship of the upper and lower lip to Rickett’s E-plane (figure 62), and the mentolabial angle (figure 63). These parameters of esthetics have been evaluated in multiple races and for both males and females.

BEHAVIORAL ASSESSMENT

It is important to assess the behavioral characteristics and psychologic needs of the patient and determine their expectations so as to compare those needs/expectations with anticipated outcomes of treatment that appear to be achievable. Prosthodontics has traditionally used several methods to evaluate the patient that were originated for use with complete denture patients but remain valid for use with patients seeking implant therapy.

The House Classification

Dr. M. M. House developed a classification for mental attitude that has been widely used in removable prosthodontics.

Indifferent: Have little concern for oral health; having treatment performed because relatives decided it should be done.

Hysterical: Dissatisfied with all treatment

Philosophical: Good, rational, sensible patient. Trusts the judgment of the dentist.

Exacting: Potentially good but have some unfavorable experiences. They are concerned about their oral health and try to be cooperative.

Minnesota Multiphasic Personality Inventory

The Minnesota Multiphasic Personality Inventory (MMPI) has proven to be very reliable in providing information concerning the emotional status of patients. The patient is presented with 566 statements and asked to respond “true” or “false”. This inventory requires 45 to 90 minutes for a patient to complete. Special scoring and evaluating procedures are required that cannot be easily accomplished by the dentist. The service is available through several computer centers.

The Cornell Medical Index (CMI)

The Cornell Medical Index (CMI) is composed of 195 yes-no questions. It is designed so that only the “yes” responses are significant and they suggest the presence of a problem. It can be scored and interpreted by the dentist.

Levin and Landesman Questionnaire
The Levin and Landesman questionnaire can be used during the first visit with prospective denture patients. It was designed to identify those patients, who, for one reason or another might be unable to cope with complete dentures. The questions help reduce the mental trauma that can occur when attempting to please an impossible patient.

Difficult Denture Birds

Some characteristics of problem denture patients have been identified through a humorous comparison with the sighting of birds.

Patient Expectations

The authors suggest that using the following items can be helpful in determining whether a patient’s expectations can be satisfied:

- Relationship with the patient. The perceived quality of the relationship that is likely to develop between the practitioner and patient is a good indication of the treatment success that is likely to occur. A high level of interaction, mutual understanding and trust coupled with a good inner feeling of comfort are valuable indicators of the potential for success.
- Flexibility and cooperation of the patient. A patient who demonstrates flexibility related to appointment scheduling, payment schedules, and treatment options is generally a patient that can be satisfied.
- Past history with prosthesis/prostheses. A thoughtful discussion with the patient regarding their likes, dislikes, and experiences with previous prostheses is invaluable in predicting success. The patient’s ability to follow directions. Valuable insight can be gained by giving a new patient some instructions to follow as part of the first interaction and at an early time during the first appointment. It is then important to determine if they remember the instructions at the end of the appointment and if they remember and have followed the recommendations at the next visit.
- Past behavioral history. When the opportunity presents itself, it is a good practice to ask the patient about what they liked and didn’t like about their previous dental care and how they enjoyed their interactions with previous dentists. Complimenting treatment provided by a previous practitioner helps to initiate a discussion.

BASIC RADIOGRAPHIC EVALUATION

An important part of the diagnosis is determining if sufficient bone is available for the placement of implants. When there are teeth approximating the edentulous areas, it is important to determine if the teeth and bone are free from pathology. It is also important to locate vital anatomic structures that can interfere with implant placement such as the maxillary sinus, inferior alveolar canal, mental foramina, and approximating roots.

Radiographic images are used to assess available bone sites for implant placement since the number, angulation, and dimensions (length and width) of implants is dependent on the available bone volume. Clinicians also use radiographs to identify bone quality. To aid in the treatment planning of implant patients, a classification system (A-E) has been developed for both the maxilla and mandible related to the degree of resorption and morphology of the residual ridge. The bone quality noted radiographically has also been classified (figures 64, 65A, 65B, 65C & 65D).
The faciolingual dimensions of the residual bone have also been measured using bone sounding and ridge mapping. With bone sounding, a periodontal probe is pushed through anesthetized mucosa to locate the depth of the bone beneath the facial and lingual mucosa. Special bone calipers with sharp points have also been developed. The points more easily penetrate the anesthetized mucosa and a measurement scale identifies the bone thickness.82

The assessment of bone sites for implant placement can sometimes be made using basic radiographs (periapical and/or panoramic radiographs) and other times advanced radiographs are required.

Various diagnostic imaging techniques are described for the assessment of bone prior to implant placement and indications for various types of radiographs have been described.42

Panoramic Radiography

Indications/Use(s)

Initial evaluation of bone dimensions and in screening for the detection of pathologic conditions when planning for dental implants
Provides approximate information regarding the location and dimensions of the maxillary sinus, nasal cavity, inferior alveolar canal, and mental foramen.
Limitations

Magnification of up to 25% has been reported which results in a linear measurement error of up to 3.0 mm.
The poor image resolution and unpredictable image distortion limits its usefulness when assessing bone adjacent to implants during follow-up.
May provide information to determine vertical dimension, but is unreliable for measurements in the horizontal direction and for assessing bone quality. (figures 3B & 5B).

Periapical Radiography

Indications/Use(s)/Advantages

Allows accurate horizontal measurement such as the proximity of adjacent roots (figures 66A, 66B & 66C).
Permits an accurate evaluation of the bone response adjacent to dental implants.
Recommended to evaluate passive fit between implant components.
High quality.
Low cost.
Low radiation exposure.
Readily available.
Limitations

Vertical and horizontal linear measurements are accurate if paralleling techniques are used to prevent image distortion.
Does not provide a cross-sectional view of the bone and only a small area of the jaw is visible.
MOUNTED CASTS AND DIAGNOSTIC TOOTH ARRANGEMENT
A thorough evaluation includes mounted diagnostic casts and a diagnostic tooth arrangement. 83

With complete denture patients, diagnosis should include completion of all the usual appointments used in the fabrication of new complete dentures. The usual exacting procedures should be used to develop wax trial dentures.84 The patient’s evaluation and approval of the wax trial dentures is a necessary component of implant treatment and can provide valuable information that clarifies patient expectations.52 This process allows the appropriate tooth positions to be identified/approved by the patient which guides implant positioning.

Following completion of the previous steps, a tentative treatment plan is developed as to the type of implant prosthesis that will be used (single crown, fixed partial denture, fixed complete denture, or overdenture).

Additional details regarding design principles and clinical procedures associated with each type of prosthesis are discussed in the sections of this CD that deal with each of these prostheses.

TENTATIVE TREATMENT PLAN

Determining the feasibility of using an implant single crown or fixed partial dentures is relatively straightforward after the previously described aspects of diagnosis have been completed. However, with completely edentulous patients, determining whether a fixed complete denture or overdenture should be used requires consideration of additional factors.565758

Factors that help identify the preferred treatment for completely edentulous patients (fixed complete denture versus overdenture):

Jaw Shape – A square mandible may produce an unfavorable, straight alignment of the implants required for a fixed complete denture, leading to unfavorable leverage being exerted on the implants and screws that attach the prosthesis to the implants.

Jaw Size – Substantial bone resorption often indicates the need for an overdenture for reasons of esthetics, phonetics, and biomechanics.

Maxillomandibular Relationships - Very few opposing teeth may contact the fixed complete denture when there is a severe Class II relationship due to limitations in the posterior cantilever length. There may also be a significant anterior cantilever.

Musculature and Habits - Overactive oral musculature make is more likely to dislodge an overdenture.

Tongue Size and Positioning - An abnormal tongue position or large tongue may favor use of a fixed complete denture that is less likely to be dislodged by the tongue movement.

History of Mucosal Pressure Intolerance52 – A past history of intolerance to pressure on the mucosa by a conventional removable prosthesis is not a significant factor when there is an absence of soft tissue contact through use of a fixed complete denture.

Smile Line - A high smile line may reveal the border of an implant fixed complete denture.

Facial Soft Tissue Support – Facial support has been determined to be better with implant overdentures.5960 With patients that lack normal muscle tone, the mentolabial angle formed between the lower lip and chin may become very obtuse (flat). The patient may have become accustomed to this look and not like the appearance of a fixed complete denture that produces a more normal mentolabial depression52 (figures 67A & 67B).
Salivation – A lack of normal saliva makes it more likely that the mucosa will be irritated by the presence of an overdenture base.

Behavioral Profile – The functional and esthetic expectations of patients require careful evaluation to determine whether a fixed or removable prosthesis has the best possibility of satisfying the psychologic needs of patients.

Phonetics – Multiple authors indicate better phonetics were developed with implant overdentures.

Esthetics - May be better with implant overdentures if the base provides better facial support.

Patient’s Ability to Maintain Good Oral Hygiene – Palatal positioning of maxillary implants due to the degree of bone resorption may produce unfavorable hygiene contours in a fixed complete denture.

Complexity of Treatment – The complexity of treatment needs to be evaluated in light of the dentist's ability to perform the treatment at the required level of care and the patient's ability to tolerate the number and length of required appointments. Fixed complete dentures are more technically demanding, require more experience, and require more patient appointments.

Cost – Fixed complete dentures cost considerably more than implant overdentures.

Time - Generally, more time is associated with the planning, fabrication and placement of implant fixed complete dentures.

Required Maintenance – The percentage of patients requiring postplacement adjustments or additional treatment procedures is higher with implant overdentures.

RADIOGRAPHIC TEMPLATE

When advanced radiographs (such as linear tomograms or computed tomography) are required to determine if sufficient bone dimensions are available and to more precisely locate the position of vital structures, it is necessary to fabricate a radiographic template.

With single crowns and fixed partial dentures, the position of the tooth/teeth is diagnostically determined and the appropriate radiograph made using some method that identifies the position of the prosthetic tooth/teeth on the radiograph. Metal objects (such as BB's or wires) have been used as well as barium impregnated resin teeth or gutta percha embedded into resin (figures 68A, 68B, 69A, 69B, 70A, 70B, 71A, 71B, 71C, 71D, 71E & 71F).

With completely edentulous patients, the wax trial placement appointment is completed and then the dentures are duplicated for use as a template during the radiographic evaluation. The number of implants, their location and the type of definitive prosthesis can then be determined (figures 72A, 72B, 72C & 72D). The denture is duplicated in such a way that the teeth contain a radiopaque material (such as barium impregnated resin or gutta percha) or porcelain teeth are used. Teeth fabricated in this manner will be radiographically visible, allowing the tooth positions to be related to the underlying bone.

Through the radiographic evaluation, it is possible to validate the proposed treatment plan by verifying that there is adequate bone below the proposed tooth locations when the teeth are arranged appropriately for esthetics and function.
After reviewing all the factors mentioned, the final treatment plan is decided. A surgical template is then made (figures 73A, 73B, 73C, 73D, 73E, 73F, 74, 75A & 75B) by duplicating the wax trial prosthesis in clear acrylic resin.

ADVANCED RADIOGRAPHS

Using a radiograph template, the selected advanced radiograph is made and analyzed. The bone dimensions are measured and the location of the bone relative to the prosthetic teeth can be analyzed. Linear tomograms and computed tomography are the 2 most common types of advanced radiographs used in conjunction with implant dentistry.

The effectiveness and accuracy of linear (conventional) tomography has been validated and articles have described the clinical use of linear tomography in presurgical planning. The accuracy of linear and computed tomography has also been compared with the accuracy of panoramic and periapical radiographs.

The following information is a synopsis of a published literature review.

Occlusal Radiography

Indications/Use(s)

May be used for the edentulous mandible to obtain information regarding faciolingual dimension and contour (figure 76).

Limitations

Anteriorly, the mental and genial tubercles may make the mandible appear wider.

Occlusal radiographs do not provide information about vertical bone dimensions.

Cephalometric Radiography

Indications/Use(s)

Evaluation of the anterior maxilla and mandible prior to implant placement (figures 77A & 77B). Accurate determination of bone height and width at the anterior midline of both the maxilla and mandible.

Evaluating residual ridge relationships, existing occlusal schemes, and designing new occlusal schemes.

Relatively low cost.

Relatively low radiation exposure.

As a less expensive alternative, an occlusal radiograph can be used laterally to evaluate the anterior mandible and maxilla.

Limitations

Availability may be limited.

Posteriorly, bone width and height is not accurately revealed.

Linear Tomography

Indications/Use(s)
The simultaneous movement of the film and x-ray beam produces an image of a slice of tissue thereby providing assessment of bone width and height (figures 68A & 70B). Posteriorly, linear tomograms permit the assessment of bone width and height in relation to adjacent anatomic structures (maxillary sinus, submandibular gland fossa, and mandibular canal). They provide a precise method of measuring the distance between the edentulous ridge crest and the mandibular canal. Anterior tomography effectively determines bone dimensions and locates anatomic structures such as the nasal cavity, incisive canal, incisive fossa, canine fossa, and sublingual gland fossa. Large metallic restorations may obscure the image and create difficulties in interpreting the image. The measurement error for tomograms is less than 1 millimeter of the actual measurement.

Limitations

The radiation exposure is higher than for panoramic or intraoral radiography, but lower than computed tomography. To locate the position of the bone relative to the teeth small metallic markers, gutta percha or barium impregnated resin teeth are required (figures 68A, 68B, 70A & 70B).


Indications/Use(s)

It is widely advocated for use in assessing potential implant sites and planning for complex treatments. The recommended slice thickness for implant analysis is 1.5 to 2 millimeters. The reported CT scan error is between 0.5 to 2 millimeters. The unit is capable of providing a numerical value of the linear attenuation coefficient of a region of bone, which is used to provide an indication of bone quality. Special software is available that creates 3-D images. The information can be analyzed in a computer, implant design/placement can be simulated, and measurements can be made of the forces/moments that will occur with proposed designs.

Limitations

There is a greater cost. There is greater radiation exposure for a CT than for other imaging techniques. Radiologic imaging is a useful clinical diagnostic tool for planning implant treatment. The radiation dose, cost, availability, and the patient's comfort must be weighed against diagnostic accuracy for all radiographic techniques described.

DETERMINATION OF DEFINITIVE TREATMENT PLAN

Following completion of the radiographic evaluation, the feasibility of the tentative treatment plan can be validated. The number, length and diameter of the implants can be finalized as can the design of the prosthesis. It is also possible to determine if bone grafting will be required to provide more bone height or width.
When these decisions are made, it is possible to determine the cost of treatment, total time required to provide the treatment, the approximate number of appointments and the length of time required for each appointment.

PATIENT PRESENTATION, ACCEPTANCE, AND INFORMED CONSENT

The definitive treatment plan should be presented to the patient and they should have an opportunity to verify that they understand the treatment and ask any questions they have. The patient can then accept or decline the treatment process. When they accept the plan of treatment, they should sign an informed consent document which serves many purposes.90-95

An informed consent should encompass the following items:

- A description of the proposed treatment.
- The benefits of the proposed treatment.
- Alternatives to the proposed treatment.
- Common risks.
- Limitations of the proposed treatment.
- Consequences of not performing the proposed treatment.

Informed consent must be voluntary and be given by someone who is of legal age and capable of mentally understanding the information contained in the document and the proposed treatment.9697

An example of an informed consent document that could be used in conjunction with implant single crowns is shown in Table 10. Other examples of informed consent documents have been published.9899

A thorough and organized presentation of the information related to a patient’s treatment facilitates their acceptance of the treatment. The presentation should be made when there is sufficient time to answer questions and make the patient feel they are receiving 100 percent of everyone’s attention. A comprehensive discussion with the patient would include the following items:

Treatment Details/Time

- Number of implants
- How many implants will be placed in each arch?
- Will they be placed at the same time?
- Type of prosthesis
- Provisional prostheses required
- Will an interim prosthesis be required for diagnostic purposes?
- Will an interim prosthesis be required to permit proper esthetics and function?
- Who will place implants?
- Does the patient have a referring surgeon?
- Sequence of procedures
- It is good to review the treatment sequence from diagnosis to completion of care so the patient understands the order and time involved

Benefits of the Treatment
Potential impact on appearance
Potential functional benefits
Preservation of the biologic environment
Alternative Treatment Possibilities

Other types of treatment
None
Conventional fixed partial denture
Conventional removable partial denture
Conventional complete denture
Implant overdenture versus fixed complete denture
Advantages/disadvantages of other prostheses
Cost of other treatment alternatives
Your personal recommendation
Common Risks (Success/Failure/Complications Data)

It is recommended that information be presented to the patient regarding surgical complications, implant loss data and the time period during which loss is most likely to occur, the most common complications associated with each type of prosthesis, and potential limitations in the treatment to be provided. The following information represents a synopsis of material presented later in the CD. For additional information, see the sections on Implant Complications, Implant Single Crowns, Implant Fixed Partial Dentures, Implant Overdentures, and Implant Fixed Complete Dentures.

Surgical complications

Three surgical complications have been reported in the dental literature in such a manner that it was possible to calculate incidence percentages.

The mean incidence of hematomas/edema/ecchymosis was 24% with a range from 12% to 30% of the patients.
The mean incidence of neurosensory disturbance was 6% with a range from 0 to 39%.
There are other complications that do not occur very often such as mandibular fracture which occurred in 0.3% of the patients.
Other papers reported complications but did not include incidence data. These complications included devitalization of adjacent teeth, life threatening hemorrhage, implant displacement into the mandibular canal, screwdriver aspiration, descending necrotizing mediastinitis, intraocular hemorrhage, and singultus (hiccups). A detailed discussion of the types of surgical complications that can occur in conjunction with root form implants is presented in the Clinical Complications section of this CD.

Implant loss data and time of loss

Implant loss varies with the type of prosthesis being used (Table 11).
Implant loss is greater in the maxilla than mandible with fixed complete dentures (10% versus 3%) and overdentures (21% versus 5%).
Maxillary and mandibular implant losses are the same with fixed partial dentures (6%).
The highest implant loss occurs with maxillary implant overdentures (21%).
There is slightly more preprosthetic implant loss than postprosthetic loss with fixed complete dentures. With overdentures and fixed partial dentures the percentage of preprosthetic loss is much greater than the postprosthetic loss (Table 12). There is slightly more postprosthetic implant loss than preprosthetic with single crowns. More than one-half (59%) of the postprosthetic failures occur during the first year after prosthesis placement (Table 13). Thirty-four percent of the postprosthetic failures occur by the end of the second year.

Most common complications associated with implant single crowns

- Prosthesis screw loosening with early designs (26%)
- Abutment screw loosening with early designs (25%)
- Fistula at implant-abutment level related to screw loosening (8%)
- Abutment screw loosening with new screw designs (7%)
- Esthetic complications (7%)

Complication number 4 indicates that the early screw loosening complications have been corrected. The overall complications incidence with implant single crowns is the lowest reported with any type of implant prosthesis.

Most common complications associated with implant fixed partial dentures

- Fracture of the resin occluding surface (22%)
- Neurosensory disturbance (15%)
- Fracture of the porcelain occluding surface (14%)
- Prosthesis screw loosening (10%)
- Esthetic complications (8%)

Most common complications associated with implant overdentures

- Need for activation of the mechanical retention device (33%)
- Dissatisfaction with the retention of the opposing complete denture (24%)
- Maxillary implant loss (21%)
- Need for a reline of the overdenture (20%)
- Gingival inflammation/proliferation (19%)

The incidence of complications recorded with overdentures indicates this type of prosthesis is associated with the greatest number of complications. Many of the complications are not catastrophic and do not result in failure of the prosthesis. However, it is important that the practitioner and patient understand the types of procedures and maintenance that may be needed over time. It is important that a clear understanding be established as to the financial responsibilities and time commitments associated with such care.

Most common complications associated with implant fixed complete dentures

- Maxillary implant loss (10%)
- Prosthesis screw loosening (8%)
- Gingival inflammation/proliferation (7%)
- Implant dehiscence prior to surgical uncovering (6%)
- Metal framework fracture (6%)
A comprehensive discussion of the types of complications that occur with each type of prosthesis is presented in the section of the CD that discusses each prosthesis and also in the clinical complications section. However, a working knowledge of the 5 most common complications associated with each type of prosthesis is helpful when discussing this topic with patients.

Limitations of Treatment

There should be a discussion of any factors you feel may limit the treatment result (esthetic, functional, biologic).

Consequences of Not Performing the Treatment

Compromised esthetics
Continued bone loss
May not be able to accomplish the treatment at a later date
The treatment may be more complex and costly at a later date
Adjacent and/or opposing teeth could move over an extended time period
Delaying the treatment may have no effect

Financial Considerations

Total cost
Possible additional costs
Are there any additional procedures that may be needed during the course of therapy and how much would they cost?
Methods of payment
Check, credit card, installments
How many payments and when should each be made?
Any discounts for full payment before treatment
How much payment is required before treatment is started?

Patient Factors

Comfort/protection

Amount of discomfort expected
Level of patient concern about discomfort
Need for stress reduction protocol
Medications needed (antibiotics, pain medication)
Inconvenience to patient

Time when they cannot wear a prosthesis
Number of appointments where someone will need to accompany them
Number and frequency of appointments
Expectations of the patient

Commitment to long term follow-up care
Understanding the importance of long-term care
Interest in and capability of performing oral hygiene
Commitment to home care
Understanding of expected esthetic outcomes
Understanding of expected functional outcomes
Long Term Care

Number of required post-placement appointments
Consequences of not returning for follow-up care
Importance of first two years of follow-up care
57% of the complications occur during the first year
34% of the complications occur during year two
Time span when post-placement care will be provided at no charge
Time at which charges will be made
Cost of typical continuing care examinations and radiographs
Financial management of failure
Who is responsible should a failure occur?
What type of failures are completely covered by the practitioner?
What failures are totally the responsibility of the patient?

CONFIRMATION LETTER

A letter that is sent to the patient confirming information that was discussed in the dental office is a valuable aid that enhances patient communication and understanding.

CONCLUSIONS

Dental implant therapy requires careful patient evaluation, surgical planning and meticulous prosthetic execution. Success is enhanced by thorough completion of the following steps in diagnosis and treatment planning:

Evaluation of the factors which limit conventional prosthodontic treatment
Medical history review
Dental history/examination
Esthetic assessment
Behavioral assessment
Basic radiography (panoramic and/or periapical radiographs)
Mounted casts and diagnostic tooth arrangement
Tentative treatment plan
Radiographic template (when needed)
Advanced radiography (when needed)
Definitive treatment plan
Patient presentation, acceptance, informed consent
Confirmation letter