

Implant Treatment: Advanced Concepts**Immediate Postextraction Placement of Implants**

When implant placement is planned before tooth extraction, consideration should be given to the most desirable time for implant placement. The implant may be placed immediately (i.e., at the time of extraction), early (i.e., 2 months after extraction), or late (i.e., more than 6 months after extraction). Each of these times has its indications, advantages, and disadvantages.

The primary advantage of immediate placement is that this allows the overall shortest healing time and combines tooth extraction with surgical implant placement. Placing a provisional restoration at the same procedure may provide the best opportunity for maintenance of soft tissue anatomy and the best immediate and long-term esthetic results. The primary disadvantage of immediate placement is related to the difference in the anatomy of the root or roots of the extracted tooth compared with the shape and size of the implant. This is particularly true of a multirooted tooth that is being replaced by an implant. Even in the case of an incisor, the difference in the shape of the root and that of the implant creates some difficulty in implant placement. Another disadvantage is that if the implant is exposed to excessive occlusal forces, the immediate and long-term stability of the implant can be jeopardized.

Immediate placement can be considered if the tooth to be removed is not infected and can be removed without the loss of alveolar bone. A critical component in the success of this technique is to complete the extraction of the tooth with minimal bone removal and without distorting or weakening the bony support. An atraumatic extraction technique using periotomes will help minimize damage to bone and help facilitate implant placement. Initial implant stability at the time of placement is also critical to long-term success. When the implant is placed, at least 4 mm of the implant apex should be precisely seated in firm bone to provide this initial stability. Surgical guides are extremely helpful in placing the implant because drilling the implant site at the correct angulation can sometimes be difficult because the drill can be easily deflected when bouncing off the wall of the socket. The implant should be countersunk slightly below the height of crestal bone to allow for resorption of bone resulting from extraction. In the esthetic zone (maxillary anterior), the platform of the implant is ideally placed 3 mm below the

Dental Implantology

5th year

Dr. Auday M. Al-Anee

free gingival margin. This allows for development of optimal emergence contour of the final restoration and soft tissue maintenance. In general the implant is also positioned 1 mm palatal to the center of the extracted tooth root. This accounts for anticipated facial bone and soft tissue remodeling that decreases the facial crestal volume.

The gap between the implant and the residual tooth socket must be evaluated and managed according to its size. If the gap is less than 1 mm and the implant is stable, often no treatment modification is needed. If the gap is greater than 1 mm, grafting with a particulate bone material may be indicated. At present the need for this is controversial. In most cases, with flapless, atraumatic extraction techniques, primary closure may not be possible or desirable. In this situation, a resorbable collagen pellet may be placed over the implant and held in place with a figure-of-eight suture. The surgeon may consider extending the time allowed for integration before loading.

In isolated cases, restoration at the time of implant placement may be considered. It is extremely important to ensure that the restoration is in ideal firm contact with adjacent teeth, which will help to reduce unfavorable loading on the implant until it is osseointegrated.

Bone Grafting and Graft Substitutes

In many cases, areas to be restored with implants have insufficient bone for implant placement. This may be a result of extraction and bone atrophy, sinus pneumatization, previous trauma, congenital defects, or removal of pathologic lesions. In these cases, bone will need to be augmented to provide adequate support for implant placement. Several potential sources of graft material can be considered, depending on the volume and configuration of bone needed.

Autogenous Grafts

Autogenous bone can be harvested from several anatomic areas. Intraorally, bone can be harvested from the mandibular symphysis, ramus, or maxillary tuberosity areas. Bone in the tuberosity is primarily cancellous, whereas in the ramus–posterior body area of the mandible, the bone is primarily cortical. The symphysis provides the best intraoral source for a reasonable volume of cortical and cancellous bone. When more bone is required for situations such as atrophic edentulous mandible or bilateral sinus lifts, an extraoral site should be considered if autogenous bone is to be used. The most common site of graft harvest is the

Dental Implantology

5th year

Dr. Auday M. Al-Anee

anterior iliac crest. Other areas where bone is sometimes harvested include the tibia, the fibula, and the calvarium.

Allografts

Allogeneic bone grafts procured from cadavers are processed to achieve sterility and decrease the potential for immune response. The sterilization process destroys the osteoinductive nature of the graft; however, the graft provides a scaffold, allowing bone ingrowth (osteoconduction). Bony incorporation, followed by remodeling and resorption, occurs during the healing phase. Granular forms of allogeneic graft material provide increased surface area and improved adaptation within the graft and are the most commonly used for augmenting alveolar ridge contour defects. The advantages of allogeneic bone grafting include the avoidance of an additional donor site, unlimited availability, and the fact that patients can undergo this type of procedure in an outpatient setting. The disadvantage is that a significant amount of grafted bone is resorbed, which results in a much smaller volume of bone for implant placement.

Xenografts

Xenografts are derived from the inorganic portion of bone harvested from a species that is genetically different from the graft recipient. The most common source of xenografts is bovine bone. The advantages and disadvantages are similar to those of allografts, including significant postgrafting resorption.

Bone Morphogenetic Proteins

One of the most exciting recent advancements in bone grafting has been the extensive research related to bone morphogenetic proteins (BMPs). BMPs are a family of protein factors that have been isolated and applied to reconstruction of the maxillofacial skeleton. These proteins have the ability to enhance bone graft healing and, in many cases, substitute for other graft materials. BMP are growth factors, belonging to the transforming growth factor- β family, induces new bone formation by inducing differentiation of multi-potent cells.

Recombinant human BMP 2 (rhBMP-2) has been isolated and has now been produced and packaged for use in grafting procedures. The BMP is placed on carriers, usually absorbable collagen sponges, to facilitate placement in the graft site. BMP can be positioned around implants within the extraction sites, aiding in osseointegration.

Dental Implantology

5th year

Dr. Auday M. Al-Anee

In larger defects, the BMP is usually combined with osteoconductive allogeneic materials to expand the graft volume and to help place, shape, and contain the graft material. BMP with a collagen sponge carrier can be used for sinus lifting and reconstruction of non-load-bearing bony defects. The obvious advantages include eliminating the need for donor site surgery and improved bone formation at the site of augmentation. The primary disadvantages include significant postoperative edema and the cost of the BMP.

Two problems associated with any type of grafting include containment and shaping of the graft material and prevention of fibrous tissue ingrowth during the healing phase. Placement of particulate grafts to augment alveolar ridges often requires some type of containment device or material to facilitate the ideal ridge size and shape. Materials used to contain and shape the graft can also be effective in eliminating the unfavorable invasion of soft tissue during healing.

Guided bone regeneration is a process that allows bone growth while retarding the ingrowth of fibrous connective tissue and epithelium. Many bone defects will regenerate with new bone if the invasion of connective tissue from adjacent soft tissue can be prevented. Guided bone regeneration involves using a barrier that is placed over the bony defect to prevent fibrous tissue ingrowth while the bone underlying the barrier has time to grow and fill the defect. This technique is particularly useful in the treatment of buccal dehiscence, where labiobuccal (horizontal) augmentation of bone is required. Guided bone regeneration can be performed simultaneously with implant placement or before stage I. A variety of materials may serve as barriers to fibrous tissue ingrowth. Expanded polytetrafluoroethylene (Gore-Tex) is the most extensively tested material. Resorbable materials are also now available, eliminating the necessity of removal. Thin, malleable titanium mesh is also a commonly used material facilitating maintenance of graft shape while eliminating extensive fibrous ingrowth. Titanium mesh trays can be created by trimming and contouring flat titanium mesh at the time of surgery, or they can be fabricated prior to surgery using diagnostic mounted dental casts or computer-aided design and computer-aided manufacturing technology.

Mandibular Augmentation

Augmentation grafting adds strength to an extremely deficient mandible and improves the height and contour of available bone for implant placement in denture-bearing areas. Superior border augmentation with a bone graft is often

Dental Implantology

5th year

Dr. Auday M. Al-Anee

indicated when severe resorption of the mandible results in inadequate height and contour and potential risk of fracture or when the treatment plan calls for placement of implants in areas of insufficient bone height or width.

Neurosensory disturbances from inferior alveolar nerve dehiscence at the superior aspect of the mandible also can be improved with superior border grafting. Sources of graft material include autogenous bone, allogeneic bone, or both, often combined with BMP (off-label use). Historically, autogenous bone has been the most biologically acceptable material used in mandibular augmentation. Disadvantages of the use of autogenous bone include the need for donor site surgery and the possibility of the significant resorption that occurs after grafting. The use of allogeneic bone eliminates the need for a second surgical site and has been shown to be useful in augmenting small areas of deficiency in the mandible. Use of allogeneic bone seems to be most effective in augmenting the width of the alveolar ridge and is much less effective in improving the height (vertical augmentation) of a deficient mandible. Current techniques for superior border augmentation of the mandible frequently involve some combination of block grafting, supplemented with an allogeneic material such as freeze-dried bone mixed with BMP often contained in some type of mesh tray.

Maxillary Augmentation

Severe resorption of the maxillary alveolar ridge presents a significant challenge to the prosthetic reconstruction of the dentition. When moderate to severe maxillary resorption does occur, the larger denture-bearing area of the maxilla may allow prosthetic rehabilitation without bony augmentation. In certain cases a severe increase in interarch space, loss of palatal vault, interference from the zygomatic buttress area, and absence of posterior tuberosity notching may make it difficult to construct proper dentures; augmentation should then be considered.

Onlay Bone Grafting

Bone grafting of the edentulous atrophic maxilla with an autogenous rib was first described by Terry in 1984. Maxillary onlay bone grafting is indicated primarily in the presence of severe resorption of the maxillary alveolus that results in the absence of a clinical alveolar ridge and loss of adequate palatal vault form. Maxillary onlay grafting is usually accomplished by using some combination of autogenous bone (corticocancellous blocks or particulate marrow), allogeneic bone, and BMP (off-label use), often contained in some type of mesh tray. When blocks of corticocancellous bone are used, they can be secured to the maxilla with

Dental Implantology

5th year

Dr. Auday M. Al-Anee

small screws, eliminating mobility and decreasing resorption. Cancellous bone is then packed around the grafts to improve contour. Implants can be placed at the time of grafting in some cases, but placement is often delayed to allow initial healing of the grafted bone.

Sinus Lift

Rehabilitation of the maxilla using implants is frequently problematic because of the extension of the maxillary sinus into the alveolar ridge area. In many cases the actual size and configuration of the maxilla are satisfactory in terms of the height and width of the alveolar ridge area. However, extension of the maxillary sinuses into the alveolar ridge may prevent placement of implants in the posterior maxillary area because of insufficient bony support. The sinus lift is a bony augmentation procedure that places graft material inside the sinus cavity but external to the membrane and augments the bony support in the alveolar ridge area. When only a few millimeters of augmentation are needed in conjunction with simultaneous implant placement, an indirect sinus lift is effective. This procedure relies on the lack of density found in maxillary cancellous bone. The initial drill is used to locate the angulation and position of the planned implant. The depth is drilled just short of the sinus floor. Osteotomes are then used to enlarge the site progressively. The osteotome is cupped on the end and compresses the walls of the osteotomy site; it also scrapes bone from the sides of the wall, pushing it ahead. The bone of the sinus floor is pushed upward, elevating the sinus membrane and depositing the bone from the lateral wall and apex of the osteotomy into the sinus below the membrane. If needed, additional graft material can be introduced through the implant site.

When more bony augmentation is needed, an open approach to the sinus is necessary. In this technique, an opening is made in the lateral aspect of the maxillary wall, and the sinus lining is carefully elevated from the bony floor of the sinus. After elevation of the sinus membrane, the graft material is placed in the inferior portion of the sinus, below and external to the sinus membrane. Allogeneic, autogenous, xenogeneic bone, BMP, or a combination of these materials can be used as a graft source. Perforation of the sinus membrane can occur during exposure of the maxillary sinus floor. Perforations are usually covered with redundancy of the elevated membrane and a “patch” of resorbable membrane material. These measures allow placement of the graft material with protection from a direct sinus communication. If insufficient bone is available to

Dental Implantology

5th year

Dr. Auday M. Al-Anee

provide initial implant stability, the graft is allowed to heal for 3 to 6 months, after which the first stage of implant placement can begin in the usual fashion.

If enough bone is available to obtain initial implant stability (usually 4 to 5 mm), then implant placement can be accomplished simultaneously with sinus grafting. This procedure can be performed as outpatient surgery. A properly relieved removable prosthesis can usually be worn after surgery, during the healing period.

Alveolar Ridge Distraction

Trauma, congenital defects, and resection of bony pathologic conditions often create a bone defect inadequate for immediate reconstruction with implants. Considerable soft tissue defects, including loss of attached gingiva, keratinized tissue, or mucosa, frequently accompany the bony discrepancy. Distraction osteogenesis has been used to correct these alveolar deficiencies. Distraction osteogenesis involves cutting an osteotomy in the alveolar ridge. An appliance is then screwed directly into the bone segments. After an initial latency period of 5 to 7 days, the appliance is gradually activated to separate the bony segments at approximately 1 mm per day. The gradual tension placed on the distracting bony interface produces continuous bone formation. In addition, adjacent tissue, including mucosa and attached gingiva, expands and adapts to this gradual tension. Because the adaptation and tissue genesis involve a variety of tissue types in addition to bone, this concept should also include distraction histiogenesis, in which the distracted segment and newly generated bone (termed regenerate) is allowed to heal for 3 to 4 months. The distraction appliance is then removed, and implants are usually placed at the time of distractor removal. Additional bone augmentation may still be required. Horizontal distraction of the alveolus to increase width followed by implant placement has also been completed successfully.

Diagnostic Imaging and Virtual Treatment Planning

The increasing availability and use of computed tomography and cone-beam computed tomography scanning, along with significant software advances, have dramatically changed the way implant cases are planned from both surgical and prosthetic standpoints. Cone-beam computed tomography scans with three-dimensional reconstruction allow detailed visualization of the bony anatomy in all three planes of space. Cross-sectional viewing of the bony anatomy allows detailed analysis of all important anatomic structures, including ridge size and shape, position of the maxillary sinus in relation to the ridge, and location of the inferior

Dental Implantology

5th year

Dr. Auday M. Al-Anee

alveolar nerve or adjacent tooth roots. Proprietary software that facilitates the integration of the desired final prosthetic result with the underlying bony anatomy is available.

By using computer technology to “virtually visualize” underlying bone anatomy along with the planned final prosthetic result, the need for bone grafting, as well as the position and angulation of implant placement can be planned with extreme precision. By using rapid prototyping technology, a surgical guide can then be created with laser polymerization of resin. Guide cylinders that exactly match the size of surgical drills used for implant site preparation can be imbedded in the surgical guide. The guide, which is securely fixed to either the maxilla or the mandible, dictates the exact position, angulation, and depth of each implant. In some cases, it is possible to place implants through the surgical guide, which can provide an index for the internal or external retention configurations of the implant. This allows the prosthetic provisional restoration to be constructed before surgery and delivered immediately at the time of implant placement.

Computer-assisted surgical treatment planning has become prominent in medicine and dentistry. The obvious next step is to implement computer-assisted surgery, or surgical navigation, to ensure accuracy and efficiency as well as reproducible outcomes. Surgical navigation has been used with positive outcomes in the hospital setting for years. Adapting this technology for intraoral dental surgical purposes has posed a number of new challenges. The primary concerns revolve around the equipment necessary to execute intraoral navigation. Bulky handpieces and reliable and reproducible calibration have been on the forefront of adapting this technology. Dynamic navigation in implant dentistry is evolving and will continue to become a key component in successful patient outcomes.

Zygomatic Implants

There are some situations where grafting of the sinus floor may not be feasible. Such cases may include patients with compromised health or individuals who are reluctant to undergo staged surgery requiring multiple surgeries and prolonged treatment times. In these cases the use of a zygomatic implant can be considered. The implant was originally developed in the early 1990s by Brånemark, with several subsequent modifications. The implants are extremely long, ranging from 35 to 55 mm. The implants are placed intraorally, with exposure to the crest of the alveolar ridge and the body of zygoma and visual access to the maxillary sinus. After the membrane is reflected, the implant traverses the maxillary sinus, with the

Dental Implantology

5th year

Dr. Auday M. Al-Anee

tip engaging the body of the zygoma and the external hex fixture emerging in the second premolar or first molar area of the maxilla. The portion of the implant embedded just medial to the alveolar crest or zygomatic bone undergoes osseointegration similar to other implants. The posterior zygomatic implants are usually combined with four anterior implants, all supporting a fixed prosthesis.

Extraoral Implants

Recognizing the success of implants for oral applications, maxillofacial prosthodontists and surgeons have expanded use of titanium fixtures to extraoral application. Extraoral implants are currently used to anchor prosthetic ears, eyes, and noses for patients with defects resulting from congenital conditions, trauma, or pathologic conditions.