

Treatment Planning Dental Implants in the Anterior Maxilla. Risk Assessment for Successful Esthetic and Functional Clinical Outcomes

Nkem Obiechina DMD, MS*

PERIODONTICS, Nkem Obiechina, Dds, 710 Easton Ave, Somerset, NJ 08873, US.

*Correspondence:

Nkem Obiechina DMD, MS, PERIODONTICS, Nkem Obiechina, Dds, 710 Easton Ave, Somerset, NJ, US.

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ABSTRACT

The anterior maxilla continues to present with unique challenges, even with success rate comparable to other parts of the mouth, the high chance for esthetic failure requires that modifications should be made to allow for natural looking restorations that are harmonious with the rest of the mouth. A number of modifications such as using a restorative driven protocol, performance of a risk assessment and addressing factors that could compromise esthetic success, as well as use of bone and soft tissue grafts to ensure adequate tissue volume as well as and understanding of timing with respect to implant placement have all contributed to achieving esthetic success in the region. This article reviews of some those concepts, and how they can contribute to dental implant esthetic success in the anterior maxilla.

Keywords

Dental implants, Restorations, Anterior maxilla, Teeth.

Introduction

The anterior maxilla presents with unique challenges for clinicians that are placing and restoring dental implants in the area. When patients smile the crowns of their teeth and some soft tissue is usually visible, it is therefore essential that implant restorations in the anterior maxilla be harmonious with adjacent natural teeth so as not to distract from a person's smile. Because the goal is to provide dental implants and restorations that are esthetically pleasing and in harmony with a patient's adjacent restorations, careful treatment planning and risk assessment is needed in order to achieve successful outcomes.

Having adequate bone and soft tissue dimensions, adequate dental implant positioning in the apico-coronal, mesio-distal and buccolingual dimensions as well as correct angulations of implants are important factors to ensuring overall esthetic success around implants. In assessing bone and soft tissue dimensions around implants, the goal of surgical therapy is a harmonious gingival margin without major changes in tissue height maintaining intact papilla and obtaining and preserving soft tissue contours [1]. The goal is that during surgical therapy, implants are placed in

positions that allow dental implant restorations in the maxilla to blend effectively with adjacent natural dentition.

During treatment planning dental implants in the anterior maxilla, a restorative driven protocol involving placing dental implants in surgical positions that will result in optimal implant restoration is recommended [2-4]. To accomplish this involves the placement of dental implants in sites with adequate bone volume and soft tissue contours present. This usually involves the use of bone grafts and soft tissue augmentation to address deficiency in bone and soft tissue to create optimal sites for implant placement. The goals of restorative driven implant placement in the anterior maxilla involves success in four components; placement of dental implants in optimal positions with adequate bone and soft tissue support, correcting any discrepancies in soft tissue contour and form and ensuring adequate tissue support for facial aspect and embrasure areas [1,4].

Other components include use of provisional restorations that is able to contour soft tissue around implants in preparation for definitive implant restoration, and finally placement of a definitive implant restoration that is in harmony with adjacent teeth and surrounding soft tissue with no major changes in color or contours [2].

Concepts in Maxillary Anterior treatment planning

In treatment planning maxillary anterior implants it is essential for both functional and esthetic success to adhere to four major concepts which include: dental implant placement in appropriate positions in the mesio-lingual, disto-lingual and apico-coronal dimensions, implant placement with the correct angulation, choosing the appropriate dental implant size, avoiding use of excessively large implant sizes for maxillary anterior implants, and ensuring that there is adequate soft tissue present for development of dental implant soft tissue contours and interproximal papilla [1].

In assessing dental implant positioning, Buser et al. characterized areas around edentulous sites for implant placement as “comfort” and “danger” zones [1]. Demarcation of these areas allow identification of locations where implant positioning could lead to potential esthetic compromise “danger zones” and areas where dental implant placement would be optimal for restorative success “comfort zones” [1] (Figure 1).

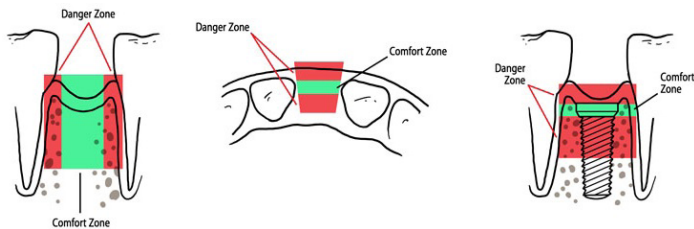


Figure 1: Comfort and Danger zones for dental implant placement.

To position dental implants in the mesiodistal dimension, the goal is to have a minimum of 1.5mm distance between adjacent roots of natural teeth and dental implants, and a minimum of 3mm between adjacent dental implants [1]. Danger zones are areas that are close to adjacent teeth and implants. Failure keep to the recommended distance can result in resorption of bone crest to the implant site causing reduced papilla height [1].

Placing implants within optimal positions in the bucco-lingual dimension requires that the implants should be placed 1mm palatal to an imaginary line at the point of emergence profile of adjacent teeth to the implant site. Implant placement facial to this site is a potential danger zone and can result in loss of facial bone. Placement more than 2mm palatal to this line can result in a potential ridge lap restoration with impeded oral hygiene assess [1] (Figure 2).

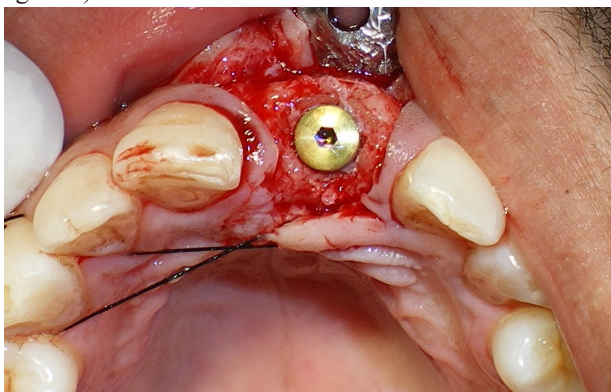


Figure 2: Dental implant positioning in bucco-lingual dimension.

The apico-coronal dimension typically involves dental implant placement 2mm from the midfacial gingival margin of the planned restoration. Apico-coronal danger zone involves dental implant placement that is more than 3mm from the gingival margin of the planned implant restoration [1]. The goal is to stay within the advised distance to prevent problems with potential bone loss, restorations that are too long, and failure to develop complete papilla inter-proximally (Figure 3).

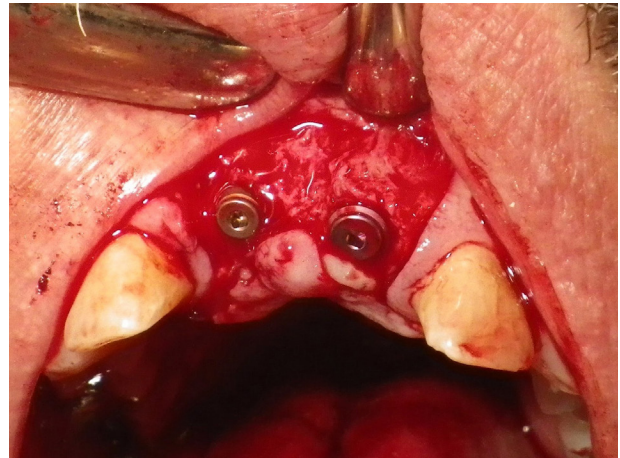


Figure 3: Apico coronal positioning of implants.

When treatment planning maxillary anterior dental implants, the goal is to identify potential causes that can be able to impede the esthetic success and try to address them prior to dental implant placement. To accomplish this involves the use of a risk assessment which lists the potential risks that can affect maxillary anterior dental implant esthetic success allowing them to be corrected prior to dental implant placement [1,2,4].

Performing a Preoperative risk assessment

In performing a pre-operative risk assessment, a medical history is completed which allows screening for uncontrolled medical conditions, radiation therapy, prolonged use of bisphosphonates and corticosteroids and smoking habits [4,5]. A chief complaint is obtained, and dental history with information to assess a patient’s overall expectations to ensure that they are realistic is also completed. This is then followed by an extraoral exam that evaluates general parameters such as facial symmetry, midline, orientation of occlusal plane, presence of lip support, assessment of smile width and smile line [6].

In assessing lip support and smile line, a patient that presents with a low smile line shows 75% or less of their teeth crown when they smile, which makes them have a low esthetic risk during dental implant restoration. Patients with medium lip line show 75%-100% of their teeth smile and usually interproximal papilla while those with high smile lines show more all the crowns of their teeth as well as 2mm or more of gingival tissue [6] (Figure 4). Patients that have low and medium smile lines tend to show less of the teeth

and gingival tissue on full smile, and present with less esthetic risk than those with high smile lines who show more of their gingival tissue when they smile.

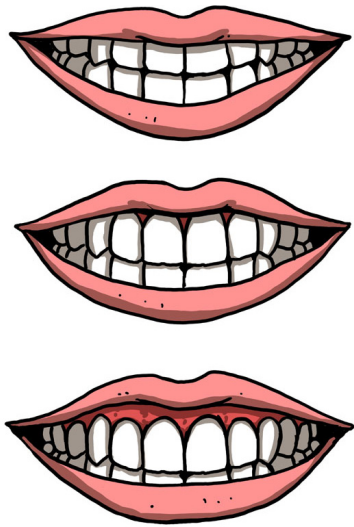


Figure 4: Low, Medium and High Smile lines.

An intra-oral examination is also completed as part of pre-operative risk assessment. This allows for assessment of the overall gingival and mucosal tissue. This is followed by an occlusal assessment which allows assessment for parafunctional habits and bruxism, as well as evaluation of the interocclusal space in the edentulous site. This is accomplished following obtaining study models, utilizing mounted casts and diagnostic wax-ups. This is then followed by obtaining appropriate xrays and then by a restorative and periodontal exam to identify caries, endodontic lesions or active periodontal disease that might be proximal to the implant site and initiate a treatment plan for treatment prior to dental implant therapy [1,4]. CT scan x-rays are also ordered for three-dimensional assessment of the anatomy of the potential implant site [1].

Performing an Anatomic and Surgical Risk assessment

In other to avoid factors from contributing to the esthetic failure of maxillary anterior implants, Buser et al. recommend completing an anatomic and surgical risk assessment to ensure that deficiencies in bone and soft tissue and other potential risk are addressed [1]. CT Scan xrays are usually combined with bone sounding in other to evaluate bone width, height, length and density at the dental implant site. CT scan xrays can also be able to detect changes in bone anatomy such as dehiscence, concavities in bone as well as fenestrations [1].

Anatomic factors which can contribute to esthetic failure of implants in the anterior maxilla include: biologic width violation, excessive loss of interproximal bone, inadequate facial bone thickness, placement of dental implants into sites with bone deficiency and concavity, and implant placement in sites with thin soft tissue phenotype [1]. In assessing biologic width, its violation can have impact of causing inflammation and bone loss similarly to around teeth [7-9]. Around implants biologic width was found

to be composed of the sulcus/peri-implant sulcular epithelium, peri-implant junctional epithelium, oral epithelium and connective tissue consisting of a distance of about 3.08mm with usually a range of 3-4mm, unlike biologic width of about 2.04mm around teeth, with its violation resulting in potential for bone loss [7,8].

Potential iatrogenic causes of esthetic dental implant failures include poor implant positioning in one or more of the three dimensions, use of dental implants that are too wide in the anterior maxilla, improper angulation of dental implant, improper mesio-distal proximity to adjacent teeth, and apical location of the microgap between the implant and abutment interphase leading to bone resorption [1]. Most iatrogenic causes of dental implant failure can be prevented during dental implant planning with using CT scans to assess implant sites, and surgical guides during dental implant placement, as well as by ensuring that there is adequate bone for implant positioning in all dimensions and by selecting standard implant diameters in the anterior maxilla rather than excessively wide implants [1,4,10].

In the assessing smile line, patients that have high smile lines are at greater risk of esthetic failure because they show more of their gingival tissue. It is therefore important that there is an adequate amount of soft tissue present as well as that the gingival color is the same as that of the adjacent teeth, to help accomplish this it is essential that the patient have good oral habits. Presence of gingival inflammation or thin gingival tissue contour significantly affects esthetics in the maxillary anterior area, so when this exists, it is essential that it should be treated prior to implant restoration [1] (Figures 5-7).

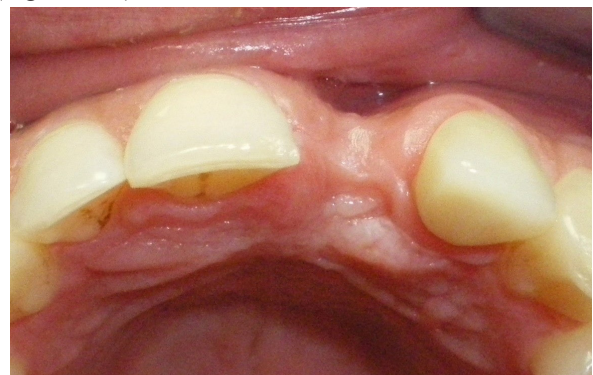


Figure 5: Site in need of bone and soft tissue augmentation.

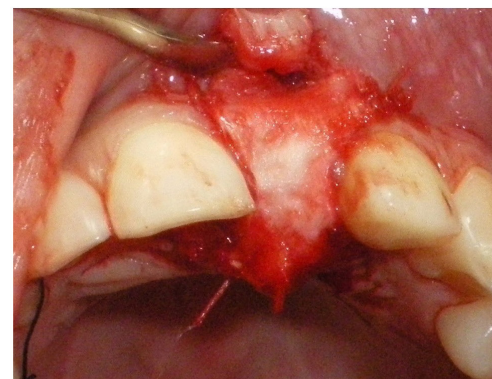


Figure 6: Bone and soft tissue augmentation of site.



Figure 7: Sutures in place.

For patients that present with thin facial tissue or thin gingival tissue phenotypes, use of soft tissue grafts help to enhance gingival contours and thickness. Thicker gingival phenotypes tend to be less prone to recession and are better at withstanding inflammation. Use of soft tissue grafts that increase thickness of tissue as well as placement of the dental implants at a more palatal location will allow for the ability to better improve esthetic outcome by improving tissue thickness around implants with thin facial gingival phenotypes [1,4,11]. Having thicker gingival phenotypes is also essential for maintaining oral hygiene around dental implants as well as preventing gingival inflammation or gingival recession [4,12].

To avoid problems in dental implant positioning in the mesio-distal, facio-lingual or apico-coronal dimensions, having adequate bone support is essential prior to dental implant placement. Bone loss and concavities in bone should be addressed with bone grafts prior to dental implant placement, for sites with thin facial bone, a combination of bone grafts and soft tissue grafts is recommended to help in formation of a thick tissue phenotype [4]. Use of surgical guides are essential to preventing problems in positioning and angulation in the anterior areas where even the slightest error can compromise esthetics especially for patients with medium and high smile lines. Prior to anterior dental implant placement, impressions are taken for surgical guides, and if guided technology is being utilized, they are combined with information from CT Scans for fabrication of surgical guides using CAD/CAM technology (Figure 8).

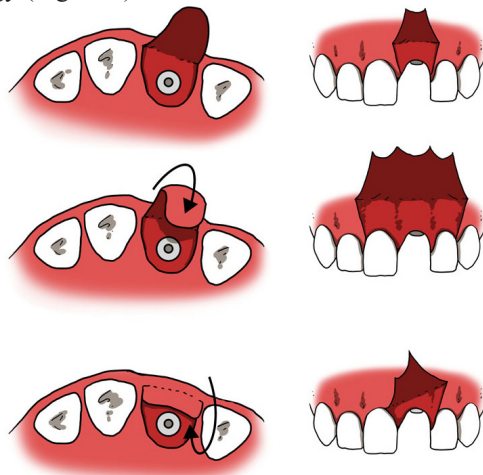


Figure 8: Types of papilla preservation technique for implant placement

and bone grafting.

When evaluating the interproximal papilla area, the goal is to have complete papilla height coverage around the anterior dental implant in order to ensure that no dark triangles occur due to incomplete soft tissue in the interproximal area. The interpapillary bone crest determines the amount of interpapillary coverage that will occur, typically when the distance is less than 5mm there is a high chance that complete interpapillary tissue will be present around implants, but as the distance increases in millimeters to 6mm the chances of getting complete papilla height decreases significantly [13]. Salama et al. identified the term “predictable papilla length” as the achievable papilla length in the maxillary anterior sextant measured as the most coronal interproximal height (IHB) immediately adjacent to a tooth or dental implant after surgical or restorative therapy [13]. The distance between implants is 4.5mm, 5mm for natural teeth, and 5.5mm between adjacent dental implants [13]. At dimensions above these distances the risk increases that the papilla might not be formed completely and dark triangles could occur [13].

The soft tissue around implant restorations play a major role in the overall health and esthetics around dental implant restorations. When thin gingival tissue is present, it can result in un-esthetic outcomes such as gingival recession showing implant components, gingival inflammation resulting from inadequate keratinized tissue around the implant site, as well as potential for peri-implantitis [14,15]. Failure of interproximal papilla to form could also occur which can result in esthetic complications especially for patients with high smile lines. A number of studies have stressed the importance of using soft tissue augmentation to improve tissue contours around dental implants as well as to increase the width of keratinized tissue around dental implants [4,10,12-16].

When patients present with thin gingival phenotypes at implant sites or potential for insufficient soft tissue exists, use of soft tissue graft have been used to improve tissue thickness, keratinized tissue width as well as gingival contours, and are highly recommend for use in the anterior zone prior to or in conjunction with dental implant placement and restoration [14] (Figures 9 and 10). When there is failure to achieve adequate soft and bone volume by augmentation, use of other methods might be utilized such as use of pink porcelain to mask tissue loss, as well as adjustment of the contact point to have an illusion of interproximal tissue might be necessary [16].



Figure 9: Patient in need of implant placement.



Figure 10: Implant restoration after implant placement and graft.

During the surgical phase modifications can be made to help preserve tissue in the interproximal areas when placing dental implants. Use of papilla preservation flaps can be able to allow implant placement without significantly affecting interproximal tissue and include techniques such as flapless technique, papilla preservation techniques, U-shaped flap design as well semilunar incisions [17] (Figures 11-15). The goal is preserving interproximal tissue in order to ensure adequate tissue height around dental implant restoration.



Figure 11: Implant site planned for placement and augmentation.



Figure 12: Site in need of dental implant placement and simultaneous graft.

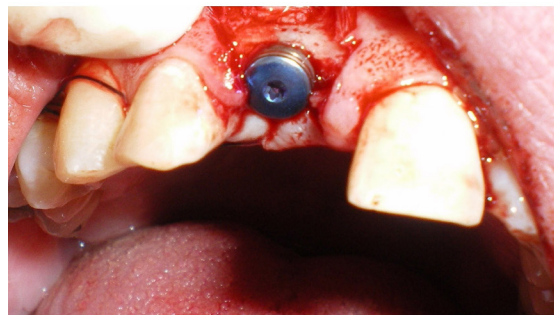


Figure 13: Implant in place.

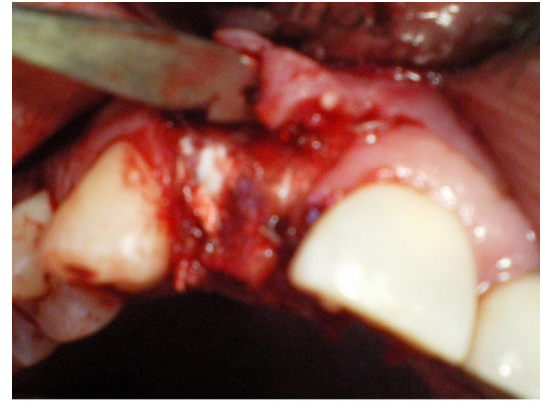


Figure 14: Graft in place.

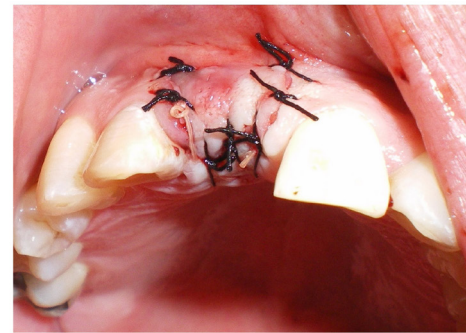


Figure 15: Sutures.

Classifying soft and hard tissue in the anterior maxilla

Palacci et al. classified tissue loss in the maxilla as vertical or horizontal [18]. According to the classification, vertical loss around the papilla area can be divided in Class I to IV while horizontal tissue loss is classified as Class A-D. Class I refers to an intact or slightly reduced papilla, Class II deals with limited loss of papilla of about 50%, Class III refers to severe loss of dental papilla while Class IV involves a complete absence of dental papilla [18]. In assessing horizontal loss tissue loss in the anterior maxilla, Class A refers to intact or slightly reduced buccal tissue, Class B involves limited loss of buccal tissue, Class C deals with severe loss of buccal tissue, while Class D involves extreme loss of tissue in combination with limited attached mucosa [18]. When assessing maxillary anterior tissue loss, based on the classification of the tissue loss, the timing and type of implant therapy required is determined.

Patients that present with Palacci Class I-A classification can be able undergo implant placement including immediate dental implant placement with minimal surgical complications expected, patients that present with Class III and Class IV classification would typically be prepared for delayed implant placement with bone and soft tissue grafting. For patients that present with Type IV-D cases, Palacci et al. advocate ensuring that the patients are fully aware of the fact they present with severe bone resorption and soft tissue collapse with high potential for esthetic compromised clinical outcome prior to starting the therapy [18]. In addition to multiple bone grafting and soft tissue augmentation, they recommend potential need for orthodontic extrusion, segmental osteotomy, distraction osteogenesis as well as potential need for use pink porcelain to mask lost tissue support [18].

Timing of Dental Implant placement

Funato and Salama et al. evaluated dental timing of dental implant placement and stressed its importance to overall implant success in the anterior maxilla [1]. They divided the timing of implant placement into three classes, Class 1, involving extraction, immediate placement using either incisionless technique or mucoperiosteal flap with osseous augmentation, guided bone regeneration or connective tissue and soft tissue allografts.

Class 2 timing includes early dental implant placement 6-8 weeks after extraction to allow soft tissue healing. Guided bone regeneration would be done at time of extraction or during dental implant placement [1]. Class 3 involves delayed implant placement at 4-6 months after extraction with preservation of the maxillary alveolar ridge using grafting or guided bone regeneration which is usually done at time of extraction or implant placement [1].

Teeth that have been scheduled for extraction due to having a hopeless prognosis would have immediate dental implant placement if there is no bone compromise and if the interproximal height of bone (IHR) of adjacent teeth is within 4.5mm in order to allow complete papilla formation, [1] distances more than that could result in incomplete papilla fill [1,13,19]. When the IHR distance is more than 4.5mm, it is recommended to utilize a delayed approach rather than immediate dental implant placement [1]. Use of orthodontic extrusion is also recommended to improve vertical tissue dimensions prior to immediate implant placement [1] (Figures 16-29).

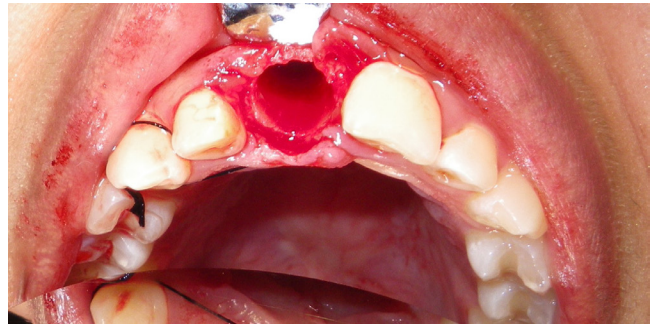


Figure 18: Immediate implant placement.



Figure 19: Immediate implant placement.



Figure 16: Immediate implant placement.



Figure 20: Immediate implant restored.



Figure 17: Immediate implant tooth xray.



Figure 21: Initial presentation for implant placement.



Figure 22: Implant in place.

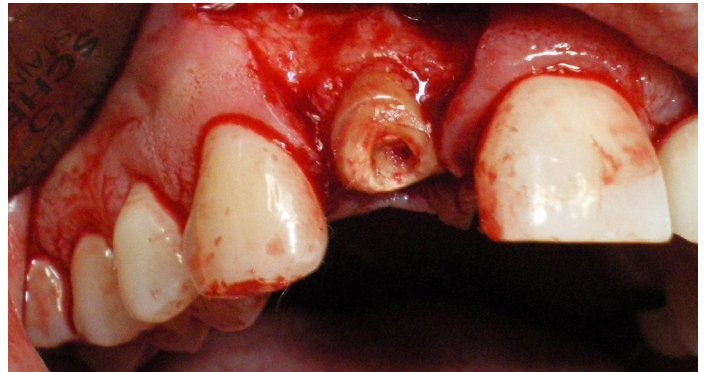


Figure 26: Immediate dental implant placement.



Figure 23: Temporary in place.

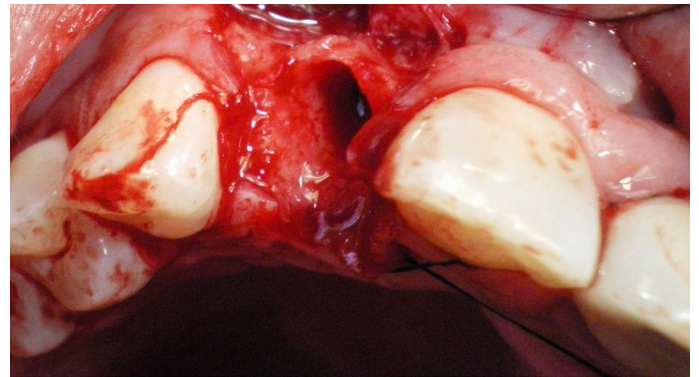


Figure 27: Immediate dental implant placement socket.



Figure 24: Implant restored.

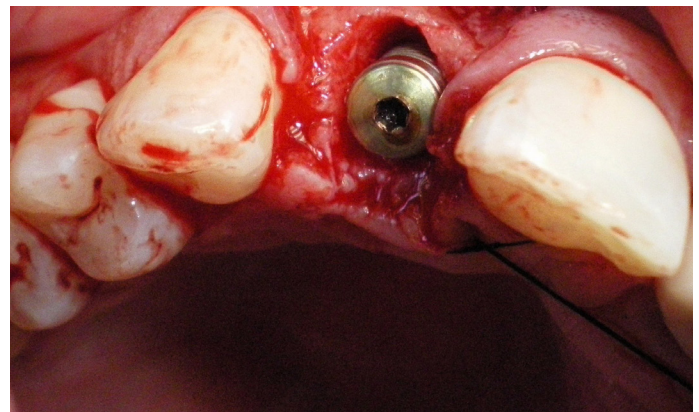


Figure 28: Implant in place with need for bone augmentation.

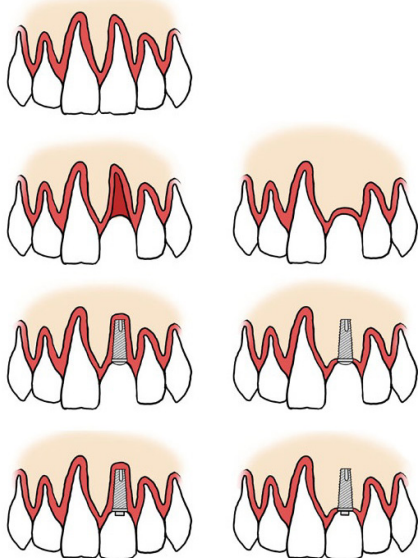


Figure 25: Immediate versus delayed Implant placement.

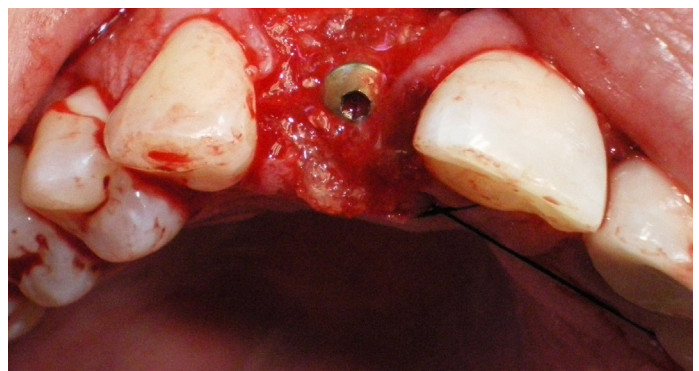


Figure 29: Immediate dental implant placement with bone graft in place.

An advantage of immediate implant placement in anterior maxillary area is the ability to preserve bone and soft tissue support in the implant site, and prevent loss of 3-4mm of bone that can occur within the first six months after tooth extraction [20]. The goal is atraumatic extraction, and immediate placement combined with a provisional restoration which is designed to place lateral pressure on tissue around the dental implant preserving the shape and location of the soft tissue, preventing tissue collapse and retaining the soft tissue emergence profile [20]. This allows for a definitive restoration that blends harmoniously with adjacent teeth (Figure 30-35).



Figure 30: Immediate dental implant placement.



Figure 31: Immediate dental implant placement.

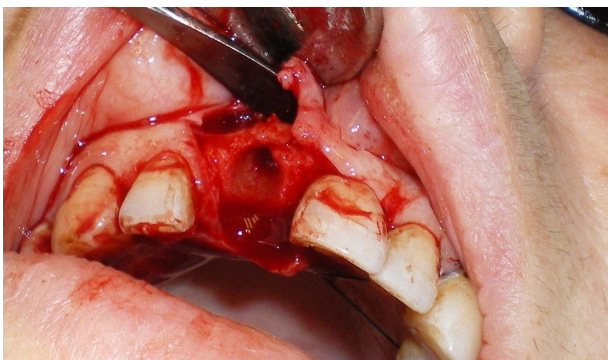


Figure 32: Immediate dental implant placement.



Figure 33: Immediate placement and restoration with temporary crown.



Figure 34: Final restoration in place.



Figure 35: Xray of Immediate dental implant restored permanently.

According to the classification proposed by Funato A and Salama M et al, Class 1 involves intact buccal bone with thick soft tissue phenotype and immediate placement of dental implant utilizing a flapless technique is completed [1]. Class 2 Involve intact buccal bone with thin gingival phenotype which requires immediate placement wit soft tissue graft or secondary soft tissue graft. Class

3 involves buccal bone with bone loss that may have implant placement with bone augmentation and guided bone regeneration depending on extent of buccal plate loss. If extensive, then they recommend a delayed approach [1]. Class 4 involves delayed dental implant placement with bone and soft tissue augmentation in which CT scan xrays and three-dimensional planning with surgical guides needed for dental implant success [1].

Conclusion

The anterior maxilla presents with unique challenges that make implant placement in the region complex. The goal is achieving esthetic and functional success with maxillary anterior restorations and careful planning as well as use of risk assessments incorporating all aspects of anatomic, surgical and esthetic factors crucial for success have been essential in continuing to provide anterior implant restorations that are esthetic and harmonious with natural dentition. Incorporating timing as well as use of restorative driven implant placement have been essential to improved accuracy and overall efficacy of dental implant placement in maxillary anterior area. Studies incorporating understanding of biologic width and soft tissue dimensions have also been essential to overall implant success in the esthetic zone, and as further research is concluded would have an even greater impact on improving overall esthetic and functional implant success in the anterior maxilla.

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