Simplifying implant planning and placement in the fully edentulous arch with in-office guide fabrication

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Short running title:

Simplifying implant placement in edentulous arches

Summary:

A geometric approach is presented that allows in-office planning with linear and angle corrections and surgical guide fabrication, simplifying the process when treating a fully edentulous arch.

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Introduction:

Implant planning and placement in the fully edentulous maxilla can present challenges both surgically and prosthetically whether a removable or fixed approach is planned. Placement of the implants free-hand does not take the osseous anatomy and its structures into consideration and may lead to problems such as nerve or blood vessel impingement as well as implant extension into sinuses or the nasal fossa. Guided placement has become the standard practice whether treating the full arch or partially edentulous arch. While printed surgical guides are the standard practice, There may be circumstances where printed guide is not possible.

Case History:

A 65-year-old male patient presented for consultation on replacement of their full maxillary denture with an implant retained approach. The patient indicated they had been wearing the maxillary denture for 14 years, retention was minimal, and wished to eliminate the palatal coverage. Examination noted shallow vestibules and minimal retention of the denture to the arch. Further discussion with the patient to determine their expectations revealed that a removable prosthesis retained by the implants would meet their expectations and allow easier home care maintenance than a fixed prosthetic approach.

Methods:

An impression of the maxillary denture was made extraorally using alginate and a Lang denture duplicator (Lang Dental, Wheeling, IL) to allow fabrication of a diagnostic guide to be utilized with a CBCT in the planning phase of treatment. The patient was dismissed and appointed to return for the CBCT.

Lucitone acrylic was mixed and poured into the duplicator. Upon setting the duplicate denture was removed and any marginal flash was removed with an acrylic bur and polished. (Figure 1)

Holes were drilled through the center of the convexity of the tissue surface through the cingulum of the oral surface of the anterior teeth and the central fossa of the posterior teeth of the duplicated denture with a $3/32^{nd}$ drill. In the proposed sites 2 mm guide sleeves were placed in the holes of the teeth of the duplicated denture.

The patient returned and the duplicate diagnostic denture with the 2 mm guide sleeves was inserted intraorally and the CBCT was performed. The patient was again dismissed, and an appointment was scheduled for the surgical phase of treatment.

The CBCT was imported into the planning software (Invivo^{TM} 5, Osteoid, Santa Clara, CA). The treatment plan was to place four implants spread around the arch to retain a new prosthesis with Atlantis Conus frictional fit abutments (Dentsply Sirona, York, PA) in the implants and corresponding caps embedded in the prosthesis. Analysis of perspective sites at tooth numbers 3, 4, 5, 6, 8, 10, 12 and 13 were selected based on a preliminary review of the initial CBCT and the position of the available bone and its relation to the maxillary sinuses bilaterally.

The maxillary right first molar site (#3) was analyzed, and it was determined insufficient crestal height was present inferior to the sinus floor and would require sinus augmentation to permit implant placement at that site. However, the patient preferred not to have the sinus elevation. (Figure 2)

The maxillary right 2^{nd} premolar site (#4) was analyzed, and sufficient bone was noted for implant placement. (Figure 3)

The maxillary right 1^{st} premolar site (#5) was analyzed, was selected for placement of a fixation screw for the full arch surgical guide and sufficient bone was present to accommodate a 17 mm screw. No angle or linear corrections are needed. (Figure 4)

The maxillary right canine site (#6) was analyzed, and sufficient height was noted for implant placement. (Figure 5)

The maxillary right central incisor site (#8) was analyzed, and sufficient bone was noted for implant placement without perforation of the nasal floor. (Figure 6)

The maxillary left lateral incisor site (#10) was analyzed, and sufficient bone was noted for implant placement without perforation of the nasal floor. However, a 15@ angle correction is necessary to place the implant as planned. (Figure 7)

The maxillary left 1st premolar site (#12) was analyzed, and sufficient bone was noted for implant placement. (Figure 8)

The maxillary right 2nd premolar site (#13) was analyzed, and sufficient bone was noted for implant placement. (Figure 9)

A decision was made for each site whether or not it was suitable for implant placement.

The scan data was imported into planning software (Invivo^{TM} 5) and each potential site was analyzed. Site #3 was analyzed, although adequate width buccal-palatal was present, insufficient crestal height was present that a crestal sinus lift would be required to allow an implant to be placed at this site. (Figure 2) It was decided based on that information that this site would not be used for implant placement. Site #4 was then analyzed, and it was determined sufficient crestal height and adequate ridge width was present buccal-palatal to allow implant placement. A 4.8 x 9mm Astra EV implant was selected for this site with no correction required in the buccal-palatal or mesial-distal directions. (Figure 3) Site #5 was decided that implant placement would not be at this site but a fixation screw would be placed to stabilize the full arch edentulous surgical guide and there was sufficient bone present to accommodate the screw without contact anatomical structures (maxillary sinus). (Figure 4) Site #6 was next analyzed, and it was determined that no angle correction would be needed at this site. A 4.2 x 11 mm Astra EV implant was planned for the site following 5mm crestal ridge reduction (Figure 5) Site #8 was determined to accommodate a fixation screw for the surgical guide and following analysis a 1mm offset correction would be needed to avoid the incisive canal. (Figure 6) Site #10 was analyzed and an angle correction to the buccal of 15 degrees would be required as well as crestal bone reduction of 5-6mm would be needed due to the thin crestal ridge. A 3.6 x 10 mm Astra EV implant was planned for this site. (Figure 7) Site #12 was planned for a fixation screw and analysis determined no angle correction would be needed. (Figure 8) Finally, site #13 was analyzed and no correction was required at this site to accommodate an implant and a 4.8 x 8mm Astra EV implant was planned for this site. (Figure 9) The final plan was for placement of implants at sites #4, 6, 10 and 13 with fixation screws at sites #5, 8 and 12.

A putty base was created in the diagnostic guide using a 2-part hard setting polysiloxane material (Coltene Whaledent, Cuyahoga Falls, OH). Guide posts (2 x 30 mm) (DePlaque) were inserted through the guide sleeves in the diagnostic guide at sites #4, 5, 6, 8, 10, 12 and 13 before the putty base had set. (Figure 10) Following setting of the putty base, the guide posts were removed, and the diagnostic guide was separated from the base. The 2-piece lower-part straight, offset and angle corrected guide posts were inserted into the 2 mm holes in the putty. (Figure 11 left) An acrylic bur was used to make indentations in the putty base so the rectangular base of the guide posts were flush with the tissue level. 2-Piece lower-part guide posts replacing 2 mm straight guide posts for the planned sites for implants and guide fixation screws were placed into the putty base at the sites #4, 5, 10, 12 and 13 previously occupied by the 2 mm guide posts. A 2 mm offset lower-part of the 2-piece guide post was placed at site #6 with the offset positioned to the distal to even out the spacing. At site #8 a 1 mm offset lower part of the 2-piece guide post was placed in the putty base. An angle correction was required at site #10, this was accomplished with the Guide Right bending tool (DePlaque) (Figures 12 and 13) and the corrected guide post was inserted into site #10. (This completed the base to fabricate the corrected surgical guide. (Figure 11 right) The 3 mm upper-removable-part of the 2-piece guide posts were placed onto the lower-part of each guide post to position the 3 mm in ID guide sleeves (Figure 14) that were to accommodate the 3 mm depth stop drills that will be utilized at surgery.

(Figure 15)

The holes in the duplicate of the denture were enlarged to allow it to seat over the guide posts and their sleeves on the putty base. Primotec LC gel (Primotec USA, Norwalk, CT) was placed to fixate the guide sleeves to the duplicate denture and then light-cured to complete the corrected surgical guide. (Figure 16)

Results:

The patient presented for the surgical phase of treatment, consent forms were reviewed and signed by the patient. Local anesthetic was applied to the maxillary arch using 4% Articaine + 1/200,000 epinephrine. The surgical guide was inserted to verify seating on the arch. A 2 mm wide screw was placed through the surgical guide at sites 5, 8 and 12 to stabilize the guide and prevent motion during osteotomy preparation. (Figure 16) Utilizing Guide Right 3 mm depth stop drills (Figure 15), sites #4, 6, 10 and 13 osteotomies were prepared through the 3 mm guide sleeves in the surgical guide. The implants were placed 4-5 mm below the alveolar crest as was planned to provide adequate room for the Conus abutments. The fixation screws were removed, and the surgical guide was removed intraorally. An incision was made at the center of the ridge and soft tissue flapped to expose the crestal bone with some buccal and palatal ridge exposure. A surgical carbide was then utilized to reduce the crestal bone across the arch to 1mm from the platform of the implants at the four sites. Alveolar crestal reduction was performed after implant placement to prevent loss of stability of the surgical guide. Cover screws were placed and soft tissue reapproximated and fixated with 4 0 nylon sutures in an interrupted pattern. The current maxillary denture was relined with Karlin, Easy Soft Liner to accommodate the reduction in crestal height performed with implant placement. A panoramic radiograph was taken to document implant placement. (Figure 17) The patient was dismissed.

The patient was allowed to heal for 4 months during which periodic post-operative visits were performed. The implants were uncovered, and healing abutments placed. Following a 2-week healing of the soft tissue, the healing abutments were removed intraorally, and impression abutments placed. (Figure 18) A full arch impression was taken with Permadyne (3M, St Paul, MN) heavy & light bodied polyether impression material in a custom tray to start the restorative phase of treatment.

A master cast was poured in ResinRock (Whip Mix, Louisville, KY) with implant analogs and GI-Mask (Coltene/Whaledent, Cuyahoga Falls, OH) to replicate the soft tissue architecture. Inter-fixture spacing was verified with a verification jig fabricated from GC Pattern Resin (GC America, Alsip, IL). An impression of the mandibular arch was taken with alginate. The master cast was mounted with a Hanau facebow on a modular, semi-adjustable articulator. A jaw relation record was made with a custom Triad (Dentsply Sirona, York, PA) resin baseplate with a wax rim and Blue-Mousse (Parkell, Brentwood, NY) VPS bite material. The wax rim was marked to show the desired midline and tooth position, then a protrusive check bite was made to set the occlusal parameters on the articulator. The patient chose shade Vita B1.

A try-in of the full arch with denture teeth (Ivoclar Vivadent, Amherst, NY) to confirm esthetics and function. The teeth were positioned to optimize esthetics and phonetics, but were repositioned, per the patient's request until a satisfactory result was achieved and patient approval was acknowledged. A buccal matrix was made on the master cast with Express VPS putty (3M) to preserve the tooth position. The dental laboratory fabricated 4 custom Atlantis Conus abutments (Dentsply Sirona) and a cobalt-chrome denture framework/baseplate that incorporated the SynCone caps (Dentsply Sirona) that would retain to the Conus abutments. (Figure 18) The denture teeth were placed on the master cast with the Conus abutments and denture framework present. Utilizing the buccal matrix a new full arch wax try-in was fabricated with a spacer over each Conus abutment.

The patient returned to the office and the Conus abutments were placed intraorally using the insertion guide and verified clinically and radiographically for fit and orientation. A new jaw relation was made and verified. The wax try-in was inserted intraorally over the Conus abutments to verify fit, occlusion and get patient approval on the esthetics. The wax try-in was returned to the lab for processing.

The maxillary overdenture was processed without the incorporation of the Syncone caps, which would be

picked up clinically using Chairside resin (Zest Dental Solutions, Calsbad, CA). The finished maxillary overdenture was returned to the office for insertion.

The finished overdenture was tried in with the Syncone caps seated on the Conus abutments and passive fit was confirmed as well as the occlusion and esthetics. Chairside resin was placed into the sites in the intaglio of the denture where the abutment spaces were present. The overdenture was then seated intraorally, and the patient instructed to occlude. Upon set of the resin the overdenture was removed with the Syncone caps embedded within. Any resin flash was removed around the Syncones and the areas polished. The overdenture was reinserted intraorally and retention was confirmed as well as occlusion. (Figure 19) The patient was appointed for a follow up appointment the following week to check fit and function.

Conclusion:

Full arch All-on-4 treatment protocol can pose challenges to surgical placement that are then reflected in the prosthetic phase of treatment when performed with free-hand implant placement. Utilization of a surgical guide eliminates those potential positioning issues that can result from free-hand placement. Replication of a full arch denture allows for fabrication of a diagnostic CBCT guide to allow virtual planning taking anatomical features into consideration and make planned implant placement more ideal for that particular patient.

The Guide Right system is a geometric approach which allows in-office planning with linear and angle corrections and surgical guide fabrication, simplifying the process while eliminating the time and additional expense normally required in having the surgical guide created at a dental lab.

Discussion:

Implant treatment is a prosthetically driven treatment with a surgical component. Implant planning and placement in the fully edentulous arch pose clinical challenges due to an absence of teeth to determine where ideal implant placement utilizing a prosthetic driven plan would occur. That information is also absent in virtual implant planning software unless a diagnostic guide is used during the CBCT scan. The diagnostic guide discussed can be fabricated in-office utilizing a replica of the patient's denture and placement of guide sleeves in that replica prior to the CBCT scan to provide the ideal prosthetic positions that virtual planning can utilize when deciding anatomical implant positions. That information can then be used to correct angulation and position of the implants to maintain the desired prosthetic positioning for fabrication of an in-house surgical guide.

Patient consent:

The treatment plan was reviewed with the patient and the patient signed the consent for treatment form.

Author contributions:

Dr. Meitner – Conceptualization, methodology, project implementation, review and editing, performed the surgical aspects of the case.

Dr. Oster – Performed the prosthetics aspects of the case, project implementation, review and editing.

Dr. Kurtzman – Original draft preparation, review and editing.

Figures:

Figure 1: A 2nd clear duplicate was fabricated and proposed sites were outlined on the interior of the maxillary denture with a marker and guide holes were created through the interior maxillary denture with a 3/32" drill, 2 mm guide sleeves were pressed into the holes in the possible implant sites.

Figure 2: Site #3 was noted to have insufficient crestal height to allow implant placement without a crestal sinus lift.

Figure 3: Virtual planning of site #4 with the diagnostic guide intraorally with Invivo5 software during the CBCT scan determined no linear or angle correction would be required at this site.

Figure 4: Site #5 was selected for placement of a stabilization screw for the full arch surgical guide and sufficient bone was present to accommodate the screw. No angle or linear corrections are needed.

Figure 5: Virtual planning of site #6 with the diagnostic guide intraorally during the CBCT scan determined no correction would be required at this site.

Figure 6: Site #8 was planned for use for a fixation screw for the surgical guide and a 1 mm linear distal correction would be needed to avoid the incisive canal.

Figure 7: Virtual planning of site #10 with the diagnostic guide intraorally during the CBCT scan determined 15° buccal angle correction would be required for this site.

Figure 8: Site #12 was planned for placement of a stabilization screw for the surgical guide and no angle or linear corrections were needed.

Figure 9: Virtual planning of site #13 with the diagnostic guide intraorally during the CBCT scan determined no angle or linear correction would be required at this site.

Figure 10: Diagnostic Guide with positions for implants at sites 4, 6, 10 and 13. The putty was pressed into the underside of the denture and 2 mm straight posts were placed through the guide sleeves while the putty was setting.

Figure 11: Corrected 2-Piece straight lower-part guide posts replacing the 2 mm straight guide posts for the planned sites for implants and guide stabilization screws into the guide post sites on the putty model.

Figure 12: Guide Right Bending Tool

Figure 13: A 15° buccal angle correction was required at site #10, this was accomplished with the Guide Right Bending Tool (DePlaque)

Figure 14: Guide sleeves that were 3 mm ID were placed on each of the upper-removable guide posts to accommodate the 3 mm depth stop drills that will be utilized at surgery.

Figure 15: Guide Right 3 mm depth stop drills for depths from 6mm to 15mm (DePlaque)

Figure 16: The holes for the guide posts are enlarged in the duplicate denture to accept the corrected positions of the guide posts. Openings are filled in with acrylic (Primotec LC gel). The acrylic gel is cured around the guide posts with UV light to form the final surgical guide to accommodate the 3 mm guide sleeves which are used with 3 mm depth stop drills. The duplicate denture and the openings are filled in with flowable acrylic LC gel (Primotec) to secure the corrected positions of the guide posts and form the final *surgical guide* . The denture is inserted in the patient and secured with three 2 X 17 mm screws to prepare the osteotomies and place the implants through the guide sleeves.

Figure 17: Panoramic radiograph taken following implant placement.

Figure 18: Milled parallel Conus abutments placed into the integrated maxillary implants (left) and interior of the maxillary overdenture with receptacles for the Conus abutments (right).

Figure 19: Final implant supported prosthesis.