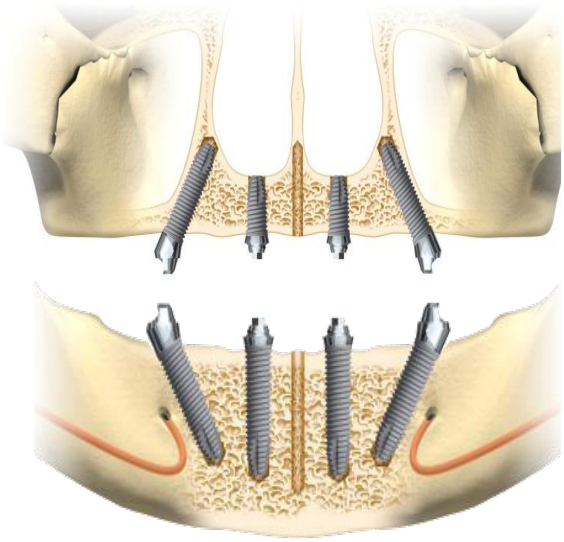
Full Arch Rehabilitation:

All-on-4™ Restorative Steps

Roadmap for Success



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BALUKE DENTAL STUDIOS

"TOGETHER WE CAN MAKE IT SEAMLESS!"

All-on-4
Restorative Steps

Full Arch Rehabilitation:
All-on-4™ Restorative Steps
Roadmap for Success

Treatment Planning/Diagnosis

1. **Setup meeting with Treatment Team to discuss case – communication is key**

2. **Qualifying the Patient**

   When evaluating a candidate for All-on-4™ treatment, the most essential components are the patients' current esthetics and function. It is important to identify the patient's smile line and vertical occlusal space. If there are noticeable problems with their current esthetics or function, now is the time to correct these.

   Examples of issues that may need to be corrected pre-operatively:

   - Poor Fitting Dentures
   - Limited Inter-Occlusal Space
   - Incorrect Bite
   - Insufficient space for prosthesis

3. **Treatment Planning Evaluation Questions**

   Comfort

   - Please describe any type of discomfort or awareness of pain associated with your denture or partial.
   - What is your experience sleeping with dentures in your mouth?
   - Do you notice a burning sensation in your mouth?
   - Do you currently have sore spots with your denture?

   Esthetics

   - Have you noticed changes in the appearance of your face?
   - Are you happy with the appearance of your teeth?
   - Are you confident with your smile?
   - Are you concerned with signs of aging (appearance of face)?
   - Do you have sores at the corners of your mouth?

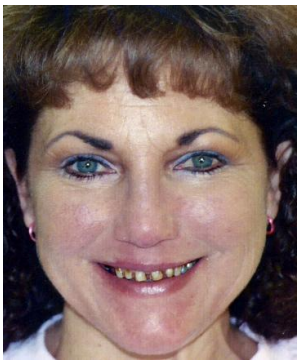
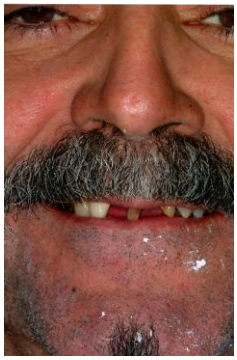
Function – Chew and Speak

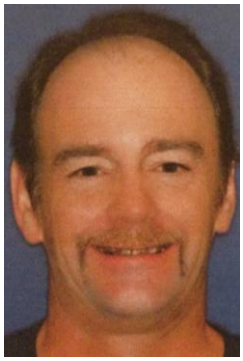
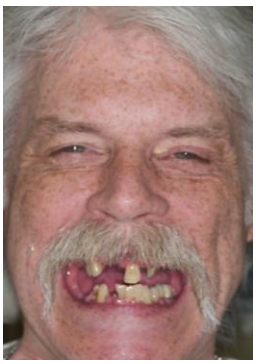
- Can you eat and speak comfortably without pain or looseness of the denture?
- Do you use denture adhesives? Occasional or routine? What is your attitude toward adhesives?
- Can you easily eat dry food (for example, a granola bar)?
- Do you ever notice dryness of your mouth, including your lips?
- Do you ever feel like your lips stick together?

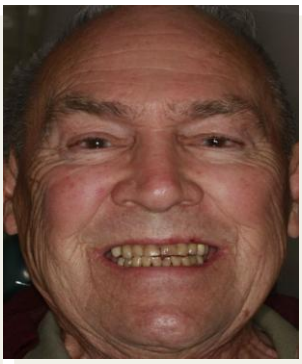
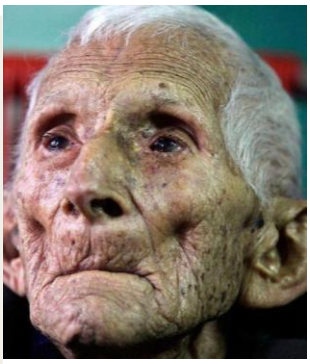
Dental History

- When was your last reline or adjustment of denture?
- How long have you been using dentures/this denture?
- Did you use a removable partial denture before full?
- What was the reason for tooth loss? (perio/destructive function/caries)
- What food limitation have you experience because of chewing challenges? Any special requirements for food preparation?
- Can you eat what you would like to eat? Why not?

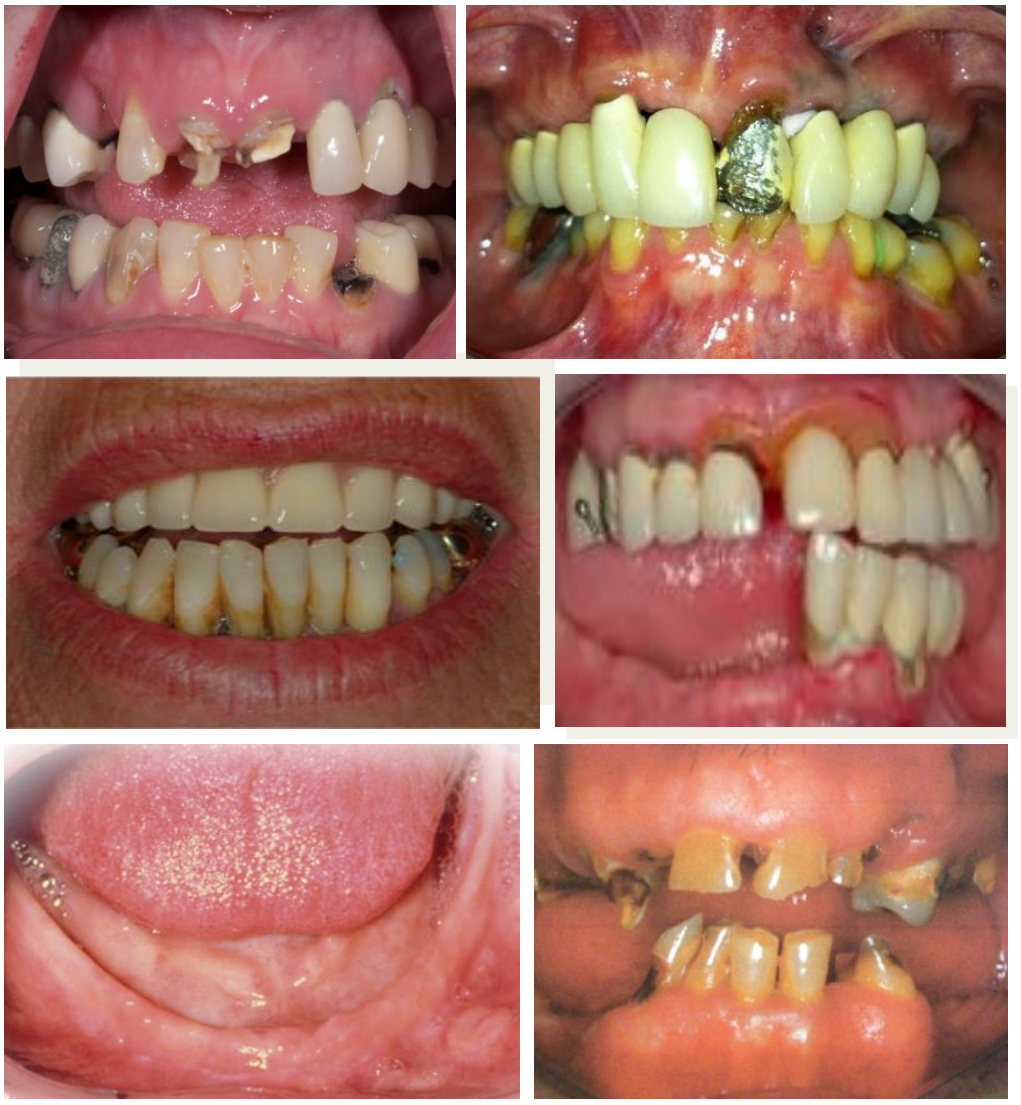
Examples of Candidates for All-on-4™ Treatment:

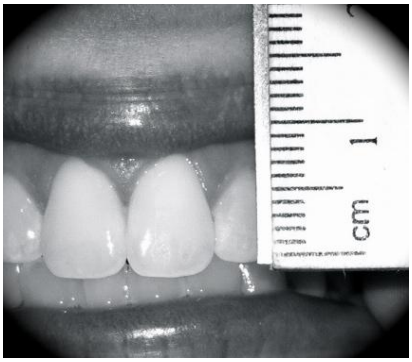
Examples of Candidates for All-on-4™ Treatment:



4. Capture Vertical Dimension of Occlusion (VDO) for Restoration/Smile Line

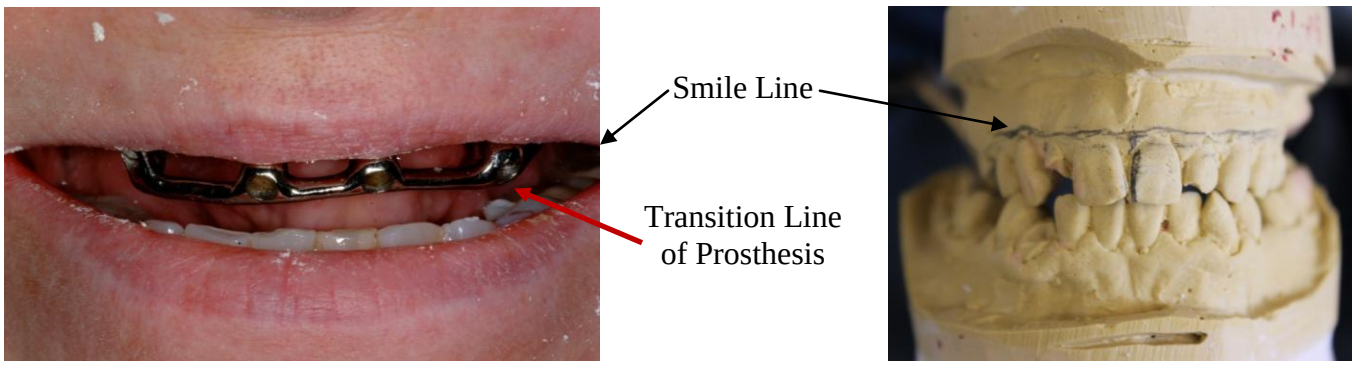
A. Vertical Dimension of Occlusion (VDO), also known as Occlusal Vertical Dimension (OVD) is a term used to indicate the superior-inferior relationship of the maxilla and the mandible when the teeth are situated in maximum intercuspation. A VDO is not only possessed by people who have teeth, however; for completely edentulous individuals who do not have any teeth with which to position themselves in maximum intercuspation, VDO can be measured based on the subjective signs related to esthetics and phonetics. Vertical dimension can be captured using a base plate and bite rim.

- 15mm of space (minimum) is required for NobelProcera® Implant Bridge - *Fixed* (Restoration (Measure Length of Central Incisor + 6mm)



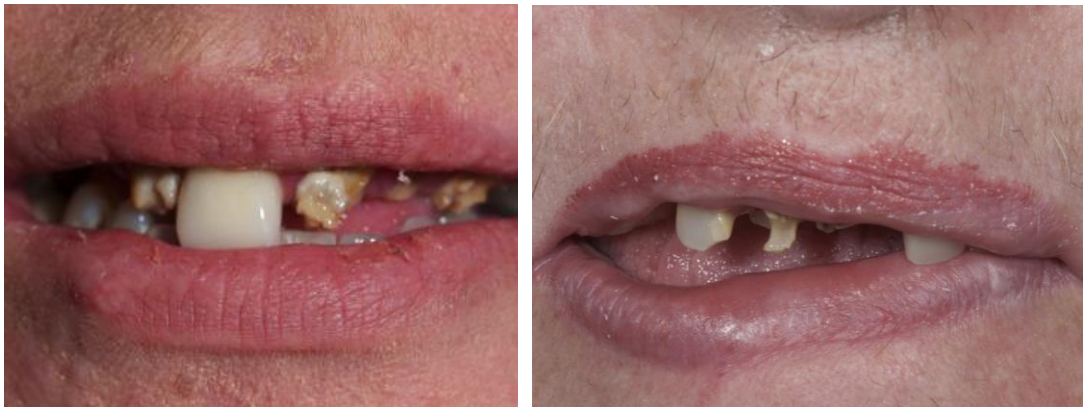
5. Identify Smile Line and Transition Line of Prosthesis - make sure transition line of prosthesis is apical to smile line

- If soft tissue is visible while smiling, measure the distance between the gingiva above central and lateral incisors and the extreme border of the upper lip

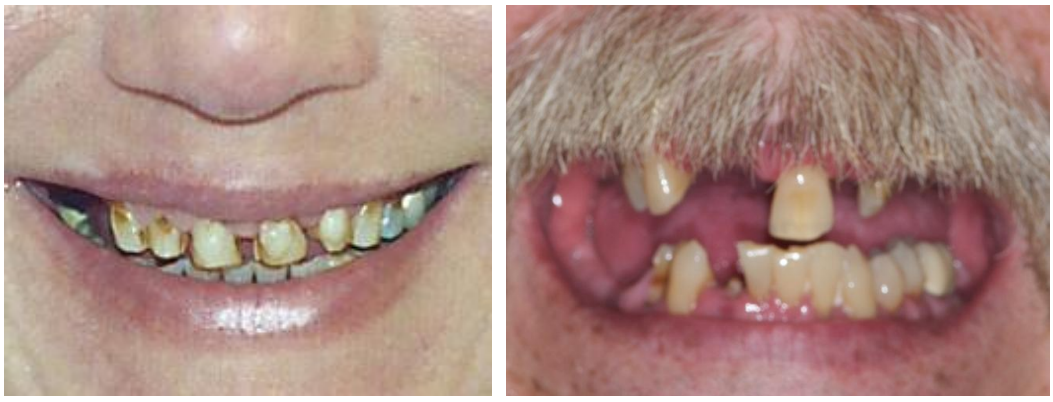


6. **Photographic Evaluation**
   - Full Face, Lips at Repose
   - No animation – with and without Denture/Partial
   - Full Face Smiling – with and without Denture/Partial
   - Lips Retracted, Teeth apart – with and without Denture/Partial
   - Lips Retracted, Teeth together – front, right, and left sides
   - Side Profile, Full Face
   - Side Profile, Smile
   - Intra-oral Alveolar Ridge without Denture
   - Denture out of Mouth: Occlusal View and Intaglio View

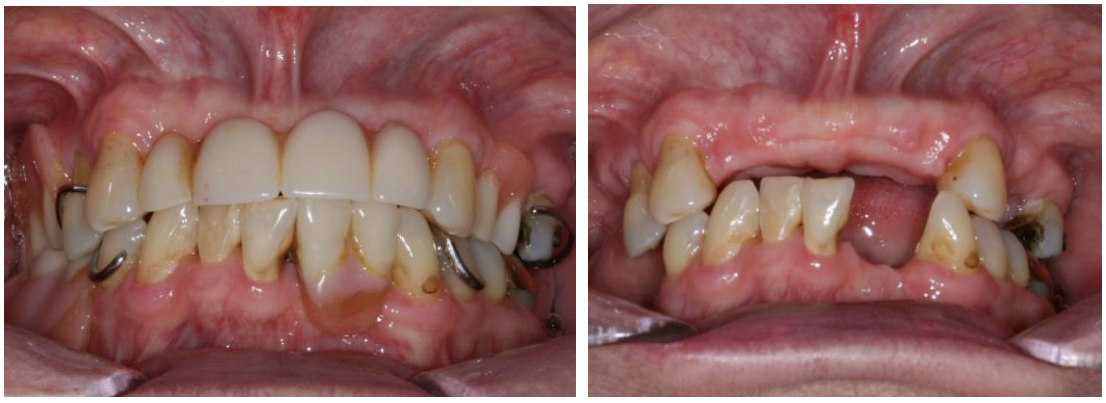
Example: No Animation with & without Denture/Partial



Example: Smiling with & without Denture/Partial



Example: Retracted with & without Denture/Partial



6. **Case Evaluation – Esthetics**
   - Lip Support
   - Naso-Labial Angle
   - Facial Midline
   - Occlusal Plane
   - Lip Size – Flat and Thin
   - Tooth Display at rest, and when speaking
   - Lip Dynamics
   - Smile Line
   - Transition Zone

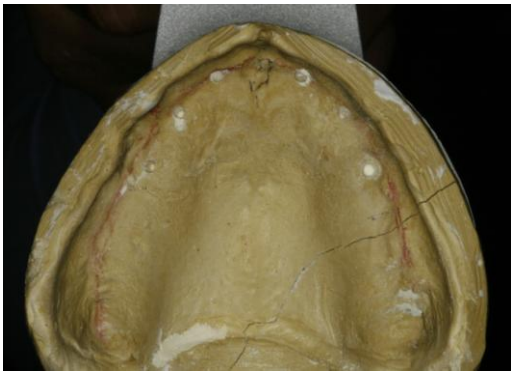
7. **Ridge Reduction (Alveolectomy)**

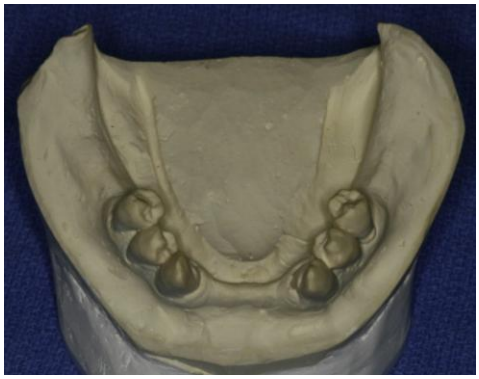
   – determine how much is necessary

8. **Take Accurate Records**

   A. Assess the condition of the oral mucosa, ridges, facial, cheek, and lip support (contours).

   B. Take Impressions of both arches and Bite Registration. The impressions must include the palate and vestibules in the maxilla and the vestibules and retro molar pads in the mandible.





   C. Make sure to include the Edentulous Saddles

      i. Bite Rims are necessary if edentulous saddles cannot be capture on initial impressions.

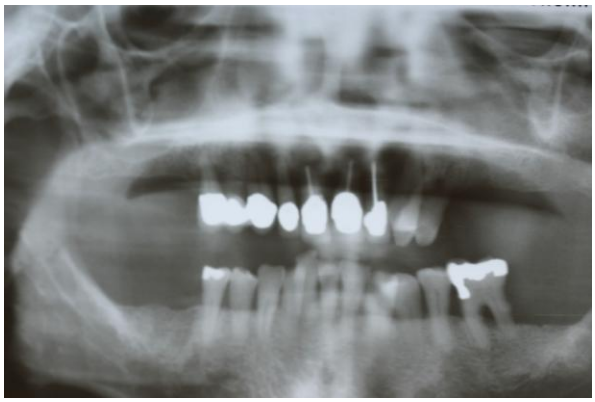
      ii. If bite will be opened, take a new bite registration with wax rims tried in

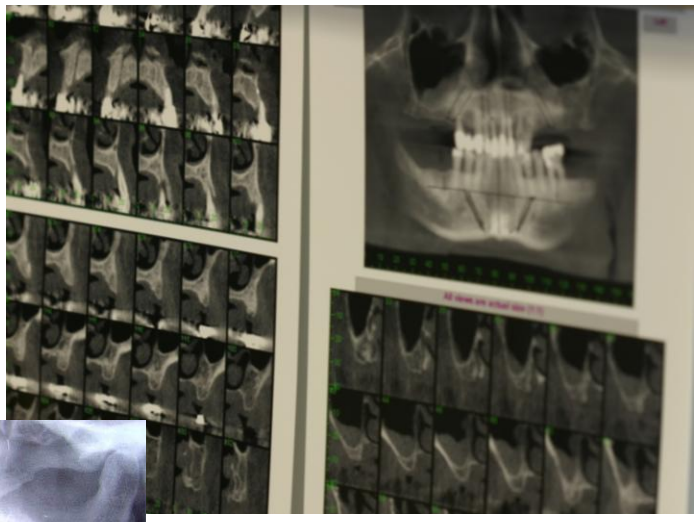
9. Shade/Mold Information –

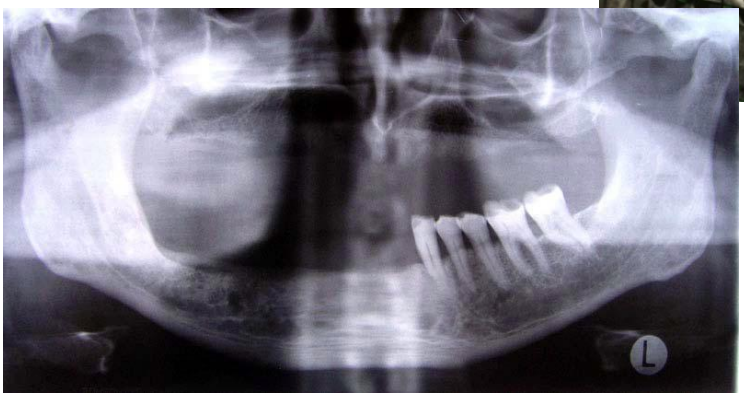
- Consult with patient regarding the color, shape, and size of teeth that will be suitable.
- Send photos, shade/mold information, measurements, and patient's desires concerning esthetics of denture to Dental Laboratory. The Laboratory will utilize the impressions and other information to fabricate immediate denture to be used as provisional prosthesis on the day of surgery.

10. Evaluate Bone Volume

- With CT Scan and X-rays determine implant/restorative options based on the amount of bone volume







11. Discuss Patient Symptoms/Issues, Expectations, and Motivation

12. Review steps/coordinate schedules

- Surgical Specialist based on CT Scan determines and orders Implants and Restorative Components w/alternative sizes/angles:
  - Multi-unit Abutments: Straight, 17°, 30° angle correction w/varying tissue depth
  - Temporary Copings Multi-unit + Prosthetic Screws (extra)
  - Multi-unit Abutment Healing Caps
  - Impression Copings – Open Tray – for final prosthesis
  - Multi-unit Abutment Lab Analogs – for final prosthesis

Immediate Provisionalization Materials:

Equipment:

- ❑ Handheld Light Unit
- ❑ Bench Lathe
- ❑ Electric Handpiece
- ❑ Dust Hood with Vacuum (Handler Bench Top Porta-Vac)

Hand Tools:

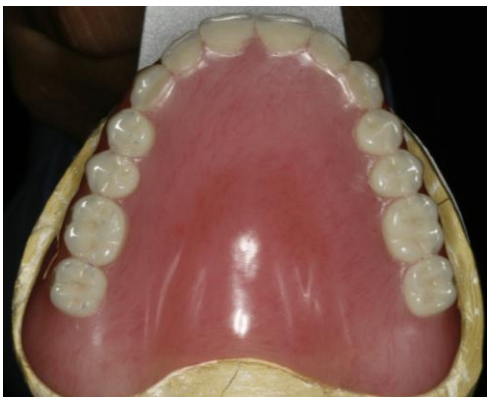
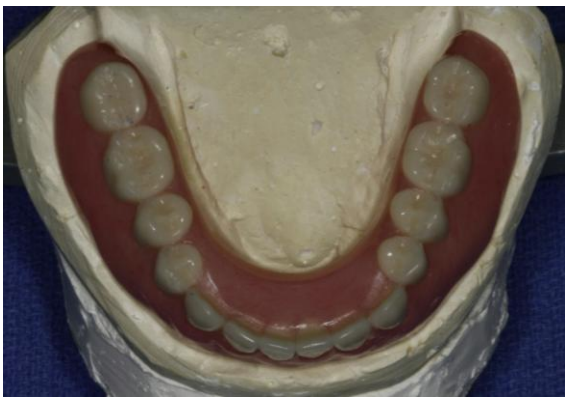
- ❑ Rubber Dam Punch
- ❑ Great White Burs (SSW HP-8)
- ❑ #25 Surgical Blades
- ❑ #6R Redwood Plaster Knife
- ❑ #7R Redwood Plaster Knife
- ❑ Small Surgical Scissors
- ❑ Instrumentation: Prosthetic Kit (torque wrench, Unigrip drivers 20, 25, 30mm, multi-unit abutment driver)
- ❑ Perio Probe or Explorer

Supplies:

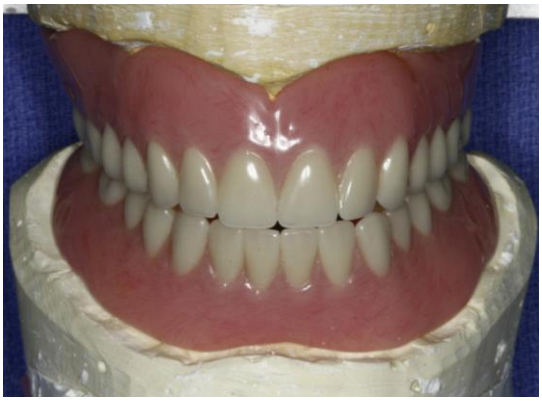
- ❑ Blue Mousse Bite Material or Similar
- ❑ Rubber Dam
- ❑ Aquasil Ultra XLV Fast Set, Teflon Tape, Cavit or Wax for blocking out screw access holes
- ❑ Exothermic Polymer Acrylic - Cold Cure (3M Secure, Dentsply Dual Line, Unifast Trad, or Quik Set)
- ❑ eFiber and Perma Mesh to strengthen the denture (Preat)
- ❑ Ivoclar Universal Polishing Paste
- ❑ Keystone b12 Brush Wheels
- ❑ Lab Pumice and Rag Wheels
- ❑ Burs and Brushes for Acrylic Finishing

Dental Laboratory creates Immediate Denture & Surgical Guide:

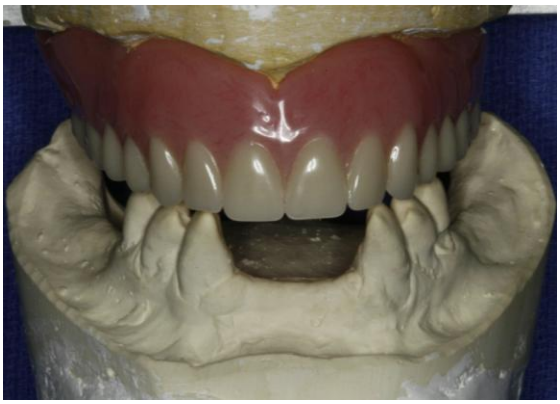
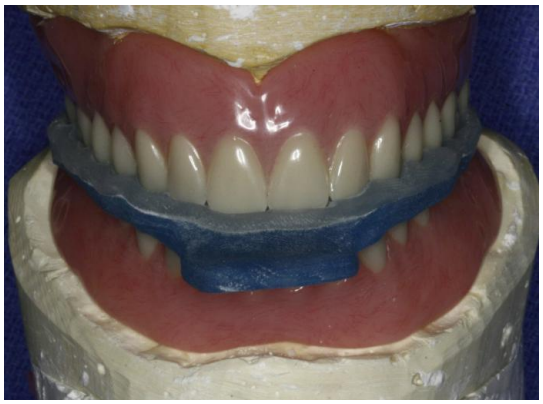
1. **Wax Try-in Denture**
   - Based upon impression and bite registration a Wax Try-in Denture is created by the Dental Laboratory. The Wax Try-in for Immediate Denture is designed to verify vertical dimension, esthetics, phonetics, and facial support. Improvements and modifications to the denture can be made at this time.
   - After modifications are complete, the Dental Laboratory processes an immediate denture

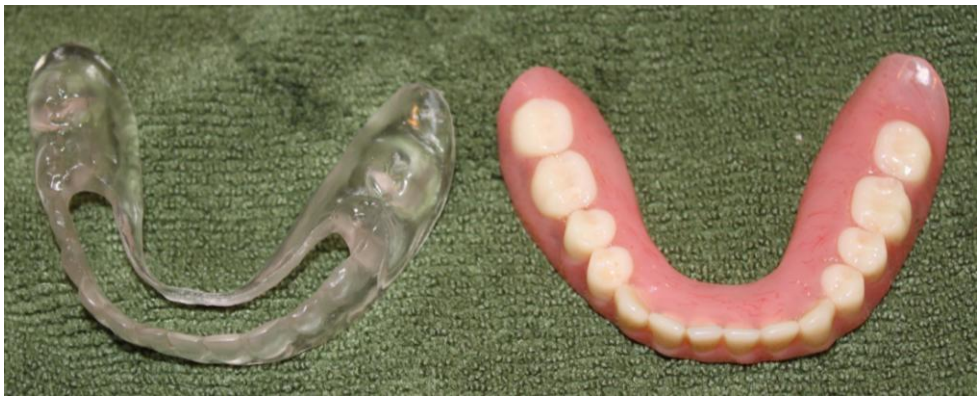
2. **Re-mount and Equilibration**



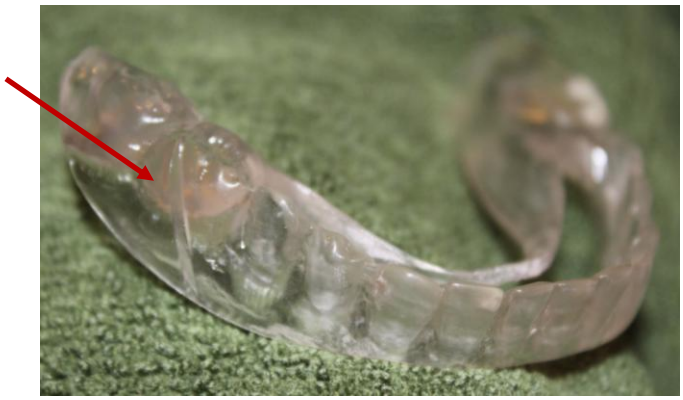
3. **Cross Mount and Occlusal Guide and Bite Registration**

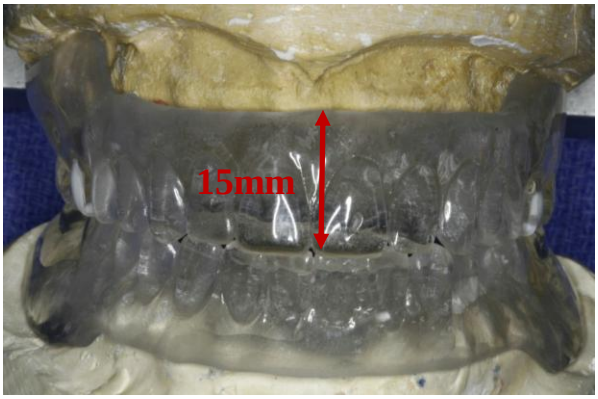
4. **Duplicate Denture and Trough out Lingual for Surgical Template**



5. **Add 30-45 Degree Angulation for Posterior Implant**

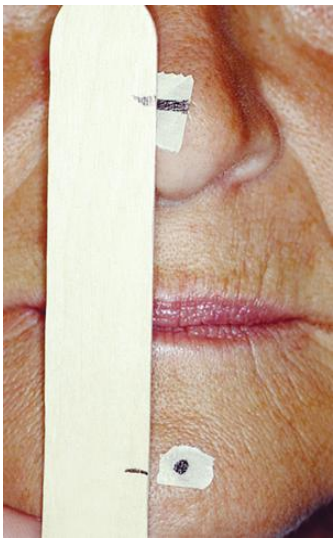


6. **Indicate Amount of Ridge Reduction and Mark on Surgical Template**

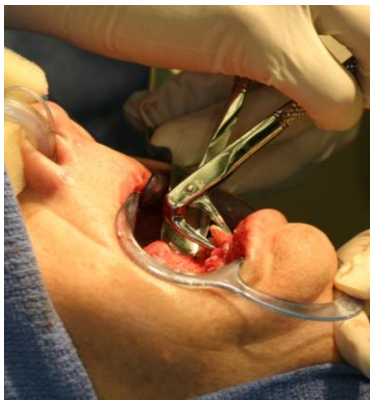


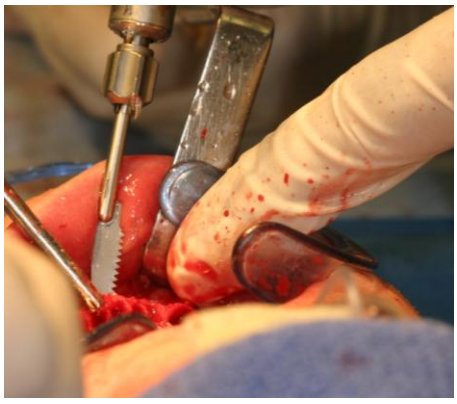
Surgery & Immediate Provisionalization:

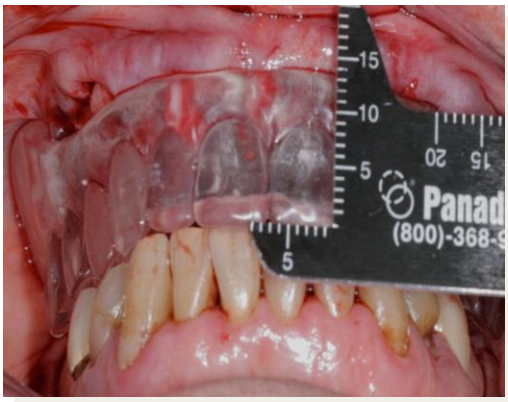
1. **Measure and Mark Vertical Dimension of Occlusion prior to Surgery**
   - Surgical placement of dental implants is based off the immediate denture in an effort to maintain the patients' proper vertical dimension. Before extracting the teeth, the surgical specialist will mark the chin and nose and measure the distance while the patient is in occlusion.



2. **Extract Teeth and Reduce Ridge (alveolectomy)**
   - Ridge is reduced based on pre-determined amount indicated in surgical template (necessary to accommodate prosthesis).

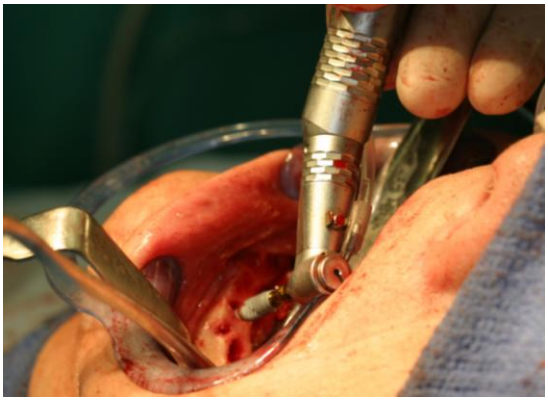
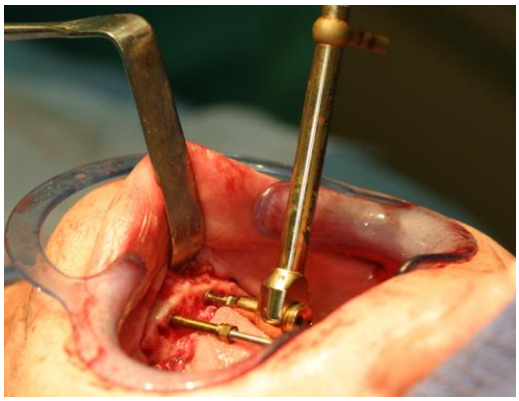






3. Placement of Dental Implants

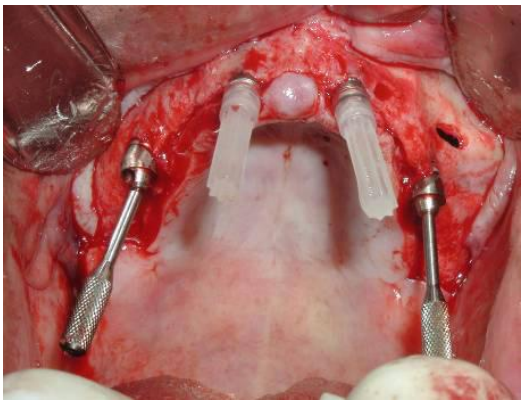
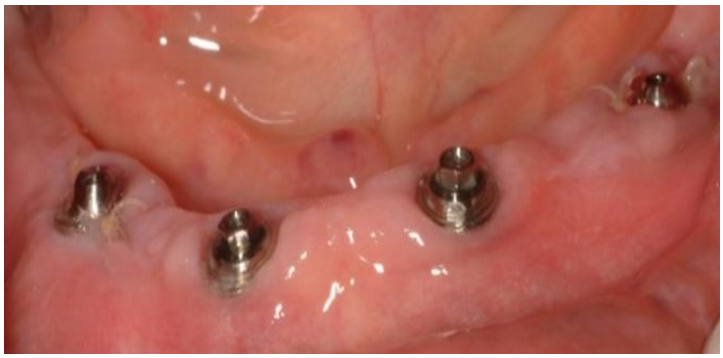
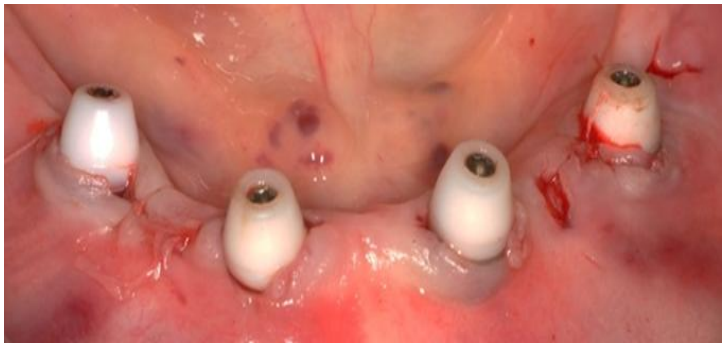
- Implants are placed in the arch, equally distributed and angulated to avoid the natural anatomy (sinus and nerve). Implants must achieve initial stability of at least 35Ncm of torque in order to immediately provisionalize the implants with the patients' immediate denture.

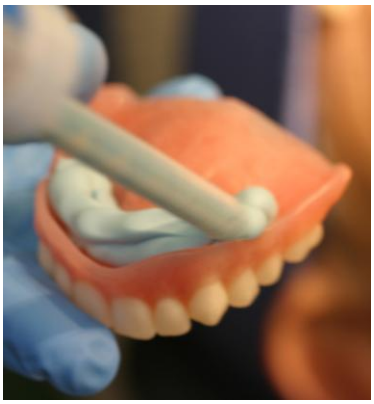
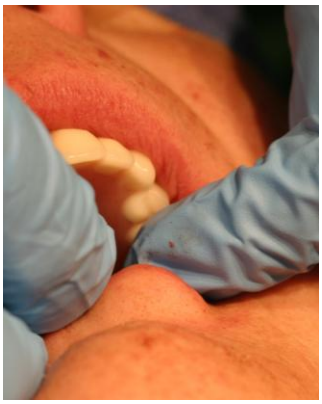
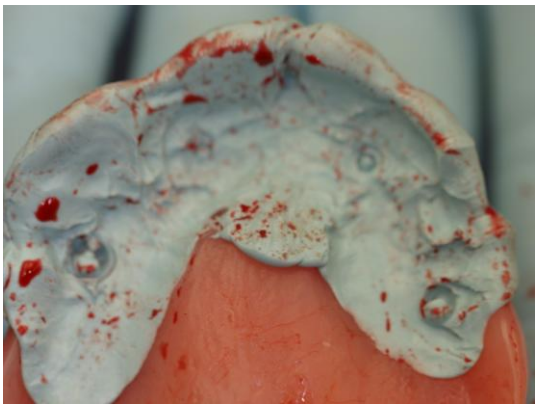
- In the case of a dual arch surgery, the upper denture should be provisionalized first, utilizing the palate as a guide in the maxilla and the retro molar pad and bite registration in the mandible.

4. Attach Multi-Unit Abutments

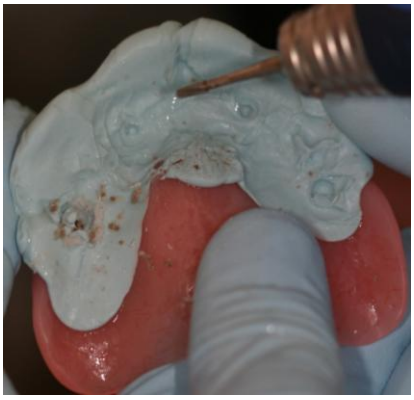
- Once implants are placed, multi-unit abutments can be placed - 30° Multi-Unit Abutments in posterior/tilted implants and Straight or 17° Multi-unit Abutment in anterior. Hand tighten – take X-ray to verify seated properly. Torque to appropriate Ncm – Angled (15Ncm)/Straight (35Ncm). Attach Multi-unit Abutment Healing Caps to top of Multi-unit Abutments prior to suturing.

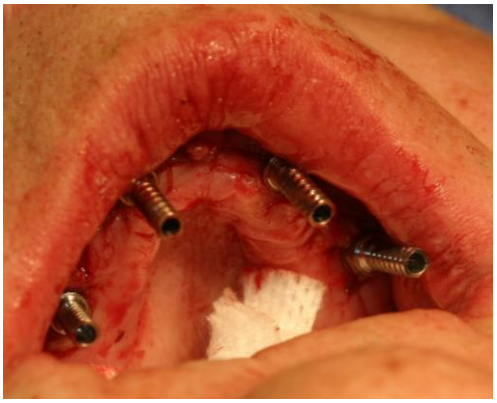
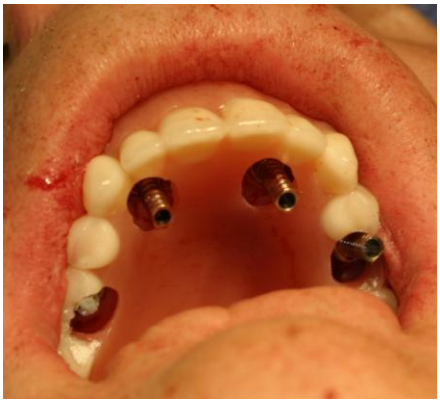
5. **Index position of Multi-Unit Abutments**
   - Use Blue Mousse to line the intaglio surface of denture to index position of abutments.

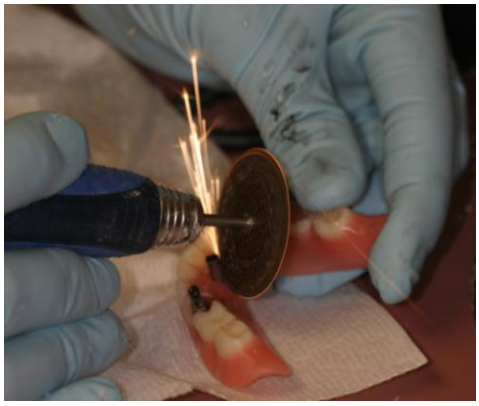
6. **Hollow-out space in denture for Temporary Coping Multi-unit**



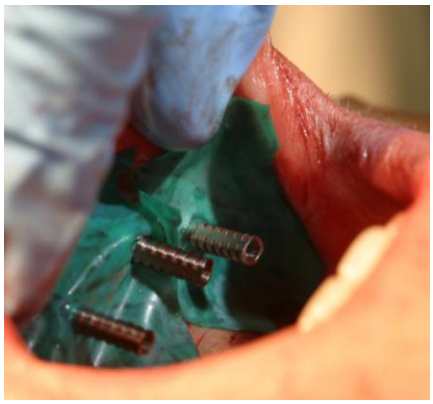

7. **Attach Temporary Coping Multi-unit to Multi-Unit Abutments**
   - Place hollowed-out denture over Temporary Coping Multi-unit cylinders (passive fit)

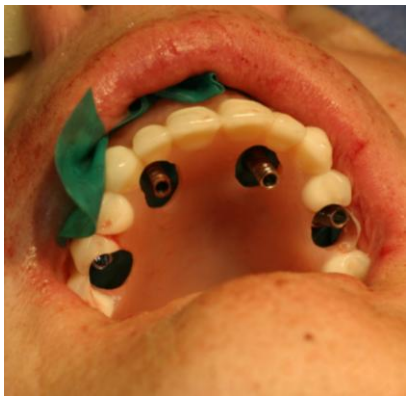



8. **Reduce Height of Temporary Coping Multi-Unit**
   - With Sharpie marker, mark the height the Temporary Coping Multi-unit cylinders need to be cut down to allow the patient to bite down. Remove Temporary Coping Multi-unit cylinders and trim to appropriate height. Can be done before or after pick-up with acrylic.

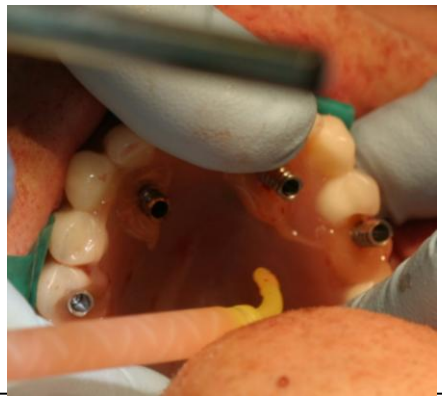


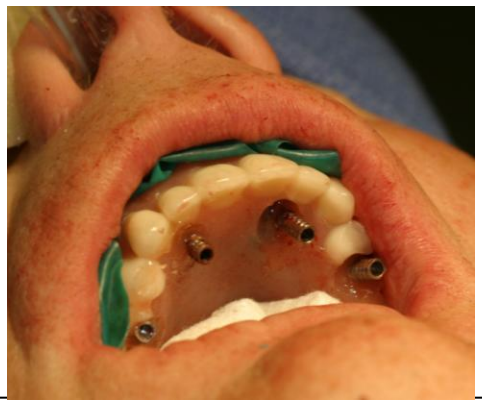
9. **Attach Rubber Dam**
   - Place Rubber Dam around Temporary Coping Multi-unit cylinders (barrier between surgical and restorative materials). Place Light Body Impression Material, wax, or Teflon Tape in top of Temporary Coping Multi-unit cylinder to prevent acrylic from getting inside. Verify proper seating and alignment of denture with pre-operative Bite Registration.





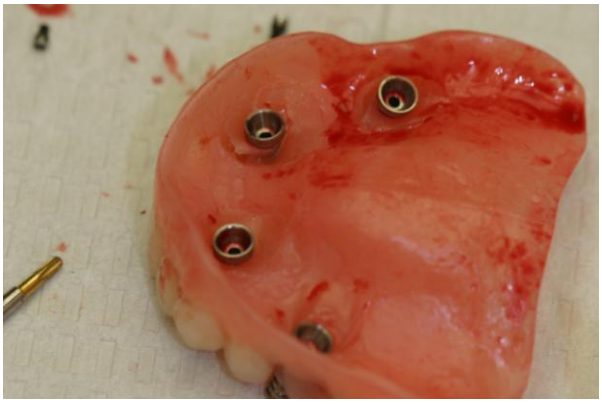
10. **Pick-up Temporary Coping Multi-unit cylinders**
    - Use Cold Cure Acrylic (any Exothermic Polymer Acrylic e.g., 3M Secure, Unifast Trad, or Quik Set). Allow Cold Cure Acrylic to set-up.





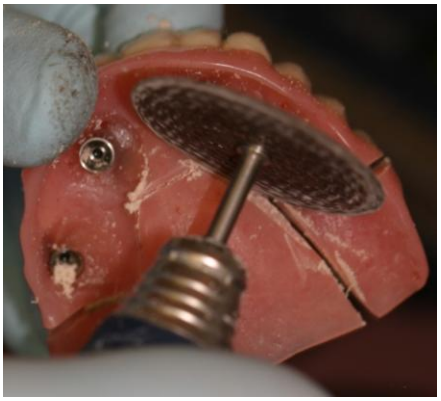
11. Remove Prosthesis with Temporary Coping Multi-unit cylinders processed in acrylic

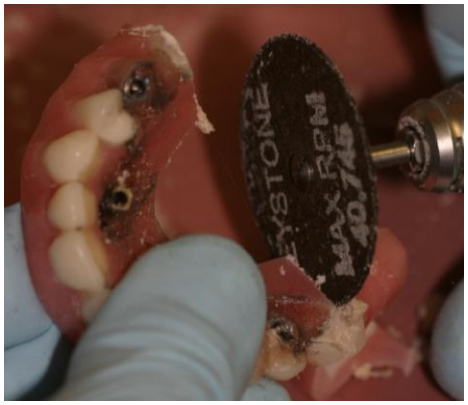
- With UniGrip Driver unscrew prosthesis and remove Prosthetic Screws with a Perio Probe (wax block-out may make Prosthetic Screws difficult to remove). Attach the white Healing Cap Multi Units on the Multi Unit Abutments while the provisional prosthesis is being finished.



12. Convert from Immediate Denture to Fixed Implant Bridge

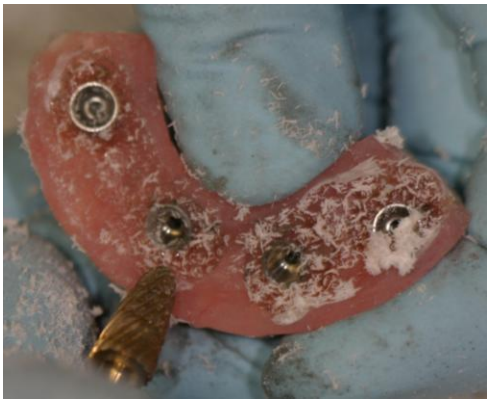
- Trim palate, borders, phalanges, and remove distal cantilevers beyond 3mm.

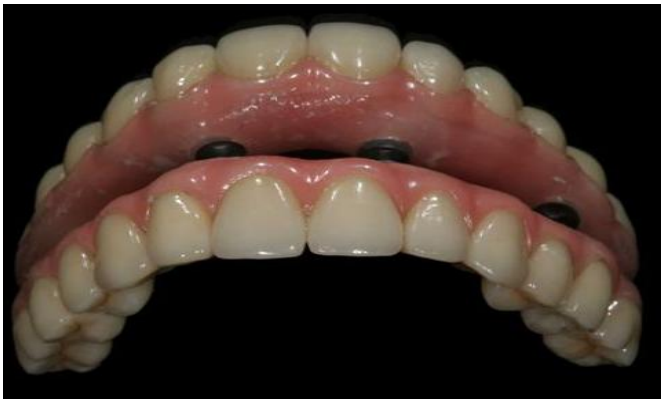




13. Polish and Smooth Surface of Fixed Implant Bridge

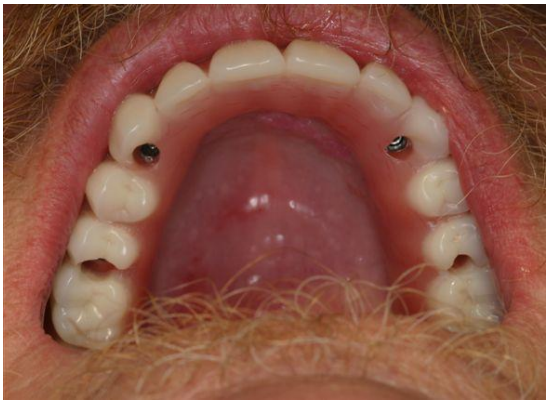
- Maintain intaglio surface of denture – create ovate pontic contour for ease of maintenance/hygiene for patient. Remove any sharp angles or edges

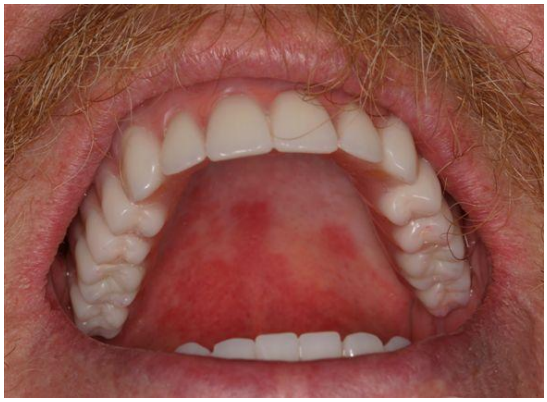


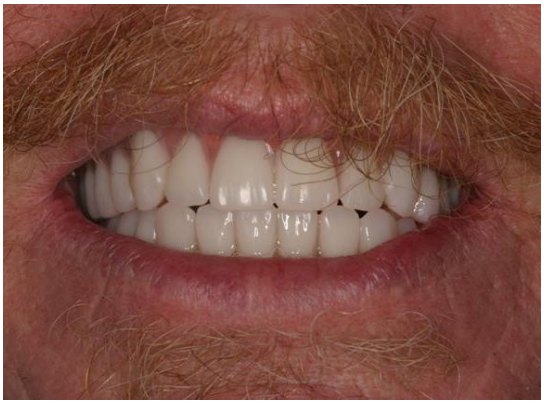


14. Attach Provisional Fixed Implant Bridge Prosthesis w/Prosthetic Screws

- Torque Prosthetic Screws with Unigrip Driver to 15Ncm.
- Fill in screw access w/Teflon Tape and composite.
- Adjust occlusion using articulation paper – reducing any high spots to level occlusion.







15. Recommended Diet during Healing Phase

- A semi-solid/soft food diet is recommended while the implants Osseo integrate – 3-4 months. The patients can eat anything they can cut with a fork (cooked vegetables, canned fruits, well-cooked meat/fish/chicken, etc. Avoid raw vegetables, fruits, and nuts until the implants have Osseo integrated.)

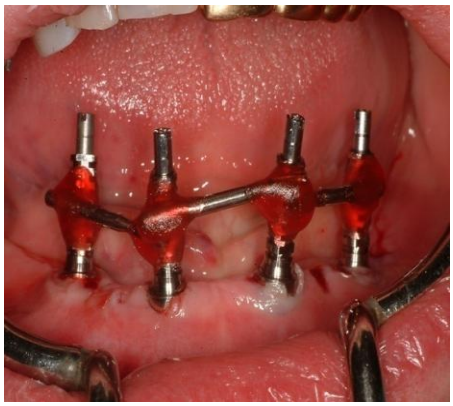
16. Hygiene and Maintenance

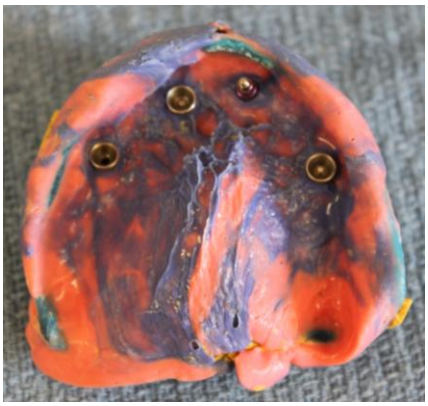
- For the first 14 days following All-on-4™ Surgery & Provisionalization – have the patient rinse with Peridex Oral Rinse.
- After 2 weeks, use a water pick and soft bristle toothbrush with non-abrasive tooth paste to clean.
- Regular hygiene visits are recommended every 6 months. Evaluate prosthesis for plaque build-up or red/inflamed soft tissue. If tissue appears healthy, have hygienist clean around implants like an ovate pontic on a bridge.
- Remove prosthesis if tissue is red/inflamed or calculus is built up on prosthesis. Use Unigrip Driver to remove Prosthetic screws and clean in the ultrasonic. Use ProClean (tartar and stain remover) for cleaning the prosthesis. Soak screws in alcohol or sterile water. Replace Prosthetic Screws with new screws after removing more than 2 times. Torque Prosthetic Screws to 15Ncm with Unigrip Driver.

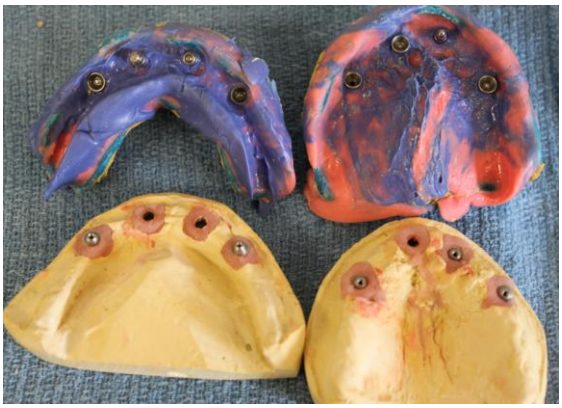
Final Prosthesis – NobelProcera® Implant Bridge:

1. **Custom Tray Impression**
   - Un-screw the provisional implant bridge with Unigrip Driver
   - Take an Alginate Impression for custom trays to be manufactured
   - Take an impression of the opposing arch, if needed
   - Take impressions of temporary dentures, to indicate the patients likes/dislikes of existing dentures

2. **Final Impression**
   - Un-screw the provisional implant bridge with Unigrip Driver
   - Attach Open Tray Multi Unit Impression Copings to Multi Unit Abutments – take X-ray to verify seated properly. Lute impression copings together with ortho wire and light cure material or pattern resin – create a rigid frame to ensure accuracy. The Dental Laboratory will lute the Multi Unit Abutment Replicas together when attaching to the impression copings and pouring up the master cast to ensure accuracy.
   - Make sure the custom tray clears the Open Tray Impression Copings, adjust tray if needed.
   - Use heavy body impression material around the impression copings and a medium body impression material for the tissue area

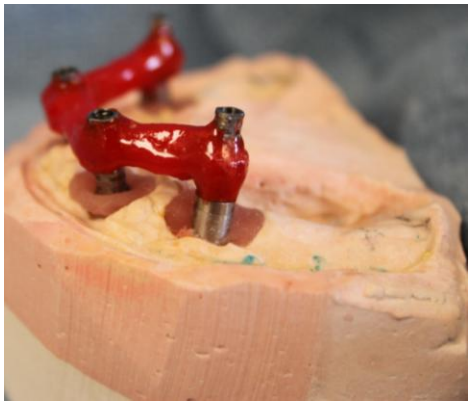






3. Verification of Master Cast and Final Records

- Un-screw the provisional implant bridge with Unigrip Driver
- Take a Bite Registration
- Mark Midline, High Lip Line, Incisal Edge and Shade
- Verification Jig Try-in - The Jig MUST sit passively to each implant/abutment. Take an X-ray to verify seated properly. If the jig does not fit passively, section the jig and re-take final impression with the custom tray over the jig.

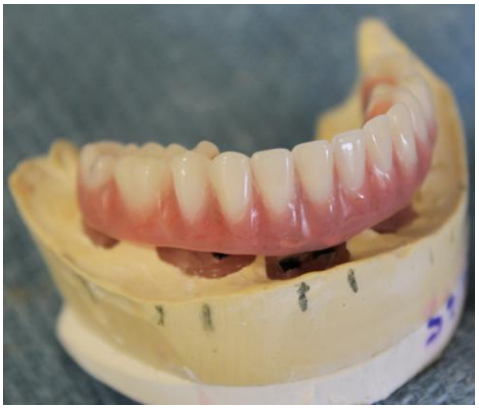
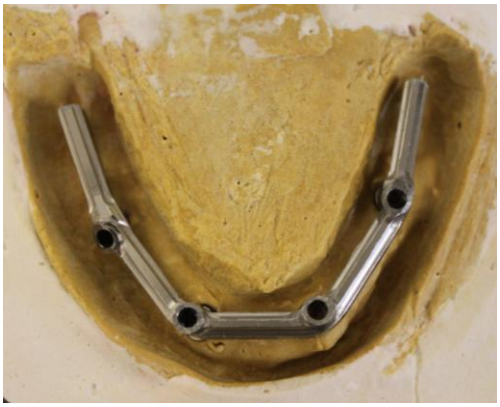


4. Wax Try-in

- Un-screw the provisional implant bridge with Unigrip Driver
- Wax Try-in - If esthetics, phonetics, function, and lip support are acceptable, send to lab for the NobelProcera® Implant Bridge Titanium framework to be milled. Note: the lip support is provided by the gingival third of the tooth. There is no denture flange to provide bulk. If more support is required than what is provided by the wax try-in, then the necks of the teeth will need to be brought forward.
- Try in Jig (if didn't fit passively the first time)

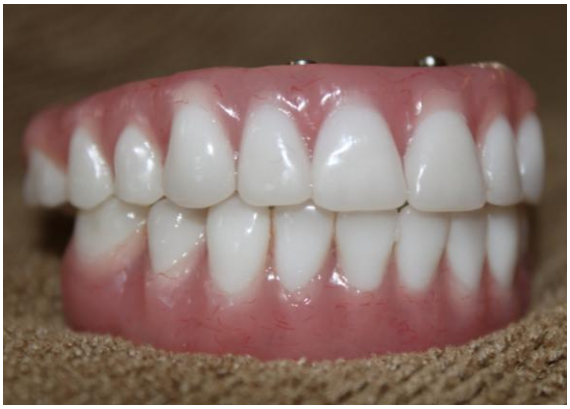
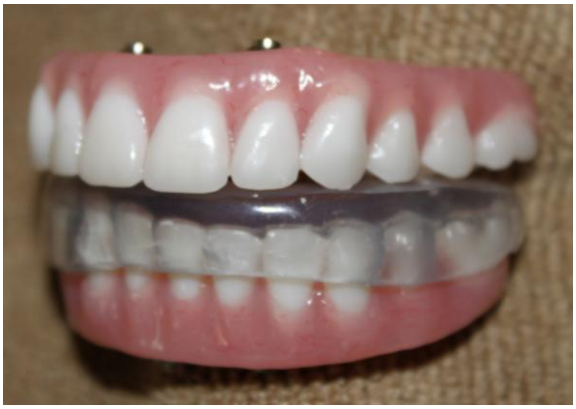
5. **NobelProcera® Implant Bridge Titanium framework Try-in**

- Un-screw the provisional implant bridge with Unigrip Driver
- Try-in the NobelProcera® Implant Bridge Titanium framework, verify passive fit with each implant/abutment
  - Teeth will be set in wax

6. **Seat the NobelProcera® Implant Bridge - Final Prosthesis**

- Un-screw the provisional implant bridge with Unigrip Driver
- Seat the final prosthesis - Take X-ray to verify seated properly. The final prosthesis should seat firmly against the soft tissue, like an ovate pontic. The design of the tissue interface should be such that it causes the tissue to roll over the prosthesis on the buccal and lingual aspects.
- Torque the Prosthetic Screws with Torque Wrench to 15 Ncm when attaching to Multi-Unit Abutments. Always use new prosthetic screws to seat the final prosthesis.
- Block out screw access holes to protect screw head with Teflon Tape, Foam, etc. Seal screw access areas with Acrylic
- A night guard is provided

Full Arch Treatment Options

Full Arch Treatment Options

Option 1: Removable Denture

Advantages

- Relatively inexpensive tooth and gingival replacement
- Provides lip support
- Easy to remove and clean outside of mouth

Disadvantages

- Uncomfortable – may cause sore spots on gum tissue
- Difficult to eat certain foods
- Accelerates bone loss
- Often requires reline to improve fit and comfort as bone deteriorates
- Difficult to speak as the removable denture may move
- May require creams or adhesives to reduce mobility of denture
- Approximately 10% functionality compared to natural teeth

Option 2: 2 or 4 Implant Over Denture (Removable)

Advantages

- Improves stability and functionality to 60% compared to natural teeth
- Relatively inexpensive tooth and gingival replacement
- Provides lip support
- Easy to clean outside of mouth

Disadvantages

- Uncomfortable – may cause sore spots on gum tissue
- Remove and clean denture outside of mouth
- May still move when chewing or speaking
- May require relines to improve fit and comfort as bone deteriorates

Option 3: All-on-4™ Implant Fixed Bridge

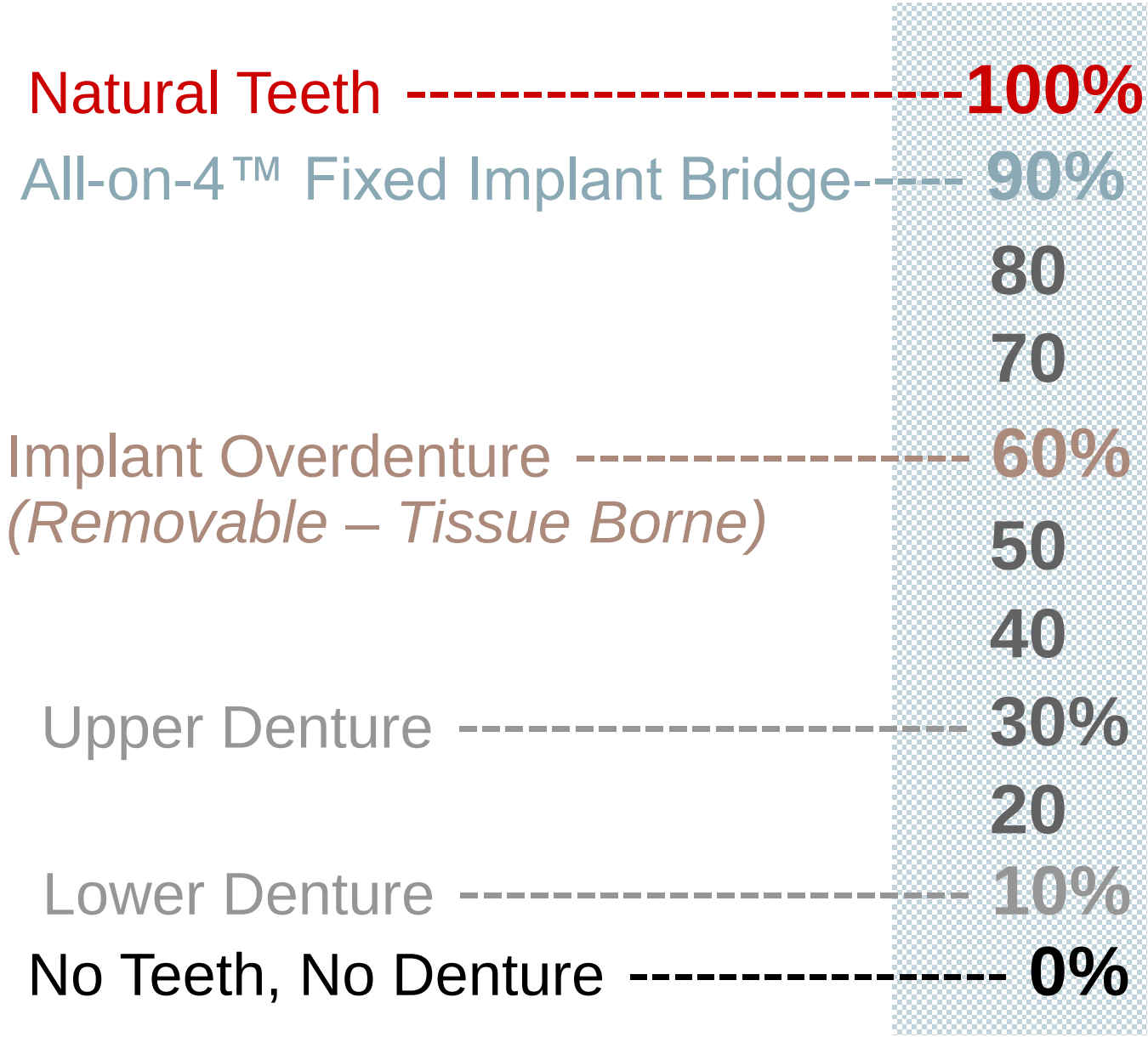
Advantages

- Improves functionality to 90% compared to natural teeth
- Eliminates need for bone grafting
- Can provide temporary bridge day of surgery - eat soft foods while healing
- Replaces roots and teeth
- Preserves bone and soft tissue
- Never decay – 95% success rate over 30 years
- Natural-looking esthetics
- Allows you to eat the foods you want
- Able to clean fixed implant bridge like natural teeth

Disadvantages

- Time (healing and restorative)
- Surgical procedure

Relative Functional Chewing Capacity



Nobel Biocare®

Multi-Unit
Abutment Quick Guide

Multi-unit Abutment Placement and impression techniques

CLOSED TRAY AND OPEN TRAY QUICK GUIDE

Abutment placement instructions

Step 1
– Remove the Healing Abutment using the Screwdriver Unigrip and by rotating it counterclockwise.

Step 2a – Straight Multi-unit Abutment
– Use the premounted plastic holder to place the abutment onto the implant and screw the abutment into the correct position. If necessary, shorten the holder with a pair of scissors. When the abutment is seated, remove the plastic holder with a slight bending movement and hand-tighten with Screwdriver Machine Multi-unit.

Step 2b – Straight Multi-unit Abutment
– Take a radiograph to verify proper seating of the abutment (radiograph for conical connection is shown). Tighten the abutment screw to 35 Ncm using the Manual Torque Wrench Prosthetic and Screwdriver Machine Multi-unit.

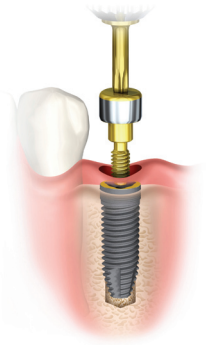
Or

Step 2a – Angled Multi-unit Abutment, 17° or 30°
– The abutment is placed over the implant by using the premounted abutment holder. Please note that there are several possible positions in which to place the abutment based on the implant connection and abutment angle.
– Tighten the abutment screw using a Screwdriver Unigrip until resistance is felt. The holder is then unscrewed from the abutment by turning it counterclockwise.

Step 2b – Angled Multi-unit Abutment, 17° or 30°
– Take a radiograph to verify proper seating of the abutment (radiograph for conical connection is shown). Tighten the abutment screw to 15 Ncm using the Manual Torque Wrench Prosthetic and Screwdriver Machine Unigrip. Be sure not to exceed 15 Ncm.

See closed or open tray instructions for next steps.

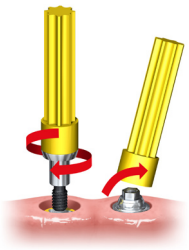
1



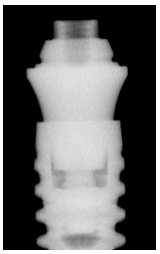
This Quick Guide does not replace the Instructions for Use. Please review the instructions for use included with the products.

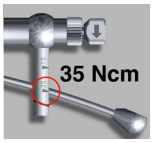
Indications:
– Multi-unit restorations
– Screw-retained
– May be used in combination with framework design if not all implants benefit from abutments.
– Used to elevate seating restoration platform when restoration-to-implant level is not practical nor indicated due to depth or angle of implant.

2a



2b

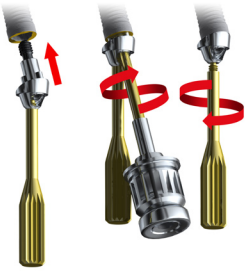




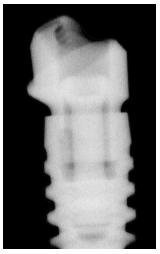
Conical connection

OR

2a



2b



Conical connection

Closed tray – Abutment level impression instructions

Step 3
– Connect the Impression Coping Closed Tray Multi-unit to the abutment by rotating it clockwise.

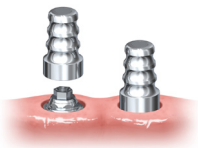
Step 4
– Inject a heavy body impression material (polyether material or polyvinylsiloxane) around the impression coping. Fill the tray with impression material and record the impression.

Step 5
– After setting, remove the impression and disconnect the impression copings. Attach an Abutment Replica Multi-unit to each impression coping.

Step 6
– Place the impression coping abutment replica assembly into its corresponding location in the impression.

Step 7
– Connect the temporary restoration or healing cap. Send the impression to the dental laboratory.

3



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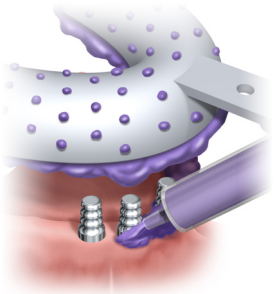

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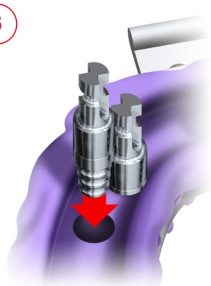


7

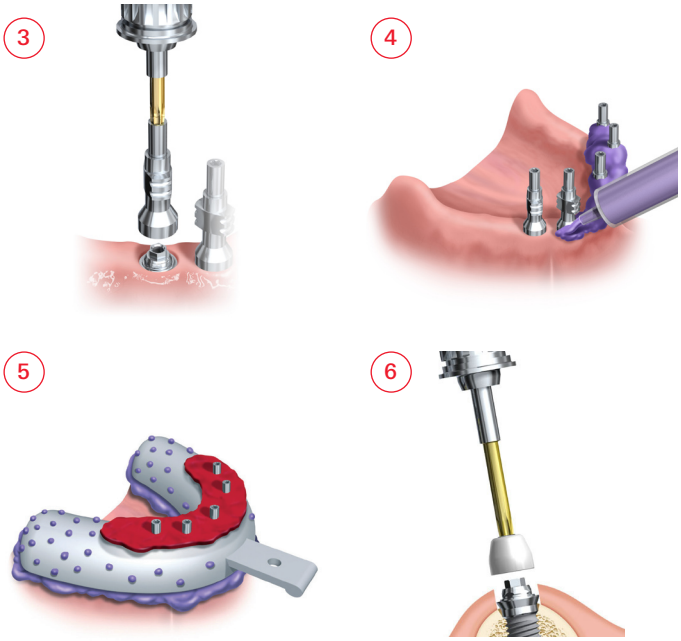
Open tray – Abutment level impression instructions

Step 3
– Connect the Impression Coping Open Tray Multi-unit on the abutment and tighten using the Screwdriver Unigrip.
– Relieve and perforate the impression tray to allow full seating of the tray and protrusion of the guide pins. If there is a large opening, it may be closed off using baseplate wax, with the guide pins indenting or perforating the wax.

Step 4
– Inject a heavy body impression material (polyether material or polyvinylsiloxane) around the impression coping.
– Fill the tray with impression material and seat the impression tray fully so that the tips of all the guide pins are identifed.
– Remove excess impression material from the guide pin access holes.

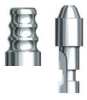
Step 5
– After setting, unscrew the guide pins and remove the impression tray and send to the dental laboratory, including the guide pins. For model fabrication, corresponding implant replicas should be provided by you or your dental laboratory.

Step 6
– Connect the temporary restoration or healing cap.



Materials to use for Multi-unit Abutment placement and closed or open tray impression techniques

	Description	Item number
	NobelReplace® Multi-unit Abutment (internal tri-channel connection)	
	17° Multi-unit Abut NobelReplace NP 2 mm	29235
	17° Multi-unit Abut NobelReplace NP 3 mm	29236
	17° Multi-unit Abut NobelReplace RP 2 mm	29237
	17° Multi-unit Abut NobelReplace RP 3 mm	29238
	17° Multi-unit Abut NobelReplace RP 4 mm	29239
	30° Multi-unit Abut NobelReplace RP 4 mm	29240
	30° Multi-unit Abut NobelReplace RP 5 mm	29241
	30° Multi-unit Abut Non-Engaging NobRpl RP 4 mm	33409
	30° Multi-unit Abut Non-Engaging NobRpl RP 5 mm	33410
	Multi-unit Abut NobelReplace NP 1 mm	29196
	Multi-unit Abut NobelReplace NP 2 mm	29197
	Multi-unit Abut NobelReplace NP 3 mm	29198
	Multi-unit Abut NobelReplace RP 1 mm	29199
	Multi-unit Abut NobelReplace RP 2 mm	29200
	Multi-unit Abut NobelReplace RP 3 mm	29201
	Multi-unit Abut NobelReplace RP 4 mm	29202
	Multi-unit Abut NobelReplace RP 5 mm	29203
	Multi-unit Abut NobelReplace WP 1 mm	29204
	Multi-unit Abut NobelReplace WP 2 mm	29205
	Multi-unit Abut NobelReplace WP 3 mm	29206
	Conical Connection Multi-unit Abutment (internal conical connection)	
	17° Multi-unit Abut CC NP 2.5 mm	36614
	17° Multi-unit Abut CC NP 3.5 mm	36615
	17° Multi-unit Abut CC RP 2.5 mm	36618
	17° Multi-unit Abut CC RP 3.5 mm	36619
	30° Multi-unit Abut CC NP 3.5 mm	36620
	30° Multi-unit Abut CC NP 4.5 mm	36621
	30° Multi-unit Abut CC RP 3.5 mm	36622
	30° Multi-unit Abut CC RP 4.5 mm	36623
	Multi-unit Abut CC NP 1.5 mm	36611
	Multi-unit Abut CC NP 2.5 mm	36613
	Multi-unit Abut CC NP 3.5 mm	36624
	Multi-unit Abut CC RP 1.5 mm	36616
	Multi-unit Abut CC RP 2.5 mm	36617
	Multi-unit Abut CC RP 3.5 mm	36625
	Multi-unit Abut CC RP 4.5 mm	36626

	Description	Item number
	Brånemark System® Multi-unit Abutment (external hex connection)	
	17° Multi-unit Abutment Brånemark System NP 2 mm	29187
	17° Multi-unit Abutment Brånemark System NP 3 mm	29188
	17° Multi-unit Abutment Brånemark System RP 2 mm	29189
	17° Multi-unit Abutment Brånemark System RP 3 mm	29190
	17° Multi-unit Abutment Brånemark System RP 4 mm	29191
	30° Multi-unit Abutment Brånemark System RP 4 mm	29192
	30° Multi-unit Abutment Brånemark System RP 5 mm	29193
	30° Multi-unit Abut Non-Engaging Bmk Syst RP 4 mm	33411
	30° Multi-unit Abut Non-Engaging Bmk Syst RP 5 mm	33412
	Multi-unit Abutment Brånemark System NP 1 mm	29176
	Multi-unit Abutment Brånemark System NP 2 mm	29177
	Multi-unit Abutment Brånemark System NP 3 mm	29178
	Multi-unit Abutment Brånemark System RP 1 mm	29179
	Multi-unit Abutment Brånemark System RP 2 mm	29180
	Multi-unit Abutment Brånemark System RP 3 mm	29181
	Multi-unit Abutment Brånemark System RP 4 mm	29182
	Multi-unit Abutment Brånemark System RP 5 mm	29183
	Multi-unit Abutment Brånemark System WP 1 mm	29184
	Multi-unit Abutment Brånemark System WP 2 mm	29185
	Multi-unit Abutment Brånemark System WP 3 mm	29186
	Instruments	
	Screwdriver Manual Unigrip 20 mm	29148
	Screwdriver Manual Unigrip 28 mm	29149
	Screwdriver Manual Unigrip 36 mm	29150
	Screwdriver Machine Multi-unit 21 mm	29158
	Screwdriver Machine Multi-unit Bmk Syst WP 20 mm	29159
	Screwdriver Machine Unigrip 20 mm	29151
	Screwdriver Machine Unigrip 25 mm	29152
	Screwdriver Machine Unigrip 30 mm	29153
	Screwdriver Machine Unigrip 35 mm	29154
	Manual Torque Wrench Prosthetic	29165
	Components	
	Impression Coping Closed Tray Multi-unit	29090
	Impression Coping Closed Tray Multi-unit Bmk Syst WP	29092
	Impression Coping Open Tray Multi-unit	29089
	Impression Coping Open Tray Multi-unit Bmk Syst WP	29091
	Abutment Replica Multi-unit	31161
	Abutment Replica Multi-unit Bmk Syst WP	31162
	Healing Cap Multi-unit	31145
	Healing Cap Multi-unit Bmk Syst WP	29066
	Healing Cap Wide Multi-unit	31146
	Healing Cap Wide Multi-unit Bmk Syst WP	29067
	Temporary Coping Multi-unit	29046
	Temporary Coping Multi-unit Bmk Syst WP	29047
	Temporary Coping Plastic Multi-unit	DCA 468-0
	Temporary Coping Plastic Multi-unit	DCA 705-0

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Case Study by
Schroering & Parrish

PracticalPROCEDURES No. 29
PROVIDING SOLUTIONS FOR CLINICAL CHALLENGES

Clinical Protocol for Rapid, Graftless, Four-Implant Restoration of the Fully Edentulous Patient

Robert Schroering, DMD* • Ken Parrish, DMD, PhD*

Osseointegration has become a predictable biological response to implant placement, enabling dental professionals to focus on surgical and restorative processes that simplify implant therapy. This has resulted in techniques that improve the predictability of aesthetic implant placement and make such treatment options accessible for a greater portion of the patient population. As shown in the following clinical protocol, the All-on-4™ Technique provides numerous advantages in the management of the edentulous patient or the soon-to-be edentulous patient.

- Ease of the procedure
- Ability to avoid grafting procedures
- Potential of immediate loading at the surgical appointment
- Decreased cost to the patient
- Aesthetics
- Can be performed on the partially or fully edentulous patient
- Ease of maintenance
- Can be flapless when using NobelGuide™ guided surgery.

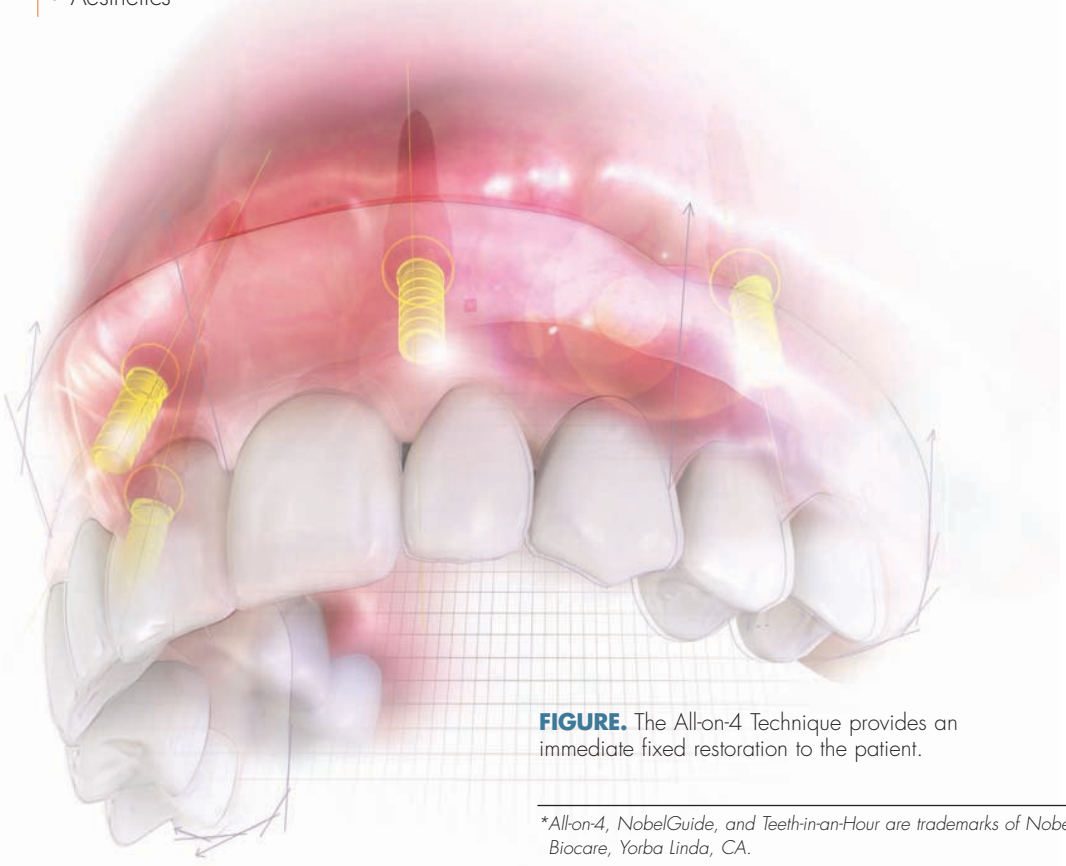


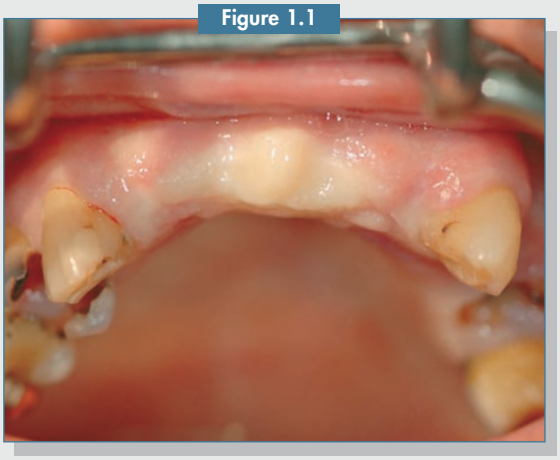
FIGURE. The All-on-4 Technique provides an immediate fixed restoration to the patient.

**All-on-4, NobelGuide, and Teeth-in-an-Hour are trademarks of Nobel Biocare, Yorba Linda, CA.*

Case 1 — Implant Placement and Prosthesis Conversion

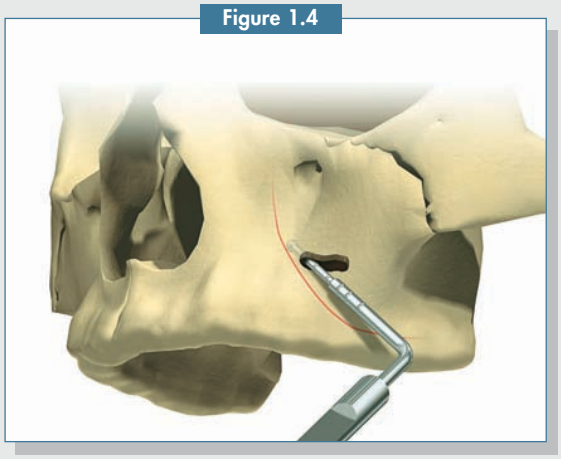
As with any implant procedure, the All-on-4™ Technique depends on standard implant protocols and sound treatment planning. Its use of the patient's existing denture or an immediate denture (for the patient with teeth) enables simple chairside modification, relining, and reseating in the patient on the day of surgery. The primary phases of treatment—implant placement, abutment connection, and prosthesis adaptation—are demonstrated in the following protocol.

Figure 1.1



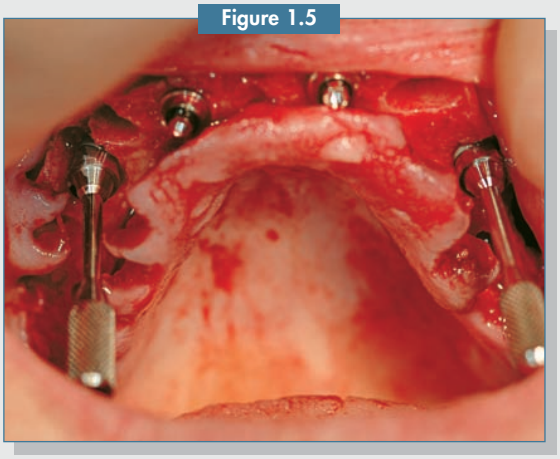
Preoperative clinical view of partially edentulous patient who requests a fixed implant restoration.

Figure 1.4



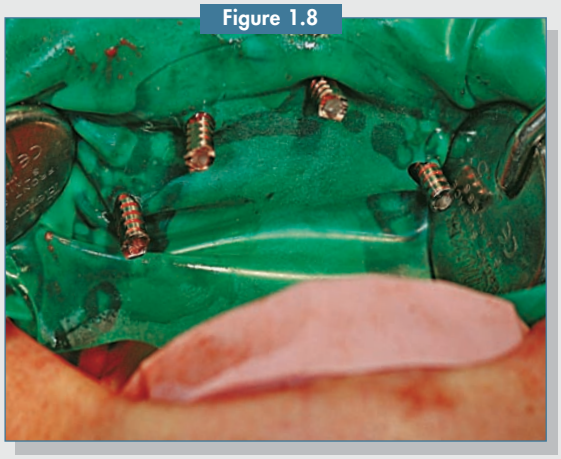
The anterior of the sinus is marked with a periodontal probe in order to identify the mesial wall of the sinus. This affords the posterior implant the most-posterior position to create a favorable anterior/posterior spread without invading the sinus.

Figure 1.5



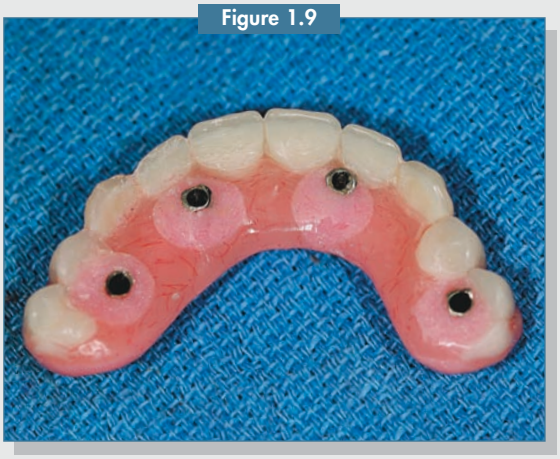
After implant placement, Multi-Unit Abutments (Nobel Biocare, Yorba Linda, CA) are placed with an abutment driver. These abutments help correct the angulation of the dental implants.

Figure 1.8



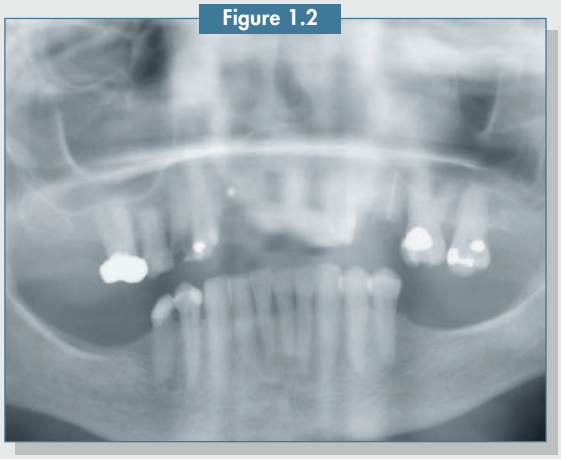
Once the temporary prosthesis is hollowed out chairside, the surgical field is covered with a rubber dam to protect the soft tissues during the restorative phase of treatment.

Figure 1.9



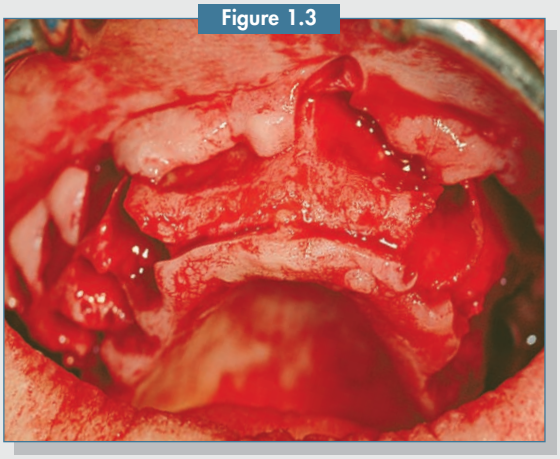
Titanium copings are "picked up" and the temporary fixed detachable prosthesis is modified. First molars are eliminated to reduce cantilever forces during osseointegration.

Figure 1.2



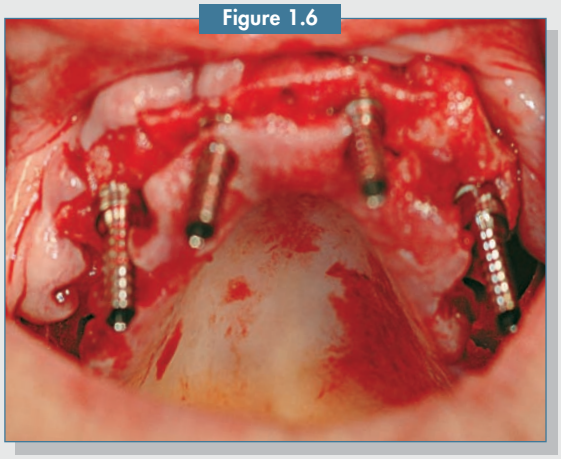
Preoperative panoramic radiograph of the partially edentulous patient, which permits evaluation of the bone levels.

Figure 1.3



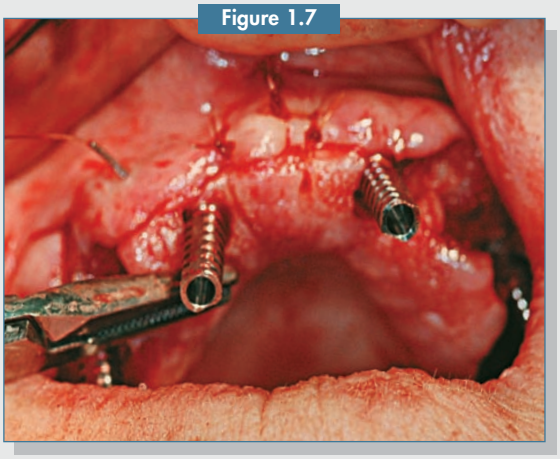
All maxillary teeth are extracted and the alveolar bone is reduced via a "horizontal osteotomy" to a height sufficient to avoid the smile line.

Figure 1.6



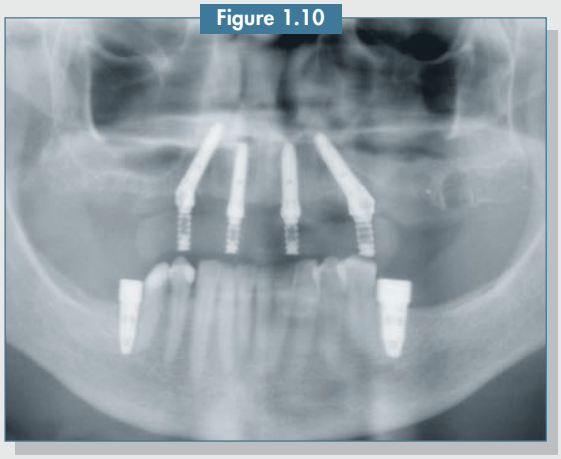
Temporary Copings (Nobel Biocare, Yorba Linda, CA) are placed.

Figure 1.7



Soft tissue closure is accomplished with horizontal mattress sutures in order to reposition the tissues for optimum healing.

Figure 1.10



Postoperative panoramic radiograph showing successful placement of four implants in the maxillary arch.

Figure 1.11

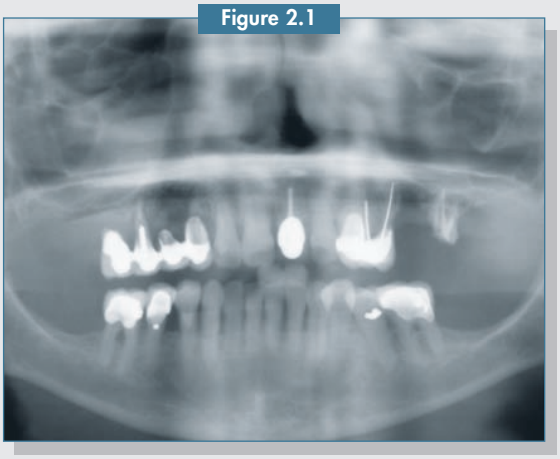
Postoperative facial view of the temporary fixed detachable prosthesis delivered that same day utilizing the All-on-4 Technique.

Additional Evidence of Success

The All-on-4™ Technique represents a viable option for clinicians seeking to bring the advantages of fixed implant prosthodontics to their patients. In proper clinical situations with minor prosthetic involvement, the technique utilizes an immediate loading protocol. The All-on-4 Technique thus constitutes a valuable addition to the practitioner's armamentarium.

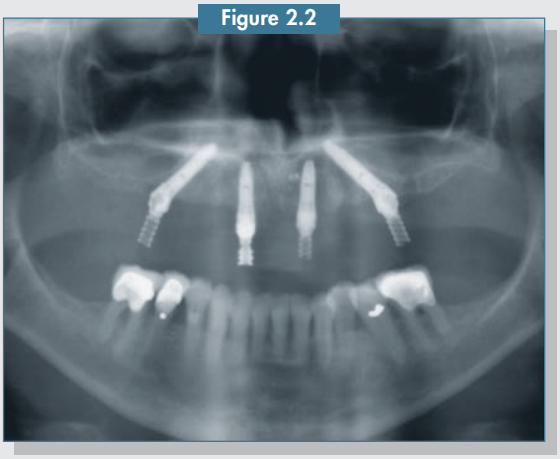
Case 2 — Patient With Hopeless Maxillary Dentition

Figure 2.1



Preoperative view of patient with hopeless dentition in the maxillary arch.

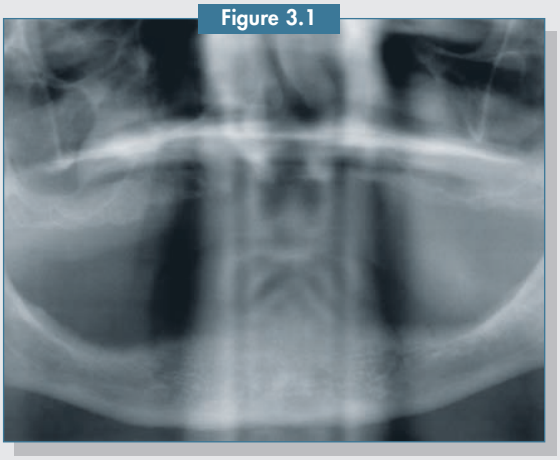
Figure 2.2



Postoperative radiograph following successful placement of four maxillary implants and the temporary fixed detachable prosthesis with the All-on-4 Technique.

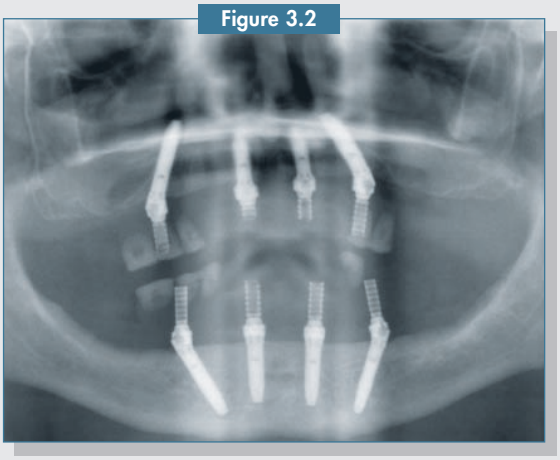
Case 3 — Completely Edentulous Patient

Figure 3.1



Panoramic radiograph demonstrates a completely edentulous patient who has worn dentures for 20 years.

Figure 3.2



Postoperative radiograph following successful immediate placement of temporary fixed-detachable dentures using the All-on-4 Technique. The final fixed detachable prostheses will be placed four months following surgery.

*Private practice devoted to advanced implant and periodontal treatment, Louisville, KY.
The authors can be contacted at r.schroering@advancedimplant.com and kenparrish@yahoo.com.

The All-on-Four Immediate Function Treatment Concept With NobelActive Implants: A Retrospective Study

Charles A. Babbush, DDS, MScD*
Gary T. Kutsko, DDS
John Brokloff, DDS

The All-on-Four treatment concept provides patients with an immediately loaded fixed prosthesis supported by 4 implants. This single-center retrospective study evaluated the concept while using the NobelActive implant (Nobel Biocare, Gothenburg, Sweden). Seven hundred eight implants placed in 165 subjects demonstrated a cumulative survival rate of 99.6% (99.3% in maxilla and 100% in the mandible) for up to 29 months of loading. The definitive prosthesis survival rate was 100%.

Key Words: All-on-Four, NobelActive implants

INTRODUCTION

A common condition in elderly patients is the occurrence of edentulism, which can be the result of many factors such as poor oral hygiene, dental caries, and periodontal disease. There are also those patients who face edentulism due to a terminal nonrestorable dentition. The edentulous condition has been shown to have a negative impact on oral health–related quality of life.[1] Clinicians are faced with the growing need to offer solutions to this population due to an increase in their life expectancy[2,3] and to fabricate prostheses that provide a replacement for the loss of natural teeth, allowing optimum satisfaction and improved quality of life.

The routine treatment for edentulism has been conventional dentures. National epidemiological survey data in the United States suggested that the adult population in need of 1 or 2 dentures would increase from 35.4 million adults in 2000 to 37.0 million adults in 2020.[4] Clinical studies have reported that patients with dentures have shown only a marginal improvement in the quality of life when compared with implant therapy.[5] The common reasons for dissatisfaction in patients using dentures are pain, areas of discomfort, poor denture stability, and difficulties in eating as well as lack of or compromised retention capability.[6] Many patients wearing complete dentures complain about poor masticatory performance, loss of function, decreased motor control of the tongue, reduced bite force, and diminished oral sensory function.[7–10] A review of the literature noted that prostheses supported by osseointegrated dental implants significantly improved the quality of life for

Cleveland ClearChoice Dental Implant Center, Pepper Pike, Ohio.
*Corresponding author, e-mail: cab@thedentalimplantcenter.com
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edentulous patients when compared with conventional dentures.[11–15]

Immediate loading of implant-supported, full-arch prostheses for these patients in the mandible or maxilla has been documented as a predictable procedure.[16–20] Excellent success rates for immediately loaded, fixed prosthetic reconstructions[19–26] and long-term follow-up results have been reported in the literature.[27–29] Immediate loading of implant-supported fixed full-arch prostheses for these cases in the edentulous maxilla and mandible has been associated with a high level of satisfaction for patients in terms of esthetics, phonetics, and functionality.[17–20,30–34]

Dental implants are traditionally placed in the vertical position. However, in the completely edentulous jaw as well as in the postextraction patient, problems such as minimum bone volume, poor bone quality, and the need for bone-grafting procedures prior to implant placement create some challenging conditions. For these situations, it has been demonstrated that distal tilting of implants may be advantageous. Tilting preserves relevant anatomical structures and allows for placement of longer implants with good cortical anchorage in optimal positions for prosthetic support.[35,36] Strain gauge measurements performed by Krekmanov reported no significant difference between tilted and nontilted implants, and theoretical models showed an increased prosthetic base due to the inclination of implants, which in turn can reduce the force acting over the implants.[36] Tilting also increases the interimplant space, reduces cantilever length in jaws,[21,31,36,37] and reduces the need for bone augmentation. Good clinical outcomes have been reported in various studies using tilted implants.[31,32,35,38–40]

The All-on-Four treatment concept provides edentulous arches and immediate/postextraction subjects with an immediately loaded, fixed prosthesis using 4 implants: 2 axially oriented implants in the anterior region and 2 tilted posterior implants.[31,32,37] The principle involves the use of 4 implants restored with straight and angled multiunit abutments, which support a provisional, fixed, immediately loaded, full-arch prosthesis placed on the same day of surgery. The All-on-Four treatment has been developed to maximize the use of available bone and allows immediate function. Overall, published data on the All-on-Four concept reported cumulative survival rates between 92.2% and 100%.[31–34,37,40–42]

The All-on-Four concept has been reported predominantly in the literature with the NobelSpeedy or the Branemark System dental implants. The purpose of this study was to evaluate the All-on-Four concept using an implant (NobelActive) with a tapered body and a variable thread design for up to 29 months of loading.

Materials and Methods

This is a retrospective single-center study. Subjects with totally edentulous arches and/or in need of extraction of the remaining compromised teeth were rehabilitated with the NobelActive implants. The first implant in the study was placed on February 21, 2008, and the last implant was placed on September 12, 2009. Each subject received an immediately loaded, fixed, complete-arch provisional prosthesis on the day of implant placement according to the All-on-Four technique. The definitive prostheses were delivered within 6 to 8 months after implant insertion. An actuarial life table method was used to determine implant cumulative survival rate.

Patients treated with the technique and therefore included in the retrospective analysis met the following criteria:

- jaw bone profile for the placement of at least 4 implants of at least 10 mm in length in either healed or immediate extraction sites

- good general health with acceptable oral hygiene
- implants achieved stability at insertion

Patients could not be treated according to the technique if they had insufficient bone quality and quantity for placement of endosseous implants, exhibited severe parafunctional habits, or had a compromised medical history that would affect implant placement (eg, bisphophonates, chemotherapy).

Surgical protocol

A cone-beam computerized tomographic scan (CBCT; I-CAT cone beam CT scan, Imaging Science Corp, Hatfield, Penn) was taken prior to surgery, and the bone profile, which included the bone quality and bone volume, was assessed[43] by 2 experienced clinicians (C.A.B. and G.T.K.). In the vast majority of cases, the patient was administered intravenous (conscious) sedation using fentanyl citrate 0.5 mg/mL (fentanyl; Hospira, Lake Forest, Ill), diazepam 5 mg/mL injection (Valium; Hospira), as well as nitrous oxide oxygen inhalation. This was in addition to articaine hydrochloride 4% and epinephrine bitartrate 1:100 000 (Septodent, Paris, France), local anesthesia that was administered in both block and infiltration technique. A few of the patients were administered general anesthesia based their preexisting medical profile.

Patients were started on a course of antibiotic (penicillin VK 250 mg, Dispensing Solutions, Santa Ana, Calif), 4 times a day, 2 days prior to the surgical procedure in cases in which teeth had to be extracted. Postoperatively, all patients were given the same antibiotic 4 times per day over a period of 10 days. If patients were allergic to penicillin, clindamycin tablets (clindamycin HCL 150 mg, Dispensing Solutions) were given using a similar dosage regimen. In addition, hydrocodone bitartrate and acetaminophen 7.5 mg/750 mg (Vicodin, Dispensing Solutions) were also used as an analgesic along with anti-inflammatory medication, methylprednisolone, 4-mg dose pack (Medrol, Dispensing Solutions). At the end of the procedure, bupivacaine 0.5% with 1:200 000 epinephrine (bupivacaine, Cook-Waite, Greensboro, NC) was also administered for its analgesic-sparing effect.

Implant placement

NobelActive implants were inserted by (C.A.B.) according to the manufacturer's guidelines (manual No. 21279-GB085, Nobel Biocare Services 2008). Each subject received 2 distally tilted implants in the posterior region followed by 2 anterior implants in either the maxilla or the mandible. In the maxilla, the tilted implants were positioned just anterior to the maxillary sinus and in the mandible; the tilted implants were positioned anterior to the mental foramen. Implant placement was assisted by the All-on-Four surgical guide (Nobel Biocare; Figure 4). The guide was placed into a 2-mm osteotomy made at the midline of the mandible and/or maxilla, and the titanium band was contoured so that the occlusal centerline of the opposing jaw was followed. The guide allowed for optimal positioning, alignment, parallelism, and inclination of the implants for subsequent anchorage and prosthetic support. The drill protocol followed the manufacturer's guidelines (All-on-Four procedures and products, manual No. 16896 Lot GB 0603, Nobel Biocare Services, 2006). The implant sites were usually underprepared avoiding countersinking to engage as maximum cortical support bone as possible. The recommended drill sequences for soft bone type IV, medium type II and type III, and dense type I bone were followed. A manual surgical torque wrench (Nobel Biocare) was used to check the final torque of the implant, which was carefully documented (Table 1). In cases of immediate implant placement, the soft

tissues were readapted to obtain a primary closure around the abutments and fresh extraction sites and then sutured back into position with interrupted resorbable 4.0 chromic sutures (Salvin Dental Specialties, Charlotte, NC). Local bone grafting to cover exposed threads and/or other osseous defects associated with extraction sockets was performed at 64% of implant sites with demineralized bone matrix gel (Dyna graft-D, Keystone Dental, Boston, Mass), and 1% of implant sites were grafted with autogenous bone from the local surgical area.

Straight, 17° multiunit abutment, internal (Nobel Biocare), and 30° angulated multiunit abutments, internal (Nobel Biocare), were used to achieve relative parallelism of the implants so that a rigid prosthesis would seat in a passive manner.

Open-tray multiunit impression copings (Nobel Biocare) were placed on the abutments, and an impression was made with a custom open tray using precision impression material (Flexitime, Heraeus Kulzer, Hanau, Germany). Patients were instructed to avoid brushing and to use warm water rinses for the first postoperative week. A cold or room-temperature soft diet for the first 24 hours following surgery was recommended, followed by a semisolid diet for the next 3 months. Patients were given antibiotics and analgesics as listed in the surgical protocol. A CBCT scan was taken immediately postoperatively to verify the implant positions and the prosthetic components.

Prosthetic protocol

A provisional denture was prefabricated with heat-cured acrylic resin (Ivocap high-impact acrylic, Ivoclar Vivadent, Schaan, Liechtenstein) prior to the surgical procedure. Immediately following surgery, the denture was modified to the master model in the laboratory. Fabrication was completed using cold-curing material (Probase, Ivoclar Vivadent). This provisional all-acrylic resin prosthesis was seated within 3 to 4 hours of completion of surgery on the same day. The patients were scheduled for routine follow-up visits after surgery at 1 week, 2 weeks, 4 weeks, and 3 months postoperative and on a yearly basis. At the 3-month appointment, fabrication of the definitive prosthesis was initiated.

TABLE 1
Torque values (implant insertion)

Ncm	n	%
<35	14	1.98
35	40	5.65
36–45	53	7.49
46–55	41	5.79
56–65	41	5.79
66–70	471	66.53
Not recorded*	48	6.78
Total	708	100

*Implants achieved primary stability, although torque was not noted in numerical values.

Periapical digital radiographs using a parallel technique were obtained at the 3-month appointment and thereafter on a yearly basis from the date of the surgery (Figures 7, 13, 14, 20, and 29). Implants were checked by visual observation for plaque and bleeding on probing at the follow-up intervals. Periapical radiographs and plaque and bleeding indices at various follow-up intervals are part of routine care for patients at the clinic and not a part of the analysis in this study.

The definitive prostheses consisted of a milled titanium frame with a wrap-around heat-cured acrylic resin (Ivocap high-impact acrylic). All restorations were performed by 1 clinician (G.T.K.).

Survival criteria

The modified Albrektsson criteria used in this investigation are the following: an implant was regarded successful when there was (1) no radiolucency around the implant; (2) no signs of infection, pain, or ongoing pathological processes at the implant site; (3) the

implant was restored and functionally loaded; and (4) the prosthesis was stable for multiple implants supporting a complete arch prosthesis. An implant was classified surviving when it remained in the jaw and was functionally loaded even though all the individual success criteria were not fulfilled. A failed implant was an implant that had fractured beyond repair or could not be classified as a successful or surviving implant.[44]

Statistics

A single reviewer abstracted the relevant data from medical records of the patients who were treated consecutively with the All-on-Four technique and entered them into a spreadsheet (Excel 2007, Microsoft, Redmond, Wash). An actuarial life table[45] was used to calculate the cumulative survival rate. Statistical analysis was done in SPSS 17.0 (SSPS, Chicago, Ill) using the Fisher exact test to determine the level of significance ($P < .05$) comparing the survival rates of the arches as well as the various implant sizes.

Results

One hundred sixty-five patients (72 men and 93 women) with a mean age of 59 (SD ±11 years) have been included in the analysis. Seven hundred eight implants restoring both jaws (109 maxillae and 68 mandibles) have been placed. Four hundred thirty-six implants have been placed in the maxilla and 272 in the mandible. Twelve patients were treated in both jaws. Each prosthesis was supported by 4 implants. Most of the implants were seated with a minimum of 35-Ncm torque. Two percent (n = 14) of the implants were seated at a torque of <35 Ncm (Table 1). All implants achieved primary stability at placement. Four hundred twenty-four implants were placed in extraction sites immediately after tooth extraction, and 284 were placed in healed sites. Local bone grafting was performed at 65% of the implant sites; no bone grafting was reported in 35% of the sites. Implant distribution according to implant type and implant length is outlined in Tables 2 and 3, respectively. Implant follow-up occurred up to 29 months. Acrylic provisional restorations were placed within 3 to 4 hours of surgery, with occlusal contact limited to the anterior area only.

Table 2
Implant placement

	Maxilla	Mandible
Position	Total Number of Implants	
Central incisor		
Right	11	2
Left	10	7
Lateral incisor		
Right	62	37
Left	66	31
Canine		
Right	38	28
Left	39	31
First premolar		
Right	14	16
Left	14	6
Second premolar		
Right	77	45
Left	72	51
First molar		
Right	15	7
Left	17	11
Second molar		
Right	0	0
Left	1	0
Third molar		
Right	0	0
Left	0	0
Total	436	272

Two anterior implants failed in 2 different patients at the 1-month and 7-month time points due to mobility. In a third patient, 1 tilted implant failed at the 4-month time point due to mobility. All 3 implants failed during the provisional prosthesis phase. All of the 3 implants have been replaced, and no further complications have been noted in these patients. None of the implant failures compromised the prosthesis function, and no relation was found between implant failure and the opposing dentition.

TABLE 3
Implant size (NobelActive TiUnite)*

Implant Diameter	Implant Length, mm	Maxillae	Mandibles
3.5	8.5	—	—
	10	—	—
	11.5	12	—
	13	31	9
	15	28 (1)	42
4.3	8.5	—	—
	10	2	2
	11.5	16	7
	13	84	18
	15	94	92
	18	4	1
5.0	8.5	—	—
	10	—	—
	11.5	5	1
	13	20	15
	15	131 (2)	81
	18	9	4
		436 (3)	272

*( ) indicates failed implants/replaced.

Two patients aged 70 and 68 years were lost to follow-up at the 1-year and less than 3-month visit. These patients passed away due to natural causes. Two additional patients were lost to follow-up at the 3-month follow-up visit. Therefore, a total of 16 implants have been lost to follow-up. One hundred sixty-two patients in the study have completed the 6-month follow-up and have had their definitive prostheses (174) delivered. Three jaws were lost to follow-up prior to definitive prosthetic delivery, and 1 jaw was lost to follow-up after definitive prosthetic delivery. One hundred fifty-six patients have completed the 1-year follow-up.

The overall implant survival rate was 99.6% (1 year; Table 4) with no significant difference between the maxillae and mandibles (99.3% vs 100%, $P = .06$, Fisher exact test). The 4.3-mm-diameter implants were most frequently used, with a survival rate of 100% (99.2% for 3.5 mm and 99.2% for 5.0 mm; Figure 1). No total arch failures have occurred to date, providing a definitive prosthesis survival rate of 100%. The life table analysis demonstrating the cumulative survival rate is reported in Table 4.

Figures 2 through 8 demonstrate a case in postextraction sites of the mandible and maxilla with immediate implant placement, Figures 9 through 14 show a case in healed sites of a patient with a severely atrophic edentulous maxilla. The patient has been edentulous for 50 years. Figures 15 through

TABLE 4
Cumulative survival analysis*

	Placed/Followed Implants	Failed Implants	Time Not Passed	Lost to Follow-up	CSR
Implant insertion »» 3 months	708	1	0	4	99.9
3 months »» 6 months	703	1	0	8	99.7
6 months »» 12 months	694	1	29	0	99.6
12 months »» 18 months	664	0	336	4	99.6
18 months »» 24 months	324	0	240	0	99.6
»» 24 months	84	0			

*CSR indicates cumulative survival rate.

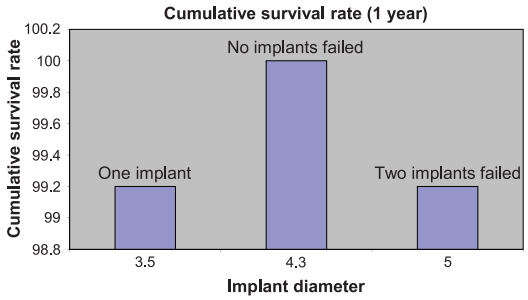


Figure 1. Cumulative survival rate in relation to implant diameter.

20 show a case displaying terminal nonrestorable dentition of the maxilla and mandible with extraction and immediate implant reconstruction, and Figures 21 through 29 show a case of a patient with an edentulous maxilla reconstructed with the All-on-Four technique.

No complications were reported during surgery or immediately after surgery.

Discussion

The overall survival rate was 99.6% (1 year), with no significant difference between the maxillae and mandibles. Three implants failed over a period of 29 months of loading. The prosthesis survival rate was 100%. This is in accordance with studies on biomechanical measurements, which demonstrated that tilted implants, when part of a prosthetic support, do not have a negative effect on the load distribution.[16,46,47] In addition, a biomechanical rationale in tilting distal implants allows a reduction in cantilever length due to the more posterior position of the tilted implants, resulting in a more favorable stress distribution.[47,48]

The methodology of using titled implants maximizing the use of the available bone without grafting has been reported, leading to successful clinical outcomes.[35,41,42] This is in comparison to the traditional implant treatment in which insufficient bone in the posterior region requires bone-grafting procedures involving greater chair time for the patient as well as increased cost and increased number of procedures.

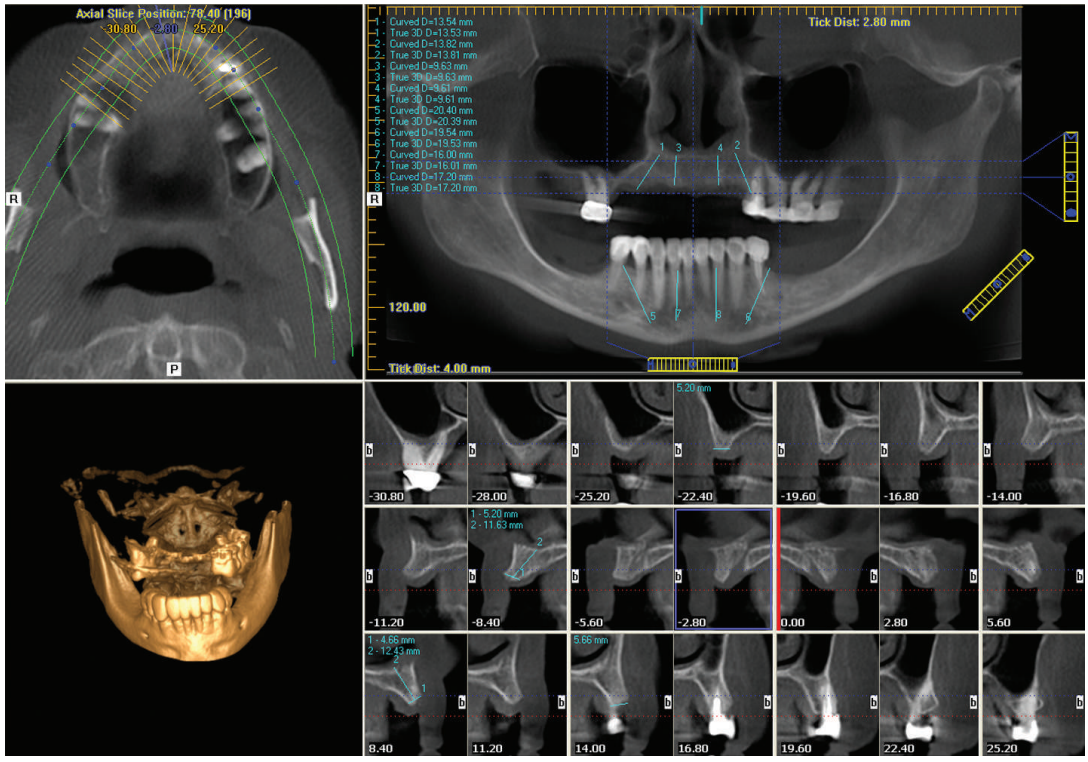
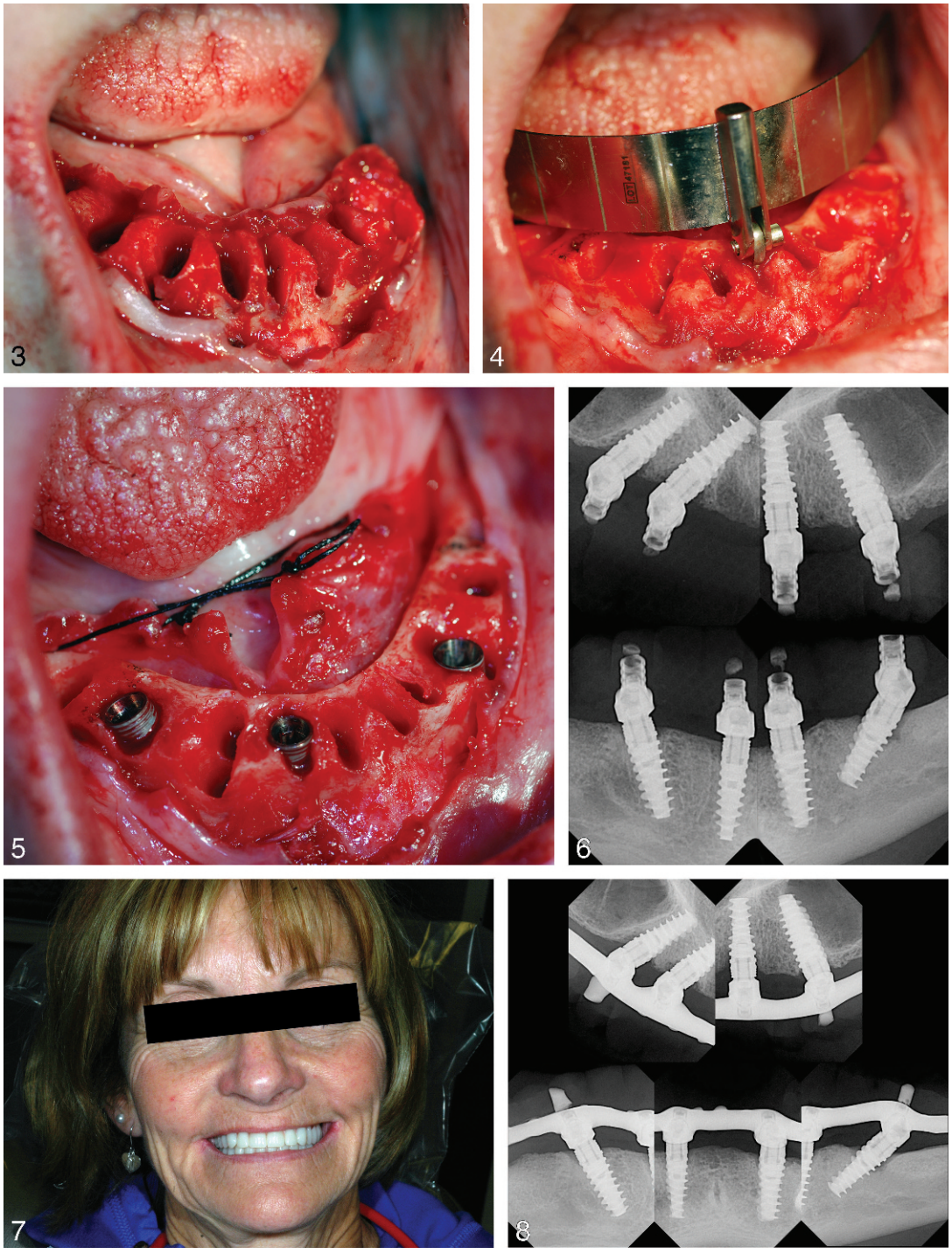


Figure 2. Case 1: maxillary and mandibular all-on-Four technique in extraction sites with immediate implant placement. Preoperative computerized tomography scan.



Figures 3–8. Case 1: maxillary and mandibular All-on-Four technique in extraction sites with immediate implant placement. **Figure 3.** Extraction sockets in the mandible. **Figure 4.** All-on-Four surgical guide in situ. **Figure 5.** Implants in final position. **Figure 6.** Postoperative radiographs at 4 months. **Figure 7.** Clinical photograph of patient at 1 year. **Figure 8.** Postoperative radiographs at 1 year.

The results of this study are comparable with studies of other implant systems using the All-on-Four concept in the maxilla. Maló et al[32] reported a high survival rate of 97.6% in a 1-year retrospective study in which 128 Branemark implants (Nobel Biocare AB, Goteborg, Sweden) were immediately loaded in 32 patients. Each jaw received 2 axial and 2 distal implants (All-on-Four) supported by a fixed all-acrylic prosthesis in the completely edentu-

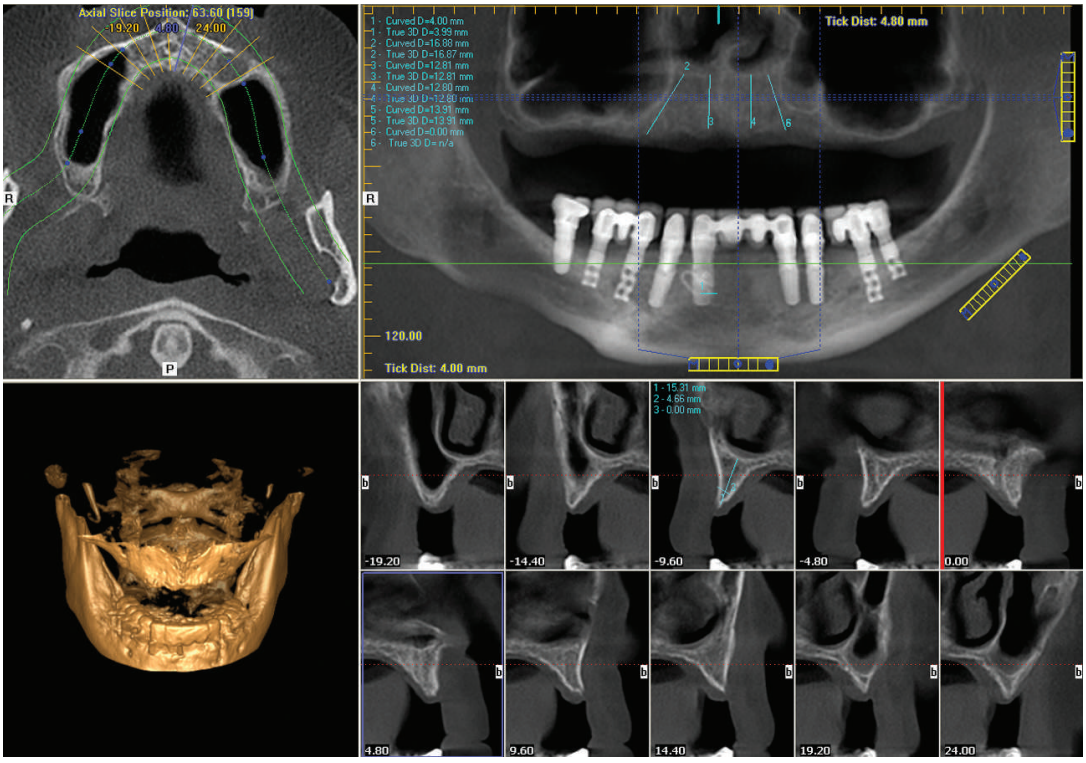
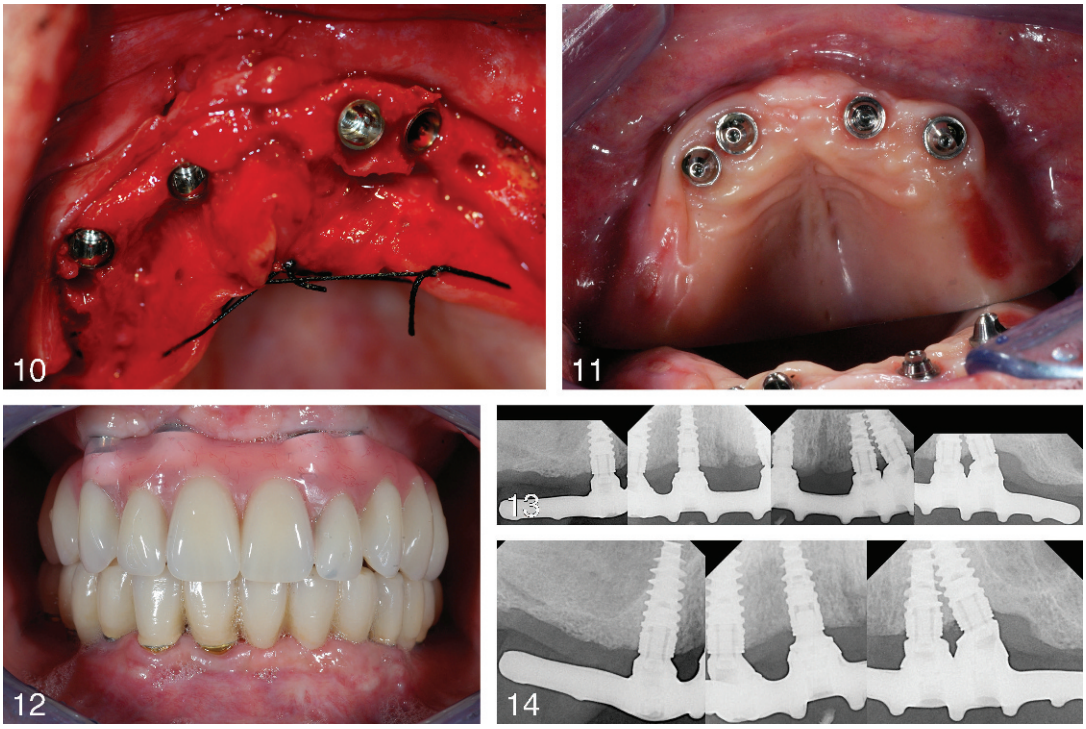
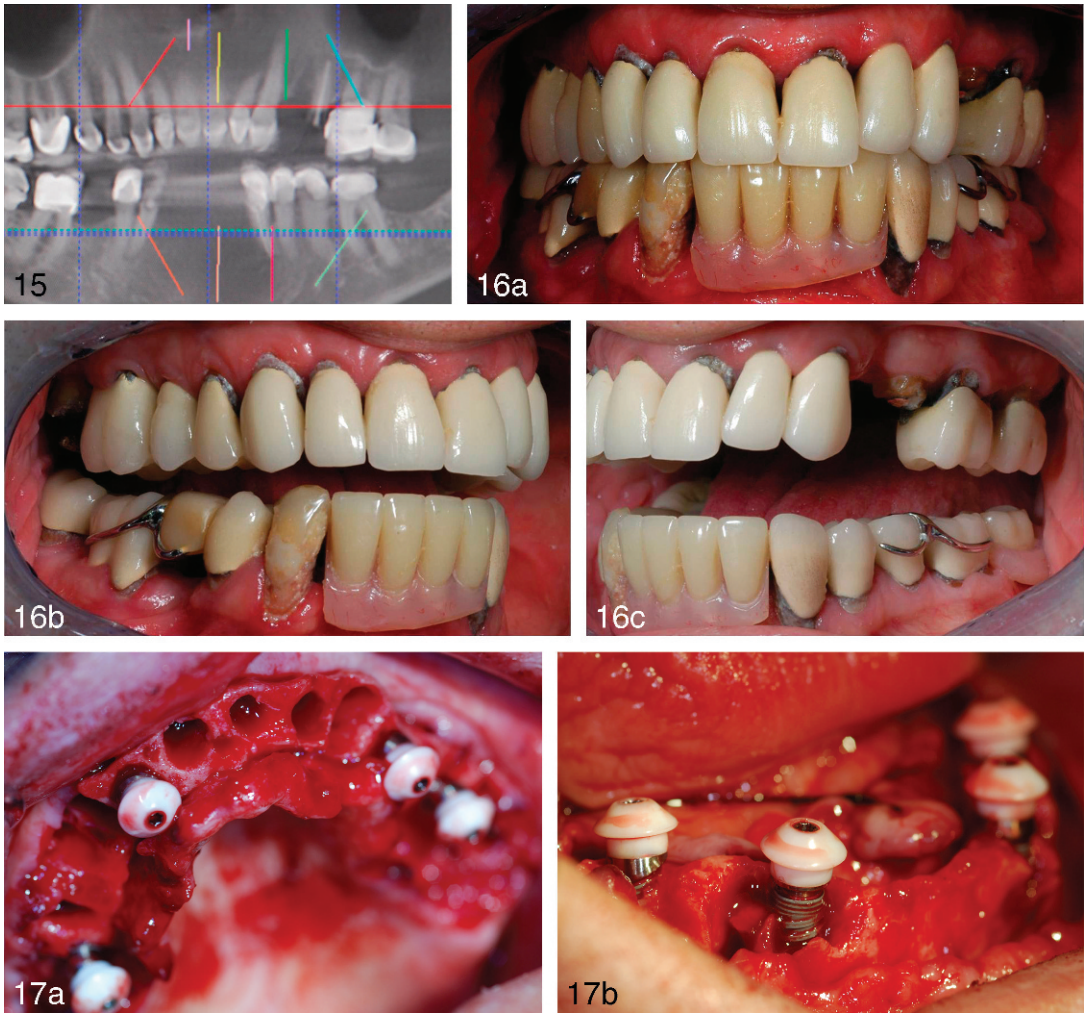


Figure 9. Case 2: 50-year history of a severely atrophic edentulous maxilla reconstructed with the All-on-Four technique. Preoperative computerized tomography scan.



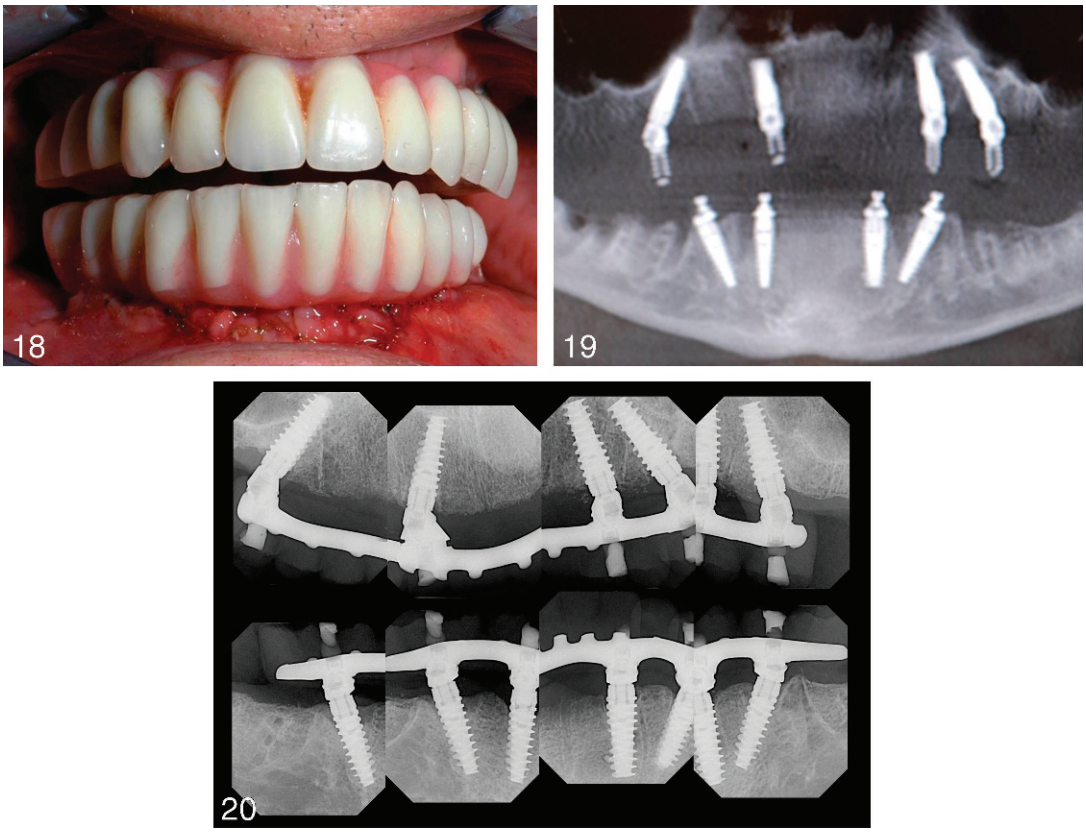
Figures 10–14. Case 2: 50-year history of a severely atrophic edentulous maxilla reconstructed with the All-on-Four technique. **Figure 10.** Implants in final position. **Figure 11.** Fixed implant bridge removed to demonstrate soft-tissue health at 1 year. **Figure 12.** Clinical view at 1 year. **Figure 13.** Postoperative radiographs at 1 year demonstrating stable bone levels. **Figure 14.** Postoperative radiographs at 2 years demonstrating stable bone levels.



Figures 15–17. Case 3: All-on-Four technique in maxillary and mandibular (nonrestorable dentition) extraction sites with immediate implant placement. **Figure 15.** Preoperative computerized tomography scan. **Figure 16.** (a, b, c) Preoperative clinical photographs of the terminal nonrestorable dentition. **Figure 17.** (a) Implants placed in maxilla with abutments and healing caps in position. (b) Implants placed in mandible with abutments and healing caps in position.

lous maxilla.[32] Testori et al[42] reported a 98.8% implant survival and a 100% prosthetic survival rate using a different type of implant system, angulation of the implant-abutment connection for the tilted implants, and a different type of technique for the fabrication of the final prosthesis. In this prospective, multicenter center study, 41 patients received an immediately placed full-arch fixed bridge supported each by 4 axial and 2 distally tilted Ossesotite NT implants (3i, Implant Innovations, Palm Beach, Fla) in the edentulous maxillae.[42] Aparacio et al[35] reported a survival rate of 100% for tilted implants, 96.5% survival for axial implants, and a prosthetic survival rate of 100% after 5 years when 101 Branemark implants were placed in the severely resorbed maxilla of 25 patients (59 axially placed and 42 in a tilted direction). Each patient received 2 to 5 implants with at least 1 tilted implant.[35] Calandriello et al[38] reported a survival rate of 96.7% in a 1-year prospective clinical study when 60 MKIV and Replace select implants (Nobel Biocare AB) were placed in the atrophic maxilla of 18 patients. In this study, 12 partial- and 7 full-arch, fixed prostheses were supported by a total of 33 axially placed and 27 tilted implants.[38]

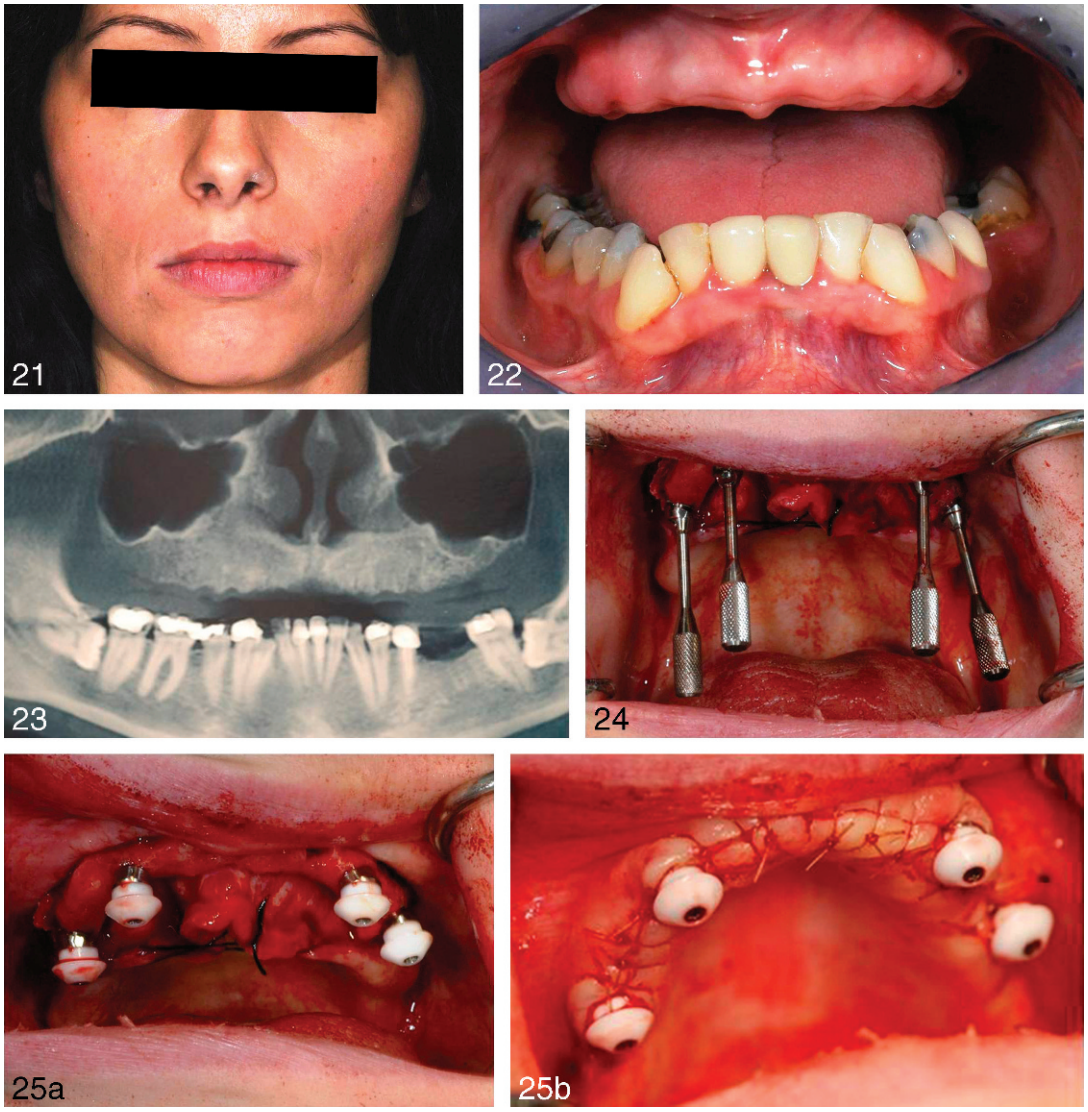
The results of this study are in accordance with other studies reporting good



Figures 18–20. Figure 18. Case 3: All-on-Four technique in maxillary and mandibular (nonrestorable dentition) extraction sites with immediate implant placement. Maxillary and mandibular immediate provisional fixed prosthesis in place. **Figure 19.** Postoperative panoramic radiograph at 4 months. **Figure 20.** Postoperative radiograph at 15 months demonstrating stable bone levels.

survival rates in the mandible. In a 1-year retrospective clinical study, Maló et al[31] reported an implant survival of 96.7% and 98.2% (2 groups) and a prosthetic survival rate of 100% when 176 Branemark implants were placed in 44 patients. An immediately loaded complete-arch all-acrylic prosthesis was supported by 4 implants (All-on-Four) in each completely edentulous mandible.[31] Another study reported a 100% implant and prosthetic survival rate when 96 MKIV or the NobelSpeedy Groovy implants (Nobel Biocare AB) were placed in 24 edentulous patients treated in the mandible according to the All-on-Four concept.[1] In addition, a 100% implant survival and prosthetic survival rate was reported in a prospective study when 80 Branemark implants were placed in 20 patients with a extremely atrophic mandible. Each patient received 2 axially placed and 2 tilted implants, supporting a fixed full-arch prosthesis (All-on-Four concept).[40]

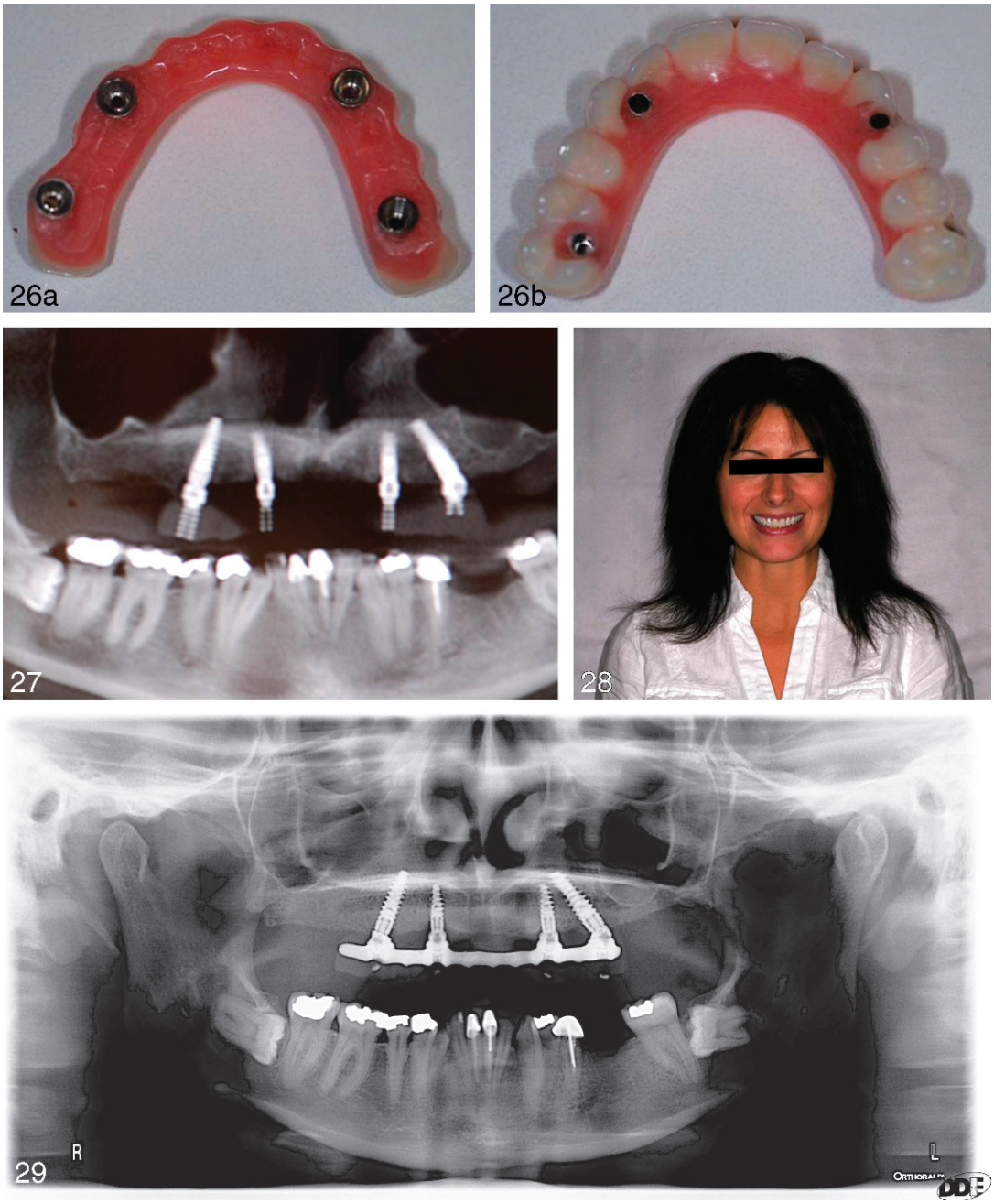
Previously published literature reporting survival rates using the All-on-Four concept in both the mandible and maxilla is similar to the results of this analysis. In a pilot study, a survival rate of 98.9% was reported in a case series when 189 NobelSpeedy implants were placed in 46 patients, supporting 53 full-arch, all-acrylic prostheses (44 maxillae, 9 mandibles) using the All-on-Four concept.[33] Maló et al[34] reported a survival rate of 97.2% and 100% in the maxilla and mandible in a 1-year prospective study when 92 NobelSpeedy implants were placed in 23 consecutively treated patients. Each jaw was restored by a immediate fixed full-arch prosthesis according to the All-on-Four concept.[34] Pomares[41] reported a 96.9%



Figures 21–25. Case 4: edentulous maxilla reconstructed with the All-on-Four technique. **Figure 21.** Preoperative clinical photograph. **Figure 22.** Preoperative clinical photograph of the edentulous maxilla. **Figure 23.** Preoperative panoramic radiograph demonstrating the edentulous maxilla. **Figure 24.** The abutments and premounted abutment holders adjusting for relative parallelism. **Figure 25.** (a) The final position of the implants, abutments, and healing caps. (b) The mucoperiosteal flaps repositioned and sutured with 4-0 chromic interrupted sutures.

implant survival (96.7% in the maxilla and 97.2% in the mandible) and a 100% prosthetic survival rate in a prospective study when 127 MKIII Groovy implants were placed in 20 patients (restoring 19 maxillae and 9 mandibles) using the All-on-Four or All-on-Six concept. A survival rate of 98.4% and 99.7% (maxilla and mandible) at the end of 1 year was reported in another single-cohort study in which 173 edentulous patients received 2 distal and 2 anterior axial MKIV or NobelSpeedy Groovy implants. In this study, each patient received a full-arch fixed prosthesis supported by 2 distal and 2 axial implants (All-on-Four).[49]

Other long-term studies using the concept are comparable to the data in this analysis. Implant survival rates from the follow-up of results of the previously mentioned studies from Maló et al[31,32] with a longer follow-up demonstrated a survival rate of 96.2% in the mandible up to 9 years and 97.7% in the maxilla up to 5 years of follow-up.[37] Citing the published literature, it was



Figures 26–29. Case 4: edentulous maxilla reconstructed with the All-on-Four technique. **Figure 26.** (a, b) The tissue and occlusal views of the all-acrylic fixed provisional implant bridge. **Figure 27.** Postoperative panoramic radiograph taken immediately after implant placement. **Figure 28.** Clinical photograph with the definitive prosthesis in place. **Figure 29.** Postoperative radiographs at 1 year with the definitive fixed implant prosthesis in place.

noted that the overall cumulative survival rate of 99.6% (1 year) in this study for the new implant system (NobelActive) while using the All-on-Four concept offers an attractive solution to clinicians treating edentulous and/or immediate extraction patients.

Conclusion

The overall survival rate using the All-on-Four immediate function treatment concept using an implant with a tapered body and a variable thread design can be considered a viable treatment concept for patients pre-

senting with edentulous arches and/or immediate placement.

Note

Dr Babbush has a consulting agreement with Nobel Biocare AB Sweden for ongoing clinical studies and continuing education courses.

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Case Study by
Khatami

ACP
AMERICAN COLLEGE OF PROSTHODONTISTS

"All-on-Four" Immediate Function Concept and Clinical Report of Treatment of an Edentulous Mandible with a Fixed Complete Denture and Milled Titanium Framework

Amir H. Khatami, DDS[1] & Christopher R. Smith, DDS, FACP[2]

[1]Assistant Professor, Department of Restorative Dentistry and Prosthodontics, The Ohio State University, Columbus, OH
[2]Associate Professor, Department of Surgery, Section of Dentistry, The University of Chicago Hospitals, Chicago, IL

Keywords
"All-on-Four"; immediate function; conversion prosthesis; tilting dental implants; milled titanium framework.

Correspondence
Amir H. Khatami, Department of Restorative Dentistry and Prosthodontics, The Ohio State University, College of Dentistry, 305 W. 12th Ave, Columbus, OH 43210.
E-mail: akhatami@msn.com

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Abstract

The "All-on-Four" concept—tilting the distal implants in the edentulous arches improves the prosthetic support—increases the inter-implant distance and provides better implant anchorage in the bone by using longer implants. Computer milling of a solid block of titanium also provides frameworks with improved fit and fewer technical challenges than conventional cast or noncast approaches. This clinical report describes a method of restoring an edentulous mandible with the "All-on-Four" immediate function concept and a milled titanium framework. The patient in our clinical report has reported for follow-up visits for 1 year and is satisfied with the outcome of the treatment. No discernable clinical and radiographic changes were noted around the dental implants. To date, there have been no prosthetic complications. The patient is scheduled for quarterly follow-ups to determine the effectiveness of home care.

Immediate loading of implant-supported dental prostheses is documented in the literature with a high and predictable success rate for the edentulous mandible.[1–4] The development of new protocols for immediate loading of dental implants has switched from placing multiple implants and loading a few to placing only four implants as an optimal number to restore a completely edentulous mandible.[5] Rehabilitation of the posterior edentulous mandible can at times be hindered by bone atrophy distal to the mental foramen and bite forces that are more posterior in the dentition.[6] Traditionally, and according to the original concept of the Branemark system, implants are placed in a fairly upright position in the anterior edentulous mandible. Therefore, it is often necessary to fabricate a bilateral cantilever, which is sometimes up to 20-mm long, to provide the patient with good chewing capacity in the molar region. Clinical studies have demonstrated that the distal tilting of implants may be advantageous, with reduction of cantilever length about 6.5 mm in the mandible and 9.3 mm in the maxilla.[7,8] More recently, a concept was developed to restore the completely edentulous arches with immediately-loaded, tilted distal implants and the use of an "All-on-Four" guide (Nobel Biocare, Yorba Linda, CA) (Fig 1).[8,9] This clinical report describes a method of restoring an edentulous mandible with the "All-on-Four" immediate function concept and milled titanium framework.

Clinical report

A 59-year-old African–American female presented to the Section of Dentistry at the University of Chicago Hospitals with the desire to have "new dentures." Her medical history included a kidney transplant due to glomerulonephritis, and she was on a daily dose of corticosteroids. On clinical examination the patient presented with maxillary and mandibular partial edentulism. She was wearing removable partial dentures (RPDs) in both arches. The patient was advised to replace the RPDs; however, she chose extraction of the remaining maxillary and mandibular teeth and receiving immediate complete denture (ICD) prostheses instead. Maxillary and mandibular ICDs were made, and after 6 months were relined for a better prosthetic fit (Fig 2). Despite all the effort to make her comfortable with the

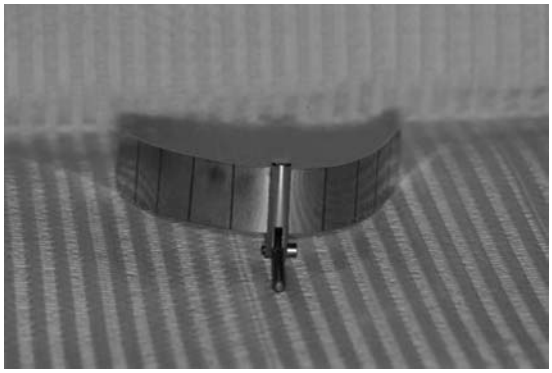

Figure 1 "All-on-Four" guide.

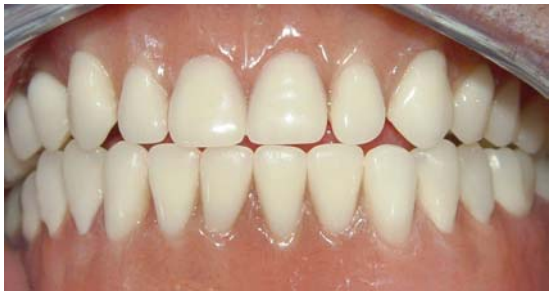

Figure 2 Preoperative view of ICDs.

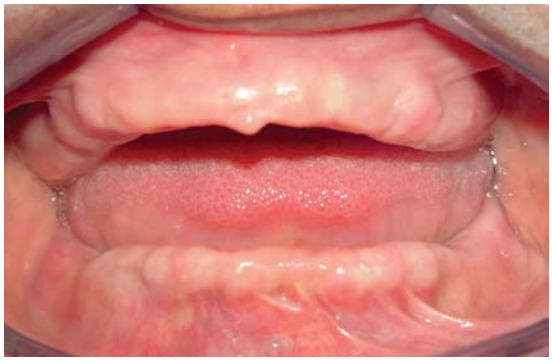

Figure 3 Maxillary and mandibular edentulous ridges.

mandibular denture, her chief concern was prosthesis stability in the mouth during function. With the advent of the "All-on-Four" concept, the patient was presented with the option of placing four implants in the mandible and immediately loading the implants with a conversion prosthesis.[8] In preparation for the procedure and due to her medical status, her physician was consulted. She was instructed to increase the daily dose of her orally administered corticosteroid (Prednisone, Deltasone®, Kalamazoo, MI) to 20 mg, the day prior to surgery and the day of surgery. She was also prescribed Penicillin-VK starting 2 days prior to surgery, 2 g per day, for 10 days.

Upon clinical and radiographic evaluation, the mandible was classified ACP PDI for Complete Edentulism Class I (Figs 3 and 4).[10]

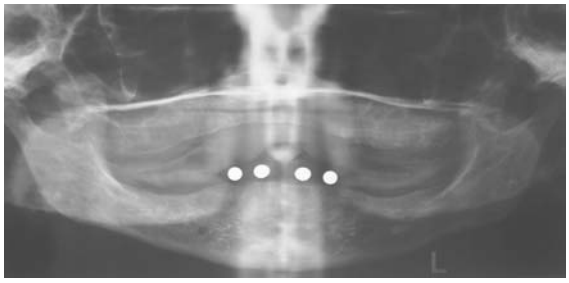

Figure 4 Preoperative panoramic radiograph.

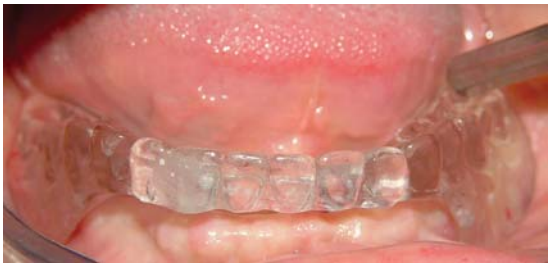

Figure 5 Surgical template try-in.

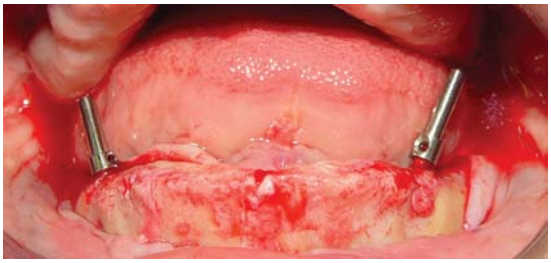

Figure 6 Angulated guide pins.

Alginate impressions (Jeltrate, Dentsply International, York, PA) of the edentulous arches were made, and the patient's mandibular denture was duplicated. This duplicate denture was used as a guide to fabricate the radiographic and surgical templates (Fig 5). A supra-crestal incision was made from the second mandibular molar area extending to the contralateral side. The mental foramina were located bilaterally to serve as landmarks for placement of the most distal implants. Implant placement was assisted by the "All-on-Four" guide. The guide was placed into a 5-mm deep osteotomy site made at the midline of the mandible, and its titanium band was adjusted to follow the mandibular arch shape. The guide is used to find the optimal position and inclination of the implants (Fig 6). Four 4.3 × 13 mm^2 implants (Replace Select Yorba Linda, CA) were placed following the Replace Select protocol and torqued to 45 Ncm (Fig 7). The platforms of the most distal implants were angled about 30° distally with the use of the "All-on-Four" guide. Multi-Unit Abutments(tm) (4-mm height) (Nobel Biocare) were connected to the most anterior implants, and 17° angled Multi-Unit Abutments(tm) (4-mm height) were connected to the distal implants to bring the screw access holes to the occlusal surface of the prosthesis

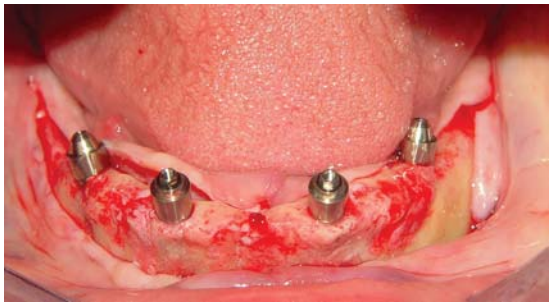

Figure 7 Connected straight and angulated abutments.

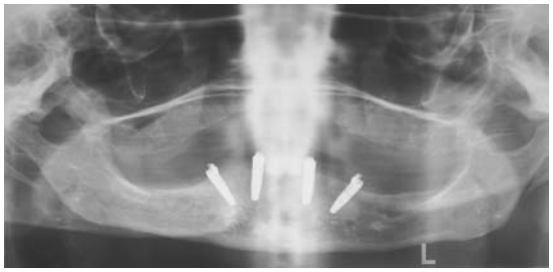

Figure 8. Panoramic radiograph after implant placement.

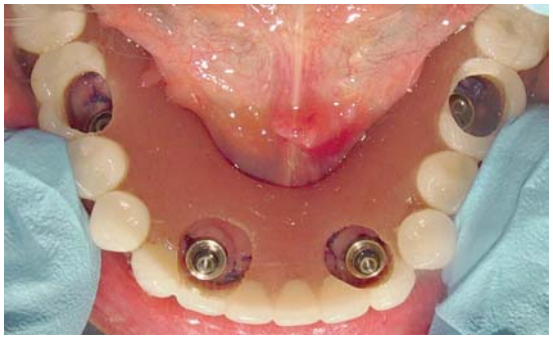

Figure 9 Hollowed mandibular ICD.

(Fig 8). Subsequent to suturing the soft tissue, temporary abutments were connected, and the hollowed-out mandibular denture (Fig 9) was indexed using denture repair resin (Natureryl, GC America, Inc., Alsip, IL). The mandibular denture was modified to an implant-supported interim fixed prosthesis in the dental laboratory. Following occlusal adjustment, the prosthesis was inserted with prosthetic retaining screws (Fig 10).

The patient was given oral hygiene instructions and placed on Peridex (Zila Professional Pharmaceutical, Phoenix, AZ) for 2 weeks. At the 2-week follow-up appointment, sutures were removed, and an open tray abutment level impression was made with transfer copings (Nobel Biocare) and vinylpolysiloxane (Aquasil, Dentsply International, York, PA). The impression was poured in die stone (Die-keen, Heraeus-Kulzer, Armonk, NY), and its accuracy was verified with the passively fitting existing implant-supported interim fixed prosthesis (Fig 11). The maxillary denture duplicate cast and the mandibular cast with the attached interim fixed prosthesis were mounted using

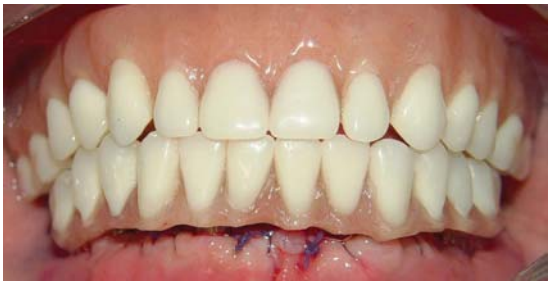

Figure 10 Implant-supported interim fixed prosthesis.

Figure 11 Accuracy verification of the master cast with interim prosthesis.

the arbitrary facebow transfer and interocclusal records. A putty jig (Lab Putty, Coltene, Cuyahoga Falls, OH) was made to register the 3D relationship of the interim prosthesis to the mandibular cast. Suture removal, final mandibular impression, and the laboratory procedures were completed in one clinic session.

Using the temporary abutments (Nobel Biocare) and the putty jig, the resin pattern was fabricated with autopolymerizing resin (GC Pattern resin, GC America, Inc.) (Fig 12). The pattern was sent to Nobel Biocare Headquarters in Sweden to fabricate a milled titanium framework. Once received, the titanium framework was tried intraorally for passivity with the recommended screw test[11–13] (Fig 13). Subsequent to the denture tooth setup, esthetics, phonetics, and centric relation occlusion were evaluated intraorally.

Necessary adjustments were made, the prosthesis was processed with acrylic resin wrap around the framework design, and occlusion was adjusted intraorally. The finished prosthesis was inserted by torque tightening the prosthesis retaining screws to 10 Ncm (Figs 14 and 15). The patient was given oral hygiene instructions and scheduled for follow-up every 3 months. At the 3-, 6-, 9-, and 12-month follow-up appointments, there were no discernable clinical or radiographic changes around the dental implants. The patient was instructed on better prosthetic care of the gingival and lingual surfaces of the prosthesis at the 12-month follow-up appointment.

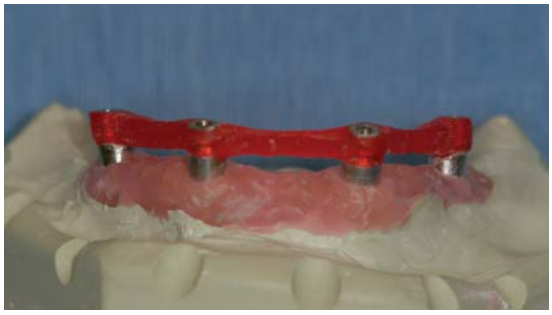

Figure 12 Resin pattern guide.

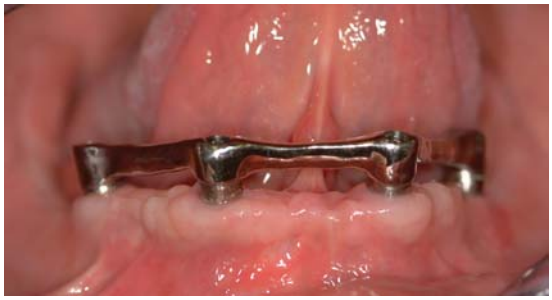

Figure 13. Milled titanium framework try-in.

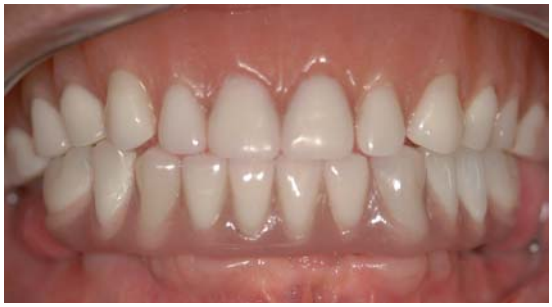

Figure 14 Final prosthesis.

Discussion

In some completely edentulous patients, implant-supported prosthetic treatment is almost impossible without complex techniques, such as nerve transposition and grafting in the posterior mandible. Moreover, upright placement of implants in the anterior edentulous mandible necessitates cantilever lengths from 10 to 20 mm to provide the patient with esthetics and function. When cantilever spans exceeding 7 mm are planned, regardless of the number of implants, an optimal biomechanical environment should exist.[14,15] In a biomechanically compromised environment, such as poor quality bone, the strain transmitted to the crestal bone can be reduced by increasing the anterior–posterior spread of the implants, placement of longer implants, and maximizing the number of implants.[16–18] The method of tilting the distal implants in the edentulous arches represents an alternative technique, which leads to placement of longer implants, improved prosthetic support with a shorter cantilever

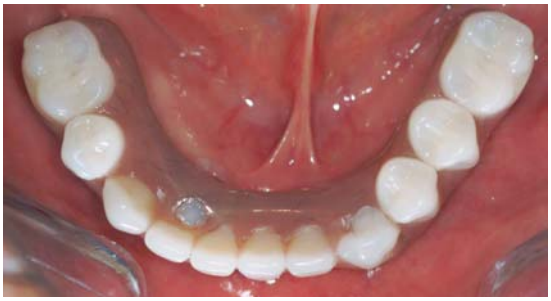

Figure 15 Occlusal view of final prosthesis.

arm, improved inter-implant distance, and improved anchorage in the bone. In vitro studies and theoretical calculations on single implants have shown that tilted implants may increase the stress to the bone. Tilted single implants may also be subjected to bending during function, which may lead to increased marginal bone stress[19–21]; however, if such implants are part of a multiple implant-supported prosthesis, the spread of the implants and rigidity of the prosthesis will reduce or change the nature of bending forces.[22] In a retrospective clinical study of tilted, immediately-loaded implants of 44 patients, Malo et al reported 96.7% and 98.2% implant survival rates for the developmental (more than four implants placed) and the routine group (four implants placed), respectively.[8] They reported a 100% prosthetic survival rate and concluded marginal bone loss values comparable to values for early loading of the mandibular full arch prostheses.[23]

The first patients with fixed complete dentures were provided with Cr–Co alloy frameworks with resin teeth. This protocol was modified over time, and gold-alloy casting was introduced to provide a more stable occlusion in metal and to allow porcelain veneering of the framework; however, in many cases, like severe bone resorption, large amounts of gold alloy had to be cast. Some of the inherent problems with the conventional lost-wax technique were distortion related to arch curvature and the amount of casting alloy. To avoid problems with casting, a few noncasting approaches, such as premachined gold-alloy cylinders/bars and laser-welded titanium frameworks, were introduced. These noncasting approaches were technically demanding and time consuming.[16,24,25]

More recently, a new protocol based on using computer numeric-controlled (CNC) milling of a solid block of titanium was developed and is free of the technical challenges involved with the previous approaches. The intraoral precision of the prosthesis in this method is completely dependent on the accuracy of the master cast and therefore necessitates verifying impression accuracy with a jig or a well-fitting interim prosthesis.[26,27]

Ortorp and Jemt, in a 5-year clinical follow-up of 129 edentulous patients, compared the clinical and radiographic performance of implant-supported prostheses with milled titanium frameworks and conventional cast gold-alloy frameworks. They found lower levels of fracture associated with milled titanium framework prostheses and also found improved framework fit compared to that of conventional castings.[28] When using gold

screws, milled titanium frameworks have preloads similar to those of gold-alloy frameworks, and the preloads were also similar before and after veneering the milled titanium framework with acrylic resin or porcelain.[29]

Conclusion

The patient in our clinical report has been treated with four dental implants placed with the "All-on-Four" concept in the mandible and a fixed complete denture with a milled titanium framework. She was followed up for 12 months and thus far remains satisfied with the outcome of the treatment. There were no discernable clinical and radiographic changes around the dental implants. At the time of this writing, there have been no prosthetic complications, and the patient is scheduled for quarterly follow-ups, mainly to determine the effectiveness of home oral care.

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Case Study by
Bedrossian

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Fixed-Prosthetic Implant Restoration of the Edentulous Maxilla: A Systematic Pretreatment Evaluation Method

*Edmond Bedrossian, DDS, FACD, FACOMS,**
Richard M. Sullivan, DDS,† Yvan Fortin, DDS,‡
Paulo Malo, DDS,§ and Thomas Indresano, DMD‖

Potential candidates for implant restoration of the completely edentulous maxilla may be interested in receiving a fixed prosthesis as opposed to a removable overdenture. Multiple surgical approaches are available in order to provide this type of care. Graftless approaches such as the use of tilted implants including the zygomatic implant, allow the surgeon to establish adequate support for a fixed prosthesis without bone grafting. Adjunctive procedures such as sinus grafting, maxillary osteotomies as well as horizontal augmentations are also available for surgeons who may prefer the grafting approach for the reconstruction of this group of patients. The ability to determine early in the consultation process the type of fixed prostheses necessary to provide the best functional and esthetic results is advantageous. This current therapy article examines 3 critical factors; the nature of the patient's dental condition and whether the residual ridge is visible in both the relaxed lip and smiling state, direct the choice of fixed dental prostheses. The presence or the absence of bone in the 3 radiographic zones, determines whether bone-grafting procedures are necessary to achieve the desired outcome.

Treatment of the edentulous maxilla poses a number of challenges. Expectations regarding the esthetics of the definitive prosthesis may be high. Achieving adequate phonetics and stable masticatory function are major concerns. Evaluation of the edentulous maxilla is complicated by the fact that patients may only be missing clinical crowns, or they may have experienced a combination of tooth, soft tissue, and bone loss, with associated changes in facial form. Bone and soft tissue loss can begin before tooth removal as a result of generalized periodontitis, creating the appearance of long teeth. The loss of teeth and use of a removable prosthesis can result in continued alveolar bone atrophy in both the vertical and horizontal dimensions.[1] In a study spanning 25 years, Tallgren observed that the greatest amount of alveolar bone atrophy occurs within the first year of edentulism.[1] Changes in the jaw relationship as well as facial musculature also may result in deformation or other changes in the facial form and morphology.[2]

A systematic pretreatment approach to evaluating edentulous patients allows for better communication between the implant team as well as the patients leading to a predictable treatment outcome. McGarry et al [3] developed a classification of complete edentulism that considers the quantity of the residual edentulous ridge, its morphology or topography, and the relationship of the maxilla to the mandible. Interarch space, tongue anatomy, and the attachment of the musculature to the edentulous ridge are considered. The possible need for preprosthetic surgical procedures prior to the fabrication of complete removable dentures is also evaluated.

The establishment of evaluation criteria may result in improved patient care, enhanced communication between dental professionals, and better screening and treatment of patients in dental educational centers.[3] Guidelines for the treatment of edentulous patients with implants should include consistent clinical

*Director of Implant Training, Department of Oral and Maxillofacial Surgery, University of the Pacific, San Francisco, CA; and Private Practice, San Francisco Center for Osseointegration, San Francisco, CA.

†Clinical Director, Nobel Biocare USA, Yorba Linda, CA.

‡Centre d'Implantologic Dentaire de Quebec, Ste-Foy, Quebec, Canada.

§Chief Scientist, Nobel Biocare AB, Gothenburg, Sweden.

‖Chairman, Department of Oral and Maxillofacial Surgery, University of the Pacific, San Francisco, CA.

Address correspondence and reprint requests to Dr Bedrossian: University of the Pacific, Oral and Maxillofacial Surgery, 450 Sutter Street, Suite 2439, San Francisco, CA 94108; e-mail: oms@sfimplants.com

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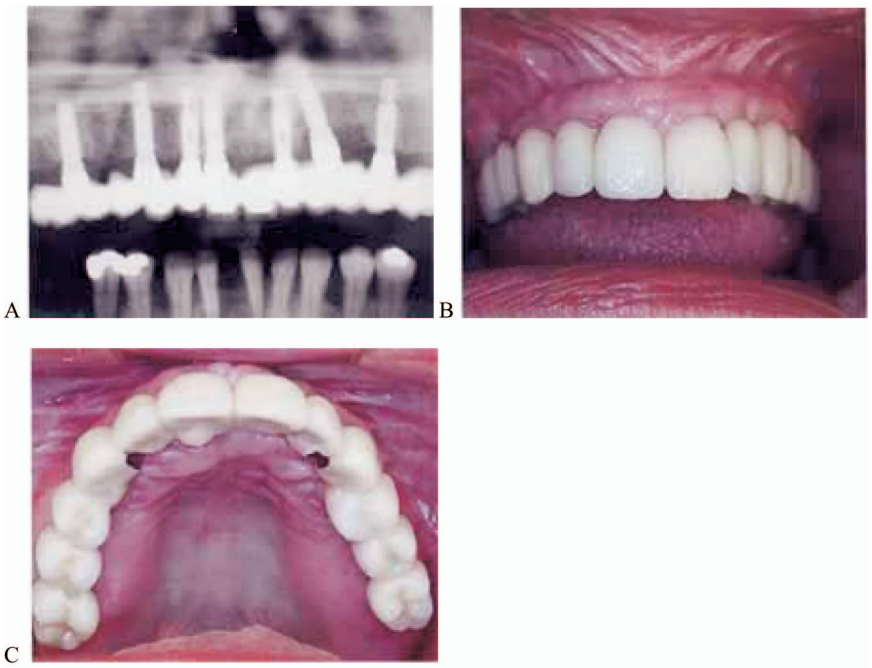

FIGURE 1. *A*, Bone volume allows placement of traditional implants in ideal location. *B*, Intact soft tissue contours enable tooth contours without gingival porcelain. *C*, Palatal contours of screw-retained restoration mimic natural teeth.

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and radiographic evaluation criteria for an accurate outcome assessment. Three factors available early in the examination process can be key determinants for the successful treatment of the completely edentulous maxilla with a fixed restoration. These factors are: *1*) the presence or absence of a composite defect, *2*) the visibility or lack thereof of the residual ridge crest without the denture in place, with normal smile and without use of retractors, and *3*) the amount of bone available in 3 separate zones of the maxilla, as shown in a panoramic survey. Evaluation of these 3 factors is not intended to be a substitute for thorough diagnosis and development of a treatment plan. However, such evaluation can provide differential diagnosis information specific to the esthetic, prosthetic, and biomechanical requirements of fixed, implant-supported maxillary restorations.

The purpose of this article is to outline initial screening methodology for determining which of 3 principal designs for fixed, implant-supported prostheses should be selected. Each design has been documented to fulfill aesthetic, phonetic, and hygienic demands and be a practical application for this treatment.

The Implant-Supported Fixed Dental Prosthesis

Complete dentures replace the clinical crowns of teeth, but depend on established denture-bearing areas of superficial bone and soft tissue during occlusal function for support.[4] To be maintained at normal physiologic levels, the bone requires internal loading such as that provided by the tooth roots or dental implants.[5] Fixed implant restorations are totally implant supported, with no transference of load to denture-bearing areas, thus avoiding the possibility of further resorption associated with tissue-borne prostheses.

Several approaches to restoring the completely edentulous maxilla have been published.[6-9] This discussion will focus on the application of 3 principal designs for implant-supported dental prostheses. These 3 variations have been chosen based on their ability to restore a broad range of soft tissue deficits. They are: *1*) the metal-ceramic restoration, *2*) the fixed hybrid restoration, and *3*) the fixed-removable restoration.

Metal-ceramic restorations may be either screw- or cement-retained.[10-12] Recognizing that ceramic restorations can include longer than normal length teeth and gingival replacement, emphasis will be on metal-ceramic restorations used to replace the clinical crowns of missing teeth only (Fig 1).

The hybrid prosthesis is a denture tooth and acrylic design with either a milled titanium or cast-gold framework (Fig 2). Early designs of implant-supported denture tooth and acrylic fixed dental prostheses had reported phonetic changes as a routine complication, due to air escaping during speech.[13] A later design known as the profile prosthesis[14] uses a framework design with subgingival abutment emergence that allows an acrylic resin wrap that butts up against the tissue as an ovate pontic so that air does not escape and cause phonetic problems. Because a ridge lap is avoided with the convex emergence from the ridge crest, oral hygiene access can be maintained in a manner similar to natural tooth fixed partial denture pontics.[14] A variation

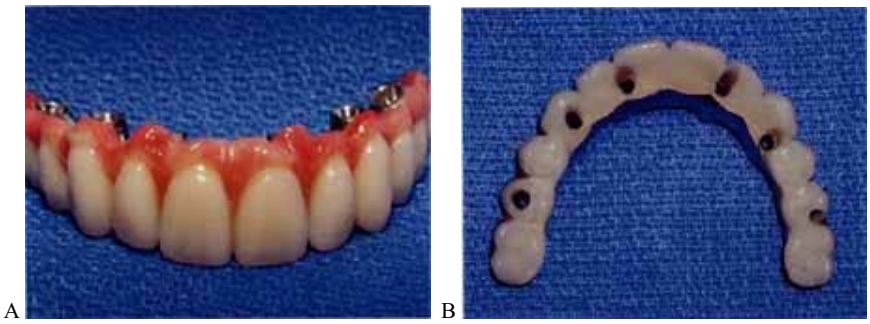

FIGURE 2. *A*, Denture teeth are supplemented with acrylic resin to replace tooth and soft tissue. *B*, Denture teeth and acrylic are veneered to milled titanium framework.

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of this design uses gingival porcelains or composite with all-ceramic crowns cemented to the framework if a porcelain restoration is desired.

For situations in which a labial flange is desirable, a fixed-removable prosthesis can be made with any number of attachments. Figure 3 shows a fixed-removable design known as a Marius bridge that is nonresilient and fully implant-supported.[15] Fixed-removable designs use a milled titanium or cast mesobar supporting a patient-removable superstructure that is held in place with a locking mechanism. This allows a ridge lap or flange design, with a suprastructure removable for oral hygiene access. Because a fixed detachable restoration does not depend on soft tissue support, no unnatural palatal extensions are required.

To determine which of these prosthetic concepts is most appropriate, 2 criteria should be considered: the nature of the patient's defect and the visibility of the residual crest. These findings help ascertain appropriate prosthetic design elements based on the combination of missing structures and unique esthetic requirements of the patient. A third criterion, radiological status, helps formulate an early strategy for achieving the structural support requirements for a fixed restoration, including type of implants to be used and probability of bone grafting procedures.

Prosthetic Selection Criteria

PRESENCE OR ABSENCE OF A COMPOSITE DEFECT

Edentulous patients may present with intact alveolar bone volume and only be missing the clinical crowns, or they may also present with resorption of their alveolar bone and loss of soft tissue as well as missing teeth (Fig 4). Differentiating between these 2 types of patients is key to creating an esthetic definitive fixed prosthesis. Patients who are missing soft tissue and underlying supporting bone in addition to teeth may be considered to have a composite defect. To evaluate the relative amount of soft tissue defi-

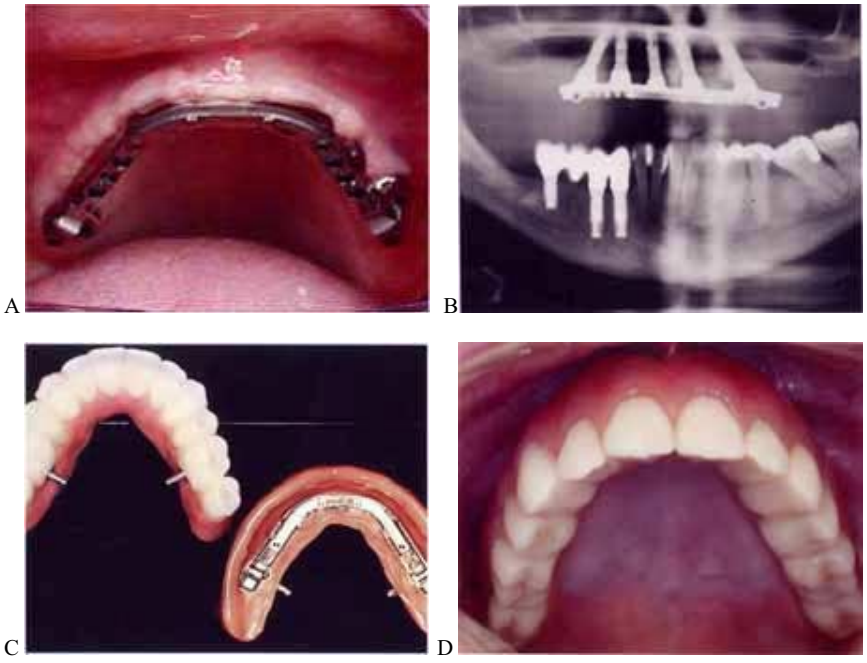

FIGURE 3. *A*, Mesobar with anterior 25 degree angle connected to implants. *B*, Radiograph of mesobar shows path of insertion not dependent on implant alignment. *C*, Two views of superstructure with posterior lock mechanism retracted. *D*, Prosthetic superstructure rigidly in place. This is implant supported without resilience.

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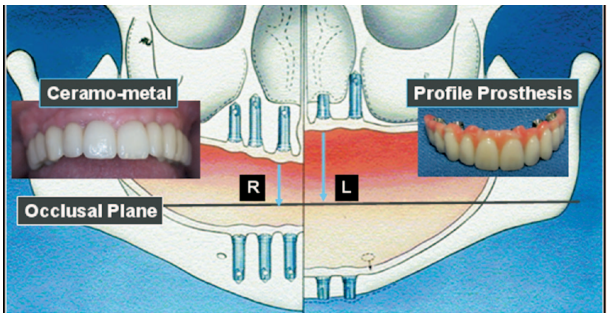

FIGURE 4. Missing only teeth (*left*) versus composite defect (*right*).

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ciency, it is advisable to utilize a denture or denture set-up in wax that has been confirmed for proper tooth position, border extension, and interarch relationship. With a satisfactory denture, the presence or absence of a composite defect can be quickly identified by assessing the thickness of the maxillary denture base and flange. Moderate to advanced resorption of the maxilla will be indicated by a denture base and flange which are generally thick. The opposite will be true in situations where minimal resorption has occurred and defects involving only teeth are present. For the latter patients, a thin denture base and a very thin or absent flange, especially in the anterior sextant, indicate an intact alveolus.[16]

It should be noted that defects due to resorption of bone and missing soft tissue occur in both the horizontal and vertical planes and may not be immediately obvious. To fully assess the presence or absence of a composite defect, duplication of the confirmed denture or tooth set-up by the dental technician or dentist using a denture duplicator (Denture Duplicating Flask; Lang Dental Mfg Co, Inc, Wheeling, IL) can be useful (Fig 5). A transparent acrylic resin (Ortho-Jet; Lang Dental Mfg Co, Inc) duplicate of the patient's denture is then placed intraorally, and the position of the cervical portion of the teeth and their relationship to the crest of the edentulous ridge is noted. For patients who present with no space between the cervical portion of the duplicated denture teeth and the edentulous ridge in either horizontal or vertical planes, a tooth-only defect is designated (Fig 6). In this situation, interarch space minimum requirements for the implant system and desired restoration still need to be observed. For patients who present with moderate to significant space between the cervical portion of the duplicated denture teeth and the edentulous ridge, a composite defect is identified (Figs 7, 8). Table 1 illustrates these considerations.

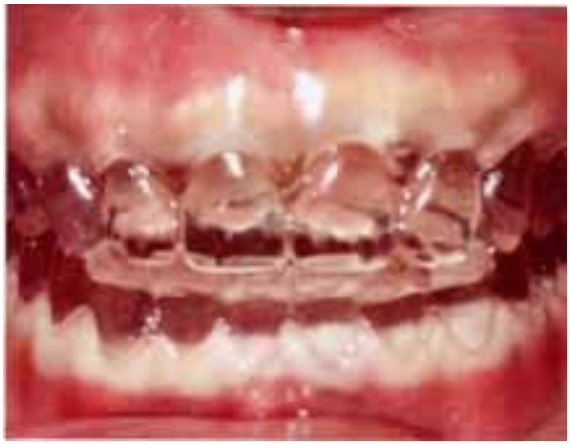

FIGURE 6. Defect of teeth only.

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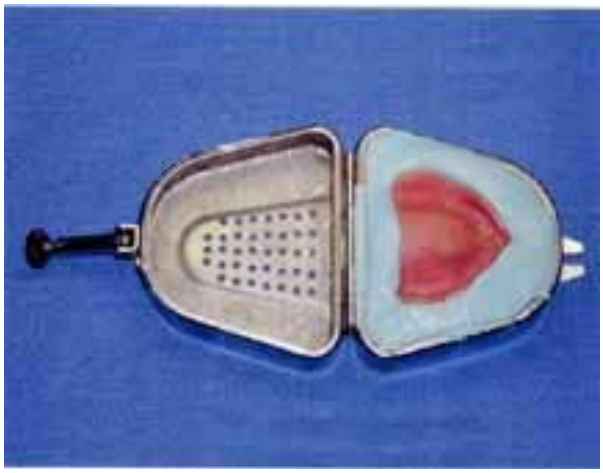

FIGURE 5. Denture duplicating flask using silicone putty for denture impression to make clear acrylic duplicate.

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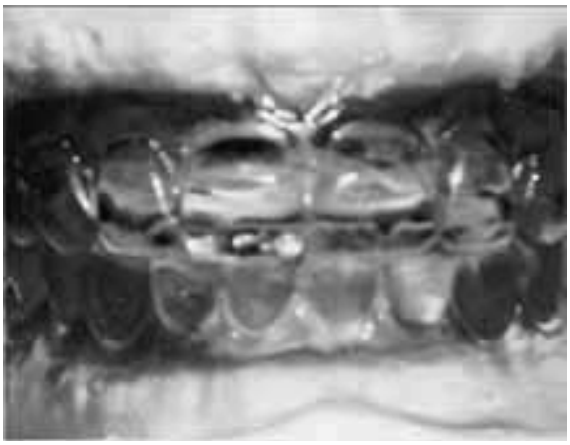

FIGURE 7. Mild composite defect.

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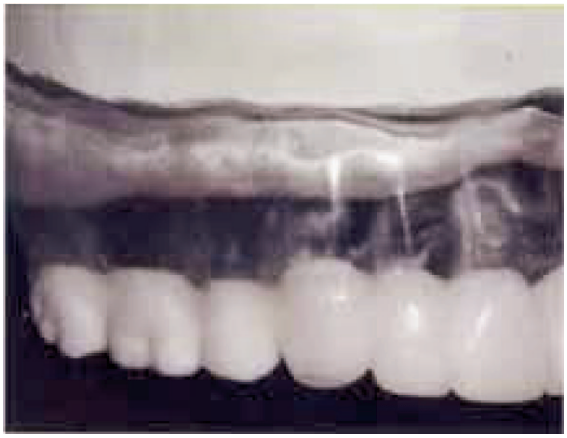

FIGURE 8. Advanced composite defect.

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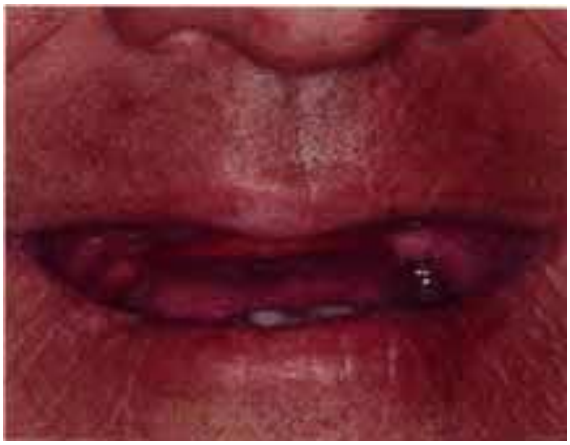

FIGURE 9. Maxillary edentulous ridge not seen during animation.

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Preoperative determination of the presence or absence of a composite defect allows the clinician to determine the restorative space available for abutments and framework design. In the absence of a composite defect, a metal-ceramic restoration without extensive gingival porcelains can be used. The presence of a composite defect points toward the use of a fixed dental prosthesis in either the profile prosthesis or Marius bridge variations.

VISIBILITY OF THE RESIDUAL RIDGE CREST

To maximize the esthetic prosthetic result, the potential for visibility of the transition between the prosthesis and the soft tissue of the edentulous maxillary ridge without the maxillary denture in place should be evaluated, both in the anterior maxilla and the buccal corridor.

With the patient's maxillary denture removed, the patient should be asked to smile (Fig 9). If the soft tissue of the edentulous ridge cannot be seen, the transition between an implant-supported prosthesis and the residual soft tissue crest will not be visible, allowing a degree of flexibility for issues such as color match, shadows, and changes of contour in the junction of the restoration against the soft tissue (Fig 10). For those patients who do display the residual ridge soft tissue crest while smiling, the transition between an implant restoration and the soft tissue will be visible, and the esthetic consequences of this will depend upon whether or not the patient also has a composite defect. If the patient is missing only teeth but has an intact soft tissue volume, a metal-ceramic restoration can be used, and the fact that the gingiva is visible will improve the aesthetics rather than detract from them. This assumes that the implants are placed in planned tooth positions, and special consideration is given to anterior ridge lap pontics for the

Table 1. PRESENCE OR ABSENCE OF A COMPOSITE DEFECT

Intraoral Status	Diagnosis	Definitive Prosthesis
No space between the cervical portion of the duplicate denture teeth and the edentulous ridge	Tooth-only defect	Metal-ceramic
Moderate to significant space between the cervical portion of the duplicate denture teeth and the edentulous ridge	Composite defect	Marius bridge (fixed-detachable) or profile prosthesis (hybrid)

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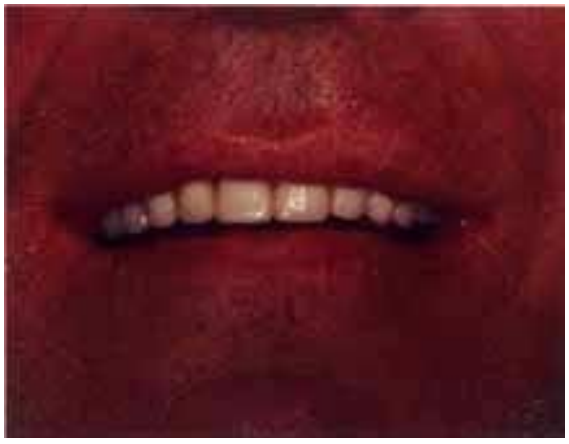

FIGURE 10. Transition of prosthesis and residual ridge soft tissue is not visible.

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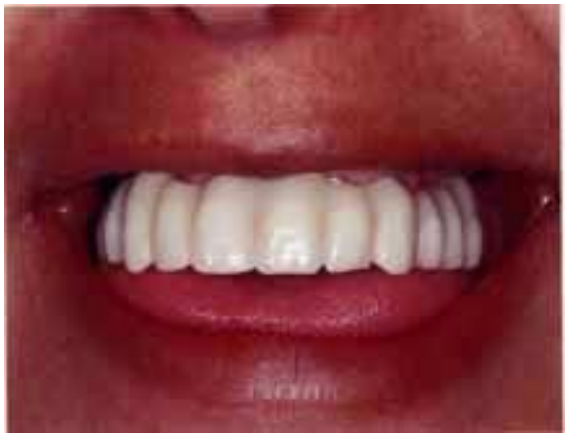

FIGURE 11. Unesthetic demonstration of transition line between prosthesis and residual ridge soft tissue.

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appearance of the papillae. Having fewer or no implants in the incisor areas if an adequate number of implants for the arch form can be placed in the posterior also allows for achieving esthetic goals with pontic designs.

However, when a composite defect is present, a metal-ceramic tooth-only restoration involves esthetic compromises due to longer than normal teeth. If a profile prosthesis is used with a visible residual ridge crest, the junction of the artificial gingiva and the natural soft tissue will be visible, and the differences in texture and contour between the 2 may be obvious (Fig 11). One method for avoiding this is to first reduce the residual ridge height to the point where the crest no longer is visible. Implants can then be placed and restored with a profile prosthesis. If the ridge is not reduced, the use of a Marius bridge with a flange that overlaps the gingival junction is indicated. This prosthesis can be removed by the patient so that oral hygiene is not compromised, yet it provides the stability of a fixed restoration.

Table 2 presents these guidelines.

Table 2. GUIDELINES FOR OPTIMAL FIXED DENTAL PROSTHETIC CHOICE

	Composite Defect	Tooth-Only Defect
Ridge visible	Marius bridge (fixed-removable)	Metal-ceramic restoration
Ridge invisible	Profile prosthesis (fixed hybrid) or Marius bridge (fixed-removable)	Metal-ceramic restoration

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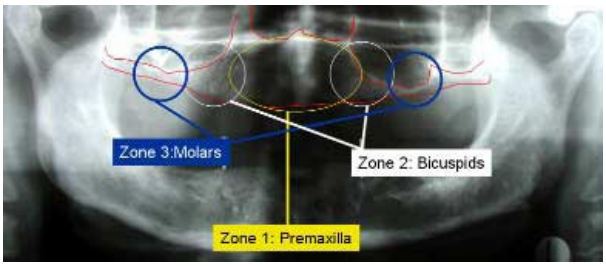

FIGURE 12. Three zones of maxilla are indicated.

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Radiographic Evaluation

Division of the edentulous maxilla into 3 radiographic zones allows for a systematic assessment of the residual alveolar bone available for implant placement. In this pretreatment screening procedure, the maxillary anterior teeth are designated as zone 1. The premolar region is considered to be zone 2, while the molar region is designated as zone 3 (Fig 12). Analysis of the radiographic results according to this schema can enable the surgical and restorative team to devise a preliminary treatment plan. In complex or borderline situations, 3-dimensional radiographic evaluation may still be necessary to confirm the preliminary conclusions.

For a fully implant-supported, non-resilient maxillary restoration, the implant-support requirements of all 3 fixed restorative options discussed in this article are the same. A minimum of 4 implants should be used, although the option to place more than 4 may be considered, depending upon the available bone volume and other functional considerations.[17,18] Rather than the number of implants used per se, once a minimum of 4 implants is achieved what is most

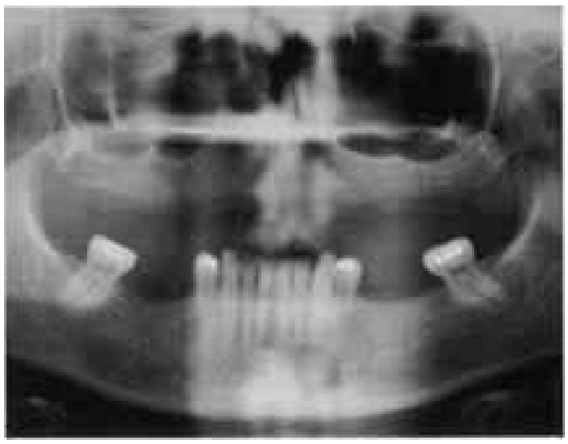

FIGURE 13. Provided adequate buccolingual width of bone is verified, presence of all 3 zones in maxilla allows straightforward placement of implants.

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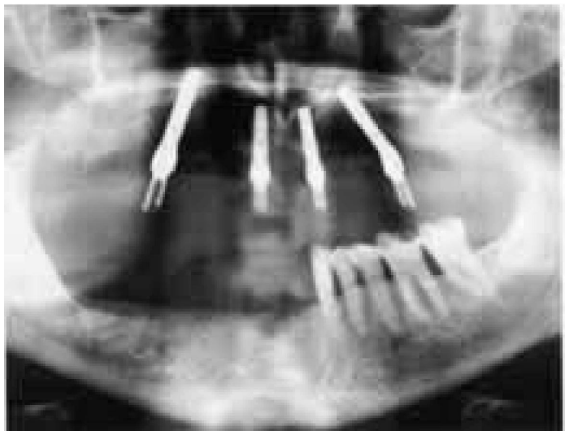

FIGURE 14. Tilted posterior and traditional anterior implant concept; presence of zones 1 and 2 only.

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important is the arch-form distribution of those implants with both posterior and anterior support. As a general principle, cantilevers in fixed maxillary restorations should be avoided or minimized to 1 tooth to achieve an adequate functional occlusion.[12,19-21] Evaluation of the 3 radiographic zones allows for a preoperative determination of whether adequate arch form support for a fixed restoration is achievable to support the planned occlusal plane.

Presence of Zone 1, 2, and 3 Bone

For patients where alveolar bone is present in all 3 zones of the edentulous maxilla, conventional implants may be placed (Fig 13). This would allow for a favorable arch form of anterior, posterior, and possibly intermediate implants so that any of the 3 fixed restorative designs may be used.[23,24]

Presence of Zone 1 and 2 Bone

For patients who have zone 1 and zone 2 bone but lack zone 3 bone secondary to large pneumatized maxillary sinuses, inclining the implants posteriorly along the anterior wall of the maxillary sinus may allow for an adequate anterior and posterior distribution of implants to support a fixed restoration while avoiding the need for grafting[15,17,25-29] (Fig 14). Use of inclined implants has also been shown to be successful with immediate-loading procedures of the completely edentulous maxilla.[18,25] An alternative to the use of inclined implants is sinus inlay grafting, followed by subsequent implant placement. When extensive sinus inlay grafting is performed to provide posterior support, a staged approach waiting for graft maturation may be preferable due to lower survival when implants are simultaneously placed.[30] This has the effect of delaying restoration compared with the use of inclined implants.

Presence of Zone 1 Bone Only

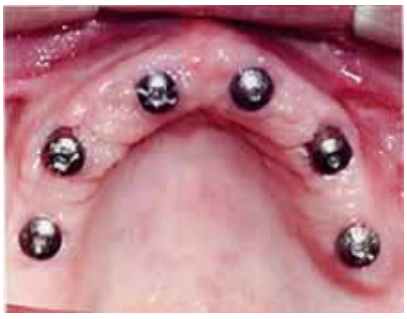
To establish posterior support for a fixed prosthesis, implants in the second premolar or first molar region are required. However, placement of implants in these positions is not possible when patients only have bone available in zone 1. Grafting of the sinus with autogenous or xenographic bone is an option in this situation. A 90% overall survival rate with 3 to 5 year follow-up has been shown with this approach.[31]

If a graftless approach is preferred, zygomatic implants have been shown to provide bilateral posterior maxillary support with a 97% to 100% implant survival measured up to 4 years.[32-34] Such implants have the added benefit of not requiring a staged approach and a period of bone graft maturation. This can shorten the overall treatment time required to achieve a fixed restoration. By placing 1 zygomatic implant in each zygoma, predictable posterior support can be established. When used in conjunction with 2 to 4 anterior implants, the restorative dentist is able to fabricate any of the 3 fixed, implant-supported prosthetic alternatives (Fig 15).

Bone Missing from Zones 1, 2, and 3

With complete resorption of the maxillary alveolus, clinical examination reveals a flat palatal vault. No maxillary vestibule is present, and the patient is unable to function with his or her conventional complete denture. Such patients present with a significantly thick denture base as well as a thick circumferential flange, confirming the presence of a significant composite defect. Physiologic reconstruction of this debilitated group of patients requires ad-

A



B

FIGURE 15. *A*, Zygoma concept; presence of zone 1 bone only. *B*, Zygoma implants allow posterior support similar to traditional implants for restoration.

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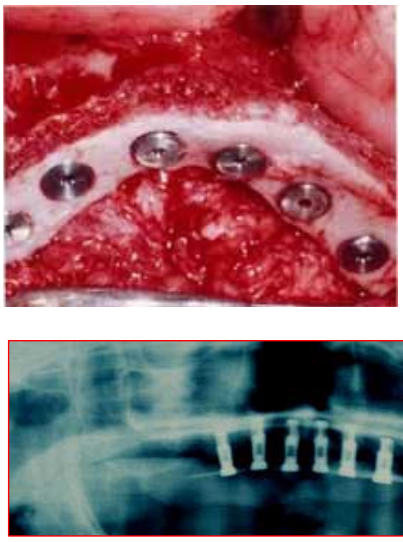

FIGURE 16. *A*, When bone is missing in all 3 zones, autogenous onlay grafting is one alternative. *B*, Previous lack of bone in all 3 zones of maxilla.

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equate implant support to stabilize an implant-supported prosthesis.

To enable prosthetic rehabilitation of such patients, Brånemark introduced the idea of using extensive onlay bone grafts in conjunction with bilateral sinus inlay grafts and placement of 6 implants.[35] The Brånemark horseshoe graft requires hospitalization and harvesting of autogenous iliac bone from the patient (Fig 16). The patient is unable to wear a denture during the 6-month osseointegration period. The social consequence of this form of treatment renders it unpopular with patients. An alternative, graftless approach is the use of 4 zygomatic implants (Fig 17). The placement of 2 zygomatic implants in each zygoma allows for the fabrication of an implant-supported fixed maxillary prosthesis without bone grafting and can be accomplished in an office setting.

Table 3 presents the guidelines for optimal implant selection.

Table 3. GUIDELINES FOR OPTIMAL IMPLANT SURGICAL APPROACH

Bone Present for Implants	Posterior Surgical Approach
Zone 1, 2, 3	Traditional implants
Zone 1, 2	Inclined implants, posterior implants Traditional anterior implants
Zone 1 only	Zygomatic implants or sinus-inlay grafting followed by implants Traditional anterior implants
Insufficient bone in any zone	4 zygomatic implants or Brånemark horseshoe graft followed by traditional implants

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Discussion

From an implant placement perspective, there is growing recognition that a large number of people with fully edentulous maxillae are able to be given a stable foundation to support a fixed restoration with fewer implants and fewer bone grafts.[15,18,25,26] Advances in computer-guided surgery allow placement of implants in the fully edentulous maxilla in a minimally invasive manner with increased precision to support the fixed prosthetic outcome.[36,37] Demonstrated viability of immediate function[18] and minimally invasive protocols [38] for fixed full-arch restorations may further increase demand and acceptance of this treatment by the public.

Definitive preoperative prosthodontic work-up for an implant-supported fixed maxillary prosthesis is a multifactor process. Steps of this process include surgical, medical, and laboratory consultations, transference of facial and occlusal records for analysis, radiographic templates, scanning procedures and subsequent interpretation, and development of a written comprehensive plan including potential complications and treatment alternatives. Completion of these preoperative steps requires significant commitments of time, resources, and ultimately patient investment. Results

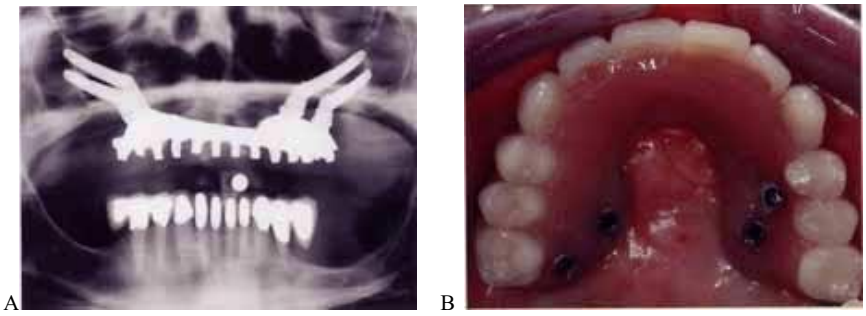

FIGURE 17. *A*, Bilateral zygoma implant concept; lack of all 3 zones of maxilla. *B*, Bilateral dual zygoma implant restoration.

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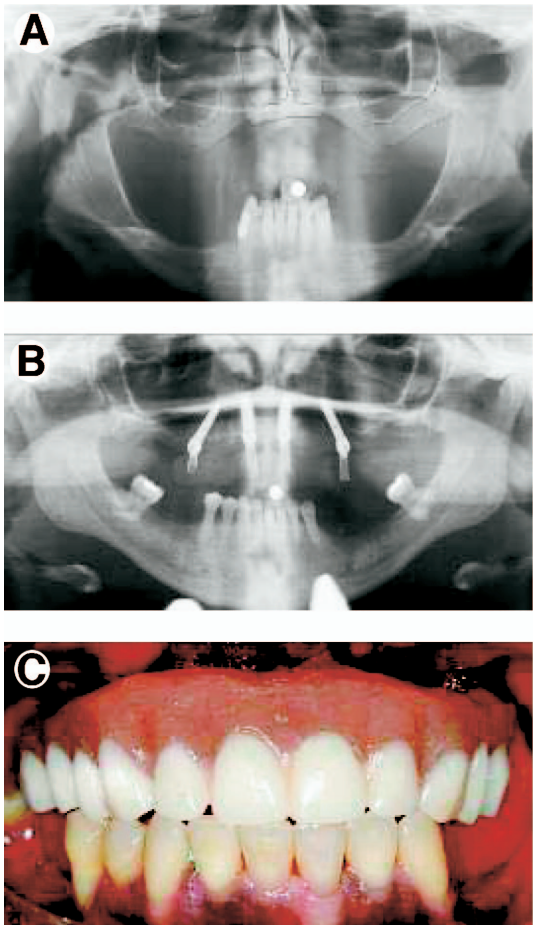

FIGURE 18. *A*, Preoperative panorex: Available zone 1 and 2 maxillary alveolar bone. *B*, Postoperative panorex: All-on-4 concept. *C*, Immediate postoperative profile prosthesis.

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of these findings will indicate but still not assure that a postoperative outcome is in accord with patient expectations identified in the preoperative subjective symptom interview.

Two prosthodontic diagnostic criteria have been coupled with 3 variations of implant-supported fixed maxillary prostheses to form a table. Each prosthesis alternative represents a potential restorative solution appropriate for the 4 possible combinations of these 2 diagnostic criteria.

The third preoperative diagnostic criterion divides a panoramic radiograph into 3 zones that have potential for implant placement. Due to a range of resorption, there are 4 potential zone combinations on each side of the maxilla that would allow for implant placement or suggest consideration of bone grafting. From a structural support perspective, there are no differences in implant requirements to support any of the 3 implant-supported fixed maxillary prosthesis variations given. Furthermore the clinical success rates for the various implant approaches are similar.[15,18,35,38] It should be noted however that for the metal-ceramic variation, the ridge position of the implants ideally corresponds with mesial-distal cervical tooth position; for the Marius bridge and profile prosthesis variations, implant alignment coincident to cervical tooth anatomy is not a factor. This second table suggests implant or grafting strategies for the posterior maxilla appropriate for different resorptive patterns.

CASE 1

A 48-year-old female presents with a full upper denture which is not retentive. Upon review of the preoperative panorex (Fig 18 *A*), she has maxillary alveolar bone in zones 1 and 2. She has minimal zone 3 bone. Using our pretreatment criteria, the All-on-4 technique was applied to establish implant support for her fixed prosthesis (Fig 18 *B*). The provisional prosthesis is a fixed, implant supported, profile prosthesis (Fig 18 *C*).

CASE 2

A 46-year-old female presented with a nonfunctional mandibular partial denture as well as a nonretentive maxillary full denture. The preoperative panorex (Fig 19 *A*) showed available bone in zone 1 and lack of alveolar bone in zones 2 and 3. The Zygomatic concept was utilized in her treatment (Fig 19 *B*). Adequate distribution of implants to support the profile prosthesis was established (Fig 19 *C*). Patient's transition line is apical to her smile line and therefore, not visible. This allows for an esthetic outcome (Fig 19 *D*).

APPLICATION OF BEDROSSIAN'S SCREENING

There are many factors to consider before treatment with implants for a fully edentulous maxilla takes place. At the same time, there is a clear benefit to identify early on as a screening procedure if there is likelihood of satisfying patient expectation with a prosthesis alternative realistically indicated by not only tooth loss but the degree of soft tissue and alveolar deficit that must be restored.

Similarly, systematic panoramic radiograph analysis based on zones of support can provide an early indication of the straightforwardness or surgical difficulty likely to be encountered. The combination of prosthodontic and radiographic diagnostic criteria can give an early impression of treatment possibilities from both surgical and restorative perspectives to help professionals clarify and communicate the potential treatment requirements and outcome. This understanding may then be used to advise the patient to proceed with commitment and investment for more definitive diagnostic procedures, confident that at

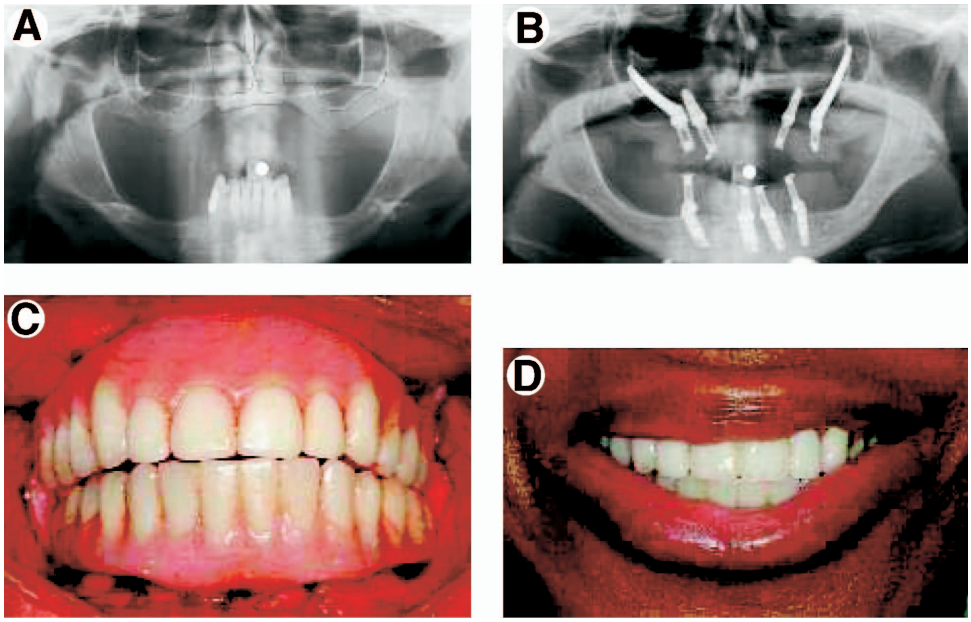

FIGURE 19. *A*, Pre-operative Panorex. Available Zone 1 and 2 bone only. *B*, Postoperative panorex. Zygoma concept, maxilla. All-on-4 concept, mandible. *C*, Immediate postoperative maxillary and mandibular profile prosthesis. *D*, Transition line is not visible resulting in an esthetic outcome.

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least the possibility for the desired prosthetic outcome exists.

One limitation of this approach is that the critical factor of sufficient alveolar ridge width still needs to be verified; this would only be discovered either after a tomographic film or scan, or intraoperatively. In either event, lack of sufficient ridge width could change the surgical approach significantly. Another limitation is that these criteria still need to be put into the overall perspective of health, medical, and dental history, and the knowledge that there can be deviations in desired outcome with even the most thorough planning. The criteria presented in this article are best looked upon as a preliminary screening apparatus to help guide patient and clinical decisions as more information is gathered. They are subject to change, however, at any time more definitive analysis or radiographic information does not support the preliminary impression.

There are also clinical situations where the objective is to remove remaining hopeless teeth and simultaneously place implants. While this preliminary diagnostic method is still applicable, it cannot account for variations in tissue height that may result subsequent to dental extraction.

Summary

The Bedrossian pretreatment screening method systematically considers the presence or absence of a composite defect, the visibility of the residual soft tissue crest, and the availability of bone in 3 radiographic zones as guidelines for the selection of 3 potential fixed implant restorative designs, as well as the optimal implant surgical approach. Use of these differential diagnosis criteria allows an early determination of the treatment necessary to meet patient expectations before a significant amount of time and resources has been invested.

A limitation of this protocol is the inability to measure the width of the residual alveolar bone available. While the panoramic survey film is a valuable 2-dimensional scouting radiograph and allows the practitioner to evaluate the height and length of the residual alveolar bone, use of 2-dimensional tomography that can precisely measure the width of the remaining ridge can aid the clinician in making a final determination of the likely outcome of the planned treatment. Communication between dental colleagues, students, and faculty, as well as third-party payment providers, can be made more uniform by the adoption of this evaluation method.

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