

IMMEDIATE PROTOCOLS AND GUIDED SURGERY FOR ESTHETIC SUCCESS WITH FULL- MOUTH IMPLANT REHABILITATIONS



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The ultimate goal for all surgical and restorative dental interventions is an optimal, long-lasting outcome. Numerous techniques and technologies are available to increase the quality and predictability of dental treatment, even in severely compromised patients. These tools include immediate implant treatment protocols, minimally invasive surgical procedures, guided implant placement, and computer-aided design/computer-assisted manufacture (CAD/CAM)-fabricated all-ceramic implant components and restorations.

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There is now ample clinical evidence in support of immediate implant placement as a safe treatment option¹⁻⁴ that preserves peri-implant bone and limits postsurgical resorption. However, in the presence of extensive periodontal or periapical lesions, a conventional multiple-step extraction and implant placement approach is still recommended.

It is also evident that flapless implant placement limits chair time and postoperative complications⁵ and seems to prevent soft and hard tissue resorption. Flapless implant placement, however, requires sound knowledge of the individual bone morphology and fabrication of orientation guides to stay within these anatomic confines. Guided surgery allows proper implant selection and precise placement with a flapless approach.⁶ The exact implant dimensions, position, and angulation are planned on the computer, based on a computerized tomography (CT) scan, and transferred to a surgical template.

The soft tissue collar around dental implants is very fragile, and repeated disconnection and connection of implant abutments disturbs this delicate environment and may lead to soft tissue recessions.⁷⁻¹⁰ Therefore, it is advisable to connect the

definitive implant abutment at the time of implant placement.

The shape and dimensions of the abutment also play a role in preventing hard and soft tissue resorption. This concept led to the development of the platform switching protocol, in which abutments with smaller diameters are connected to larger implant platforms.¹¹⁻¹⁵ In addition, zirconium oxide ceramics have demonstrated favorable soft tissue response and esthetics, making them the preferred abutment material, especially in the esthetic zone.^{16,17}

The immediate restoration of dental implants provides multiple advantages. These advantages, including postoperative patient comfort, are most pronounced in full-mouth rehabilitations.^{18,19} Function and esthetics can be established immediately with provisional restorations, which also provide valuable information for the definitive restorations.¹⁹ Therefore, the provisional restorations should always be fabricated as closely as possible to the desired final outcome to evaluate and verify all functional and esthetic parameters.

All of these techniques and technologies are geared toward optimal, predictable, and stable long-term esthetic and functional results. Further, they share one common goal: to limit the invasiveness and number of clinical steps during treatment and to preserve or enhance existing oral conditions. The following case presentation illustrates the implementation of these concepts in a clinical full-mouth rehabilitation. Teeth were extracted, dental implants were placed with guided surgery (flapless), custom-made final abutments were inserted (platform shifting), and provisional restorations were relined and cemented in a single clinical appointment. While the clinical outcome and limited chair time are convincing, a comprehensive step-by-step treatment plan and meticulous preparation of multiple components in the laboratory are still necessary before surgery. The treatment plan must include waxups, provisional restorations, radiographic guides, CT scans, surgical templates, master casts, final zirconia abutments created by scanning customized composite

abutments, and finally provisional shells fabricated in acrylic resin for direct relining in the mouth.

CASE REPORT

A 57-year-old male patient presented in good general health. He was a nonsmoker with acceptable oral hygiene and a history of bruxism. He was highly motivated, seeking a fixed restoration despite a history of unsuccessful dental restorations in the past. According to the patient, "Everything that was ever done with my teeth broke," including removable partials dentures (RPDs), which he could not tolerate. The intraoral and radiographic examination revealed partially edentulous arches and failing restorations on the remaining teeth/roots with periapical pathologies (Figs 1 to 4). There were two failing porcelain-fused-to-metal fixed partial dentures (FPDs) in the anterior maxilla with bilateral distal ball attachments for anchorage of an RPD. The missing posterior teeth in the mandible were replaced with a conventional RPD. The remaining anterior teeth were severely compromised with failing restorations, periapical lesions, and suppuration on the mandibular right canine. The vertical dimension of occlusion (VDO) was collapsed due to excessive wear and loss of posterior occlusal support.

As a result of the compromised functional situation, one of the primary goals was to first increase the VDO while establishing proper anterior guidance and group function. The anterior guidance should be as flat as possible, while at the same time providing posterior disclusion and distribution of occlusal forces on all anterior teeth.

Waxup

The desired functional parameters were implemented in a diagnostic waxup (Figs 5 to 8), which also corrected the anterior diastema. The first steps of the diagnostic waxup included establishment of the proper occlusal plane, which was clinically eval-

CASE REPORT



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Figs 1 to 4 Preoperative situation of a 57-year-old male patient.



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Figs 5 to 8 Mounted preoperative casts, abutment casts with increased VDO, additive waxup, and final waxup.



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Fig 9 PVS impression of the maxillary and mandibular waxup for provisional fabrication.

Fig 10 Direct reline of the acrylic resin shell provisional restorations.

Fig 11 Occlusal and functional parameters were verified and adjusted to achieve proper anterior guidance.

uated and transferred to the articulator with a wax rim layer. The Kois Dento-Facial Analyzer System (Panadent, Grand Terrace, CA, USA) was used to facilitate direct mounting of the maxillary cast and transfer of the incisal edge position in reference to the hinge axis. The diagnostic cast was mounted on the mounting platform with the occlusal plane wax rim fabricated during the clinical esthetic evaluation. The mandibular cast was then mounted against the maxilla with the interocclusal records. The 9-mm-wide central incisor Golden Proportion Waxing Guides (Panadent) were used to start the maxillary waxup on the Analyzer mounting platform to achieve a balanced and harmonious anterior tooth arrangement. After establishing the occlusal plane in the maxilla, the VDO was increased to achieve proper anterior guidance. Therefore, the mandibular waxup was started in the anterior region and then completed in the posterior region. The waxup was duplicated with a polyvinyl siloxane (PVS) impression (Virtual putty base regular set and extra-light-body fast set, Ivoclar Vivadent, Schaan, Liechtenstein) and poured with dental stone (Fig 9). The same PVS impression was used to fabricate indirect provisional restorations (Integrity, Dentsply, York, PA, USA), which were relined with acrylic resin in the patient's mouth and occlusally adjusted in centric relation and all excursions (Figs 10 and 11).

After an exact occlusal equilibration and esthetic evaluation, pickup PVS impressions were made for fabrication of radiographic stents for the Nobel-Guide (Nobel Biocare, Göteborg, Sweden) surgical procedures.

Template for Guided Surgery

The PVS impressions of the adjusted provisional restorations were poured with stone (GC Fuji-rock EP Pearl white color, GC, Alsip, IL, USA) to create master casts for radiographic guide fabrication (Figs 12 and 13). Cold-curing acrylic resin denture base material (Pink Acrylic, Candulor, Wangen, Switzerland) was added to form bilateral posterior buccal flanges in the maxilla while avoiding the palatal aspect of the six anterior teeth. This was necessary to allow for evaluation of the complete tooth contours in the subsequent scanning process for ideal implant placement in respect to the desired tooth position. Strategically distributed 1-mm-wide holes were ground into the pink acrylic resin and filled with gutta percha (Guttapercha Points, Dentsply DeTrey, Konstanz, Germany) for the scanning procedure and posterior matching of the two CT images (Figs 14 to 16). The first CT scan was taken with the radiographic guides

Fig 12 Pickup impressions of the relined provisional restorations.

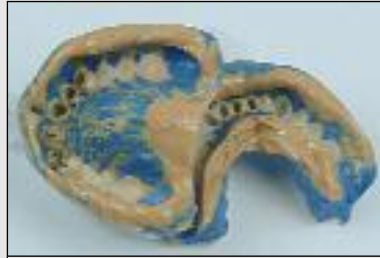
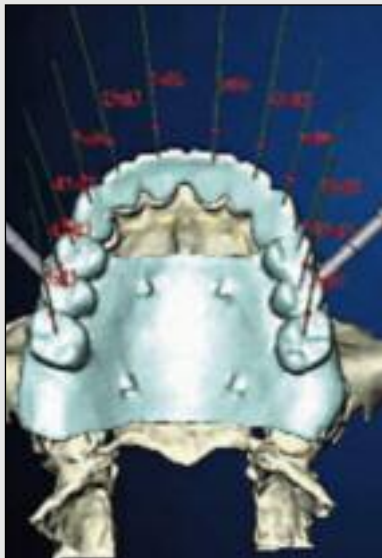
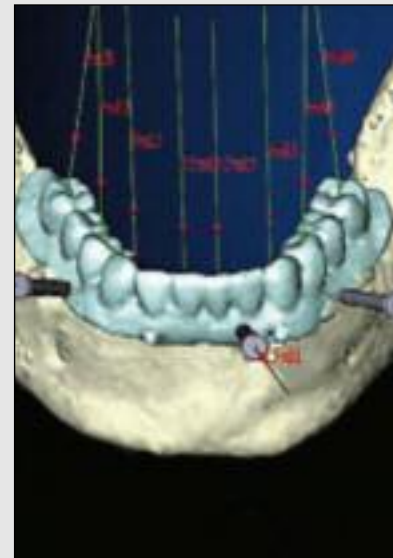


Fig 13 Master cast for radiographic



Figs 14 to 16 The diagnostic waxup and setups were transferred into fixed and removable restorations in the maxilla and an over-denture, retained by two immediate provisional implants, in the mandible.

Figs 17 to 19 Radiographic guides and virtual implant placement.



in place. Then, the guides were scanned separately to allow for matching of the images of the guides and the individual patient information in a single three-dimensional virtual model to achieve ideal implant placement and positioning (Figs 17 to 19). The desired implant dimensions and positions were planned virtually with Procera software

(NobelGuide, Nobel Biocare). For the 12 planned maxillary implants, two surgical templates were designed and ordered from the manufacturer. The six remaining anterior teeth needed to be extracted at the time of implant placement. In addition to these six implants, three were planned in the right and left maxillary posterior regions. One



Figs 20 to 22 Conventional fabrication of the mandibular master cast: modified guide cylinders inserted in the surgical template and connected to the laboratory analogs before pouring with stone. Orientation of laboratory analogs with one of the lobes toward the buccal aspect was marked with a black line for optimal transfer and accurate delivery of the immediate restoration.

implant per tooth in the anterior esthetic zone is ideal to support and maintain the existing hard and soft tissues. Another supportive factor for this treatment plan was an ideal biotype with flat and thick bony and gingival tissues.

A different approach was selected for the mandible. All mandibular anterior teeth needed to be extracted due to severe perioendodontic pathologies, which created less than ideal hard and soft tissue conditions. An immediate overdenture supported by two immediate provisional implants (Immediate Provisional Implant System, Nobel Biocare) and relined with soft reline acrylic resin was fabricated (see Fig 16). The overdenture was planned and prefabricated from the previous diagnostic waxup and set up using the same denture teeth. In the maxilla, a provisional restoration was fabricated from canine to canine, and the RPD was adjusted to fit these new restorations. Denture teeth from the previous RPD were replaced by new acrylic resin teeth from the diagnostic waxup to create an exact replica of the waxup and to verify the desired occlusal situation. The final treatment plan for the mandible included placement of eight implants at the sites of the first molars, first premolars, canines, right lateral incisor, and left central incisor, and fabrication of four three-unit FPDs.

Fabricating a Master Cast from the Surgical Template

After receiving the surgical templates (NobelGuide) from the manufacturer, master casts were fabricated from the templates with the guided cylinders that were holding the laboratory analogs in position. Care was taken to orient the laboratory analogs in the exact same way as for the prospective implant placement. Implant orientation is of utmost importance when immediate function is planned to achieve well-fitting prefabricated prostheses. Maxillary and mandibular master casts were fabricated differently from each other. The conventional NobelGuide protocol was followed for the mandible to create the master cast during implant placement. Laboratory analogs were connected to the surgical template (Fig 20). Transfer copings with reduced diameters were selected for a reduced emergence profile. It is crucial to properly connect and orient the laboratory analogs. When a tri-lobe internal connection—as featured in the NobelReplace system (Nobel Biocare)—is used, one of the internal connection lobes should be oriented toward the buccal aspect and in the same orientation as is planned for clinical placement. As an aid, black lines were painted with a permanent marker on the cast to orient the implant lobe during surgery (Figs 21 and 22).



Figs 23 to 27 Two surgical templates were fabricated for guided placement of 12 implants in the maxilla (NobelGuide). The first template was used for strategic insertion of the first 5 implants. The second template was retained by the 5 implants already in place for accurate insertion of the remaining 7 implants. A master cast was fabricated with the surgical template, modified guide cylinders, and cor-



The master cast for the maxilla was fabricated using an alternative approach (Figs 23 to 27) to preserve the soft tissue architecture as present in the pickup impression of the relined maxillary provisional restorations. The tissue and tooth morphology already created with the provisional restorations allowed for accurate fabrication of customized zirconia abutments in respect to soft tissue and crown support as well as finishing line configuration and depth. A tungsten bur was used to carefully hollow each root/implant site in the posterior region to allow for perfect fit of the template and 12 laboratory analogs. The transfers

were undercontoured with a bur to fit the socket, prevent distortion of the soft tissue architecture, and create an ideal emergence profile. It is important for this master cast fabrication technique to generate the radiographic guide from the same cast to ensure accurate fit when the surgical template is retrofit to the cast. Once the radiographic guide was exactly positioned on the master cast, it was secured and glued with wax. Stone was mixed and then poured from the apical portion of the cast between the analog and the carved holes until set. Type II snow-white plaster (Kerr, Orange, CA, USA) was used to limit distortions.



Fig 28 Temporary plastic abutment modified with composite resin to achieve the ideal shape and contour according to provisional restorations.



Fig 29 Definitive customized zirconia abutments. Platform shifting concept was applied with PS adapters.



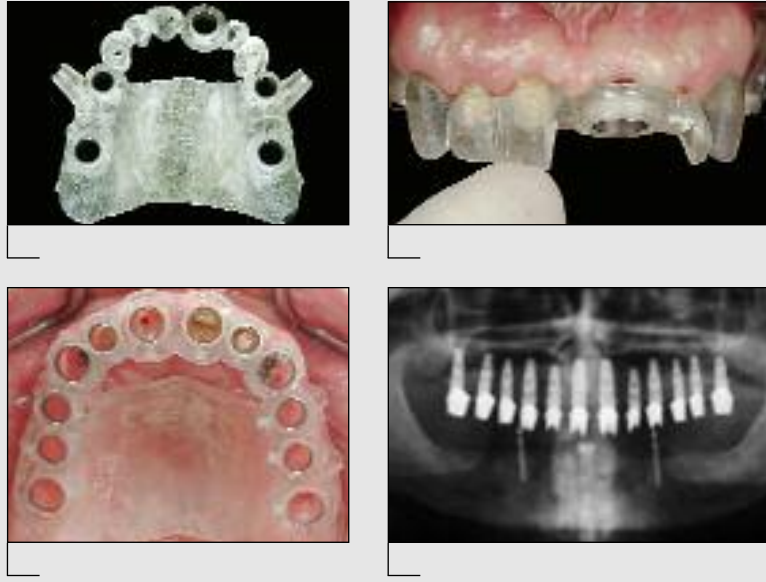
Figs 30 to 32 Resin impression copings for stable transfer and precise positioning of the duplicate epoxy resin abutments in the final impression. All zirconia abutments were duplicated.

Abutment Fabrication

The implant abutments were fabricated based on the master cast with its ideal implant positions. PVS matrices (Zetalabor laboratory high-precision condensation silicone, Zhermack, Badia Polesine, Italy) were made from the provisional pickup impressions to design and scan the abutments for the posterior areas, which were ultimately made of zirconia. Temporary plastic abutments (Nobel Biocare) were customized circumferentially with composite resin (Fig 28) until the final shape was achieved (Tetric Ceram, Ivoclar Vivadent). These customized abutments were then prepared and polished for scanning (Procera forte scanner, Nobel Biocare) and transferred into zirconia abutments (Fig 29). The zirconia abutments were ordered with smaller-diameter platforms than the supporting implants to take advantage of the platform shifting (PS) concept. PS adapters (Nobel Biocare) were later connected intraorally to convert regular-platform implants into narrow-platform abutments as well as wide-platform implants into regular-platform abutments. Once the abutments

were received and polished, impressions were made of each abutment with a PVS material (Virtual putty base regular set and extra-light-body fast set, Ivoclar Vivadent) to fabricate a duplicate cast with epoxy resin (Exakto-form, Bredent, Senden, Germany) and a precise master cast from the eventual final impression. These steps aimed to circumvent any future abutment disconnection after insertion and, therefore, to avoid any disturbance of the fragile abutment/bone/soft tissue interface. The impression copings were deemed necessary for stable positioning of the duplicate epoxy resin abutments on the final PVS impression and to avoid any micromovements of the duplicate abutments during pouring of the impression. Each coping was fabricated from the zirconia abutments with GC Pattern Resin LS (GC, Tokyo, Japan) and verified on the corresponding epoxy resin duplicates. Small retentive wings were designed on each coping for mechanical retention of the PVS impression (Figs 30 to 32). A provisional shell was fabricated with acrylic resin (Integrity, Dentsply) for the maxilla and mandible, complet-

Figs 33 to 37 The first surgical template in position after the extraction of the maxillary left central incisor. The template was stabilized by the remaining teeth and anchor pins and used to place five implants. The remaining implants were placed with a second surgical template.



ing all prerequisites and components for the surgical steps.

Surgery and Immediate Provisional Restorations

Implant placement was performed without elevating full-thickness flaps and exposing the supporting bone. Some soft tissue preparations were performed to simplify the subsequent procedures or to enhance local soft tissue support. Split-thickness flaps were prepared close to the bone to allow fast and effective insertion of the PS zirconia abutments during the final stages of the surgical procedure. The modified roll technique was used in the areas of the right and left first premolars and first molars to increase the available soft tissue. The internal aspects of the flange areas of the surgical template were carefully relieved. After extraction of the maxillary left central incisor, the first surgical guide, now resting on the remaining teeth, was secured in place with anchor pins according to the virtual planning. A consecutive placement protocol

was followed starting with the insertion of the implant in the area of the right first premolar, followed by left first premolar, first molars, and finally the left central incisor to avoid any rocking and to ensure optimal stability of the surgical template during implant insertion (Figs 33 to 35). After removal of the template, a roll flap was prepared in the posterior areas to move as much soft tissue as possible from the occlusal ridge to the buccal aspect. Once the first five implants were inserted, the remaining teeth were extracted and the second surgical template was placed. The template was secured and stabilized by the five implants already in place to accurately guide the insertion of the seven remaining implants (Figs 36 and 37).

All implants were torqued with 50 Ncm to ensure primary stability. Care was taken to orient one of the lobes of the trilobe internal implant connection toward the buccal aspect. The surgical template was marked with a line during the laboratory stage to indicate orientation of the analogs in the master cast. The definitive zirconia abutments were inserted with the corresponding PS adapters and torqued in place with 35 Ncm. Screw access



Figs 38 and 39 Postsurgical views with all implants and corresponding custom zirconia abutments in place.

Fig 40 Intraoral situation immediately after placement of the implants and immediate provisional restorations.

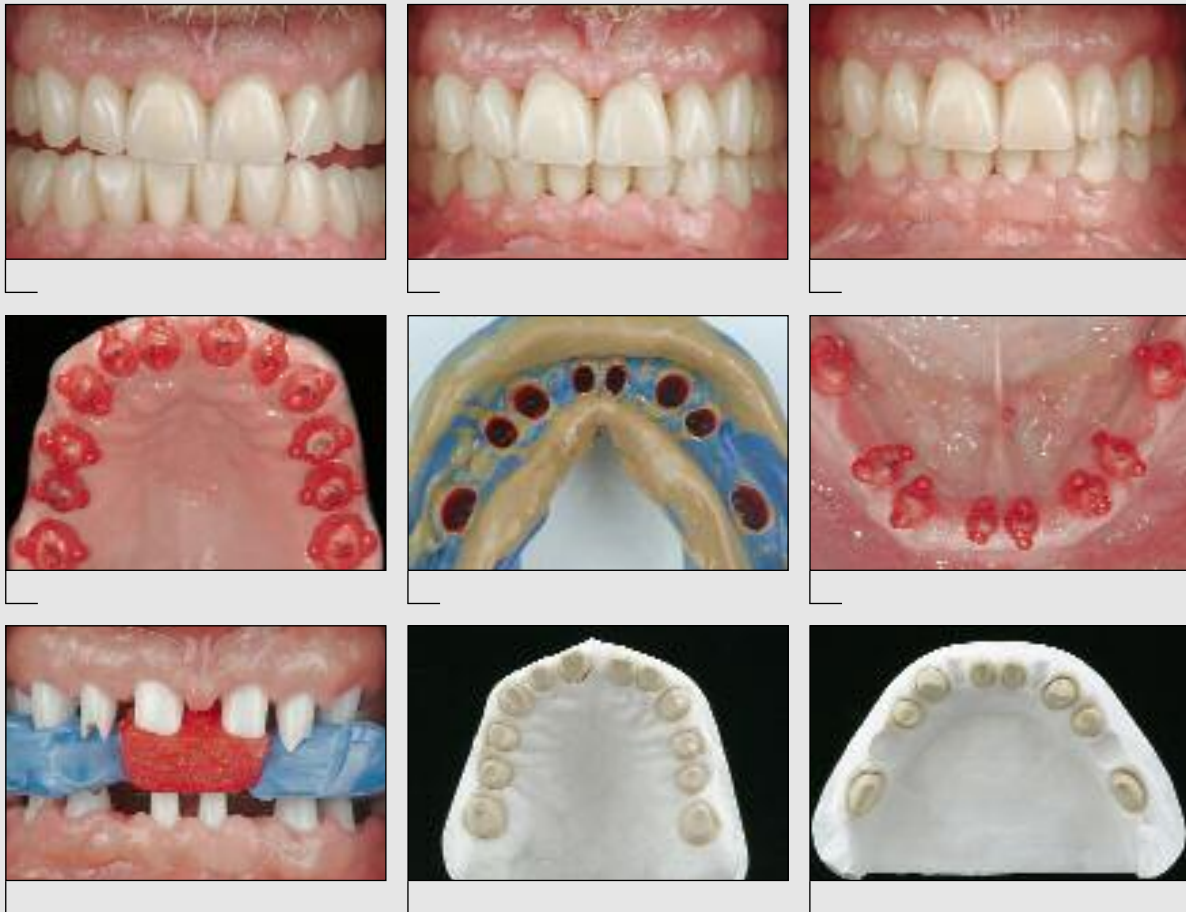
openings were closed with temporary restorative material (Fermit, Ivoclar Vivadent). All abutments were painted with petroleum jelly before relining the complete-arch provisional shell restorations with self-curing acrylic resin. It is recommended to verify functional parameters such as centric occlusion before relining to limit possible occlusal adjustments. The provisional shell should rest on the free gingival margin surrounding the implant abutments to create an ideal emergence profile from the preparation finish line of the zirconia abutments. After complete polymerization of the acrylic resin, the provisional restoration was refined and polished in the laboratory.

Definitive implant surgery in the mandible started with the removal of the immediate provisional implants placed earlier in the mandibular canine sites. The surgical template was secured in place with three anchor pins. References were marked with a periodontal probe, creating bleeding points in the planned implant sites through the openings of the surgical stent. To preserve as much gingival tissue as possible, the template was removed, a crestal incision was made, and a split-thickness flap was raised to move the tissues laterally. The template was reinserted, and a similar sequencing protocol to the one applied in the maxilla was followed. The first implant was placed in the middle of the stent anteroposteriorly in the area of the left first premolar, followed by the right first premolar, first molars, canines, and finally the central incisors. Dense bone burs were used due to

the high bone density, especially for the narrow-platform implants that were placed for the mandibular central incisors. Once the implants were placed, the corresponding PS adapters with the zirconia abutments were inserted, and a series of periapical radiographs was taken to verify all parameters. Abutments were secured with a torque of 35 Ncm. The provisional restoration was completed the same way as in the maxilla. Maxillary and mandibular provisional restorations were cemented one at a time with temporary cement (Temp-Bond NE, Kerr). Abutments, radiographs, and completed provisional restorations are shown in Figs 38 to 40.

Definitive Restorations

Periapical radiographs were taken at 4, 6, and 12 months to evaluate the progression of the bone remodeling and the effect of the platform shifting. Figures 41 to 43 reveal the intraoral situation and soft tissue response 1 month, 4 months, and 7 months after implant placement and provisional insertion. Small recessions were detected on the maxillary left incisors. A retraction cord and hand instruments were used to carefully displace the marginal gingiva apically and to reprepare the abutment with diamond burs. A silicone impression was made (Virtual putty base regular set and extra-light-body fast set, Ivoclar Vivadent) of both abutments to fabricate new impression copings and accurate die duplicates for rescanning. Of the



Figs 41 to 43 (left to right) Intraoral situation 1 month, 4 months, and 7 months after implant placement and provisionalization. The slight gingival recessions on the maxillary left incisors were eliminated via intraoral preparation of the abutments and relining of the provisional restoration. A new final impression was made.

Figs 44 to 46 Impression copings in place before final pickup impressions were made with PVS impression material.

Fig 47 Interocclusal records for accurate VDO transfer and cross-mounting of casts.

Figs 48 and 49 Master casts with duplicated epoxy dies.

20 zirconia abutments delivered on the day of the surgery, only these 2 abutments needed slight modification of the finish line. The impression copings were directly relined on the abutments with self-cure acrylic resin (GC Pattern resin) to adjust the copings to the minimal modifications made to the zirconia abutments.

After a healing period of 9 months, final pickup PVS impressions (virtual VPS putty base regular set and extra-light-body fast set, Ivoclar Vivadent) were made of both arches using impression copings (GC

Pattern) positioned on the corresponding zirconia abutments (Figs 44 to 46). Afterward, both full-arch provisional restorations were relieved posterior to the canines to maintain the desired VDO while recording centric occlusion (Fig 47) with wax (bite registration wax sheets, Almore International, Portland, OR, USA). Casts were cross-mounted to transfer the provisional information for fabrication of the definitive prostheses. Alginate impressions were also made of both provisional restorations, and a facebow transfer was performed to communicate all necessary information



Fig 50 Customized resin pattern copings for ideal support of the veneering ceramic.



Fig 51 Definitive zirconia copings.

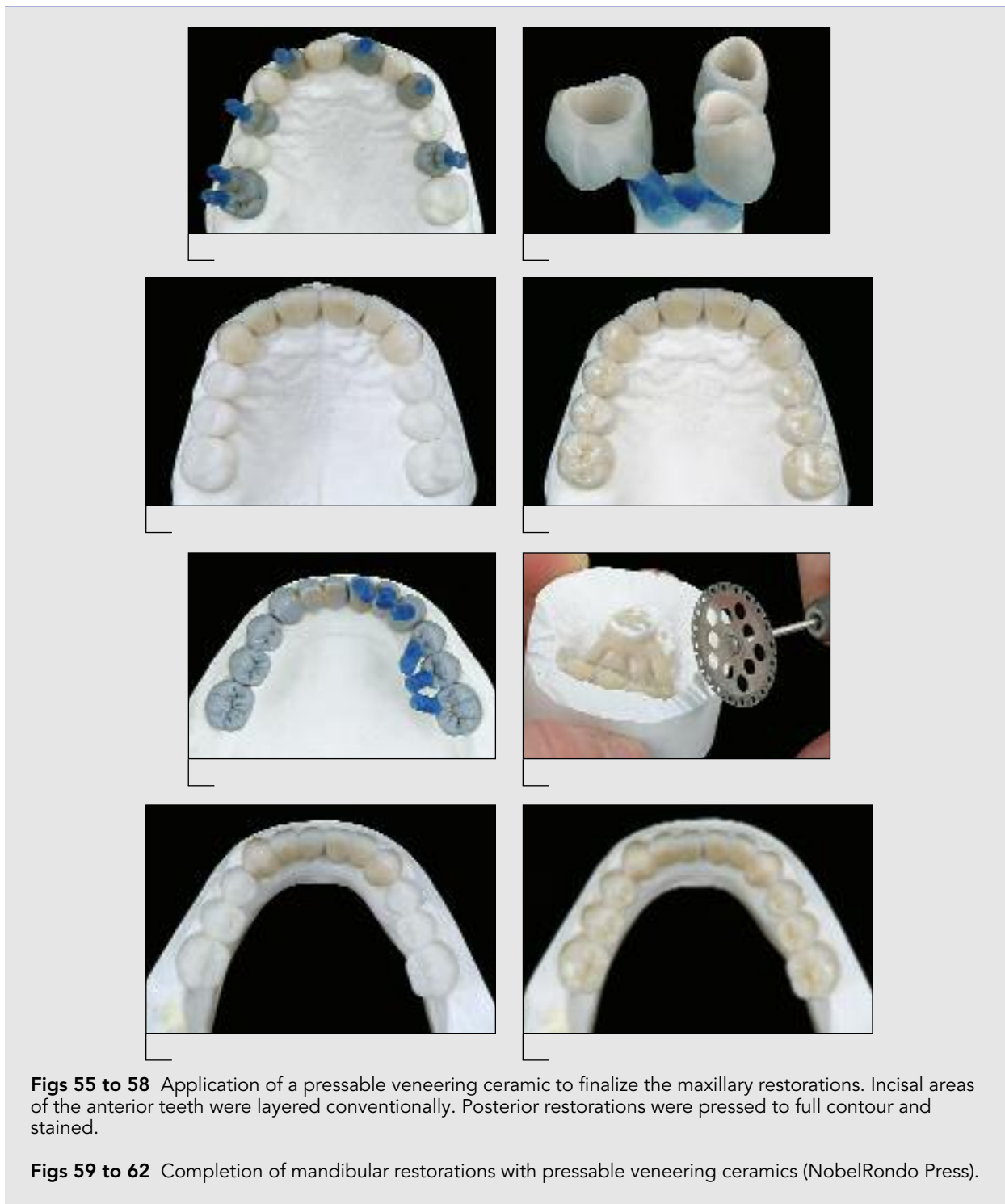


Figs 52 to 54 Fit of the frameworks for the mandibular FPDs was verified intraorally. Wax was added to the framework patterns for optimal support of the veneering ceramic. Frameworks were designed with a double-scan technique and fabricated from zirconia.



to the dental technician. Duplicate epoxy dies of all abutments were integrated in the master cast (Fig 48 and 49). All definitive restorations were made with zirconia substructures in the form of single crowns (Procera Zirconia Crown, Nobel Biocare) in the maxilla and four three-unit FPDs (Procera Zirconia Bridge, Nobel Biocare) in the mandible. Copings were made with silicone matrices taken from the alginate impressions of the provisional restorations, which facilitated the double-scanning technique and supportive coping designs. Acrylic resin copings (GC Pattern LS) were fabricated, and wax was added to create ideal support for the veneering ceramic (Fig 50). The minimum thickness of the definitive copings (Fig 51) was 0.6 mm, and the connector areas for the FPDs were at least 9 mm². The acrylic resin framework patterns

for the mandibular FPDs were verified intraorally (Fig 52) and then modified for optimal support for the veneering ceramic (Fig 53). The double-scanning technique was used in the same manner as for the maxillary copings (Fig 54). A pressable veneering ceramic was applied on all zirconia copings and frameworks (NobelRondo Press, Nobel Biocare) for increased fracture resistance. Posterior restorations were pressed to full contour and stained, while the anterior restorations were slightly cut back. The incisal edges were completed with a conventional layering technique to achieve optimal esthetics (Figs 55 to 62). A PVS pickup impression was made from the restorations at the bisque-bake try-in to communicate subtle details of tooth contour, contact points, emergence profiles, and occlusal additions. All definitive restora-



tions were cemented with RelyX Unicem (3M ESPE, St Paul, MN, USA). Final occlusal parameters were evaluated and adjusted after cementation. Alginate impressions were made in both arches, and two dif-

ferent types of night guards were fabricated. These night guards varied in respect to disclusion and VDO to prevent adaptation, as typically occurs when only one night guard is used. Periodic follow-up visits

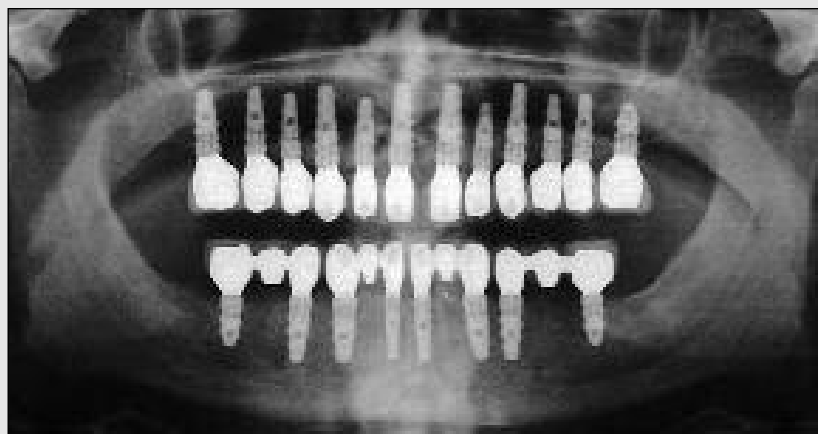


Fig 63 Postoperative radiograph.

Figs 64 to 67 Occlusal views of the maxillary and mandibular definitive zirconia restorations on custom implant abutments.

Figs 68 and 69 Definitive maxillary anterior implant-supported restorations (six implants) on the master cast and after insertion.

Figs 70 and 71 Definitive mandibular anterior implant-supported restorations (four implants) on the master cast and after insertion.

Fig 72 Final outcome.



were scheduled at 6-month intervals. Figures 63 to 75 show the preoperative conditions, restorations on the master casts, and final result.

CONCLUSION

New techniques and technologies, including minimally invasive procedures, immediate implant protocols, guided implant placement, platform shifting, and CAD/CAM implant components and restorations, are geared toward optimal and predictable functional and esthetic success. The implementation of these techniques in only a few clinical appointments requires comprehensive planning and meticulous fabrication of numerous components in the laboratory before the surgical phase. This article illustrates the step-by-step implementation of such protocols in a clinical case that required comprehensive full-mouth rehabilitation.

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