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CLINICAL REPORT

Prosthetically guided bone sculpturing for a maxillary complete-arch implant-supported monolithic zirconia fixed prosthesis based on a digital smile design: A clinical report

Fernando Rojas-Vizcaya, DDS, MS[a]

ABSTRACT

A digital smile design was used to create an average smile and to develop a removable interim restoration for an edentulous patient with a high smile line and different bone levels in the maxilla. The interim restoration was used as a guide to perform bone sculpturing to create space for the biological width and to restore a monolithic zirconia implant-supported fixed restoration. (J Prosthet Dent 2017;118:575-580)

Determining the incisal edge and maxillary incisal curve is the first step in complete mouth rehabilitation.[1] The average smile (69%) exposes 75% to 100% of maxillary teeth. The maxillary incisal curve is parallel to the lower lip (85%), touching the lower lip in women (58%) and showing the 6 maxillary anterior teeth and the first maxillary left and right premolars (49%). In a slightly covered smile (16%), the patient covers a portion of the maxillary anterior teeth with the lower lip.[2]

Different physical[3,4] and 2-dimensional virtual[5] approaches are possible to achieve and visualize an esthetic smile. A physical approach is setting denture teeth in a record base and modifying until the desired smile is obtained.[4] For digital smile design (DSD), digital clinical photography and specific computer programs (Smile Designer Pro; Digital Smile Design; Aesthetic Check; Digital Smile System) or general photo-editing or presentation programs can be used for smile design planning (Photoshop Software; Adobe Systems, PowerPoint; Microsoft Corp, Keynote; Apple Inc).[6,7]

DSD was introduced in dentistry to plan restorations in dentate patients, but the authors are unaware of reports using DSD to perform bone sculpturing for complete-arch implant-supported rehabilitations in patients with edentulism. Analysis of the distance between the margin of the planned crowns and existing bone is necessary to determine if the restoration needs to incorporate a pink prosthetic area, if a grafting procedure will be required, if implants can be placed at the level of the bone, or if bone reduction is needed.[3-5] Some guidelines using the margin of the planned crown as a reference can be applied.[4,5,8,9] Implants must be placed 3 mm apical from the margin of the planned crowns to create space for average biological width thickness,[8,10] and 2 mm of buccal bone is desired after implant placement to avoid its resorption[11] (3A-2B rule).[9] In the extraction socket, the implant must be below the level of the bone to compensate for the loss of bundle bone, in palatal position, and a gap between the implant surface and the socket bone wall of 1.5 to 2 mm are required to expect the 2 mm of buccal bone after bone remodeling.[12]

For a definitive restoration, an alternative treatment[13-17] is a computer-aided design and computer-aided manufacturing (CAD-CAM) screw-retained, stained monolithic zirconia implant-supported fixed prosthesis (MZ-FP). The MZ can be made to anatomic contour or partially cut back and veneered in feldspathic porcelain. The incisal edge should be in zirconia to avoid chipping of the feldspathic ceramic. Maxillary complete-arch prostheses supported by 4 implants and made of metal-acrylic resin[18] or MZ supported by 3[19] or 4[17] implants have been reported. A prosthetically driven protocol based on DSD for the rehabilitation of a complete

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[a]Adjunct Assistant Professor, Department of Prosthodontics, School of Dentistry, University of North Carolina at Chapel Hill, NC; and Director, Mediterranean Prosthodontic Institute, Castellon, Spain.

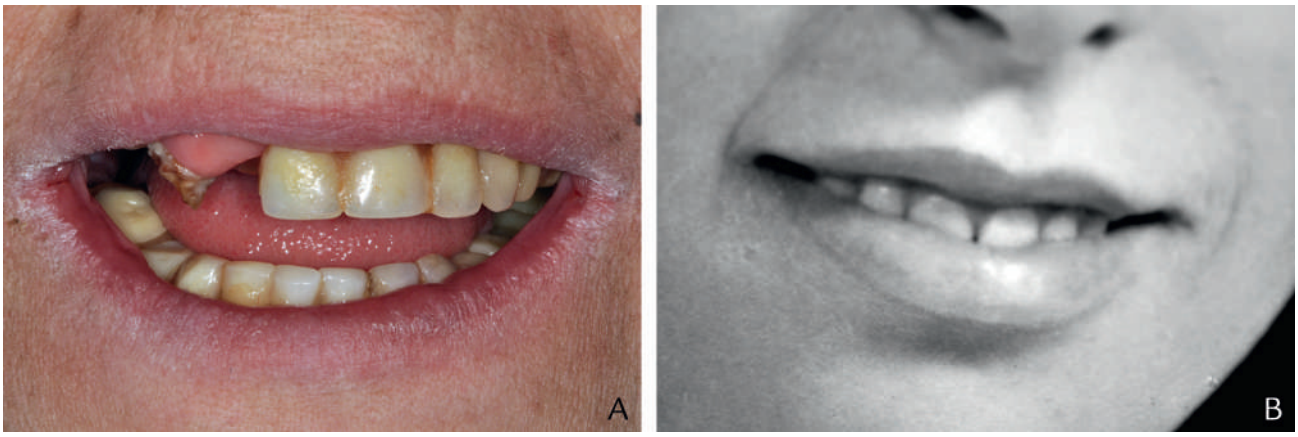

Figure 1. A, Existing poor esthetics and functional conditions. B, Forty years previously, lower lip covered 50% of maxillary teeth.

maxillary arch using MZ-FP in a patient who required bone recontouring is described.

CLINICAL REPORT

A 61-year-old woman sought care at the Mediterranean Prosthodontic Institute in Castellon, Spain, with a maxillary removable prosthesis and a mandibular complete denture with a hopeless remaining maxillary right canine (Fig. 1A), and with a request for her teeth to be fixed. According to the classification system for partial edentulism developed by the American College of Prosthodontists, the case was characterized as Class IV.[20]

Complete-arch, implant-supported restorations with 6 implants in the maxilla and 4 in the mandible were proposed, but because of financial and esthetic reasons, the patient wanted to start with the maxillary arch. Because the maxillary arch was small, the rehabilitation of the complete maxillary arch with an MZ-FP screw retained by 4 implants,[17-19] and a mandibular complete denture was the selected treatment plan.

The patient provided photographs of herself 40 years previously. An analysis of the smile in these photographs revealed that she had a high smile line[2] without asymmetries in the lips. The maxillary incisal curve was slightly covered by the lower lip in the rest position (Fig. 1B).

Image analysis showed that the maxillary right canine margin was slightly overextruded compared with 40 years earlier. Left side asymmetry of the gingival margins had developed because of bone loss, producing an asymmetry in the lower lip.

A DSD was performed using computer software (Keynote; Apple Inc). The right side of the lower lip was used to create the maxillary incisal curve to restore proper support on the left side of the lip (Fig. 2A). A maxillary interim prosthesis and mandibular complete denture were fabricated with the same relationship between the maxillary incisal curve and lower lip as in the DSD analysis for esthetic and functional evaluation in the patient.

Maxillary casts of the patient with and without the interim prosthesis and the mandibular complete denture cast were scanned in an optical strip-light scanner (Scanner S600 ARTI; Zirkonzahn). Two maxillary interim prostheses were designed virtually by using the cast with the interim prosthesis of the patient as a reference and from a block of acrylic resin (Temp Premium; Zirkonzahn); both interim prostheses were milled with a milling unit (Milling Unit M5; Zirkonzahn). One prosthesis fit in the maxillary cast with the existing patient anatomy and ideal margins (Fig. 2B); the other had planned ovate pontics 1.5 mm deep, except in both maxillary canines and both maxillary first molars (Fig. 2C), where it was planned to place the implants.

Twelve radiopaque markers made of 1 mm lead foil strips were fixed with sticky wax (Sticky Wax; Kerr Corp) from the zenith to the palatal margin of each planned crown, and the removable prosthesis was used as a radiographic template. The distance from the margin of each planned crown to bone level is seen in Fig. 3, and the required action to obtain the 3 mm space for the biological width is presented in Table 1. For the ovate pontics, a 1.5 mm space was required for the prosthetic material, and a 1.5 mm space below the ovate pontic was needed for the soft tissue. The radiographic analysis showed that bone reduction was necessary at the level of the ovate pontics.

After a supracrestal full-thickness flap was raised, the ideal margin prosthesis was positioned (Fig. 4A), and fit was verified in the palatal area. Bone reduction was performed to obtain the 3A[9] (Fig. 4B). After the drilling sequence was completed, 2B[9] was achieved, the ovate pontics prosthesis was positioned, and bone in contact with the ovate pontics (Fig. 4C) was reduced. Then 4 fluoride-modified screw-shaped implants, 4.0 mm in diameter and 11 mm in length (OsseoSpeed TX 4.0 S, 11 mm, Astra Tech; Dentsply Sirona), were placed. Four healing abutments (Healing Abutment 3.5/4.0 diameter 4, 2 mm, Astra Tech; Dentsply Sirona) were attached, the

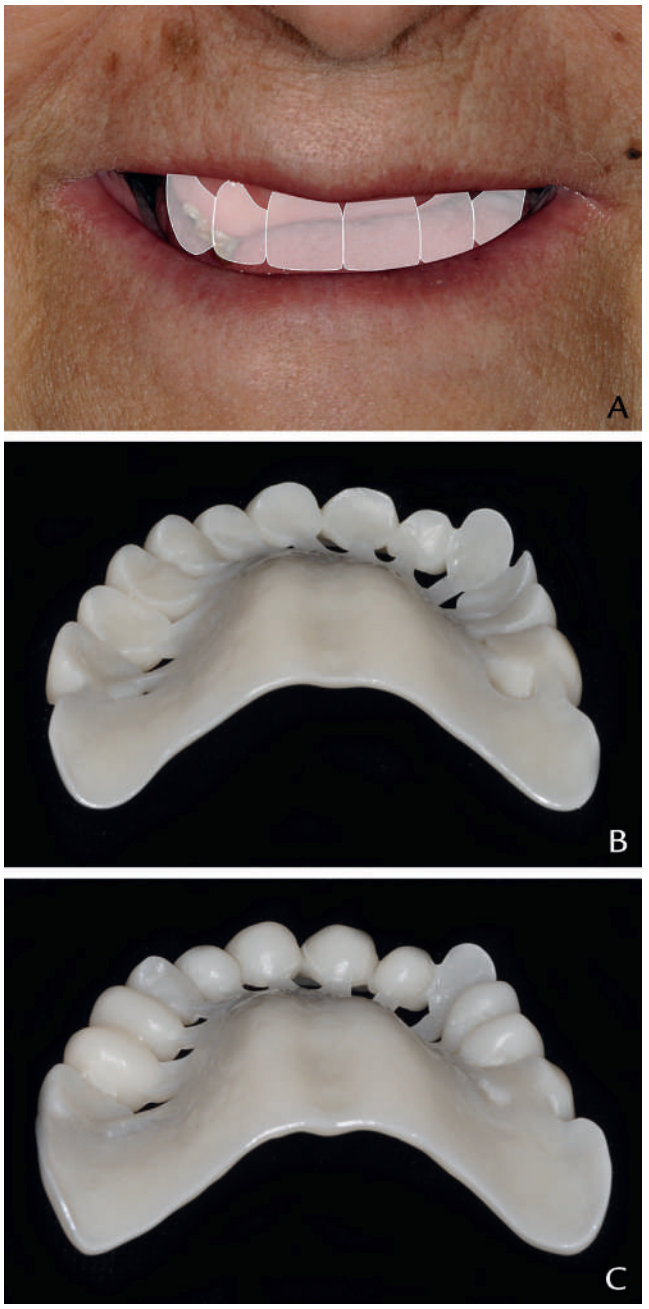

Figure 2. A, Virtual desired position of anterior teeth. B, Acrylic resin computer-aided design and computer-aided manufacturing (CAD-CAM) prosthesis without ovate pontics. C, Acrylic resin CAD-CAM prosthesis with ovate pontics.

flap was sutured with 3-0 silk (stoma-silk; Stoma), and the complete denture was adapted to avoid contact with the healing abutments.

After 12 weeks, the healing abutments were replaced with solid titanium abutments for screw-retained restorations (20° UniAbutment 3.5/4.0-2 mm, Astra Tech; Dentsply Sirona) (Fig. 4D). An open tray definitive abutment level impression was made with a polyvinyl siloxane impression material (Coltoflax; Coltène). Healing caps (20

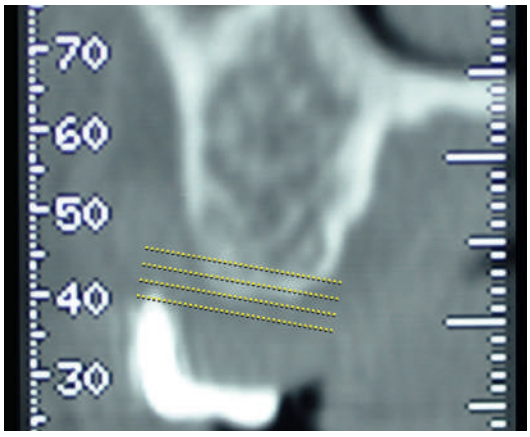

Figure 3. Distance of 1.5 mm between maxillary left first molar margin and bone level was indication for bone reduction of 1.5 mm.

degree ProHeal Cap, diameter 4.3 mm, Short, Astra Tech; Dentsply Sirona) were placed on the abutments. Soft tissue was reproduced in the impression using polyvinyl siloxane (Gingifast Rigid; Zhermack), and the maxillary definitive cast was poured with Type IV stone (T.C. 15; Techim Group).

The removable prosthesis was positioned on the definitive cast, and 2 silicone (S) indexes (Zetalabor; Zhermack) were made: the first, to copy the margin (SM) of each crown, was made of the buccal aspect and the second covered the buccal, occlusal (SO), and palatal aspect of the prosthesis. The ideal emergence profile, the contour of the soft tissue, and the ovate pontics were created in the artificial soft tissue. The SM was placed with the cast, and the artificial soft tissue was carved using a laboratory bur. First, the ovate pontic areas were created to a depth of 1.5 mm until the carved area matched the margin of the corresponding crown. Then artificial soft tissue was removed from the definitive cast. Using the same SIM, the emergence profile was established in the abutment areas and reduced until it matched the margin of each crown (Fig. 5A). Temporary cylinders (Temporary Cylinder, Uni 20°, Astra Tech; Dentsply Sirona) were then attached to the abutment replicas, and an interim prosthesis was made using the SO and autopolymerizing acrylic resin (Bosworth Trim II; Bosworth Co).

After removing the healing caps, the prosthesis was positioned, and the patient was asked to occlude for 20 minutes until the interim prosthesis fit in the abutments; it was then screwed in. In this way, after 2 weeks, a new soft tissue contour was obtained (Fig. 5B).

The definitive cast was mounted using the interim prosthesis, and then a copy of the interim restoration was also mounted. In the laboratory, the definitive cast and a copy of the interim prosthesis and mandibular cast were scanned (Scanner S600 ARTI; Zirkonzahn); a virtual copy of the interim restoration was then designed as described

Table 1. Analysis of distance between margin of planned crowns and bone level and required action to obtain 3A-2B rule at implant level

Implant Position	Distance from Margin of Planned Crown to Bone (mm)	Action Required to Obtain 3A	Action Required to Obtain 2B
Maxillary right first molar	2	1 mm bone reduction	Keep 2 mm of buccal bone
Maxillary right canine	1	Implant placement 2 mm below bone	Keep buccal space 1.5 to 2 mm
Maxillary left first molar	1.5	1.5 mm bone reduction	Keep 2 mm of buccal bone
Maxillary left canine	1.5	1.5 mm bone reduction	Keep 2 mm of buccal bone

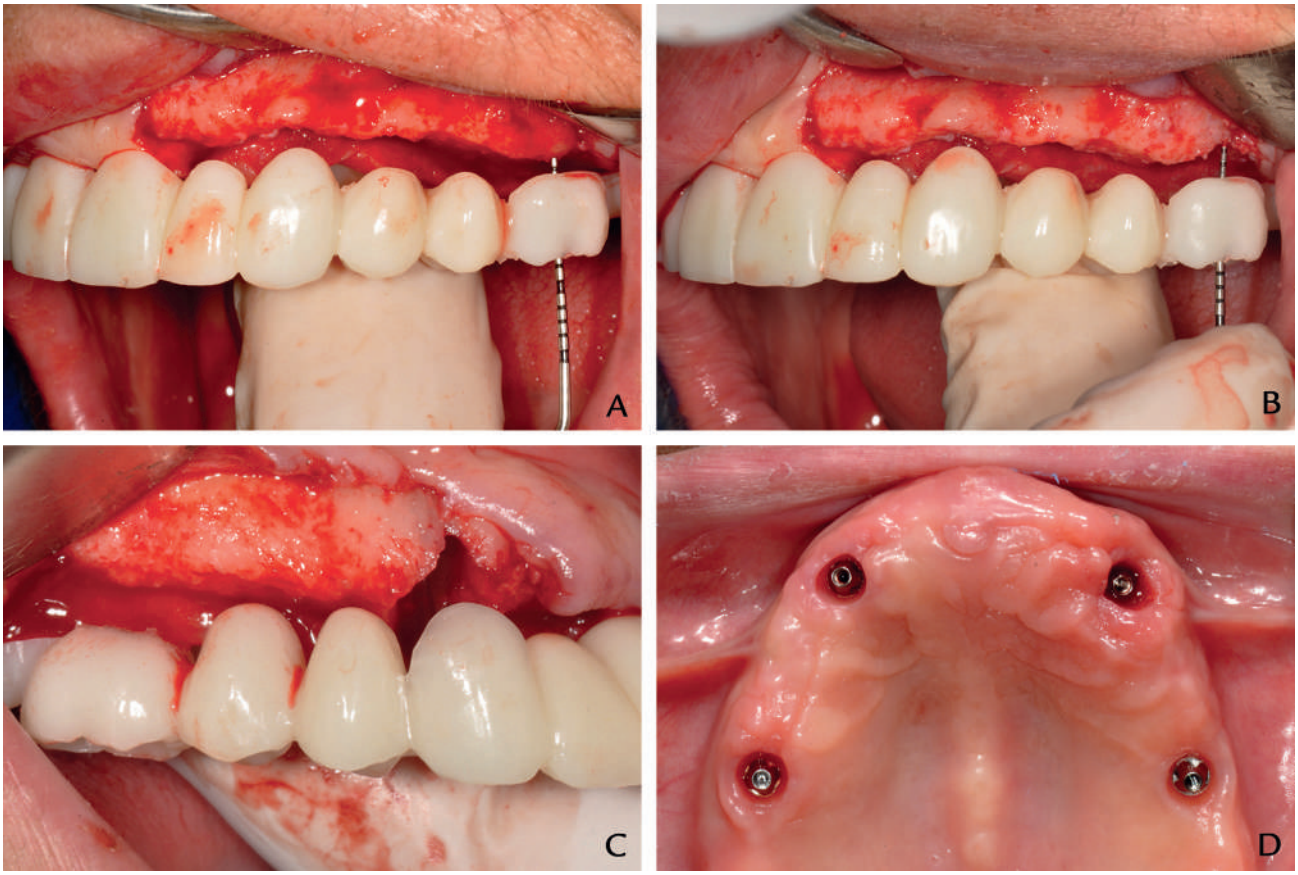

Figure 4. A, Distance (1.5 mm) between margin of maxillary left first molar and bone level confirmed intraorally. B, Space (3 mm) obtained after bone reduction at level of maxillary left first molar. C, Lack of space confirmed with acrylic resin computer-aided design and computer-aided manufacturing prosthesis at ovate pontic level. D, Flat soft tissue architecture after osseointegration.

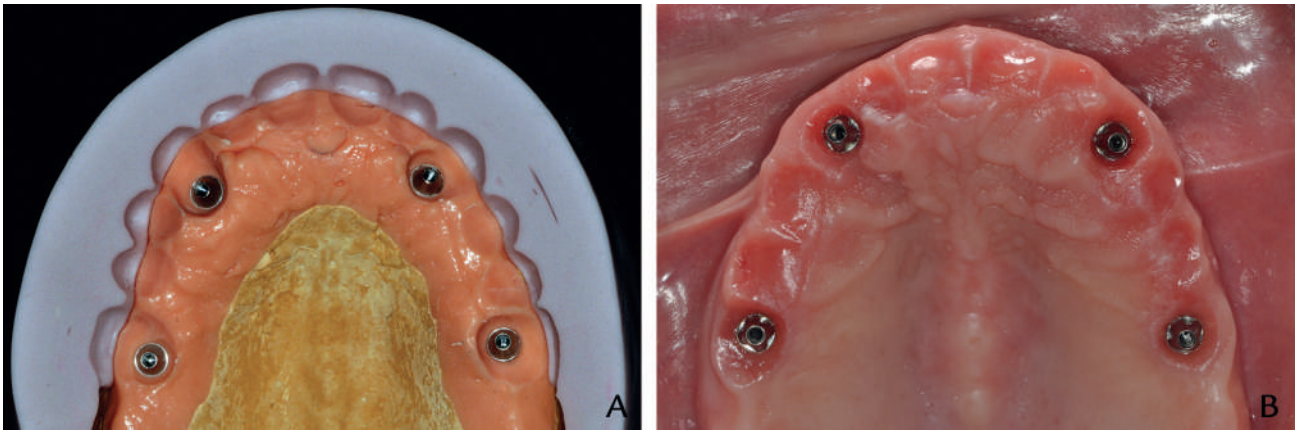

Figure 5. A, Prosthetically guided new soft tissue design. B, New soft tissue architecture.

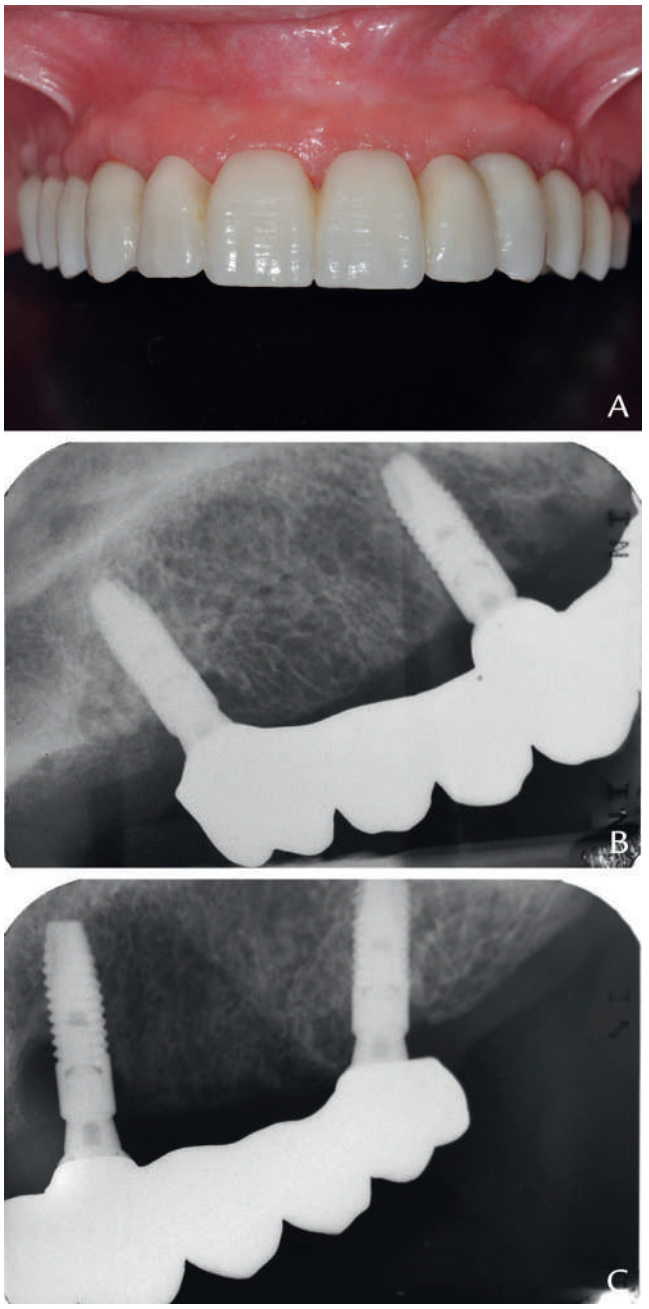

Figure 6. A, Prosthesis after 3 years of service. B, Radiograph shows passive fit on maxillary right-side implants. C, Radiograph shows passive fit on maxillary left-side implants.

previously. An interim restoration was milled (Milling Unit M5; Zirkonzahn) from a block of acrylic resin (Temp Premium; Zirkonzahn). The interim restoration was delivered for esthetic and functional evaluation. No modifications were needed in the interim restoration.

An MZ-FP (Prettau; Zirkonzahn) was milled from a block of zirconium oxide (yttrium partially stabilized with tetragonal polycrystalline structure) (Prettau Zirconia 16er XH40; Zirkonzahn) and partially cut back

Figure 7. Maxillary incisal curve followed and in light contact with lower lip during smile.

from canine to canine, keeping the incisal edges in zirconia.[13-17] The primary liquid color (Colour Liquid; Zirkonzahn) was added, dried under an infrared lamp, sintered, and veneered with feldspathic porcelain (Ice Zircon Ceramic; Zirkonzahn). Titanium cylinders were cemented in the laboratory using a dual polymerizing resin cement (Multilink Automix; Ivoclar Vivadent AG). The interim prosthesis was replaced with the MZ-FP (Fig. 6A), evaluated for passive fit as described by Rojas-Vizcaya in 2011,[13] and then tightened at 15 Ncm to the abutments. The screw access openings were covered with polytetrafluoroethylene tape (Teflon; Traxco, SA) and light-polymerizing composite resin (Z100 Restorative; 3M ESPE). Seating was confirmed from radiographs (Fig. 6B, C).

After 3 years in service, the maxillary incisal curve and lower lip relationship was reestablished. After the lips had recovered tonus with lip support, an average open smile type[2] was achieved, improving esthetics (Fig. 7).

SUMMARY

A patient with edentulism and a slightly covered maxillary incisal curve in the rest position presented with a band of soft tissue during smiling. An average smile[2] was previsualized using DSD for communication with the patient and dental technician, and a removable prosthesis was created. Bone reduction was performed to create the biological width and ovate pontic spaces, and copies of the designed removable prosthesis were made using the margin and the base of the ovate pontics from 2 CAD-CAM acrylic resin interim prostheses as a reference. The definitive gingival esthetics was the result of the adaptation of the soft tissue to the adequate shape of the definitive prosthesis in the space created between the prosthesis and the bone. After 3 years in service, no chipping of the ceramic or fracture of the incisal or occlusal surface in the zirconia were observed in the

MZ-FP. This is in agreement with previous reports using MZ-FPs with partial cut-back or without cut-back of the zirconia in the esthetic zone.[13-17]

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Corresponding author:
Dr Fernando Rojas-Vizcaya
Mediterranean Prosthodontic Institute
Avenida Rey Don Jaime, 5
12001 Castellon
SPAIN
Email: fernando@prosthodontics.es

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