Oral Rehabilitation with Implant Supported Monolithic Zirconia Prosthesis: Clinical steps and Procedures

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Abstract: Osseointegration has a successful track record, however some recent developments have included reduced prosthesis loading times and development of new prosthetic materials. Today's clinician has several new materials to choose from compared to the past. A thorough understanding of the material properties is critical to selecting the appropriate material for the patient using an evidence-based protocol. This case report demonstrates patient rehabilitation with a monolithic zirconia complete arch prosthesis supported by endosseous dental implants. The rationale and clinical decision making as to why this was the optimal treatment will be discussed in detail for this patient.

Keywords: Screw retained prosthesis, tilted implants, immediate loading, Fixed Complete Denture.

INTRODUCTION

For many years, removable complete dentures (CD) were the only treatment option for edentulous patients [1]. Most patients benefited from CD treatment, but some had trouble adapting to this type of prosthesis [2]. In the 1980s dental implants completely revolutionized the treatment of edentulism [3]. Patients that previously could not tolerate complete dentures due to xerostomia and dyskinesia could now benefit from dental implant therapy. This article demonstrates rehabilitation of an edentulous individual that could not adapt to removable complete dentures. It is intended to give readers an overview of diagnosing, treatment planning, and comprehensive treatment with a dental implant supported zirconia reconstruction.

MATERIALS AND METHODS

A 70 year old male patient presented to the implant center with a chief concern of a poor fit and function of his dentures. As a professional singer, he was concerned that his dentures would de-stabilize while performing.

Medical History and Medications

This patient's medical history was significant for Parkinson disease (with neurotransmitters placed a year ago), Type II diabetes mellitus (recent HbA1c of 6.9) and hypercholesterolemia. Our patient had no known drug allergies and his medications included: atorvastatin, carbidopa, exenatide, metformin and insulin.

Dental History

His dental history was significant for dental anxiety and medication induced xerostomia that caused him to gradually lose his teeth. He was unable to tolerate removable complete dentures fabricated by a previous dentist. Due to his frustration with the removable CDs he stopped wearing them.

Social History

The patient is a singer by profession and his appearance and singing ability is a source of livelihood. His inability to wear dentures was affecting his career, self-esteem, nutrition, and his ability to communicate with his mentally challenged son. He does not use recreational drugs, was previously a cigarette smoker but has now stopped and drinks alcohol in moderation. He plans to get married in one year.

Vital Signs

Preoperative vital signs: BP: 132/83 mmHg, heart rate: 82 beats/min, O_2 saturation: 98%, respiratory rate 12 breaths/min and afebrile.

Examination

Extraoral examination revealed a mesocephalic appearance and no masses, scars or lymphadenopathy were appreciated. The patient's face appeared symmetrical from the frontal view and deficient in the lower third in the profile view. This was due to the loss of dentition and therefore reduced occlusal vertical dimension (OVD). No abnormalities were noted in the temporomandibular joint or muscles of mastication (Figures **1**, **2**).

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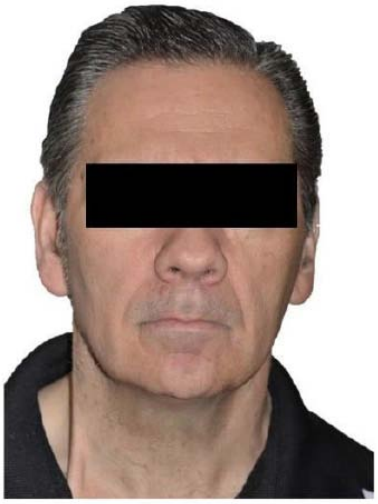


Figure 1: Full face frontal view.

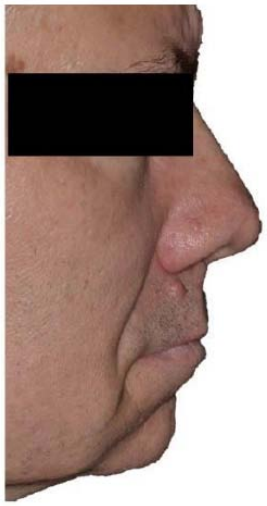


Figure 2: Full face profile view.

Intraoral Examination revealed no abnormalities of the mucosal tissue and the oral cancer screening was unremarkable. The lips were symmetrical with normal shape and color; however, the upper lip was slightly longer than average. The mucosa appeared normal in color, a patent Stensons' duct while no lesions were present. The hard and soft palates were of normal size and shape. The tongue was enlarged with a retracted position. Saliva flow was slightly diminished with a normal consistency. The floor of the mouth had a normal appearance with a patent Wharton's duct, and no masses, scars, or lesions were appreciated. Maxillary and mandibular arches were completely edentulous with a 'u' shaped maxillary arch and an ovoid shaped mandibular arch. On palpation the alveolar ridge demonstrated minor irregularities while noting bilaterally deficient volume of bone in the mandibular posterior regions (Figures **3-5**).

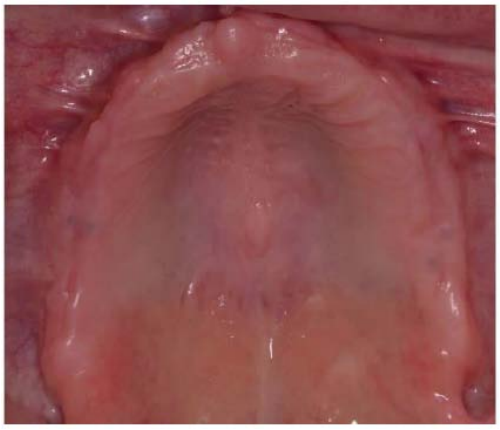


Figure 3: Pre-operative maxillary arch.

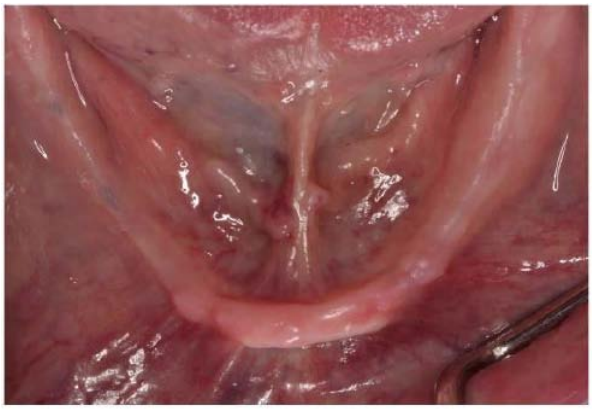


Figure 4: Pre-operative mandibular arch.

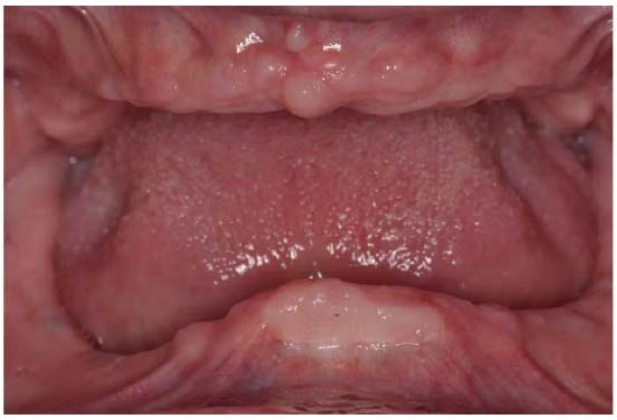


Figure 5: Pre-operative intraoral view at approximate OVD.

Imaging

A cone beam computed tomography (CBCT) revealed no pathology and a sufficient volume of bone for implant placement between the maxillary sinuses and mental foramina. The maxillary and mandibular alveolar bone volume in the posteriorly was inadequate for traditional vertical implant placement without additional bone augmentation procedures (Figure **6**).

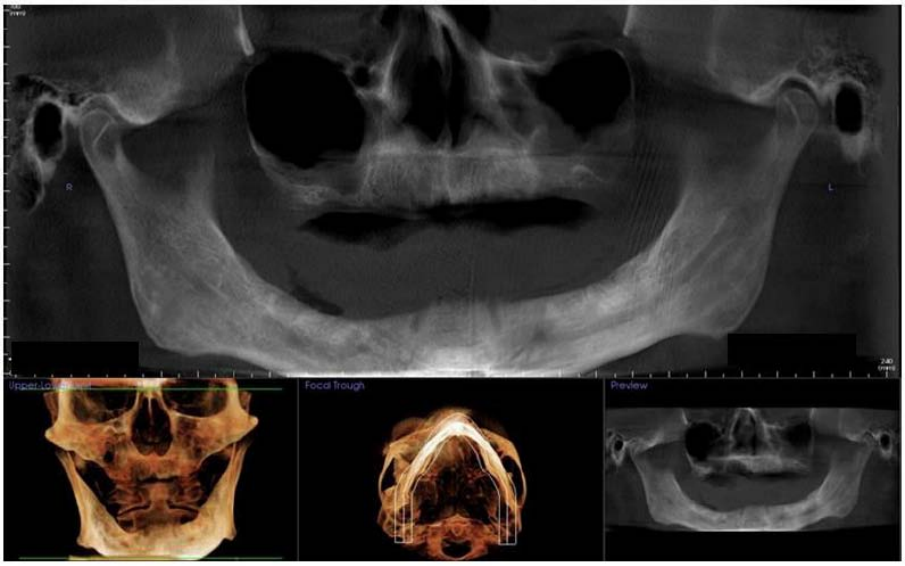


Figure 6: Pre-operative panoramic view.

The following is our patient's problem list and diagnosis:

1. Complete edentulism
2. Inability to tolerate removable prostheses
3. Loss of OVD
4. Residual ridge resorption in the maxillary and mandibular posterior regions
5. Retracted tongue position

Decision Making and Treatment Planning

The medication induced xerostomia, compromised denture foundation, Parkinsonian tremors and retracted tongue position are reasons the patient had difficulty adapting to removable complete dentures. Preliminary irreversible hydrocolloid impressions were made. Maxillomandibular relation records (MMR) were obtained using record bases, wax rims and casts mounted on a semi-adjustable articulator. An artificial tooth arrangement try-in was performed to evaluate esthetics and occlusion. Using this information, the treatment plan was developed. The diagnosis and treatment options were discussed with the patient along with the various types of implant supported restorations. The patient did not want a removable full palatal coverage prosthesis which could potentially de-stabilize or dislodge while singing and therefore a fixed implant supported prosthesis was chosen. Due to the patient's cost restraints and timeliness to complete the treatment, a fixed implant prosthesis supported by 4 implants was selected to eliminate the need for grafting and provide a fixed provisional restoration on the day of surgery. The procedure, alternatives, risks, and benefits of treatment were discussed and all questions were answered. Oral hygiene practices were demonstrated pre-operatively and while the patient had Parkinsonian tremors, he had sufficient dexterity to use a water flosser. Regular follow up and maintenance were emphasized as part of his continued keys to success.

Treatment Plan

Sufficient mandibular bone volume was present to accommodate four implants between the mental foramina. In the anterior mandible the implants were placed axially. Posteriorly the implants were angled to avoid the mental foramen and increase the anterior – posterior (A-P) spread. In the maxilla, the maxillary sinuses were relatively large with moderate pneumatization; therefore, axially oriented implants were placed anteriorly, and tilted implants anterior to the sinuses posteriorly to maximize the A-P spread (Figure **7**).

The patient was educated preoperatively that initially the new prostheses could feel bulky, since he had not been wearing a prosthesis for several months. He was also informed that adapting to the prostheses could be challenging from an oral – function standpoint as there could be biting of the cheek, tongue, and lip as well as challenges with pronunciation of certain letters/sounds. He was reassured that most patients eventually overcome these challenges.

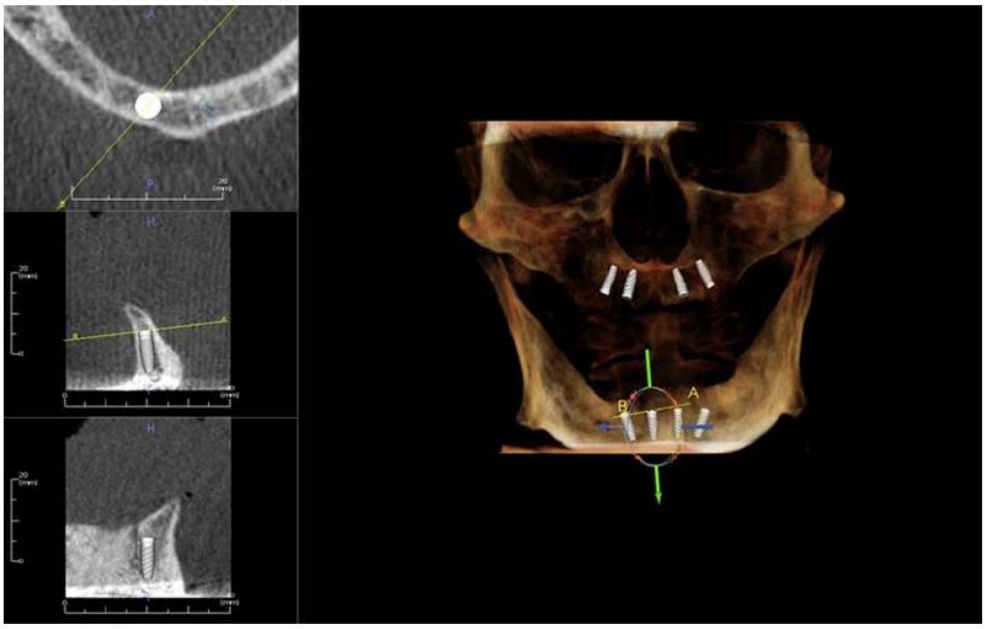


Figure 7: Dental implant planning using an implant planning software.

The maxillary and mandibular artificial tooth arrangement from the diagnostic try-in were processed in heat polymerized acrylic resin to fabricate removable CDs that would eventually be modified into the fixed provisional restorations. The CDs were duplicated in a clear acrylic resin that served as the surgical template to assist with bone reduction, implant placement and abutment orientation.

Surgical Phase

The patient was sedated with 175mcg of fentanyl, and 1.25 mg of midazolam. Local anesthesia in the form of 2 % lidocaine with 1:100,000 epinephrine was used intraorally to achieve profound anesthesia. Crestal incisions and full thickness flaps were raised and an alveolectomy procedure performed reducing bone using the surgical guide, to approximately 15mm from the incisal edges in both arches to the fixture head. This procedure enabled hiding the prosthesis tissue junction when the patient smiled and created a leveled bony bed for implant placement. Four implants were inserted in each arch and primary stability achieved. Straight and angled 17 and 30 degree multiunit abutments (MUA) were placed to correct implant angulation and allowed prosthetic screw access to emerge favorably through the occlusal table (Figure **8**).

White healing caps were placed on the MUAs and continuous sutures helped obtain primary closure around these healing caps and ensure adequate hemostasis.

Prosthodontic Phase

The primary torque of the implants was sufficient to fabricate and load a fixed provisional restoration on the day of surgery. Healing caps were removed, and open tray impression copings were attached to the MUAs to make an abutment level impression with splinted copings using orthodontic wire and fast setting auto-polymerizing acrylic resin. A vinyl poly-siloxane (VPS) putty material was used for the pick-up impression. After removal, rigidity of all the components were verified. White healing caps were replaced. After disinfection of the impressions, analogues were attached to the impression copings and the impressions were poured up in the laboratory using vacuum - mixed die-stone to fabricate master casts.

Fixed Provisional Restorations

An occlusal registration VPS material was expressed in the intaglio surface of the provisional dentures to index the position of the healing abutments within the prostheses at the appropriate OVD. Holes were drilled through the dentures in sites of the anterior abutments. Temporary copings were attached to the anterior abutments and the fit-verified radiographically. A minimum of 1mm of clearance circumferentially was verified between the copings and prostheses. An auto-polymerizing acrylic resin was syringed around the temporary coping to secure the components to the prosthesis. Acrylic resin was mixed and syringed, and the patient was guided into centric relation (CR) at the

Implant site (FDI)	Implant length (mm)	Implant diameter (mm)	Multiunit abutment (degrees)	Insertion torque (Ncm)
15	13	3.5	30	35
12	10	3.5	17	25
22	10	3.5	30	35
25	13	3.5	30	35
35	13	3.5	30	45
32	11.5	3.5	0	45
42	11.5	3.5	0	40
45	13	3.5	17	45

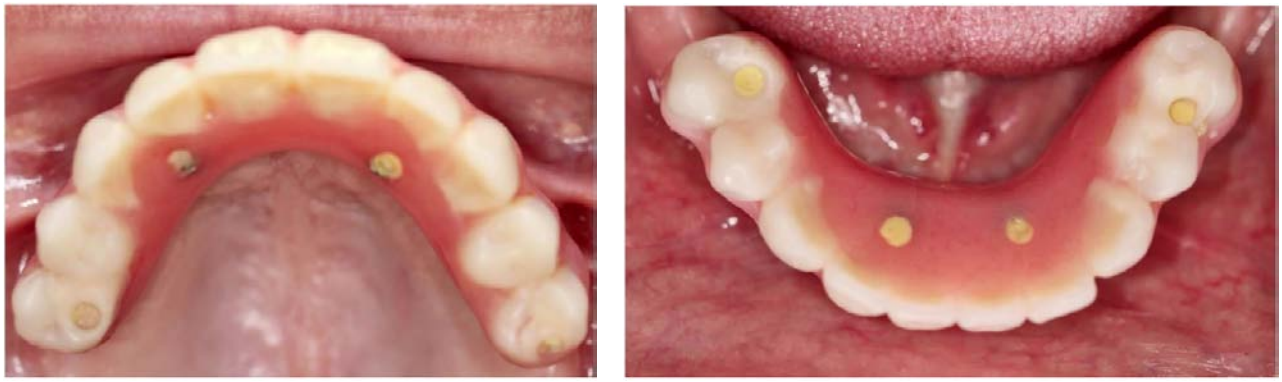
Figure 8: Implant site, dimension, abutment and insertion torque chart.

desired OVD. After setting of the acrylic resin a facebow transfer and CR record was made and the maxillary and mandibular provisional dentures were removed. Rigidity of the components in the prostheses were verified before sending it to the dental laboratory. In the dental laboratory, after appropriate disinfection, the provisional dentures were attached to the master casts using the anterior temporary copings and then mounted on a semi-adjustable articulator using the face bow and CR records. The conversion process from the removable CD to the fixed provisional restorations was completed by the dental laboratory technicians through picking up the posterior abutment copings and eliminating the flanges and palate. The intaglio surface of the prosthesis was then back-filled with auto-polymerizing acrylic resin before finishing and polishing.

The maxillary and mandibular fixed provisional prostheses were delivered on the day of surgery, and prosthetic screws were torqued to 15Ncm. Peri-apical radiographs were taken to verify seating of the fixed provisional prostheses prior to occlusal adjustments (Figure **9A**, **B**). The patient was given written instructions regarding soft diet, post-surgical care, and the use of analgesics postoperatively. Ten days after the procedure the patient was re- examined, and healing was noted as unremarkable. Oral hygiene instructions were reinforced, and general questions answered.

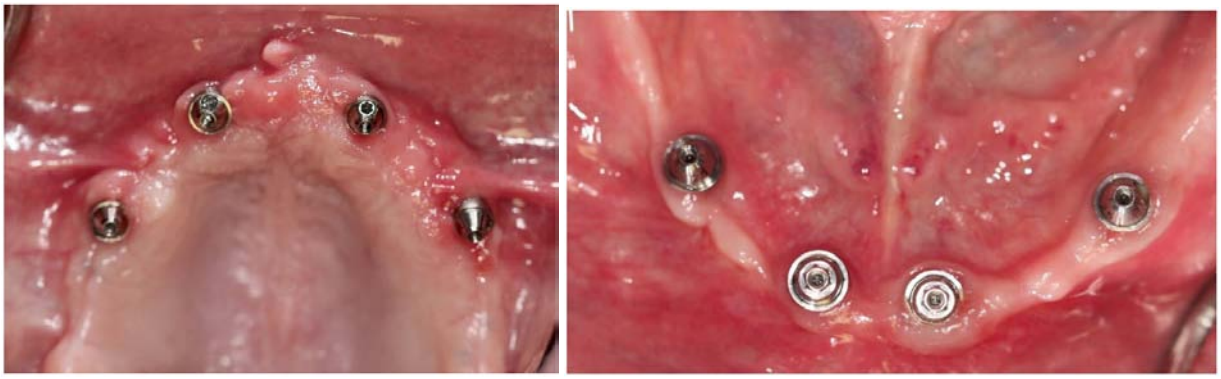
Definitive Prostheses

Four months after uneventful healing, radiographs were taken. There were no radiolucencies or evidence of pathology around the implants. The patient was asked if he wanted any esthetic changes made to the definitive prostheses and notes were made accordingly. New face-bow transfer and CR records were made prior to removing the provisional prostheses. Upon removal, the soft tissues were noted to have healed well (Figure **10A**, **B**). Abutment screw



A **B**

Figure 9: A. Maxillary fixed provisional prosthesis. **B**. Mandibular fixed provisional prosthesis



A **B**

Figure 10: A. Maxillary abutments and soft tissues. **B**. Mandibular abutments and soft tissues.

torque was confirmed to be at the recommended levels. The acrylic resin verification jigs were then sectioned and connected intra-orally with auto-polymerizing acrylic resin, and open tray master impressions were made using heavy body VPS. New master casts were fabricated, and the provisional prostheses were used to articulate the casts on a semi-adjustable articulator.

A new wax tooth arrangement was completed using denture teeth and esthetics and occlusion were verified with the patient. Molar teeth were added to the artificial tooth arrangement accounting for the A-P spread, which was deemed acceptable. The new maxillary and mandibular acrylic resin provisional prostheses were fabricated to serve as the prototypes for the monolithic zirconia screw retained fixed prostheses. The patient used the prototype prostheses for 4 weeks to ensure that he was satisfied with the esthetics and function. Once approved by the patient, the prototype prostheses were removed, and the initial provisional restorations returned to the patient's mouth. The maxillary and mandibular prototype prostheses were sent to the dental laboratory to scan and mill into monolithic zirconia prostheses (Zirkonzahn, Straumann).

The maxillary and mandibular monolithic zirconia prostheses were delivered, and passive fit confirmed with the one screw test and radiographs (Figure **11**). Occlusion was evaluated for centric relation and centric occlusion to be coincident and a mutually protected occlusal scheme in excursive movements (Figures **12-14**). The patient was provided with a hard, maxillary occlusal device to protect the restorations.

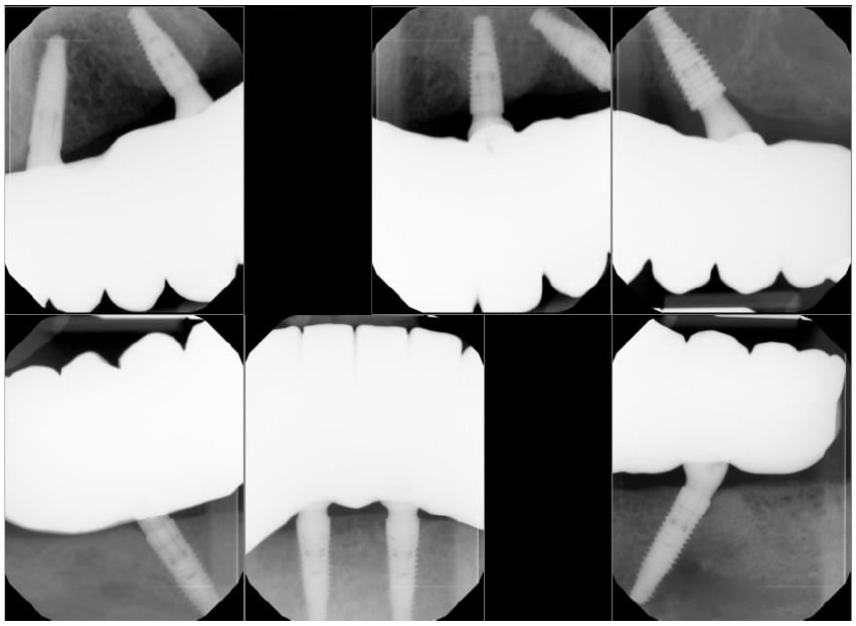


Figure 11: Final seating of zirconia prostheses radiographs.

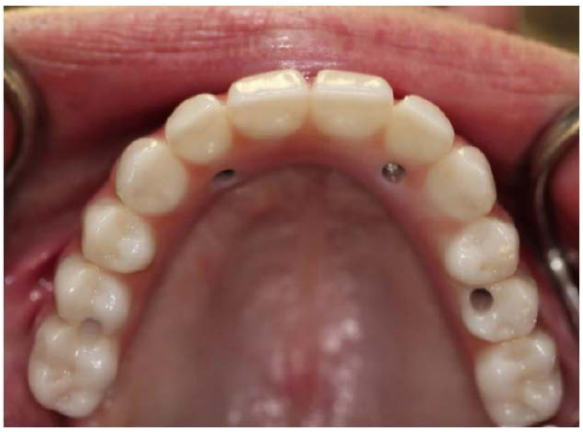


Figure 12: Maxillary zirconia prosthesis.

Figure 13: Mandibular zirconia prosthesis.

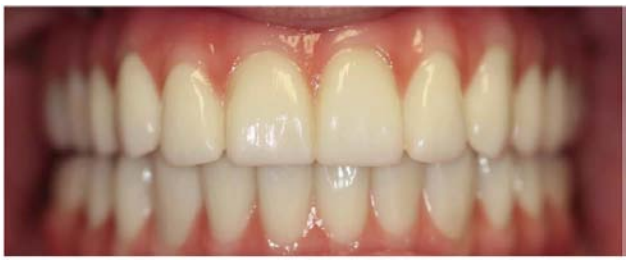


Figure 14: Definitive zirconia prostheses in centric occlusion.

Home care instructions were given, and the use of a water flosser was demonstrated as the use of regular floss was not possible due to compromised manual dexterity. Our patient was instructed to maintain good oral hygiene and return to the dentist for regular periodic exams. He was followed up in one week, one month and then every 6 months thereafter. No complications were noted at the 2-year exam. Overall, the patient was very satisfied with the results (Figure **15**).

RESULTS AND CONCLUSION

There are various configurations and materials that can be used to fabricate an implant supported fixed complete prosthesis. The decision to select the optimal restoration is multifactorial. Using an evidence-based model it is important for the clinician to evaluate the literature, patient factors, their own skill set as well as their clinical judgement.

Figure 15: Smile with definitive prostheses.

From the patient's perspective, the cost and timeline to complete treatment can influence the treatment chosen. Considering that our patient had limited finances and was getting married in a year we chose a treatment option that minimized the number of implants, avoided him having to wear a removable prosthesis, avoided adjunctive procedures like grafting and could be completed in a year. Due to Parkinson disease and limited dexterity we also wanted to retrieve the restoration to evaluate hygiene at future maintenance exams. Since this patient had been edentulous for years, the maxillary and mandibular resorption pattern required replacement of teeth as well as gingival tissues. Regarding materials, due to his medical condition and involuntary movements we chose a material that was tough and did not have any veneering material that had the potential to fracture.

With respect to the research and literature available, the All-on-4 concept is well documented in the literature to be a successful treatment solution [4,5]. A screw retained prosthesis that is retrievable is shown to have less technical and biological complications compared to a cement retained restoration [6]. Since this patient was diabetic, we wanted to minimize the risk of infections and be able to retrieve it if complications did

arise. Four implants are adequate to support a prosthesis and easier to maintain than multiple implants [7]. As for material choices for a complete arch prosthesis, the options available are a combination of acrylic resin, metals, high performance polymers and ceramics. Zirconia has shown to have promising results in the short to medium term with respect to having minimal breakage [8] and also has shown to have a favorable soft tissue response [9]. Acrylic-titanium hybrid restoration are prone to fracture [8,10] and metal ceramic restorations are costly and difficult to repair [8].

The implant center where the treatment was completed was staffed with two prosthodontists, an oral and maxillofacial surgeon and an onsite dental laboratory with 3 technicians including auxiliary staff. Collectively, the team had over 10 years of experience managing these types of treatments.

Some of the shortcoming of this type of treatment include using only 4 implants per arch. If there is a failure of one or more implants the patient cannot use the existing fixed prosthesis. Managing this complication would require finding an alternate implant site or bone grafting and placing a new implant. During the interim phase the patient may have to use a removable prosthesis which may be challenging. During the initial post-surgical healing phase, the acrylic resin provisional restorations are prone to fracture and therefore cantilevers are eliminated. The patient needs to be informed that routine maintenance is necessary and oral hygiene is required.

Zirconia has shown very promising results when it is used as a monolithic material for complete arch reconstructions. This case report illustrates the planning and treatment of a completely edentulous patient with implant supported, screw retained complete arch monolithic zirconia prostheses.

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