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Prosthetic Rehabilitation Following Lateral Resection of the Mandible with a Long Cantilever Implant-supported Fixed Prosthesis: A 3-year Clinical Report

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Abstract

This clinical report describes the prosthetic management of the surgical reconstruction of a patient after mandibular resection. Complete oral rehabilitation was achieved with a maxillary complete denture and a mandibular implant-supported fixed prosthesis with a custom titanium framework and a long unilateral cantilever.

Head-and-neck cancer is estimated to represent 2.9% of all new cancer diagnoses,¹ and squamous cell carcinoma (SCC) represents 96% of all oral malignancies.² Surgical resection is considered the most common treatment for head-and-neck SCC, whereas postoperative external beam radiation therapy may be used to improve the therapeutic outcome.^{3, 4, 5, 6, 7, 8, 9, 10} The microvascularized fibula flap is commonly used to restore mandibular continuity because of its adequate length and shape.^{11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23} Various resection prostheses have been used for the functional rehabilitation of patients with postsurgical mandibular defects, such as conventional removable,^{13, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33} implant-retained and implant-supported removable,^{11, 13, 20, 21, 25, 26, 30, 32, 34, 35, 36} and implant-supported fixed prostheses.^{11, 13, 15, 20, 21, 32, 37, 38, 39, 40, 41, 42, 43}

Osseointegrated dental implants may significantly benefit patients with surgical defects after treatment for head-and-neck cancer.^{3, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20, 25, 26, 30, 32, 36} However, reports of complete-arch fixed implant rehabilitation in patients who have undergone mandibulectomy for cancer have been sporadic.³⁵ This clinical report describes the prosthetic rehabilitation of a patient with a history of SCC who was treated with lateral resection of the mandible and immediate reconstruction using a vascularized free fibula flap. Prosthetic rehabilitation was achieved by means of an implant-supported mandibular fixed prosthesis opposed by a maxillary complete denture.

Clinical Report

A 69-year-old man was referred to the Graduate Prosthodontics Clinic at Texas A&M Health Science Center, Baylor College of Dentistry, for prosthetic rehabilitation. The patient had been treated for head-and-neck cancer 6 years before his referral. The malignancy was diagnosed as invasive moderately differentiated SCC, staged as T3N1M0.⁴⁴ Treatment included the right lateral resection of the mandible distal to the canine along with unilateral neck dissection and free fibula flap reconstruction. Surgical intervention was followed by photon beam radiation therapy (60 Gy to the mandible, 50 Gy to the lower neck). Multiple teeth were extracted before the cancer treatment. More extractions followed in the year before his referral, for which the patient received hyperbaric oxygen treatment.

Extraoral examination revealed facial asymmetry. Intraoral examination showed no mucosal lesions. Salivary gland function was reduced, and the patient had postradiation xerostomia. The mucosa lining the graft was thin and had postsurgical sensory impairment. Additionally, there was lack of labial and lingual vestibule at the reconstruction site, and tongue mobility was compromised. The remaining maxillary canines were abutments for an anterior fixed dental prosthesis. Radiographic evaluation showed the mandibular reconstruction of the right side and the presence of an impacted tooth on the maxillary left side (Fig. 1). Temporomandibular joint examination showed a reduced range of mandibular motion but no pain or discomfort. Preliminary impressions were made with irreversible hydrocolloid (Accu-Dent System 1; Ivoclar Vivadent AG). Diagnostic casts were mounted (SAM 3; SAM Präzisionstechnik GmbH) with base plates and wax rims, a facebow (Axioquick Anatomic Transferbow; SAM Präzisionstechnik GmbH), and a centric relation record. A diagnostic tooth arrangement was completed.

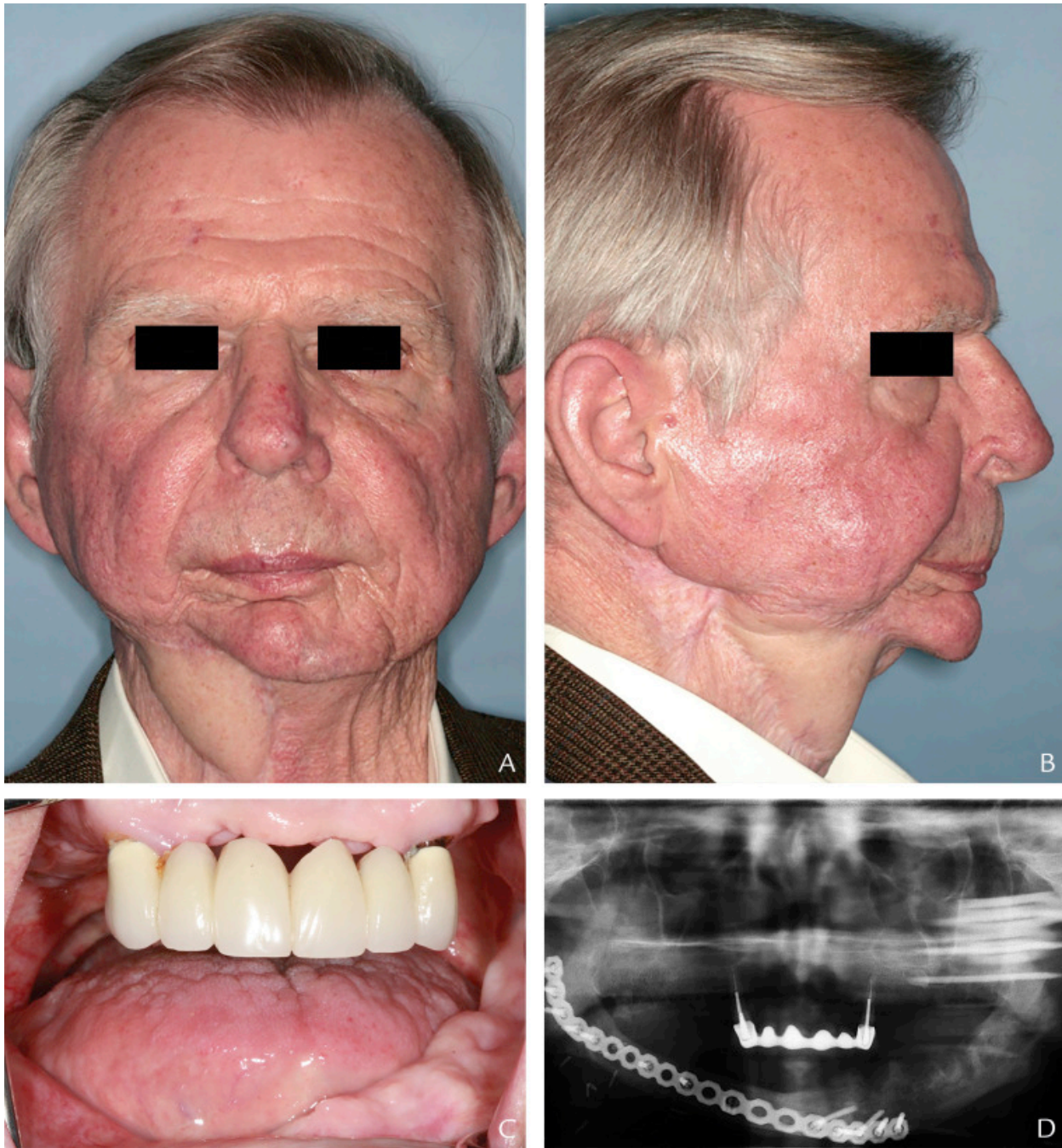


Figure 1. Pretreatment. A, Full face frontal view; note facial asymmetry as result of mandibular reconstruction after lateral mandibular resection. B, Full face, right lateral view. C, Intraoral frontal view. C, Panoramic radiograph.

The list of problems associated with the patient's periodontal, restorative, esthetic, and functional status was extensive. His oral hygiene was inadequate, and soft tissue inflammation and deep probing depths were found around his remaining teeth. The remaining teeth had a poor prognosis because of caries. The mandibular surgical reconstruction was not restoratively driven, and the existing mandibular anatomy could not provide adequate retention, stability, and support for a conventional removable prosthesis. Restorative space on the left mandibular side was inadequate for an implant-supported prosthesis. Also, his mandibular function and tongue mobility were compromised. The patient's condition was diagnosed as partial edentulism, carious infection, periodontal disease, and xerostomia. He was categorized as class IV based on the Prosthodontic Diagnostic Index for partial

edentulism.⁴⁵ Treatment objectives were to manage xerostomia, to restore the loss of teeth and soft tissues, to fabricate esthetically pleasing and functionally stable prostheses, to monitor the patient for oral cancer recurrences, and to provide the patient with an appropriate maintenance program. The existing mandibular defect, radiotherapy, and associated morbidity were factors that could negatively affect the treatment outcome.

Cone beam computed tomography was used to evaluate newly reconstructed and native bone. After consultation with the Department of Oral and Maxillofacial Surgery and a discussion of potential risks, the patient rejected any removable mandibular prosthesis and chose an implant-supported fixed mandibular prosthesis. Implant placement in the reconstructed defect side was not recommended because of radiation therapy at 60 Gy and the facial position of the flap in relation to the proposed tooth position. Maxillary teeth were extracted, and the left posterior mandibular ridge was reduced to provide adequate restorative space.⁴⁶ Bone reduction was accomplished with a reduction guide based on the diagnostic tooth arrangement. Four implants were placed in the mandibular left first molar, second premolar, and canine locations and in the mandibular right lateral incisor location (SLActive Standard Plus RN 4.1×10 mm and 4.1×12 mm; Straumann USA LLC) (Fig. 2). Surgical removal of the maxillary impacted tooth was contraindicated because of its location.

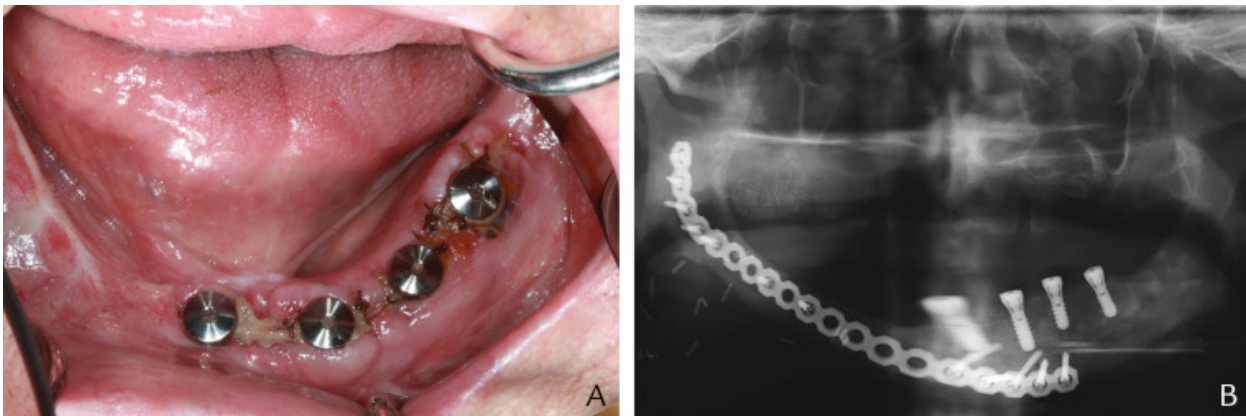


Figure 2. Implant placement. A, Intraoral view. B, Panoramic radiograph.

A maxillary interim complete denture was inserted, which was tolerated well with an oral lubricant (Oral Balance Gel; Biotène). After 6 months (Fig. 3), new diagnostic impressions were made to fabricate custom trays. The maxillary definitive impression was made with modeling plastic impression compound (Impression compound; Kerr Corp) and polysulfide impression material (Permlastic; Kerr Corp). A mandibular implant level open tray definitive impression was made with polyvinyl siloxane material (Aquasil Ultra; Dentsply Sirona). The impression copings were splinted with light-polymerizing acrylic resin (Triad Gel; Dentsply Sirona).⁴⁷ The maxillary definitive cast was poured in Type III (Microstone; Whip Mix Corp) dental stone and the mandibular cast in Type IV (ResinRock; Whip Mix Corp) dental stone. The implant abutments were connected to implant analogs (RN synOcta 1.5; Straumann USA LLC), and an implant verification device was made with temporary cylinders and autopolymerizing acrylic resin (Pattern Resin; GC America). The accuracy of the device was evaluated intraorally using the 1-screw test (Fig. 4).⁴⁸

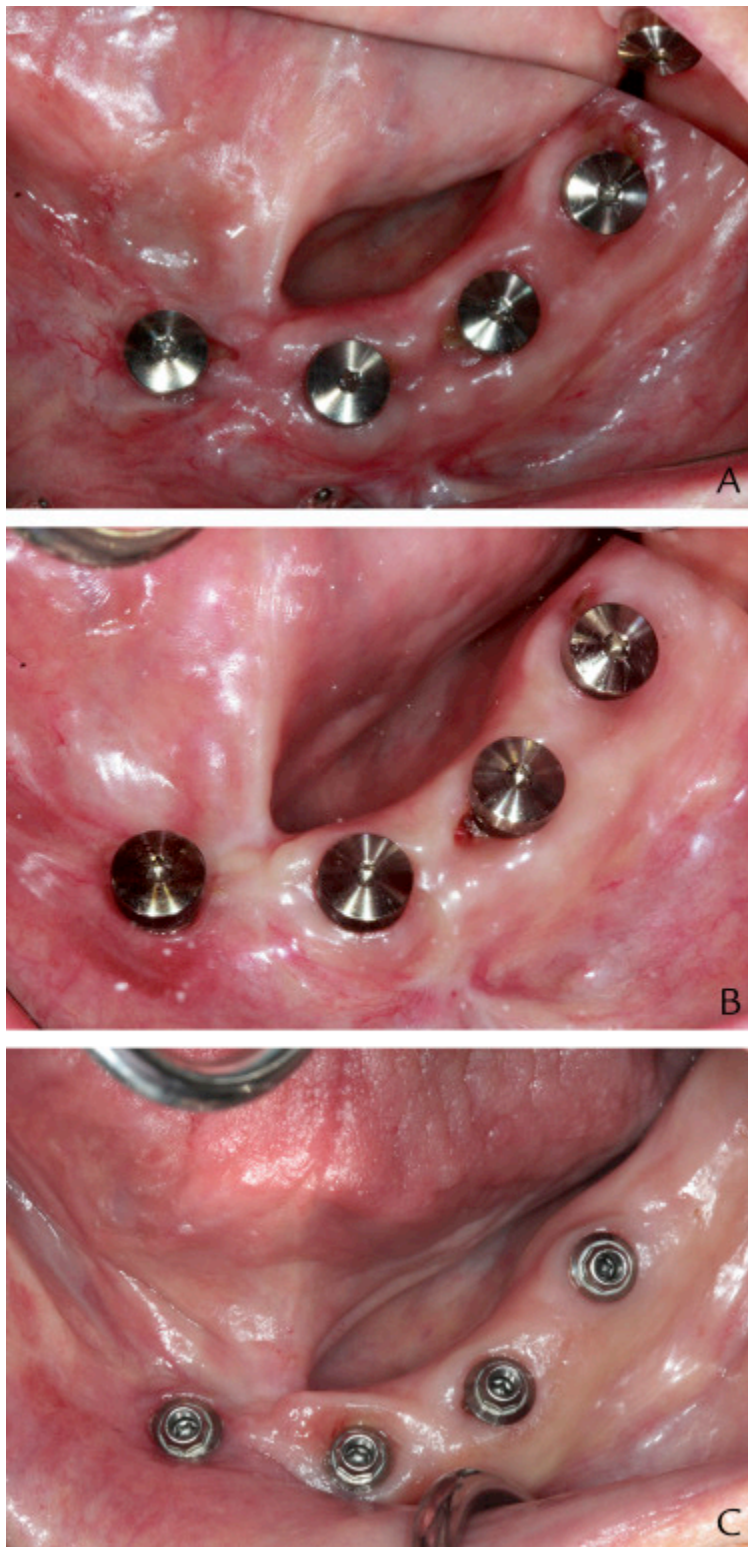


Figure 3. Peri-implant soft tissue healing. A, One-month follow-up. B, Three-month follow-up. Note slow progress of healing around implants in left molar and premolar positions. C, Six-month follow-up. Definitive abutments were placed on implants.

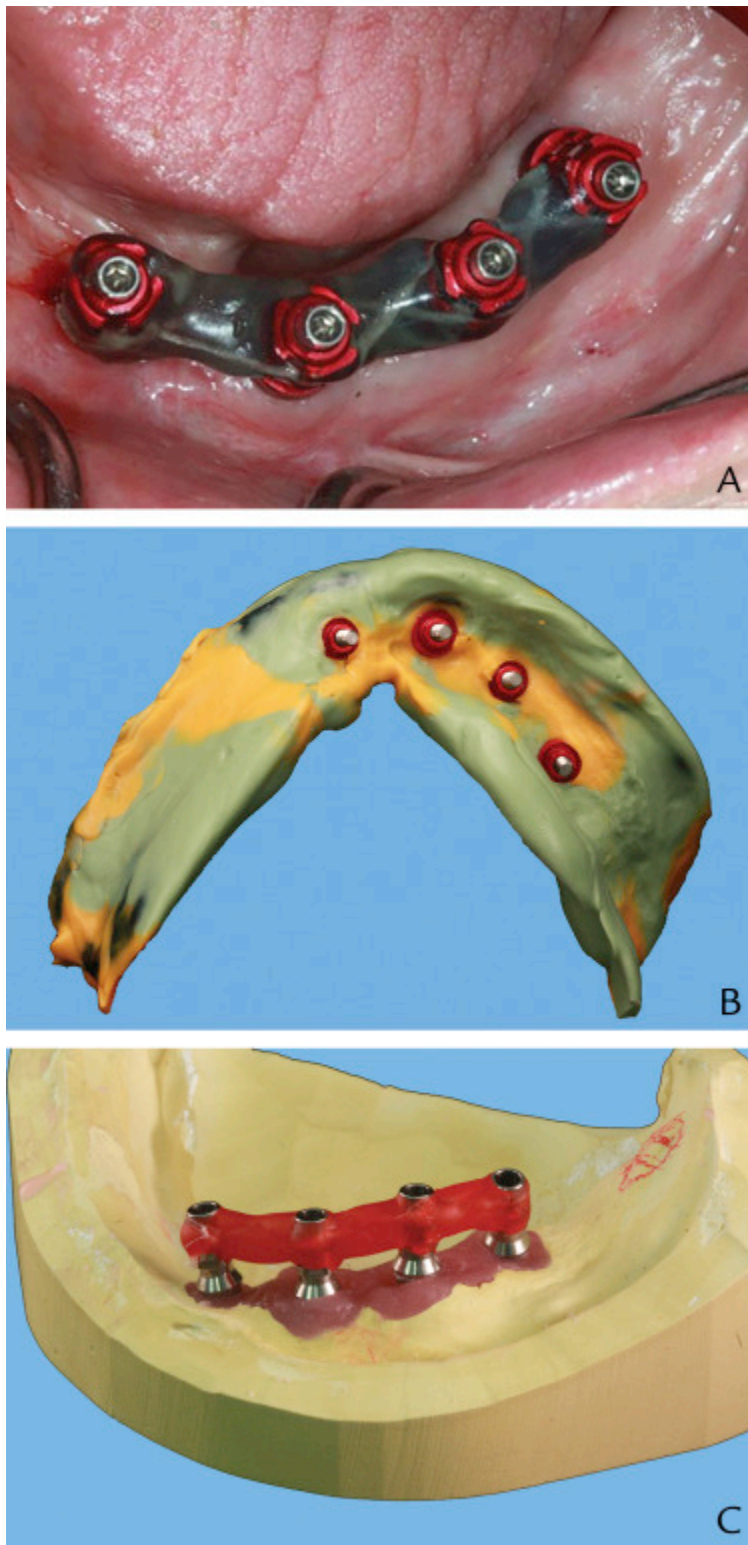


Figure 4. Mandibular definitive impression. A, Implant open tray impression copings connected with light-polymerizing acrylic resin. B, Pick-up impression. C, Definitive cast and implant verification device made with autopolymerizing acrylic resin.

Incisal edge position, occlusal plane, occlusal vertical dimension, and maxillomandibular relationship records were determined with record bases/wax rims made on the definitive casts. The artificial tooth

arrangement was completed with semianatomic posterior teeth and was verified intraorally. A stone matrix preserved the tooth position, and a framework pattern was made with plastic copings and light-polymerizing acrylic resin (Triad Gel; Dentsply Sirona). Adequate space for base acrylic resin was determined by the proposed tooth positions.⁴⁶ A titanium alloy framework was made using the copy-milling technique (CAM StructSURE; BIOMET 3i LLC). The framework accuracy was evaluated with radiographic and clinical methods.⁴⁸

The definitive tooth arrangement was completed on the framework, providing bilateral balanced articulation (Fig. 5). The previously established esthetics, occlusal vertical dimension, and maxillomandibular relationship records were clinically verified. Both prostheses were processed in heat-polymerizing acrylic resin (SR Ivocap High Impact; Ivoclar Vivadent AG) (Fig. 6). The prostheses were inserted, and prosthetic screws were tightened according to the manufacturer's recommendations. Minor occlusal adjustments were made after a clinical remount. Screw access channels were covered with polytetrafluoroethylene (Teflon) tape and flowable composite resin (PermaFlo; Ultradent Products, Inc) (Fig. 7).

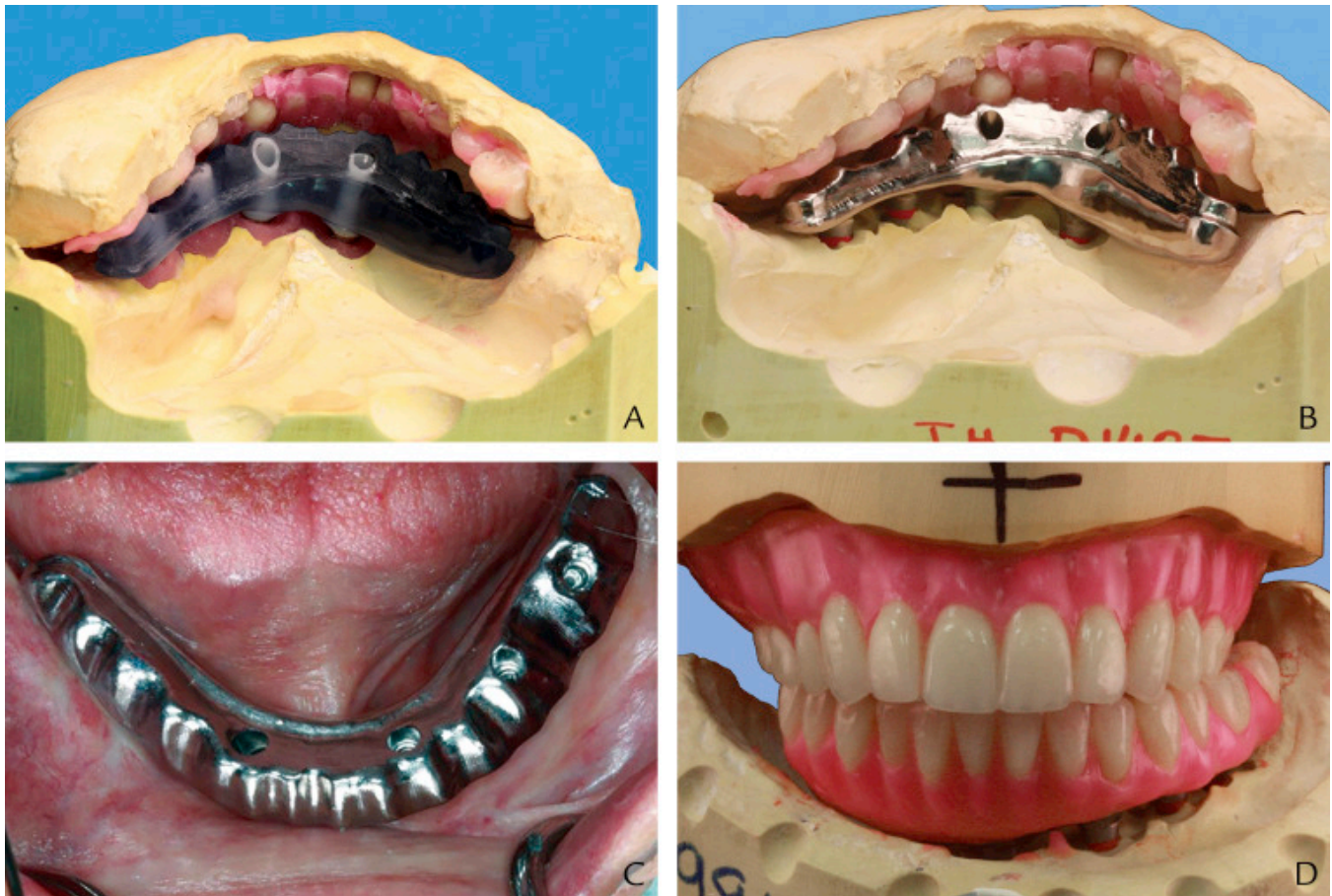


Figure 5. Mandibular framework fabrication A, Framework pattern made with light-polymerizing acrylic resin following restoratively driven approach. B, Milled titanium framework 1-piece replica of resin pattern. C, Framework evaluation. Note unilateral cantilever length. D, Definitive artificial tooth arrangement. For mandibular right side, 3 premolars were set.

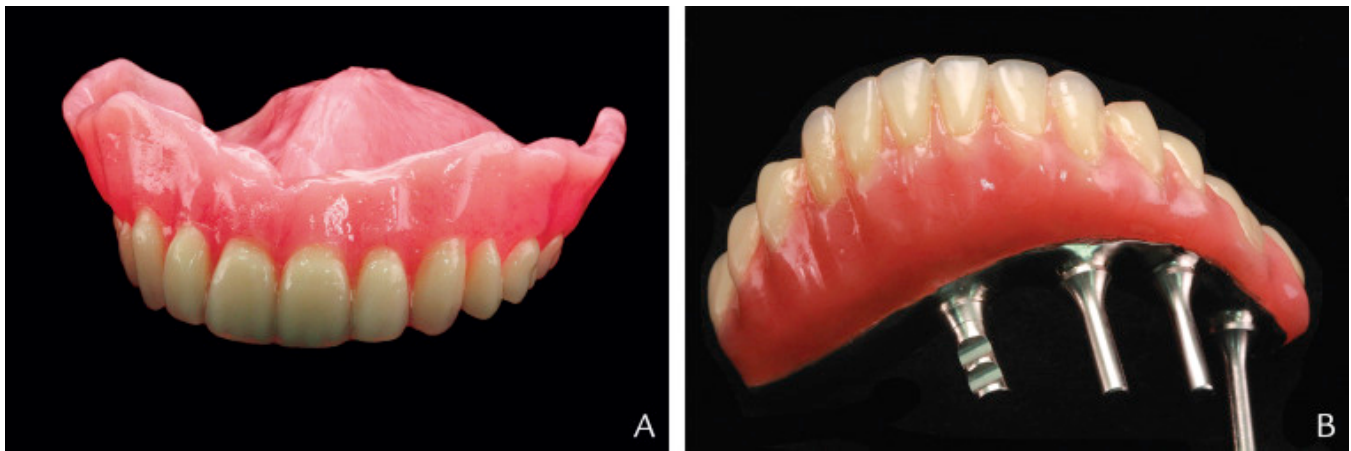


Figure 6. Processed definitive prostheses. A, Maxillary complete denture. B, Mandibular implant-supported fixed prosthesis.



Figure 7. Definitive prostheses. A, Maximum intercuspation position, frontal view. B, Mandibular occlusal view. C, Maximum intercuspation, right lateral view. D, Maximum intercuspation, left lateral view. Note reverse articulation because of arch width discrepancy. Second mandibular molar functioned as balancing ramp.

The patient was seen 24 hours and 1 week after insertion. The prosthetic treatment did not negatively affect the patient's neuromuscular control, and the patient was satisfied with the function and the appearance of his prostheses (Fig. 8). He began a 4-month recall schedule, and at the 3-year follow-up, the prostheses and implants were stable (Fig. 9).

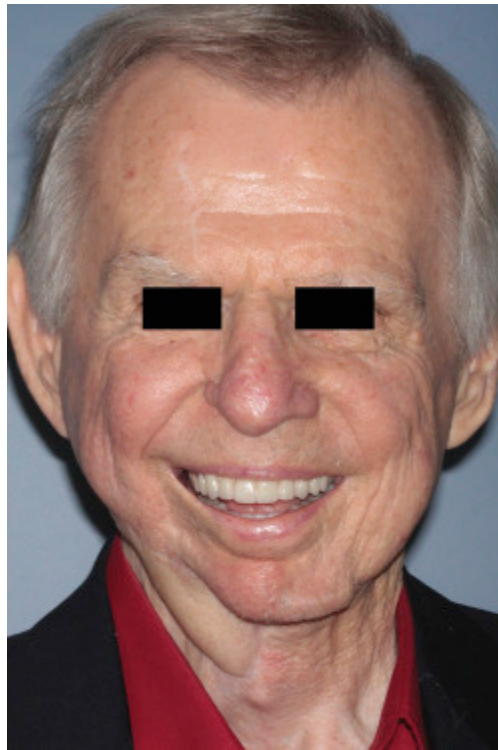


Figure 8. Posttreatment, full smile, frontal view.



Figure 9. Panoramic radiograph at 3-year follow-up.

Discussion

Prosthetic rehabilitation with dental implants results in significant social¹¹ and functional improvement,^{25, 26, 36} enhancing the quality of life of patients with mandibular reconstruction.^{12, 32} Unfortunately, only a small number of patients receive implant-supported prostheses, and implant placement should be delayed for at least 12 months after ablative surgery because of the high rate of recurrence or metastasis.²⁵

The fibula flap is a reliable option for patients with mandibular resection, as it shows low resorption during the early healing stage¹⁸ and low failure rates for the reconstructed bone, implants, and prosthesis.^{16, 19, 20, 22} However, reconstructed bone combined with radiotherapy has been a negative factor for implant survival.^{7, 9, 22} The 5-year implant survival in irradiated fibula flaps was 38%, as

opposed to 82% for irradiated mandibular bone and 86% for nonirradiated bone.¹⁷ No radiation threshold is considered safe for implant placement. Although no implant failures were observed in radiation doses lower than 45 Gy, doses above 55 Gy significantly reduce implant survival.^{3, 8} Implant placement within 1 year after radiotherapy may result in a 34% higher risk of failure.¹⁰

Whether hyperbaric oxygen has a positive effect on implant survival is unclear.^{7, 8, 10, 49, 50} In this patient, the time interval between radiotherapy and implant placement was 6 years. However, the healing of peri-implant tissues progressed slowly and was not complete until 6 months after implant placement (Fig. 3).⁴ Additionally, bone resorption may be higher around implants placed in fibula flaps compared with native bone.¹³ Another potential problem with fibula flaps is the reduced graft height, which may result in height discrepancy with the adjacent native bone, esthetic problems, difficulty in implant placement, or difficulty using conventional removable prostheses.¹⁴ In this patient, the mandibular surgical reconstruction did not follow an interdisciplinary approach, which could optimize treatment results.¹² The nonprosthodontically driven mandibular surgical reconstruction resulted in a flap position that could not allow implant placement in the flap based on the proposed tooth position and without encroaching on the patient's cheek (Figs. 5, 7).³⁴

An implant-supported fixed prosthesis was selected for this patient. However, implant distribution did not allow for a favorable anteroposterior implant spread. This resulted in an increased distal and lateral cantilever that could lead to biomechanical complications.⁵¹ The occlusal scheme chosen was bilateral balance with semi-anatomic artificial teeth. This choice resulted in a tooth arrangement that met the esthetic and functional goals of the treatment. These patients should be restored with nonanatomic teeth following the neutrocentric occlusal concept,⁵² which can, however, result in the absence of balanced articulation and lack of anterior vertical overlap. Evidence regarding the benefits of balanced articulation is limited, but it is the recommended occlusal concept for patients with complete dental removable prostheses.⁵³ Lingualized occlusion could be another option but was impossible because of the present arch width discrepancy, which indicated a reversed articulation on the left side.

Despite the unfavorable implant distribution, no complications were noted at the 3-year follow-up. In addition, oral hygiene can be more difficult with fixed implant prostheses. No consensus has been reached as to which type of implant prosthesis is more successful in these patients, as the majority of evidence relies on clinical reports.^{35, 37, 38, 39, 40, 41, 42, 43} Nevertheless, therapeutic outcomes can be maximized with the recent advances in guided reconstruction and 3-dimensional planning because of favorable fibula flap and implant placement.^{21, 35, 37, 40}

Summary

This clinical report describes the complete mouth rehabilitation of a patient with a reconstructed mandible after segmental mandibulectomy. A mandibular implant-supported fixed prosthesis with a custom-made titanium milled framework combined with a maxillary complete denture resulted in satisfactory esthetics and function.

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