prosthesis

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Case Report

Refabrication of a Mandibular Prosthesis Using an Intraoral Scanner and CAD/CAM in a Patient Who Had Undergone Mandibulectomy: A Case Report

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Abstract

This report describes a 72-year-old patient for whom a maxillofacial prosthesis was created to treat trismus and jaw deviation after mandibulectomy for osteoradionecrosis following radiotherapy for cancer. The patient's chief complaints were an ill-fitting denture, discomfort, and difficulty with mastication. Clinical examination revealed a right-sided lateral mandibular defect, trismus, and right-sided deviation of mandibular occlusion. The diagnosis was discomfort associated with ill-fitting dentures. A resin-based denture was created using the piezography technique. Although the patient was satisfied wearing the new resin-based prosthesis, it was thin because of the limited denture space and developed a fracture. Thereafter, a metal-based denture was fabricated. Digital impressions were obtained with an intraoral scanner. A prosthesis with a metal framework as an internal support was recreated using CAD/CAM technology. This case report demonstrates the feasibility of a digital workflow for prosthesis refabrication in a patient with complex mandibular defects.

Keywords: radiotherapy; trismus; duplicate; intraoral scanner; CAD/CAM

1. Introduction

Radiotherapy is the cornerstone of organ-sparing and adjuvant therapy for nearly all head and neck cancers. Unfortunately, aggressive radiotherapy may have severe late toxicities, including trismus and osteoradionecrosis of the jaw (ORNJ). Increased fibrosis caused by radiotherapy and scar-related soft tissue contractures contributed to trismus [1,2]. ORNJ is an inflammatory process of bone marrow with a tendency to progress and often involves the cortical plates and periosteal tissues [3]. Bone tissue is highly susceptible to the effects of ionizing radiation, especially at higher dosages, because of its propensity to absorb 40% more radiation than the surrounding tissues [4]. The prevalence of ORN varies widely in the literature ranging from 0.4 to 56% [5]. Several studies have suggested that the higher the radiation dose, the greater the risk of ORNJ [6], and the mean dose to the affected mandibular bone in this case was 57.6 Gy [7]. Although antibiotics can augment the treatment of ORNJ, surgery remains the main therapeutic intervention [8,9], particularly segmental resection and free flap reconstruction appear to have more favorable

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Academic Editor: João Paulo Mendes Tribst

Received: 7 March 2026
Revised: 6 July 2026
Accepted: 7 July 2026
Published: 10 July 2026

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outcomes, although it is associated with relatively high complication rates and surgical burden [10,11].

Mandibulectomy often leads to cosmetic deformity, malocclusion, mandibular deviation, and joint pain. Mandibular deviation is influenced by multiple factors, including the size and site of resection, amount of soft tissue involved, how tightly the wound is closed, and the presence of remaining teeth [12]. These factors may promote mandibular deviation and trismus. After insertion of a maxillary palatal ramp and a mandibular prosthesis, the mandible can achieve a functional position [13], and the effectiveness of maxillofacial prostheses for recovery of masticatory function in the treatment of mandibular deviation has been confirmed [14]. However, trismus and deviation caused by radiotherapy, ORNJ, and mandibulectomy give rise to problems such as insufficient restoration space, and difficulty determining the occlusal relationship limits the denture design.

Three-dimensional (3D) digital technology enables recording of 3D shapes as digital data, which are then processed and rendered to construct 3D shapes with computer assistance [15]. This technology is now widely used in several fields of medicine and dentistry, including for measurement of 3D shapes and target design as well as fabrication of prostheses [16,17]. In recent years, conventional impression-taking has shifted toward digital impression-taking in maxillofacial rehabilitation [18,19]. An intraoral scanner (IOS) can make capture of scan data easier in patients with trismus [20]. Using this technology, the framework can be designed on a 3D model obtained from 3D scans of the working cast [21]. Variations in the evaluation and design of the 3D shape of maxillofacial prostheses from dentist to dentist can be objectively controlled by using 3D data [22]. Despite these advances, there is limited evidence on the application of intraoral scanning and CAD/CAM technologies for refabrication of mandibular prostheses in patients with severe trismus and complex post-mandibulectomy defects. In particular, the integration of existing prosthesis data into a digital workflow for accurate reconstruction of the intaglio surface remains insufficiently described.

This report describes successful refabrication of a mandibular prosthesis using IOS and CAD/CAM technology in a patient with trismus and lower jaw deviation after mandibulectomy.

2. Clinical Report

The patient was a 72-year-old man with a removable prosthesis who presented to the Department of Maxillofacial Prosthetics, Tokyo Medical and Dental University Hospital in September 2021 with chief complaints of discomfort and difficulty chewing with his existing denture.

Intraoral examination revealed a right-sided lateral mandibular defect (Figure 1A), limited mouth opening (maximal, 15 mm), right-sided deviation of mandibular occlusion, and insufficient restoration space. A panoramic X-ray (Figure 1B) showed a segmental mandibular defect with fibular flaps grafted with a reconstruction titanium plate. His past medical history included an oropharyngeal tumor (T4N1M0) that was treated by volumetric-modulated arc therapy (66 Gy/33 Fr) at Ariake Hospital in July 2017. In February 2018, the patient presented with ORNJ in the right mandible, the symptoms of which were not responsive to medication. In May 2020, the patient underwent segmental mandibular resection and simultaneous reconstruction with a free vascularized fibula flap at Tokyo Medical and Dental University Hospital. Despite surgical reconstruction, the patient continued to experience mandibular deviation, trismus, and functional impairment, necessitating prosthetic rehabilitation. The prosthesis was fabricated at Saitama Medical University International Medical Center but did not work well, at which point the patient was referred to our institution (Figure 1C). The remaining dentition was carefully evaluated before treatment planning. Considering the patient's history of high-dose radiotherapy,

mandibular resection with fibular reconstruction, severe trismus, mandibular deviation, and limited restorative space, extensive restoration of the remaining dentition was not considered a predictable treatment option. Therefore, prosthetic rehabilitation focused on fabrication of a removable prosthesis. First, a new denture was created using the piezography technique [23] to confirm his denture space and deliver the optimal type of denture. This denture fractured 6 months later. A denture with a metal framework as an internal support in the base was designed to solve this problem.

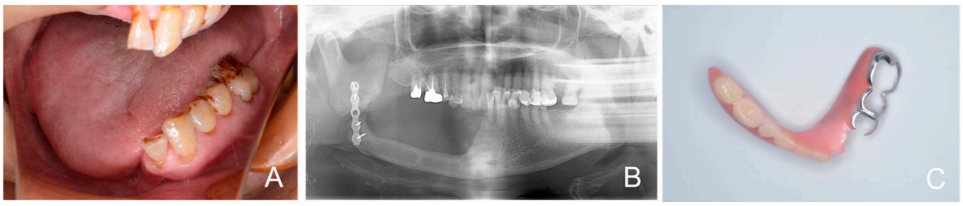


Figure 1. Intraoral view, panoramic radiographs, and existing denture. (**A**) Intraoral view showing a surgically reconstructed right-sided lateral mandibular defect. (**B**) Panoramic radiographs showing a segmental mandibular defect with a fibular flap grafted with a titanium reconstruction plate. (**C**) Photograph showing the existing denture, which was a prosthesis with an acrylic base.

The patient's trismus subsequently became more severe, making it difficult to insert an impression tray for traditional impression-taking. Therefore, digital impressions were obtained using an intraoral scanner (Trios 3 Wired; 3Shape A/S, Copenhagen, Denmark). The mandibular arch, both without (Figure 2A) and with (Figure 2B) the existing denture in place, the opposing maxillary arch (Figure 2C), and the maxillomandibular relationship (Figure 2D) were sequentially recorded. The maxillomandibular relationship was recorded using the existing denture as a functional reference. The patient was guided to close into a reproducible intercuspal position based on the habitual occlusion of the existing prosthesis. In addition, the presence of remaining posterior teeth on one side provided supplementary occlusal support. This position was captured using the intraoral scanner, ensuring a stable and clinically reproducible jaw relationship. The existing denture (Figure 2E) was scanned using a laboratory scanner (D2000; 3Shape) outside the patient's mouth. All the files were imported in STL (standard tessellation language) file format into the CAD software (3Shape Dental System 2021) for the design process.

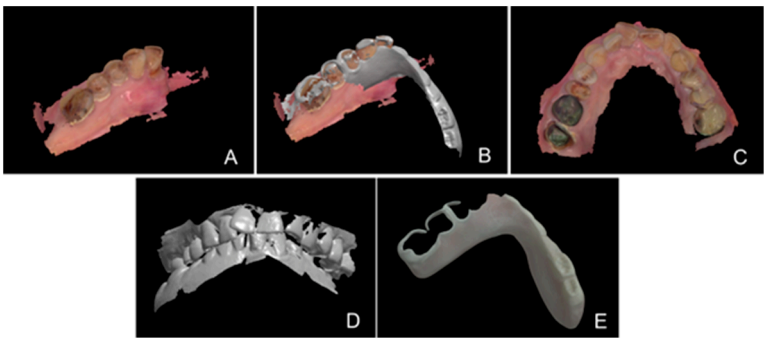


Figure 2. Scan data used. (**A**) Scan obtained without the existing denture. (**B**) Scan obtained with the existing denture in place. (**C**) Scan data for the opposing dental arch. (**D**) Scan data for the maxillomandibular relationship. (**E**) Scan data for the existing denture obtained from outside the patient's mouth.

The scan data of the mandible with and without the existing denture, along with the data of the existing denture, were aligned using interactive surface-based registration in the CAD software, employing a three-point surface registration method (Figure 3A) [24].

Inversion of the mucosal surface of the existing denture can provide the digital mucosal impression data for the patient's right mandibular arch area (Figure 3B). The limitations of the IOS meant that the mucosal surface could not be scanned clearly and the changes in the structure of the lip and tongue could not be detected. Therefore, a digitally altered technique using the 3D data for the resin-based prosthesis was used to solve the problem. The shape and orientation of the framework were designed using CAD software (3Shape Dental System) to achieve intraoral conditions (Figure 3C). The framework thickness was determined based on mechanical strength requirements and the limited restorative space, ensuring sufficient rigidity while maintaining patient comfort. The extension of the framework was defined according to the anatomical boundaries and the external contours of the existing denture, with its posterior extent terminating at the external end line of the existing denture and fully enclosed within the denture base.

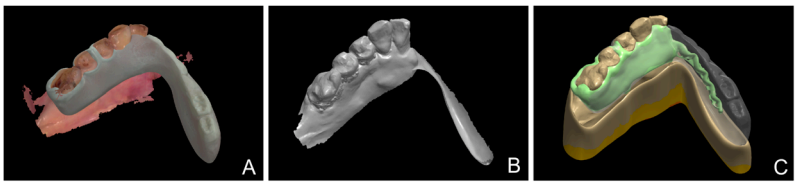


Figure 3. The CAD/CAM design process. (**A**) Aligned positional relationship of the mandible and the existing denture data. (**B**) The patient's mandibular data after inversion of the right arch area surface of the existing denture. (**C**) CAD framework.

The final digitally designed metal framework was exported as an STL file to be fabricated by a desktop 3D printer (Form 3B; Formlabs, Somerville, MA, USA) in castable wax resin (Figure 4A). The framework was fabricated using wax (Castable Wax; Formlabs) and a 3D printer (Form 4B; Formlabs). Next, conventional investment casting and finishing methods were applied. A cobalt–chromium alloy was used. The artificial teeth were arranged using the CAD software and the existing denture as a reference. The modal data for the maxilla and mandible were printed using Model Resin (FormLabs) (Figure 4B). The base of the trial fit denture was designed using Meshmixer 3.5 (Autodesk Inc., San Francisco, CA, USA) and Blender 2.92 (Blender Foundation, Amsterdam, The Netherlands) software and printed in Surgical Guide Resin (FormLabs).

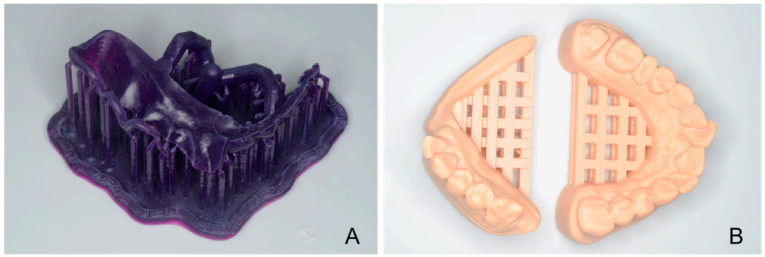


Figure 4. Images of the 3-dimensional printed structures. (**A**) Printed pattern of CAD framework for casting. (**B**) Printed cast of the maxilla and mandible.

The trial denture consisted of three separate parts, a bottommost base part, a top resin part that was a combined arrangement of milled waxed teeth, and a metal framework as an internal support in the middle (Figure 5A). First, the metal framework was tried in order to confirm its fitness, retention, and wearability. The fit accuracy was clinically evaluated using visual inspection and tactile assessment, including checking for pressure areas, stability, and passive seating on the supporting tissues. Next, the lower structure, metal frame, and upper structure were bonded together with self-curing acrylic resin (Unifast III; GC Corporation, Tokyo, Japan) at the chair side and tried again, after which the surface

contour, extent of the border region, position of the artificial teeth, and occlusal relationship was checked and any unsuitable areas adjusted. Wearability was then confirmed again (Figure 5B).

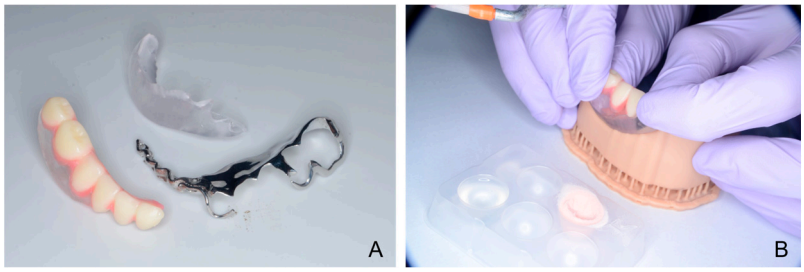


Figure 5. Trial denture components and bonding procedures. (**A**) All parts of the trial denture. (**B**) Bonding procedures used for the trial denture.

The trial denture was scanned using a laboratory scanner and the data were imported into the CAD software; the overlap of these data with the existing denture data was assessed. The denture base was divided into two parts on the CAD software for milling, namely, a bottom (mucosal) side and an upper (artificial teeth) side, using the metal framework as the middle boundary. The denture base was milled using a 53DC milling machine (DGSHAPE, Hamamatsu, Japan) from a customized resin disk. The denture base, artificial teeth, and metal framework were bonded together using polymerizing denture resin (Palappress; Kulzer, Hanau, Germany) with camber to apply pressure (Figure 6).

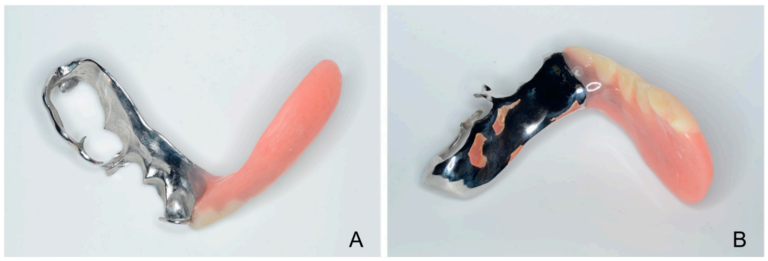


Figure 6. Definitive prosthesis. (**A**) Tissue surface view. (**B**) Occlusal surface view.

After final delivery of the prosthesis, the fit accuracy was clinically verified by evaluating tissue adaptation, stability, and the absence of pressure areas, confirming accurate seating of the prosthesis (Figure 7). The patient reported satisfactory comfort and was able to wear and remove the prosthesis without difficulty.



Figure 7. Definitive prosthesis in situ.

Masticatory performance was assessed by food-comminuting and food-mixing ability 6 months after delivery of the prosthesis. Each test was performed three times under

each condition (with and without the prosthesis), and the mean value was calculated. Food-comminuting ability was evaluated by measuring the concentration of dissolved glucose obtained from gummy jelly (Glucolumn; GC Corp.). The patient was instructed to chew the jelly for 20 s, rinse the mouth with 10 mL of distilled water, and then spit out the soaked particles into a cup containing filter paper. The amount of glucose dissolved from the comminuted jelly was measured using a portable blood glucose meter (Glucosensor GS-II; GC Corp.). Food-mixing ability was assessed using color-changeable chewing gum (70 × 20 × 1 mm, 3.0 g, Xylitol; Lotte Co., Ltd., Saitama, Japan). The gum was chewed for 1 min, after which it was collected and the color change measured using a colorimeter (CR13; Konica-Minolta, Tokyo, Japan). For food-mixing ability, ΔE provides a single value that allows for differences in L*, a*, and b* between the sample and a standard [25]. The ΔE1min value used as the index of masticatory performance was calculated using the following formula:

$$\Delta E = [(L^* - 72.3)^2 + (a^* + 14.9)^2 + (b^* - 33.0)2]^{1/2}. \quad (1)$$

The prosthesis was fitted successfully. The patient was able to wear and remove it easily and could clean it by himself. His mean food-comminuting ability determined using the blood glucose meter was 149.7 mg/dL with the prosthesis and 127.7 mg/dL without it. Food-mixing ability determined by colorimetry was as follows:

$$a^* = 9.7, b^* = 17.2, L^* = 57.6, \Delta E1min = 32.7 \quad (2)$$

with the denture and

$$a^* = 8.3, b^* = 18.3, L^* = 61.5, \Delta E1min = 29.5 \quad (3)$$

without the denture.

Patients were scheduled for regular follow-up visits every 6 months. During each visit, clinical evaluation included assessment of prosthesis integrity, oral hygiene, soft tissue condition, and any complications.

3. Discussion

This report describes a patient who developed ORNJ following radiotherapy for an oropharyngeal tumor and subsequently underwent segmental mandibular resection. The radiotherapy dose (66 Gy) far exceeded the average dose [6] that could induce ORNJ. This led to trismus, mandibular deviation, and challenges in prosthetic rehabilitation due to the limited denture design space.

Trismus, a frequent complication after radiotherapy, is attributed to increased fibrosis and scar-related contractures in the head and neck region [1,2]. It is a common sequela of certain medical conditions and treatments and has been reported in 6–86% of patients who have undergone surgery or radiation therapy involving the temporomandibular joint or masseter muscles [26]. The patient's severe trismus posed a significant challenge for the conventional impression-taking methods used in maxillofacial prosthetics. However, recent advancements in digital technology, particularly IOS, have been shown to be effective in capturing scan data, even in patients with limited mouth opening [18].

In the present case, the defect was surgically reconstructed. The flat topography of the deep floor of the defect tended to show greater variation and was difficult to capture using only the IOS. Inversion of the scan data for the mucosal surface can be used as the impression data because the existing denture fitted the mucosal surface well. This simplified the clinical processes because time-consuming steps, such as border molding

and preliminary impression-making of the defect area, were eliminated. This reproduction technique also minimized the time required for adaptation because the general features of the existing prosthesis were retained.

Although resin-based dentures are commonly used, their inherent brittleness and susceptibility to fractures pose challenges [27]. The most common causes of failure of removable partial dentures are cracks and fractures because of poor mechanical properties [28]. The lower minimum thickness of denture bases should be regarded with some caution [29]. Metal bases and frameworks have been incorporated into denture bases to improve fracture resistance, dimensional stability and retention [30]. In the present case, the anterior area of the existing denture was very thin because of insufficient restoration space, and a metal framework as an internal support in the base needed to be designed. Therefore, a cobalt–chromium alloy was selected because of its high strength and rigidity, which are essential for ensuring adequate mechanical support in thin denture base regions [31]. With the help of CAD/CAM, the surface edge data of the existing denture were recorded, and the surface edges of the metal framework were easily determined. This technique reduces the laboratory fabrication time and procedures needed for a patient with inadequate interocclusal or interarch space. Poly(methyl methacrylate) is widely used as a denture base material because of its biocompatibility, ease of processing, and acceptable mechanical properties. Instead of manually mixing the resin powder and liquid, poly (methyl methacrylate) resin blocks for CAD/CAM denture bases are industrially fabricated [32]. The CAD/CAM milling technique is a digital workflow to fabricate a removable partial denture using the subtractive method. Therefore, CAD/CAM denture base resins are highly condensed, have fewer microporosities, and effectively reduce polymerization-related dimensional changes [33].

The evaluation of the patient's masticatory performance following the prosthesis fitting revealed an improvement in food-mixing and food-comminuting abilities. Even with the denture in place, the occlusal area increased only marginally, suggesting that the enhanced masticatory function might be attributable to the denture's ability to confine the tongue to the oral cavity proper, thereby increasing the effective force exerted by the lingual muscles during mastication [34].

However, there are some limitations of this reproduction technique that must be acknowledged. For instance, direct inversion of the mucosal surface to obtain impression data is suitable only within a short period after delivery of the old denture, limiting its applicability in cases of significant alveolar bone and soft tissue remodeling. In addition, it may not be suitable for edentulous patients or those requiring replacement of long-worn dentures.

4. Summary

This case presented in this report demonstrates the application of digital technologies in addressing challenges in prosthodontics associated with trismus and mandibular deviation after mandibular resection due to ORNJ, suggesting the potential of digital methods to support rehabilitation. The combination of IOS for precise data acquisition and CAD/CAM technology for prosthesis design and fabrication facilitated management of the patient's limited mouth opening and complex defect topography, while the application of an inversion technique using existing denture data expedited the process and contributed to a more efficient and patient-friendly procedure. The incorporation of a CAD/CAM-designed metal framework improved mechanical integrity, stability, and retention, and the use of industrially fabricated poly (methyl methacrylate) resin blocks may have contributed to reduced microporosities and improved durability of the prosthesis. Clinical evaluation revealed improvements in masticatory function and oral comfort, suggesting the potential

of the digital workflow in achieving functional rehabilitation. The novelty of this report lies in the integration of several digital and clinical strategies, including the use of the existing denture as a functional and anatomical reference, inversion of the mucosal surface for intaglio reconstruction, and a scan-merging workflow integrating intraoral and extraoral data, which together contributed to a more efficient and clinically applicable workflow for prosthesis refabrication and may provide a reference for managing similar cases.

Several limitations should be acknowledged. Given that this is a single case report, the masticatory performance outcomes should be interpreted as descriptive observations rather than evidence of treatment effectiveness. Although higher values were observed with the prosthesis, no statistical analysis was performed, and the findings cannot be generalized. These results illustrate the functional changes in this specific patient. The inversion technique relies on the fit and condition of the existing denture, and its accuracy may be affected if the prosthesis is ill-fitting or has been used for an extended period. In addition, soft tissue remodeling after surgery or during prosthesis use may influence the reliability of the reconstructed intaglio surface. The workflow is primarily based on static records and may not fully capture dynamic functional contours. Finally, its applicability may be limited in completely edentulous patients or in cases with different defect configurations.

In conclusion, the successful refabrication of a mandibular prosthesis utilizing IOS and CAD/CAM technology in a patient with trismus and mandibular deviation post-mandibulectomy suggests that this digital workflow may be a feasible option in similar clinical situations, within the limitations of a single case. Regular follow-up visits remain crucial to ensuring optimal fit, function, and patient satisfaction. Further advancements in digital dentistry hold considerable promise for addressing a range of issues, offering improved treatment outcomes, and enhancing patient well-being.

Author Contributions: Writing—original draft preparation, M.M.; software, Y.Y. and M.M.; investigation, Y.S., M.H., Y.Y. and M.M.; funding acquisition, Y.S.; writing—review and editing, Y.S., M.H. and M.M.; supervision, Y.S., M.H. and N.W. All authors have read and agreed to the published version of the manuscript.

Funding: This study was partly supported by the Tokyo Metropolitan Government (grant number 2023) and Japan Science and Technology Agency (JST) SPRING (grant number JPMJSP2120).

Institutional Review Board Statement: This study was approved by the Ethics Committee of Institute of Science Tokyo (protocol code D2024-010 and date of approval 4 September 2024).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Clinical data, including digital scan data and masticatory performance measurements, were collected and analyzed for this case report. Data sharing is not applicable to this article.

Acknowledgments: During the preparation of the graphical abstract, the authors used ChatGPT (GPT-4, OpenAI) for the purpose of generating graphical elements and assisting with the design concept. The authors have reviewed and edited the output and take full responsibility for the content of this publication.

Conflicts of Interest: The authors declare no conflicts of interest. The sponsors had no role in the study design, in the collection, analysis, or interpretation of data, in the writing for the report, or in the decision to submit the article for publication.

Abbreviations

The following abbreviations are used in this manuscript:

CAD/CAM	Computer-aided design/computer-aided manufacturing
ORNJ	Osteoradionecrosis of the jaw
3D	Three-dimensional
IOS	Intraoral scanner

References

1. Ichimura, K.; Tanaka, T. Trismus in patients with malignant tumours in the head and neck. *J. Laryngol. Otol.* **1993**, *107*, 1017–1020. [CrossRef] [PubMed]
2. Engelmeier, R.L.; King, G.E. Complications of head and neck radiation therapy and their management. *J. Prosthet. Dent.* **1983**, *49*, 514–522. [CrossRef] [PubMed]
3. Thapliyal, G.K. Peterson's Principles of Oral & Maxillofacial Surgery. *Med. J. Armed Forces India* **2006**, *62*, 89. [CrossRef]
4. Delanian, S.; Lefaix, J.L. The radiation-induced fibroatrophic process: Therapeutic perspective via the antioxidant pathway. *Radiother. Oncol.* **2004**, *73*, 119–131. [CrossRef] [PubMed]
5. Chronopoulos, A.; Zarra, T.; Ehrenfeld, M.; Otto, S. Osteoradionecrosis of the jaws: Definition, epidemiology, staging and clinical and radiological findings. A concise review. *Int. Dent. J.* **2018**, *68*, 22–30. [CrossRef] [PubMed]
6. Kubota, H.; Miyawaki, D.; Mukumoto, N.; Ishihara, T.; Matsumura, M.; Hasegawa, T.; Akashi, M.; Kiyota, N.; Shinomiya, H.; Teshima, M.; et al. Risk factors for osteoradionecrosis of the jaw in patients with head and neck squamous cell carcinoma. *Radiat. Oncol.* **2021**, *16*, 1. [CrossRef] [PubMed]
7. De Felice, F.; Thomas, C.; Patel, V.; Connor, S.; Michaelidou, A.; Sproat, C.; Kwok, J.; Burke, M.; Reilly, D.; McGurk, M.; et al. Osteoradionecrosis following treatment for head and neck cancer and the effect of radiotherapy dosimetry: The Guy's and St Thomas' Head and Neck Cancer Unit experience. *Oral Surg. Oral Med. Oral Pathol. Oral Radiol.* **2016**, *122*, 28–34. [CrossRef] [PubMed]
8. van Merkesteyn, J.P.; Groot, R.H.; van den Akker, H.P.; Bakker, D.J.; Borgmeijer-Hoelen, A.M. Treatment of chronic suppurative osteomyelitis of the mandible. *Int. J. Oral Maxillofac. Surg.* **1997**, *26*, 450–454. [CrossRef] [PubMed]
9. Koorbusch, G.F.; Fotos, P.; Goll, K.T. Retrospective assessment of osteomyelitis. Etiology, demographics, risk factors, and management in 35 cases. *Oral Surg. Oral Med. Oral Pathol.* **1992**, *74*, 149–154. [CrossRef] [PubMed]
10. Baur, D.A.; Altay, M.A.; Flores-Hidalgo, A.; Ort, Y.; Quereshy, F.A. Chronic osteomyelitis of the mandible: Diagnosis and management—An institution's experience over 7 years. *J. Oral Maxillofac. Surg.* **2015**, *73*, 655–665. [CrossRef] [PubMed]
11. Contrera, K.J.; Chinn, S.B.; Weber, R.S.; Roberts, D.; Myers, J.N.; Lai, S.Y.; Lewis, C.M.; Hessel, A.C.; Gillenwater, A.M.; Mulcahy, C.F.; et al. Outcomes after definitive surgery for mandibular osteoradionecrosis. *Head Neck* **2022**, *44*, 1313–1323. [CrossRef] [PubMed]
12. He, Y.; Zhang, Z.Y.; Zhu, H.G.; Wu, Y.Q.; Fu, H.H. Double-barrel fibula vascularized free flap with dental rehabilitation for mandibular reconstruction. *J. Oral Maxillofac. Surg.* **2011**, *69*, 2663–2669. [CrossRef] [PubMed]
13. Bhattacharya, S.R.; Majumdar, D.; Singh, D.K.; Islam, M.D.; Ray, P.K.; Saha, N. Maxillary palatal ramp prosthesis: A prosthodontic solution to manage mandibular deviation following surgery. *Contemp. Clin. Dent.* **2015**, *6*, S111–S113. [CrossRef] [PubMed]
14. Liu, R.; Hattori, M.; Zhang, M.; Sumita, Y.I. Use of an occlusal ramp for rehabilitation after a mandibulectomy and its effects on mastication. *J. Prosthet. Dent.* **2023**, *129*, 234–238. [CrossRef] [PubMed]
15. Koyama, S.; Kato, H.; Harata, T.; Sato, N.; Hanawa, S.; Sasaki, K. Evaluation of water absorption properties and fabrication of hollow obturator model using 3D digital dentistry. *Dent. Mater. J.* **2018**, *37*, 521–525. [CrossRef] [PubMed]
16. van der Zande, M.M.; Gorter, R.C.; Aartman, I.H.; Wismeijer, D. Adoption and use of digital technologies among general dental practitioners in the Netherlands. *PLoS ONE* **2015**, *10*, e0120725. [CrossRef] [PubMed]
17. Yoshioka, F.; Ozawa, S.; Hyodo, I.; Tanaka, Y. Innovative Approach for Interim Facial Prosthesis Using Digital Technology. *J. Prosthodont.* **2016**, *25*, 498–502. [CrossRef] [PubMed]
18. Michelinakis, G. The use of cone beam computed tomography and three dimensional printing technology in the restoration of a maxillectomy patient using a dental implant retained obturator. *J. Indian Prosthodont. Soc.* **2017**, *17*, 406–411. [CrossRef] [PubMed]
19. Ye, H.; Ma, Q.; Hou, Y.; Li, M.; Zhou, Y. Generation and evaluation of 3D digital casts of maxillary defects based on multisource data registration: A pilot clinical study. *J. Prosthet. Dent.* **2017**, *118*, 790–795. [CrossRef] [PubMed]
20. Gao, Y.; Hattori, M.; Sumita, Y.I.; Wakabayashi, N. Creating and analyzing digital scans of a mandibulectomy cast with simulated trismus. *J. Prosthet. Dent.* **2025**, *134*, 477–483. [CrossRef] [PubMed]
21. Omran, M. Novel 3D Modeling Technique of Removable Partial Denture Framework Manufactured by 3D Printing Technology. *Int. J. Adv. Res.* **2014**, *2*, 686–694. [CrossRef]

22. Stoker, N.G.; Mankovich, N.J.; Valentino, D. Stereolithographic models for surgical planning: Preliminary report. *J. Oral Maxillofac. Surg.* **1992**, *50*, 466–471. [CrossRef] [PubMed]
23. Awuti, S.; Wang, T.-M.; Ariani, N.; Naveau, A.; Somogyi-Ganss, E.; Sumita, Y.I. Piezography approach to denture fabrication for a partial glossectomy patient: A clinical report. *Int. J. Maxillofac. Prosthet.* **2021**, *4*, 37–42. [CrossRef]
24. 3 Shape Ortho System. OrthoAnalyzer 2012 User Manual. 2012. Available online: http://promed.ua/wp-content/uploads/2012/01/2012_OrthoAnalyzer_English.pdf (accessed on 11 May 2023).
25. Komagamine, Y.; Kanazawa, M.; Minakuchi, S.; Uchida, T.; Sasaki, Y. Association between masticatory performance using a colour-changeable chewing gum and jaw movement. *J. Oral Rehabil.* **2011**, *38*, 555–563. [CrossRef] [PubMed]
26. Teguh, D.N.; Levendag, P.C.; Voet, P.; van der Est, H.; Noever, I.; de Kruijf, W.; van Rooij, P.; Schmitz, P.I.; Heijmen, B.J. Trismus in patients with oropharyngeal cancer: Relationship with dose in structures of mastication apparatus. *Head Neck* **2008**, *30*, 622–630. [CrossRef] [PubMed]
27. Thomaidis, S.; Kakaboura, A.; Mueller, W.D.; Zinelis, S. Mechanical properties of contemporary composite resins and their interrelations. *Dent. Mater.* **2013**, *29*, e132–e141. [CrossRef] [PubMed]
28. Ali, I.L.; Yunus, N.; Abu-Hassan, M.I. Hardness, flexural strength, and flexural modulus comparisons of three differently cured denture base systems. *J. Prosthodont.* **2008**, *17*, 545–549. [CrossRef] [PubMed]
29. Steinmassl, O.; Offermanns, V.; Stöckl, W.; Dumfahrt, H.; Grunert, I.; Steinmassl, P.A. In Vitro Analysis of the Fracture Resistance of CAD/CAM Denture Base Resins. *Materials* **2018**, *11*, 401. [CrossRef] [PubMed]
30. Grunewald, A.H. Gold base lower dentures. *J. Prosthet. Dent.* **1964**, *14*, 432–441. [CrossRef]
31. Al Jabbari, Y.S. Physico-mechanical properties and prosthodontic applications of Co-Cr dental alloys: A review of the literature. *J. Adv. Prosthodont.* **2014**, *6*, 138–145. [CrossRef] [PubMed]
32. Steinmassl, P.A.; Klaunzer, F.; Steinmassl, O.; Dumfahrt, H.; Grunert, I. Evaluation of Currently Available CAD/CAM Denture Systems. *Int. J. Prosthodont.* **2017**, *30*, 116–122. [CrossRef] [PubMed]
33. Infante, L.; Yilmaz, B.; McGlumphy, E.; Finger, I. Fabricating complete dentures with CAD/CAM technology. *J. Prosthet. Dent.* **2014**, *111*, 351–355. [CrossRef] [PubMed]
34. Tashiro, K.; Soutome, S.; Funahara, M.; Kawashita, Y.; Kitamura, M.; Fukuda, H.; Furugen, R.; Iwasaki, T.; Hayashida, H.; Kawasaki, K.; et al. The Relationship between Dental Findings and Tongue Pressure: A Survey of 745 Community-Dwelling Adults and Elderly Persons in Japan. *Gerontology* **2021**, *67*, 517–524. [CrossRef] [PubMed]

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