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TECHNIQUE

A digital duplicating obturator with 3D printing technology

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ABSTRACT

Obturators are vital for restoring function and appearance in patients with maxillofacial defects, though traditional fabrication involves multiple clinical visits and extended production time. This technique report details a digital approach using computer-aided design/manufacturing (CAD/CAM) and 3D printing to duplicate an obturator for a 74-year-old patient with maxillary bone necrosis. By using a chairside intraoral scanner, we obtained a digital model of the existing obturator, avoiding traditional impression-taking and reducing procedural discomfort. A 3D-printed obturator was fabricated, adjusted with a tissue conditioner, and refined to ensure optimal fit. Laboratory processes included using specialized materials and retention techniques. The digital workflow minimized patient visits and improved comfort, underscoring CAD/CAM and 3D printing's potential to enhance clinical efficiency and quality of life for patients requiring complex prosthetic rehabilitation. This approach highlights the practical benefits of integrating digital and analog methods in maxillofacial prosthetics. *(Int J Maxillofac Prosthetics 2024;7:16-19)*

Keywords

Maxillofacial prosthetics, 3D printing, CAD/CAM technology, Obturator duplication, Intraoral scanning.

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AUDIOABSTRACT

INTRODUCTION

Oburators play a critical role in restoring oral function and appearance for patients with maxillofacial defects. Traditionally, the fabrication of a new obturator requires multiple steps over a span of one to two months, typically involving four clinical appointments for impression-taking, bite registration, try-in, and final delivery, along with necessary adjustments.[1] For patients already using an obturator, clinical steps and fabrication time can be reduced through duplication techniques.[2] Duplication materials, such as alginate and silicone, streamline the impression and bite registration stages, which are often uncomfortable for patients with maxillofacial defects. However, traditional methods face limitations, particularly in replicating the complex structure of obturators, which are more intricate than conventional dentures.

To address these challenges, advancements in 3D digital technology offer promising solutions for medical and dental applications. Computer-aided design and computer-aided manufacturing (CAD/CAM) have significantly transformed prosthodontics, introducing two major digital fabrication techniques: milling and 3D printing.[3] In milling, a computerized machine carves the denture base from a solid material block,[4] while 3D printing employs additive manufacturing to build the prosthesis layer by layer from a digital model.[5]

Both milled and 3D-printed dentures provide advantages over traditional fabrication, such as high precision, improved fit, and enhanced patient comfort.[6] Furthermore, digital workflows allow for straightforward modifications and adjustments, reducing the need for labor-intensive manual interventions.[7] Nonetheless, adopting digital technologies requires considering initial investments in equipment and materials and navigating the associated learning curve. The aim of this technique is to explore the application of 3D printing technology for duplicating an obturator in a bi-maxillectomy patient with an edentulous maxilla, emphasizing its potential to improve clinical efficiency and patient outcomes.

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TECHNIQUE

Case Summary

A 66-year-old male patient presented with a histopathologically confirmed diagnosis of adenoid cystic carcinoma (T4aN0M0) located in the hard palate. Treatment involved a combination of radiotherapy and chemotherapy. However, over time, the patient developed progressive bone necrosis that extended to the adjacent, anterior, and contralateral maxillary regions. As a result, an open-type obturator was initially fabricated using a traditional processing technique. At the age of 74, the patient reported increasing instability with his current obturator and expressed a desire for a new, more secure prosthesis (Fig. 1). Consequently, a plan was made to fabricate a new obturator using computer-aided design and computer-aided manufacturing (CAD/CAM) technology to enhance fit, stability, and comfort.

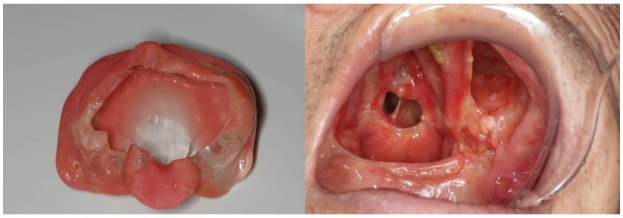


Fig 1. Left, an open type obturator (44.5g) / Right, Intra oral photo.

Chairside and Laboratory Procedures

Sealing stickers were applied to the polished surface of the current obturator. The obturator was then scanned using an intraoral scanner (Medit 500, Yoshida) to capture a digital model (Fig 2). Differences between the existing obturator and the digital STL data were visually assessed, and adjustments were made using STL adjustment software (Meshmixer, Blender). A 3D-printed obturator was then ordered from the dental laboratory (BITEC GLOBAL JAPAN INC).

Upon initial insertion, the patient reported that the new obturator felt oversized. Adjustments were made using pressure-indicating paste following standard protocol. Although the obturator's appearance showed no significant changes, it remained slightly loose (Fig 3). To improve fit and patient comfort, a tissue conditioner was applied, and the patient was instructed to wear the obturator for approximately two weeks to monitor comfort and stability. After two weeks, with no issues reported during clinical use, the obturator with tissue conditioner was sent back to BITEC GLOBAL JAPAN INC for further processing (Fig 4). During this period, the patient continued using their original obturator.



Fig 2. Left, Preparation for digital scanning / Right, The image of scanned STL data.

The laboratory used a cara Print 4.0 3D printer (Kulzer Japan) to fabricate a secondary obturator with improvements based on the initial feedback. The denture base material, dima Print Digital Denture Base (Kulzer Japan), and artificial tooth material, dima Print Digital Denture Teeth (Kulzer Japan), were used. The 3D printing process took approximately 60 minutes for the base and 30 minutes for the teeth. To ensure sufficient stability, additional sprues were applied, as the obturator was heavier than conventional dentures. The laboratory created drainage holes to allow excess liquid material to flow out during fabrication, then sealed these areas afterward. Adhesion between the base and artificial teeth was achieved by applying a base liquid to both surfaces, connecting them, and finally light-curing to secure the attachment.

The secondary 3D-printed obturator (Fig 5) demonstrated improved fit and appropriate sizing; however, retention around the nostrils was insufficient. An autopolymerizing resin (Unifast III Pink) was applied to enhance nostril retention. After this modification, the obturator achieved stability, and the patient expressed satisfaction with both fit and comfort (Fig 6).



Fig 3. Comparison between a present obturator and 3D printed obturator.



Fig 4. Comparison between 3D printed obturator of adjusted with tissue conditioner (40.6g) and secondary 3D printed obturator.



Fig 5. Secondary 3D printed obturator After adjustment of nostrils retention with auto polymerization resin (37.8g).



Fig 6. Checking the stability of adjusted obturator when opening the mouth.

DISCUSSION

In this technique, a patient presented with complaints of obturator instability, prompting the fabrication of a new obturator using CAD/CAM technology. To digitally duplicate the existing obturator, an intraoral chairside scanner was first used to capture its structure. Given the limitations of milled prostheses, a 3D-printed system was selected, which significantly eased the patient's experience by minimizing both the discomfort of traditional impression-taking and the time needed for fabrication and post-fitting adjustments.

For obturator fabrication, particularly in facilities equipped with in-house labs or university hospital laboratories, the ability to promptly return a completed prosthesis to the patient is critical for maintaining quality of life. When lab access is delayed or unavailable, even a single day without a prosthesis can greatly impact the patient. Digital technology offers a remarkable advantage here: chairside scanning can be completed within minutes, allowing for rapid digital duplication without needing to retain the original prosthesis in the lab.

During the initial chairside scan of a large obturator, some challenges in precision and accuracy arose. However, these were effectively managed by stabilizing the prosthesis with a tissue conditioner, minimizing the need for extensive adjustments. With both the old obturator and the digital duplicate available, the duplicate could be retained at the lab for scanning and additional adjustments without impacting the patient's daily function.

Sealing stickers were applied to the obturator's polished surfaces to facilitate accurate scanning. Stickers with asymmetrical, uneven textures were found to yield better scan quality compared to smooth ones. Future improvements in scanner technology are likely to further streamline this process, potentially eliminating the need for such stickers.

In cases where the obturator requires adjustments, such as tissue conditioning, prolonged use may not be feasible. Therefore, the existing prosthesis served as a reference, allowing adjustments on the newly fabricated 3D-printed obturator, which was then scanned again to refine the final prosthesis. Compared to the traditional process, which involves multiple clinic visits for impression-taking, occlusion registration, trial fittings, and final adjustments, digital duplication significantly reduced both patient burden and clinic time.

For patients without a usable existing denture, digital duplication still offers a way to minimize the need for uncomfortable oral cavity and maxillofacial defect impressions by adjusting and scanning the old denture, even if it is no longer functional. This approach is especially beneficial in a super-aging society where creating new dentures may be challenging and supportive care is critical. Digital denture technology can enhance the quality and accessibility of care for such patients, ensuring consistent and safe outcomes.

In this case, the size of the obturator prosthesis made it impractical to manufacture using milling techniques, which led to the selection of a 3D-printed system. As materials continue to advance, offering lighter and stronger options, the potential for even lighter obturators will further enhance patient comfort and function.

CONCLUSIONS

The use of an intraoral scanner enabled the fabrication of an obturator without the need for traditional impression-taking procedures, effectively reducing both clinical steps and adjustment time. By integrating digital and analog technologies, a maxillofacial prosthesis can be developed to enhance the quality of life for elderly patients with head and neck cancer, offering a streamlined, patient-centered approach in prosthetic rehabilitation.

Conflict of Interest

The authors declare that they have no conflicts of interests related to this study.

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REFERENCES

1. Li N, Otomaru T, Said MM, Yeerken Y, Fujita H, Taniguchi H. Prosthodontic management of a bilateral total maxillary defect patient with chemoradiotherapy-related progressive osteonecrosis: A case report. pen J Clin Med Case Rep. 2018;1405.
2. Ali IE, Otomaru T, Sumita Y. Refabrication of an implant-retained obturator using the denture duplication technique in a bilateral maxillectomy patient with a free fibula osteocutaneous flap. J Prosthodont Res. 2023;67:157-160.
3. Ali IE, Enomoto K, Sumita Y, Wakabayashi N. Combined digital-conventional workflow to fabricate a definitive obturator from an interim obturator for a patient with an anterior maxillectomy defect. J Prosthet Dent. 2023:S0022-3913(23)00285-8.
4. Soeda Y, Kanazawa M, Arakida T, Iwaki M, Minakuchi S. CAD-CAM milled complete dentures with custom disks and prefabricated artificial teeth: A dental technique. J Prosthet Dent. 2022;127:55-58.
5. Hada T, Kanazawa M, Iwaki M, Arakida T, Soeda Y, Katheng A, et al. Effect of Printing Direction on the Accuracy of 3D-Printed Dentures Using Stereolithography Technology. Materials (Basel). 2020;13:3405.
6. Soeda Y, Komagamine Y, Kanazawa M, Hada T, Iwaki M, Minakuchi S. Trueness and precision of artificial teeth in CAD-CAM milled complete dentures from custom disks with a milled recess. J Prosthet Dent 2024;132:1014-1019.
7. Murase M, Pradhan N, Sumita YI, Wakabayashi N. Use of digital technology in prosthesis fabrication for an elderly patient with a maxillectomy and severe trismus: A clinical report. J Prosthet Dent. 2023:S0022-3913(23)00330-X.