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Short Communication

Combined tomography and conventional impression with notch system to fabricate prosthesis with palatal obturator in patients with severe limited mouth opening

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Abstract In oral cancer therapies, surgery or radiotherapy frequently result to maxillary defects and limited mouth opening (LMO). For prosthetic rehabilitation, these sequelae present significant challenges to achieving accurate impressions. Intraoral scanners (IOS) are unsuitable due to the size of the scanner tips, while conventional impression techniques risk tearing during tray removal. Additionally, cone-beam computed tomography (CBCT) alone, without superimposed IOS data, lacks the precision required due to insufficient tissue precision and artefacts. To address these limitations, a novel hybrid technique combining CBCT and conventional impressions was presented in 3 patients. A 3D-printed model was created from CBCT data, which serves as base for fabricating a palatal plate with notches. This plate is used to capture a conventional impression of the dentition, and the two components are aligned extraorally using notches. This approach ensures capture of hard and soft tissues while reducing patient discomfort with severe LMO during the impression process.

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Introduction

Oral cancer treatments are still invasive, including surgery, radiotherapy and/or chemotherapy often leading to maxillary defects and limited mouth opening (LMO) with modified and exacerbated sensitivity of mucous membranes.[1,2]

The rehabilitation of these patients presents unique challenges, particularly in capturing accurate impressions without causing patient discomfort. Conventional techniques often result in distortion or tearing of impressions due to undercuts, while the risks of aspiration and foreign body impaction further complicate the process.[3] Fully digital workflows utilizing intraoral scanners (IOS) in combination with CBCT require the use of specific software but have shown excellent accuracy and efficiency in prosthesis fabrication.[4,5] However, the main disadvantage is that it can be difficult to match STL files if there are too many metallic artefacts.

However, IOS remains impossible for severe LMO due to the size of scanner tips. Alternative techniques, such as the use of CBCT data alone for prosthesis design, offer some solutions but are limited by the lack of soft tissue detail and the potential for imaging artifacts.[4] These techniques partially address these issues but do not consistently allow for the precise integration of teeth required for definitive maxillary prostheses.[1,6] Furthermore, sectional trays or two-part prostheses with flexible silicone obturators can be viable alternatives, but they require complex assembly processes and may cause patient discomfort.[7]

In response, a novel hybrid approach is proposed that integrates conventional and digital impression techniques, utilizing an easily notch system to reassembly the 3D-printed palatal plate derived from CBCT data with the conventional denture impression.

Technique

This technique is applied to the rehabilitation of maxillary prostheses with palatal obturators in three patients (ages 69, 71, and 78) with a history of palatal squamous cell carcinoma treated by radiotherapy and hemi-maxillectomy. All patients exhibited severe limited mouth opening (LMO), with inter-incisor distances of 14, 11, and 13 mm, respectively, precluding the use of intraoral scanners or conventional impressions with customized trays.

Thus, a combined tomography-conventional technique was performed according to the following protocol (Fig. 1):

1. A annual follow-up control CBCT of the patient in DICOM format was used to record the entire maxillary, including the bone defect. CBCT (Promax 3D Max; Planmeca, Helsinki, Finland) was obtained at 90 kVp, 12 mA, 12-s scanning time, 0.2-mm voxel size, and DAP (dose area product) of 780 mGy/cm. During imaging, the patient must not have any occluding teeth, and the tongue must not be in contact with the palate. The practitioner can use a prefabricated thermoformed plate that is fitted to the patient's arch to hold the tongue on the floor of the mouth.

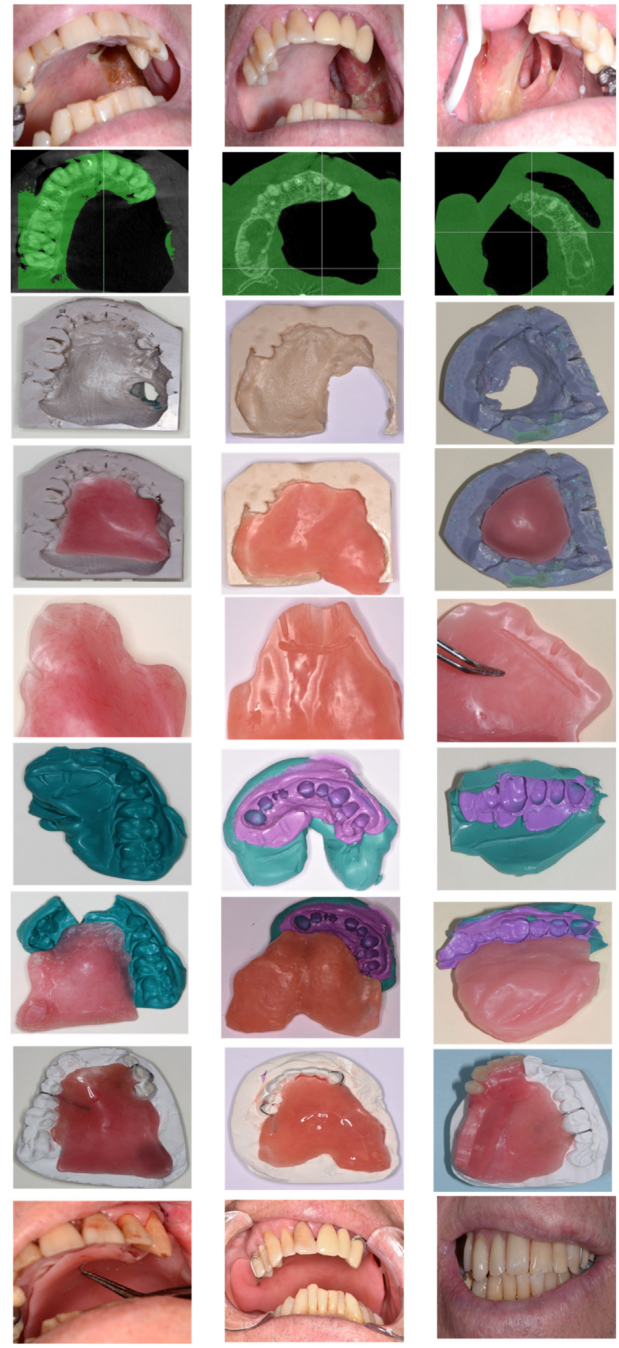

Figure 1 Clinical steps illustrated in the 3 patients for the creation of the prosthesis a. Intraoral view, b. DICOM file segmentation, c. Printed cast from the STL file, d. Palatal plate on the printed cast, e. Checking the fit of the plate in the mouth, f. Notches on palatal plate, g. Conventional impression of teeth, h. "Combined Impression" of teeth with plate, i. Final obturator palatal plate, j. Prosthetic insertion.

2. The DICOM files were imported into a software program (Rhino3D Medical, Kallisto®, Toulouse, France) to segment the 3D volumetric data of the craniofacial soft tissues. This segmentation was saved as an STL file. Frequently, a good definition of the maxillary zone and defect was obtained, but poor definition of the teeth due to artefacts (metallic restorations).

3. The STL file was printed using a stereolithography desktop 3D printer (Formlabs Form 3B+; Formlabs Inc., Somerville, MA, USA The digital cast was obtained. From this model, a palatal plate was fabricated in PMMA resin. The fit of the plate was checked in the mouth, and notches were made in the palatal plate.
4. Conventional techniques were used to obtain the contour of the teeth. With the plate repositioned in the mouth, an impression was made using putty polyvinylsiloxane (PVS) and a sectional partial tray to obtain good definition of the teeth. The two-part impression was uninserted, and then the same procedure was repeated, relining the PVS impression using light PVS. Next, cyanoacrylate was used to glue the two parts together following the notches, which allowed the impression of the teeth to be repositioned on the palatal plate.
5. Gypsum was poured into the two-part impression to obtain a conventional cast, which was used to add the clasps and occlusal rim to the palatal plate.
6. The conventional technique involved in making a removable prosthesis are carried out: recording the occlusion, fitting teeth on wax and polymerization.
7. Phonation, sealing, and the retention of palatal obturator were tested. We verified the patient's absence of nasal leakage during drinking, and satisfactory obstruction of the defect by speech performance. Follow-up appointments were scheduled at 1 week, 1 month, 6 months, 1 year and once a year. During these appointments, the seal integrity, comfort, absence of pain or ulceration, occlusal stability are checked. After two years of follow-up, all 3 patients are satisfied and no relining has been necessary.

Discussion

The hybrid "combined" technique described in this study offers a practical solution by combining CBCT data with conventional impressions. The use of a 3D-printed palatal plate as a base for a conventional impression allows for accurate capture of both hard and soft tissues while mitigating patient discomfort. This technique avoids the challenges associated with in-mouth impression tray manipulation by enabling tray assembly outside the oral cavity. Additionally, the notch system ensures precise reassembly of the components, enhancing the accuracy of the final cast. Post-insertion evaluations confirmed satisfactory sealing, with no reports of nasal leakage during speech or swallowing. This outcome highlights the technique's ability to provide a functional and comfortable prosthesis.

Palin and al. used only CBCT with DICOM file with Mimics® (Materialise, Louvain, Belgique) segmentation software to obtain a working model sufficient to produce a soft silicone bulb in a patient with LMO.[1] However, this technique does not allow the fabrication of the definitive prosthesis with prosthetic clasps and teeth due to the lack of soft tissue precision and the potential for numerous artifacts (implants or crowns or metal restorations on the remaining teeth).[1,8] In addition, the images produced by the X-ray beam may be distorted, particularly on the occlusal surface of teeth. This is why CBCT must be combined with complementary imaging of the dentition to improve accuracy.[9] Additionally, Shahid et al. proposed an alternative to sectorial impressions in cases of LMO, using the patient's CBCT to create an individual custom tray adapted in shape and thickness.[6] Then, a conventional impression was scanned and imported into Blender V3.3.1 (Blender Institute, Amsterdam, Netherlands) software. The final cast was used in Blender to design the obturator with a bulb and was then printed. Sectional trays present a viable alternative for obtaining precise impressions. A critical requirement for these trays is their ability to be easily assembled and disassembled within the mouth, necessitating the incorporation of a reliable and easy locking mechanism.[10] Alternatively, individualized impression trays can be utilized; however, this approach requires the creation of preliminary impressions, which may cause patient discomfort.

The use of combined tomography and conventional impression techniques offers a significant advantage by allowing tray assembly outside the patient's mouth, simplifying the process for the practitioner. For all three patients, this approach reduced patient discomfort while the impression was made and avoided possible impression misfits and errors in the subsequent steps of production of the definitive cast. Importantly, the highly accurate and detailed definitive cast created from tissue segmentation of the maxillary defect area in the CBCT data enabled effective use of undercut areas. Regarding the long-term impact on quality of life, the three patients reported improving speech, swallowing, and overall oral function. After one and two years, no significant changes in patient satisfaction or quality of life were observed. This suggests that once patients adapt to the prosthesis, their functional and comfort levels remain stable over time. Sealing should be reassessed at each follow-up visit, regardless of the technique or materials used, to ensure optimal prosthesis function and long-term comfort. While this approach successfully addressed the challenges faced by the three patients, its implementation requires practitioner expertise in digital segmentation with specialized equipment such as advanced software (Mimics® or Rhino3DMedical® for exemple) and 3D printers.

In conclusion, despite these limitations, this hybrid method represents a promising advancement in maxillofacial prosthetics, providing an effective and patient-friendly solution for individuals with severe LMO. Future research should focus on improving workflow efficiency, validating reproducibility, and reducing the cost and complexity associated with this technique.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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