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APPLICATION OF DIGITAL TECHNOLOGY FOR FABRICATING THE OBTURATOR IN REHABILATATION OF MAXILLARY DEFECT: A SYSTEMATIC REVIEW

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Abstract

Statement of problem - The purpose of this systemic review is to assess the outcomes of applications of digital technology for the fabrication of obturators in patients with maxillectomy defects. Digital techniques have been applied in dentistry to simplify oral rehabilitation procedures. The acquisition of 3 dimensional (3D) images of oral structures has made it possible to virtually define treatment planning, to design and mill restorations, and to monitor the result of surgical and restorative procedures.

Material and methods- This study was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The protocol had been registered on PROSPERO (International Prospective Register of Systematic Reviews) with the registration number The PICOS (Population, Intervention, Comparison, Outcomes, and Study) criteria employed in the systematic review included. The focused question was "Applying digital technology and assessing the accuracy of obturators fabricated using digital techniques." Inclusion criteria for this review was studies evaluating the rehabilitation of acquired maxillary defect using digital scanning methods.

Conclusion- The main outcome of the review was that the application of digital workflows in the fabrication of obturators was found to reduce working time, minimize material consumption, and enhance patient comfort and acceptance.

INTRODUCTION

In dentistry, digital methods have been used to streamline oral rehabilitation processes. It is now feasible to visually define treatment planning, design and fabricate restorations, and track the outcomes of restorative and surgical operations because to the capture of 3D (3D) pictures of oral structures[1]. A face prosthesis is a detachable substitute for a facial component that can enhance a patient's comfort, function, look, and overall quality of life.

Conventional manufacturing of facial prostheses involves multiple clinical and laboratory procedures including a facial impression, handcrafting a wax pat tern and manually converting the wax pattern into a silicone prosthesis. Conventional manufacturing processes can have a variety of limitations from both the patient and healthcare service perspective. For example, large facial impressions can be uncomfortable or claustrophobic for patients and may distort the soft tissues which could impair final prosthetic fit.[2]

Face scanners have a wide range of possible uses in dentistry and medicine, such as maxillofacial rehabilitation, facial characterization, facial emotion capture, and facial cosmetic planning and surgery. Increased preciseness enhances the quality of the face scanner data, which eventually improves the final product.[3] The development of highly customized and patient-specific prosthetic devices is made possible by CAM technologies. The technology enables the fabrication of prostheses that precisely fit the unique anatomical features of an individual patient's maxillofacial region by using subtractive (milling) or additive technologies like Stereolithography (SLA), Selective Laser Sintering (SLS), Digital Light Processing (DLP), and Fused Deposition Modelling (FDM).[2]

The entire digital workflow is currently constrained to small, clearly identified flaws. An assessment of the most recent data pertaining to the viability of digital workflows in maxillofacial prosthetics is essential given the growing number of recent publications and the paradigm shift in CAD-CAM.[2]

Even though surgical reconstruction is the preferred treatment for maxillectomy defects, many patients still receive obturator prostheses through conventional methods for a variety of reasons, including specific anatomic features and tumor recurrences. This is inconvenient for both the patient and the clinician. Therefore, the integration of several digital processes in the manufacturing of maxillofacial prosthesis has increased the patients' acceptance of the treatment since the emergence of digital procedures related to dentistry. Even though digital techniques have supplanted some outdated ways for building obturator prostheses, there is still a lack of literature showing a totally digital workflow for this purpose.[4]

MATERIAL AND METHODS

This study was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The protocol had been registered on PROSPERO (International Prospective Register of Systematic Reviews) with the registration number CRD42025113595.

The PICOS (Population, Intervention, Comparison, Outcomes, and Study) criteria employed in the systematic review included

The focused question was "Applying digital technology and assessing the accuracy of obturators fabricated using digital techniques."

population (P) as "patients with maxillectomy defects,"

Intervention (I) as "applications of digital techniques in obturator fabrication,"

Control (C) as "digital technique vs. conventional method of fabrication of obturators,"

Outcome (O) as "the accuracy of obturator prostheses fabricated using digital technology based on patient comfort and ease of fabrication."

ELIGIBILITY CRITERIA

Inclusion Criteria

Inclusion criteria consisted of case reports, case series and randomized controlled trials on the fabrication of obturators in patients with maxillectomy defects using digital techniques from 2017. studies evaluating the rehabilitation of acquired maxillary defect using digital scanning methods.

Exclusion Criteria

Reviews, letters, abstracts, case reports, or studies in which do not used the digital technology for rehabilitation of maxillary defect were not considered for analysis.

Data Sources & Search Strategy

A main search strategy was formulated and applied in the PubMed (MEDLINE) database. Furthermore, individual search strategies were formulated using the main search as the reference and applied in the Science Direct, Scopus, and Cochrane databases. In addition, reviewed literature was assessed on Scholar Google, and Open Grey sources.

Search Terms Used (example for PubMed):

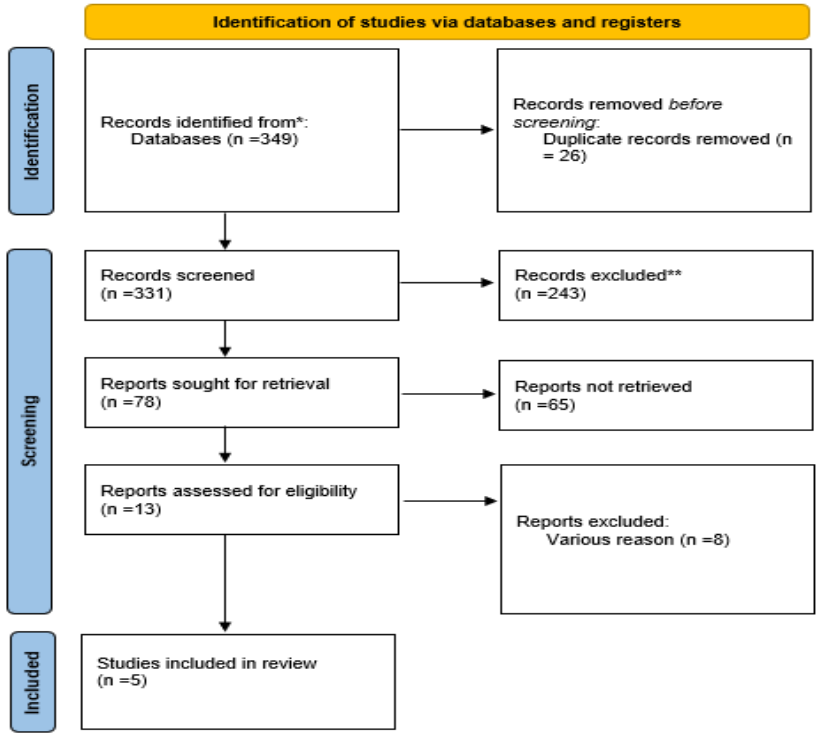
The keywords used for search strategy were rehabilitation, acquired maxillofacial defects, accuracy, digital technology, scanning, obturator and digital workflow, fabrication of obturator or maxillectomy or obturator or maxillofacial prosthesis, etc.

Data Extraction Process and Risk of Bias

Two independent reviewers participated from the first phase of study selection by choosing. articles based on the information provided in the title and abstracts. When all inclusion criteria items were described, articles were selected for full-text reading, and articles considered eligible for review were selected.

STUDY SELECTION

The initial number of identified articles was 349, out of which 26 articles were found to be duplicates, which were then eliminated, and the remaining 331 articles underwent title and abstract screening. Following this, 243 articles were excluded, leaving 78 articles, of which 65 articles were excluded as they did not meet the inclusion criteria. Finally, a total of 5 articles were included in the study as they met the inclusion criteria, they were case reports. The study selection has been done based on PRISMA guidelines.



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

RISK OF BIAS/QUALITY ASSESSMENT

All the included studies were assessed using a criterion given by NIH for quality assessment of case reports and observational studies. The criteria consisted of nine questions for case reports/series.

Criteria	Park et al. (2017)	Tasopoulos et al. (2018)	Michelinakes et al. (2018)	Tasopoulos et al. (2020)	Ye et al. (2021)
1. Was the study question or objective clearly stated?	Yes	Yes	Yes	Yes	Yes
2. Was the study population clearly and fully described, including a case definition?	Yes	Yes	Yes	Yes	Yes
3. Were the cases consecutive?	NA	NR	NR	NA	NR
4. Were the subjects comparable?	NA	NR	Yes	Yes	NR
5. Was the intervention clearly described?	Yes	Yes	Yes	Yes	Yes
6. Were the outcome measures clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	Yes	Yes	Yes	Yes
7. Was the length of follow-up adequate?	No	Yes	Yes	Yes	Yes
8. Were the statistical methods well-described?	NR	NR	NR	NR	NR
9. Were the results well-described?	Yes	Yes	Yes	Yes	Yes

*CD, cannot determine; NA, not applicable; NR, not reported

RESULTS

A case report on the fabrication of a maxillary obturator utilizing an intra-oral digital impression for a patient who had a partial maxillectomy was published by Park et al. Evaluation of whether creating obturators with intraoral scanners can be a practical substitute for the traditional approach. The case report's findings demonstrated that the maxillary obturator made using an intraoral digital impression produced satisfactory short-term therapy results.

Tasopoulos et al. published a case report on Fabrication of an interim obturator using 3D printing the purpose of this study was to eliminate discomfort to maxillectomy patients during conventional impression technique. According to the study's findings, the temporary maxillary obturator was made using 3D printing technology, which also allowed for a shorter treatment duration by doing away with the necessity for painful traditional impression techniques.

Michelinakis et al. did Case report on Use of intra-oral scanner and CAD/CAM for fabrication of obturator prosthesis in patient with hemi-maxillectomy. The purpose was to eliminate the need for conventional impressions leading to a reduction in the number of appointments and increase patient comfort. The result of this study showed that the intra-oral scanning of the hemi-maxillectomy defect and implementation of CAD/CAM techniques for obturator fabrication serve as a viable option for less tissue irritation and more patient comfort.

Tasopoulos et al. in 2020 published a case report on Fabrication of a PEEK maxillary hollow-bulb obturator using intra-oral scanning, 3D printing, and CAD/CAM. The main objective of this study was to fabricate the obturator with PEEK to be more biocompatible and lightweight. The study resulted in an accurate two-piece hollow-bulb obturator while avoiding the discomfort associated with analogue impressions.

Ye et al. published a case report on Fully digital workflow for design and manufacture of obturator for maxillectomy defects. The main objective of this study was the assessment of accuracy of obturator fabricated using a fully digital workflow. The result of this study showed that the fully digital technique allowed efficient recording of the cavity of the defect accurately, and more convenient fabrication of a hollow-bulb obturator without patient discomfort

The main outcome of the review was that the application of digital workflows in the fabrication of obturators was found to reduce working time, minimize material consumption, and enhance patient comfort and acceptance.

DISCUSSION

Rehabilitation of maxillectomy defects can be challenging. These defects eventually impact the quality of life of the patients, subsequently also affecting their psychological status. These defects may be rehabilitated through surgical reconstruction or prosthodontic reconstruction, including the fabrication of obturator prostheses, depending on the clinical and physical condition of the patient. Therefore, prosthodontists play a crucial role in the rehabilitation of maxillectomy patients. Hence, meticulous knowledge of making precise impressions of defects in maxillectomy patients is extremely necessary for adequate prosthetic treatment, minimizing time for clinical appointments and providing greater patient comfort.

Obturator prostheses fabricated using digital impression have been found to have shown acceptable short term treatment outcomes, as suggested by Park et al. (2017), in a clinical case wherein they assessed whether using intraoral scanners for obturator fabrication in a patient with partial maxillectomy can be a viable alternative to conventional methods. They concluded that digital impressions can reduce patient discomfort and make impression-making easier.

Tasopoulos et al in 2018, reported a case in which 3D printing technology was used to fabricate the interim maxillary obturator, which in turn eliminated the need for uncomfortable conventional impression techniques, facilitating the shortening of treatment time as well. In the same year (2018), Michelinakis et al. reported a case in which they utilized intra-oral scanning of the hemi-maxillectomy defect in the patient and implementation of CAD/CAM techniques for obturator fabrication. They concluded that the use of the aforementioned digital techniques serves as a viable option for less tissue irritation and more patient comfort.

In a procedure where PEEK was used for the fabrication of a maxillary hollow-bulb obturator using intraoral scanning, 3D printing, and CAD/CAM by Tasopoulos et al. in 2020, it resulted in a lightweight and accurate two-piece hollow-bulb obturator while avoiding the discomfort associated with analog impressions.

In 2021, Ye et al reported a case wherein they assessed the accuracy of an obturator fabricated for maxillectomy patients using a fully digital workflow. The fully digital workflow used by them allowed efficient recording of the cavity of the defect accurately and more convenient fabrication of a hollow-bulb obturator without patient discomfort.

The advantages of using several digital applications for the fabrication of obturators, in patients with maxillectomy defects, which can aid a prosthodontist in making better clinical decisions while treating such patients.

CONCLUSIONS

The present systematic review includes case reports that have applied various digital techniques in the fabrication of obturators for maxillectomy patients. The main outcome of the review was that digital techniques, when applied to the fabrication of obturators, were found to reduce working time, minimize material consumption, and enhance patient comfort and acceptance.

Limitations

The current systematic review has a few limitations because only limited databases have been accessed. Only limited studies on digital technologies that are used in the fabrication of obturators are available in the literature, and in the present study, only case reports could be included.

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