ISSN: 2966-6864
International Journal of Maxillofacial Prosthetics
Published by DigitoPub | Digitodontics International Academy
DigitoPub
Open Access & Peer-reviewed
Indexed in: Crossref, ICI, Google Scholar

Evolution of Additive Manufacturing in Maxillofacial Prosthetic Rehabilitation: A Bibliometric and Clinical Evidence Mapping Study

Abdalmanem A. Abounqab[1]* | Ahmed M. Abdesalam[2] | Hesham I. Habibi[3] | Najah Almajdoub[4]

[1]Department of Paediatric Dentistry, Faculty of Dentistry, University of Zawia, Libya.
[2]Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, University of Zawia, Libya.
[3]Department of Orthodontics, Faculty of Dentistry, University of Zawia, Libya.
[4]Department of Oral and Maxillofacial Surgery, National Cancer Institute, Sabratha, Libya.

ABSTRACT

Purpose: To investigate the evolution of additive manufacturing in maxillofacial prosthetic rehabilitation from 2000 to 2026 by integrating bibliometric analysis with clinical evidence mapping, emphasizing research trends, technological applications, and the maturity of clinical evidence.

Materials and Methods: Original Scopus-indexed journal articles (2000–2026) were screened for direct or indirect additive manufacturing applications in maxillofacial prosthetic rehabilitation. After full-text assessment, 125 articles were included. Bibliometrix /Biblioshiny summarized publication trends, sources, citations, and bibliographic indicators; VOSviewer was used for co-authorship, country, keyword, bibliographic-coupling, and co-citation networks. Study designs and clinical outcome reporting were independently mapped.

Results: The 125 publications, drawn from 56 sources, received 2,955 Scopus citations; output peaked at 17 articles in 2025. The three leading prosthodontic journals contributed 56 articles (44.8%). The most cited paper received 133 citations. VOSviewer identified 53 recurrent authors, 36 countries, 42 harmonized author keywords, 14 bibliographic-coupling clusters, and five normalized co-citation clusters. Single-patient reports predominated (55.2%), and only seven studies (5.6%) used comparative clinical designs. Patient-reported feedback was confirmed in 37 of 98 clinically oriented reports, with structured instruments in nine and prosthesis follow-up in 29.

Conclusion: Additive manufacturing research in maxillofacial prosthetics has expanded substantially, progressing from technical development toward diverse clinical applications. However, the literature remains dominated by descriptive reports, with limited comparative evidence and inconsistent clinical outcome reporting. (*Int J Maxillofac Prosthetics 2026;9:26-39*)

Keywords: Additive manufacturing, Maxillofacial prostheses, Three-dimensional printing, Bibliometric analysis, Clinical evidence mapping.

ARTICLE INFO

*Corresponding author:
Abdalmanem A. Abounqab
Email: a.abounqab@zu.edu.ly

Received: 03 October 2026
Accepted: 05 October 2026
Published: 07 November 2026

DOI:
https://doi.org/10.26629/ijmp.2026.04

Copyright: © 2026 by the authors.
Articles published in the *Int J Maxillofac Prosthetics* are licensed under a Creative Commons Attribution-Noncommercial 4.0 International License.
https://creativecommons.org/licenses/by-nc/4.0/

AUDIOABSTRACT

How to cite this article | Abounqab AA, Abdesalam AM, Abdesalam AM, Habibi HI, Almajdoub N. Evolution of additive manufacturing in maxillofacial prosthetic rehabilitation: A bibliometric and clinical evidence mapping study. Int J Maxillofac Prosthetics 2026;9:26-39.

INTRODUCTION

Maxillofacial defects caused by oncologic resection, trauma, congenital anomalies, and infection may compromise facial appearance, speech, swallowing, mastication, and psychosocial well-being. Prosthetic rehabilitation remains an essential option when surgical reconstruction is inappropriate, incomplete, or unable to restore the required form and function. Nevertheless, conventional fabrication relies on complex impressions, manual sculpting, and repeated laboratory procedures that can be uncomfortable for patients and highly dependent on operator experience. Early investigations of rapid prototyping illustrated its potential to reproduce complex facial morphology, while subsequent studies extended computer-aided workflows to functional rehabilitation with maxillary obturators and palatal augmentation prostheses.[1-3]

The integration of three-dimensional (3D) imaging, computer-aided design (CAD), and additive manufacturing (AM) has progressively changed how maxillofacial prostheses are designed and produced. Foundational work demonstrated laser-based digitization, virtual reconstruction, and the manufacture of facial prosthesis replicas or negative molds; subsequent applications translated these concepts into patient-specific auricular rehabilitation.[4-6] Unlike conventional molding alone, AM can manufacture complex geometries directly from digital files and facilitate repeatable production. However, its contribution extends beyond printing the definitive prosthesis to printed patterns, molds, casts, frameworks, and intermediate components may also be integral to the delivery of a conventionally finished device. A proof-of-concept investigation also demonstrated how existing obturators could be scanned and retained as digital records for potential replacement.[7] This distinction is fundamental when evaluating the clinical maturity of digital prosthodontic workflows.

More recent developments include the direct printing of silicone facial prostheses, multimaterial auricular devices, and digitally manufactured obturator bases and artificial teeth.[8-10] Direct fabrication may streamline production and reduce dependence on manual pattern duplication, whereas indirect workflows preserve the established processing characteristics of conventional maxillofacial elastomers. Digitizing an existing obturator also enabled its replacement and delivery in two visits for a frail older patient.[11] Yet technical barriers remain clinically relevant. Polymerization inhibition at the interface between printed resin molds and room-temperature-vulcanizing silicone has been documented during nasal prosthesis fabrication, underscoring the importance of material compatibility, postprocessing, and biological safety.[12] Therefore, the availability of a printable geometry does not necessarily establish that the resulting device is durable, esthetically acceptable, or appropriate for long-term patient use.

Experimental investigations have examined dimensional trueness, manufacturing accuracy, cost, and structural properties in an effort to clarify the performance of emerging processes. Comparative analyses of obturator bases and hollow obturator designs, as well as evaluations of alternative printing systems for oculopalpebral models, provide increasingly quantitative technical evidence.[13-15] Clinical comparisons have also assessed the esthetics, marginal adaptation, patient visits, and fabrication time associated with rapid-prototyping-assisted auricular prostheses.[16] However, laboratory accuracy or reduced manufacturing time cannot be assumed to translate into improved chewing, speech, retention, comfort, or prosthesis survival. Distinguishing laboratory specimens, anatomical models, observers, and treated patients is therefore necessary to avoid overstating the extent of clinical validation.

Clinical investigations are beginning to move beyond isolated demonstrations, although their objectives and endpoints remain heterogeneous. A randomized crossover study

investigated the effect of printed obturator bulb-wall thickness on mastication, while other comparative studies evaluated patient satisfaction with digitally produced obturators and the chairside adaptation of definitive printed obturators.[17-19] Not all findings favor digital production: a clinical feasibility study of statistically shaped nasal prostheses reported lower descriptive satisfaction with the modeled devices than with conventional prostheses.[20] Prospective observations of printed nasal rehabilitation have nevertheless provided patient-reported information about feasibility and acceptability.[21] Taken together, these reports suggest expanding clinical application but do not, by themselves, establish generalizable superiority over conventional prosthetic rehabilitation.

Although the AM literature encompasses several decades of technological development, a combined assessment of its publication landscape and clinical evidence remains important. Bibliometric indicators can characterize growth, influential contributions, collaboration, and evolving research themes, but they do not measure clinical effectiveness. Conversely, an evidence map can identify study designs, patient involvement, measured outcomes, follow-up, and complications, but provides limited insight into the field's intellectual and collaborative structure. Therefore, this study aimed to characterize the evolution of original research on AM in maxillofacial prosthetic rehabilitation from 2000 to 2026 through Scopus-based bibliometric and network analyses, and to map the corresponding clinical and preclinical evidence, with particular attention to the transition from manufacturing feasibility to patient-centered evaluation.

MATERIALS AND METHODS

Search Strategy

A bibliographic search was conducted in Scopus (Elsevier), with the final database export performed on September 2026. The search covered publications from 2000 to 2026 and used combinations of terms related to additive manufacturing, including *3D printing, three-dimensional printing, rapid prototyping,* and *additive manufacturing*, and maxillofacial prosthetic rehabilitation, including *maxillofacial prostheses, obturators,* and *auricular, nasal, ocular, and orbital prostheses*. The initial search yielded 461 records. After restriction to English-language journal articles and reviews, 362 records underwent title-and-abstract screening. Full texts of 129 potentially eligible original articles were assessed, resulting in 125 included publications. Reviews, conference papers, and studies involving exclusively surgical applications without direct relevance to prosthetic rehabilitation were excluded.

Eligible reports examined direct printing of interim or definitive maxillofacial prostheses or indirect printing of components integral to their fabrication, including molds, patterns, casts, and frameworks. Applications included obturators, palatal augmentation devices, and ocular, orbital, nasal, auricular, and other facial prostheses. Clinical studies, case reports, original technical investigations, and laboratory studies were eligible. Records were reconciled using article identifiers, DOIs, and Scopus electronic identifiers; no duplicate EIDs remained in the final set.

Study Classification and Evidence Extraction

Full texts were assigned one mutually exclusive primary design: single-patient clinical report/technique, clinical case series, noncomparative clinical pilot, nonrandomized or randomized clinical comparison, technical development with patient-specific clinical demonstration, preclinical technical feasibility, or preclinical comparative laboratory investigation. A secondary grouping distinguished clinical study designs, technical studies with clinical demonstrations, and preclinical investigations. Patient-derived scans and prototype fabrication alone were not considered evidence of definitive clinical treatment.

Extracted variables comprised prosthetic indication, number of patients treated or evaluated, printing process and printed component, comparator, patient-reported and functional outcomes, manufacturing outcomes, follow-up, maintenance, adverse events, and material or fabrication problems. Patients, healthy volunteers, observers, prostheses, and specimens were counted separately. The clinical outcome-reporting census included 98 clinical-design or patient-specific demonstration articles; 27 preclinical studies were assessed separately. Only outcomes explicitly supported by the source were coded as confirmed; uncertain or incompletely documented outcomes were classified as not established. Post-delivery prosthesis follow-up was distinguished from surgical healing, osseointegration, oncologic surveillance, and laboratory aging.

Bibliometric and Network Analysis

Scopus-derived annual production, source productivity, global citation impact, and descriptive bibliometric indicators were validated with the bibliometrix R package and its Biblioshiny interface.[29,30] The 125-record was retained as the common bibliographic source; 2026 was treated as an incomplete year. Source-derived total citations were distinguished from citations within the selected corpus. Bibliometrix name-based author counts and its international co-authorship measure were retained as software-specific estimates and compared against source author identifiers and an independently audited affiliation-country dataset. No additional thematic-map or three-field figures were selected because they would overlap with the dedicated VOSviewer visualizations.

Bibliometric networks were generated using VOSviewer version 1.6.21.[28] Affiliation strings were conservatively corrected for country extraction. Author and country co-authorship used full counting, with minimum document thresholds of two per author and one per country; a two-document country sensitivity network was also assessed. Author-keyword co-occurrence used full counting, a two-occurrence minimum, and a synonym thesaurus; node colors in its overlay reflected mean publication year. Document-level bibliographic coupling retained all 125 included records (zero minimum citations), and cited-reference co-citation required at least three within-corpus citations per reference. Association-strength normalization was used for citation-based network layouts. Descriptive results are presented as frequencies, percentages, citations and network indices; no meta-analysis was performed because clinical populations and endpoints were heterogeneous.

RESULTS

Publication Characteristics and Citation Impact

Of 461 Scopus records, 362 proceeded to title-and-abstract screening, 129 potentially eligible original articles were assessed in full text, and 125 were included. The included articles appeared across 56 publication sources from 2000 to 2026. Annual production peaked at 17 articles in 2025; seven articles were indexed during the incomplete year 2026 (Fig. 1). Bibliometrix estimated annual growth of 7.77%, which should be interpreted cautiously given the partial final year. The 125 articles accumulated 2,955 Scopus citations (median, 14; mean, 23.64 per document) by September 2026. The Journal of Prosthetic Dentistry published 28 articles (22.4%), the Journal of Prosthodontics 15 (12.0%), and the International Journal of Prosthodontics 13 (10.4%); jointly, these journals accounted for 56 articles (44.8%) (Fig. 2). Among included papers, the highest global citation counts were recorded for Unkovskiy et al. (2018; 133), Liacouras et al. (2011; 116), and Subburaj et al. (2007; 110), followed by Nuseir et al. (2019) and Cheah et al. (2003), each with 100 (Fig. 3). Citation counts reflect scholarly uptake, not clinical evidence quality.

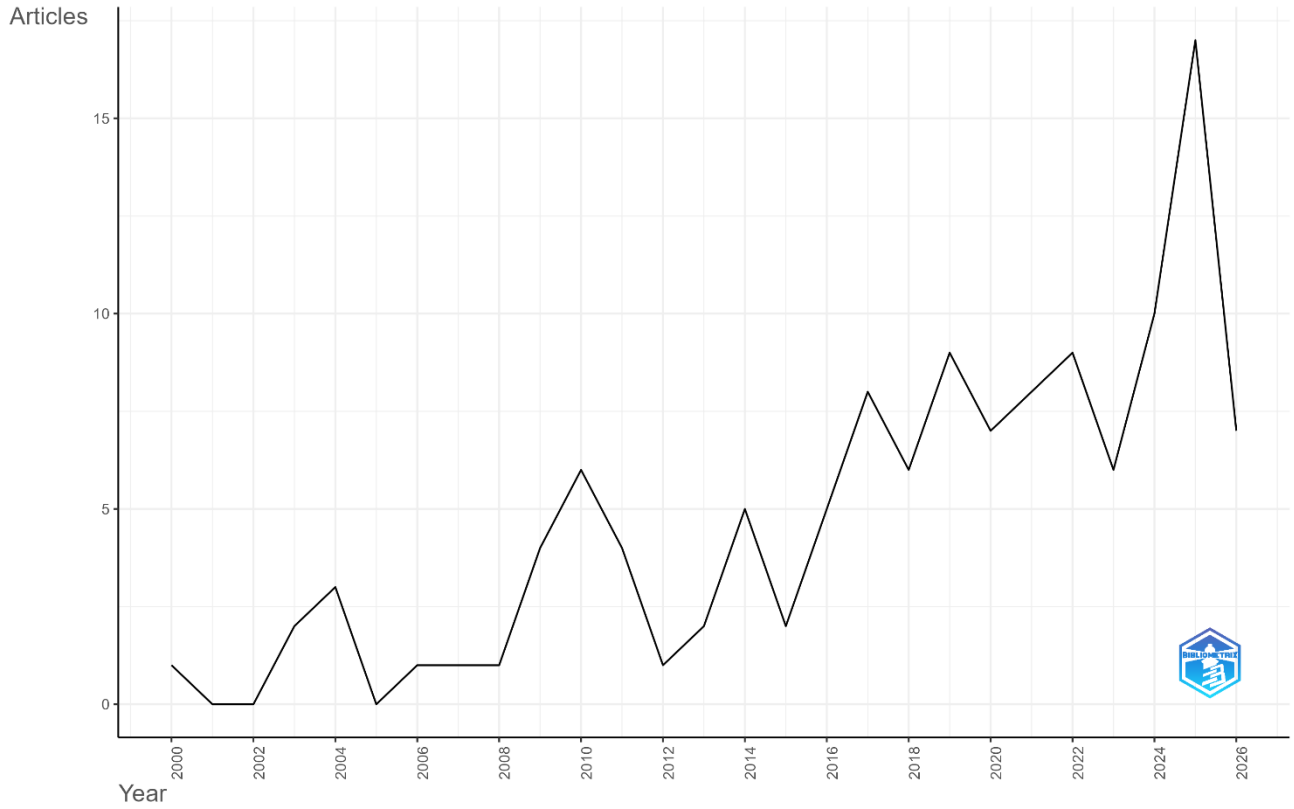


Fig 1: Annual scientific production in additive manufacturing research for maxillofacial prosthetic rehabilitation (2000–2026).

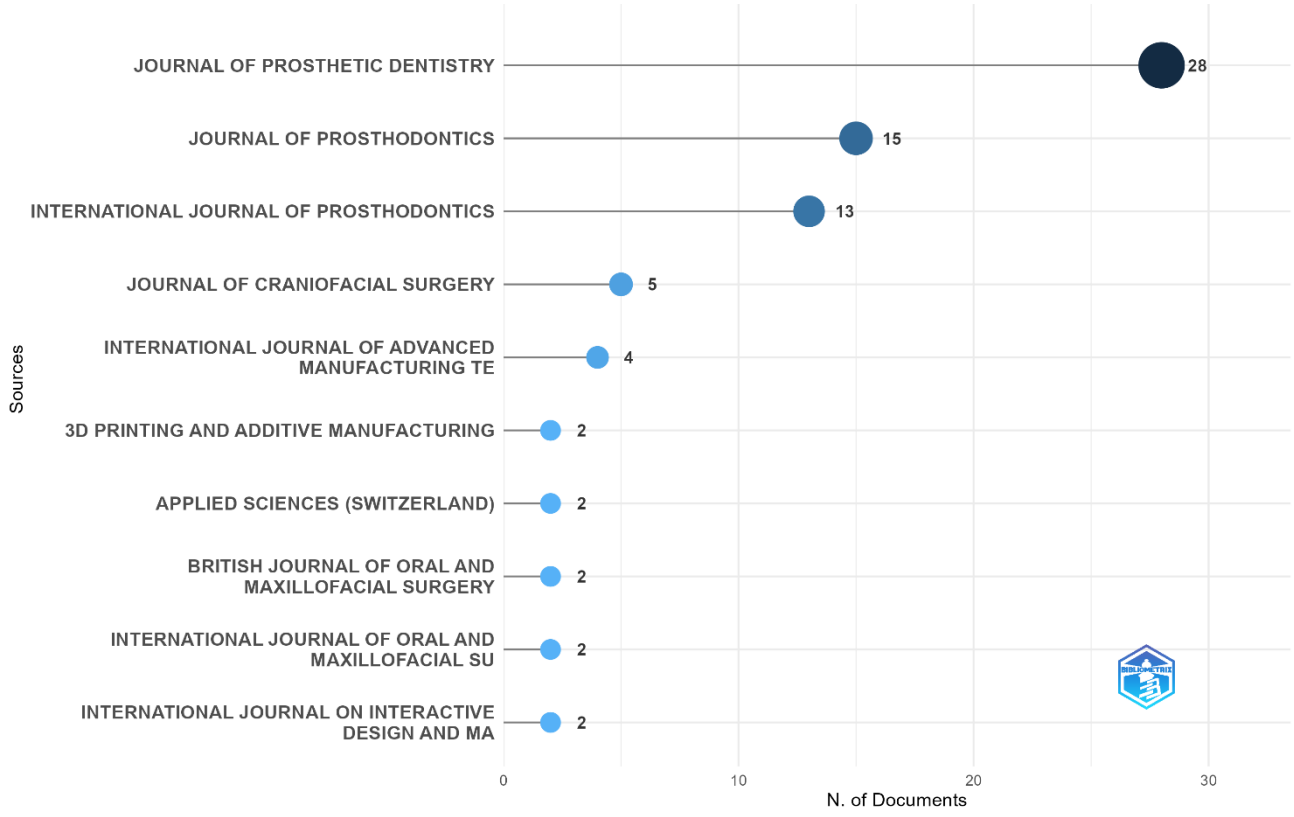


Fig 2: Ten most productive publication sources (Bibliometrix/Biblioshiny).

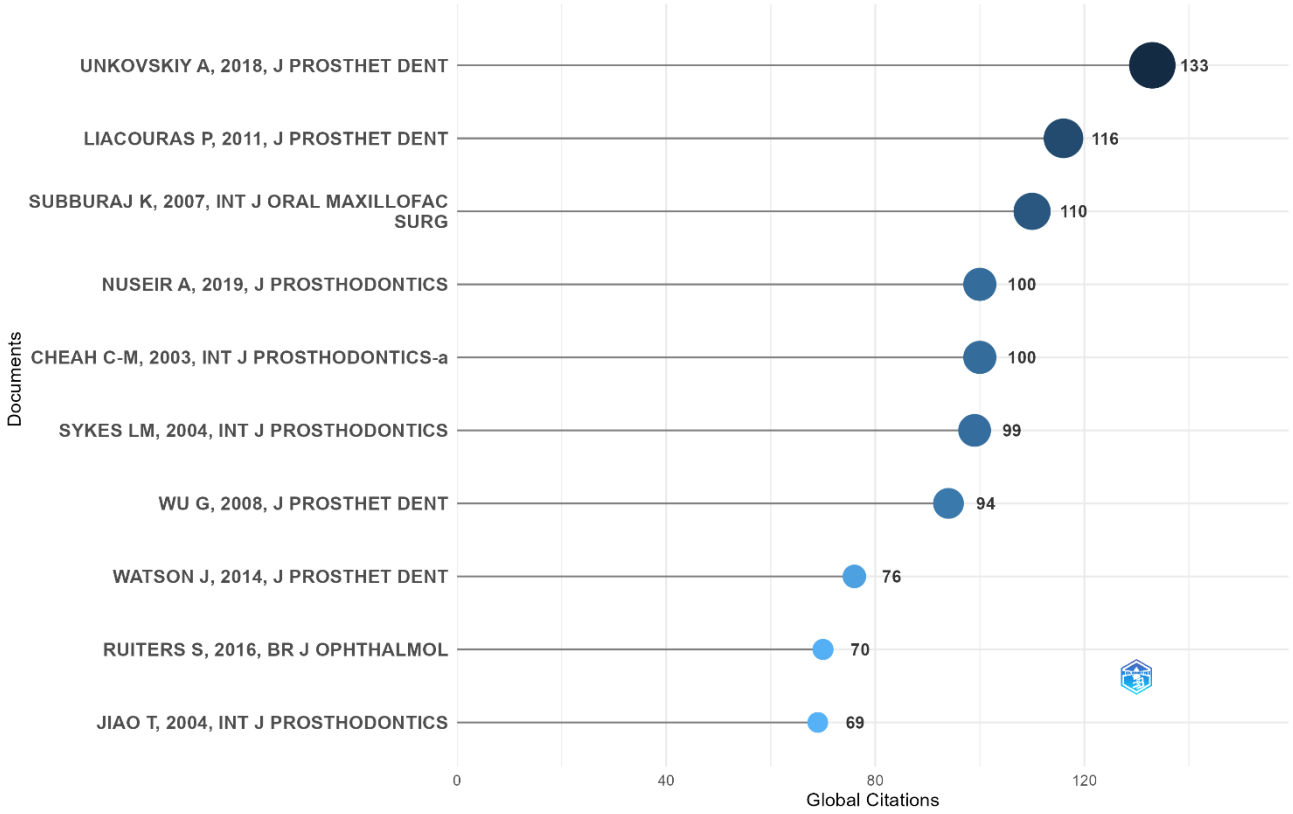


Fig 3: Ten most globally cited included publications (Bibliometrix/Biblioshiny).

Collaboration and Thematic Networks

Bibliometrix parsed 459 distinct author names (4.43 co-authors per document), whereas source-record reconciliation identified 449 distinct Scopus author IDs; these non-equivalent definitions were not combined. In VOSviewer, 53 authors met the minimum two-publication threshold, forming 17 clusters, 69 links, and total link strength 148 (Fig. 4). The corrected country network comprised 36 countries, 26 clusters, 16 links, and total link strength 22 when all contributing countries were retained (Fig. 5). At a minimum of two publications per country, 24 countries remained, with 16 clusters, 14 links and total link strength 20. Bibliometrix classified 12.8% (16/125) of publications as internationally co-authored, compared with 17 publications containing multiple affiliation countries in the independent corrected-field audit. These definitions and parsing differences remain unreconciled and are reported separately. The visualized networks indicate relatively limited cross-group collaboration.

Author keywords were available for 77 publications (61.6%). After synonym harmonization, the VOSviewer co-occurrence network contained 42 keywords at a minimum two-occurrence threshold, eight clusters, 166 links, and total link strength 256 (Fig. 6A). Connected topics included 3D printing, rapid prototyping, computer-aided design, additive manufacturing, and prosthesis-specific applications. The overlay (Fig. 6B) associated rapid prototyping and reverse engineering with earlier average publication years, whereas digital impressions, digital workflows, and patient-centered terminology tended to appear more recently. These are patterns of keyword use, not dates of technological introduction or evidence of effectiveness.

Citation-based Structure

Cited-reference metadata were present for 121 articles (96.8%). VOSviewer bibliographic coupling of the 125 selected publications yielded 14 clusters, 1,098 links and total link strength 1,888 (Fig. 7). Six clusters contained

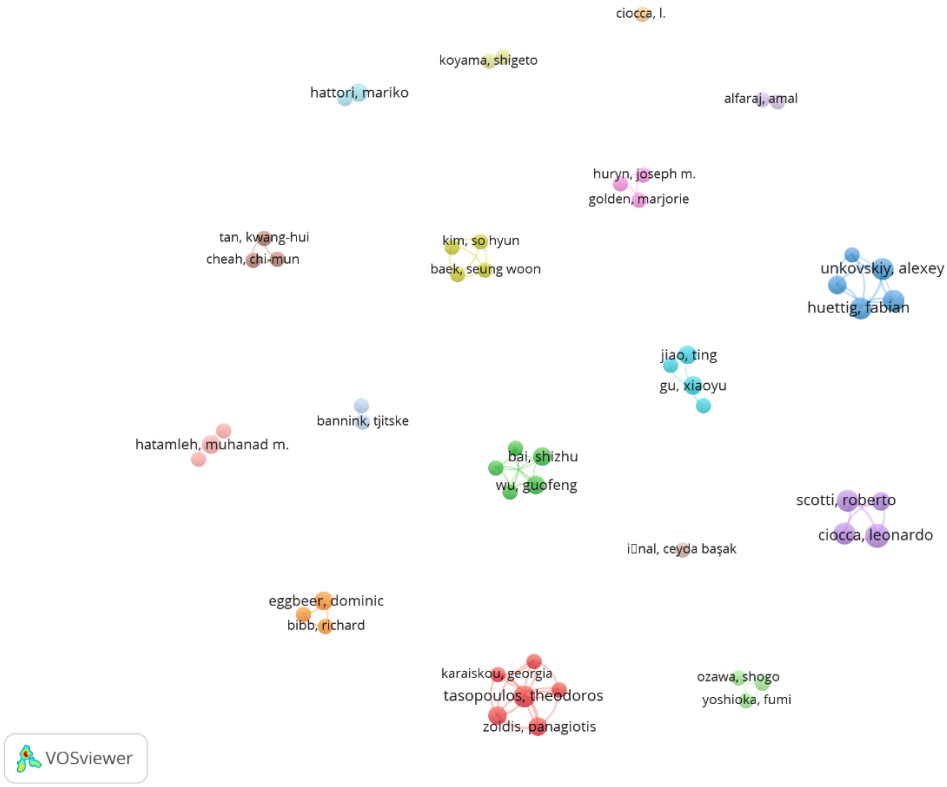


Fig 4: Author co-authorship network (VOSviewer 1.6.21). Full counting; minimum two documents per author.

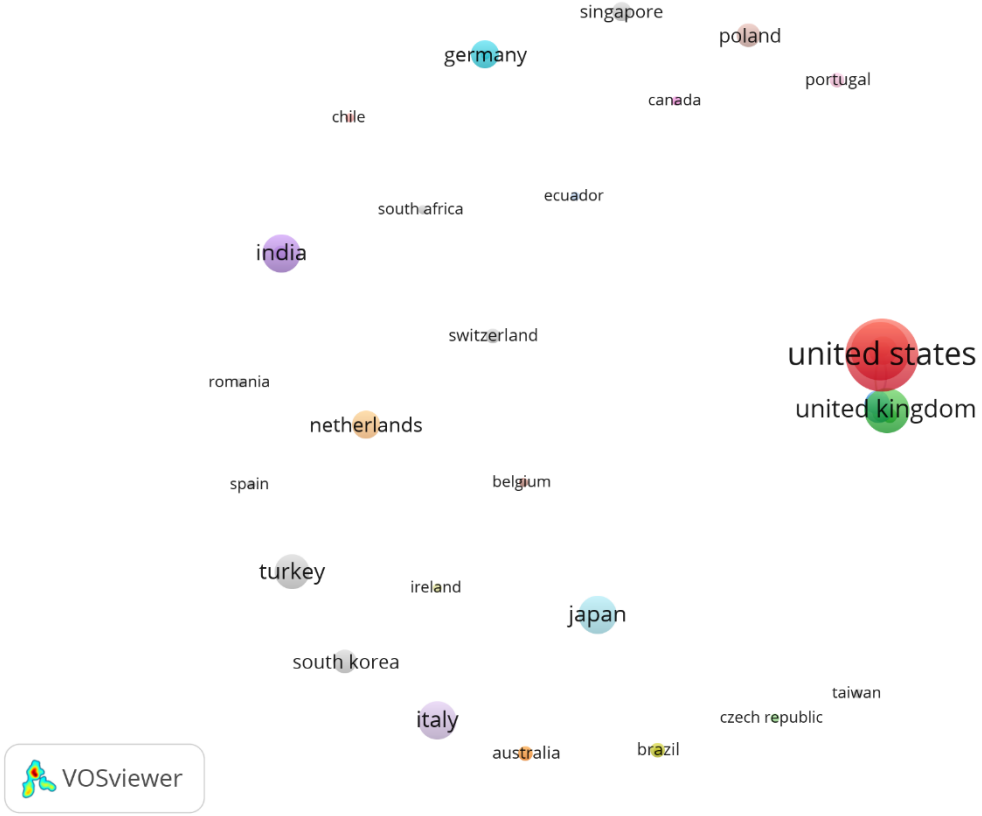


Fig 5: Country-level co-authorship network using corrected affiliation metadata, full counting, and a one-document minimum.

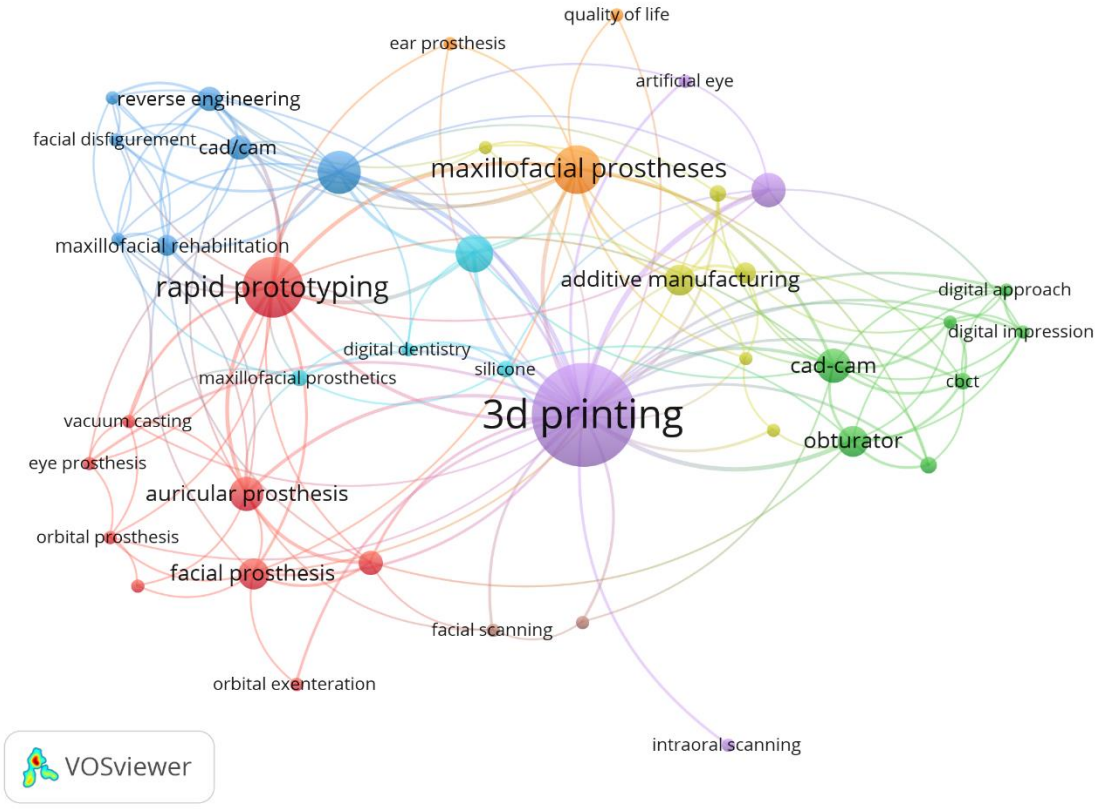


Fig 6A: Harmonized author-keyword co-occurrence network (VOSviewer 1.6.21).

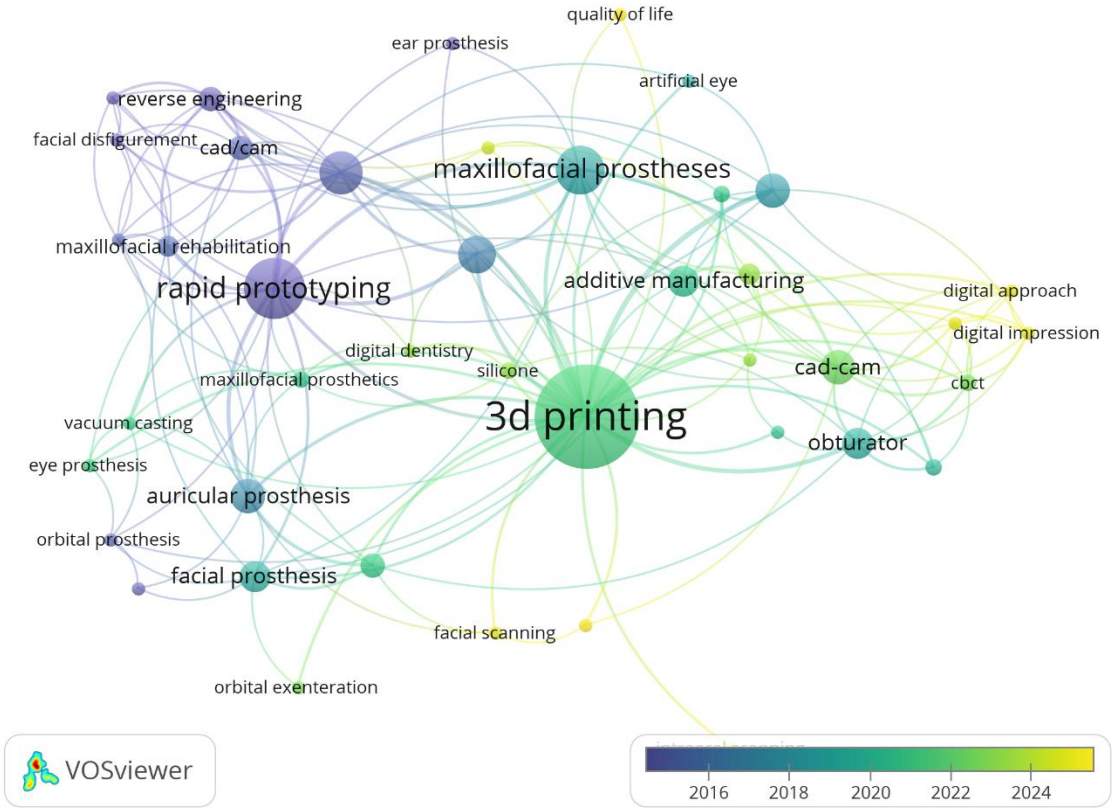


Fig 6B: Average-publication-year overlay of the author-keyword network in Figure 6A.

117 publications (93.6%), while eight comprised single publications. After cited-reference disambiguation, co-citation mapping retained 66 cited references, five clusters, 448 links and total link strength 709 (Fig. 8). The reference groups linked established obturator design and maxillofacial prosthodontic principles with digital facial prosthesis development and fabrication techniques. Shared-reference and co-citation relations describe intellectual proximity, not patient-level benefit.

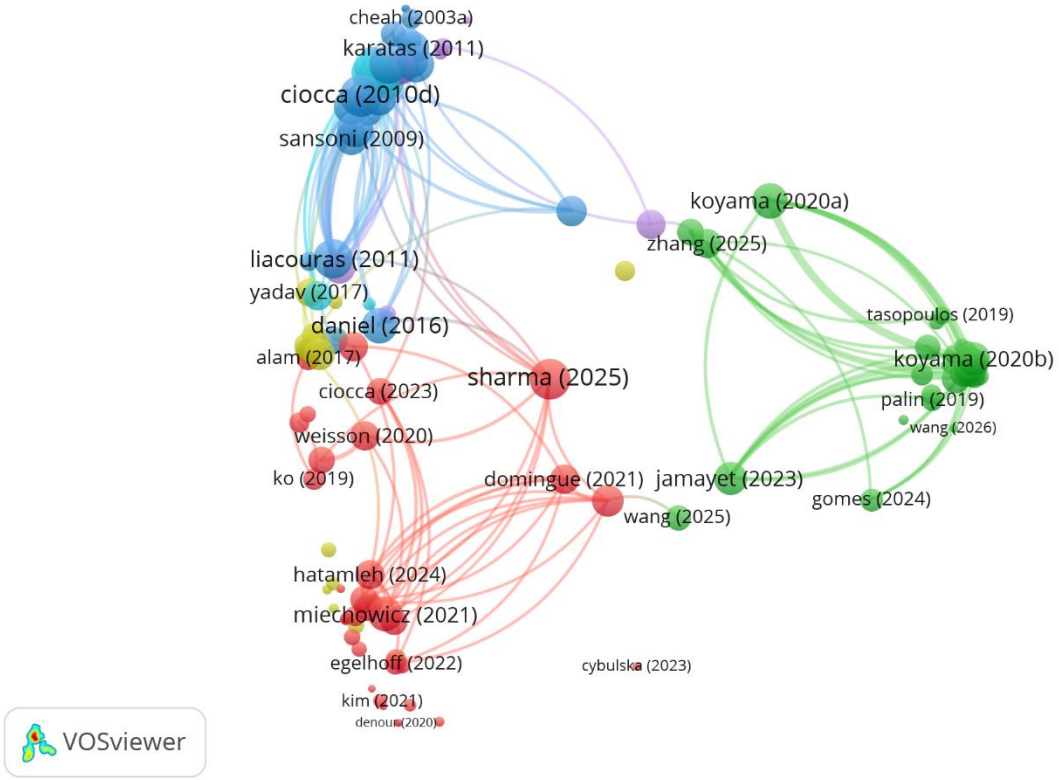


Fig 7: Bibliographic coupling among the 125 included publications (VOSviewer 1.6.21).

Study Designs and Clinical Evidence

Single-patient clinical reports or techniques predominated (69/125, 55.2%), followed by preclinical technical feasibility (17, 13.6%), technical development with clinical demonstration (11, 8.8%), and preclinical comparative laboratory studies (10, 8.0%). Eight articles (6.4%) were clinical case series, four (3.2%) nonrandomized clinical comparisons, three (2.4%) randomized clinical comparisons as described by their authors, and three (2.4%) noncomparative clinical pilots. Overall, 87 studies (69.6%) had clinical study designs, 11 (8.8%) contained patient-specific clinical demonstrations, and 27 (21.6%) were preclinical. Only seven articles (5.6%) used comparative clinical designs.

Among the 98 clinically oriented articles, clinical use or fitting was explicitly established in 77 (78.6%), with prototype-only fitting in eight (8.2%). Patient-reported feedback was confirmed in 37 (37.8%), use of a named structured patient-reported instrument in nine (9.2%), objective functional testing in two (2.0%), and documented prosthesis follow-up in 29 (29.6%). Clinical adverse events were confirmed in two reports and manufacturing or material problems in five.

Clinical comparisons assessed disparate

outcomes. Digital obturator impressions required approximately 320 seconds versus 764 seconds conventionally (P < .001).[19] A crossover comparison of 3D-printed obturator bulb thicknesses found higher masticatory questionnaire scores with 1-mm than 3-mm walls (70.88 versus 48.23; P < .001),[17] but did not compare printing with conventional manufacture. Modeled nasal prostheses showed lower descriptive satisfaction than conventional prostheses (median, 56 versus 71),[20] although evaluation denominators differed. Rapid-prototyping-assisted auricular workflows reduced laboratory fabrication time relative to conventional fabrication.[16] Eight case series documented 37 prosthetically treated patients. Across uncontrolled reports, follow-up, prosthetic maintenance, and patient-centered outcomes were inconsistently documented.

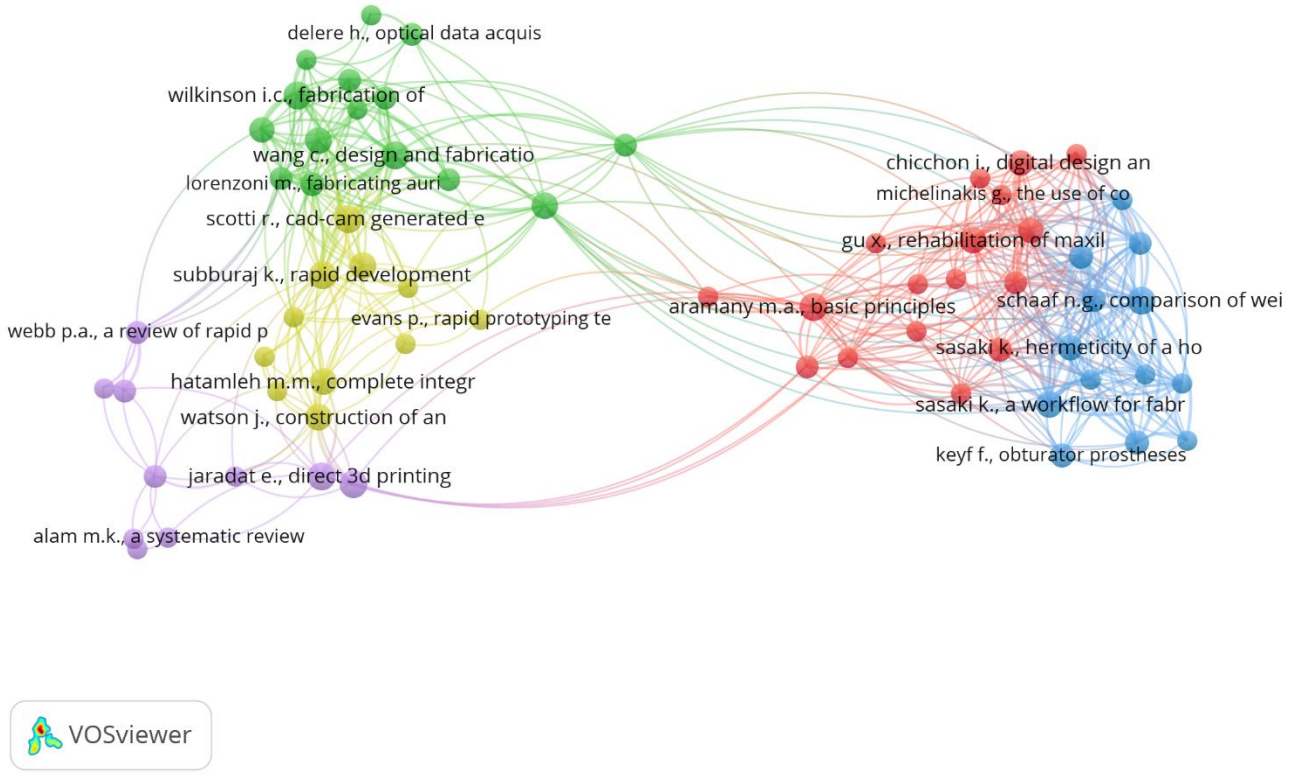


Fig 8: Cited-reference co-citation network after reference normalization (VOSviewer 1.6.21).

DISCUSSION

The present bibliometric and clinical evidence map reveals a marked expansion of additive manufacturing research in maxillofacial prosthetic rehabilitation, particularly during the past decade, but comparatively modest progression toward higher-level clinical evidence. Although 87 of the 125 included publications were assigned a clinical study design, 69 were single-patient reports or technique descriptions, while only seven used a comparative clinical design. This imbalance is consistent with a field in which technological innovation has often preceded systematic clinical evaluation. Early CAD/CAM investigations established the feasibility of digitally reproducing complex facial anatomy and fabricating prosthetic patterns or molds.[4-6] Subsequent work extended these principles to printed silicone prostheses, obturators, and patient-specific manufacturing workflows.[8-10,22] However, the number of clinically oriented papers should not be interpreted as the number establishing clinical effectiveness:

many demonstrate fabrication, fitting, or short-term acceptability without a comparator or validated outcome measure.

Bibliometric findings reinforce the distinction between research dissemination and clinical-evidence maturity. Bibliometrix confirmed the predominance of three prosthodontic journals, which together contributed 44.8% of publications, and highlighted the influence of early CAD/CAM and fabrication-oriented articles among the most cited works. Yet citation totals cannot establish methodological rigor or comparative clinical benefit. The VOSviewer author and country maps revealed relatively fragmented collaboration, while keyword and citation-based networks linked technical manufacturing themes to clinical indications. Name-based author counts differed from Scopus author-ID counts, and a corrected affiliation audit identified one more internationally affiliated publication than Bibliometrix; these discrepancies underscore the importance of specifying counting methods. Keyword interpretation remains restricted by the 48 records without author keywords. Taken together, the findings suggest broad technological diffusion but less consistent progression toward multicenter clinical validation.

The strongest emerging clinical signal concerns workflow feasibility and selected aspects of manufacturing efficiency, although results differ by indication and comparator. A clinical comparison of digitally fabricated obturators reported substantially shorter impression times than conventional techniques without a statistically significant difference in adaptation,[19] while a small auricular pilot documented fewer appointments and reduced manufacturing time using rapid-prototyping-assisted methods.[16] A crossover trial found improved scores for some patient-reported domains with a digitally manufactured obturator, but its conventional-first treatment sequence and treatment of repeated observations in the analysis warrant caution.[18] A separate randomized crossover investigation compared wall thicknesses among printed obturators, rather than additive manufacturing with conventional fabrication, and therefore addresses prosthesis design optimization rather than technology superiority.[17] Importantly, a nasal feasibility study reported lower satisfaction with statistically shaped prostheses than with conventional devices.[20] These mixed findings argue against a general claim that digital fabrication produces better patient outcomes across prosthesis types; performance appears to depend on the anatomy, manufacturing pathway, material, and outcome being evaluated.

Practical benefits and limitations are closely intertwined. Indirect additive manufacturing remains relevant when conventional silicone or other established definitive materials are required: printed patterns, molds, and working models can facilitate complex anatomical reproduction while preserving conventional finishing and characterization.[5,22-25] Such hybrid workflows may be especially valuable for patients with severely restricted mouth opening, in whom CT-derived models can be combined with targeted conventional impressions.[23] Clinical reports of bilateral auricular rehabilitation and replacement of an implant-retained ear demonstrate how digital methods can support challenging anatomical reconstruction and streamline subsequent prosthesis production.[24,25] A digital obturator archive has been demonstrated in a technical pilot,[7] while a separate single-patient report documented reproduction of an existing obturator within two appointments;[11] neither establishes comparative clinical effectiveness. Noncontact orbital surface mapping and silicone casting offer another example of an indirect digital approach.[27] Yet direct printing introduces distinct biological and mechanical questions. A pilot investigation of printed ocular prostheses included material safety testing and short-duration clinical assessment,[26] whereas a material-jetting nasal prosthesis report documented silicone cure inhibition at the resin-mold interface and subsequent prosthetic deterioration.[12] Dimensional accuracy and

mass reduction documented in laboratory obturator studies are useful engineering outcomes but cannot substitute for measurements of comfort, retention, speech, mastication, mucosal tolerance, or service life.[13-15]

The outcome census exposes an important reporting gap. Among 98 clinically oriented or patient-specific demonstration articles, explicit patient feedback was identified in 37, a named structured patient-reported measure in nine, objective functional testing in at least two, and a clinical follow-up interval in 29. These values are conservative minima based on the available extraction and should not be interpreted as evidence that unconfirmed studies collected no relevant data. Nor should the low number of explicitly reported adverse events be taken to indicate a low complication rate: systematic surveillance and consistent definitions were uncommon. Future investigations should prioritize multicenter prospective cohorts and appropriately randomized comparisons, adequate sample sizes, standardized patient-reported instruments, objective function and prosthesis-fit assessments, material biocompatibility, and prespecified maintenance or failure endpoints. Longer follow-up is particularly important because digital precision at delivery does not establish long-term retention or material durability. Comparative studies should also separate the effect of the printing technique from differences in prosthesis design, impression method, and clinical management.

Several limitations warrant consideration. The Scopus-only search, restriction to English-language original journal articles, and reliance on indexed metadata may have excluded relevant studies. The 2026 publication year was incomplete, making annual growth estimates sensitive to coverage. Citation counts are age-dependent and do not indicate clinical quality. Source affiliations required correction; Bibliometrix and author-ID based counts differed, and their multinational-publication classifications were not identical. Author keywords were missing in 48 publications, and residual cited-reference variants may remain after normalization. All network indices depend on counting, inclusion thresholds, and normalization choices; clustering does not establish distinct clinical evidence classes. Clinical studies were heterogeneous in indication, manufacturing pathway, comparator, and endpoints, and reporting frequencies represent confirmed minima rather than confirmed absence of outcomes. Consequently, the synthesis maps reported research and evidence gaps rather than providing a pooled estimate of effectiveness.

CONCLUSION

Additive manufacturing has become an established component of the published maxillofacial prosthetic rehabilitation workflow, with research extending from printed anatomical patterns and molds to definitive prosthetic components. Nevertheless, the literature remains dominated by single-patient and technical reports, and comparative clinical evidence is limited. Available studies support manufacturing feasibility and selected efficiency benefits, but do not consistently establish superior function, patient satisfaction, or long-term performance. Future multicenter investigations using standardized clinical outcomes, material-safety assessment, and longitudinal follow-up are needed to translate technological advances into robust evidence for patient care.

Conflicts of Interest

The authors declare no conflicts of interest.

CRediT authorship contribution

Abounqab AA: Conceptualization, Methodology, Investigation, Writing – Original Draft. **Abdesalam AM and Habibi HI:** Data Curation, Formal Analysis, Visualization, Writing – Review & Editing. **Almajdoub N:** Supervision, Project Administration, Writing – Review & Editing.

All authors have read and approved the final

manuscript and agree to be accountable for all aspects of the work.

REFERENCES

1. Sykes LM, Parrott AM, Owen CP, Snaddon DR. Applications of rapid prototyping technology in maxillofacial prosthetics. Int J Prosthodont. 2004;17:454-459.
2. Jiao T, Zhu C, Dong X, Gu X. Rehabilitation of maxillectomy defects with obturator prostheses fabricated using computer-aided design and rapid prototyping: A pilot study. Int J Prosthodont. 2014;27:480-486. doi:10.11607/ijp.3733.
3. Li B, Murase M, Yamatani Y, Masaki K, Hattori M, Wakabayashi N. Applying Digital Technology to a Hollow Palatal Augmentation Prosthesis in an Older Adult Hemiglossectomy Patient: A Case Report. Gerodontology. 2025;42:429-433. doi:10.1111/ger.12828.
4. Cheah CM, Chua CK, Tan KH, Teo CK. Integration of laser surface digitizing with CAD/CAM techniques for developing facial prostheses. Part 1: Design and fabrication of prosthesis replicas. Int J Prosthodont. 2003;16:435-441.
5. Cheah CM, Chua CK, Tan KH. Integration of laser surface digitizing with CAD/CAM techniques for developing facial prostheses. Part 2: Development of molding techniques for casting prosthetic parts. Int J Prosthodont. 2003;16:543-548.
6. Subburaj K, Nair C, Rajesh S, Meshram SM, Ravi B. Rapid development of auricular prosthesis using CAD and rapid prototyping technologies. Int J Oral Maxillofac Surg. 2007;36:938-943. doi:10.1016/j.ijom.2007.07.013.
7. Elbashti M, Hattori M, Sumita Y, Aswehlee A, Yoshi S, Taniguchi H. Creating a digitized database of maxillofacial prostheses (obturators): a pilot study. J Adv Prosthodont. 2016;8:219-223. doi:10.4047/jap.2016.8.3.219.
8. Unkovskiy A, Spintzyk S, Brom J, Huettig F, Keutel C. Direct 3D printing of silicone facial prostheses: A preliminary experience in digital workflow. J Prosthet Dent. 2018;120:303-308. doi:10.1016/j.prosdent.2017.11.007.
9. Unkovskiy A, Wahl E, Huettig F, Keutel C, Spintzyk S. Multimaterial 3D printing of a definitive silicone auricular prosthesis: An improved technique. J Prosthet Dent. 2021;125:946-950. doi:10.1016/j.prosdent.2020.02.021.
10. Krämer Fernandez P, Kuscu E, Weise H, Engel EM, Spintzyk S. Rapid additive manufacturing of an obturator prosthesis with the use of an intraoral scanner: A dental technique. J Prosthet Dent. 2022;127:189-193. doi:10.1016/j.prosdent.2020.07.033.
11. Elbashti ME, Sumita YI, Hattori M, Aswehlee AM, Taniguchi H. The role of digitization in the rapid reproduction of an obturator in a frail elderly patient. Int J Prosthodont. 2016;29:592-594. doi:10.11607/ijp.4932.
12. Chen C, Chao D, Jayanetti J. Silicone cure inhibition with material jetting additive manufacturing utilized for facial prosthesis fabrication – A clinical report. J Prosthodont. 2026;35:18-22. doi:10.1111/jopr.13968.
13. Alfaraj A, Yang CC, Levon JA, Chu TMG, Morton D, Lin WS. The Trueness of Obturator Prosthesis Base Manufactured by Conventional and 3D Printing Techniques. J Prosthodont. 2022;31:221-227. doi:10.1111/jopr.13396.
14. Spatz HI, Schmitz JT, Singh A, Golden M, Riedel E, Randazzo JD, et al. Comparison of the weight of conventionally heat-processed hollow and solid obturators and 3D printed hollow obturators. J Prosthet Dent. 2025;134:492-500. doi:10.1016/j.prosdent.2023.09.030.
15. Eyzaguirre D, Salazar-Gamarra R, Binasco Lengua S, Lauria Dib L. Evaluation of additive manufacturing processes in the production of oculo-palpebral prosthesis. F1000Res. 2022;11:505. doi:10.12688/f1000research.111231.2.

16. Manju V, Babu AS, Krishnapriya VN, Chandrashekar J. Rapid Prototyping Technology for Silicone Auricular Prosthesis Fabrication: A Pilot Study. J Head Neck Physicians Surg. 2021;9:35-40. doi:10.4103/jhnps.jhnps_22_21.
17. Benli M. The Effect of the Wall Thickness of 3D-Printed Obturator Bulbs on Masticatory Function in Patients with Aramany Class I Defects: A Randomized Crossover Clinical Trial. Int J Prosthodont. 2023;36:681-688. doi:10.11607/IJP.8084.
18. AboShady MM, Amer MM. Patient satisfaction with conventional versus fully digital obturators fabricated with 3D printing: a randomized crossover trial. BMC Oral Health. 2025;25:826. doi:10.1186/s12903-025-06106-y.
19. Zhang H, Gan J, Zhu C, Jiao T. A digital workflow for fabrication of a 3D-printed definitive obturator prosthesis and a preliminary evaluation of its clinical adaptation: A randomized self-controlled study. J Prosthodont. 2026;35:143-152. doi:10.1111/jopr.70052.
20. Bannink T, de Ridder M, Bouman S, van Alphen MJA, van Veen RLP, van den Brekel MWM, et al. Computer-aided design and fabrication of statistically shaped nasal prostheses: A feasibility study. J Prosthet Dent. 2025;134:2615-2622. doi:10.1016/j.prosdent.2024.12.008.
21. Salati V, Reinhard A, Broome M. Three-Dimensional Printed Nasal Prostheses After Oncologic Rhinectomies: Workflow and Patients' Satisfaction. J Craniofac Surg. 2021;32:2297-2300. doi:10.1097/SCS.0000000000007659.
22. Wang S, He F, Fu Y, Gu X. A digital workflow for designing and fabricating a split negative mold of obturator for patients with palatal defects. Support Care Cancer. 2025;33:729. doi:10.1007/s00520-025-09804-z.
23. Mense C, Silvestri F, Mansuy C, Bezier C, Lan R. Combined tomography and conventional impression with notch system to fabricate prosthesis with palatal obturator in patients with severe limited mouth opening. J Dent Sci. 2025;20:1908-1911. doi:10.1016/j.jds.2025.02.020.
24. Hatamleh MM, Hatamlah HM, Nuseir A. Use of 3-dimensional imaging and manufacturing for bilateral auricular prostheses: a case series of six patients with congenital auricular defects. J Prosthet Dent. 2024;132:1076-1081. doi:10.1016/j.prosdent.2022.09.022.
25. Inal CB, Ayten UBC, Nemli SK. Replacement implant-retained ear prosthesis using a semidigital workflow: a case report. Int J Prosthodont. 2025;38:268-270. doi:10.11607/ijp.9021.
26. Kim BR, Kim SH, Ko J, Baek SW, Park YK, Kim YJ, et al. A pilot clinical study of ocular prosthesis fabricated by three-dimensional printing and sublimation technique. Korean J Ophthalmol. 2021;35:37-43. doi:10.3341/kjo.2020.0125.
27. Weisson EH, Fittipaldi M, Concepcion CA, Pelaez D, Grace L, Tse DT. Automated noncontact facial topography mapping, 3-dimensional printing, and silicone casting of orbital prosthesis. Am J Ophthalmol. 2020;220:27-36. doi:10.1016/j.ajo.2020.06.032.
28. van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics. 2010;84:523-538. doi:10.1007/s11192-009-0146-3.
29. Aria M, Cuccurullo C. bibliometrix: An R-tool for comprehensive science mapping analysis. J Informetr. 2017;11:959-975. doi:10.1016/j.joi.2017.08.007.
30. Aria M, Cuccurullo C, D'Aniello L, Spano M. Biblioshiny and the SAAS Workflow: An integrated framework for transparent and reproducible science mapping. A demonstration through the replication of a study. J Informetr. 2026. doi:10.1016/j.joi.2026.101837.