Alqalam Journal of Medical and Applied Sciences. 2026;9(7):2215-2223
https://doi.org/10.54361/ajmas.269754

Original article

Evolution of Maxillofacial Prosthetic Materials: Conventional, Digital, and Nanotechnology Perspectives

Gamal Alwafi[1]*, Eshraq Alsherif[2], Mohamed Edribi[2]

[1]Department of Prosthodontics, Faculty of Dentistry, Misurata University, Misurata, Libya
[2]Department of Prosthodontics, Faculty of Dentistry, University of Tripoli, Tripoli, Libya
Corresponding email. alabdali.jamal@gmail.com

Abstract
Maxillofacial prosthetics is a specialized branch of prosthodontics concerned with the rehabilitation of patients presenting with congenital, traumatic, or oncologic defects of the craniofacial region through the use of artificial substitutes. Despite significant advances in materials science, the ideal maxillofacial prosthetic material that fully replicates the appearance and behavior of human skin has not yet been achieved. This narrative review provides a comprehensive synthesis of conventional, digital, and nanotechnology-based materials used in maxillofacial rehabilitation, with emphasis on their clinical performance, limitations, and future potential. Conventional materials, including acrylic resins, polyvinyl chloride derivatives, polyurethane elastomers, and silicone elastomers, are widely used in clinical practice. Among them, silicone elastomers remain the gold standard due to their superior biocompatibility, flexibility, and esthetic outcomes, although drawbacks such as limited tear strength and color instability persist. Recent advances in digital workflows, including computer-aided design/computer-aided manufacturing (CAD/CAM), three-dimensional (3D) printing, and digital color-matching systems, have improved precision, reproducibility, and efficiency of prosthesis fabrication. Furthermore, nanotechnology has introduced novel enhancements by incorporating nanoparticles such as titanium dioxide, zinc oxide, and silver into elastomeric matrices, improving mechanical strength, color stability, and antimicrobial properties. Emerging hybrid materials and artificial intelligence-driven approaches are expected to further transform the field. Continuous integration of material science and digital technologies is progressively improving functional and esthetic outcomes in maxillofacial prosthetic rehabilitation.
Keywords. Maxillofacial prosthetics; Silicone elastomers; CAD/CAM; 3D printing; Nanotechnology

INTRODUCTION

Maxillofacial prosthetics is defined as that branch of prosthodontics that is concerned with restoration and replacement of both stomatognathic and associated facial structures by artificial substitutes that may or may not be removed on a regular or elective basis (GPT) [1]. The facial deformities can result from injury, treatment of neoplasm, or inherent abnormality [2]. The prosthodontist is restricted by insufficient material accessible for facial rebuilding efforts, mobile tissue underneath, difficulty in retaining large prostheses and the patient's capacity to accept the final result [3].

As of now, materials utilized for the maxillofacial prosthesis are vinyl plastics, polyurethane, silicone elastic, and acrylic types. These new materials introduced some great properties, as well as significant deficiencies. A material has not been developed that looks like or copies human skin [4]. The physical, biological and clinical properties of various maxillofacial materials have been studied by researchers to achieve clinical success and patient acceptance. The critical task to a facial prosthesis material is its clinical performance testing. Research should concentrate on two major goals: a) Improving the physical and mechanical properties of the material, so that it will behave more like human tissue and increase the life of the prosthesis. b) Finding colour-stable agents or colouring facial prostheses and developing a technique to simulate human skin colour [5].

The evolution of maxillofacial prosthetics reflects broader advances in materials science and medical technology. In Egyptian mummies, artificial eyes, noses, and ears constructed from various materials have been found. Chinese were known to fabricate nasal and auricular prostheses utilizing natural waxes, clay and wood [6]. Ambroise Pare [7] in 1541 made nasal prostheses using gold, silver, paper and liner cloth glued together. Pierre Fauchard [8] in 1678 made a silver mask painted with oil paints to replace the lost portion of the mandible of a French soldier. William Morton [9] in 1862 fabricated a nasal prosthesis utilizing plated porcelain to coordinate with the patient's complexion. Claude Martin [10] in 1889 fabricated a nasal prosthesis using ceramic material.

Upham [11] in 1900 fabricated a nasal and auricular prosthesis made from vulcanite rubber. In 1913 [10], gelatin-glycerin compounds were presented for use in facial prostheses. But their lifespan was too short for practical clinical application. In early 1940 [11], acrylic resin was introduced to the dental profession and it replaced vulcanite rubber. Its translucency, colorability and simplicity of handling were attractive in spite of its rigidity. To overcome the rigidity problem of acrylic resin, Tylman introduced the utilization of a resilient vinyl copolymer acrylic resin for facial prostheses. Udagama and Drane [8] in 1970 introduced the utilization of Silastic medical adhesive silicone type A for the manufacture of facial prosthesis. Gonzalez [9] in 1978 described the use of polyurethane elastomer. Lewis and Castelberry [11] described the potential use

***Received**: 22-05-2026 - **Accepted**: 19-07-2026 - **Published**: 25-07-2026*

https://doi.org/10.54361/ajmas.269754

of silylene for facial prosthesis. Antonocci and Stansberry [3] introduced a new generation of acrylic resin. Gettleman was the first to introduce Polyphosphazenes [5].

Methods

This review was conducted following established guidelines for narrative reviews. A comprehensive literature search was performed across PubMed, Scopus, and Web of Science databases for peer-reviewed articles published in English between January 2000 and March 2026.

Search Strategy

The following search terms were employed using Boolean operators:

Primary Search

("maxillofacial prosthetics" OR "facial prosthesis" OR "maxillofacial rehabilitation")
("materials" OR "silicone elastomers" OR "acrylic resins" OR "polyurethane" OR "polyvinyl chloride")

Secondary Search (Digital Technologies)

("maxillofacial prosthetics" OR "facial prosthesis") AND ("CAD/CAM" OR "computer-aided design" OR "3D printing" OR "additive manufacturing" OR "digital workflow")

Tertiary Search (Nanotechnology)

("maxillofacial prosthetics" OR "silicone elastomers") AND ("nanoparticles" OR "nanotechnology" OR "titanium dioxide" OR "zinc oxide" OR "silver nanoparticles")

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Peer-reviewed original research articles, systematic reviews, and clinical studies
- Studies addressing material properties or clinical applications in maxillofacial rehabilitation
- Articles published in English

Exclusion Criteria:

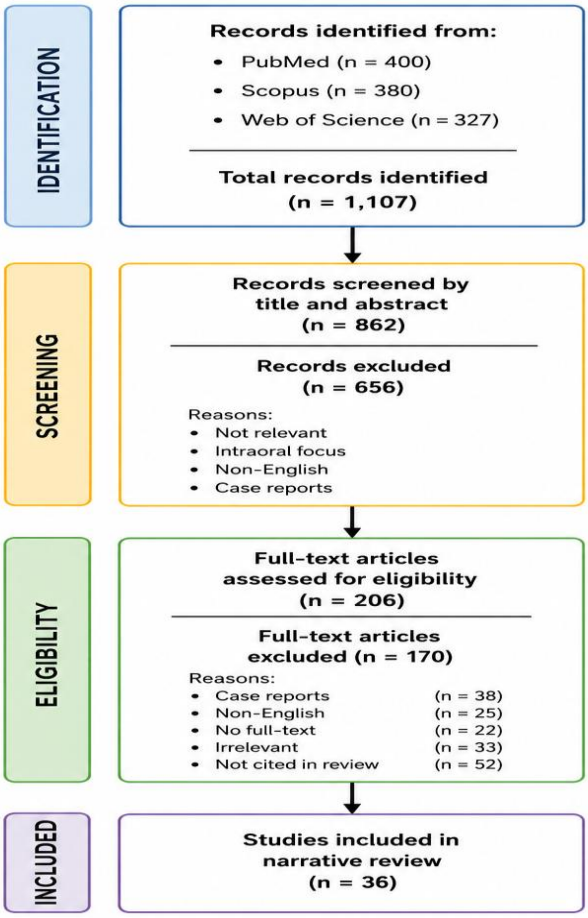
- Case reports, opinion pieces, and editorials
- Non-English publications
- Studies without relevance to extraoral prostheses

Study Selection and Data Synthesis

The initial search yielded articles that were screened by title and abstract. Full-text evaluation was performed for potentially relevant articles. Data were extracted using a standardized form capturing author(s), publication year, material type, key findings, and limitations. Data were synthesized narratively, organized by thematic categories including conventional materials, adhesives and coloration, digital technologies, and nanotechnology-based innovations as shown in Figure 1.

Figure 1. RISMA flow diagram of the literature search and study selection process.

***Received**: 22-05-2026 - **Accepted**: 19-07-2026 - **Published**: 25-07-2026*



Ideal properties of maxillofacial prosthetic materials

1 Biological and Chemical Properties

The material should remain stable when exposed to environmental assaults, adhesives and solvents. It should not be toxic, allergenic, or carcinogenic and must be biocompatible. Resistance to stains is a distinct advantage for it and allows the use of cosmetics to camouflage margins. Finally, it should exhibit a life of at least six months without significant compromise of esthetic and physical properties [12].

2 Physical Properties

The material should be flexible, dimensionally stable, light in weight, with low thermal conductivity and good strength [5].

3 Esthetic Properties

The completed facial prosthesis should be unnoticeable in public, faithfully representing lost structures in the finest detail. Its color, texture, form, and translucence must duplicate that of missing structures and adjacent skin [12].

4 Fabrication Characteristics

Materials that are easily processed with readily available instrumentation offer distinct advantages. Polymerization or transformation from liquid to solid should occur at a temperature low enough to allow reusability of molds. Mixing of individual components should be easy, permitting some margin for error. Appropriate working time is likewise beneficial and should be easy to color [10,13].

Table 1: Ideal Properties of Maxillofacial Prosthetic Materials

Property Category	Desired Characteristics	Clinical Significance
Biological	Biocompatible, non-toxic, non-allergenic, non-carcinogenic	Prevents adverse tissue reactions, ensures patient safety [12]
Chemical	Stable to environmental assault (UV, heat, moisture); resistant to adhesives, solvents, stains	Maintains material integrity; allows cosmetic camouflage [4]

Received: 22-05-2026 - **Accepted**: 19-07-2026 - **Published**: 25-07-2026

Physical	Flexible, dimensionally stable, lightweight, low thermal conductivity, adequate tensile/tear strength	Ensures comfort, function, and durability [5]
Esthetic	Color-matched to adjacent skin; appropriate translucency, texture, surface details	Optimizes patient acceptance and psychosocial well-being [12]
Fabrication	Easy processing with readily available instrumentation; adequate working time; reusable molds	Facilitates clinical efficiency and reproducibility [10,13]
Longevity	Minimum service life of 6 months without significant compromise of properties	Ensures cost-effectiveness and patient satisfaction [12]

Conventional materials
A number of materials are available for the fabrication of a successful prosthetic maxillofacial replacement.

1 Acrylic Resin
Acrylic resin is most commonly used for denture bases, became popular for facial prosthesis, is easily available, easy to stain and color, and has good strength to be fabricated with a feather margin and a good life of about 2 years [14,15]. These materials, because of their rigidity and high thermal conductivity, are a disadvantage. Visible light-cured resin is likewise being utilized, which has an organic filler made of acrylic resin beads of various sizes that become part of the polymer network structure on curing. The matrix is a urethane dimethacrylate with microfine silica and contains a camphoroquinone amine as photoinitiator [16,17].

2 Acrylic Copolymer
Acrylic copolymers are soft and elastic but have poor edge strength, poor durability, and are subject to degradation when exposed to sunlight. Additionally, complete restoration is often tacky, predisposing to direct collection and staining [18,19].

3 Polyvinylchloride and Copolymer
Earlier, these consisted of a combination of polyvinyl chloride and a plasticizer. However, these days, 5–20% vinyl acetate is being added. They exhibit many desirable properties such as flexibility, easy coloration, and acceptable initial appearance. The primary deficiency arises from migration of plasticizer, leading to discoloration and hardening of the prosthesis [3].

4 Chlorinated Polyethylene
A material similar to polyvinyl chloride in which coloration can be done using oil-soluble dyes. It is available as thin sheets in a variety of shades. Processing involves high heat curing pigmented sheets in metal molds. Additionally, it is resistant to environmental degradation and can be developed into soft, tough elastomers without the need for plasticizer [7].

5 Polyurethane Elastomers
Polyurethane elastomers contain a urethane linkage. The reactants are a polymer terminating with a hydroxyl group and others terminating with isocyanate in the presence of a catalyst. They can be synthesized with a wide range of physical properties by varying the reactants and their amounts. They have excellent properties like elasticity and ease of coloration, but the presence of moisture in the air leads to the production of carbon dioxide, resulting in a porous elastomer. Linotype metal molds are necessary to control the moisture contamination [20,21].

6 Silicone Elastomers
Long-chain molecules composed of alternating chains of silicone and oxygen atoms, by adjusting the length of this silicon-oxygen chain, silicones can be produced in the form of fluids, resins, or elastomers (rubbers) [22]. They exhibit good physical properties over a range of temperatures and can be cured at room temperature or under high temperatures. Silicone elastomers are divided into two main types based on vulcanizing temperature: Room temperature vulcanizing (RTV) silicones and high-temperature vulcanized (HTV) silicones [6].

Room Temperature Vulcanizing (RTV)
They are viscous silicone polymers including a filler diatomaceous earth, a stannous octate catalyst, and an orthoalkyl silicate cross-linking agent. Fillers are usually added to improve strength [23].
Silastic 382,399: These polymerize by condensation reaction. These are color stable, biologically inert, and retain their physical and chemical properties at wide temperature ranges. These are much easier to process, and moulds of dental stone can be used. Silastic 399 is translucent and Silastic 382 is opaque and white [6].

Received*: 22-05-2026 -* ***Accepted****: 19-07-2026 -* ***Published****: 25-07-2026*

MDX4.4210: In a survey by Andres, 41% of clinicians used this material for maxilla prosthesis fabrication. Moore reported that it exhibits improved qualities relative to coloration and edge strength. The material is not heavily filled; hence it is translucent. It exhibits adequate tensile strength, is non-toxic, color stable and biologically compatible [21].
Silastic 891: It is also known as Silastic Medical Adhesive Silicone Type A and is a methyltriacetoxysilane-cross-linked silicone. It is a translucent, non-flowing paste, which polymerizes at room temperature on contact with moisture. It does not contain solvents, plasticizers, or catalysts and can be processed in gypsum moulds. Metal moulds are not recommended as it may react with acetic acid, which is liberated as a by-product of polymerization. The color stability is good and is compatible with a wide range of colorants [23].
Cosmesil: Cosmesil is an RTV silicone which can be processed to a varying degree of hardness [6].
Silastic 386 (Foaming Silicones): A form of RTV silicone that has limited use in maxillofacial prosthesis is the foam-forming variety. The base silicone has an additive so that a gas is released when the catalyst, stannous octate, is introduced. The purpose of the foam-forming silicones is to reduce the weight of the prosthesis. However, the foamed material has reduced strength and is susceptible to tearing, leading to weakening of the material [3].

High-Temperature Vulcanizing (HTV)
Mainly designed for higher tear resistance in engineering applications, this type of polymer requires more intense mechanical milling of the solid HTV stock elastomers compared with the soft putty RTV silicone, especially for incorporating the required catalyst for cross-linking. These silicones require advanced equipment for processing and have better physical properties [24].
Silastic 370, 372, 373, 4-4514, 4-4515: They are usually white, opaque materials with a highly viscous, putty-like consistency. The catalytic agent is dichlorobenzoyl peroxide. They exhibit excellent thermal stability and are biologically inert but do not possess sufficient elasticity to function in movable tissue beds [21].
PDM siloxane: This HTV silicone was developed by the Veterans' Administration and reported by Lontz and Schweiger. Independent evaluations of physical and mechanical properties were reported by Abdelnnabi [25].
Q7-4635, Q7-4650, Q7-4735, SE-4524U: This new generation of HTV silicone was evaluated by Bell, which showed improved physical and mechanical properties compared to MDX4-4210 and MDX4-4514 (RTV silicone elastomers) [25].

Table 2: Comparative Analysis of Conventional Maxillofacial Materials

Material	Advantages	Limitations	Processing	Longevity	Clinical Use
Acrylic Resins	Available, strong, easy to color, feather margin	Rigid, high thermal conductivity	Heat/light cure	~2 years [14,15]	Limited use
Acrylic Copolymers	Soft, elastic	Poor edge strength, degrades, tacky	Heat cure	<1 year [18,19]	Limited use
PVC Derivatives	Flexible, easy coloration	Plasticizer migration, hardening	Heat cure	1-2 years [3]	Moderate use
Chlorinated Polyethylene	Resistant to degradation, no plasticizer	Limited shade range	High heat cure	2+ years [7]	Limited use
Polyurethane Elastomers	Excellent elasticity, easy coloration	Moisture sensitivity, porous	Specialized molds	1-2 years [20,21]	Moderate use
RTV Silicones	Biocompatible, flexible, easy processing	Low tear strength, color instability	Room temperature	6-18 months [6,23]	Most common
HTV Silicones	Superior tear strength, durable	Complex processing, equipment needs	High temperature	1-2 years [21,24]	Specialized use

Recent Materials
1. Siphenylenes: Siphenylenes are siloxane copolymers (combinations of silicone and carbon polymers) and therefore they have many of the advantages of both types of polymers. These materials exhibit many desirable properties including biocompatibility, resistance to degradation on exposure to U.V light and heat, improved edge strength and colorability [5].
2. Silicone block copolymers: Silicone block copolymers are new materials under development to improve on some of the weaknesses of silicone elastomers, such as a low tear strength, low elongation and the potential to support bacterial and fungal growth. They are more tear-resistant than conventional cross-linked silicone polymers [25].

Received: 22-05-2026 - Accepted: 19-07-2026 - Published: 25-07-2026

3. Polyphosphazines: Polyphosphazines flour elastomers have been developed for use as a resilient denture liner and has the potential to be used as a maxillofacial prosthetic material. Modification of physical and mechanical properties of Polyphosphazines may be needed to satisfy the requirement for fabrication of maxillofacial prosthesis [21].

Adhesives, primers, and coloration

1. Primer

With the introduction of urethane-line silicone prosthesis, there has been an increased interest in primers used for promotion of bonding between silicone and other maxillofacial prosthetic material. Commonly used ones include S-2260, 4O4O, Z 6032 and Z 607 [26].

2. Adhesives

A variety of adhesive systems have been employed to retain facial prostheses in position. They are commonly classified by the method in which they are dispensed: Pastes, liquids, emulsions, sprayers, and double-sided tapes. Double-sided tape is the most commonly used (41%) among patients with facial prostheses because of its ease of application, removal and maintenance. Most cured silicone, because of its low solubility and low surface energy, will not adhere to conventional tissue adhesive. The single-component RTV silicones were developed to serve as adhesives for silicone prostheses (medical adhesive type A) [21].

3. Coloration

Realistic coloration of external facial prosthesis is an important feature for patient acceptability and satisfaction. From the standpoint of attaining ideality for any extra-oral prosthesis, it ranks high and indeed is the final emotional arbiter in successful rehabilitation. The base shade selected for a patient should be slightly lighter than the highest skin tones of the patient because the prosthesis will darken as color is added [27]. Cosmetic realism involves exacting replication of intrinsic and extrinsic coloration. Intrinsic coloration is longer lasting and is preferred, but is more difficult to achieve than extrinsic [28].

Digital technologies in maxillofacial prosthetics

Recent advances in digital technologies have transformed the field of maxillofacial prosthetics. Three-dimensional facial scanning, computer-aided design (CAD), and computer-aided manufacturing (CAM) have improved the accuracy and efficiency of prosthesis fabrication [29]. Digital workflows reduce clinical visits, enhance reproducibility, and facilitate long-term data storage for future prosthesis replacement [30]. Additionally, digital color-matching systems and spectrophotometric analysis have improved esthetic outcomes and patient satisfaction by providing more accurate skin color reproduction [31]. Table 3 summarizes digital technologies in maxillofacial prosthetics.

Table 3: Digital Technologies in Maxillofacial Prosthetics

Technology	Principle	Advantages	Limitations	Clinical Applications
3D Facial Scanning	Structured light/laser capture	Non-contact, rapid, accurate	Equipment cost, learning curve	Facial data acquisition [29]
CAD	Digital design software	Precise, repeatable, modifiable	Software cost, training	Prosthesis design [30]
CAM	Subtractive/Additive manufacturing	Accurate, efficient	Equipment cost, waste	Fabrication [29,30]
Digital Color Matching	Spectrophotometry	Objective, reproducible	Equipment cost, training	Shade selection [31]

3D printing and advanced manufacturing

Additive manufacturing technologies have emerged as promising tools in maxillofacial rehabilitation. Techniques such as stereolithography (SLA), fused deposition modeling (FDM), and PolyJet printing enable the fabrication of highly detailed anatomical models and prosthetic components [32]. The integration of 3D printing with medical-grade silicone materials has improved prosthesis customization and reduced fabrication time. However, challenges remain regarding long-term color stability, flexibility, and biocompatibility of printable materials [33].

Nanotechnology and novel composite materials

Nanotechnology has been increasingly investigated to enhance the performance of maxillofacial prosthetic materials. The incorporation of nanoparticles such as titanium dioxide (TiO_2) [34], zinc oxide (ZnO), and silver nanoparticles into silicone elastomers has demonstrated improvements in tear strength, color stability, antimicrobial activity, and resistance to environmental degradation [35]. Furthermore, advanced composite materials including graphene-reinforced silicones and polyhedral oligomeric silsesquioxane (POSS)-based polymers have shown promising mechanical and esthetic properties for future clinical applications [36]. Table 4 summarizes nanotechnology applications in maxillofacial materials.

***Received**: 22-05-2026 - **Accepted**: 19-07-2026 - **Published**: 25-07-2026*

Table 4: Nanotechnology Applications in Maxillofacial Materials

Nanoparticle	Mechanism	Enhanced Properties	Clinical Status
Titanium Dioxide (TiO_2)	Photocatalytic, UV absorption	Antimicrobial, color stability, mechanical [34]	Research/Clinical
Zinc Oxide (ZnO)	Ion release, UV absorption	Antimicrobial, color stability, mechanical [35]	Research
Silver (Ag)	Ion release, membrane disruption	Antimicrobial (broad-spectrum) [35]	Clinical
Graphene	Molecular reinforcement	Mechanical, thermal properties [36]	Early research
POSS-based polymers	Molecular reinforcement	Mechanical, thermal, stain resistance [36]	Research

Discussion

This narrative review regarding maxillofacial prosthetic materials. The literature demonstrates that while multiple material options exist, none fully satisfies all criteria for an ideal prosthetic material. Silicone elastomers, particularly RTV types, emerge as the most widely used and preferred materials due to their favorable biocompatibility, flexibility, and esthetic properties [4,6]. The review reveals a clear evolution from rigid materials like acrylic resins to more flexible elastomers, and now toward digitally fabricated and nanotechnology-enhanced materials [5,29]. This progression reflects the field's response to clinical demands for improved esthetics, durability, and patient satisfaction.

When comparing conventional materials, silicone elastomers demonstrate clear advantages in biocompatibility and flexibility over acrylic resins and PVC derivatives [12,21]. However, HTV silicones show superior mechanical properties compared to RTV types, though at the cost of increased processing complexity [24,25]. Polyurethane elastomers offer excellent elasticity but are compromised by moisture sensitivity [20,21].

Digital technologies have introduced significant improvements in fabrication precision and reproducibility [29,30]. The integration of CAD/CAM and 3D printing has reduced fabrication time and improved customization [32,33]. However, challenges with printable materials, particularly regarding long-term color stability and biocompatibility, persist [33].

Nanotechnology represents a promising frontier, with nanoparticles demonstrating significant improvements in mechanical strength, color stability, and antimicrobial properties [34,35,36]. However, long-term clinical data remain limited, and concerns regarding nanoparticle toxicity require further investigation [35].

The selection of maxillofacial prosthetic materials significantly influences clinical outcomes. Key considerations include:

Silicone elastomers (both RTV and HTV) are recommended for most extraoral applications due to biocompatibility and esthetic properties [4]. RTV silicones are preferred for routine cases due to ease of processing, while HTV silicones are indicated for applications requiring superior mechanical strength [6,24]. Where resources permit, digital workflows improve precision, reproducibility, and efficiency [29,30,32]. Digital color matching enhances esthetic outcomes [31]. Intrinsic coloration is preferred for longevity, though extrinsic methods offer greater artistic control [27,28]. Digital color matching improves shade accuracy [31].

Limitations

This review is limited by its narrative design, which may introduce selection bias in the included literature. In addition, most evidence on nanotechnology-based materials and digital workflows is derived from in vitro or laboratory studies, with limited long-term clinical data available. Furthermore, heterogeneity among studies regarding material composition, testing methods, and outcome measures limits direct comparison between different materials.

Future perspectives

The future of maxillofacial prosthetic rehabilitation is expected to be driven by the convergence of advanced biomaterials, digital technologies, and artificial intelligence. Recent developments in nanotechnology-modified silicone elastomers have demonstrated improved mechanical strength, color stability, and antimicrobial performance; however, further long-term clinical investigations are required to validate their behavior under functional oral and environmental conditions. Artificial intelligence (AI) and machine learning algorithms are increasingly being explored for automated facial analysis, defect reconstruction, and prosthesis design optimization, which may significantly reduce operator dependency and improve reproducibility. In parallel, fully digital workflows combining three-dimensional (3D) facial scanning, computer-aided design/computer-aided manufacturing (CAD/CAM), and additive manufacturing technologies are expected to become the standard approach in complex maxillofacial rehabilitation.

Emerging concepts such as smart biomaterials and stimuli-responsive polymers may offer dynamic adaptation to temperature, light, and mechanical stress, improving prosthesis longevity and patient comfort. Furthermore, 4D printing technology, which enables time-dependent shape transformation, represents a promising direction for personalized prosthetic design.

Received*: 22-05-2026 -* ***Accepted****: 19-07-2026 -* ***Published****: 25-07-2026*

Despite these advancements, challenges remain related to material standardization, cost-effectiveness, regulatory approval, and long-term biocompatibility of novel nanocomposites. Addressing these limitations will be essential before widespread clinical translation can be achieved

Conclusion

Materials at present accessible don't totally meet our needs. There are certain advantages and disadvantages of materials. Loads of clinical testing and research need to be done so that we can get an ideal material for facial restoration. Future research should focus on two major objectives. Firstly and foremost, working on the physical and mechanical properties of the material so that it will act more like human tissues and increase the life of the prosthesis. Second objective: discovering color-stable agents for coloring facial prostheses and fostering a logical technique for shading coordinating to human skin. The convergence of material science, digital technologies, and nanotechnology promises to progressively improve functional and esthetic outcomes in maxillofacial prosthetic rehabilitation.

References

1. The Academy of Prosthodontics. The glossary of prosthodontic terms. J Prosthet Dent. 2005;94(1):10-92.
2. Bharti P, Gupta H, Kumar A. Treatment of post-traumatic facial deformities. J Maxillofac Oral Surg. 2023;22(4):972-8.
3. Salazar-Gamarra R, Binasco S, Seelaus R, Dib LL. Present and future of extraoral maxillofacial prosthodontics: Cancer rehabilitation. Front Oral Health. 2022;3:1003430.
4. Aparajita M, Sunita C, Hemlata G, Jagadeesh H. Maxillofacial prosthetic materials: An inclination towards silicones. J Clin Diagn Res. 2014;8(12):8-13.
5. Lanzara R, Viswambaran M, Kumar D. Maxillofacial prosthetic materials: Current status and recent advances: A comprehensive review. Int J Appl Dent Sci. 2021;7(2):255-9.
6. Annamma LM, Hattori M, Ali IE, Dsouza J, Waqar A, Chugh A, et al. Frequently used extraoral maxillofacial prosthetic materials and their longevity: A comprehensive review. Jpn Dent Sci Rev. 2024;60:137-47.
7. Harsh M, Kshitij G. Maxillofacial prosthetic materials: A literature review. J Orofac Res. 2012;2(2):87-90.
8. Maller U, Karthik K, Maller S. Maxillofacial prosthetic materials: Past and present trends. J Indian Acad Dent Spec Res. 2010;1:25-30.
9. Reddy JR, Kumar BM, Ahila SC, Rajendiran S. Materials in maxillofacial prosthesis. J Indian Acad Dent Spec Res. 2015;2:1-4.
10. Hernigou P. Ambroise Paré's life. Int Orthop. 2013;37:543-7.
11. Nair KC, et al. The early development of maxillofacial prosthetics: A historical review. Acta Sci Dent Sci. 2023;7(12):20-8.
12. de Caxias FP, Dos Santos DM, Bannwart LC, de Moraes Melo Neto CL, Goiato MC. Classification, history, and future prospects of maxillofacial prosthesis. Int J Dent. 2019;2019:8657619.
13. Arora J, Gulati M, Mishra A. Maxillofacial prosthesis materials: A review. Int J Health Sci. 2021;5(2):112-24.
14. Shenoy K, Sarfaraz H, Dandekeri S, Ragher M, Paulose A, Banu R. A simplified approach for customized esthetic acrylic ocular prosthesis: A case report. IJSS Case Rep Rev. 2015;1(9):49-51.
15. Tripuraneni S, Vadapalli S, Ravikiran P, Nirupama N. An innovative impression technique for fabrication of a custom-made ocular prosthesis. Indian J Ophthalmol. 2015;63(6):545-7.
16. Shaikh S, Gangurde A, Shambharkar V. Changing ocular prostheses in growing children: A 5-year follow-up clinical report. J Prosthet Dent. 2014;111(4):346-8.
17. Andreotti A, Goiato MC, Moreno A, Nobrega AS, Pesqueira AA, Dos Santos DM. Influence of nanoparticles on color stability, microhardness, and flexural strength of acrylic resins specific for ocular prosthesis. Int J Nanomedicine. 2014;9:5779-87.
18. Moreno A, Goiato MC, Dos Santos DM, Haddad MF, Pesqueira AA, Bannwart LC. Effect of different disinfectants on the microhardness and roughness of acrylic resins for ocular prosthesis. Gerodontology. 2013;30(1):32-9.
19. Silva AL, Guerrero JS, De Rezende PH, Carvalho RC, Porto VC. Evaluation of surface roughness and color change of a light-cured and heat-cured acrylic resin employed for fabrication of prosthetic bases after exposure to different types of disinfectants. J Res Dent. 2013;1(3):199-209.
20. Deb S. Maxillofacial prosthetic materials: An overview. Int J Prev Clin Dent Res. 2018;5(2):63-5.
21. Gupta A, Verma A, Kapoor R. Maxillofacial prosthetic part II: Materials and technology. A review of past, present and future trends. Int J Adv Res. 2020;8(4):915-25.
22. Abraham S, et al. A review of materials used in maxillofacial prosthesis: Part 2. Drug Invent Today. 2018;10(8):1569-73.
23. Choubisa D. A comprehensive review of silicone elastomers as an extraoral maxillofacial material. Dent J Adv Stud. 2025;13(1):36-41.
24. Vadlamudi C, Rao B, Satyanarayana T, Parvathi P, Sravanthi, Santhi. Burgeoning maxillofacial prosthetic materials. J Prosthodont Dent. 2021;16:68-81.
25. Bonatto LDR, Goiato MC, da Silva EVF, Oliveira SHP, Haddad MF, Chaves Neto AH, et al. Biocompatibility of primers and an adhesive used for implant-retained maxillofacial prostheses: An in vitro analysis. J Prosthet Dent. 2017;117(6):799-805.
26. Ranabhatt R, Singh K, Siddharth R, Tripathi S, Arya D. Color matching in facial prosthetics: A systematic review. J Indian Prosthodont Soc. 2017;17(1):3-7.
27. Khatod SK, Nimonkar SV, Sathe S, Pisulkar SK. Techniques of shade selection in maxillofacial prosthodontics. J Res Med Dent Sci. 2022;10(10):255-9.
28. Prahaladhan S, Afifa R, Ahmed S, Nandini V. Digital revolution in maxillofacial prosthesis advancement: The role of 3D imaging and printing. Int J Zool Appl Biosci. 2025;10(6):272-7.
29. Soni M, Soni P, Soni P, Chokhandre S, Moni M, Gupta S. The role of digital workflow in customizing prosthetic solutions: A literature review. J Pharm Bioallied Sci. 2025;17(2):1095-7.

***Received**: 22-05-2026 - **Accepted**: 19-07-2026 - **Published**: 25-07-2026*

https://doi.org/10.54361/ajmas.269754

30. Pawar P, Borle AG, Patil RM, et al. Digitization in skin shade matching for maxillofacial prostheses: A systematic review. Cureus. 2023;15(8):e43886.
31. Turek P, Zaborniak M, Grzywacz-Danielewicz K, Bałuszyński M, Lewandowski B, Kluczyński J, et al. A review of the most commonly used additive manufacturing techniques for improving mandibular resection and reconstruction procedures. Appl Sci. 2025;15(17):9228.
32. Jamayet N, Nizami MM, Rahman A, Twinkle A, Rashid F, Hasan Farook T, et al. Fabrication of ear prosthesis with the integration of CAD/CAM system. Pediatr Med Rodz. 2019;15:327-31.
33. Shakir DA, Abdul-Ameer FM. Effect of nano-titanium oxide addition on some mechanical properties of silicone elastomers for maxillofacial prostheses. J Taibah Univ Med Sci. 2018;13(3):281-90.
34. Sonnahalli NK, Chowdhary R. Effect of nanoparticles on color stability and mechanical and biological properties of maxillofacial silicone elastomer: A systematic review. J Indian Prosthodont Soc. 2020;20(3):244-54.
35. Bunyan SF, Suhaimi FM, Zardawi FMM, et al. Nanoparticles in enhancing mechanical properties of silicone for maxillofacial rehabilitation: A review. J Evol Med Dent Sci. 2023;12(9):280-5.
36. Fayad MI, Ahmed MA, Kothayer M, Aboelnagga MM, Essa EESF, Abu-Hammad O, et al. Innovations driving the future of maxillofacial prosthetics, part I: The technological leap in maxillofacial rehabilitation. Eur J Dent. 2026;20(2):370-80.

Received*: 22-05-2026 -* ***Accepted****: 19-07-2026 -* ***Published****: 25-07-2026*