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Advancements And Clinical Perspectives In Extraoral Maxillofacial Prosthesis: A Comprehensive Review

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Abstract:
Background:
Maxillofacial prosthetics is a vital subspecialty of prosthodontics that addresses the rehabilitation of patients with facial defects resulting from trauma, congenital anomalies, or surgical resections. Among these, extraoral prostheses restore esthetics and psychosocial well-being, significantly improving the quality of life.
Objective:
This review aims to provide a comprehensive overview of extraoral maxillofacial prostheses, including their classifications, materials, retention techniques, fabrication advancements, and impact on patient outcomes.
Results:
The evolution of materials from polymethyl methacrylate to medical-grade silicones and the integration of digital technologies like CAD/CAM and 3D printing have transformed prosthesis fabrication. Implant-retained prostheses offer superior retention, while psychological rehabilitation remains a core component of successful outcomes.
Conclusion:
Extraoral prostheses continue to evolve, driven by innovations in biomaterials and digital technologies. Interdisciplinary collaboration remains essential to meet the functional, esthetic, and psychosocial needs of patients with maxillofacial defects.

Keywords:
Maxillofacial prosthesis, Extraoral prosthesis, Facial defects, Silicone prosthesis, 3D printing, Osseointegrated implants

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I. Introduction

Maxillofacial prosthetics is a specialized branch of prosthodontics concerned with the restoration and replacement of craniofacial structures lost due to congenital defects, trauma, surgical resection, or disease. While intraoral prostheses address functional issues such as speech and mastication, extraoral prostheses primarily restore facial aesthetics, helping patients reintegrate into society and regain self-confidence. Extraoral defects, often involving the orbit, nose, or ear, present significant challenges in terms of prosthetic design, retention, colour matching, and long-term durability. Traditional prosthetic approaches relied on acrylic materials and basic mechanical retention methods. However, with advancements in biomaterials**,** Osseointegrated implants, and digital technologies, modern prostheses can now offer improved outcomes in both form and function.

Given the diversity of defect types and rehabilitation needs, this review aims to:[1]
- Classify the types of extraoral maxillofacial prostheses
- Examine materials and fabrication techniques
- Discuss retention methods and digital innovations
- Highlight psychosocial aspects and future directions in prosthetic rehabilitation

Through this comprehensive overview, the article underscores the significance of multidisciplinary care in optimizing outcomes for patients requiring extraoral maxillofacial prostheses.

II. Classification Of Extraoral Maxillofacial Prostheses

Extraoral maxillofacial prostheses can be categorized based on **anatomical site**, **retention methods**, and **materials used**. A clear classification is essential for diagnosis, treatment planning, prosthesis design, and long-term maintenance.

1. Based on Anatomical Site Involved

This classification reflects the type of facial defect and guides the design and complexity of the prosthesis.

- **Orbital Prosthesis**: Replaces the eye, eyelids, and surrounding periorbital tissue, commonly needed post-enucleation, evisceration, or exenteration.
- **Auricular Prosthesis**: Restores the external ear (pinna), usually indicated after trauma or congenital anomalies like microtia.
- **Nasal Prosthesis**: Reconstructs partial or total nasal defects, typically following tumour resection or trauma.
- **Midfacial Prosthesis**: A composite prosthesis that includes orbital, nasal, and/or cheek regions. Used in extensive defects such as those resulting from advanced carcinomas.
- **Combined Prostheses**: In some cases, multiple facial components are combined, e.g., an **orbitonasal** or **orbitonasalauricular** prosthesis, especially after aggressive oncologic surgery.

2. Based on the Method of Retention

Retention is critical for both function and patient comfort. Different techniques are used depending on defect size, location, and patient anatomy:

- **Anatomic Retention**: Utilizes undercuts and contours of the defect to retain the prosthesis passively.
- **Mechanical Retention**: Incorporates eyeglasses, straps, or headbands to hold the prosthesis in place.
- **Adhesive Retention**: Employs medical-grade adhesives (e.g., silicone-based) to secure the prosthesis to the skin.
- **Implant-Retained Prosthesis**: Uses osseointegrated titanium implants placed in craniofacial bones (e.g., zygoma, mastoid) with attachments like magnets or bar clips for superior stability and ease of use.
- **Magnetic and Spectacle-Assisted Retention**: Particularly useful in orbital prostheses where magnets are embedded into spectacles or the prosthesis.

3. Based on Material Used

Materials significantly influence the aesthetics, durability, and comfort of the prosthesis.

- **Polymethyl Methacrylate (PMMA)**: An Earlier material with high strength but poor flexibility and aesthetics.
- **Silicone Elastomers**: Most commonly used today due to their life-like appearance, flexibility, and biocompatibility.
- **Polyurethane**: Offers enhanced strength but has limited aesthetic properties and is less commonly used.
- **Modern Composites and Nanomaterials**: Under experimental use, offering improved colour stability, texture, and longevity.

III. Prosthetic Materials And Techniques[4]

The evolution of prosthetic materials and fabrication techniques has improved extraoral maxillofacial prostheses' aesthetics, comfort, and longevity. An ideal material should be biocompatible, colour-stable, lightweight, durable, and able to mimic natural skin texture and tone.

1. Historical Evolution of Materials

- **Polymethyl Methacrylate (PMMA)** was initially popular due to its strength and ease of manipulation. However, it lacks flexibility and fails to simulate the translucency of skin.
- The **1960s–1980s** saw a shift towards **latex**, which offered more flexibility but caused allergic reactions and degraded rapidly.
- **Medical-grade silicone elastomers** emerged as the gold standard due to their skin-like texture, ability to accept intrinsic and extrinsic pigmentation, and overall biocompatibility

2. Contemporary Prosthetic Materials

a. Silicone Elastomers

- Widely used due to excellent flexibility and aesthetics
- Types include **room temperature vulcanizing (RTV)** and **high temperature vulcanizing (HTV)** silicones
- Allow intrinsic pigmentation during fabrication and extrinsic staining for surface colour matching
- Limitations: prone to **colour instability**, **degradation**, and **marginal tear** over time

b. Polyurethane Elastomers
- High tear resistance and strength
- Less aesthetically pleasing compared to silicone
- Higher toxicity concerns and more complex processing

c. Acrylic Resins
- Still used occasionally for rigid components
- Advantageous in auricular prostheses or where rigidity is preferred
- Poor marginal adaptability and brittle in thin sections

d. Experimental and Emerging Materials
- **Nanocomposite silicones**: Improved mechanical properties and fungal resistance
- **Photopolymer resins** used in **3D printing**: customizable and suitable for mold creation
- **Tissue-engineered scaffolds**: Prospects in biointegration and regeneration

3. Pigmentation and Colour Matching
- **Intrinsic Staining**: Pigments added during mixing before material curing. Offers longer-lasting and natural-looking colour.
- **Extrinsic Staining**: Surface coloration with medical-grade paints or inks. Allows fine-tuning of skin tones, veins, and freckles.

Challenges:
- Achieving long-term colour stability
- Matching the surrounding skin tone under varying lighting conditions
- Pigment degradation due to UV exposure, sweat, and cleansing agents

4. Fabrication Techniques
a. Conventional Techniques
- Manual impression using irreversible hydrocolloid or silicone-based materials
- Wax pattern sculpting to replicate anatomy
- Mold-making using dental stone or gypsum
- Silicone packing and curing in a flask

b. Digital Techniques
- **3D Facial Scanning**: Replaces physical impressions with accurate digital imaging
- **CAD/CAM Design**: Digital design of the prosthesis using software tools
- **3D Printing**: Used for printing molds, prototypes, or even final prosthetic shells
- **Rapid Prototyping**: Allows faster turnaround and standardized result

IV. Retention Methods In Extraoral Maxillofacial Prostheses

Retention plays a pivotal role in the success of extraoral maxillofacial prostheses. A stable, well-retained prosthesis not only enhances aesthetics and comfort but also improves patient confidence and compliance. The choice of retention method depends on factors such as the location of the defect, the extent of tissue loss, availability of anatomical undercuts, patient dexterity, and financial considerations.

1. Anatomical Retention
- Utilizes natural undercuts and contours of the defect to hold the prosthesis in place.
- Common in auricular or nasal prostheses with deep recesses.
- **Advantages**: Non-invasive, cost-effective, no additional materials or devices required.
- **Limitations**: Inadequate for shallow or irregular defects; often requires combination with adhesives

2. Mechanical Retention
- Employs external devices such as **eyeglasses, spectacle frames, headbands, or elastic straps**.
- Common in orbital prostheses where integration with eyeglass frames provides simultaneous support and camouflage.
- **Advantages**: Economical, reversible, and easy to apply.
- **Limitations**: May be esthetically unappealing; depends on patient compliance and external visibility.

3. Adhesive Retention

- Uses **medical-grade skin adhesives**, typically silicone- or acrylic-based, to bond the prosthesis to surrounding skin.
- Applied to the tissue-contacting surface of the prosthesis and adjacent skin prior to placement.
- **Advantages**: Allows for precise positioning; ideal in patients where implant placement is contraindicated.
- **Limitations**:

○ Skin irritation or allergic reactions
○ Decreased retention with sweat, oil, or humidity
○ Requires daily cleaning and reapplication
○ Adhesive residue buildup over time

4. Implant-Retained Prostheses

- **Osseointegrated implants** (usually titanium) placed in craniofacial bones (e.g., mastoid process, zygomatic arch, glabella) allow for firm anchorage of the prosthesis.
- Common attachment mechanisms:

○ **Magnetic Abutments**: Easy to align and maintain
○ **Bar and Clip Systems**: Provide strong mechanical retention
○ **Ball Attachments**: Simpler but limited in directional control

- **Advantages**:

○ Superior retention and esthetics
○ Improved patient confidence and ease of use

- **Limitations**:

○ Requires sufficient bone quality and volume
○ Invasive surgical procedure
○ Cost-intensive
○ Risk of implant failure or infection

5. Magnetic and Spectacle-Assisted Retention

- **Magnets** embedded within prostheses can be used in combination with spectacle frames, particularly in orbital or midfacial prostheses.
- Offers dual benefits of retention and esthetic integration with eyeglasses.
- **Advantages**: Non-invasive and patient-friendly; can be used with weakened tissue bases.
- **Limitations**:

○ Magnetic field degradation over time
○ Risk of demagnetization
○ Corrosion if not properly sealed

V. Technological Advances In Extraoral Maxillofacial Prosthesis[6]

1. 3D Facial Scanning

- Contactless 3D scanning systems such as structured light scanners and laser-based devices have replaced traditional physical impressions.
- Accurately captures fine surface details of the defect and surrounding tissue.
- Enables digital storage and simulation for future revisions or replacements.

Advantages:

- Highly precise and reproducible
- Reduces patient discomfort during impression-taking
- Facilitates remote planning and design

2. CAD/CAM Technology

- **Computer-Aided Design (CAD)** allows virtual modeling of the prosthesis based on scanned data.
- **Computer-Aided Manufacturing (CAM)** enables fabrication using subtractive or additive techniques.
- Allows rapid prototyping, easy corrections, and repeatable accuracy.

Applications:

- Designing wax patterns or silicone shells
- Customizing implant abutments and bars
- Creating templates for surgical planning

3. 3D Printing and Rapid Prototyping

- **Additive manufacturing** allows layer-by-layer fabrication of molds, prototype prostheses, or even final prosthetic parts.
- Materials used include **photopolymer resins, PLA/ABS**, and medically approved polymers.
- Enables creation of complex shapes with minimal manual effort.

Clinical Uses:

- Printing of master molds for silicone packing
- Pre-surgical planning models for extensive resections
- Production of low-cost educational and simulation tools

4. Digital Color Matching and Texture Simulation

- Tools like **spectrophotometers** and **digital colorimeters** help in objectively matching skin tones.
- Advanced 3D rendering software can simulate **pores, wrinkles, and vascular patterns** on the prosthetic surface.

5. Virtual Surgical Planning (VSP)

- Multidisciplinary planning involving **surgeons, prosthodontists, and radiologists** using 3D imaging and simulation.
- Allows prediction of post-surgical facial contours and planning of prosthetic design even before defect creation.

6. Artificial Intelligence (AI) and Machine Learning (Future Directions)

- AI-powered tools are being explored for:
  - Automated margin detection
  - Predictive color adaptation under variable lighting
  - Adaptive prosthesis design using facial movement data

7. Smart Prosthetics and Sensor Integration (Experimental)

- Development of sensor-integrated prostheses for detecting facial movements or external stimuli.
- Research is underway for integrating temperature sensors**,** pressure feedback, and mobile app-based tracking.

VI. Psychological And Social Impact Of Extraoral Maxillofacial Prostheses

1. Psychological Impact of Facial Disfigurement

Facial appearance holds a significant place in human identity and social communication. Disfigurement due to trauma, cancer, or congenital deformities often results in:

- **Depression and Anxiety**
- **Social withdrawal** and fear of stigma
- **Loss of self-confidence**
- **Post-traumatic stress disorder (PTSD)** in cases of sudden trauma or disfiguring surgery

Children and adolescents may face bullying or exclusion, while adults often report difficulty in employment or forming relationships.

2. Role of the Prosthesis in Psychosocial Rehabilitation

A well-fitting and esthetically acceptable prosthesis:

- Helps restore **self-esteem**
- Enhances **social confidence**
- Allows reintegration into **workplace and family roles**
- Promotes **psychological healing**

Patients often express deep emotional relief upon wearing a prosthesis that restores symmetry and a sense of normalcy. This "invisible healing" is often cited as being as important as the physical restoration.

3. Patient Expectations and Adaptation

- Unrealistic expectations regarding prosthetic function or esthetics may lead to dissatisfaction.
- Adaptation period varies; some patients quickly regain social confidence, while others may need longer to adjust.
- Regular follow-up and counseling are essential to address concerns, reinforce positive coping mechanisms, and build compliance.

4. Need for Psychological Support and Counseling

An interdisciplinary approach should include:

- **Pre-prosthetic counseling** to manage expectations
- **Ongoing psychological support** from trained professionals
- **Support groups or peer counseling**, especially for oncology survivors

5. Quality of Life (QoL) Assessments

Several QoL assessment tools have been developed for maxillofacial prosthetic patients, including:

- **Obturator Functioning Scale (OFS)**
- **EORTC QLQ-H&N35 (Head & Neck Module)**
- **McGill QoL Questionnaire**
- These help clinicians evaluate physical, emotional, and social outcomes, guiding further support strategies.

VII. Challenges And Limitations In Extraoral Maxillofacial Prosthetics

1. Material Degradation and Colour Instability[4]

- Silicone prostheses, though widely accepted, are prone to discoloration and material degradation due to:
  - UV exposure
  - Skin oils and perspiration
  - Atmospheric pollutants
  - Cleansing agents
- Loss of marginal integrity and tearing at edges are common in high-mobility areas like the cheeks and nose.
- Frequent replacement is often necessary, usually every 12–18 months, adding to long-term costs.

2. Retention Difficulties

- Inadequate anatomical undercuts or soft, mobile tissue beds compromise adhesive or mechanical retention.
- Adhesive failure in humid climates or oily skin reduces prosthesis stability.
- Implant-retained prostheses require surgical intervention and sufficient bone stock, which may be absent in post-oncologic resection cases.
- Cost and access to implant systems can be a barrier in resource-limited settings.

3. Aesthetic Limitations

- Achieving a perfect skin match remains difficult, especially in darker or mixed skin tones.
- Pigment fading over time requires frequent extrinsic repigmentation.
- Texture simulation (e.g., pores, wrinkles, hair integration) is labor-intensive and often inconsistent without advanced tools.

4. Financial Burden and Accessibility

- Prosthetic treatment is often not covered by insurance in many countries.
- High costs of materials, lab processes, and implant surgery limit widespread access.
- In rural or underserved areas, lack of trained professionals and technology further restricts prosthetic rehabilitation.

5. Patient Compliance and Maintenance

- Daily care, adhesive application, and storage require patient discipline and education.
- Poor hygiene can lead to fungal growth on the prosthesis or adjacent skin irritation.
- Elderly or physically challenged patients may find self-care difficult.

6. Limited Longevity and Frequent Replacements

- Average lifespan of facial prostheses: 12–24 months
- Need for remaking due to wear, discoloration, or changes in facial morphology
- Long-term care costs can accumulate substantially

7. Lack of Standardized Guidelines

- No universal protocols exist for:
  - Material selection
  - Retention strategy
  - Follow-up and replacement frequency
- Treatment often depends on **clinician expertise and available resources**, leading to inconsistency in outcomes

8. Psychosocial Challenges

- Social stigma and emotional distress may persist even with a prosthesis.
- **Adjustment period** can be prolonged without adequate psychological support.
- Unrealistic aesthetic expectations can result in **patient dissatisfaction**, even with technically sound prostheses.

VIII. Conclusion

Extraoral maxillofacial prostheses play a crucial role in restoring form, function, and dignity to individuals with facial defects resulting from trauma, congenital conditions, or oncologic surgery. While current materials and techniques have significantly advanced the field, ongoing limitations in retention, durability, and accessibility still hinder universal success. With the integration of digital technologies, biomaterial research, and patient-centered care models, the future of maxillofacial prosthetics holds tremendous promise. A multidisciplinary and compassionate approach remains the cornerstone for delivering esthetic, functional, and emotionally fulfilling outcomes to patients in need.

References:

[1] Chalian Va, Drane Jb, Standish Sm. Maxillofacial Prosthetics: Multidisciplinary Practice. Williams & Wilkins; 1971.
[2] Goiato Mc, Dos Santos Dm, Haddad Mf, Pesqueira Aa. Effect Of Accelerated Aging On The Microhardness And Color Stability Of Flexible Resins For Dentures. Braz Oral Res. 2010;24(1):114–9.
[3] Goiato Mc, Haddad Mf, Dos Santos Dm, Pesqueira Aa, Moreno A. Use Of Facial Prostheses In Rehabilitation Of Patients With Head And Neck Cancer. J Craniofac Surg. 2009;20(4):1121–4.
[4] Lemon Jc, Kiat-Amnuay S, Gettleman L, Martin Jw. Facial Prosthetic Rehabilitation: Preprosthetic Surgical Techniques And Biomaterials. Curr Opin Otolaryngol Head Neck Surg. 2005;13(4):255–62.
[5] Ciocca L, De Crescenzio F, Fantini M, Scotti R. Cad/Cam And Rapid Prototyped Scaffold Construction For Bone Regenerative Medicine And Surgical Transfer Of Virtual Planning. Comput Med Imaging Graph. 2009;33(1):58–62.
[6] Hatamleh Mm, Watts Dc. Current Prosthetic Treatment Options For Patients With Facial Defects. J Prosthodont. 2010;19(2):97–104.
[7] Taylor Td. Clinical Maxillofacial Prosthetics. Quintessence Publishing; 2000.
[8] Beumer J, Curtis Ta, Marunick Mt. Maxillofacial Rehabilitation: Prosthodontic And Surgical Considerations. Ishiyaku Euroamerica; 1996.
[9] Hussain S. Zaki And Eugene N.Myers. Prosthetic Management Of Large Nasal Septal Defects. J Prosthet Dent 1997;77:335-8.
[10] Arcuri Mr, La Vellewe, Fyler A. Effects Of Implant Anchorage On Mid Face Prostheses. J Prosthet Dent 1997;78:496-9.
[11] Robin W. C. Chung, Adam S. C. Siu, Frederick C.S. Chu, Talk W. Chow. Magnet Retained Auricular Prosthesis With An Implant Supported Composite Bar: A Clinical Report. J Prosthet Dent 2003;89:446-9.
[12] Wang R. Adhesion Of Silicone To Polyurethane In Maxillofacial Prosthese. Int J Prosthodont 1994;7:43-9
[13] Gillis R. Psychological Implications Of Patient Care. In Laney W. Maxillofacial Prosthetics. Littleton, Ma: Psg Publishing Co,1979:Chapter 2.
[14] Lemon Et Al. Color Stability Of Facial Prostheses. J Prosthet Dent 1995;74:613-8.
[15] Tamamata T Et Al. Evaluation Of Color Changes Of Silicone Materials After