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Review Article

Extra-oral maxillofacial prosthesis - A review

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INTRODUCTION

Maxillofacial deformities are embarrassing to patients and may negatively affect their physical and psychological health, potentially resulting in serious psychiatric, familial, and social problems. These deformities can be congenital, caused by malformation and developmental disturbances, or acquired, caused by pathologies such as necrotizing diseases and oncosurgeries or trauma [1].

According to GPT 9, **prosthesis** can be defined as- "An artificial replacement of part of the human anatomy restoring form, function, and aesthetics" Patients who have suffered maxillofacial disfigurement exhibit a compromised appearance making them incapable of leading a normal life [2].

Maxillofacial prosthetics is a branch of dentistry that deals with congenital and acquired defects of the head and neck. Maxillofacial prosthetics integrates parts of multiple disciplines including head and neck oncology, congenital malformation, plastic surgery, speech, and other related disciplines.[3]

In 1953, **Ackerman** defined maxillofacial prostheses as the phase of dentistry that repairs and artificially replaces parts of the face after injuries or surgical intervention. **Maxillofacial reconstruction** involves implanting artificial substitutes for intraoral and extraoral structures such as the eyes, ears, nose, maxilla, mandible, esophagus, cranial bones, and palate. Maxillofacial prostheses are primarily fabricated using acrylic resin and/or silicone according to the facial structure of the patient.[1]

Facial prostheses require something to **keep them in place**, and the main methods involve adhesives, anatomical countersinks, glasses, or magnets. During the last two decades, osseointegrated implants have been used to improve the hold and retention of facial prostheses. Implants have been used for retention in the intraoral or extraoral craniofacial regions, and these can offer excellent support and retention, as well as eliminating or reducing the need for adhesives. [4]

With recent advancements in prosthetic materials, coloring techniques and retentive mechanisms, a life like prosthesis can be given. The biggest impact of such prostheses is not only on the appearance but majorly on the psyche of the patient. The main objective is not only rehabilitation of the defect but also restoring confidence and improving quality of life of the patient.

Several materials, techniques, and clinical approaches have been used for maxillofacial prostheses. This article deals with objectives, classification of maxillofacial prosthesis, types of extraoral maxillofacial prosthesis, materials available, retention system to retain them and design and manufacturing of maxillofacial prosthesis.

OBJECTIVES

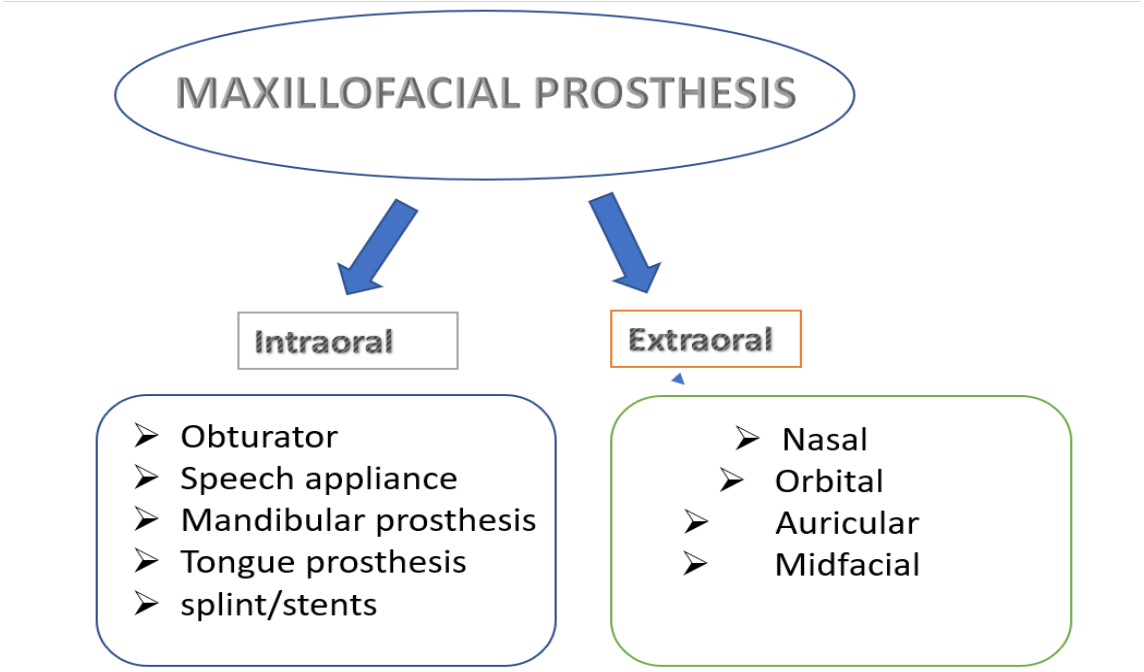
The objectives of maxillofacial prosthetics includes the following important objectives-

a) Restoration of esthetics or cosmetic appearance of patient.
b) Restoration of function.
c) Protection of tissue.
d) Therapeutics or healing effect.
e) Psychological therapy.

When these objectives are met in a patient during the rehabilitation, then it can be concluded that the treatment is totally successful. [2]

CLASSIFICATION OF MAXILLOFACIAL PROSTHESES

In general, maxillofacial prostheses can be classified as restorative or complementary. Restorative prostheses substitute for bone loss or repair deformities of facial contour. They can be located internally within the tissue or externally as oral, ocular, or facial prostheses. Complementary prostheses help with plastic surgery, in the pre-, trans-, or postoperative period, or in radiotherapy sessions. [1]



EXTRA ORAL PROSTHESIS

The care of patients with extraoral head and neck malignant disease is not limited to the elimination of disease only. A comprehensive treatment plan for a patient requiring extraoral rehabilitation should be drawn up before surgery.[2]

An extraoral prosthesis acts like a cosmetic bandage that camouflages a surgical defect not desirable for surgical reconstruction.[2]

An extraoral prosthesis may be considered for the following -

1. Incomplete closure of large defects with grafted soft tissue.
2. Difficult surgical reconstruction of structures, (i.e., an eye, nose, or ear).
3. Patient's psychological or physical incapability of tolerating a multistage surgical reconstruction.
4. Surgical defects that need to be monitored for recurrent disease.
5. Temporary use during multistage surgical reconstruction.

Fig. 1 Various extraoral maxillofacial prosthesis

OCULAR PROSTHESIS

Partial or total eye loss not only results in vision loss but also impacts the patient's self-esteem and social life due to difficulty in establishing emotional ties, new life style, insecurity and rejection [1,5]. The mutilated face can be a stigma for the patient and relatives.[5]

Fig.2 Ocular prosthesis replaces a missing left eye

Furthermore, the ocular prostheses also function to retain tone of the upper eyelid muscles, preserve the tear duct to avoid eyelash adherence and conjunctival dryness, prevent eyelid atresia due to lack of function, and protect the cavity mucosa from debris and dust [1].

Ocular bulb loss results from pathologic or accidental causes. Three types of orbit and eyelid surgeries are related to ocular prostheses: evisceration, the partial removal of the eye bulb while preserving the sclera; enucleation, the complete removal of eye bulb with only the capsule and oculomotor muscles remaining; and exenteration, the removal of all contents of the orbital cavity and surrounding tissues [6].

A well-adapted prosthesis requires simple maintenance. The patient removes it daily for cleaning with water and neutral soap. The efforts necessary for the techniques involved in the fabrication of eye prostheses aim to assist the patients who need it in the numerous complex aspects associated with the loss of vision and organ mutilation.[1]

MID-FACIAL PROSTHESES

Facial defects result in multiple functional and psychosocial difficulties. [7]

In general, facial prostheses can be classified as nasal, lip, oculopalpebral, auricular, skullcap, and traqueostomal. Although facial prostheses primarily function to restore aesthetics, they also have other physiological functions. For example, the nasal prosthesis improves airflow and speech . Lip prostheses seal the lips and reestablish lip support, to ensure better chewing, swallowing, and speech . Auricular prosthesis improves hearing in noisy environments. Skullcap prostheses protect the brain . Traqueostomal prostheses allow breathing, speech , and filtering the air. [1]

Fig.3 Mid-facial prosthesis covering left eye, cheek, nose and upper lip

Most facial prostheses like nasal prostheses are retained with adhesives and mechanisms including anatomic undercuts, eyeglasses attachments, attachment to maxillary obturators , magnets , and prosthetic connections to endosseous implants. Each

of these methods has its own advantages and disadvantages. [7]

AURICULAR PROSTHESES

Loss of external ear can be congenitally missing or acquired due to accidental trauma or malignant disease. Congenital anomaly of the external ear may be termed as "Microtia".

Surgical reconstruction of ear results in morphology that is less similar to opposite side because of its complex nature and it is considered to be one of the most demanding challenges for the plastic surgeons.

Fig.4 Ear prosthesis retained with mangnet attached with implant

The commonly followed technique in making the wax pattern is to make impression and cast of the contra-lateral ear to be used as reference while sculpting the wax pattern. Recent advances in the field of maxillofacial prosthetics for the wax pattern fabrication like 3D rapid prototyping had enabled the clinicians to provide quality health care to patients in need. There are acrylics and silicone based materials available for the fabrication of the maxillofacial prosthesis but traditionally acrylic resin had been the material of choice for fabrication of ear prosthesis, as it is economically viable treatment option [8]

NASAL PROSTHESIS

Malignancies of the nasal septum are considered rare, and accounts for 9% of all cancers of nasal cavity . Squamous cell carcinoma comprises about 66% of such lesions. The quality of life after rhinectomy is severely compromised if an efficient surgical reconstruction or a prosthetic device is not provided. Prosthetic management of nasal defects that result from trauma or surgery has been well-documented.

A temporary nasal prosthesis may be considered for these patients. Such prosthesis can be delivered as soon as 3 to 4 weeks after surgery providing the patient with an improved appearance. Surgical reconstruction techniques, prosthetic rehabilitation or a combination of both the methods to restore these facial disfigurements may improve the level of function and self-confidence for patients

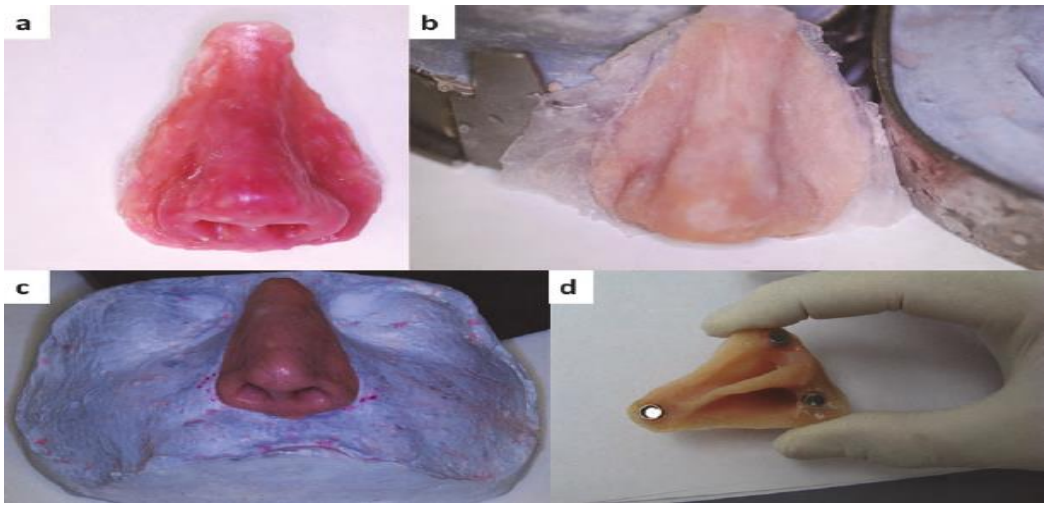


Fig.5 a) wax up; b) polymerization; c) coloration d) magnet insertion

Providing adequate retention and airway in nasal prostheses should be considered as it can improve the patients function and comfort. The prosthesis should be lightweight. When suitable conditions are provided, mechanical retention obtained by anatomic undercuts is the most advantageous. Traditionally

facial prosthesis has been made by hand worked sculpted wax or clay pattern. Recently, the computer-aided design of a nasal prosthesis based on pre-operative virtual laser scanning of the affected site was virtually adapted to the post-operative laser-scanned surface. The mould for the nasal prosthesis was rapid prototyped using a computer-aided design and manufacturing (CAD-CAM) procedure, increasing the quality of the final product [7].

MATERIALS USED FOR MAXILLOFACIAL PROSTHESIS

In the history of anaplastology a wide range of materials have been used such as porcelain, natural rubber, gelatin and latex but the most commonly used materials are methacrylates and silicones.[9,10,12]

Desirable properties of maxillofacial prosthetic material

1. Physical properties -The material should be flexible, dimensionally stable, light in weight, with low thermal conductivity and good strength.
2. Biological and Chemical properties ñ The material should remain stable when exposed to environmental assaults, adhesives and their solvents. It should be non-toxic, non-allergenic and biocompatible. It should exhibit good life of at least six months without significant compromise of esthetic and physical properties.
3. Fabrication characteristics ñ Polymerization should occur at a temperature low enough to permit reusability of molds. Blending of individual components should be easy, allowing some margin of error. It should have suitable working time and be easy to color.
4. Esthetic characteristics ñ The complete prosthesis should be unnoticeable in public, faithfully representing lost structure in the finest detail. Its color, texture, form and translucence must duplicate that of missing structure and adjacent skin.

MATERIAL AVAILABLE [10,12]

ACRYLIC RESIN

- Acrylic resins are employed for specific types of facial defects, particularly those in which little movement occurs in the tissue bed during function (e.g. fabrication of orbital prosthesis) and for temporary facial prostheses.
- Acrylic resin is easily available, easy to stain and color, has good strength to be fabricated with feather margin and a good life of about two years.
- Its rigidity and high thermal conductivity is a drawback.

ACRYLIC COPOLYMER

- Acrylic copolymers are soft and elastic but have not received wide acceptance because of poor edge strength, poor durability and being subject to degradation when exposed to sunlight.
- In addition complete restoration is often tacky predisposing to direct collection and staining.

POLYVINYLCHLORIDE AND COPOLYMER

- Earlier these consisted of a combination of polyvinyl chloride and a plasticizer. But these days 5 to 20% vinyl acetate is being added.
- They exhibit many desirable properties like flexibility, easy coloration and acceptable initial appearance.
- The primary deficiency arises from migration of plasticizer leading to discoloration and hardening of the prosthesis

CHLORINATED POLYETHYLENE

- Lewis and Castleberry[5] reported chlorinated polyethylene, a material similar to polyvinylchloride in which coloration can be done using oil soluble dyes.

POLYURETHANE ELASTOMERS

- Polyurethane elastomers contain a urethane linkage. The reactants are a polymer terminating with hydroxyl group and others terminating with isocyanate in the presence of a catalyst.
- They have excellent properties like elasticity and ease of coloration but have certain deficiencies like isocyanates, and are moisture sensitive leading to gas bubbles when water contaminated and can also cause local irritation as described by Gonzalez.

SILICONE ELASTOMERS

- Barnhart (1960) was the first to use silicone elastomers for extra-oral prostheses.
- They are a combination of organic and inorganic compounds. Chemically, they are termed as polydimethyl siloxane.
- They are of two basic types.
  - ✓ Room temperature vulcanizing (RTV)
  - ✓ Heat vulcanizing (HTV)

NEW MATERIALS

SILICONE BLOCK COPOLYMERS	POLYPHOSPHAZENES
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.	Polyphosphazene fluoroelastomers have been developed for use as resilient denture liners and have the potential to be used as maxillofacial prosthetic materials. (MFP 14)

COLORATION SYSTEMS	
Intrinsic coloration	**Extrinsic coloration**
• Long lasting and preferred • Incorporated in depth coloration • Difficult to accomplish	• Bring about final outcome • Attains natural skin color • Widely accepted

RETENTION SYSTEMS FOR EXTRAORAL MAXILLOFACIAL PROSTHETIC [4,7,9,11]

MAXILLOFACIAL PROSTHESIS DESIGN AND MANUFACTURING [13]

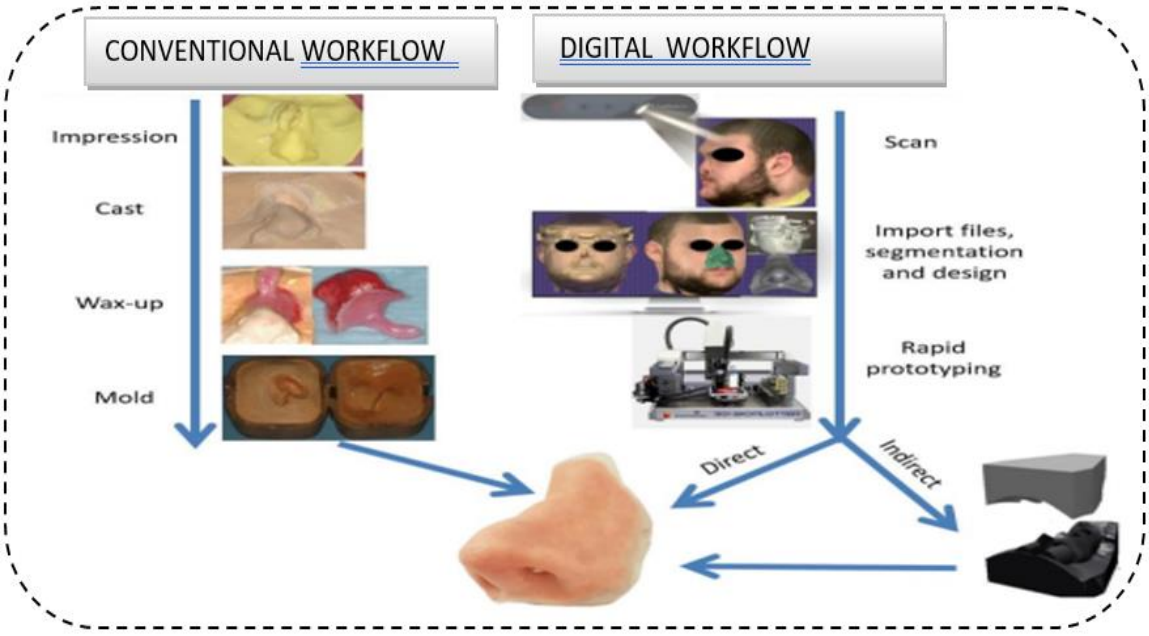
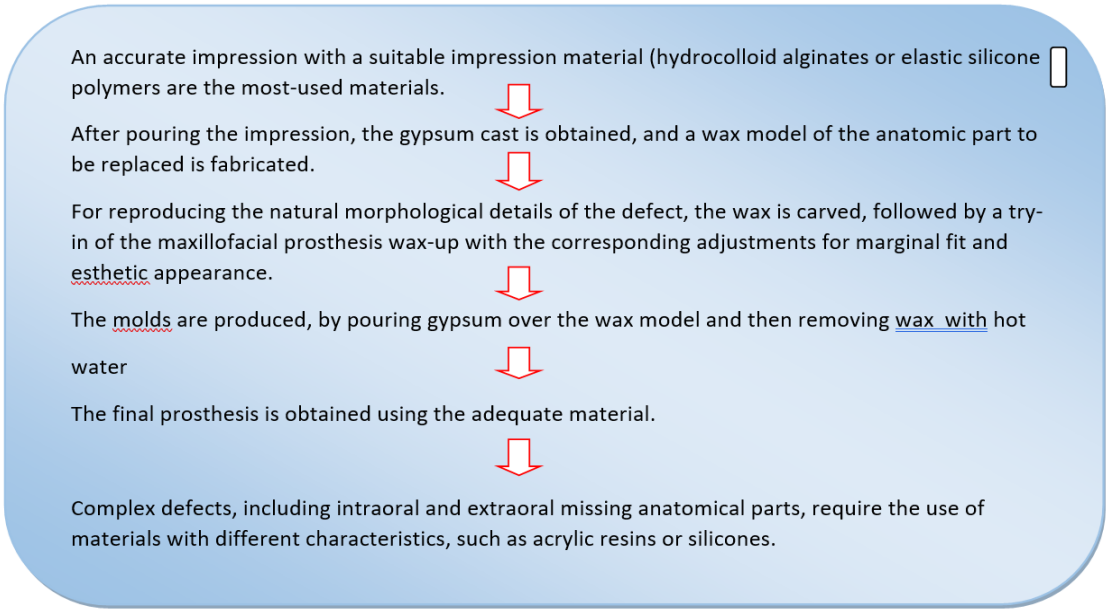
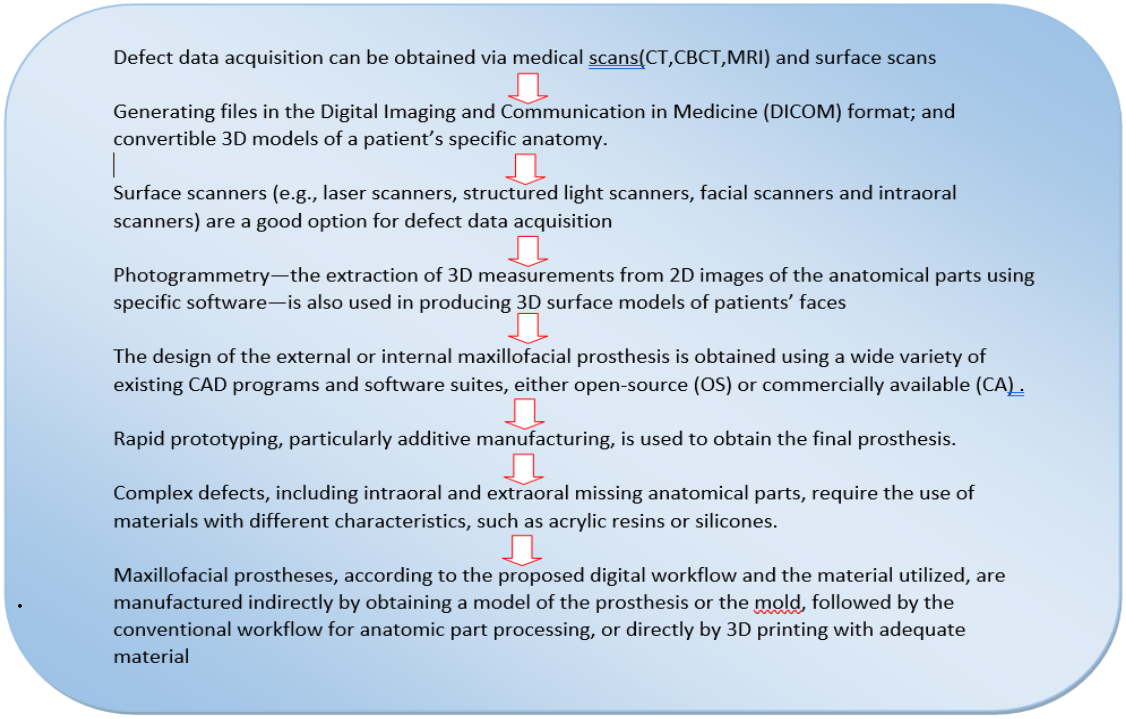


Fig.6 Comparison of conventional and digital workflows for nasal extraoral prosthesis manufacturing

CONVENTIONAL WORKFLOW



DIGITAL WORKFLOW



CONCLUSION

Extraoral maxillofacial prostheses restore several types of orofacial defects as well as improve the patient's quality of life.[1]

The rehabilitation of extraoral defects is a challenging aspect of maxillofacial prosthodontics. It requires constant practice of the art to gain confidence and expertise. The goals of the surgeon and prosthetic specialist regarding rehabilitation of the patient are closely allied.[2] The prosthetic approach is superior to the surgical approach if the defect is large or the blood supply to the area is compromised (eg, nasal septal defects, tracheoesophageal fistula, radiated bed).[3] It brings back not only their appearance but also the confidence needed to live in the society. Even though repair is difficult, replacement is an attractive option.[9]

Conventional impression materials have been used for decades in dentistry and maxillofacial prosthetics.Recent studies have focused on computer-assisted rapid prototyping machines to sculpt facial prostheses. The development and evaluation of these advances continue till date.[14]

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