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Materials Used for Maxillofacial Prosthesis: A Review

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***Abstract**: Congenital and acquired defects of the face create an unfortunate condition for the affected individual. To lead a comfortable life patient requires facial rehabilitation. To perform rehabilitation of such patients, reassessment of materials used in the field of maxillofacial prosthesis seems desirable. Maxillofacial material should best suit the ideal selection criteria to satisfy the functionality, biocompatibility, aesthetics as well as the durability. While the new materials have exhibited many desirable properties they have also exhibited some frustrating deficiencies. This article presents a systemic review of the materials used for maxillofacial prosthesis.*

***Keywords:** Heat-vulcanized silicones, Maxillo-facial materials, Room temperature vulcanized Silicones*

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I. Introduction

Maxillofacial prosthetics is defined as that branch of prosthodontics concerned with restoration and/or replacement of the stomatognathic and craniofacial structures with prosthesis that may or may not be removed on a regular or elective basis[1].Facial defects can result from congenital malformation, trauma or treatment of neoplasm. These defects of the face create an unfortunate condition for an individual and these patients require rehabilitation using maxillofacial prosthesis.Main limitations in rehabilitation are inadequate material available for facial restorations, difficulty in retaining large prostheses, movable tissue below and the patient's capacity to accept the final result.The history of maxillofacial prosthesis fabrication dates centuries back when the Chinese and Egyptians used wax and resins to reconstruct missing portion of the head and neck region [2].
The journey of searching for an ideal material was started since 1500 A.D[3] and have evolved from earlier prosthesis, made from silver, gold, cloth, paper, leather, ceramics, wrought metals, vulcanite, acrylic , polyvinyl chloride and copolymers, chlorinated polyethylene, polyurethane elastomers, medical grade silicones and polyposphazines.

Desirable properties of maxillofacial prosthetic material

1. **Physical properties** - The material should be dimensionally stable, with low thermal conductivity, flexible, light in weight and good edge strengrth.
2. **Biochemical properties** - The material should be non-toxic, non-allergenic and biocompatible. It should remain stable when exposed to environmental assaults, adhesives and their solvents. It should exhibit life of at least six months without significant comprornise of physical and esthetic properties.
3. **Fabrication characteristics**- It should have suitable working time and be easy to color**.** Polymerization should occur at a low temperature so that molds can be reused. Blending of individual components should be easy.
4. **Esthetic characteristics**- The complete prosthesis should be barely noticable in public, faithfully representing lost structure to the finest detail. Its texture, form, color and translucency must duplicate that of missing structure and adjacent skin.

II. The Evolution Maxillofacial Prosthesis Materials

Acrylic resins (1940-1960): Mainly used in situations where there is little movement of tissue bed during function. Various advantages being its colour stability, ready availability, ease of relining and repairing, have good edge strength, can be fabricated with feather margin and a good shelf life of about two years. But main disadvantages are that they are rigid, have water absorption and duplication is not possible[4].

Acrylic copolymers: They have better elastic properties than acrylic resins but have disadvantages like poor edge strength, poor durability and degradation upon exposure to sunlight. The prosthesis often becomes tacky and predisposes to dust collection and staining. New generation of acrylic monomers,

macromers and oligomers are thermal, chemical and photo initiated and can eliminate the short comings of traditional acrylic co-polymers[5].

Polyvinylchloride and copolymer: Earlier forms were consisted of a combination of polyvinylchloride and a plasticizer. But newer forms have 5 to 20% vinyl acetate added to improve their properties. They exhibit many desirable properties like ease of coloration, flexibility and acceptable initial appearance. Main disadvantage is migration of plasticizer leading to discoloration and hardening of the prosthesis**.**

Chlorinated polyethylene: Processing involves high heat curing pigmented sheets in metal molds. They are less irritating to the mucosa than silicone, less toxic than thermosetting silicone materials and non carcinogenic. Chlorinated polyethylene elastomer appears to be a suitable substitute for silicones for the fabrication of extraoral maxillofacial prosthesis in situations where cost of silicone is prohibitive.

Polyurethane elastomers: Polyurethane elastomers contain a urethane linkage. The reactants are a polymer terminating with isocyanate group and others terminating with hydroxyl 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 ease of coloration and elasticity but have certain deficiencies like isocyanates are moisture sensitive leading to gas bubbles when contaminated with water and can also cause local irritation[6].

Thermoset urethane elastomers: They are produced through introduction of primary chemical crosslinks. If reactants are combined in Stoichiometric ratios and reactions are preferentially catalysed, a known controlled morphology can be developed[7].

Silicone elastomers: Barnhart (1960)[8] was the first to use silicone elastomar for fabrication of 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.

1. Room temperature vulcanizing (RTV)
2. Heat vulcanizing (HTV)

Room temperature vulcanizing silicone elastomers (RTV): They are viscous silicone polymer including a filler diatomaceous earth, a stannous octate catalyst and an orthoalkyl silicate cross linking agent. Fillers are usually added to improve strength.

Important RTVs include

1. Silastic 382, 391
2. MDX4 - 4210
3. Silastic 891
4. Cosmesil

Heat-temperature vulcanizing silicone elastomers (HTV): Mainly designed for higher tear resistance in engineering applications. HTV 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 link.

Important HTVs include:

1. Silastic 37O, 372, 373, 4 - 4574, 4 - 4515
2. PDM Siloxane
3. Q7-4635, Q7-4650, Q7 -4735, SE -4524U

Foaming silicones:

a) **Silastic 386 -** The main purpose of the foam forming silicones is to reduce the weight of the prosthesis. However, the foamed material has reduced strength. This weakness can be overcome partially by coating foam with another silicone which adds strength but increase stiffness.

b) **Siphenylenes -** Siphenylenes are siloxane copolymers that contain phenyl and methyl groups. T'hese exhibit low modules of elasticity, improved edge strength and color ability over the more conventional silicones.

III. New Materials

Silicone Block Copolymers: In silicone block polymers, blocks of polymers other than siloxane are positioned with the traditional siloxane polymers. The foreign and hydrophobic nature of silicones has been proven to cause problems by interacting with the body on a molecular level. This can lead to the induction of foreign body reactions. Silicone block copolymers can to some extent overcome these problems by incorporating amphiphilic polymers, hydrophilic portion of which provides improved wettability and thus tissue compatibility. An example of this is the intertwining of poly methyl methacrylate into the chains of siloxane [9].

Polyphosphazenes: Developed by researchers in New Orleans who dealt with maxillofacial prosthesis and have found that compounding Polyphosphazenes with little or no fillers decreasing the ratio of acrylic to

rubber and yields a softer rubber. The rubber is compounded with pigments for appropriate matching with the patients' skin[10].

Adjuvants

1) **Primer:** There has been an increased interest in primers used for promotion of bonding between silicone and other maxillofacial prosthetic material with the introduction of urethane-line silicone prosthesis. Commonly used ones include S-2260, 4O4O, Z 6032 and Z 607.
2) **Adhesives:** A variety of adhesive systems have been introduced to retain facial prostheses in position. They are commonly classified by the method in which they are dispensed: Parts, emulsions, liquids, double sided tapes and sprayers Double sided tape is the most commonly used (41%) among patients with facial prostheses because of its ease of maintenance, application and removal. Most cured silicones, because of their low surface energy and low solubility, will not adhere to conventional tissue adhesive. The single component RTV silicones were developed to serve as adhesives for silicon prostheses (Medical Adhesive Type A)
3) **Coloration:** Realistic coloration of external facial prosthesis is an important feature for patient acceptability and satisfaction. From the stand point 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. 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.

IV. Summary

With the growing number of head and neck cancers diagnosed each year, the demand for both extraoral and intraoral prosthetic rehabilitation continues to rise. Although prosthetic rehabilitation is not always considered a necessary course of treatment, but it should be noted that it is not a vanity issue; rather, it is a psychological issue that impacts more and more people throughout the world each year. To date, none of the commercially available materials satisfy all the requirements of the ideal maxillo-facial material. Each material has its own advantages and disadvantages. It might be a dream but the possibility of fabricating a high quality lifelike prosthesis directly on the face which requires an excellent skill of the Prosthodontist and the role of a dental material scientist who can help by providing a perfect material with improved properties and colour stable colouring agents to rehabilitate the patient with maxillo-facial defect who deserves the best we can offer.

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