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Prosthodontics

MATERIALS USED IN MAXILLOFACIAL PROSTHESIS – A REVIEW

KEY WORDS: Maxillofacial, Prosthesis, Polymers, Silicones, Polyphosphazenes

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ABSTRACT

Maxillofacial Prosthesis materials used for rehabilitation of congenital or acquired defects of patients should fulfil certain criteria to satisfy the functionality, biocompatibility, aesthetics and durability. This is a review article about maxillofacial prosthesis materials.

INTRODUCTION

Maxillofacial prosthetics is the branch of prosthodontics concerned with the restoration and/or replacement of the stomatognathic and craniofacial structures with the prosthesis that may or may not be removed on a regular or elective basis (Glossary of Prosthodontic Terms).

Defects of face which may be congenital or acquired makes the condition of the affected person very disastrous mentally, physically as well as emotionally. Patient wants facial rehabilitation for a healthy happy life. Prosthesis offers the advantage of quick, reversible and medically uncomplicated rehabilitation. In addition, the restoration may readily remove to allow evaluation of the health of underlying tissues.

Historically, many types of materials have been used. Wood, wax metals, valcunite and many types of plastics have been used as rigid materials while flexible ones like gelatin glycerine mixtures, latex and elastic plastics have also found some usefulness.

Ideal Requirements For Maxillo-facial Prosthesis Materials

1. Materials should be biocompatible.
2. Flexibility: Should be flexible at temperatures from 4.4°C to 60°C.
3. Color and Translucency: Color should blend with the adjacent skin as close as possible.
4. Chemical and environmental stability.
5. Thermal conductivity: Poor conductor of heat.
6. Ease of processing and ease of duplication.
7. Weight: Light and easily retained in position and be comfortable to the patient.

Maxillofacial Prosthesis Materials

Acrylic resins

Polymethyl methacrylate was used before on the facial defects where the little movement occurs in the tissue bed during the function. Advantages of the material are compatible with most of the adhesive systems, the strength of the material enables feather exposed margins.

Plasticized methylmethacrylate

It has been formulated with a foaming agent. As a result of heat or an initiating chemical, a foaming agent releases a gas that is incorporated into the material as it cures. The resulting product is spongy, with a solid skin wherever the material contacts the mold surface. Disadvantage: Tackiness of the surface of the finished prostheses which creates the affinity for the collection of dust, necessitating special cleaning with benzene.

Vinyl polymers and copolymers

Introduced in the mid-1940s as plastisols. Most widely accepted are realistic (polyvinyl chloride) and mediplas (polyvinyl acetate chloride), they are susceptible to the degradation or destruction by UV light, ozone, peroxide, and tetraethyl lead and they are relatively rigid and must be made flexible by the use of a plasticizer.

Chlorinated polyethylene

Described by Lewis and Castleberry, involves high heat curing of pigmented sheets of the thermoplastic polymer in metal molds and coloration using oil soluble dyes. The disadvantage is the use of metal molds.

Polyurethane

Three components of polyurethane are Part A - polyol, Part B - isocyanate, and Part C - initiators such as dibutyltin dilaurate or stannous octoate. Three components must be accurately proportioned and carefully mixed to produce a usable product. The presence of moisture in the air leads to the production of carbon dioxide resulting in the porous elastomer. Linotype metal molds are necessary to control the moisture contamination.

Silicones

Long chain molecules composed of alternating chain 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). They have better physical and chemical properties. The extraordinary properties of silicones are due to the special characteristics of the silicon-oxygen bonds in their backbone. Because the silicon-oxygen bond is much stronger than the carbon-carbon bond of organic polymers, silicones make better electric insulators and are more resistant to oxidation.

Silicones are divided into type main types based on vulcanizing temperature:

- Room temperature vulcanizing (RTV) silicones.
- High-temperature vulcanized (HTV) silicones.

Room temperature vulcanizing - silicones

They set by condensation polymerization, stannous octoate is the catalyst, and ortho-alkyl silicate is the cross-linking agent. They are easy to process and allow intrinsic coloration.

Silastic 382, 399

Viscous silicone polymer consists of a filler, stannous octoate as a catalyst, and ortho alkyl silicate as a cross-linking agent. They are color stable, biologically inert, poor edge strength, and difficult to color.

Foaming silicones (Silastic 386)

The form of RTV silicone has limited use in maxillofacial prosthetics. Volume is increased by as much as sevenfold the purpose is to reduce the weight of the prosthesis. It has reduced the strength and susceptible to tearing.

High-temperature vulcanized - silicones

Requires heat for vulcanization, they are highly viscous, white, and opaque. Available as one or two component putty. Catalyst or vulcanizing agent is dichlorobenzoic acid (for condensation polymerization), platinum salts (for addition polymerization). These silicones require advanced equipment for processing and have better physical properties.

PDM siloxane (HTV silicone)
Have improved physical and mechanical properties. The drawback of the material are opaqueness, difficulty in intrinsic coloration, it has high superficial surface hardness, difficulty in processing and does not readily accept extrinsic coloration.

MDX 4-4210
Moore reported that it exhibited improved qualities relating to coloration and edge strength. It is not heavily filled, making it translucent. Platinum acts as a catalyst; the cross-linking agent is hydro-methylsiloxane. It has high tensile strength (compared to other RTV silicones). It shows increased elongation and resistance to tear.

Silastic 891: (Silastic Medical Adhesive Type A)
Udagama and Drane first reported the use of this material, also known as Silastic Medical Adhesive Silicone Type A, for the fabrication of the facial prosthesis. They are translucent, nonflowing paste which polymerizes at room temperature in contact with moisture in the air. Metal molds are not used because its surface may react with acetic acid, which is liberated as a by-product of polymerization.

Recent Advancements In Maxillofacial Prosthesis Materials
Silicone block copolymers
To improve some of the weakness of silicone elastomers such as low tear strength, low-percent elongation, and the potential to support bacterial or fungal growth.

Polyphosphazenes
Polyphosphazenes fluoroelastomer has been developed for use as a resilient denture liner and has the potential to be used as a maxillofacial prosthetic material.

Cosmesil
High flexibility with high tear strength contains condensation RTV silicone elastomer. Newer version SM4 is very flexible and has high tear strength.

A-2186 (factor II)
Physical properties better than MDX4-4210. The mechanical properties of A-2186 were less affected than cosmesil by accelerated aging.

Machinable bioactive glass ceramics
Employed in maxillofacial augmentation as a substitute for bone grafts and studies show no inflammatory reaction and rejection of the implant.

Other Materials
Adhesives
A material used to adhere external prosthesis to skin and associated structures around the periphery of an external anatomic defect. A single component RTV has been developed to serve as adhesives for silicone prosthesis.

Primers
They Promote bonding between silicone and other maxillofacial prosthetic material. Example: S-2260, A-4-4, 1205, 4040, Z-6032, Z-6076.

Colours
The realistic coloration of external facial prosthesis is an important feature for the patient satisfaction and acceptability. Three basic techniques:
1. Extrinsic.
2. Intrinsic.
3. Combination of both.

According to Chalian, intrinsic coloring in HTV silicones is accomplished with a milling machine. Metallic oxides/ pigmented silicone concentrates are generally used and red fibers may be incorporated to simulate the blood vessels. Coloring in RTV silicones (MDX 4-4210) is accomplished by adding various dry earth pigments.

Bartlett et al, recommended extrinsic coloring of the maxillofacial prosthesis using medical adhesives.

Ouellete described spray coloring of silicone elastomer maxillofacial prosthesis.

Craig evaluated the color stability of 6 MF materials (PVC, polyurethane, Silastic 382, 399, 4-4210, & 4-4515) PVC became lighter after 100 h. Polyurethane disintegrated after 600 h. He concluded that all the silicones exhibited good color stability especially Silastic 4-4210.

According to Schaaf, the color easily peels off or rubs off during manipulation of the prosthesis or during daily cleansing.

CONCLUSION
The normal anatomy and appearance is restored by the Maxillofacial Prosthesis, it protects the tissues of the defect and provides great psychological benefits to the patient. Maxillofacial Prosthesis materials should possess high edge strength, high resistance to abrasion, high tear strength, high tensile strength, low coefficient of friction, low specific gravity, low surface tension and low thermal conductivity, odourless, non-inflammable, no water sorption, translucent, softness compatible with supporting tissues, variable flexibility, non allergic, non toxic, cleansable with disinfectants without losing surface details or margins, colour and dimensional stability, resistance to environmental discoloration and growth of microorganisms.

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