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ABSTRACT

Craniofacial region suffers from many defects due to carcinoma, trauma and other iatrogenic causes. Surgery leaves defects ranging from minor cosmetic discrepancy to major functional limitation. Rehabilitation of these patients with disabilities due to either congenital or acquired defects is challenging. To achieve this, several maxillofacial materials have been used that best suit the ideal selection criteria to satisfy the functionality, biocompatibility, esthetics as well as the durability. The aim of this article was to accentuate about their evolution and current trends in using these materials.

Keywords: Foaming silicones, Maxillofacial prosthesis, Polyphosphazenes, Room temperature vulcanized, Silicone block copolymers, Silicone elastomers heat vulcanized.

INTRODUCTION

Anaplastology is a branch of medicine dealing with the prosthetic rehabilitation of an absent, disfigured or malformed anatomically critical location of the face or body. Maxillofacial prosthesis is defined as any prosthesis used to replace part or all of any stomatognathic and/or craniofacial structures. Materials for maxillofacial prosthetic reconstruction include those with physical properties ranging from hard, stiff alloys, ceramics and polymers to soft, flexible polymers and their formulation as latex and plastisols. However, till date no material has emerged that possesses all the distinct and desirable characteristics.

Silicones (1960 to 1970)

Silicones were introduced in 1946, but were used in fabrication of maxillofacial prosthesis only for the past few years. It consists of alternate chains of sodium and oxygen which can be modified by attaching various organic side groups to the silicon atoms or by cross-linking the molecular chains. They have properties ranging from rigid plastics through elastomers to fluids. When adequately cured, they resist absorbing organic materials that lead to bacterial growth; so, with simple cleaning, these materials are relatively safe and of adequate sanitary quality as compared to other materials.

Silicones are classified into four groups according to their applications as follows:

1. Class I: Implant grade, which requires the material to undergo extensive testing and must meet ‘food and drug administration’ requirements. These materials are used in breast implantation.
2. Class II: Medical grade, which is approved for external use. This material is used for fabrication of maxillofacial prosthesis. Some studies tested the cytotoxicity of this material; however, none has reported any negative side-effects.
3. Class III: Clean grade, this material is applied to use in food coverage and packaging.
4. Class IV: Industrial grade, commonly used for industrial applications.

Vulcanization makes the silicone resistant to ultraviolet (UV) light. Depending whether the vulcanizing process uses heat or not, silicones are available as heat vulcanized (HTV) or room temperature vulcanized (RTV), and both exhibit advantages and disadvantages.

Heat-vulcanized Silicones

Heat-vulcanized silicones are seldom used for maxillofacial prostheses. They include a polydimethyl vinyl siloxane copolymer with approximately 0.5% vinyl side chains, 2,4-dichlorobenzoyl peroxide as an initiator (vulcanizing agent), and a silica filler obtained from burning methyl silane; catalyst of HTV is platinum salt (salt of chloroplatinic acid). By altering the ratio of the...
matrix and the filler particles, the desired physical and mechanical properties can be achieved. The process of vulcanization requires greater milling of the solid HTV stock elastomer for mixing the catalyst for cross-linking and pigmenting. Chalian et al explained the milling of HTV silicone using a two-roll mill with a motor drive so that greater translucency can be obtained with increased dispersion of internal pigments used. Vulcanization or cross-linking occurs by free radical addition. The processing temperature ranges from 180 to 220°C for about 30 minutes under pressure using metal molds. They have excellent tear strength and highest tensile strength at 5.87 MPa (polyurethane has the lowest at 0.83 MPa), excellent thermal, color and chemical stability (rendering it more biologically inert) and high percent elongation.

The examples of HTV are Silastic S-6508, Silastic 382 and Silastic 399.

Room Temperature Vulcanizing Silicones

There are two types of room temperature vulcanizing silicones (RTVS):

1. Cross-linkage occurs by condensation reaction: They have reactive groups, such as silariols (hydroxyl-terminated polysiloxanes), cross-linking agent, e.g. tetraethyl silicate, and a catalyst, such as triacetoxy silane is used as the cross-linking agent. Their use has been limited to that of an extrinsic colorant carrier applied to the surface of the prosthesis.

2. Cross-linking of polysiloxanes by addition reactions: These involve the addition of silyl hydride groups (—SiH) to vinyl groups (CH₂=CH—) attached to the silicone in presence of platinum as catalyst. These silicones are not truly room vulcanized silicones as curing of these silicones require heating the material at 150°C for an hour. Prostheses are polymerized by bulk multiple packing. Recently, epoxy resins and stainless steel molds are being used. Its examples are silastic 382, 399, 891, MDX4-4210, cosmesil, A-2186 and A-2186F.

Silastic 382 and 399 are viscous silicone polymers which are color stable and biologically inert. They are available as clear solutions that enable the fabrication of translucent prosthesis.

The MDX4-4210 is a clear-to-translucent two-part (10:1, base:catalyst) silicone which was introduced to the maxillofacial prosthetics field in the 1970s. According to Beumer, in a survey by Andres, 41% of the clinicians used this material for fabrication of maxillary prosthesis. Moore et al stated that it exhibited improved qualities relative to coloration and edge strength, has adequate tensile strength, is nontoxic, color stable and biologically compatible.

The silicone ‘A-2186’ was introduced in 1986 by Factor II (lakeside, AZ). It was the first commercial platinum-catalyzed silicone elastomer. A fast polymerization rate version of A-2186 with higher platinum content ‘A-2186F’ became commercially available in 1987, which was not a very preferred material for prosthesis purpose.


Silastic 891: Udagama and Drane first reported the use of this material. It is also known as silastic medical adhesive silicone type A and is also compatible with wide range of colorants.

Several other commercially available silicone products include—cosmesil, realistic, VerSilTal (VST) and liquid silicone rubber (LSR).

Properties of HTV and RTV

In comparison to other materials, both HTV and RTV have high tear resistance. Room temperature vulcanizing has the lowest dynamic modulus of 2.12 MPa. According to a survey by Montgomery and Kiat-Amnuay, MDX4-4210 and A-2186 RTV silicones along with silastic medical adhesive type A (for extrinsic coloring of prostheses) were the most preferred maxillofacial prosthetic materials used; due to hydrophobic nature, these have low adhesion than nonsilicone adhesive material and suffer from limited working time. Later, researchers have found stronger enhancement through the use of nano silica powder, which has a larger surface area than micrometer-sized silica powder.

Commercially Available Newer Materials

They include acrylic resin copolymer, vinyl polymers and copolymers, polyurethane elastomers, silicone elastomers—RTV and HTV, Silastic 372 and 373, Dow corning Mich A-2186, factor zinc ariz and cosmosil.

ALTERNATIVE MATERIALS

Silicone Block Copolymers

The silicone block copolymers can, to some extent, overcome the problem caused by silicone (especially with regard to its interaction with the body on a molecular level, foreign body reaction) as the more hydrophilic part of these amphiphilic polymers provides improved wettability and thus tissue compatibility.
Cosmesil

Cosmesil can be processed to varying degree of hardness as described by Wolfaardt et al.19 It is a RTV silicone showing a high degree of tear resistance.

Foaming Silicones

Silastic 386 is a type of RTV material. The purpose of the foam forming silicones is to reduce the weight of the prosthesis.

Siphenylones

These exhibit improved edge strength, low modulus of elasticity and color stability over the more conventional polydimethylsiloxane.

POLYPHOSPHAZENES

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

CONCLUSION

The demand for both intra- and extraoral prosthetic rehabilitation is increasing with the increasing rate of head and neck cancers being diagnosed each year. Prosthetic rehabilitation is not always considered mandatory as a 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. Till date, none of the commercially available materials satisfy all the requirements of an ideal maxillofacial material. Every material has its own advantages and disadvantages. The possibility of fabricating a high quality life-like prosthesis directly on the face 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 color stable coloring agents to rehabilitate the patient with maxillofacial defect.

REFERENCES