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Maxillofacial Prosthetic Materials-An Overview

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Abstract

There have been constant searches and researches which are intriguing place in the field of dental materials .The ultimate use of maxillofacial prosthetic material suits the ideal selection criteria to satisfy the functionality, biocompatibility, aesthetics of an individual.Acquired and congenital defects of the face create an deformity for an individual. For the individual to lead at ease life he requires facial rehabilitation, so the materials used in the field of maxillofacial prosthesis seems desirable. The materials have traveled a lengthy way from wood, wax, primitive metal, leather and lastly rubber. Along with these materials, Silicone is the most popularly used and is labeled as the "ideal maxillofacial prosthetic material".This article comprises the materials used with its superior quality and its drawbacks.It also help to understand the major fields where the materials lack and thus needs improvement to render an individual with the best maxillo-facial prosthesis from good material.

Keywords: Maxillofacial prosthetic material, Resins, Silicones

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] Maxillofacial prosthesis is defined as any prosthesis used to replace part or all of any stomatognathic and/or craniofacial structures.[2] Facial defects may consequence from trauma, treatment of neoplasm, genetic or congenital malformation. The prosthodontist is incomplete by derisory material available for facial restorations, movable tissue below, complexity in retaining large prostheses, and the patient's capacity to agree the final result. Materials for maxillofacial prosthetic reconstruction extent the full range of chemical structures, with physical properties ranging from hard, stiff alloys, ceramics and polymers to soft, flexible polymers, and their formulation as latex and plastisols.[3]

History

In olden times using maxillofacial prosthetic materials dates centuries back once the Egyptians and Chinese used wax and resins to reform missing portion of the head and neck region [3]. This journey of searching an ideal material was in progress since 1500 A.D when facial prostheses were described by French surgeon Ambrose Pare in 1575 [4] and have evolved from previous prosthesis, made from gold, silver, paper, cloth, leather,

wrought, metals, ceramics, vulcanite, acrylic to latex, polyvinyl chloride and copolymers, chlorinated polyethylene, polyurethane elastomers, medical grade silicones and polyposphazines.

Silicones were introduced recently in 1946 and were used for the foremost time by Barnhart (1960) for extra-oral prosthesis [5] and became more popular over other materials.

Desirable Properties of Maxillofacial Prosthetic Material[6,7]

1. Physical properties

A. It should be flexible
B. Dimensionally stable
C. Light in weight
D. Low thermal conductivity
E. Good strength.

2. Biological and chemical properties

- It should be non-toxic
- non-allergenic
- biocompatible
- It should exhibit good life of at least 6 months

3. Fabrication characteristics

It should have suitable working time and be easy to color.

4. Esthetic characteristics

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

Materials Available

Acrylic Resin (1940-1960):

Acrylic resin is simply available, effortless to stain and has high-quality strength to be fabricated with feather margin and a excellent life of about 2 years. It has drawback of rigidity and high thermal conductivity. Visible light-cured resin is also used, which has organic filler made of acrylic resin beads of different sizes that become part of the polymer network structure on curing. The matrix is a urethane dimethacrylate with microfine silica and contains a camphoroquinone amine as photoinitiator.[8]

Acrylic Copolymer

Acrylic copolymers are soft and elastic but is not used widely due to poor edge strength, poor durability. It is easily degraded when when exposed to sunlight.[9,10] New generation of acrylic monomers macromers and oligomers are thermal, chemical and photo initiated and can eradicate the little comings of traditional acrylic co-polymers.[11]

Polyvinylchloride and Copolymer

It is a clear, tasteless and odorless material**.** Previous it was in a combination of polyvinyl chloride and a plasticizer.Recently 5–20% vinyl acetate is being added which have the property like flexibility, easy coloration, and acceptable initial appearance. The primary deficiency arises from migration of plasticizer primary to discolor-ation and hardening of the prosthesis.[12,13]

Chlorinated Polyethylene

According to Lewis and Castleberry,they reported that chlorinated polyethylene, which is similar to polyvinylchloride where coloration can be done by means of oil-soluble dyes.[8]

Processing involves high heat curing pigmented sheets in metal molds.They are not as much of irritating to the mucosa than silicone, less toxic than thermosetting silicone materials and non carcinogenic. Chlorinated polyethylene elastomer appears to be a appropriate substitute for silicones for the fabrication of extraoral maxillofacial prosthesis where cost of silicone is prohibitive.[7]

Polyurethane Elastomers (1970 to 1990)

Polyurethane elastomers contain a urethane linkage. They can be synthesized with a wide range of physical properties by changeable the reactants and their amounts. They have outstanding properties such as elasticity and ease of coloration but show disadvantages like isocyanates and are moisture sensitive, leading to gas bubbles when water contaminated and can also cause local irritation as described by Gonzalez.[14,15]

NEW Thermoset urethane elastomers

They are formed 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.[16]

Silicone Elastomers

Barnhart (1960) was the unique to use silicone elastomers for extraoral prostheses. They are a combination of organic and inorganic compounds. Chemically, they are termed as polydimethylsiloxane.[17] They are of two basic types.

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

NEW Room temperature vulcanizing silicone elastomers (RTV)

They are viscous silicone polymer as well as a filler diatomaceous earth, a stannous octate catalyst and an orthoalkyl silicate cross linking agent. Fillers are 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)

Principally 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, particularly for incorporating the necessary 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.[18]

Foaming Silicones

The idea of the foam forming silicones is to reduce the weight of the prosthesis.[17] as material has reduced strength leading to weakening of the material.

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.[19]

Siphenylenes

Siphenylenes are siloxane copolymers[20] that include methyl and phenyl groups. These show improved edge strength, low modulus of elasticity, and color ability over the more conventional polydimethylsiloxane.

Silicone Block Copolymers

Silicone block copolymers are novel materials under progress to improve on some of the weaknesses of silicone elastomers such as low tear strength, low elongation, and the potential to hold bacterial and fungal growth. They are supplementary tear resistant than conventional cross-linked silicone polymers.[21,22]

Polyphosphazenes

Polyphosphazene fluoroelastomers have been developed for use as resilient denture liners and have the probable to be used as maxillofacial prosthetic materials.[7]

Adjuvants

Primer

There has been an amplified 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.

Adhesives

A diversity of adhesive systems have been introduced to keep hold of facial prostheses. They are normally classified by the method in which they are dispensed: Parts, emulsions, liquids, double sided tapes and sprayer's most cured silicones, as 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).

Coloration

Realistic coloration of outer facial prosthesis is a chief feature for patient acceptability and satisfaction. The base shade selected for a patient should be slightly lighter than the highest skin tones of the patient because the prosthesis willdarken 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.[19].

Conclusion

It might be a dream, but the possibility of fabricating a high-quality prosthesis directly on the face would require no more skills than a prosthodontist already has, if the dental material scientist can help us by providing a perfect material with all the ideal properties to rehabilitate the patient with orofacial defect who deserves the best we can offer.

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, 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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