Materials Used in Maxillofacial Prosthesis: A Review

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Abstracts

Maxillofacial prosthetic materials are used to replace facial parts lost through disease or trauma. Facial defect should be surgically corrected to restore function and esthetics. However, surgical reconstruction may not be possible because of size of defect and location of the defect hence prosthetic rehabilitation is indicated in such cases. The appearance can be restored by the maxillofacial prosthesis and provides great psychological benefits to the patient. Materials for maxillofacial prosthetic reconstruction span the full range of chemical structures with physical properties ranging from hard polymers to soft flexible polymers and elastomers and their formulations as latex and plastisols. The historical development followed closely and adjunctively over the years with innovations in dental materials from primitive to sophisticated and intricate configurations, in conformity with required functionality and cosmetic appearance. This article presents a systematic review of the material used in maxillofacial prosthodontics.

Keywords : *Maxillofacial Prosthesis, silicon elastomers, Polyphosphazenes*

Introduction

Facial defects can be the result of trauma or tumor surgery, congenital anomaly. Such a defect should ideally be surgically reconstructed to restore function and esthetics. However, due to size or location of the defect surgical reconstruction may not be possible. The patient's medical condition or personal desires may also preclude reconstructive surgery in these cases, prosthetic rehabilitation is indicated.[1] The normal anatomy and appearance is restored by the maxillofacial prosthesis, it protects the tissues of a defect, and provides great psychological benefits to the patient.

Maxillofacial prosthesis is defined as "Any prosthesis used to replace part or all of any stomatognathic and or craniofacial structure".[2]

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The search for more acceptable materials for maxillofacial prosthesis have been made in past several decades, though the quality of prosthesis remains less than satisfactory. This article presents a systematic review of the material used in maxillofacial prosthodontics.

Historical review

In Egyptian Mummies, auricular, nasal, and even ocular prosthesis fabricated from various materials, have been found. Chinese were known to fabricate nasal and auricular prosthesis using natural waxes, resins and metals usually gold or silver. Alphonse Louis fabricated silver mask to French soldier who become injured in war. Amroise Pare in 1541 introduced obturator, consists of simple disc attached to sponge.[3] Tycho Brache in 1576, used an artificial nose made from gold to replace nose. Pierre Fauchard in 1678 made monumental contribution to prosthetic facial reconstruction.[4] William Morton in 1862 fabricated nasal prosthesis from porcelain and matched the color exactly to the patients face.[4] Kingsley in 1880 described the combination of nasal and palatal prosthesis in which obturator portion was prime part of nasal prosthesis. Upham in 1900 he described the fabrication of nasal and auricular prosthesis made from vulcanite rubber. Baird and Baker in 1905 reported their

cases of maxillofacial prosthesis using black vulcanized rubber.[4]

In 1913 - Gelatin-glycerin compounds were introduced for use in facial prosthesis in order to mimic the softness and flexibility. Bulbulian & Clarke –during the period of World War II he introduced Latex material for facial prosthesis.In early 1940's Acrylic resin was introduced in dental profession. Tylman –introduced resilient Vinyl copolymer to overcome rigidity property of acrylic resin.

Barnhart in 1960 use silicone rubber for construction and coloring of facial prosthesis. Tashma in 1967 used dry earth pigments dispersed in colorless acrylic resin polymer powder for intrinsic coloring of silicon facial prosthesis. Lontz in 1974 modifies Polysiloxane elastomers. Gonzalez in 1978 described the use of polyurethene elastomer.Lewis and Castelberry described potential use of siphenylene for facial prosthesis.[4] Antonocci & Stansberry introduced new generation acrylic resin. Gettleman was first to introduce Polyphosphazenes.

Classification of Maxillofacial Prosthesis materials

• According to Beumer:[5]

1. Acrylic resins.

2. Acrylic copolymers.

3. Polyvinyl chloride & copolymers.

4. Chlorinated polyethylene.

5. Polyurethane elastomers.

6. Silicone elastomers – HTV, RTV, Foaming silicones.

7. New materials- Silicone block copolymers, Polyphosphazenes.

Ideal properties [5]

A. Physical & Mechanical properties:

Dynamic properties comparable to tissues and maxillofacial material should possess have high edge strength, high resistance to abrasion, high tear strength & high tensile strength, low coefficient of friction, low specific gravity, low surface tension & low thermal conductivity, should be odorless, non-inflammable, No water sorption, translucent, softness compatible to tissue & variable flexibility.

B. Biological properties:

It should be compatible with supporting tissues, non allergic & non toxic, cleansable with disinfectants without losing details at surface or margins, color stability & dimensional stability, resistance to environmental discoloration & growth of microorganisms.

Materials used in maxillofacial prosthesis-

1. Acrylic Resins:

In specific type of facial defect particularly those in which little movement occurs in tissue bed during function, such as Orbital or Ocular etc.[5]

Different types of resin available are; Heat activated, cold activated, light activated

Advantages: Readily available, easy in intrinsic and extrinsic coloring, good strength and compatible with adhesives, color stability, easily repaired or relined.[4]

Disadvantages: Rigidity, discomfort, no duplication possible, as after processing mould is destructed.[4]

2. Acrylic Copolymers:

These are soft and elastic but not widely accepted because of questionable properties. It has like poor edge strength, poor durability, degrade in sunlight, processing & coloration is difficult, gets stained easily.[6]

Cantor and Hildestad discussed the well documented properties off acrylic copolymer and fabrication of prosthesis.[5]

3. Vinyl Polymer & Copolymers:

It was popular but replaced by newer materials with better properties. Recently, a copolymer of 5%to 20% Vinyl acetate with the remaining % being vinyl chloride has been introduced.[5] This copolymer is more flexible but comparatively less chemically resistant than polyvinyl chloride itself. It is more stable to heat and light and is flexible.[4]

Disadvantages: Loss of plasticizers, tear of edges easily, easily stained degrade easily, metal molds required, has short service life

4. Chlorinated Polyethylene:

Lewis & Castleberry introduced this material which is similar to Polyvinylchloride in both chemical composition & physical properties, processing involves high heat curing of pigmented sheets of thermoplastic polymer using metal mould.[4]

5. Polyurethane Elastomers:

Polyurethane elastomers contain a urethane linkage. They arises from two major reactants, composed of extended segment of aliphatic diisocynate groups and a segment of polyol groups .In the presence of a catalyst organotin,

a polymer terminating with isocyanate is combined with one terminating with a hydroxyl group. They can be synthesized with a wide range of physical properties by varying the reactant and their amounts.[7]

Advantages: Elastic without compromising their edge strength, flexible, easy coloration, have superior cosmetic results, high tear resistance, good ultimate strength and elongation

Disadvantages: They are moisture sensitive leading to gas bubble cause defect and poor curing of material, difficult to process, poor color stability, service life less, poor compatibility with adhesives, toxic.

6. Silicones:

Silicone is combined with methyl chloride to form dimethyl dichlorosiloxane which then reacts with water and forms polymer. This polymer is translucent, watery fluid whose viscosity is determined by length of polymer chain. Additives are used to provide colors.[8,9]

The process of cross linking polymer is called as vulcanization, which occur with or without heat depending upon the catalyst and cross linking agent used.[5]

Silicon elastomers are available in two forms:-

A. Heat Vulcanized Silicones (HTV):

It is Polydimethyl vinyl siloxane copolymer with approx. 0.5% vinyl side chains.[9] Dichlorobenzoyl peroxide used as a vulcanizing agent. Silica of particle size 30um is used as filler.It is usually a white opaque material and putty like in consistency. Silicones exhibits excellent thermal and colour stability when exposed to environmental factor.[4]

i. SILASTIC 370, 372, 373, 4-4514, 4-4515:

They are white, opaque material, highly viscous and putty like consistency. Dichlorobenzoyl peroxide or platinum salt used as a catalyst.Silica as fillers added to harden materials. It has excellent thermal stability and color stability, biologically inert.[8]

ii. PDM SILICONES:

It was developed by veterans administration and reported by Lontz and Schweiger.[8]

Independent evaluation of physical and mechanical properties were reported by Abdelnnabi.

iii. Q7-4635, Q7-4650, Q7-4735, SE-4524U:

Bell evaluated a new generation of HTV silicone. This Silicone shows improved physical and mechanical properties compared to other silicon.

B. Room Temperature Vulcanized Silicones (RTV):

They are used more often than any other silicone. They are viscous silicon polymer including stannous octate used as a catalyst, filler as diatomaceous earth, an orthoakyl silicate as a cross linking agent.

i. Silastic 382, 399:

It is Viscous and color stable, easy to process, biologically inert, but it has poor strength, cosmetic results are inferior.[8]

ii. MDX4-4210:

Moore reported improved properties related to coloration and edge strength. 5% solution of mild soap can be employed as a releasing agent.[5]

Advantages: Increased elongation & hardness is measured within the range of human skin, color stable, simple processing and compatible with adhesives.[6]

iii. Silastic 891:

Also called Silastic Medical Adhesive Silicone Type A. Udagama & Drane first reported its use. It is translucent, polymerizes in air and is compatible with wide range of colorants.

iv. Cosmesil / Silskin 2 Systems:

It can be processed to varying degree of hardness as described by Woofaardt. This material has high tear strength.[6]

C. Foaming Silicones

i. Silastic 386:

Foam of RTV silicone has limited use in maxillofacial prosthetics. When the catalyst stannous octate is introduced to basic silicone the gas is released. The gas forms bubbles within the vulcanizing silicone. After the silicon is processed the Gas is eventually released leaving a spongy material, the formation of bubble within the mass can cause the volume to increase by as much as 7 times.[5]

ii. Siphenylenes

These are the siloxane copolymer that contains methyl and phenyl groups. These exhibits improved edge strength, low modulus of elasticity and color stability over other silicon.

7. Recent Advances:

i) Silicone Block Copolymers:

These materials are under development which will improve some of the weakness of silicon elastomers, such as low elongation and the potential to support bacterial and fungal growth. It is more tear resistant.[8]

ii) Polyphosphazenes:

These are developed for use as a resilient denture liner and have a potential to be used as maxillofacial prosthetic material.

iii). A-2186 (Factor II):

A recently developed material initially showed improved physical and mechanical properties. It doesn't retain its improved properties when subjected to environmental variables.

Coloration- coloration of prosthesis depends upon the material used. The basic skin tone should be developed into shade guide for materials that are used. The basic shade selected for patient should be slightly lighter than the skin tone of the patient.[5]

There are two types of coloration system: -

1. Intrinsic coloration- it is long lasting and preferred but difficult to accomplish. It is incorporated in depth coloration.[8]

2. Extrinsic coloration- brings about final outcome and attains natural skin coloration, medical adhesive silicone is thinned with xylene to which pigment are palleted and then applied topically to the prosthesis, and is widely accepted.[8]

Conclusion

Materials currently available for use in maxillofacial prosthesis do not completely meet required needs. Certain advantages and disadvantages of materials are present. Lots of clinical testing and research needs to be put in, so that, dentist can get ideal material for maxillofacial prosthesis.

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