Oral & Maxillofacial Prosthetics-II: Materialistic Approach

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Abstract

The objective of maxillofacial prosthodontics has always been to improve the quality of life for the persons who have congenital anomalies, alternations in growth, development, acquired ablative surgical, or oncologic management needs as well as those with severe traumatic injuries. Previous article of this series dealt with the history and objectives of Oral and maxillofacial Prosthetics. Present article reviews the materials which are generally used in Oral and maxillofacial Prosthetics. The search for more acceptable materials for facial prostheses have been made in past several years, often the quality of prosthesis remains less than satisfactory . The search for new materials should continue while existing materials are being used to their best advantage.

Classification of Maxillofacial Prosthesis

Extraoral: Facial restorations are used to return the patient's appearance to an acceptable esthetic state e.g. nasal prosthesis, orbital and ocular prosthesis (Fig: 2), auricular prosthesis (Fig: 1), finger prosthesis (Fig: 3) and composite prosthesis [3,4].

Intraoral: These prosthesises are used to restore or complete the portions of the oral cavity and nearby anatomical structures e.g. obturators (Fig: 4), speech aids (Fig: 5), modified complete and partial dentures, and infant feeding prosthesis[3,4].

Ideal Requirements

They should be biocompatible, strong and stable. The color and texture should be compatible. They should be resistant to tearing and withstand thermal and chemical changes and also should be inexpensive[3,4,5].

Materials

Vulcanite : Toward the end of 19th century, vulcanite found simultaneous use in maxillofacial prosthetics. It replaced most of the earlier materials, such as cellulose acetate, ceramic & metals. In 1901, Upham, a Boston dentist, described the use of vulcanite rubber as the best material to use. It has got a good workability, has no odor and it is not easily broken. During World War I vulcanite proved its value for maxillofacial injuries. In this period V.H. Kazanjian used vulcanite in combination with various metals to improve the design and construction of many types of oro-facial prosthesis. In time some workers showed that it lacked life like appearance[2].

Gelatin-glycerin Compound : This compound was introduced in Germany in 1913 and was used in cases of facial injuries involving the soft tissues. These are easy to manipulate, pliable, translucent and can be tinted by intrinsic color. But the drawback of this material is that the restorations last for only a few weeks only[2].

Latex : Pre-vulcanized latex is used where hollow light weight prosthesis are required. It requires only an ordinary plaster of Paris or dental stone mold. It has the advantages of being soft, inexpensive and life like appearance. But the disadvantages include weakness, rapidly degeneration, color instability and can lead to allergic reactions[2,6].

Recent advances in Latex

- Synthetic Latex is a Tri-polymer of Butyl acrylate, Methyl methacrylate and Methyl methacrylamide
- Transparent material having enhanced translucency and improved blending. But it has limited applications as process is lengthy and resultant prosthesis is not long lasting.

Vinyl Plastisols: These are thick liquids comprising of small vinyl particles dispersed in plasticizer. Colorants are added to match skin tones. They harden with age because of loss of plasticizers. Ultra violet light has an adverse effect on these materials. Their uses are limited[2].

Acrylic resin : Employed in those defects in which little movements occur in tissue bed during function e.g. fabrication of orbital prosthesis, used for extra oral prosthesis. Advantages are excellent cosmetic results, color stability, compatible with most adhesive systems. Disadvantages include rigidity, its high thermal conductivity precipitate discomfort in cold climates; duplication of prosthesis is not possible. Fonder in 1955 used acrylic resins for fabrication of cleft palate, missing ear, nose, part of face[3,5].

Acrylic copolymer (Palamed-Kulzer): Prosthesis with Palamed (a plasticized methacrylate) was provided by Cantor & Hildestad. And the development of new generation of acrylic monomers, oligomers & macromers was reported by Antonucci & Stansberry. These materials can be polymerized easily and approach is to incorporate high molecular weight acrylic polymers with molecular blocks of other types of polymers (e.g. polyether-urethane, -hydrocarbon, -fluorocarbon or -siloxane) that can eliminate shortcoming of traditional acrylic copolymers and meet requirement of a maxillofacial elastomer[3]. Disadvantages include Time consuming, more technique sensitive, poor edge strength, less durability, degrade as exposed to UV light, prosthesis becomes tacky predisposing to dust collection and staining.

Polyvinylchloride and Copolymers : Earlier form of this material consisted of polyvinylchloride & plasticizer which allows processing at low temperature. Recently a copolymer of 5-20% vinyl acetate with remaining percentage being vinyl chloride has been introduced. This copolymer is more flexible, adaptable to intrinsic& extrinsic coloration and having acceptable initial appearance when properly manipulated. But it is less chemically resistant. Metal molds are required as curing is done at high temperature. Disadvantages of these materials include discoloration, hardening of prosthesis at margins, tearing of edges if thin, easily stained and degrade when exposed to U.V. light, lack of life like translucency and poor dimensional stability. The life span of poly vinyl chloride has been extended to 9-11 months by limiting amount of plasticizer[7].

Chlorinated Polyethylene: Chlorinated Polyethylene is similar to polyvinyl chloride in chemical composition and physical properties. Its coloration and molding is possible. The processing of it involves high heat curing of pigmented sheets of thermoplastic polymer in metal molds. Disadvantage being the use of metal mold [8].

Polyurethane Elastomers : These block copolymers of hard segment of an extended Di-isocyanate and soft segment of hydroxyl group. They contain urethane linkage. These are used in blood contacting devices. These elastomers are four compound system which is commercially known as **Epithane-3:**

Part A: Polyol - a combination of polyesters.

Part B: Isocyanate - a mixture of non yellowing aliphatic di-isocyanate.

Part C: Catalyst - stannous octane or dibutyline diurate.

Part D: Thermosetting deglossing emulsion of polyurethane with silica powder.

Polyurethane Elastomers are quite elastic, flexible and colorable intrinsically& extrinsically with superior esthetic results. These materials can be synthesized with the wide range of physical properties. Precise stiochiometric admixing of the polyurethane components is required. Di-isocyanate is a hazardous material hence should be used with extreme care. These materials require metal mold for polymerization to attain tensile strength. These have no color stability, difficult to process, moisture sensitive, poor compatibility with adhesives.

Lewis & Castleberry reported an aliphatic polyurethane prepolymer, 'isophorene'[9].

Silicone Rubbers : Introduced in 1940's and most widely used materials for facial restorations[10]. These are combination of organic & inorganic compounds. By various reactions silicone is combined with methyl chloride to form dimethyl dichloro siloxane which reacts with water to form a polymer.

Polydimethy-lsiloxane is commonly reffered as silicones. Most rubbery forms of silicone are compounded with fillers that provide additional strength. Additives are used to provide color. Antioxidants and vulcanizing agents are also used to transform the raw mass from a plastic to a rubbery resin during processing. The long chained polymers can be separated with difficulty only. This network makes the silicones especially resistant to degradation from U.V. light exposure. The process of cross linking the polymers is referred to as vulcanization[3,4,11].

Silicones are classified into four groups[3,4]:

1. Implant grade: it requires the material to undergo extensive testing and must meet or exceed FDA requirements.
2. Medical grade: it is approved for external use only and most commonly used in fabrication of maxillofacial prosthesis.
3. Clean grade: used for industrial applications
4. Industrial grade: used for industrial applications.

These are available in two forms:

Heat treatment vulcanizing (HTV): Supplied as a semi solid or putty like material. These materials require milling; packing under pressure and 30 minutes heat application cycle at 180°C. Pigments are milled into the material to achieve intrinsic color.

Silastic 370, 372, 373, 4-4514, 4-4515: These are usually white, opaque materials with a highly viscous putty like consistency. These exhibit excellent thermal and color stability when exposed to U.V. light. These are biologically inert and have better strength[3].

Disadvantages: It requires milling machine, a press, metal mold (Fabrication of mold is lengthy process) and there is an increased risk of damage to the material during deflasking (when using stone mold).

PDM Siloxane: This material was developed by Veterans Administration and reported by Lontz & Schweiger[12].

Q 7-4635, Q7-4650, Q7-4735, SE-4524U

A new generation by Bell was shown to have improved physical and mechanical properties. These are single component system with unlimited shelf life[3,12].

Room Temperature Vulcanizing (RTV): They are supplied in single paste system and colored by dyed rayon fibers, dry earth pigments and Oil paints and they can be polymerized in artificial stone molds. These are more durable epoxy resins than metals. These are not resistant and are monochromatic[13].

Silastic 382, 399: They are available as clear solutions that enable the fabrication of translucent prosthesis. Cosmetic appearance is inferior to polyurethanes, acrylic resins and poly vinylchlorides[14].

MDX-4-4210 : This medical grade type silicone is most commonly used material for oral and maxillofacial prosthesises. It exhibits improved qualities of coloration and edge strength. It appears to be compatible with most skin adhesive systems. It has superior cosmetic results[14].

Silastic 891 : Also known as silastic medical adhesive silicone type A. It is used for fabrication of facial prosthesis . No catalyst is required and it is compatible with a wide range of colorants[15].

Cosmesil: This material has higher tear strength at failure than MDX-4-4210[4].

A-2186: Recently developed material which shows improved physical and mechanical properties when compared to MDX-4-4210[4].

Foaming Silicones

Silastic 386: It has limited use in maxillofacial prosthesis. The use of foam forming silicone is to reduce the weight of prosthesis. Foamed material has reduced strengthand is susceptible to tearing[4].

Siphenylenes : These are siloxane copolymers that contain methyl and phenyl groups. They exhibit improved edge strength, low modulus of elasticity and colorability over more conventional polydimethyl siloxanes[4].

New Materials

Silicone Block Copolymers : These are new materials under development to improve the low tear strength, low percent elongation and low potential to support bacterial or fungal growth. These have more tear strength.

Polyphosphazenes : It is used as a resilient denture liner and has the potential to be used as a maxillofacial prosthetic material.

Adhesives : These have been employed to retain facial prosthesis in position. Materials used for adhesives are siloxanes of low molecular weight, polyisobutylene, silicone silastic (type A) and acrylic formulation (pros - aide). For cleaning the previous adhesive isopropyl alcohol with xylene is used. Firm functional retention should be achieved during speech, facial expression, eating, splash of water, perspiration, accumulation of moisture and adjustment of eyeglasses.

Coloration: It is done for successful rehabilitation so that patient can be satisfied; the prosthesis is accepted by patient and it acts as an emotional arbiter also. Cosmetic realism is the exacting replication of subdermal i.e. intrinsic coloration and external i.e. extrinsic coloration. Finally topical glaze gives reflectance and texture resembling the adjacent tissue[16].

Intrinsic Coloration : It is longer lasting and preferred but difficult to accomplish than is extrinsic coloraton. It is incorporated in-depth coloration i.e. Arterial red, Venous red purple, Carotenoid yellow, Melanoid brown and Opaque dispersed cellular lipids.

Extrinsic Coloration : It brings about final realism and attains natural skin coloration, medical adhesive silicone (dow corning), is thinned with xylene to which pigments are palleted and then applied topically to the prosthetic device. It is widely accepted.

Conclusion:

The materials currently available still do not completely meet our need even then widely used and improvement are needed in maxillofacial prosthesis material. Materials are expected to be translucent and should have pigmentation ability to match any skin color.

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Legends

Fig: 1, Auricular Prosthesis
Fig: 2, Ocular Prosthesis
Fig: 3, Finger Prosthesis
Fig: 4, Obturator
Fig: 5, Speech aid


Fig. 1


Fig. 2

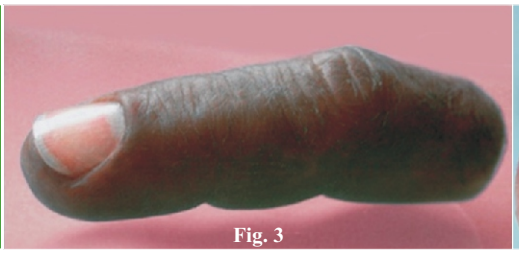
Fig. 3

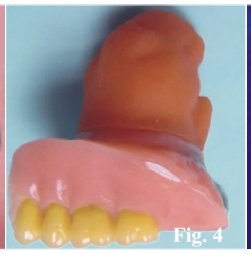
Fig. 4


Fig. 5