Research Paper

Volume : 5 | Issue : 4 | April 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

Maxillofacial Silicone: A Literature Review

Medical Science

KEYWORDS :

Dr. Shaily Tyagi	Postgraduate student, Department of Prosthodontics, I.T.S- Centre of Dental Studies and Research, Delhi- Meerut road, Ghaziabad.
Dr. Syamantak Srivastava	Postgraduate student, Department of General Surgery, Subharti Medical College, Meerut.
Dr. Divya Ratan Dahiya	Postgraduate student, Department of Prosthodontics I.T.S- Centre of Dental Studies and Research, Delhi- Meerut road, Ghaziabad.
Dr.Ram Kumar Srivastava	Professor,Department of Oral and Maxillofacial Surgery,Career P.G. Institute of Dental Sciences,Lucknow.

ABSTRACT

The rehabilitation of patients with disabilities of head and neck region, due to either congenital or acquired defects is a challenging task. These defects range from minor cosmetic discrepancies to major functional limitation. The prosthodontic management of these patients should aim at not only restoring the functional and esthetic handicap, but also ensure psychological well being. For facial rehabilitation assessment of silicone used in maxillofacial prosthesis is necessary. Till date we have come across various types of silicones which exhibit some excellent properties but also have some deficiencies.

Introduction

Maxillofacial prosthodontics or anaplastology refers to the specialty that designs and manufactures prostheses used to replace part or all of any stomatognathic and/or craniofacial structure. The prostheses provide descriptive evidence of the prosthesis, including location, retention, support, time, materials, and form.[1] It is both an art and a science of cosmetics, anatomical and functional reconstruction that is achieved by means of artificial substitutes of head and neck structures that are missing or defective. It is the branch of dentistry that rehabilitates intra and extra-oral deformities.[2] Maxillofacial prostheses are often constructed to correct facial disfiguration or deficiencies. These can be due to surgical ablation of cancer, severe facial trauma or congenital craniofacial anomalies.[3]

Extensive tissue loss of facial (or body) structures often cannot be corrected surgically because of lack of sufficient donor tissue required for surgical repair and reconstruction. Furthermore, the patient's age and general condition may not permit extensive surgical procedures or allow for the often protracted course of reconstructive surgery, recovery and associated morbidity. Additionally, the final outcome can often be aesthetically and functionally compromised. In such cases, defects may be replaced artificially by the provision of facial prostheses to provide functional rehabilitation and aesthetic repair. Often there is an associated improvement in social, emotional status and overall quality of life.[4] Conventional methods of prosthesis fabrication are well established and are used even today. These include taking an impression, making a cast and ultimately, hand crafting a polymeric prosthesis. The provision of prostheses in this manner has provided considerable comfort and support to many patients, and allowed them to continue with normal activities and social life.[5] Despite the great advantages that this method has achieved, its application has shown some limitations and shortcomings. These are primarily related to the processing strategy, technical expertise required, time, effort, cost and retention problems. Furthermore, there are durability problems due to the material's degradation and colour fade after a relatively short period of servicing and exposure to ultraviolet radiation from sunlight. For these reasons, facial prostheses require renewing and replacement periodically, which is a costly and time-intensive - both burdening patients and prosthodontists alike.[6]

Elastomers have been used for over 50 years to fabricate facial prostheses for individuals missing facial anatomy due to resection, trauma, or congenital anomalies. To approximate human skin colour, the prostheses are coloured with various pigments often suspended in various solutions. Colour stability of the prosthesis is an important factor in patient acceptance. Evaluation of colour stability using combinations of pigments, opacifiers, and elastomeric materials allows an understanding of the effects and interactions of each component and aids in identification of the combination of these ingredients that could be used to produce the most colour stable prosthesis.

Historical background

Before 1600 A.D

An interesting account of an artificial nose was quoted from the life history of Tycho Brahe, who used an artificial nose made from gold.

Ambroise Pare, a famous French surgeon, appears to have been the first to describe fabrication of a nasal prosthesis using gold, silver, paper, and linen cloth glued together.

1600 to 1800

Pierre Fauchard made a monumental contribution to prosthetic facial reconstruction; he made a silver mask to replace the lost portion of the mandible for a French soldier.

1800 to 1900

William Morton was credited with fabrication of a nasal prosthesis using enamelled porcelain to match the complexion of the patient.

1900 to 1940

Upham described the fabrication of nasal and auricular prostheses made from vulcanite rubber.

Kazanjian described the use of celluloid paints for colouring vulcanized rubber facial prostheses.

1940 to 1960

Transparent photographic paints were used by Henry Bigelow for colouring of an acrylic resin facial prosthesis.

To overcome the rigidity problem of acrylic resin, Tylman introduced the use of a resilient vinyl copolymer acrylic resin for facial prostheses.

Adolph Brown used colorants certified by the Food and Drug Administration for colouring facial prostheses.

1960 to 1970

Barnhart was the first to use silicone rubber for constructing and colouring facial prostheses by combining a silicone rubber base material with acrylic resin polymer stains.

Tashma used dry earth pigments dispersed in colourless arylic resin polymer powder for intrinsic colouring of silicone facial prostheses.

1970 to 1990

Different types of elastomers were also used for fabrication of facial prostheses.

Gonzalez described the use of polyurethane elastomers.

Lewis and Castleberry described the potential use of siphenylenes for facial prostheses.

Lontz used modified polysiloxane elastomers.

Turner documented the use of isophorone polyurethane.

1990 to present

Advances in polymer chemistry have renewed interest in developing new materials for facial prostheses.

New generations of acrylic resins are being investigated by Antonucci and Stansbury.

Gettleman described using polyphosphazenes for facial prostheses.

Desired Properties

Physical & Mechanical Properties

1. High edge strength
2. High elongation
3. High resistance to abrasion
4. High tear strength
5. High tensile strength

Processing Characteristics

1. Adjustability
2. Chemically inert after processing
3. Dimensionally stable during and after processing
4. Ease of intrinsic and extrinsic colouring with commercially available colorants
5. Ease of mould fabrication

Biological Properties

1. Compatible with supporting tissues
2. Non allergenic
3. Non toxic
4. Cleansibility without loss of detail at surface or margins
5. Cleansable with disinfectants

Classification of Silicones

1. Room temperature vulcanization (RTV)
2. Heat temperature vulcanization (HTV)
3. Others (Malleable, CAD/CAM etc.)

Room temperature vulcanization (RTV) Silicones

These include a filler of diatomaceous earth particles and are composed of two main parts; a catalyst (stannous octate) and a cross linking agent, ortho-alkyl silicate. This group includes a variety of materials namely Silastic 382 and 399. They are inert, colour stable viscous polymers. MDX4-4210 is also widely used in the manufacture of maxillofacial prostheses.[44] These materials are translucent so they can be blended with suitable earth pigments to replicate the patient's basic skin colour, with higher colour stability. The material is biologically inert and processed easily. Furthermore, it can retain physical and mechanical properties at a wide range of temperatures. The main disadvantage of these materials is poor edge strength.[7]

Silastic 382, 399

It includes filler as diatomaceous earth particles, catalyst as stannous octate, cross-linking agent as ortho alkyl silicate and polymerization is by condensation reaction. They are available as clear solution that enable the fabrication of translucent prosthesis. RTV silicone is blended with suitable earth pigment, to produce the patient basic skin colour. The main advantages are that they are colour stable, biologically inert, easier to process, retain physical and chemical properties at wide range of temperature and stone molds can be used. The main disadvantages are poor edge strength, difficult to colour, costly and cosmetic appearance of the material is inferior to that of polyurethenes, acrylic resins, polyvinyl chloride.

MDX4-4210

This medical-grade silicone elastomer is popular among clinicians. Catalyst is chloroplatinic acid. Cross linking agent is hydro-methylsiloxane. The polymerization reaction is an addition reaction with no reaction by-products. The cured material has shown adequate tensile strength. Accelerated aging testing have shown that the elastomer is very colour stable.

Silastic 891

First reported by Udagma and Drane. Also known as Silastic Medical Adhesive Silicon TypeA. It is translucent, non-flowing paste, polymerizes at room temperature on contact with moisture in the air. It is processed in a gypsum mold.

Metal molds are not recommended as its surface may react with acetic acid, which is liberated as a by-product of polymerization. No catalyst is required, compatible with wide range of colourants.

In 1987, Udagma reported improving the edge strength of this material by bonding the prosthesis to a prefabricated polyurethane film using primer,S2260. It was reported that different mechanical properties can be obtained by varying the amount of MDX4-4210 base elastomer to Adhesive TypeA to allow for better simulation of facial tissues.

Cosmesil

Its an RTV silicone. Woofaardt described that it can be processed to varying degree of hardness. Studies showed high tear strength than MDX4-4210.

A-2186

Initially showed improved physical and mechanical properties when compared to MDX4-4210. Haug reported that after subjected to environmental conditions, the A-2186 did not retain its physical and mechanical properties when compared to MDX4-4210.

Heat-temperature vulcanizing (HTV) silicones

Heat-temperature vulcanizing (HTV) is used when higher tear strength is required. Tear strength is determined by the type and nature of the cross linking in the catalyst. Different heat vulcanized silicone elastomers exist and include: Silastic 370, 372, 373, 4-4514, and 4-4515. They are highly viscous white/opaque materials with a Dichlorobenzyl peroxide/platinum salt catalyst.

Volume : 5 | Issue : 4 | April 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

Different amounts of silica fillers are added according to the degree of hardness, tensile and tear strength that is required. The material has thermal and colour stability but it lacks flexibility and restricts movement. It has poor aesthetic output because the material is opaque and many consider it to have an artificial or lifeless appearance. A new generation of (HTV) are Q7-4635, Q7-4650, Q7-4735, SE-4534U and these have shown improved mechanical properties compared to MDX4-4210 and MDX4-4514 RTV Silicone.[8, 9]

Silastic 370, 372, 373, 4-4514, 4-4515
Usually it is a white, opaque material with viscous, putty like consistency. It is a 1-component or 2-component putty. Catalyst/vulcanizing agent of HTV is dichlorobenzyl peroxide/platinum salt. Various amounts of fillers are added depending on degree of hardness, strength and elongation. Copolymerization of silicone with small amount of methyl vinyl, or methyl phenyl siloxy radical, varies the relative softness and tear strength. Polydimethyl siloxane may be added to reduce the stiffness, hardness of the prosthesis. The advantages are excellent thermal stability, colour stability when exposed to ultraviolet light and biologically inert. The disadvantages are that it do not possess sufficient elasticity, low edge strength and require nylon reinforcement at the margins, do not readily accept extrinsic colouration and metal molds are required.

PDM Siloxane
Developed by Veterans Administration and reported by Lontz and Schweiger. Physical and mechanical properties were reported by Abdelnnabi.

Q7-4635,Q7-4650,Q7-4735,SE-4524U
Evaluated by Bell and showed improved physical and mechanical properties when compared to MDX4-4210(a RTV silicone) and MDX4-4514. Processing characteristics of Q7-4635 and SE-4524U favourable because of their single component system with unlimited shelf life. In general, HTV silicones have better physical and mechanical properties than do RTV silicones. The drawback of the material is its opacity, difficulty in intrinsic colouration, high superficial surface hardness and difficulty in processing.

Conclusion
The art and science of maxillofacial prosthetics have made significant advances during the past four centuries. Improvements have been made possible through the application of dental techniques and by the availability of newer and more suitable materials. Further improvements will depend upon the discovery and introduction of even more promising materials. But a factor of much greater importance is that of fuller cooperation between the plastic surgeon and the maxillofacial prosthetist.

The prostheses can also be considered as definitive prostheses for those patients in different parts of the world who cannot gain access to highly skilled maxillofacial technicians and what has been produced here is much better than available alternatives. Moreover, these prostheses could last for a long time if they are handled and maintained in a proper way.

References
1. Glossary 2005. The glossary of prosthodontic terms. Journal of prosthetic dentistry, 94, 10-92.
2. Worthington P, Branemark P. Advanced osseointegration surgery: applications in the maxillofacial region. Chicago: Quintessence 1992.
3. Khan Z, Gettleman L, Jacobson C. Conference report: materials research in maxillofacial prosthetics. J dent res 1992; 71:1541-2.
4. Leonardi A et al. Maxillofacial prosthetic rehabilitation using extraoral implants. J craniofac surg 2008; 19: 398-405.
5. Markt JC, Lemon JC. Extraoral maxillofacial prosthetic rehabilitation at the m. D. Anderson cancer centre: a survey of patient attitudes and opinions. J prosthet dent 2001; 85:608-13.
6. Valauri AJ. Maxillofacial prosthetics. Aesthetic plast surg 1982 ; 6:159-64.
7. Maller US, Karthik K, Maller SV. Maxillofacial Prosthetic Materials-Past and Present Trends. JIADS 2010;1: 25.
8. Beumer J, Curtis TA, Marunik MT. Maxillofacial rehabilitation; Prosthodontic and surgical reconsiderations St Louis; Ishiyaku Euro America Inc 1996.
9. Lontz JF. State-of-the-art materials used for maxillofacial prosthetic reconstruction. Dent Clin North Am 1990; 34:307-25.