ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)
IJDSIR : Dental Publication Service
Available Online at: www.ijdsir.com
Volume – 2, Issue – 1, January - February - 2019, Page No. : 81 - 85

Present And Future Of Maxillofacial Prosthetic Materials

Dr Dushyant Chauhan, Dr Ashish Thakur, Dr M Viswambaran, Dr R.K. Yadav, Dr Amit Khattar, Dr Dhruv Sharma

Army Dental Centre R & R, Delhi Cantt

Corresponding Author: Dr Dushyant Chauhan, Army Dental Centre R & R, Delhi Cantt, India.

Type of Publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Maxillofacial rehabilitation is one of the most challenging aspects of treatment of a facial or associated structures defect. The field of maxillofacial rehabilitations is fast growing and so are the materials and techniques. It is most essential to be informed with the past present and future of the materials and modalities of the maxillofacial rehabilitation so as to choose and provide with the best available option for a particular rehabilitation. The search of an ideal material has made us travel from the wood and ivory from ancient times to silicones and much newer materials but still a material which fulfills all the requirements of being an ideal material has not been found. This review is aimed to upgrade the knowledge and understanding of the various materials available in present and are like to be developed in future for maxillofacial rehabilitation.

Introduction

Body abnormalities or defects that compromise appearance, function and esthetics sufficient to render an individual incapable of leading a relatively normal life have usually prompted responses that seek to bring the person to state of acceptable normalcy. Facial disfigurement can be the result of a congenital anomaly, trauma or tumor surgery. Surgical reconstruction may not be possible owing to size or location of the defect hence despite remarkable advances in surgical management of oral and facial defects, many such defects, especially those involving the eyes and ears, cannot be satisfactorily repaired by plastic surgery alone. [1] In such cases, the role of a prosthodontist is crucial and important in prosthetic rehabilitation. A facial prosthesis restores normal anatomy and appearance, protects the tissues of the defect, and provides great psychological benefit to the patient. [2] Rehabilitation goals are focused on the restorative, supportive, palliative and preventive aspects of treatment by the prosthodontist. [3]

This article focuses on the various materials and their implications, which have been put to use for the prosthetic rehabilitation of such defects over the time. Facial prosthesis were first described by French surgeon Ambrose Pare in 1575. And over the years the facial prosthetic materials have evolved from earlier 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. [4,5] Maxillofacial prosthetics has been described as the branch of prosthodontics concerned with the restoration and/or replacement of the stomatognathic and craniofacial structures with the prosthesis that may or may not be removed on a regular or elective basis. The commonly used materials for construction of facial prostheses includes: Acrylic resins and its copolymers, vinyl polymers, polyurethane elastomers, and silicone elastomers but unfortunately none of them fulfill all the ideal requirements for a satisfactory prosthesis.

Ideal properties of maxillofacial materials for extra oral use

Ideal physical and mechanical properties of the maxillofacial materials include high edge strength, high elongation, high tear strength, softness, compatible to tissue, and translucency. Ideal processing characteristics of the maxillofacial materials include chemical inertness after processing, ease of intrinsic and extrinsic coloring with commercially available colorants, long working time, no color change after processing, reusable molds and retaining of intrinsic and extrinsic coloration during use. Ideal biological properties of the maxillofacial materials include Non-allergenic, cleansable with disinfectants, color stability, inert to solvents and skin adhesives, and resistance to growth of microorganisms. [2,5]

Materials

Acrylic resin (Methyl methacrylate resins)

Use of acrylic resin in maxillofacial prosthesis is old. Use of acrylic resin in fabricating prosthetic eye was documented by US army at the time of II World war. [7] Various types of acrylic resins have been used like heat activated, light activated or self/cold activated. But they are primarily denture base resin. Their use is limited to the area of defects were the underlying supporting tissue is minimally mobile. They share common advantages like being rigid, easy to place and remove at the defect site, good strength, dimensionally stable, color stability, ease of rebasing or repairing. But due to its limitations such as poor edge strength, poor durability and degradation when exposed to sunlight, its use has been limited to ocular prosthesis as substructure to silicone prosthesis. [8]

Latexes

Historically, natural latexes were used as materials of choice for maxillofacial reconstruction because the material was inexpensive and easy to manipulate but due to disadvantages like its poor color stability and easy degeneration with time along with poor tear strength, reforms in latex were required.[9] Recently synthetic latex, a terpolymert of butyl acrylate, methacrylamide and methyl methacrylate, was developed, which is superior to natural latex. [10]

Vinyl plastisols

Vinyl chloride and copolymers were used in 1940 as favored materials for external prosthesis. But they lost their popularity due to its rigidity as a material. [9] To enhance flexibility plasticizer are added which becomes the weak link for this material.[8] Chlorinated polyethylene were another group of materials used for maxillofacial rehabilitation as they shared similar structure and properties as vinyl chlorides. These were introduced by Lewis and Castleberry. [11] Chlorinated polyethylene elastomer appears to be a suitable substitute for silicones for the fabrication of extraoral maxillofacial prosthesis in situations where cost of silicone is prohibitive.[5]

Silicone

Most commonly used material includes silicone since their introduction in this field in 1940s. [12] The use of silicones has been undisputed in rehabilitating external maxillofacial defects. Silicones are a favored material because of various advantages like minimum irritation or inflammatory response, can be vulcanized by heat or at room temperature and better physical and chemical properties.[2] Silicone chemically is a mixture of organic and inorganic compounds and termed as polydimethyl siloxane. Uniqueness of silicones is that although they are just long chain polymer of silicone and oxygen but by altering the length of these chains we can get fluids, resins, or elastomers. [2]

Silicones can be broadly classified as

Room temperature vulcanization (RTV) silicones

As the name suggests the silicone polymers can be polymerized at room temperature by condensation. Composition includes basic oxygen silicone backbone with stannous oxalate catalyst, orthoalkyl silicate crosslinking agent and diatomaceous earth as filler. [13] Though RTV can be intrinsically stained and are easy to manipulate as well as give a good colour match but still they have certain disadvantages like produces by-products, curing time is excessively long, relatively low tear strength and incapable of maintaining edge resistance. [5]

Examples include Silastic 382,399 MDX4-4210 &Silastic 891

Foaming Silicones

These variety of silicones have property to swell up or increase in volume up to 7 times their original volume which makes the prosthesis light. The expansion occurs due to release of silicone gas on introduction of stannous oxalate catalyst. But they have poor properties like poor tear resistance & reduced strength. [14]

Eg. Silastic 386

Heat-vulcanizing silicones

Like the name these silicones require heat for vulcanization and thus requiring specialized equipment to do so. These silicones are not only more opaque but white and highly viscous. They are a polydimethyl vinyl siloxane copolymer with vinyl side chain. Advantages of HTV silicones are better color stability, thermal properties and better physical and chemical properties. [15]

Egsilistic 370,372, PDM silicones.

Recent advances

Silicone block co-polymers

As conventional silicones have some common problems like induction of foreign body reactions, poor antimicrobial activity at interface between silicone and tissue etc. Silicone block co-Polymer can decrease the hydrophobic property of silicone improving wettability and also reduce chances of soft tissue reactions. an example of this is intertwining of poly methyl methacrylate into the chains of siloxanes. [16]

Polyphosphazenes

Most common drawback of various maxillofacial material available is the perfect blend of strength and elasticity. If a material has strength, then it lacks elasticity or vice versa. With polyphosphazenes this shortcoming was overcome. It is made up of polymers ending with hydroxyl group and isocyanate group and by altering the number of isocyanate group its properties can be changed.[17]

Pigments used with extra-oral maxillofacial prosthesis materials

Most common material used is undoubtedly RTV silicone which is milky white in color or nearly transparent and thus to make it appear like skin, coloring agents have to be added. The color used for silicones are generally inorganic dyes/ compounds like metal oxides. They can be added intrinsically or used for surface characterizations once base color is achieved. The intrinsic pigments are always better as they are permanent and don't fade away easily.[18,19]

Techniques used in maxillofacial prosthesis fabrication

Past

In the past, mostly acrylic prosthesis were made with craftsmanship of the operator or with the help of donor. The results were not very esthetic and always left the feel of a prosthesis. The need to improvement was answered by use of silicones but still the replication of lost part was largely limited to hand crafting the missing part. [20]

Present

Presently, with advances in the field of radio imaging and with digitalization of dentistry as a whole, use of CBCT and other radiographic means have increased many folds. The increased efficiency to evaluate bone has led to increased use of implants in the maxillofacial rehabilitation which has overcome the problem of retaining the prosthesis in critical areas like ear or orbit. The used of 3D printing has made possible to mimic and replicate contralateral vital structures reducing the discrepancies incorporated by hand crafting. [21]

Future

Future hold a plethora of opportunity, the need to make a maxillofacial prosthesis appear life like doesn't stop at making it cosmetic sound. A prosthesis which functions like the original is what we should be aiming at. A nasal prosthesis which can regulate the airflow, and orbital/ ocular prosthesis which replicates the movement of contralateral eye etc is what we should be targeting at in the future. Impression making procedures with various materials will be primitive in future as equipment like, 3dMD face™ system have already being developed. These systems record the 3D images of the defect and makes it easy to rehabilitate and match. Tissue engineering is another field were trials are ongoing to regenerate lost parts which may eliminate need of nonvital prosthesis in future. [22-24]

Conclusion

With increasing number of head and neck cancers, trauma due to road traffic accidents etc, there is increase in demand of maxillofacial prosthesis. Till now, no material satisfies the ideal requirements of maxillofacial prosthesis and has their own advantages and disadvantages. Thus, future research should concentrate on improving the physical and mechanical properties of material so that it should behave more like human tissue and finding color stabilizing agents to obtain ideal human skin color match.

References

1. Beumer J. Maxillofacial Rehabilitation: Prosthodontics and Surgical Considerations. St. Louis: Ishiyaku Euro-American Inc., Pulblishers;1979.
2. Reddy JR, Kumar BM, Ahila SC, Rajendiran S. Materials in maxillo-facial prosthesis. Journal of Indian Academy of Dental Specialist Researchers. 2015 Jan 1;2(1):1.}
3. Vialka-Moser F, Crevenna R, Korpan M, Quittan M. Cancer rehabilitation. Particularly with aspects on physical impairment. J Rehabil Med. 2003;35:153-62.
4. Mahajan Harsh, Gupta Kshiliz. Maxillofacial prosthetic material: A literature review. J Orofac Res. 2012;2(2):87–90.
5. Mitra A, Choudhary S, Garg H, HG J. Maxillofacial prosthetic materials-an inclination towards silicones. Journal of clinical and diagnostic research: JCDR. 2014 Dec;8(12):ZE08.
6. The Glossary of Prosthodontic Terms [2005].
7. Erpf, S .F .; Dietz, V.H.; and Wirtz, M.S. Prosthesis of the eye in synthetic resin. Bull US Army Med Dept 4:76 July 1945.
8. Maxillofacial prosthetic materials. REPORTS OF COUNCILS AND BUREAUS / JADA, Vol. 90, April 1975.
9. Bulbulian, A.H. Facial prosthetics. Springfield, III, Charles C Thomas, 1973, p 184.
10. Chalian, V.A.; Drane, J.B.; and Standlsh, S.M. Maxillofacial prosthesis; multidisciplinary practice. Baltimore, Williams & W ilkins Co., 1971, p 96.
11. Moore DJ, Glaser ZR, Tabacco MJ, Linebaugh MG. Evaluation of polymeric materials for maxillofacial prosthetics. J Prosthet Dent 1977;38:319-26

12. Polyzois GL. Evaluation of a new silicone elastomer for maxillofacial prostheses. J Prosthodont1995;4:38-41.
13. Barhate AR, Gangadhar SA, Bhandari AJ, Joshi AD. Materials Used in Maxillofacial Prosthesis: A Review. Pravara Medical Review. 2015 Mar 1;7(1).
14. Beumer J, Curtis TA, Marunick MT, editors. Maxillofacial rehabilitation: prosthodontic and surgical considerations. Ishiyaku Euroamerica; 1996.
15. Kenneth J Anusavice. Phillips' science of dental materials.11th ed. St.Louis:Saunders Elsevier; 2009.
16. Tsai FH, et al. Synthesis of silicone blocks copolymers for use as maxillofacial materials. Proceedings of Conference on Materials Research in Maxillofacial Prosthetics. Transactions of the Academy of Dental Materials. 1992;5:126.
17. Udagama A. Urethane-lined silicone facial prostheses. J Prosthet Dent 1987;58:351-4.
18. Chalian VA, Phillips RW. Materials in maxillofacial prosthetics. J Biomed Mater Res 1974;8:349-63.
19. Taylor TD. Clinical Maxillofacial Prosthetics. Berlin: Quintessence Publishing Company; 2000.
20. Maller US, Karthik KS, Maller SV. Maxillofacial prosthetic materials past and present trends. J Indian Acad Dent Spec 2010;1:25-30.
21. Beuer F, Schweiger J, Edelhoff D. Digital dentistry: An overview of recent developments for CAD/CAM generated restorations. Br Dent J 2008;204:505-11.
22. Khan Z, Farman AG. The prosthodontist role in head and neck cancer and introduction – Oncologic dentistry. J Indian Prosthodont Soc 2006;6:4-9.
23. Ariani N, Visser A, van Oort RP, Kusdhany L, Rahardjo TB, Krom BP, et al. Current state of craniofacial prosthetic rehabilitation. Int J Prosthodont 2013;26:57-67.
24. Wolfaardt J, Gehl G, Farmand M, Wilkes G. Indications and methods of care for aspects of extraoral osseointegration. Int J Oral MaxillofacSurg 2003;32:124-31.
25. Eggbeer D, Evans PL, Bibb R. A pilot study in the application of texture relief for digitally designed facial prostheses. Proc Inst Mech Eng H 2006;220:705-14.)