Current Trends in Biomedical Engineering & Biosciences
ISSN: 2572-1151

Juniper Publishers
key to the Researchers

Mini Review
Volume 2 Issue 3 -March 2017
DOI: 10.19080/CTBEB.2016.01.555588

Curr Trends Biomedical Eng & Biosci

Application of Biomaterials in Dentistry

Zahra Abdolahpour[1], Zahra Saneipour[1] and Mohammad Javad Azarhoosh[1,2]*

[1]*College of Dentistry, Tehran University of Medical Science, Iran*

[2]*Chemical Engineering Department, Amirkabir University of Technology, Iran*

Submission: February 19, 2017; **Published:** March 21, 2017

***Corresponding author:** Mohammad Javad Azarhoosh, College of Dentistry, Tehran University of Medical Science, Tehran 14155-6447, Iran, Email: m.j.azarhoosh@aut.ac.ir

Abstract

Today, biomaterials are widely used in dentistry. Over the past thirty years; a new field of materials science has emerged as a biomaterial. Today, biomaterials are widely used in dentistry. Biomaterials used in dentistry are divided into four general categories of polymers, ceramics, metals and composites. In this paper, the application of these biomaterials in dentistry was investigated.

Keywords: Biomaterials; Dentistry; Polymers; Ceramics; Metals; Composites

Introduction

A biomaterial is any substance to fix the defects, repair or replacement of defective organ in the body. Over the past thirty years, a new field of materials science has emerged as biomaterial. It is a result of development and the integration of various branches of materials (metals, composites, ceramics and polymers).These materials are synthetic (synthetic - mineral or organic) or natural which have been designed and made to work and fix defects in the organism (mostly men). One of the familiar and experienced biomaterials is dental materials (mercury compounds) for dental fillings. In this way, industries related to biomaterials, gradually emerged over the last thirty years, especially in United States of America, and now has allocated a huge number of world trade (about 70 billion dollars a year), which more than 700 companies are involved in it. A very important point is that, these materials are sold very low in volume but at high price, and are considered as strategic products. In this paper, we try to investigate application of these biomaterials in dentistry [1-3].

Polymers

Today, the use of polymers is widely spread in dentistry. With the advancement of material science, new materials produced have properties similar to natural biomaterial. One of the most common cases is the use of polymeric base material in complete and partial denture. In addition, denture soft liners, resin cements, pit and fissure sealants contain polymer. Polymers used for denture base includes: Vulcanite, Celluloid, Phenol-formaldehyde (Bakelite), Polyvinylchloride (PVC), Poly methyl methacrylate (PMMA) [4,5].

Despite the introduction of new materials for denture base, PMMA is still preferred for both types of dentures. The advantages that led to consider PMMA as the most common polymer include: low cost, low weight, great beauty, low solubility and low water absorption, possibility of repairment convenient and easy processing. One of the weaknesses of this polymer is clinical failure and fracture due to Impact forces or fatigue. To resolve this problem, it has tried to increase flexibility and strength of this matter, for this purpose, this material has combined with substances such as Copolymer and a variety of glass and metallic fibers and nanoparticles [4].

Another example of the use of polymers is related to use in tissue engineering and dental structures regeneration. In dental implants which are the most common method of replacing lost teeth, to avoid biological and mechanical failures, we need to have a certain amount of bone in the tooth socket. In one study on eight human cases, they found that the use of poly (lactic-co-glycolic acid) (PLGA) before replacing metallic implants can improve and repair the alveolar socket [6-8].

Another use of polymers in tissue engineering is using them as delivery vehicles in which by incorporating regenerative factors (such as growth factors) with polymers, they are transferred to the desired location and they will be sustained release [8-10].

Ceramics

Ceramics are considered as a combination of metal elements and non-metallic materials such as, oxides, nitrides and silicates, and can be appear in two solid crystalline and amorphous (shapeless) solid, the second group is also called glass [11,12].

They form hard, stiff, and brittle materials due to the nature of their inter-atomic bonding, which is ionic and covalent [13]. Ceramics have very good resistance against compressive stresses, but are vulnerable under shear and tensile stress [14]. Ceramics can be very translucent or opaque. This feature is dependent on their microstructure. That means that whatever amount of amorphous phase is more, they will be more translucent and whatever the amount of crystalline phase is more, they will become more opaque. Ceramics have many applications in dentistry. For example, they can be used as filler in the composite resins, glass ionomer, investment and porcelain cements [15].

Porcelains are biocompatible dental restorations that are made in the laboratory (restorations such as crown, bridge and veneers). The benefits of these compounds can include an excellent biocompatibility, being natural chemically, beauty, the dissolution and having high toughness [16,17].

Metals

Nowadays, metal-free dental sciences have been developed more rapidly, but the metals are still discussed in durable and long-lasting clinical applications [17].

Metals are elements that are charged positive ion in solution, and have allocated about 70 percent of its periodic table to itself. During ionization, metal releases its valence electron. Metal and user behavior off metals in dentistry depends on their features to create free positive and stable ions [18].

Metallic elements commonly used in dentistry are divided into two groups, noble and base metal. Base metal elements are a group of elements which will be oxidized when are heated in the open air and are cheaper compared with precious metals. These elements include titanium, silver, copper, zinc, indium, tin, gallium, nickel and cobalt [19].

Gold, platinum, palladium, iridium, rhodium, osmium and ruthenium are considered as noble metals. Their resistance to oxidation, tarnish and corrosion in heating and soldering and use in the mouth is excellent [20].

Gold alloy is one of metal alloys are used in dentistry today, which most of it includes the noble metals (gold, platinum, and palladium). Gold is one of the oldest materials used in dentistry that despite the emergence of new materials are still used in various fields of dentistry. High Biocompatibility, low corrosion, low accumulation of plaque and good marginal fit are considered as its most important feature.

Their most important applications in dentistry include [21,22]:

1. indirect restorations (in lay and onlay(
2. post & core
3. crown (all metal and porcelain fused to metal (PFM))
4. Telescopic crown that is used as retentive elementin over denture.
5. Bridge
6. Frame work for removable denture
7. Implants

The use of gold alloys has developed in PFM restorations in the last 20-30 years, which, is due to the unique characteristics of the metal, such as resistance to bending and thermal expansion coefficient close to porcelain. In addition to dental restorations,some of the orthodontic wires and splints can also made by a gold alloy [21,22].

Composites

Composite resins are used to rebuild the tooth structure, change the color, contour correction and improvement of facial surface of the teeth beauty. Composites used in dentistry are composed of three main components organic (resin matrix, inorganic filler components and coupling agent) and other components [23].

The most common resins used are dimethacrylate (Bis-GMA) or urethane di methacrylate oligomers (UDMA). These resins are viscous fluid which monomers with low molecular weight such as triethylene glycol dimethacrylate (TEGDMA) to control the consistency of the dough materials are added to them. Recent materials are known with carbon-carbon double bond that after the reaction lead to the conversion of material to polymer. New monomers such as silorane reduce shrinkage and internal stresses caused by polymerization and increase the durability of the restoration [24].

Composites are classified according to size or type of filler components. In terms of filler components size, composites are divided into two categories: fine (with an average size of 0.4-3 micrometers) and micro-fine (with an average size of 0.2-0.4 micrometers) [25]. Based on the type of fillers, the composites are divided into two groups of microhybride and microfilled. Filler particles in microhybride are combination of fine and micro-fine. Micro-fine particles being among the filler Fine particles lead to pack and improve the properties. Microfilled composites have micro-fine filler particles with a large surface [26]. Coupling agents can also be used to create a strong bond between the inorganic fillers and r organic resin matrix [27].

The advantages of composites include beauty, bonding to tooth structure (by micro mechanical-band), the ease to repair, reducing the need for extensive preparation of tooth surfaces (unlike Amalgam), reducing the mercury release in the environment and reducing mercury exposure for dentists and reducing corrosion [28].

Some of the disadvantages of composites include: polymerization shrinkage, secondary caries due to marginal

How to cite this article: Zahra A, Zahra S , Mohammad J A. Application of Biomaterials in Dentistry. Curr Trends Biomedical Eng & Biosci. 2017; 2(3): 555588. DOI: 10.19080/CTBEB.2016.01.555588

leakage, the need for high skills and high technique sensitivity, time-consuming, urgent need for isolation and the restoration location is completely dry, the risk of chipping and low toughness [28].

Conclusion

Biomaterials refer to a substance with synthetic or natural origin, which is used to improve, treat, heal or replace tissues of living organisms. Today, biomaterials are widely used in dentistry. Biomaterials used in dentistry are divided into four general categories of polymers, ceramics, metals and composites which were studied in this paper.

References

1. Bayne SC (2005) Dental biomaterials: where are we and where are we going? Journal of dental education 69(5): 571-585.
2. Duraccio D, Mussano F (2014) Biomaterials for dental implants. Elsevier Inc 50(14): 4779-4812.
3. Curtis RV, Watson TF (2014) Dental biomaterials: imaging, testing and modelling, Elsevier, pp. 528.
4. Alla R, Swamy K, Vyas R (2015) Conventional and contemporary polymers for the fabrication of denture prosthesis: part I-overview, composition and properties. International Journal of Applied Dental Sciences 1(4): 82-89.
5. Yildiz O, Seyrek M, Guven Polat G, Marti Akgun O, Macit E (2014) Dental Polymers: Effects on Vascular Tone, Encyclopedia of Biomedical Polymers and Polymeric Biomaterials. Taylor & Francis, New York, USA, pp. 1-13.
6. Nair PR, Schug J (2004) Observations on healing of human tooth extraction sockets implanted with bioabsorbable polylactic-polyglycolic acids (PLGA) copolymer root replicas: a clinical, radiographic, and histologic follow-up report of 8 cases, Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology 97(5): 559-569.
7. Obregon F, Vaquette C, Ivanovski S, Hutmacher DW, Bertassoni LE (2015) Three-dimensional bioprinting for regenerative dentistry and craniofacial tissue engineering. Journal of Dental Research 94(9suppl): 143S-152S.
8. Ensanya Ali Abou Neel, Wojciech Chrzanowski, Vehid M Salih, Hae-Won Kim, Jonathan C Knowles (2014) Tissue engineering in dentistry. Journal of dentistry 42(8): 915-928.
9. Leedy MR, Jennings JA, Haggard WO, Bumgardner JD (2014) Bumgardner, Effects of VEGF-loaded chitosan coatings, Journal of Biomedical Materials Research Part A, 102(3): 752-759.
10. Vishwakarma A, Sharpe P, Shi S, Ramalingam M, (2014) Stem cell biology and tissue engineering in dental sciences, Academic Press, USA, pp. 932.
11. Kelly JR, Nishimura I, Campbell SD (1996) Ceramics in dentistry: historical roots and current perspectives. The Journal of prosthetic dentistry 75(1): 18-32.
12. Höland, Rheinberger V, Apel E, van't Hoen C, Höland M, et al. (2006) Clinical applications of glass-ceramics in dentistry. Journal of Materials Science: Materials in Medicine 17: 1037-1042.
13. McLaren EA, Cao PT (2009) Ceramics in dentistry-part I: classes of materials. Inside dentistry 5(9): 94-103.
14. Babu PJ, Alla RK, Alluri VR, Datla SR, Konakanchi A (2015) Dental ceramics: Part I-An overview of composition, structure and properties. American Journal of Materials Engineering and Technology 3(1): 13-18.
15. Denry IL (1996) Recent advances in ceramics for dentistry, Critical Reviews in Oral Biology & Medicine 7: 134-143.
16. Chen X, Chadwick TC, Wilson RM, Hill RG, Cattell MJ (2011) Crystallization and flexural strength optimization of fine-grained leucite glass-ceramics for dentistry. Dental Materials 27(11): 1153-1161.
17. Givan DA (2007) Precious metals in dentistry. Dental Clinics of North America 51(3): 591-601.
18. Wataha JC (2000) Biocompatibility of dental casting alloys: a review. The Journal of prosthetic dentistry 83(2): 223-234.
19. Fonseca RG, de Almeida JG, Haneda IG, Adabo GL (2009) Effect of metal primers on bond strength of resin cements to base metals. The Journal of prosthetic dentistry 101(4): 262-268.
20. Schmalz G, Garhammer P (2002) Biological interactions of dental cast alloys with oral tissues. Dental Materials 18(5): 396-406.
21. Knosp H, Holliday RJ, Corti CW (2003) Gold in dentistry: alloys, uses and performance. Gold Bulletin 36(3): 93-102.
22. Oleszek-Listopad J, Sarna-Bos K, Szabelska A, Czelej-Piszcz E, Borowicz J, (2015) The use of gold and gold alloys in prosthetic dentistry–a literature review. Current Issues in Pharmacy and Medical Sciences 28(3): 192-195.
23. Cebe MA, Cebe F, Cengiz MF, Cetin AR4 Arpag OF, et al. (2015) Elution of monomer from different bulk fill dental composite resins. Dental Materials 31(7): e141-e149.
24. Khosravi M, Esmaeili B, Nikzad F, Khafri S (2016) Color stability of nano-filled, micro-hybrid, and silorane-based dental composite resin materials. Saudi Journal of Oral Sciences 3(2): 116-125.
25. Randolph LD, Palin WM, Leloup G, Leprince JG (2016) Filler characteristics of modern dental resin composites and their influence on physico-mechanical properties. Dental Materials 32(12): 1586-1599.
26. Randolph L, Beauquis j, Palin W, (2016) Modern resin--based composite filler characteristics and related physico-mechanical properties. Dental materials 32(Suppl 1): e100.
27. Thorat SB, Diaspro A, Salerno M (2014) In vitro investigation of coupling-agent-free dental restorative composite based on nano-porous alumina fillers. Journal of dentistry 42(3): 279-286.
28. Bijelic-Donova J, Garoushi S, Vallittu PK, Lassila LV (2016) Mechanical properties, fracture resistance, and fatigue limits of short fiber reinforced dental composite resin. The Journal of prosthetic dentistry 115(1): 95-102.

How to cite this article: Zahra A, Zahra S , Mohammad J A. Application of Biomaterials in Dentistry. Curr Trends Biomedical Eng & Biosci. 2017; 2(3): 555588. DOI: 10.19080/CTBEB.2016.01.555588

DOI: 10.19080/CTBEB.2016.01.555588

How to cite this article: Zahra A, Zahra S , Mohammad J A. Application of Biomaterials in Dentistry. Curr Trends Biomedical Eng & Biosci. 2017; 2(3): 555588. DOI: 10.19080/CTBEB.2016.01.555588