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Review Article

A literature review on various implant biomaterials

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Abstract

Now a day's dental implant prosthesis has gained much popularity as a first treatment option in replacing the missing single tooth or the multiple teeth in the oral cavity. Continuous efforts have been made in the modification of the material of the implant, to increase the longevity of the implant in the oral cavity. Several modifications have been made in terms of materials and design of the implant to increase the success rate of the implant prosthesis. To maintain healthy and long term contact or otherwise known as good Osseo integration with the alveolar bone, material type, design type and surface texture of the implant is very much important for the long term survival of the prosthesis. For a long term success of dental implant prosthesis, selection of accurate implant biomaterial is of key success. Alveolar bone does not accept any material completely, so in terms to optimize the performance biologically, implant should be selected in terms to reduce the negative biologic response while maintaining the good adequate function of the implant prosthesis. Every dentist should have an adequate knowledge of all types of implant materials, so that out of all best material can be chosen for the implant prosthesis.

Keywords: Implant, Osseo integration, Biocompatibility, Implant design, Titanium, Zirconia, Surface topography.

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1. Introduction

With increasing advancement and increasing success rate of the implant prosthesis in the replacement of missing single tooth to missing multiple teeth to full mouth implant prosthesis, implants gain a major boom.[1-4] In todays time there are different treatment options in the replacement of missing single tooth to replacement of missing multiple teeth. Different treatment options include removable partial denture, cast partial dentures, under fixed partial prosthesis, it includes single crown to multiple bridges, which is made up of different materials like porcelain fused to metal, or from zirconia, depending upon the site of missing teeth. Under fixed prosthesis, now a days implants are totally an in thing, as the implant prosthesis is fixed, it can work as a single entity like natural tooth.[3-5]

For the ultimate success of implant treatment is totally depend upon the material of choice of implant. Along with this, the second important thing in the success of the implant treatment modality is osseointegration. The better the osseointegration, better will be the longevity of the implant prosthesis. Osseointegration of the implant also depends upon the choice of bio material, which is used in the fabrication of the implant prosthesis. Other things also add up in the longevity of the implant prosthesis like implant design, surface texture of the implant.[6-8]

1.1. Ideal properties of implant biomaterials

1. It should be biocompatible with the surrounding soft and tissue.
2. It should ensure a good suitable strength to withstand the forces.
3. It should be easy to fabricate.
4. It should be easy to sterilize without getting degraded.
5. It should not be toxic to the surrounding soft and hard tissue.
6. Some studies should be done over the material, to check the efficacy, strength of the material.[7-11]

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1.2. Different types of implant bio materials

Metals and alloys of metals;

They are one of the most widely used materials in the fabrication of the implant materials. Under the category of metal and its alloys, it includes titanium, tantalum, vanadium, chromium, cobalt, nickel.[9-12]

2. Titanium

Due to the reason of the excellent biocompatibility of titanium, it is the material of choice for the fabrication of the implant prosthesis. As this material does not show any toxic effects with the surrounding soft as well as hard tissue. No allergic reactions are seen with the use of this material. The physical and mechanical properties of titanium make it desirable material of choice for the fabrication of implant. There are mainly six different types of titanium used in the fabrication of imlant. Prosthesis, namely CpTi grade i, CpTi grade ii, CpTi grade iii, CpTi grade iv, Ti-6Al-4V, Ti-6Al-4V (ELI).

CpTi alloys are the mixture of titanium and oxygen. The mechanical properties of pure titanium also got enhanced by trace elements of carbon, oxygen and nitrogen.

Recently addition of different elements like zirconium, niobium, and tantalum to the alloy, and it has shown no toxicity. Recently a new alloy roxolid, came in to dentistry and is used in the fabrication of narrow diameter implant, shows good result in terms strength and biocompatibility.[12-15]

2.1. Cobalt chromium molybdenum alloys

These alloys are most commonly used in the castable forms of the prosthesis as well as in annealed metallurgic states, which enables them in the formation of custom designed implants for e.g. those implants which are having sub periosteal frames. This alloy contains mainly proportion of cobalt i.e. 63%, chromium 30% and molybdenum as 5%. In this chromium provides corrosion resistance, while bulk and strength is being provided by molybdenum, and the main drawback of this alloy is, it is nit corrosion resistant when compared to titanium.[11-14]

2.2. Iron chromium nickel based alloys

These alloys are basically used in the fabrication of surgical steel items. They have been used since long in as orthopaedic devices and in dental implants. This alloy show high strength and high ductility when it is combined with system of titanium. This alloy is most commonly used in the fabrication of blades of ramus, frames of ramus, as well as in mucosal inert systems. This alloys shows high strength and on the other side the corrosion resistance of this alloy is on a lower side when it is compared to the titanium.[12-15]

2.3. Precious metals

Ceramics: there are different ceramics which can be used in the fabrication of dental implants, such as aluminium oxide, zirconia, hydroxyapatite, bio glass and calcium phosphate.

2.4. Aluminium oxide

This is one of the excellent biomaterials for the fabrication of the ceramic dental implant, just because of its bio inert nature. These implants shows good property of osseointegration with the surrounding alveolar bone but because of poor survival rate, this is withdrawn from the use. This material shows excellent corrosion resistance, good strength, as well as high wear resistance.[8-14]

2.5. Calcium phosphate ceramic

This material is totally bio compatible with the host tissue. Two most commonly used calcium phosphate ceramics are hydroxyapatite and tricalcium phosphate. This material have a tendency to make direct bond in alveolar bone and implant, so it can be used as a graft material, which helps in formation of new alveolar bone. They can also be used as coating materials over the implants, which enhances the bone healing and helps in promoting the process of osseointegration.[7]

2.6. Bio glass

It is one of the ceramic material, which is bio active in nature and helps in formation of bone a little faster. This material shows ability of osteoinduction. Along with this, bio glass material is very brittle in nature, which restrict its use in stress bearing areas. This material is mostly used as bone graft material in cases of ridge defects or bone defects.[11]

2.7. Zirconia

This material was used in the field of dentistry in early 1990, for initially used as zirconia crowns, fixed bridges and in manufacturing of abutments. It can be used as a dental implant material, with advantages like they posses high strength, they are bioinert to degradation, along with this, they have some of the drawbacks like they having low ductility, are brittle in nature. This material is having high compressive strength, high tensile strength, and high bending strength, this material also exhibit high modulus of elasticity, which leads to limited application of this biomaterial with special design only.[6-9]

2.8. Polymers and composites

Polymers used as implant biomaterials are first used in the field of dentistry in the year of 1930. At that time poly methyl methacrylate and Polytetrafluoroethylene are used. With advancement other types of material which are used as implant materials are polyamide, polyethylene, polyurethane, polydimethylsiloxane, and silicone materials. As compared to the other materials which are used for the fabrication of the implant, these polymer materials posses low strength, low

modulus of elasticity along with higher elongation of fracture.[18-21]

Recently a newer materials in polymers have been introduced, PEEK material, polyether ether ketone, which is used in the fabrication of the dental implant. The main advantage of this material for being used as implant fabrication material is its value of elastic modulus, which is close to the alveolar bone. Along with this, if this material is added with carbon fibres, it shows value of elastic modulus close to the cortical bone.[12-18]

3. Discussion

For a long term success of dental implant prosthesis, selection of accurate implant biomaterial is of key success. Alveolar bone does not accept any material completely, so in terms to optimize the performance biologically, implant should be selected in terms to reduce the negative biologic response while maintaining the good adequate function of the implant prosthesis.

4. Conclusion

Going towards the modern era, one should know the tradition biomaterials for the fabrication of the implant. One should have a thorough knowledge of all the materials in terms of strength, corrosion resistance, and biocompatibility. Now a days the most common biomaterial for the fabrication of the dental implant is titanium, as this material is totally bio compatible with the soft and the hard surrounding tissue. Studies revealed that, the survival rate of the titanium implants are much higher as compared to the other material implants.

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None.

6. Conflict of Interest

None.

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