Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Review Article

Bio implants- A Review

Farhat Jabeen

Post Graduate Student, Department of Prosthodontics, Himachal Dental College, Sundar Nagar, Himachal Pradesh, India

ABSTRACT:
Bio materials are those materials that are accepted by living tissues and can be used for tissue replacements. Dental implants are the most improved treatment for teeth that have been either extracted or have been ejected as a result of periodontal disease that provides a living PDL connection for titanium implants. The bioimplant consists of a hydroxyapatite coated titanium screw, unsheathed in cell sheets made from immortalized human periodontal cells. customized bioimplants to suit the individual needs.
Key words: Bio materials, Bio implants, hydroxyapatite

Corresponding Author: Farhat Jabeen, Post Graduate Student, Department of Prosthodontics, Himachal Dental College, Sundar Nagar, Himachal Pradesh, India

This article may be cited as: Jabeen F. Bio implants- A Review. J Adv Med Dent Scie Res 2018;6(1):169-172.

INTRODUCTION

Bio materials are those materials that are accepted by living tissues and can be used for tissue replacements. On a macroscopic level these devices are used to fix or replace a bone and to support its healing process. With the worldwide increase in the average age of population there is a subsequent increase in the number of surgical procedures which has in turn urged researchers to improve and optimize bio materials. Although implant treatment has a high success rate, there are some fundamental vulnerability associated with osseointegration, the healing mechanism between the bone and the titanium implant fixture. The osseointegration process at the implant surface, however, does not incorporate the periodontal ligament (PDL) space. Additive Manufacturing is coming into its third decade of commercial technological development. During that period, we have experienced a number of significant changes that has led to improvements in accuracy, better mechanical properties, a broader range of applications and reductions in costs of machines and the parts made by them.

A bio-implant is an implant with a biological component that is placed in a cavity of the human body for a period of 30 days or more. It aims to restore, support or enhance the functions of the human tissues by maintaining the compatibility and conformity with the tissues along with the acceptability by the body, the strength of materials and the intactness of the implant. However, much effort is required to make implants that are of complex geometry and custom fitted for individual patients through traditional cutting, forming and casting methods such as Computer Numerical Control machining. Thus, this leads to the rise of Addictive Manufacturing (AM) which is a manufacturing technique that adds rather than subtracts material. The ability of AM technology to produce actual functioning parts is also a contributing factor to its newly acquired popularity.[1]

ADDICTIVE MANUFACTURING (AM)

Addictive Manufacturing (AM) also known as rapid prototyping (RP) technologies or 3D printing consists of different automated fabrication. The AM process consists of design modelling and production. 3D models can be designed by 3D CAD software or obtained through CT scan or MRI. After which, the file is converted to a STL (stereolithography) file or

the new AFM format and sliced into series of 2D cross-sectional layers, creating a computer file showing the path for the printer to take for tracing. The process is usually done bottom up. Depending on the AM technology, parts may or may not have to be post processed to obtain the finished product.

BIOPRINTING

One of the most sophisticated applications of additive biomanufacturing involves the fabrication of scaffolds. For the specific requirements of periodontal regeneration, multiphasic scaffolds have significant advantages as they facilitate compartmentalized tissue healing. While the strategy appears promising, the approach needs to be optimized and tested into large animal studies and eventually in human clinical studies. By taking advantage of the power of additive (bio)manufacturing, exciting developments in the field of regenerative periodontology are envisioned. One such development involves bio fabrication technologies, such as bioprinting, which refers to printing of all of the components that form a specific tissue, including living cells embedded in matrix materials, to generate tissue analogue structures. While applications of bioprinting of oral tissues are still in early stages, this strategy has displayed interesting results in various preclinical studies and seems encouraging, progressing beyond templates and models.

TYPES OF AM TECHNOLOGIES

There are currently many different AM technologies used for making bio-implants such as Inkjet Printing (Polyjet), 3D printing (3DP), Stereolithography (SLA), Selective Laser Melting (SLM), and Bioprinting which is another category by itself. They are classified by various ways such as the type of energy source used or the production process etc. They are classified based on the ability to print biological materials: (i) directly or (ii) indirectly.[2]

- Directly – prints support structure and biological materials (cell, DNA, proteins) together, also known as Bioprinting.
- Indirectly – prints support structure only.

3D AM TECHNOLOGIES

Most technologies discussed here are established manufacturing techniques that have been around for quite some time. Indirect printing technologies do not print biomaterials. Such methods are used mainly for the construction of scaffolds which are then used for the seeding of cells, drug delivery systems, potential biochips or biosensors. However, it is important to note that each technology has its own limitations and applications.[3]

Some technologies such as SLA and polyjet inkjet-based systems use ultraviolet (UV) or white light to cure liquid materials while others use laser to melt or soften materials for joining (SLS, and SLM) and some like 3DP uses binding materials such as glue to stick the materials together. To make microstructures such as the "lockyballs" interlock micro scale scaffold to hold cells inside the two photon polymerization is used. AM technologies have shown to be extensively involved in the fabrication of tissue engineering structure with its ability to provide precise control over both external macrostructure and internal microstructure of scaffolds. Although complex geometry can be achieved with indirect 3D printing, cells are still seeded secondary. Therefore, problems such as the inability to replicate a multi-cellular structure arise.[4]

Direct bioprinting have been gaining huge interest in the field of science as there is a need for accurate control of cell position and tissue architecture in 3D constructs with micro-scale precision. Currently, there are three main ways that cells can be printed on the implants directly, (i) Inkjet, (ii) Extrusion and (iii) Laser Assisted Based (LAB). Many commercial printers are currently available such as NovoGen MMX Bioprinter™ and regenhuBioFactory® which combines the different methods such as different nozzle heads (inkjet or Extrusion) where multiple cell types and biomaterials can be directly placed in specific spatial arrangements. There are three key components of any LAB technique are a pulsed laser source, a target plate (Quartz ribbon) and the biopolymer hydrogel or cell suspension. Two widely employed variation: Matrix-assisted pulsed laser evaporation direct write (MAPLE-DW) and Biological laser printing (BioLP) which are distinguished by the nature of the ribbon.

Fused Deposition Modelling (FDM) Layer by layer, a part's cross-sectional geometry is laid out by extruding a build material in a filament form through a temperature-controlled nozzle. After the build material exits the nozzle, it hardens and binds to the layer below. The materials used with this technology are mainly thermoplastics such as ABS, Polycarbonate, biodegradable PLA or PLGA and also low melting point metals. This technology is known for its rough surface finish, slow build speed and the minimum wall thickness is relatively large due to the nozzle.[5]

Three-Dimensional Printing (3DP) Layer by layer a powder-based material is thinly laid out and an ink-jet printing head with a liquid adhesive binds the loose particles together. 3D printing build materials include polymers, ceramics, sand and metal powders such as stainless steel. This technology is well known for its fast process, rough surface finish, weak parts and producing models with multiple colours. No support material is required and a post-processing of hardening is necessary. Biocompatible and biodegradable materials can be used in this technique although the selection process of finding the right binding adhesives is complex. Due to the powder grain size, binding material and post processing

methods, 3DPs are restricted in the bio-molecule incorporation and the minimum building size.

STEREOLITHOGRAPHY (STL OR SLA)

A UV laser is focused at a vat of liquid photosensitive polymer which traces one cross section at a time. This technology is known for a smooth surface finish and highly detailed parts, average build speed and a wide range of materials. This requires a support structure, support removal process and post-curing.[6]

SELECTIVE LASER SINTERING (SLS)

The SLS technology combines the selective laser technique of the SLA technology and the powder material layering from 3D printers. Together, this technology is known for average surface finish due the large powder particles [16], good part stability and functionality, fast building speed and a wide variety of materials such as rubber like materials (SOMOOS), biocompatible and biodegradable polymers and metal composites with high heat applications. No support material is required and only minimal post processing is necessary.[7]

BIOIMPLANTS AND THEIR TYPES

Bioimplants possess individual specific requirement and are usually produced in low volume. As their name suggests, bioimplants are for medical-clinical applications such as porous implants, prosthetics, drug delivery and biosensors they can be described as implants since they are usually most or less implanted into the body for long periods of time. There are three types of bio implants and can be classified as

- Biological Implants
- Biologized implants
- Bio functional implants.

The difference between the three classifications is mainly due to the number of cellular components that make up the implants.[8]

A. BIOLOGICAL IMPLANTS

Biological implants are manufactured from biological materials such as cells, protein etc. using bioprinting. Usually, two key components are needed for making biological implants; firstly, a bioprinter containing materials such as living cells (i.e. stem cells or tissue spheroids and biodegradable scaffolds/matrices (hydrogels) which predetermine the 3D form for creating the organ.[9]

BIOLOGIZED IMPLANTS

Biologized implants are made of a combination of cellular components and permanent biomaterials.[10] The difference between biological implants and biologized implants are the degradability of the 3D structure. Biologized implants structures are permanent and nonbiodegradable. The permanent biomaterial structures are biocompatible and provide the mechanical stability for cellular colonization. Most biomaterials involved in the implants are Bioinert (materials that do not react with the body-implant covered in a thin layer of mucous membrane).[11]

BIO FUNCTIONAL IMPLANTS

Biofunctionctionalised refer to the field of surface treatment with the purpose to optimally use the surface for life science applications. This means that after implantation, bioactive surfaces of Biofunctionctionalised implants interact with the biological environment in the body. The development and application of customized properties of the base materials required. The materials for biofunctionalized implants are usually bio-active.[12]

Beside the making of scaffolds, other customised microsystems and therapeutic devices for controlled highly specific and precise drug delivery can also be made with AM. By using AM technology such as SLS, the pore size and micro-features of can be incorporated in the PLA or PMMA scaffold, allowing the release of drug in a controlled manner.[13] However, over the years more different materials have been developed and adapted of AM technologies to print. Using 3DP, Elke and team were able to print simultaneous geometry with hydroxypropylmethylcellulose (HPMC) and tricalcium phosphate (TCP), localized organic bioactive loading (recombinant bone morphogenic protein 2 (rhBMP-2), heparin (a model polysaccharide), and vancomycin (an antibiotic glycopeptide), and localized diffusion control. Using the 3D bioplotter, Mesoporous bioactive glass (MBG) can also be printed.[14]

LIMITATIONS OF AM

Although there is no doubt that medical models are useful aids to solving complex surgical problems, there are numerous deficiencies in existing AM technologies related to their use to generate medical models. Part of the reason for this is because AM equipment was originally designed to solve problems in the more widespread area of manufactured product development and not specifically to solve medical problems. Development of the technology has therefore focused on improvements to solve the problems of manufacturers rather than those of doctors and surgeons. However, recent and future improvements in AM technology may open the doors to a much wider range of applications in the medical industry. Key issues that may change these deficiencies in favor of using AM include: – Speed – Cost – Accuracy – Materials – Ease of use By analyzing these issues, we can determine which technologies may be most suitable for medical applications as well as how these technologies may develop in the future to better suit these applications.

CONCLUSION

Additive manufacturing will enable the production or fabrication of improved medical implants. Additive

manufacturing allows implants to be custommatched to a specific individual and this review showed that it is used for making better titanium bone implants, prosthetic limbs and orthodontic devices. As more inter disciplinary researchers are recruited into the field together with the advancement in biomaterials, it is likely that AM machines and techniques will be further improved over the years.

REFERENCES

1. Nair, L.S., S. Bhattacharyya, and C.T. Laurencin, Development of novel tissue engineering scaffolds via electrospinning. Expert opinion on biological therapy, 2004. 4(5): p. 659-668.
2. Sichert, J.A., et al., Quantum size effect in organometal halide perovskite nanoplatelets. Nano letters, 2015. 15(10): p. 6521-6527.
3. Park, G.E. and T.J. Webster, A review of nanotechnology for the development of better orthopedic implants. Journal of Biomedical Nanotechnology, 2005. 1(1): p. 18-29.
4. Murphy, C.M, Haugh, M.G. O'Brien, F.J.: The effect of mean pore sizeon cell attachment, proliferation and migration in collagenglycosaminoglycan scaffolds for tissue engineering. Dublin, Ireland.Department of Anatomy, Royal College of Surgeons, Biomaterials.2010; 461–466.
5. Shrivastava, S. and D. Dash, Applying nanotechnology to human health: revolution in biomedical sciences. Journal of Nanotechnology, 2009. 2009.
6. Ivanovski, S., C. Vaquette, S. Gronthos, D. W. Hutmacher, and P. M. Bartold. Multiphasic scaffolds for periodontal tissue engineering. J. Dent. Res. 2014; 93:1212–1221.
7. Obregon, F., C. Vaquette, S. Ivanovski, D. W. Hutmacher, and L. E. Bertassoni. Three-dimensional bioprinting for regenerative dentistry and craniofacial tissue engineering. J. Dent. Res. 2015; 94:143–152.
8. Groll, J., T. Boland, T. Blunk, J. A. Burdick, D. W. Cho, P. D. Dalton, B. Derby, G. Forgacs, Q. Li, V. A. Mironov, and L. Moroni. Biofabrication: reappraising the definition of an evolving field. Biofabrication 2016; 8:013001.
9. Park, C. H., H. F. Rios, A. D. Taut, M. Padial-Molina, C. L. Flanagan, S. P. Pilipchuk, S. J. Hollister, and W. V. Giannobile. Image-based, fiber guiding scaffolds: A platform for regenerating tissue interfaces. Tissue Eng. Part C 2014; 20:533–542.
10. Skalak, R. and C.F. Fox, Tissue engineering: proceedings of a workshop, held at Granlibakken, Lake Tahoe, California, February 26- 29, 1988. Vol. 107. 1988: Alan R. Liss.
11. Langer, R. and J. Vacanti, Tissue engineering. Science 260: 920-926. Tissue engineering: the union of biology and engineering, 1993. 98.
12. Nair, L.S., S. Bhattacharyya, and C.T. Laurencin, Development of novel tissue engineering scaffolds via electrospinning. Expert opinion on biological therapy, 2004. 4(5): p. 659-668.
13. Sichert, J.A., et al., Quantum size effect in organometal halide perovskite nanoplatelets. Nano letters, 2015;15(10): 6521-6527.
14. Park, G.E. and T.J. Webster, A review of nanotechnology for the development of better orthopedic implants. Journal of Biomedical Nanotechnology, 2005. 1(1): 18-29.

DECLARATION

This paper was presented by Dr, Farhat Jabeen in 19th IPS PG convention held at Seema Dental College & Hospital, Rishikesh from 15th June to 19th June 2017.