



3D PRINTING -THE TRANSFORMING FUTURE OF PERIODONTAL THERAPY.

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ABSTRACT-

Periodontics, the dental specialty focused on preventing, diagnosing, and treating periodontal disease and maintaining healthy periodontal structure, is being transformed by 3D Printing Technologies. 3D printing technology is common in dentistry. 3D Bioprinting is the utilization of 3d printing technology to combine cells, growth factors, and biomaterials to fabricate biomedical parts that maximally imitate natural tissue characteristics. It's a novel technique that brings evaluation over the years. This helps in opening several new avenues of regenerative periodontology. Different types of 3D printing are droplet-based printing, laser-assisted printing, and extrusion 3d printing. This technology facilitates the production of bio- active materials that mimic the natural bony structures, improving the success rates of bone grafts. Personalised Periodontal applications include education models, scaffolds, socket preservation, sinus and bone augmentation, and guided implant placement. It showed better alveolar ridge preservation, better regenerative capabilities, greater reduction in pocket depth and bony fill, ease of implant placement in complex cases with greater precision tailored to the unique anatomy of each patient, ensures higher accuracy during procedures, and expedites the healing process. The optimised bioprinting system is the first step towards a revolutionary approach, not only elevating the standard of periodontal care but also reducing costs and treatment times, heralding a new era in periodontal therapy.

INTRODUCTION-

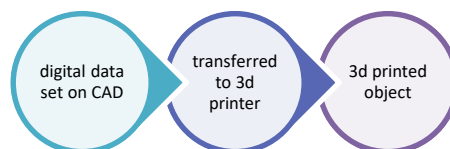
In this technological era, proper treatment planning and completing other tasks have become much simpler than they were before. Technology has invaded dentistry and made diagnosis much easier and more accurate. The introduction of advanced technologies like Velscope, RVG, CBCT, OPG, healOzone, DIAGNOdent, intraoral cameras, zoom whitening, laser dentistry, Invisalign, and 3D printing helps in proper investigation and treatment.

In this, 3D printing is widely recognized in the field of medicine. 3D printing technologies are not all new; many modalities used today were first developed in the 1980s and 1990s. The first treatment was done in 1999^[1]. Meanwhile, it is then recognized in dentistry.

In dentistry, 3D printing has diverse applications. The high grade of fit accuracy achieved by this additive process is increasing the possibilities of many new and exciting treatments. The combination of different manufacturing methods displays the enormous potential of this method. Regenerative dentistry follows the concept of tissue engineering, which consists of scaffolds, implanted cells, signaling molecules, and an adequate blood supply to obtain new periodontal ligament, cementum deposition, and bone formation [2].

while its application in periodontology is still emerging, but has significant potential. This technology is being used in diverse ways, including the creation of educational models, scaffolds, socket preservation materials, and tools for bone and sinus augmentation, as well as for repairing periodontal defects and guiding implant placement are advanced manufacturing technologies based on computer-aided design digital models to create personalized 3D objects

The 3d printing process can be described as follows



The interesting combination of a digital working environment and an analog craft makes dental technology more attractive to young people looking for a varied and diverse work experience, becoming the future of dentistry^[3].

THE EVOLUTION OF 3D PRINTING TECHNIQUE^[4].

2000	First extrusion-based 3d bio printing
2002	Kidney printed by micro-extrusion
2003	First inkjet bioprinting
2005	RepRap to build a 3d printer that can print most of its parts.
2007	SLS printer available for parts fabrication
2008	First 3d printed prosthetic legs
2009	1 st printed vessel
2012	Printed jaw
2014	Human liver tissue
2015	3d printed scaffold for periodontal repair
2018	Full human skin
2019	Heart with blood vessels Lung air sacs with surrounding vessels
2020	Personalised medicine

CBCT-REVIEW-

Walter et al.'s methodical review evaluates the effectiveness of CBCT in diagnosing periodontal conditions and its part in treatment planning. The authors note that CBCT offers superior imaging quality compared to conventional radiographs, allowing for enhanced visualization of periodontal structures, including bony blights frequently missed in standard assessments^[5].

BIO PRINTING-

Bioprinting ways bring a natural functionality to a conventional 3D published altar, as it mimics a cell- cell and cell- to- matrix commerce in construction^[6].

The material used in 3D bioprinting involves the operation of living natural cells, hydrogels, chemical factors and biomolecules, under the name of bioink. A difference must be made regarding the types of printing material, between bioinks and biomaterial inks, as those two terms do not assimilate each other.

TYPES OF 3D PRINTING-

Droplet based printing

- Thermal DOD
- Piezoelectric
- Electrostatic
- Continuous ink jetting
- Electro hydro dynamic

Laser assisted 3d printing

- Laser assisted bioprinting
- Stereolithography schematic principle
- Digital projection printing principle
- Selective laser printing

extrusion 3d printing

- Thermal extrusion 3d printing
- Non thermal extrusion 3d printing

RIDGE PRESERVATION-

Clinical procedure aimed at preventing, diminishing, or avoiding dimensional changes of the alveolar process, followed by tooth extraction.

After tooth extraction, within 1-2 months, socket healing happens naturally with bone tissue. This healing response of alveolar bone around a tooth socket is resorptive in nature, occurs with substantial reduction of the original height and width of the alveolar ridge. Van der weijden's systemic review, reduction of width and height of alveolar bone was 3.87 and 1.67mm respectively, within 3months after dental extraction in humans.^[7]

These Bone resorption after dental extraction represents a common challenge and various techniques have been developed and investigated, 3D printing scaffold included, in order to preserve an adequate height of the alveolar bone. Scaffolds were made by using nontoxic and tissue compactable material, which has been used for several year in dentistry. Which gives mechanical stability and better ridge preservation.

A customised scaffold was made by using fused depositing modelling FDM to fit the socket. By analysing prototype model of patient defect by CBCT. The unique feature of using 3d printing fused deposition modelling scaffolds lies in the three-angle layering, which results in a fully interconnected network that provides maximum anchorage for cell attachment. Polycaprolactone FDM-designed plugs are used for ridge preservation successfully, providing an alternative to synthetic calcium phosphate or deproteinized xenograft materials.

INTRABONY DEFECTS-

Intrabony defect treatment is an important therapeutic goal of periodontal therapy. Intrabony defects which has vertical bone loss surround the tooth by two or three bony walls or a combination of these. In this 3-wall defect address and to enhance the precision of evaluation done by CBCT, it demonstrates a sensitivity for detecting and categorization bone defects. Then 3d printed scaffolds were made by analysing CBCT, which contains biocompatible oral regenerative cells installed into a porous which endures mechanical functions and allows the essential elements to transfer, which contributes to the healing process^[8].

3d personalised scaffolds play a pivotal role in regenerative therapy by achieving mechanical and biological tissue rehabilitation.

FURCATION INVOLVEMENT-

A condition in which periodontal disease invades the bifurcation and trifurcation of multi multi-rooted tooth. Glickman in 1953 proposed classifications that are based on the extension of the defect and the degree of horizontal/vertical attachment loss^[9]. By using guided tissue regeneration additive therapy, 3d printed models made by analysing CBCT, which provides high accuracy for detecting furcation involvement and morphology of vertical bony loss.

By infusion of plasma rich protein, plasma rich fibrin, and growth factors bone graft model customised by using 3D printed and placed in the required area, which induces periodontal disease healing.

CONCLUSION

3D printing is revolutionizing the field of periodontics by offering innovative solutions for diagnosis, treatment planning, and surgical procedures. Its ability to produce highly accurate, patient-specific models and tools has enhanced the precision and predictability of periodontal therapies. From custom bone grafts and guided tissue regeneration scaffolds to personalized surgical guides, 3D printing is streamlining workflows and improving patient outcomes. As the technology continues to evolve, it promises to make periodontal treatments more efficient, minimally invasive, and cost-effective, solidifying its role as a transformative force in the future of periodontics.

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Nil

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