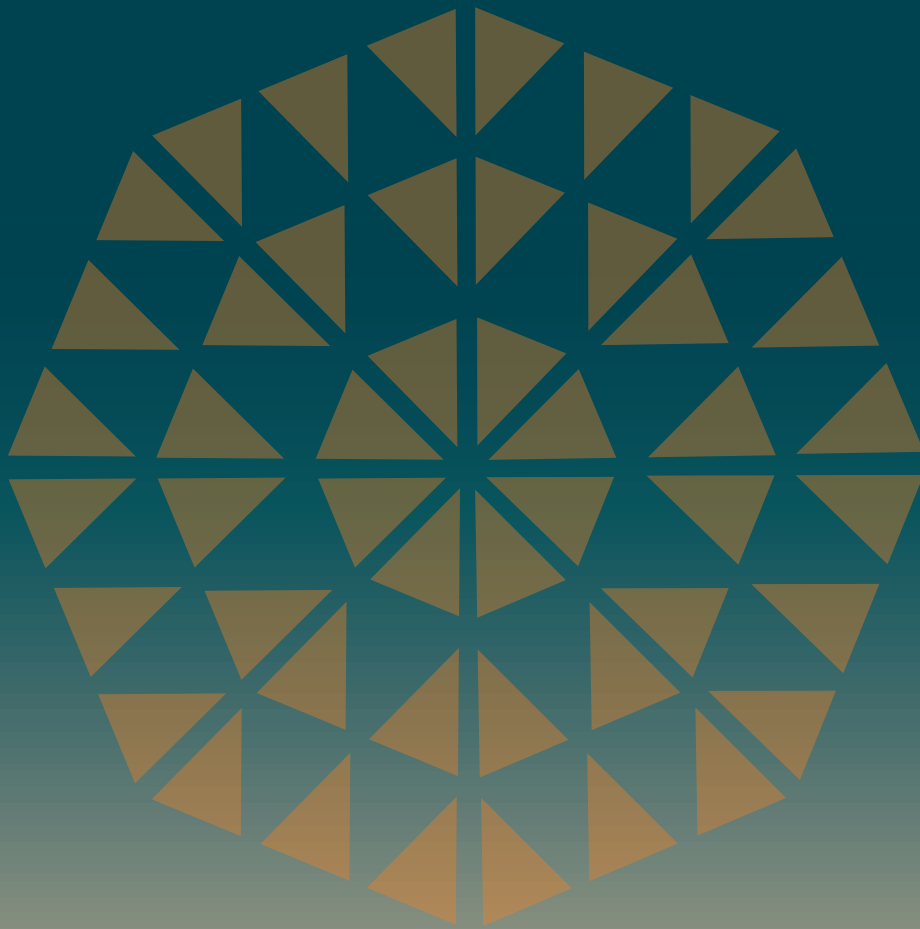


DENTAL BITES

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Orthodontic and Orthognathic



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Dear Readers,

Editorial: The Role of Virtual Planning and 3D Printing in Orthognathic Surgery

Orthognathic surgery, a critical procedure for correcting dentofacial deformities, has seen remarkable advancements with the integration of technology. At KMCT Dental College, we are at the forefront of embracing innovations that enhance precision and patient outcomes. Among these, virtual planning and 3D printing stand out as revolutionary tools that are transforming the landscape of orthognathic surgery.

Virtual planning involves using sophisticated software to create a detailed, three-dimensional model of a patient's craniofacial structure. This process allows for meticulous pre-surgical analysis and planning, which offers several key benefits:

Surgeons can view the patient's anatomy in a comprehensive manner, facilitating better understanding and decision-making. This visualization includes the ability to simulate surgical outcomes, enabling more accurate prediction of results.

The precision of virtual models ensures that surgical plans are tailored to the patient's specific needs. This reduces the margin of error significantly compared to traditional methods, which rely heavily on manual measurements and estimations.

Virtual models serve as an excellent tool for patient education. Surgeons can clearly explain the planned procedures and expected outcomes, increasing patient confidence and satisfaction.

3D printing takes the virtual plan and brings it into the physical world. Custom surgical guides, splints, and even implants can be produced. The combination of virtual planning and 3D printing ensures that surgeries are executed with the highest precision, leading to improved functional and aesthetic results.

At KMCT Dental College, we have integrated virtual planning and 3D printing into our orthognathic surgery protocols. Our state-of-the-art facilities and commitment to continuous learning ensure that our faculty and students are well-versed in these technologies.

Our multidisciplinary team, including orthodontists, oral surgeons, and prosthodontists, collaborates closely to develop comprehensive treatment plans. The integration of technology enhances this collaboration, ensuring all team members are aligned and informed.

We are actively involved in research to further explore the potential of these technologies. Our findings contribute to the global body of knowledge and help refine best practices in orthognathic surgery.

The integration of virtual planning and 3D printing in orthognathic surgery marks a significant advancement in the field. At KMCT Dental College, we are proud to lead the way in adopting these technologies to improve surgical precision, patient outcomes, and educational opportunities. As we continue to innovate and embrace new tools, we remain committed to providing the highest standard of care for our patients.

By embracing virtual planning and 3D printing, we are not just improving the present; we are shaping the future of orthognathic surgery. At KMCT Dental College, we are excited to be part of this transformative journey.

With warm regards,

Dr Manoj Kumar K.P

Principal

TABLE OF CONTENTS

- 1.** Surface modification of Titanium dental Implants and Tissue regeneration - Review Article **pg 8**

Sheejith M, Sukhil T Sathyan, Akhila S Aboobacker

- 2.** Gentle or Assertive: Role of Histopathology – Case Report **pg 18**

Akhila Stanly S, Rajeesh Mohammed P K, Swapna Honwad, Reshmi A

- 3.** Navigating antibiotic resistance challenges in Periodontal therapy - Review Article **pg 25**

Athira Vijayan P V, Harish Kumar V V, Anish Varkey, Aparna T K

- 4.** Role of Cone Beam Computed Tomography in Periodontology - Review Article **pg 31**

Abad Shibily, Santhosh V.C, Anish Varkey, Subhisha SB.

5. Traumatic bone cyst of the mandible: A Case Report pg 40

Fidha.T.K, Shahlaa Aravassery, Aswathy.S, Ashir.K.R, Manoj Vengal

6. Temporomandibular joint disc displacement after orthognathic surgery- Review Article pg 45

Manoj Kumar KP, Vipin Das, Dr.Abdulla Noor M

7. Artificial Intelligence in Orthodontics - Review Article pg 51

Athulya KP, Fasil KT, Bini KK, Sanoopa Balan., Joyal Xavier

8. 3-Dimensional Printing: Expanding horizons of Digital Dentistry -Review Article pg 56

Tabitha Mary Joseph, Ranjith M, Namitha A P

Review Article

SURFACE MODIFICATION OF TITANIUM DENTAL IMPLANTS AND TISSUE REGENERATION

*Sheejith M ,** Sukhil T Sathyan,*** Akhila S Aboobacker

Abstract

Surface modification is essential in modern dentistry, significantly affecting implant integration and longevity. This review explores physical-chemical and biochemical methods to enhance tissue regeneration at implant interfaces. Physicochemical techniques enhance surface properties for improved osseointegration. Biological strategies enhance biocompatibility and tissue interaction, facilitating bone healing and integration. Recent advances like gold nanoparticles (GNPs) coatings and simvastatin-coated implants show promise in refining implant outcomes.

Keywords: Additive methods, Subtractive methods, Biomimetics, Recent advances

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Introduction

Dental implant surface modification is a crucial aspect of modern dentistry and oral implantology. The success of dental implants largely depends on their integration with the surrounding bone, a process known as osseointegration. Surface modification techniques are employed to enhance the implant's ability to integrate with the bone, improve stability, and

ultimately increase the long-term success of the implant.

By generating a coating onto a titanium surface that mimics the organic and inorganic components of living bone tissue, a physiological transition between the non-physiological titanium surface and surrounding bone tissue is established. In this way, the coated titanium implant functions as scaffold for improved bone cell

attachment, proliferation and differentiation. Such a coating is supposed to further enhance early and strong fixation of a bone-substituting implant by stimulating bone formation starting from the implant surface.

Thus, the surface treatment is used not only to maintain the existing properties of the implants but also to enhance several behaviours as required by dental applications particularly in improving the healing process.

This paper reviews current physicochemical and biochemical surface modification approaches to enhance soft and hard tissue regeneration at the interface of titanium(alloy) implants and adjacent tissues.

Classification of Implant surface modifications

➤ **Physical (Subtractive)**

1. Machined surface
2. Abrasive/sandblasting with grit media
3. Laser etching
4. Nanoparticle compaction
5. Porous tantalum trabecular metal

➤ **Chemical (Additive)**

1. Acid etching
2. Alkaline treatment

3. Anodization of the surface
4. Peroxidation
5. Fluoride treatment
6. Plasma coatings and surface treatments

➤ **Biological/Biomimetic**

1. Bioactive coatings
2. Attachment of peptides
3. Attachment of antibiotics
4. Attachment of growth factors

Physical / Subtractive

Machined

A machined implant surface refers to the implant's surface that has been processed using techniques such as turning, milling, or polishing. These processes involve the use of manufacturing tools to shape and finish the implant. As a result, the surface is relatively smooth and polished compared to other surface treatments like grit blasting or hydroxyapatite coating.

Abrasive/sandblasting with grit media

Grit blasting is a technique used to roughen the surface of dental implants to promote better adhesion of coatings and facilitate osseointegration. It involves projecting particles, such as ceramic materials (e.g., alumina), silica, hydroxyapatite, sand, or TiO₂ particles, onto the surface of dental implants under high pressure.¹ This process

roughens the surface of the implant, creating a texture that promotes better adhesion of coatings and allows for enhanced osseointegration. The purpose of grit blasting is to improve the surface topography, which can influence how bone cells attach and grow on the implant.

Laser etching

Laser-etched implants have applications in various fields, including dentistry and orthopaedics. By modifying the implant surface at a microscale and nanoscale level, they can potentially improve osseointegration, enhance tissue adhesion, and promote better long-term implant success.² Laser etching allows for selective modification of the implant's surface. This means that certain areas can be targeted for modification while leaving other areas unchanged. This level of precision is difficult to achieve with traditional mechanical techniques.

Nanoparticle compaction

Nanoparticle compaction involves depositing and compressing nanoparticles onto a surface. This process can be achieved through various techniques such as physical vapor deposition, chemical vapor deposition, or plasma spray

deposition. Compacting nanoparticles onto an implant's surface is a technique that allows for tailored modification of surface properties while conserving the beneficial chemistry of the underlying surface. This has potential applications in enhancing the performance and biocompatibility of various medical implants.

Porous tantalum trabecular metal

Porous tantalum trabecular metal is a biomaterial designed to improve the performance of dental implants. It consists of a porous structure made from tantalum, a biocompatible and corrosion-resistant metal. This structure is intended to mimic the natural trabecular (spongy) bone, with the aim of facilitating bone ingrowth and promoting osseointegration.³ Dental implants with porous tantalum trabecular metal can be used in various clinical scenarios, especially where high primary and secondary stability are essential, such as cases with compromised bone quality or in immediate load protocols.

Chemical / Additive

Acid etching

Acid etching involves exposing the implant's surface to an acidic solution, such as a mixture of hydrochloric acid (HCl) and

sulfuric acid (H_2SO_4), or a combination of hydrofluoric acid (HF) and nitric acid (HNO_3). The acid selectively removes grains and grain boundaries from the surface.⁴ These areas are more sensitive to etching, resulting in a pitted surface texture. The combination of acid etching and particle blasting aims to improve the implant surface's characteristics, enhancing its ability to promote osseointegration. The dual surface roughness can provide a more favourable environment for bone cells to attach, grow, and integrate with the implant.

Alkaline treatment

The implant is immersed in a high alkaline solution, often containing substances like sodium hydroxide (NaOH). Subsequently, the implant is subjected to heat treatment. The combination of alkaline soaking and heat treatment induces changes in the implant's surface chemistry and structure.^{5,6} Alkaline oxidation aims to improve the biocompatibility and osseointegration potential of dental implants. This process can be particularly useful in cases where enhanced bone integration is desired, such as compromised bone quality or situations requiring faster healing.

Anodization of the surface

Anodization is an electrochemical process employed to modify the surface of an implant. The implant is subjected to anodic oxidation, a technique where the implant acts as the anode (positively charged electrode) in an electrolyte. The process results in the formation of a microstructured surface with micrometer-sized open pores.⁷ anodization through anodic oxidation is an electrochemical technique used to create microstructured surfaces with micrometer-sized open pores on dental implants. The process allows for the integration of ions into the surface layer, potentially leading to improved osseointegration and biocompatibility.

Peroxidation

Peroxidation is a chemical process involving hydrogen peroxide treatment that results in the formation of a titania gel layer on the implant surface.⁸ This layer enhances bioactivity and the potential for osseointegration, making it a promising technique for improving the success of dental implant procedures. The success of the peroxidation process depends on precise control of the treatment parameters and the specific clinical context. Research is

ongoing to optimize the peroxidation technique for dental implant applications.

Fluoride treatment

Titanium implants with a fluoride-modified TiO₂ surface demonstrated enhanced biomechanical anchorage in bone compared to implants with an unmodified TiO₂ surface.⁹ Additionally, the fluoride-modified implants achieved greater integration with bone tissue, leading to improved osseointegration. Fluoride-modified TiO₂ surfaces offer a way to enhance the performance of dental implants by promoting faster and more effective osseointegration. This is particularly relevant in modern implant dentistry, where reducing healing times and expanding the scope of implant procedures are essential considerations.

Plasma coatings and surface treatments

Plasma spray coating is a technique used to deposit thick layers of materials, such as hydroxyapatite and titanium, onto implant substrates. The process involves spraying thermally melted materials onto the implant surface, creating a coating that offers enhanced properties. Combining a hydroxyapatite (HA) coating on a titanium alloy substrate has gained attention due to

their combined benefits of biocompatibility and mechanical properties. Plasma spraying is particularly useful in creating these coatings on implants.^{10,11}

Plasma spray coatings substantially increase the surface area of implants by enhancing surface roughness. This increased roughness can facilitate better cell adhesion, proliferation, and osseointegration.

Different surface modification techniques, such as acid etching and grit blasting, influence the effectiveness of HA coatings. The combination of plasma spraying with specific surface modifications can impact bone contact and integration.^{12,14}

The addition of yttria-stabilized zirconia to HA coatings has been explored to enhance mechanical properties and coating performance. This composite coating has shown improved bond strength and dissolution behaviour of titanium implants.¹⁵

Biological

Bioactive coatings

Bioactive coatings are formulated to encourage the attachment and growth of bone cells onto the implant surface. The

coating can provide chemical cues that stimulate bone cell adhesion and proliferation, aiding in the formation of a strong bond between the implant and the surrounding bone. These coatings often have the ability to initiate the deposition of hydroxyapatite, a mineral component found in natural bone, onto the implant surface. This helps create a bone-like environment, further enhancing the implant's integration with the host bone.

The materials used in bioactive coatings are carefully selected to ensure they are biocompatible and safe for interaction with biological tissues. Compatibility is vital to prevent inflammation, rejection, or other adverse reactions.

Various techniques are used to apply bioactive coatings, including plasma spraying, sol-gel deposition, electrochemical deposition, and biomimetic mineralization. The choice of technique depends on factors such as the implant material, desired coating thickness, and the specific characteristics of the coating material.¹⁶ Common materials used in bioactive coatings include hydroxyapatite, calcium phosphate-based compounds, bioactive glasses, and certain biocompatible polymers. These materials have

demonstrated bioactivity and the ability to bond with bone tissue. Bioactive coatings represent a crucial advancement in implant technology, as they contribute to the improved integration and long-term success of metallic implants within the human body.^{17,19} These coatings aim to create a seamless interface between the implant and the surrounding bone tissue, reducing the likelihood of complications and promoting overall patient well-being.

Peptides

Peptide coating is a surface modification technique used to enhance the biocompatibility and interaction of titanium implants with biological tissues. In this technique, the surface of a titanium implant is coated with synthetic peptides, particularly the arginyl glycyl aspartic acid (RGD) peptides.²⁰ These peptides are designed to facilitate cell adhesion and integration by providing specific binding sites for integrin receptors, which are proteins found on the surfaces of cells. This approach aims to improve the implant's ability to adhere to surrounding tissues, promote cellular interactions, and enhance the overall success of the implant procedure.

Antibiotics

Antibiotic-releasing coatings are particularly useful in implant surgeries where there's a risk of post-operative infection. This is common in orthopaedic implants, dental implants, and other implant procedures where the implant comes into direct contact with tissues. Antibiotics such as cephalothin, carbenicillin, amoxicillin, cefamandol, tobramycin, gentamicin, and vancomycin can be integrated into the calcium-based coatings of implants.^{21,22} These antibiotics can adhere to the coating's surface due to their interaction with calcium ions.

Growth factors

Incorporating growth factors in bioactive coatings represents an innovative approach in bone tissue engineering. This technique aims to enhance osteoinduction, creating optimal conditions for the bone healing process and improving implant fixation.

Growth factors, such as bone morphogenetic proteins (BMPs), Fibroblast growth factors (FGFs), transforming growth factor β 1 (TGF- β 1), vascular endothelial growth factors (VEGFs), platelet-derived growth factors (PDGFs), or insulin-like growth factors (IGFs) are play a

crucial role in enhancing the bioactivity of coatings for implants.^{24,26} Their ability to influence cellular behaviours, promote tissue regeneration, and improve tissue integration contributes to the overall success and effectiveness of bioactive coatings in a wide range of clinical applications.

Recent Advances

Gold nanoparticles (GNPs) coatings

GNPs coated onto titanium implant surfaces can enhance osteoblast proliferation, reduce inflammatory mediators, and promote bone regeneration. They improve implant-to-bone contact, leading to better osseointegration and allowing for early implant loading.²⁷ GNPs have been shown to promote periodontal ligament cell proliferation, making them useful in periodontal regeneration. They can also inhibit biofilm formation, aiding in periodontal disease prevention and treatment.

Simvastatin-Coated Implant

Coating dental implants with simvastatin, a medication commonly used to lower cholesterol, coating dental implants with simvastatin represents an innovative approach to enhance osseointegration,

reduce inflammation, and promote bone healing.²⁸ While this area of research is still evolving, the potential benefits of simvastatin-coated dental implants could contribute to improved implant success rates and better patient outcomes.

Conclusion

The surface treatment in the field of implantology has shown tremendous increase in the success rate of implant. A modified surface can influence cell behaviour, protein adsorption, and overall tissue response, leading to improved osseointegration. The choice of surface modification technique depends on factors such as the implant material (commonly titanium or titanium alloy), the patient's bone quality, and the specific clinical context. Researches in this field is ongoing, and new techniques and materials continue to be explored to further improve the performance of dental implants.

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Case Report

GENTLE OR ASSERTIVE: ROLE OF HISTOPATHOLOGY

****Akhila Stanly S, *Rajeesh Mohammed P K, ***Swapna Honwad, **** Reshmi A**

Abstract

Ameloblastoma is a true benign neoplasm of odontogenic epithelial origin mostly seen in the mandible. After odontoma, it is the second most commonly seen odontogenic neoplasm. Ameloblastoma comprises of several clinical, radiological and histological varieties, making it the most significant odontogenic neoplasm. Among these, the unicystic type is the least explored due to the fewer numbers of reported cases. Clinically and radiographically, it represents a cyst, but displays classic ameloblastomatous epithelial lining part of the cyst cavity, with or without intraluminal and/or mural tumour growth. We present an unusual case of unicystic ameloblastoma (UA) showing mural proliferation with mixed histological pattern.

Keywords: *Mural ameloblastoma, Unicystic ameloblastoma*

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Introduction

Ameloblastoma, second most common tumour of odontogenic origin, develops from epithelial component of the odontogenic apparatus. They have multiple histological variants and have high recurrence rates, if inadequately treated.¹ As per the WHO 2022 (5th edition) classification, ameloblastoma is classified as Ameloblastoma-conventional,

Ameloblastoma-unicystic, Ameloblastoma-extraosseous/peripheral ameloblastoma, Metastasizing ameloblastoma. The term ‘Unicystic Ameloblastoma’ was adopted in the second edition of the *International Histologic Classification of Odontogenic Tumours* and was first described by Robinson and Martinez in 1977.² 80% of this lesion is said to occur exclusively in the mandibular third molar area, where most

cases are associated with unerupted teeth and seen in young patients during the second decade of life. They are slow growing and are relatively locally aggressive.³ Although the term unicystic would imply a unilocular radiographic appearance, the lesion can sometimes have a multilocular radiographic appearance as well. Unicystic ameloblastomas are those cystic lesions that show clinical and radiographic characteristics of an odontogenic cyst but on histologic examination show a cystic cavity lined by ameloblastomatous epithelium with or without intraluminal and/or mural proliferations.⁴ We thereby illustrate an unusual case of unicystic ameloblastoma-mural type of the mandible.

Case Report

- A 60-year-old female patient presented with a swelling in the lower left side of the oral cavity since 1 month. There is no associated pain but difficulty in chewing/mouth opening.
- Clinical examination showed an expansile growth on the left body region involving angle to ramus.
- Complete erosion of overlying mucosa also noted.

- A provisional diagnosis of ameloblastoma was made and the patient was hospitalized. Under GA the cystic lesion was enucleated.



Figure 1: Excised specimen

The H & E stained soft tissue section from the submitted biopsy specimens shows; ameloblastomatous cystic lining epithelium and connective tissue. Epithelium is seen proliferating into the connective tissue as network of interconnecting strands with peripheral ameloblast-like cells and central stellate reticulum like cells. Numerous areas of squamous metaplasia and areas of cystic degeneration are evident. Connective tissue is moderately collagenous with chronic inflammatory cell infiltrate predominantly of lymphocytes. Vascular channels engorged with RBCs and extravasated RBCs are also seen.

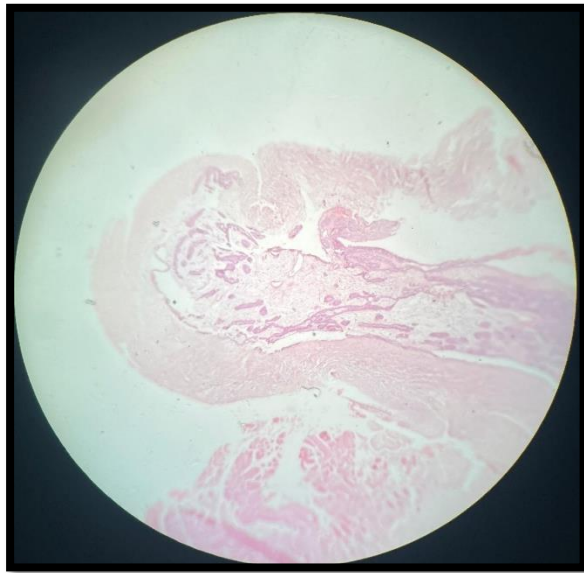


Figure 2: Hematoxylin & Eosin stain showing histopathological mural variant of UA under 4X magnification

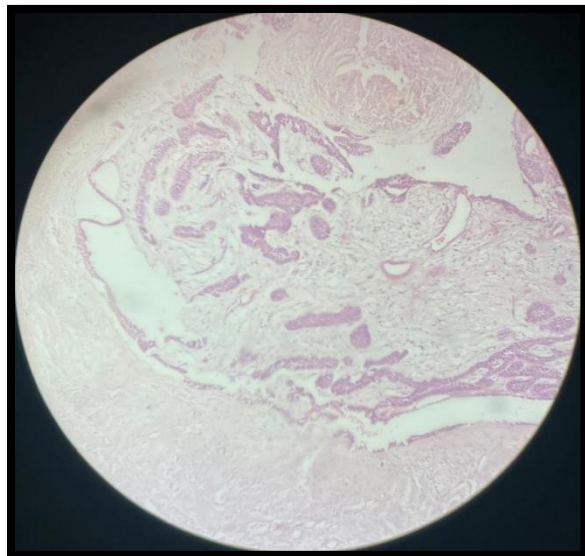


Figure 3: H & E stain showing histopathological mural variant of UA under 10X magnification

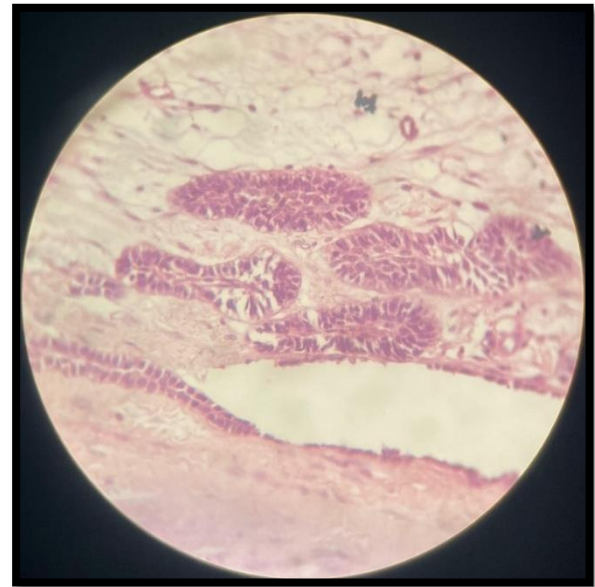


Figure 4: H & E stain showing histopathological mural variant of UA under 40X magnification

Discussion

WHO (2007) classification of Ameloblastoma variants

Classification of Ameloblastomas according to histology			
Conventional ameloblastoma	Unicystic ameloblastoma	Ameloblastoma Extra bone/ peripheral	Ameloblastoma Metastatic
Acanthomatous	Luminal	Similar to conventional ameloblastoma	Similar to conventional ameloblastoma
Basaloid	Intraluminal		
Desmoplastic	Mural		
Follicular			
Granular cell			
Plexiform			

Source: Shi Ha, et al. [11]

Odontogenic Tumours (OT) are a heterogeneous group of lesions of diverse clinical behaviour and histopathologic types, ranging from hamartomatous lesions to malignancy. The classification of odontogenic tumours is essentially based on

interaction between odontogenic ectomesenchyme and epithelium. This classification is constantly renewed with the addition of new entities and the removal of some older entities.⁵

Unicystic ameloblastoma is a subtype of intraosseous ameloblastoma, consisting of a large single cyst. It is a rare type of ameloblastoma, accounting for about 6% of ameloblastomas.⁶ They are likely to present a decade earlier than conventional ameloblastoma. Radiographs often show a unilocular, well-demarcated radiolucency that surrounds the crown of the unerupted tooth, resembling dentigerous cyst. The ratio of mandibular to maxillary unicystic ameloblastoma has been reported to be 13:1.⁷ Eversole *et al.* identified numerous radiographic patterns of UA ranging from well-defined unilocular to multilocular appearances: unilocular, scalloped macromultilocular, pericoronal, interradicular, and periapical expansile radiolucencies. For dentigerous type, the unilocular to multilocular ratio is 4.3:1 and for the nondentigerous type, this ratio is 1.1:1.^{8,9}

Pathologic mechanisms attributed for the development of UA:³

1. The reduced enamel epithelium, associated with the developing tooth, undergoes ameloblastic change with subsequent cystic transformation.
2. Ameloblastomas arise in dentigerous or other types of odontogenic cysts in which the neoplastic ameloblastic epithelium is preceded temporarily by a non-neoplastic stratified squamous lining.
3. Solid ameloblastoma undergoes cystic degeneration of ameloblastic islands with a subsequent fusion of multiple microcysts and then into a unicystic lesion.

Minimum histopathological criteria for diagnosing a unicystic ameloblastoma is based on the Vickers and Gorlin criteria which describes¹⁰ –

- Presence of single cystic sac, which is lined by odontogenic (ameloblastomatous) epithelium with a tall columnar basal layer.
- Subnuclear vacuoles.
- Reverse polarity of hyperchromatic nucleus and a thin layer of edematous.
- Degenerating stellate reticulum like cells on the surface in focal areas.

Our case showed a cystic cavity with epithelial lining which was highly proliferative and extended into the

connective tissue, suggesting mural type of UA.

In 1988, Ackermann studied 57 cases and categorised unicystic ameloblastoma (UA) in 3 histologic growth patterns:¹⁰

- I. Luminal UA (tumour confined to the luminal surface of the cyst)
- II. Intraluminal/plexiform UA (nodular proliferation into lumen without infiltration of tumour cells into connective tissue wall)
- III. Mural UA (invasive islands of ameloblastomatous epithelium in the connective tissue wall not involving the entire epithelium).

Later, another subgrouping was given based on treatment modalities by Philipsen and Reichart:¹¹

- Subgroup 1: luminal UA;
- 1.2: luminal and intraluminal UA;
- 1.2.3: luminal, intraluminal and intramural UA
- 1.3: luminal and intramural UA.

The UA diagnosed as subgroups 1 and 1.2 can be treated conservatively, while subgroups 1.2.3 and 1.3 showing intramural growths require radical resection as for solid or multicystic ameloblastoma.

Traditionally, unicystic ameloblastomas are treated conservatively, regularly by

enucleation of the cysts, and recurrence is uncommon. Following enucleation, vigorous curettage of the bone should be avoided as it may implant foci of ameloblastoma more deeply into the bone. Chemical cauterization with Carnoy's solution (powerful fixative that penetrates the cancellous spaces and thus fixes the remaining tumour cells) is also advocated for subgroups 1 and 1.2. Subgroups 1.2.3 and 1.3 have a high risk for recurrence, requiring more aggressive surgical procedures. This is because the cystic wall in these cases have islands of ameloblastoma tumour cells and there may be penetration into the surrounding cancellous bone.¹¹

Conclusion

Usually, diagnosis of Ameloblastoma may be delayed because of its low-grade symptoms and prevalence. Moreover, unicystic ameloblastomas are difficult to diagnose with clinical and radiographic examination alone because of its close similarity to cysts. In the present case, the diagnosis was possible because of thorough the histopathologic examination of enucleated specimen.

Hence, we conclude that the surgical protocol must include a thorough

postoperative histopathologic examination for odontogenic cystic lesions to rule out any ameloblastomatous changes, so that appropriate treatment can be instituted with regular follow up to avoid possible recurrence.

Therefore, in addition to analyzing the clinical and radiological data of the lesion, histopathological examination is of greater importance for an accurate diagnosis and consequently to choose the most appropriate treatment.

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Review Article

NAVIGATING ANTIBIOTIC RESISTANCE CHALLENGES IN PERIODONTAL THERAPY

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Abstract

Antimicrobial agents have been pivotal in managing and treating infectious diseases. However, the advent of the first antibiotic marked the onset of a significant challenge antibiotic resistance. This resistance poses a formidable obstacle to the effectiveness of these crucial agents in combating infectious diseases. the infectious nature of most periodontal diseases and the limited results that are sometimes achieved with conventional mechanical therapies, the use of antibiotics is warranted in certain cases. In the past 20 years, reports of the existence of antibiotic-resistant, and even multiresistant, oral bacteria have been increasing.

Keywords: Antibiotics, Antibiotic resistance, Periodontitis

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Introduction

Advanced periodontitis is considered an opportunistic infection initiated by native bacteria (Page & Schroeder 1981). The prevention of further periodontal breakdown involves a combination of surgical and non-surgical methods for mechanical plaque removal, coupled with diligent oral hygiene practices.¹ Given the

infectious nature of periodontitis and the limited results that are sometimes achieved with conventional mechanical therapies, the use of antibiotics is warranted for certain forms of the disease or for certain patients.² Numerous systemic agents have undergone scrutiny for their capacity to halt the progression of periodontal disease and contribute to effective periodontal therapy.¹ However, in deciding whether to use

curative systemic antibiotic therapy, it is important to consider the potential benefits and adverse effects, including the development of resistant bacterial species.³

Antimicrobial resistance (AMR) is one of the most serious global public health threats in this century. The World Health Organization (WHO) has long recognised the need for an improved and coordinated global effort to contain antimicrobial resistance.⁴

Mechanism of Antibiotic resistance

The emergence of bacterial resistance is characterized by a rise in the minimum inhibitory concentration of an antibiotic for a particular bacterial strain, relative to the minimum inhibitory concentration of the same antibiotic for the wild population. Minimum inhibitory concentration of an antibiotic refers to the lowest amount of the antibiotic required to hinder the growth of a specific bacterial strain. A strain is deemed resistant when it no longer responds to a typically effective concentration of the antibiotic.¹

Types of resistance

Intrinsic Resistance: Some specific bacterial genera (or) species have unique structural/functional characteristics that

provide resistance to certain antibiotics. These groups of bacteria normally do not have a target site for the specific antibiotic, thus making them ineffective.⁵

Acquired resistance: In which the naturally susceptible bacteria can develop resistance against certain antibiotics by receiving genetic codes from other bacterial strains. There are three major mechanisms of acquired resistance.⁵

- Modification of enzymes or inactivation of antimicrobial agent.⁶
- Reduced intracellular accumulation of antimicrobial agents.⁵
- Alterations at the target sites of the antimicrobial agents.⁷

Bacteria employ diverse mechanisms to resist antibiotics, and a specific type of resistance is not confined to a particular antibiotic family. Conversely, distinct bacterial species may employ varied mechanisms to resist the same antibiotic agent.

Typically, antibiotics for treating periodontitis are prescribed empirically, posing the risk of inappropriate treatment and the potential development of bacteria resistant to one or more antibiotics. The association between the prevalence of resistant bacterial strains at subgingival

sites and the consumption of antibiotics has already been demonstrated.⁸ The principal

mechanisms of antibiotic resistance in periodontology are summarized in table 1.²

Table 1 Mechanisms of resistance to the principal antibiotics used in periodontology.²

Antibiotic	Mode of action of antibiotic	Bacterial response
Penicillins and cephalosporins	Inhibition of synthesis of the cell wall	• Destruction of the β-lactam ring by β-lactamases • Conformational modification of the target • Reduction in autolysis
Erythromycin	Inhibition of protein synthesis	• Immediate excretion by intramembranal pumps • Conformational modification of the antibiotic target
Tetracycline and derivatives	Inhibition of protein synthesis	• Immediate excretion by intramembranal pumps • Conformational modification of the antibiotic target • Enzymatic modification of the antibiotic
Metronidazole	Inhibition of DNA replication	• Lack of metronidazole activation through modification of bacterial nitroreductases • Reduction in uptake

The specific organization of pathogenic periodontal bacteria in the biofilm affects their resistance to antibiotics.^{9,10} Within the biofilm, bacteria can exhibit up to 1,000 times greater resistance compared to their planktonic form, where they are not attached to one another or to a solid surface.¹¹

An essential mechanism involves the reduced metabolic activity of bacteria within the biofilm, impeding the assimilation of antibiotics. Furthermore, the extracellular matrix in the biofilm restricts the diffusion of antimicrobial agents. Lastly, the extracellular bacterial enzymes responsible for deactivating antibiotics become confined and concentrated within

the biofilm, thereby enhancing their capacity to neutralize antimicrobial agents. So mechanical therapy is an essential prerequisite for eventual antibiotic treatment.

Resistance to an antibiotic may arise if the bacterium synthesizes an enzyme that can hydrolyse the antimicrobial agent. The most well-known example of this mechanism is penicillin-resistant *Staphylococcus*.¹²

Resistant strains of this bacterial genus produce a β -lactamase that hydrolyses the constitutive β -lactam ring of penicillin and cephalosporins. The resistance mechanism is overcome through the use of a combination of penicillin and clavulanic acid. Clavulanic acid functions as a

"decoy," acting as the primary target for β -lactamase and, in turn, safeguarding the β -lactam core of penicillin.

Another resistance mechanism entails modifying the antibacterial properties by introducing chemical groups to the molecule.¹³ For instance, microorganisms might phosphorylate aminoglycosides or acetylate chloramphenicol.

Bacteria can expel recently entered antibiotics from their cells, utilizing intramembranal pumps as part of this mechanism.¹⁴ These pumps efficiently remove the drug before it can exert its effects. These transport proteins exhibit a degree of nonspecificity and are commonly linked to resistance against multiple agents. Additionally, the genetic modification of the antibiotic's target, achieved through mutation, can lower the drug's affinity for its substrate. This genetic alteration is frequently observed in resistance to erythromycin and vancomycin.

Irrespective of the specific mechanism, resistance is triggered not by the antibiotic per se, but by its usage. The utilization of antibiotics imparts a selective pressure on bacterial species, conferring a competitive advantage to resistant organisms over susceptible ones. Consequently, the extent

of bacterial resistance is directly tied to the frequency of antibiotic use.

Conclusion

Antibiotics have been a successful treatment method in preventing and treating microbial infections, and it has a key role in saving the lives of billions of people. Antibiotic resistance is a significant concern in the realm of periodontal therapy. While antimicrobial agents have been instrumental in treating periodontal infections, the escalating challenge of resistance jeopardizes their efficacy. Dental professionals must exercise caution in antibiotic prescription, adhering to evidence-based practices and exploring alternative strategies such as enhanced oral hygiene and targeted antimicrobial interventions.

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Review Article

ROLE OF CONE BEAM COMPUTED TOMOGRAPHY IN PERIODONTOLOGY

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Abstract

Periodontal disease diagnosis by traditional two-dimensional radiographs, are constrained by projection geometry and superpositions of adjacent anatomical structures, prompting a need for advanced imaging modalities. CBCT emerges as a powerful tool in periodontal diagnostics, providing detailed cross-sectional and volumetric images. It excels in visualizing intra-bony defects, furcation involvements, and alveolar bone defects. Comparative analysis with conventional radiography highlights CBCT's superior accuracy in assessing periodontal bone levels and defects.

This comprehensive review assesses the role of Cone Beam Computed Tomography (CBCT) in periodontology, considering its applications, advantages, limitations, and impact on radiological evaluation of periodontal tissues.

Key words: *Cone Beam Computed Tomography, periodontal disease, radiographic assessment, two-dimensional radiographs, diagnostic imaging, treatment planning.*

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Introduction

Diagnosis of periodontal disease mainly depends on clinical signs and symptoms. Radiographs are valuable diagnostic tools as an adjunct to the clinical examination. Two dimensional radiographs routinely

used for diagnosing periodontal bone levels in periodontal disease has certain limitations due to projection geometry and superpositions of adjacent anatomical structures.¹

Three-dimensional imaging techniques such as computed tomography can eliminate limitations of 2D radiographs. CBCT applications provide obvious benefits in periodontics, however; it should be used only in correct indications considering the necessity and the potential hazards of the examination.

Advantages of CBCT ^{2,3}

- A single rotation is sufficient during irradiation of the patient for acquisition of base projection images
- CBCT scanners use two-dimensional flat-panel detectors which provide a scan of the entire region of interest
- The collimation of the X-ray beam to the area of interest minimizes the radiation dose.
- Most CBCT units offer different field of view (FOV) options with various sizes. The use of small FOV lowers the effective radiation dose.
- A high degree of measurement accuracy can be obtained.
- This feature contributes to the high diagnostic capacity of CBCT

images obtained from high-density dento-maxillofacial structures such as teeth and bone.

- All CBCT units provide axial, coronal and sagittal multiplanar reconstructed images without magnification.⁴
- Panoramic images can also be generated with curved planar reformation.
- In comparison to medical CT, CBCT offers lower radiation dose and cost along with smaller space requirement.
- CBCT has better spatial resolution when compared with medical CT.

Limitations of CBCT ⁵

- CBCT is not able to offer high contrast resolution and it cannot utilized soft tissues (CBCT is mainly indicated for the evaluation of hard tissues in the dento-maxillofacial complex).
- When compared to 2D imaging, CBCT has higher cost and effective radiation dose but it has lower resolution and lack of availability.

- The scatter radiation is higher in CBCT than with fan-beam tomography.⁶
- Moreover, the beam-hardening artifacts that comprise radiolucent areas and radiopaque lines can occur more often in CBCT images.
- The presence of metal artifacts, i.e., image flaws that are unrelated to the scanned object, which are caused by metal and amalgam restorations and, to a lesser extent, root-canal filling material and implants.^{5,6,7}

[Such artifacts include streaks around materials as well as dark zones that affect the overall quality of the image. Streak artifacts appear as linear hyperdensities that radiate from a metallic object and may extend to the width of the field, affecting visualization of areas even on the opposite side of an image (Figure 1). Beam hardening artifacts, which appear as dark bands adjacent to high-density structures, may mimic disease.]

Beam hardening artifacts, which appear as dark bands adjacent to high-density structures, may mimic disease.]

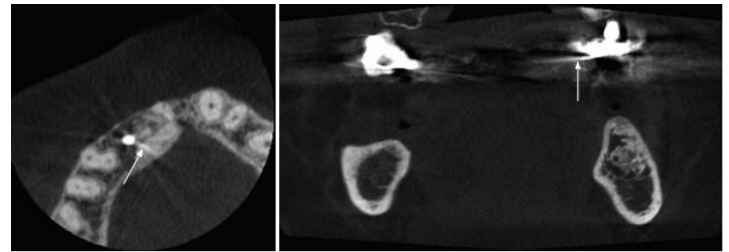


Figure 1- Streak artifacts are observed as radiopacity in a radial manner (arrows).

The features of cone beam computed tomography and conventional radiographs.^{5,6}

Table -1

Conventional Radiography	CBCT
2D imaging	3D imaging
Superpositions	Cross-sectional and volumetric images
Distortion and magnification	Elimination of image deformity
Slower radiation dose	Higher radiation dose
Lower cost	Higher cost
Smaller space requirement	Larger devices

Radiological evaluation of periodontal tissues

Radiographs provide information about:

- Quantity

- localization and pattern of bone resorption
- changes in bone trabeculations
- conditions of lamina dura and periodontal space
- length and shape of teeth roots
- ratio of clinical crown length to root length.

CBCT displays two dimensional and three-dimensional images that are necessary for the diagnosis and treatment planning of intra bony defects, furcation involvements and buccal/lingual bone destructions^{8,1,9} but periapical radiographs have better image quality than CBCT including contrast resolution, clarity and detail.^{7,11}

Mol et al ¹¹ observed that the CBCT images provided more accurate information on periodontal bone levels in three dimensions than the images of photostimulated phosphor plates. In a similar study, it was found that CBCT was better in morphological description of periodontal bone defects, while the images obtained by charged coupled device sensor provided more bone details.

Mengel et al demonstrated that CBCT images were better in detection of periodontal defects compared with periapical radiographs and medical CT.¹²

Noujeim et al concluded that CBCT technique has better diagnostic accuracy than periapical films in the detection of interradicular periodontal bone defects.¹³

Furcation involvement

An accurate diagnosis of inter radicular bone loss is an important issue prior to the decision of appropriate treatment options including apically repositioned flaps with or without tunnel preparation, root amputation, hemi-/trisection or root separation.

3D images provide detailed information about areas of multi rooted teeth (Figure 2).

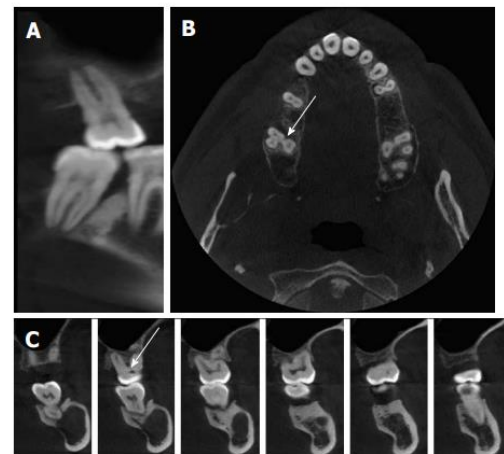


Figure 2- Furcation involvement cannot be observed in the panoramic like section (A) whereas it can be evaluated in the axial (B) and crosssectional (C) cone beam computed tomography image (arrows)

CBCT images of maxillary molars provided detailed information of furcation involvement and a reliable basis for treatment decision¹⁰ (Figure 3).

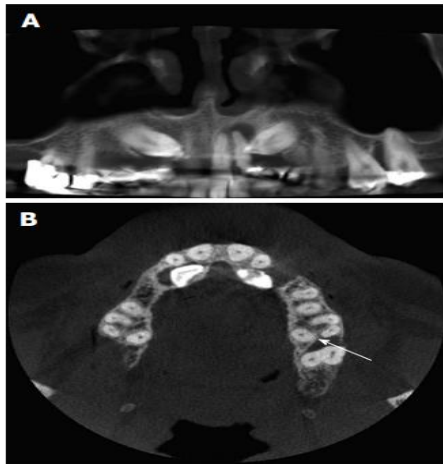


Figure 3- The amount and shape of bone resorption in the furcation area of maxillary molar tooth cannot be assessed in the panoramic-like section (A), however, this involvement is seen in the axial section (B) (arrow)

It was reported that CBCT images demonstrated a high accuracy in assessing the loss of periodontal tissue and classifying the degree of furcation involvement in maxillary molars.¹⁰

Alveolar bone defects

Radiographs are frequently utilized to diagnose the amount and shape of alveolar bone destruction that affects treatment planning in periodontal therapy.¹² 2D

radiographs can be insufficient for the detection of intra-bony alveolar defects due to obstruction of spongy bone changes by cortical plate.

Thus, three-dimensional imaging is required for mapping of alveolar defects.⁹ Intraoral and panoramic radiographs could not determine the dehiscence unequivocally, tomographic images displayed all dehiscences and provided accurate measurements of the defects. Authors also reported that CBCT displayed the best imaging quality.

CBCT measurements were found to be equivalent to direct measurements and dehiscences were diagnosed with higher accuracy than fenestrations.¹⁴

Regenerative periodontal therapy and bone grafts

Bone grafting is commonly used for maxillary sinus lifting and treatment of intra bony defects but evaluation of osseous defect regeneration with conventional radiography can be insufficient due to superimpositions.^{12,15}

CBCT was found to be significantly more accurate than digital intraoral radiographs when direct surgical measurements served as the gold standard for the evaluation of

intra-bony defects' regenerative treatment outcomes.

CBCT can replace surgical re-entry by providing 3D images and measurements that are almost equivalent to direct surgical measurements.¹⁴

Dental implants

Dimensions of alveolar process should be examined in detail prior to dental implant placement to avoid various complications and evaluation of CBCT images has a major importance in preoperative planning and postoperative localization of dental implants^{4,16} (Figure 10). Moreover, the evaluation of CBCT images are preferred method to observe bone graft healing prior to dental implant placement (Figure 4).⁷

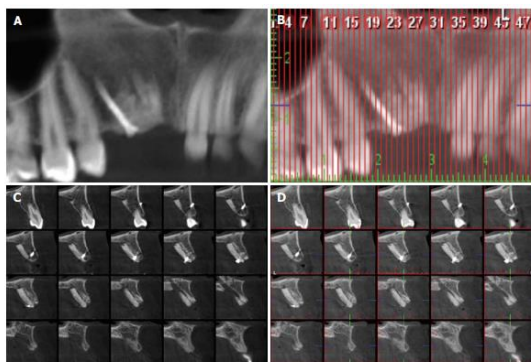


Figure 4 - The block graft and mini screw providing graft stabilization are placed in the maxillary anterior region (A and B), the amount of bone augmentation can be

evaluated in the cross-sectional images (C and D)

Immediate implant placement enables one-stage surgery and eliminates bone recovery time. In this technique, dimensions of alveolar process which is selected for dental implant placement and relationships with adjacent anatomical structures of this region should be carefully assessed.^{4,16} Jin et al studied bone thickness evaluation on the buccal and palatal aspects of the maxillary canine and premolars using CBCT and it was concluded that CBCT images might be advantageous in preoperative planning of dental implants.¹⁶

Summary

CBCT applications provide obvious benefits in periodontology, although it should be used when two-dimensional radiographs are insufficient considering the necessity and the potential radiation hazards of the examination.¹⁶

Where two-dimensional imaging is an inadequate method for accurate diagnosis of periodontal defect configuration and guiding for appropriate treatment planning, three-dimensional radiographic examinations may be required. Periodontal intra-bony defects and furcation

involvements keep a challenge for the examiner.

Misdiagnosed or misclassification of these pathologies can lead to progress of bone destruction and teeth loss as a result of improper treatment.^{18,6} CBCT evaluation can be used for determining the width, height and distance to the anatomical structures of alveolar process in pre-surgical dental implant planning. Likewise, the surgical guide stents used during dental implant surgery is produced by aid of CBCT images and software packages.⁷ There are numerous studies that 3D imaging had high accuracy in the detection of alveolar defects and furcation involvements.

CBCT is well complied for imaging the highly mineralized structures such as bone or teeth but it cannot provide clear images of soft tissues. However, a novel, CBCT-based method to display and measure the dimensions of the palatal mucosa was reported in a recent study.^{19,20}

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Case Report

TRAUMATIC BONE CYST OF THE MANDIBLE: A CASE REPORT

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Abstract

Traumatic bone cyst (TBC) is an uncommon non-epithelial lined cavity of the jaws. The lesion is mainly diagnosed in young patients most frequently during the second decade of life. The majority of TBCs are located in the mandibular body between the canine and the third molar region. Clinically, the lesion is asymptomatic in the majority of cases and is often accidentally discovered on routine radiological examination. Radiographically TBC usually presents as a unilocular radiolucent area with a "scalloping effect". The definite diagnosis of traumatic cyst is invariably achieved at surgery. Since material for histologic examination may be scant or non-existent, it is very often difficult for a definite histologic diagnosis to be achieved. We present a well-documented case of TBC involving the body of the mandible.

Keywords: Traumatic bone cyst, Scalloping, trauma –Hemorrhagic theory

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Introduction

The traumatic bone cyst appears in the literature as hemorrhagic cyst, extravasation cyst, solitary bone cyst, simple bone cyst, solitary hemorrhagic cyst, hemorrhagic extravasation cyst, traumatic hemorrhagic cyst, and progressive bone cavity. It was Lucas in 1929 to describe it as a separate disease entity.¹ The multitude

of the names applied to this lesion attests to the lack of understanding of the true etiology and pathogenesis. In the classification of the World Health Organization (WHO), TBCs are included in the group of bone-related lesions, together with the aneurysmal bone cyst, ossifying fibroma, fibrous dysplasia, osseous dysplasia, central giant cell granuloma and

cherubism². Different causal factors have been proposed such as bone tumor degeneration, altered calcium metabolism, low-grade infection, local alterations in bone growth, venous obstruction, increased osteolysis, intramedullary bleeding, local ischemia, or a combination of such factors. Radiologically, TBCs appear as a radiolucent image with irregular or scalloped but well-defined margins. The size is variable, and a fine sclerotic margin is sometimes seen when the radiolucency affects the interdental bone spaces, the lesion appears lobular or scalloped³. Histologically, the lesion appears as a cancellous bone cavity that may be vacant and without a lining, or present a thin connective tissue layer with a scant liquid content.

Case report

A 15-year-old male reported having a decayed tooth in the lower left back jaw region for one month. Clinical examination revealed deep dentinal caries in relation to 38. The patient was completely free of symptoms. No palpable lymph nodes were present. Routine radiological assessment of the patient with panoramic radiograph revealed a fairly large radiolucent lesion in the left body of the mandible. A CBCT of

the lesion showed well defined unilocular radiolucency with corticated margins extending from mesial-root of 36 to distal root of 38 sizing anterior-posteriorly 38.67mm and superior-inferiorly 19.76mm approximately. Axial view revealed no expansion of buccal and lingual cortical plate, but thinning of lingual cortical plate was noted (figure 2) and internal structure was completely radiolucent. The superior margins of the lesion showed scalloping between the roots. The medical history was not contributory. The differential diagnosis included Odontogenic cysts (probably Odontogenic keratocyst) and Odontogenic tumors (unicystic ameloblastoma).

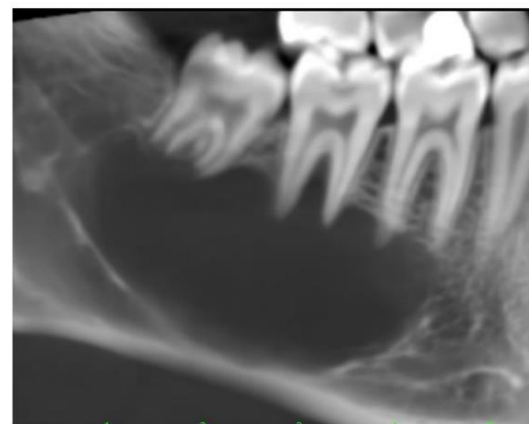


Figure 1 Showing unilocular radiolucency with scalloped borders

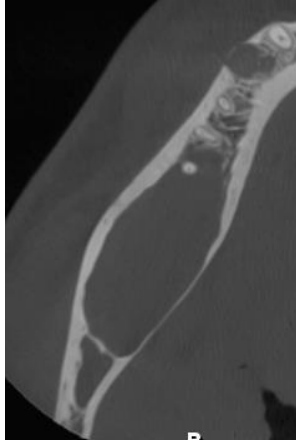


Figure 2 Showing no expansion

The patient was operated under local anesthesia for removal of the cyst. Following a nerve block of the left mandibular nerve together with infiltration anesthesia of the surrounding tissues, an incision was made along the external oblique ridge. A mucoperiosteal flap was raised exposing both buccal and lingual surfaces of the ascending ramus. None of the two surfaces presented any noticeable bony expansion. A window was made with a surgical bur in order to reach the lesion. The bony cavity was completely empty of tissue or fluid and there was not any lining on its walls apart from an extremely thin layer of connecting tissue in some place. Following a careful curettage small bone chips with parts of the membrane were submitted for microscopic examination.

The operative findings were highly suggestive for the diagnosis of TBC;

therefore, no further treatment was done apart from curettage. Histological examination revealed normal appearing bone spicules with parts of vascular connective tissue wall devoid of epithelial lining and the diagnosis was consistent with that of a TBC. Postoperative healing was uneventful and follow-up panoramic radiograph (Figure 3) after 6 weeks indicated restoration of bone structure and resolution of the lesion.

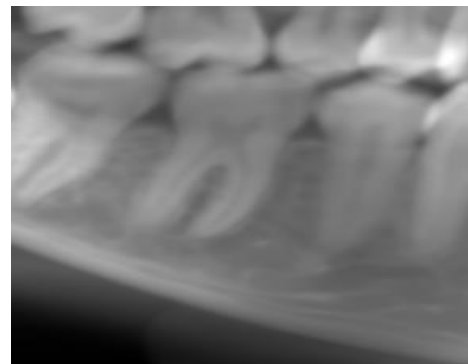


Figure 3 Post-operative radiographic image

Discussion

Traumatic bone cysts are considered almost exclusively mandibular lesions, with a preference for the posterior body and ramus. They rarely may be present in the maxilla. Possibly it's almost exclusive location in the mandible is related to its pathogenesis; the trauma-hemorrhage theory. The traumatic-hemorrhagic theory,

which suggests that lesions develop if intramedullary clots due to trauma do not undergo lysis or resolution⁴. This theory explains why traumatic bone cysts occur more often in young individuals (an age at which trauma occurs more often) and also explain the presence of blood within the cavity at the time of surgical exploration. Reports of trauma at the site of lesions and the presence of blood in the cavities, however, are uncommon, as seen in our sample. This opens the possibility that micro trauma of teeth and the alveolar ridge are involved in the pathogenesis of traumatic bone cysts. Clinically most patients don't have any symptoms and the lesion is often discovered during routine radiologic examination. Occasionally they present with pain, swelling, paresthesia or expansion of the bone. Radiographically usually resembles a well demarcated radiolucent lesion of variable size. The lesion is usually unilocular, occasionally multilocular, sometimes there is a thin sclerotic border and scalloped margins when it extends between the roots of the teeth. Close examination of the tooth root reveals an intact lamina dura and normal width of periodontal ligament space surrounding tooth roots.⁵

There is seldom any displacement of the tooth. Histologic examination had revealed a variety of findings with little agreement with the authors, sometimes thin connective tissue membranes may line the cavity and it is common to find no other significant features.⁶ Inflammation has been reported in 67% of cases in a recent survey. Other features include bone marrow, nerve fibers, osteoid, osteoclast, giant cells and cholesterol within the lesion in varying proportions. A definitive diagnosis cannot be made without surgical exploration or histopathologic examination hence the traditional way of treating traumatic bone cyst has been surgical exploration and curettage of the lesion. More recently there have been reports in the literature of other techniques such as injection of autogenic blood to stimulate osteogenesis, enucleation with primary closure, insertion of gel foam which was saturated with thrombin and penicillin, insertion with bone grafts and keeping under observation to determine whether it heals by itself. Surgical intervention usually results in healing with filling of new bone, however few cases have shown recurrences after surgery.⁷

Multiple lesions and recurrences of TBC

The possibility of multiple foci of TBCs developing independently appears small, but multiple lesions were reported in 10.7% of the cases in the literature review. Some of the cases appeared clinically and radiographically compatible with FCOD, while it was not possible in others to determine a cause from the limited available information in the literature. Recurrent lesions were more likely to occur in females. It is anticipated that lesions that become large enough to erode the cortex would have a higher recurrence rate.⁸

Conclusion

Traumatic bone cyst is an asymptomatic lesion, mostly discovered during routine radiographic examination. The lesion seldom causes any complications, but the possibility of pathologic fracture in larger lesions cannot be completely ruled out. Moreover, simple surgical intervention and careful curettage to induce bleeding can itself lead to resolution of smaller lesions. For larger lesions other alternatives like bone grafting or the use of synthetic materials like hydroxyapatite, bio-glass etc. could favor a harmonious outcome.

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Review Article

TEMPOROMANDIBULAR JOINT DISC DISPLACEMENT AFTER ORTHOGNATHIC SURGERY

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Abstract

Orthognathic surgery plays a crucial role in correcting facial deformities and dental malocclusions. During orthognathic procedures, bone segments are realigned, which might influence the temporomandibular joint (TMJ), soft tissues, jaw muscles, and mandibular condyle position. Condylar displacements are thought to have a role in both further skeletal relapse and bone remodelling. This study aims to provide an overview of the existing literature on the positional changes in the mandibular condyle as a result of orthognathic operations, including quantitative analysis. The majority of the publications offer a comparative and critical evaluation of treatment outcomes with reference to various surgical techniques, fixation strategies, or skeletal defect types. The relationship between skeletal relapse, TMJ dysfunction, and condylar displacements was taken into consideration.

Key words: *Orthognathic surgery (OS), Temporomandibular joint (TMJ) disorders, Articular disc*

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Introduction

Orthognathic surgery is one of the methods used for the correction of malocclusion and temporomandibular disorders. Changes introduced to the geometry of maxillofacial structures have an impact on the biomechanics of the stomatognathic system and the

position of the mandibular condyle.¹

Postoperative displacement of the condyle is considered as one of the determinants of the outcome of treatment. The position of the mandibular condyle may be affected by various factors, such as distal segment repositioning, the alignment of bony

fragments, the method of bony segment fixation, the tensional balance of the muscles and surrounding tissue, and the surgeon's experience.^{2,3}

Most of the time, performing only orthognathic surgery is an acceptable option in patients with healthy TMJs and is rare that patients require additional surgery. However, on occasion the Temporomandibular disorder may be the causative factor for the jaw deformity, or develop as a result of the jaw deformity, or the two entities may develop independently of each other,⁴ An accurate diagnosis and an appropriate surgical intervention for the specific TMD should provide highly predictable and stable results,⁵ Proper evaluation of the TMJs, especially in the presence of TMD, requires a magnetic resonance imaging (MRI). Its use is indicated to confirm the stage of internal derangement of a TMJ disc, the irregularity of the articular surface, the changes in the size and structure of the mandibular condyle, and the condition of the masticatory muscles.⁶

Currently, two methods are available for evaluation of TM disc position and morphology. The first method is

arthrography which is performed by fluoroscopy after injection of contrast liquid media in superior and inferior articular spaces. This technique produces an indirect image from the articular disc (2). Another method is Magnetic Resonance Imaging (MRI) in which magnetic field and pulses of radio waves are used instead of ionizing radiation to obtain images. As MRI can produce high quality images of the soft tissue, it can be ideal for radiographic evaluation of the articular disc.^{7,8}



Figure 1: Anterior disc displacement

Discussion

The literature review encompassed thirty articles, showcasing a wide range of surgical approaches, fixation methods, and evaluations of treatment results. Most studies conducted comparative and



evaluative analyses, addressing different aspects such as short-term changes, Class III malocclusion, yaw rotation, and 3D cephalometry measurements.

Key Findings

1. Skeletal Relapse and Bone Remodeling:

- Condylar displacements were identified as factors contributing to bone remodeling and subsequent skeletal relapse.
- Correlations between condylar displacements and bone remodeling, skeletal relapse, and TMJ dysfunctions were explored in the reviewed studies.

2. Comparative Analysis of Treatment Approaches:

- Studies compared outcomes of various surgical approaches, fixation methods, and skeletal defect types.
- The most frequently studied variables included short-term changes, Class III malocclusion, yaw rotation, and 3D cephalometry measurements.

3. Concomitant TMJ Surgery:

- A specific study examined the outcomes of two surgical treatment options for Class II malocclusion, comparing maxillomandibular advancement (MMA) with or without concomitant TMJ surgery for articular disc repositioning (ADR).
- Results indicated that concomitant OS with ADR was stable and beneficial in improving symptoms in subjects with displaced discs and TMJ pain.

4. Influence on TMJ Disc Position:

- Studies utilizing magnetic resonance imaging (MRI) evaluated the influence of orthognathic surgery on articular disc position.
- Findings generally suggested that orthognathic surgery did not significantly alter the disc and condyle relationship.

5. Intercondylar Changes and TMJ

Symptoms:

- A study on intercondylar width (ICW) and intercondylar angle (ICA) after bilateral sagittal split osteotomy found no significant difference between preoperative and postoperative measurements.
- Rigid fixation did not significantly change ICW or ICA, and no increase in TM symptoms occurred

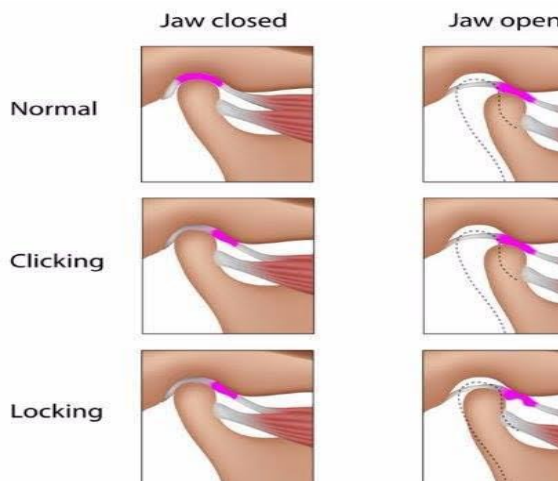


Figure 2: Position of the articular disc on movement with clinical symptoms

Conclusion

During preoperative and postoperative MRI scans, the study found a considerable shift in the position of the articular disc depending on a certain mouth opening. In spite of this modification, the analysis of the data revealed no appreciable differences in the articular disc's position or the IDD stage during the mouth closure phase. Furthermore, the degree of mandibular setback—a frequent operation in orthognathic surgery—had no discernible effect on articular disc placement alterations. In conclusion, orthognathic surgery had negligible short-term impacts on the condyle-disc complex in the TMJ and had no appreciable impact on the joint's normal and functional characteristics. But the study also emphasises the need for more investigation, particularly in the long run, to completely grasp the ramifications.

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Review Article

ARTIFICIAL INTELLIGENCE IN ORTHODONTICS

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Abstract

In recent years, artificial intelligence (AI) has emerged as a transformative force across various fields, including orthodontics. This review provides a comprehensive overview of the current applications of AI in orthodontics, which can be categorized into the following areas: (1) diagnosis, encompassing cephalometric analysis, dental analysis, facial analysis, skeletal-maturation-stage determination, and upper-airway obstruction assessment; (2) treatment planning, involving decisions for extractions, orthognathic surgery, and treatment outcome prediction; and (3) clinical practice, including practice guidance, remote care, and clinical documentation. We have observed a significant expansion in the use of AI in orthodontics, along with improvements in its performance. Additionally, this review addresses the current limitations within the field and presents future perspectives.

Key Words; *Artificial intelligence; Orthodontics; Machine learning; Deep learning*

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Introduction

Artificial intelligence (AI) has rapidly evolved into a transformative technology, reshaping numerous fields, including healthcare. In orthodontics, AI is revolutionizing traditional practices by enhancing diagnostic accuracy, optimizing treatment planning, and improving clinical outcomes. The integration of AI in

orthodontics encompasses a range of applications, from automated cephalometric analysis and dental assessments to predictive models for treatment outcomes and remote patient monitoring.

As AI technologies such as machine learning and deep learning advance, they offer unprecedented capabilities in handling complex datasets, identifying patterns, and

making data-driven decisions. These technologies not only streamline orthodontic workflows but also contribute to personalized patient care, reducing the need for invasive procedures and enhancing overall treatment efficiency.

This article aims to provide a comprehensive overview of the current state of AI applications in orthodontics, exploring its impact on diagnosis, treatment planning, and clinical practice. By examining recent advancements and identifying existing limitations, we also offer insights into the future perspectives of AI in this dynamic field. Through this exploration, we highlight the potential of AI to revolutionize orthodontics, paving the way for more precise, efficient, and patient-centered care.

1. AI in Orthodontic Diagnosis

AI has significantly advanced diagnostic processes in orthodontics, enhancing accuracy and efficiency in the following areas:

- **Cephalometric Analysis:** AI algorithms can automatically identify landmarks and perform cephalometric analyses, reducing human error and time consumption. Compared to classical machine

learning, deep learning, especially CNNs, demonstrates superior performance. Research has reported the use of CNNs for automated landmarking on posteroanterior cephalograms to assess mandibular deviation, which can aid in evaluating facial symmetry. AI has also made progress in three-dimensional (3D) cephalometric landmark detection, and deep learning and CNNs are the most efficient methods.¹

- **Dental Analysis:** AI can assist in detecting caries, assessing tooth alignment, and identifying periodontal diseases through image analysis. The development of digital technology has significantly facilitated the adoption of 3D intraoral scanner images and digital dental models in clinical practice. Some companies, such as Invisalign (Align Technology, Santa Clara, CA, USA), have effectively utilized 3D oral scan data and digital models for automated measurement and analysis.¹
- **Facial Analysis:** AI tools can analyze facial symmetry and

aesthetics, aiding in comprehensive treatment planning.

- **Skeletal Maturation Stage Determination:** AI systems can evaluate skeletal maturity from radiographic images, helping in the timing of orthodontic interventions.
- **Upper-Airway Obstruction Assessment:** AI can analyze airway obstructions from imaging data, contributing to the diagnosis and treatment of sleep apnea and other airway-related conditions.

2. AI in Treatment Planning

AI enhances treatment planning by providing data-driven insights and predictions:

- **Decision Making for Extractions and Orthognathic Surgery:** AI algorithms can assist in making precise decisions about the need for extractions or surgical interventions.
- **Treatment Outcome Prediction:** AI models can predict treatment outcomes based on historical data, helping orthodontists set realistic expectations and customize treatment plans.

● Simulation of Treatment

Progression: AI can simulate various treatment scenarios, allowing orthodontists to visualize potential outcomes and adjust plans accordingly.

3. AI in Clinical Practice

AI is transforming clinical practice by improving efficiency and patient care:

- **Practice Guidance:** AI systems can provide real-time guidance during procedures, enhancing accuracy and reducing the likelihood of errors.
- **Remote Care:** AI-powered teleorthodontics enables remote monitoring of patient progress, allowing for timely interventions and adjustments without frequent in-office visits.
- **Clinical Documentation:** AI can streamline clinical documentation by automatically generating detailed reports from patient data, freeing up valuable time for orthodontists.

Existing Limitations and Future Perspectives

Despite the promising advancements, AI in orthodontics faces several limitations:

- **Data Quality and Quantity:** High-quality, diverse datasets are essential for training robust AI models. Limited access to comprehensive datasets can hinder AI development.
- **Integration with Existing Systems:** Integrating AI tools with current orthodontic systems and workflows can be challenging and may require significant adjustments.
- **Ethical and Legal Considerations:** Ensuring patient data privacy and addressing ethical concerns related to AI decision-making are critical.

Looking ahead, the future of AI in orthodontics is bright. Continued advancements in machine learning and deep learning will enhance AI's capabilities, making it an indispensable tool in orthodontic practice. Future research should focus on overcoming existing limitations, developing standardized protocols for AI integration, and ensuring ethical use of AI in patient care.

Conclusion

AI is poised to revolutionize orthodontics by improving diagnostic accuracy, optimizing treatment planning, and enhancing clinical practice. As AI technologies continue to

evolve, they will offer more precise, efficient, and patient-centered care. Embracing AI in orthodontics promises a future where treatments are not only more effective but also more personalized, ultimately leading to better patient outcomes.

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Review Article

3-DIMENSIONAL PRINTING: EXPANDING HORIZONS OF DIGITAL DENTISTRY

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Abstract

The field of dentistry has witnessed significant advancements due to technology. One such advancement is 3D printing, which has improved diagnostic accuracy, streamlined treatment delivery, and reduced chair time. In dental practice, 3D printing allows dentists to visualize and record hard and soft tissues with precise measurements, and it enables the creation of detailed models. This scoping review explores the various applications of 3D printing in dentistry, summarizing findings from in vitro, in vivo, and clinical studies. It sheds light on the current state of 3D printing technology in dentistry and highlights its main applications across different dental specialties. Notably, 3D printing has been used for tissue engineering, fabrication of anatomical and prosthetic materials, and designing drug-delivery systems. While the quality of 3D printing applications continues to improve, long-term clinical studies are essential to establish standards and ensure safe implementation in dental practice.

Key words: 3 D Printing, SLA

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Introduction

In the realm of modern dentistry, advancements in technology continue to reshape the way oral health care is provided. Among these innovations, 3D printing has emerged as a game-

changing tool, offering unprecedented possibilities for personalized treatment solutions. Three-dimensional (3D) printing is a rapidly developing technology that has gained wide spread

acceptance in dentistry. Compared to conventional (lost-wax technique) and subtractive computer numeric controlled methods, 3D printing offers process engineering advantages. Materials such as plastics, metals, and ceramics can be manufactured using various techniques. 3D printing was introduced over three decades ago. Today, it is experiencing rapid development due to the expiration of many patents and is often described as the key technology of the next industrial revolution. The transition to its clinical application in dentistry is highly dependent on the available materials, which must not only provide the required accuracy but also the necessary biological and physical properties.¹

- Three dimensional printing is a form of additive manufacturing whereby adding layers of a given material on top of one another makes the final object. Though there is variety in the types of 3D printers available, the tasks that they are best suited for, and the types of materials they can utilize, the 3D printing process itself proceeds according to the following steps:

1. A digital 3D model of a specific object is generated,
2. The model is sliced into numerous 2D layers,
3. The 3D printer then builds each layer sequentially,
4. The printed object undergoes post-processing as needed.²⁻⁴

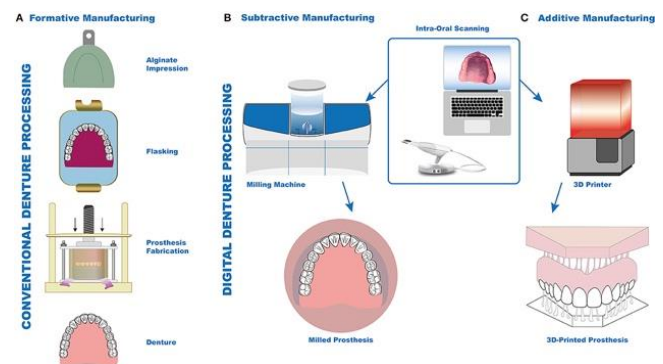


Figure 1: Formative, Subtractive and Additive manufacturing

- **Three-dimensional printing techniques:**

Figure 2: Three-dimensional



printing technologies

- According to different working principles, 3D printing technologies can be divided into three categories:
- Powder Bed Fusion (PBF), Light Curing, and Fused Deposition Modelling (FDM).⁵
- Powder Bed Fusion (PBF). Any powdered material, which can be sintered or fused by laser radiation and solidified by cooling, could be suitable for laser sintering or fusion technologies.⁶ According to the energy sources and powder materials, PBF is divided into the following printing technologies: selective laser melting (SLM), selective laser sintering (SLS), electron beam melting (EBM), and direct metal laser sintering (DMLS).⁷
- In dentistry, PBF is used to manufacture all kinds of metal products including AM titanium (Ti) dental implants, custom subperiosteal Ti implants, custom Ti mesh for bone grafting-techniques, cobalt chromium (Co-Cr) frames for implant impression procedures, and Co-Cr and Ti frames for dental implant supported prostheses. The

definitions of the terms “laser sintering” and “selective laser melting” are inconsistent.⁸ The operating ambient temperatures of SLS and DMLS do not reach the materials’ melting points. The metal powder is partially melted, which results in a large porosity and a rough surface.⁹ However, in the SLM process, the powder melts directly at the melting point. Another technique, EBM, differs from SLM by using an electron beam to melt the material. Both technologies completely melt the metal powder in an inert build chamber containing purified argon gas. PBF uses the roller to apply the powdered substrate from the reservoir onto the build platform. Thereafter, a laser or electron beam selectively fuses the powder particles according to the cross-sectional configuration of the CAD file being produced. The shapes of the build platform descend by orders of magnitude in the thickness of the printed layers, and then the process goes in cycles until the object has finally been built.¹⁰

- **Light Curing.** Light curing technology is a general term for a type of 3D printing technologies using photosensitive resin materials that are cured and moulded under light irradiation.¹¹ It consists of three main technologies: SLA, digital light processing (DLP), and photo jet (PJ). The printing process in SLA and DLP technologies can be divided into three discrete procedures: light exposure, building platform movement, and resin refilling. SLA is one of the earliest practical 3D printing technologies, and its device consists of a reservoir for the material supplier of photosensitive liquid resin, a model build platform, and an ultraviolet (UV) laser to cure the resin. In the building process, the build platform is submerged in a liquid resin, and the resin is polymerized using a UV laser. Then, the build platform moves a distance equivalent to the thickness of one layer, and the uncured resin then covers the previous layer. There are two ways to move the platform in SLA technology. The first is the top-down movement of the platform. A

layer of resin covers the construction platform that is soaked in the resin reservoir. After scanning the first layer with the laser, the construction platform moves down, and a new layer of resin is added by a wheel next to it. The build cycle is repeated until the object is created. In contrast, in the platform-bottom-up approach, the platform is submerged at the bottom of the resin reservoir, and the gap between the platform and bottom can spread only a single layer of resin. The laser is placed at the bottom of the reservoir, and the resin layer would be scanned. After curing, the platform increases the distance of one layer, and the resin material can completely fill the gap between the platform and the bottom owing to gravity. The platform-bottom-up approach has several advantages over the platform-top-down approach. First, in the second approach, the resin is in direct contact with oxygen as it undergoes polymerization, whereas light-curing occurs at the bottom to avoid oxygen interference in the platform-bottom-up approach. Second, the

laser is located at the bottom, which reduces the potential for injury to the operators. Third, the resin can be refilled automatically owing to gravity. Therefore, most SLA printers currently introduce this technology.¹²

- **Fused Deposition Modelling.** FDM is one of the most popular and cheap 3D printing technologies in dentistry.¹³ The filamentous thermoplastic material is heated and melted by the nozzle. Under the control of the computer, the nozzle and worktable move in the X- and Y-axis directions, respectively, and the material in the molten state is extruded and finally solidified through the accumulation of materials layer-by-layer to form the product.¹⁴⁻¹⁶ 4 To create complex objects, support structures are required. The printing process takes between 30 min and 8 h, depending on the object's size. Material costs for a complete skull model are less than €5 (approximately US\$6). The dimensional error of the fabrication process by FDM in the field of dentistry varies between 0.22%¹⁷

and 3.76%¹⁸ depending on the type of printer.

Current and potential 3D printing applications in dentistry:

Use in surgical planning:

A surgeon's training and the pre-surgical planning process are critical for ensuring a successful surgical outcome. The planning process involves steps such as visualizing tissue anatomy, simulating the surgical process, selecting surgical equipment, and communicating the surgical plan to the patient. There is an increasing body of evidence that supports the use of 3D printed models to aid in pre surgical planning. For example, using 3D models for patients with tumours, has allowed surgeons to accurately plan the extent of resection by better visualizing surgical landmarks and tumour dimensions.¹⁹



Figure 3: Applications of 3D printing

Periodontics:

The technology also has potential applications in regenerating periodontal tissue. Specifically, it is possible to 3D print bioresorbable scaffolds that can facilitate bone and December 2021 tissue formation and regeneration.^{20 21} it is possible to adjust the properties of these materials by adding factors such as bone morphogenetic proteins (BMP-2 and BMP-7) that stimulate osteogenic differentiation to increase the integration of bone tissue into the printed scaffolds. This in turn allows for better cell adhesion, proliferation, and vascularization.²²

Orthodontics:

Early adopters of 3D printing technology in the field of orthodontics include Align Technology Inc. - a company that has taken advantage of the 3D printing process by introducing the world to its Invisalign brand of aligners. The system operates by using patients' dental scans to digitally realign their teeth. A series of aligners are then 3D printed and serve to gradually reposition patients' teeth.²³

Researchers have also conducted in-vitro studies exploring the possibility of 3D printed orthodontic brackets.²⁴⁻²⁵ Integrating 3D printing into their practices allows orthodontic offices to transition towards a digital lab workflow where tasks such as impression taking and pouring models are replaced by intraoral digital scans and printed models.²⁶

Prosthodontics:

3D printing has revolutionized the field of prosthodontics, offering innovative solutions for dental care.

1. Customized Dentures: With 3D Systems' Next Dent solution, dental labs and clinics can create customized dentures more efficiently. The Next Dent 5100 3D printer allows for rapid production, reducing treatment time and material waste. Patients benefit from quicker prosthodontic solutions and fewer office visits

2 High Precision Models: Accurate dental models are essential for treatment planning, especially in prosthodontics.

VisiJet M2R-TN is a 3D printing material that produces high-quality, stone-like models. These models replicate the patient's

oral anatomy with exceptional detail

3. Metal Printing for Removable Partial Dentures (RPDs):

RPDs are commonly used to replace missing teeth. Traditionally, these are cast in metal frameworks.

Direct metal printing (using machines like DMP) allows for the direct fabrication of metal RPDs through 3D printing. Researchers have also attempted to use 3D printing to create tooth restorations such as crowns. An in-vitro study found that the 3D printed crowns were more accurate and showed more consistent results - with regards to fit - in the proximal, marginal, and internal regions than crowns fabricated using the moulding and milling methods.

Dental education:

Study results show that the models would be useful for integration into the medical school curriculum. It is thus not difficult to see that 3D models may be useful in the field of dentistry. In fact, some dental schools are starting to replace typodont teeth with 3D printed tooth models. Unlike typodont models, which have ideal anatomies, the 3D printed tooth models are based on digital scans of extracted teeth with more realistic anatomical root canal structure. Integrating

3D-printed models into dental education equips students with practical skills, boosts confidence, and prepares them for the complexities of clinical practice.

The future of 3 D printing:

From developing new printing materials to techniques, research continues to push the boundaries of 3D printing. Perhaps the most exciting of these advancements is 4D printing, which involves 3D printed objects composed of materials that possess a self-deformation property. This deformation property allows the printed objects to transform over time by reacting to stimuli such as temperature and humidity.²⁸⁻²⁹ 4D printing adds a fourth dimension to the standard 3D printing process: motion over time.

Unlike static 3D objects, 4D-printed materials can change shape or function based on environmental conditions.

Conclusion

While 3D printing holds immense potential to transform dentistry, several challenges remain. Optimization of 3D printers, enhancing printing resolution, and accuracy are critical areas. Additionally, post-processing steps often accompany 3D-

printed products, impacting workflow efficiency and costs. Research efforts should focus on streamlining post-processing to further optimize manufacturing. Rigorous in-vitro and in-vivo studies are essential before widespread clinical adoption. Lastly, establishing regulatory standards for 3D-printed dental products is crucial for safe and effective use.

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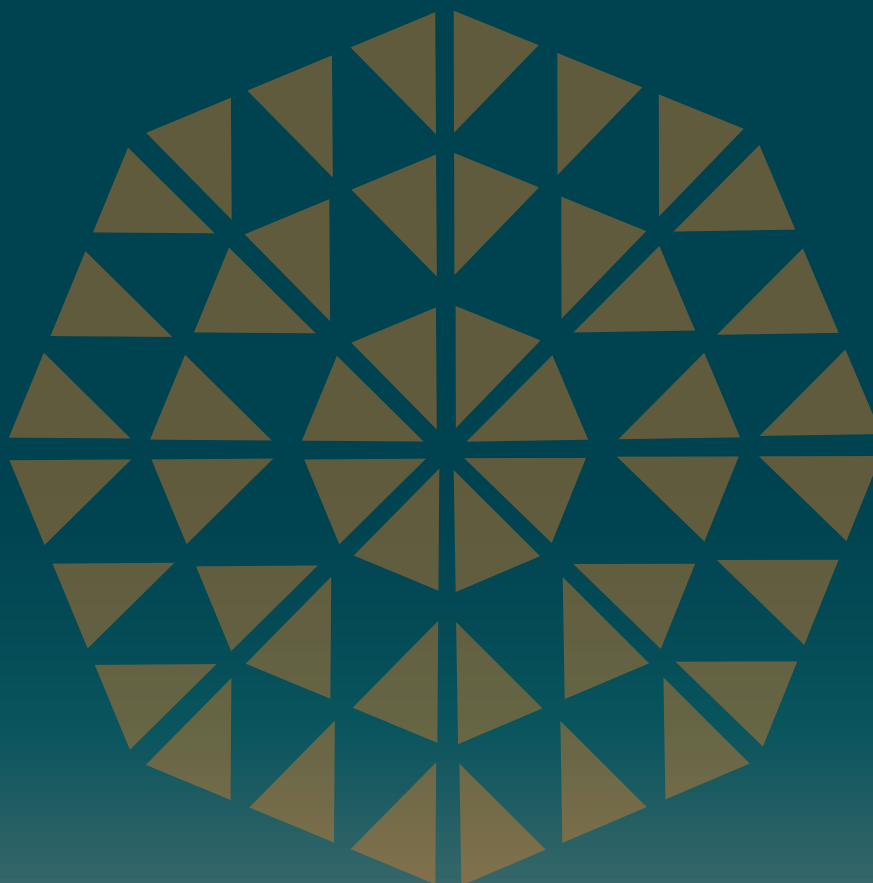
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