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Editorial

From The Desk of Guest Editor.....

Bridging the Gap : The Rising Public Health Implications of the Periodontal-Systemic Link

Heal Talk A Journal of Clinical Dentistry. (2025). Bridging the Gap : The Rising Public Health Implications of the Periodontal-Systemic Link. In Heal Talk A Journal of Clinical Dentistry (Vol. 17, Number 3, p. IV–V). Zenodo. https://doi.org/10.5281/zenodo.14890862

In recent decades, the understanding of the relation-ship between oral health and systemic well-being has evolved significantly. Periodontal Disease, once considered a localized issue (affecting only the gums and teeth), is now recognized as potentially influencing a variety of systemic conditions. This connection, known as the periodontal-systemic link, has become a topic of increasing research, clinical focus, and public health concern. The emerging evidence underscores the crit-ical need to view oral health not as a standalone concern but as a significant determinant of overall health.

Understanding the Link

Periodontal disease, commonly known as gum disease, refers to infections that affect the structures around the teeth, including the gums, periodontal ligament, cementum and bone. This condition is primarily caused by poor oral hygiene, which leads to the accumulation of bacteria, plaque and calculus. Periodontal disease begins with inflammation of the gingiva (Gingivitis), which if left untreated can progress to a more severe form, periodontitis, which can result in tooth loss and other health complications.

Over the past two decades, however, research has suggested that the consequences of periodontal disease extend far beyond the mouth. Inflammation, which is the hallmark of gingival disease, can spill over into the bloodstream, affecting other organs and tissues. This creates a potential pathway through which oral bacteria and inflammatory mediators may contribute to the development or exacerbation of systemic diseases.

Among the most compelling connections between periodontal disease and systemic health are links to cardiovascular disease, diabetes, respiratory conditions, preterm births, and Alzheimer's disease. The mechanisms by which periodontal disease influences these conditions are the topics of present research, but they likely involve systemic inflammation, bacterial translocation, and the exacerbation of existing risk factors.

Cardiovascular Disease : The Heart of the Matter

One of the most researched and widely discussed links is between periodontal disease and cardiovascular disease (CVD). Studies have shown that individuals with periodontitis are at a higher risk of developing atherosclerosis (plaque build-up in the arteries), heart attack, and stroke. The inflammation and bacterial invasion that characterize periodontal disease may contribute to the formation of arterial plaques, making the cardiovascular system more vulnerable to damage. Moreover, some oral bacteria have been detected in atherosclerotic plaques, reinforcing the theory that the oral microbiome plays a direct role in heart health (D'Aiuto F et al., 2013; Preshaw PM et al., 2012).

Although the exact causal mechanisms remain unclear, the correlation is strong enough to prompt calls for better integration of oral health into cardiovascular risk management. Regular dental check-ups, effective brushing and flossing, and periodontal disease management could serve as essential preventive measures for reducing cardiovascular disease risk (Harris M et al., 2009).

Diabetes : A Two-Way Street

The relationship between periodontal disease and diabetes is another crucial area of concern. Individuals with diabetes, particularly those with poorly controlled blood sugar levels, are more susceptible to gum disease due to the weakened immune response and reduced blood circulation that characterize the condition. Conversely, research has also demonstrated that periodontal disease can worsen glycemic control, making it more difficult for diabetics to maintain healthy blood sugar levels. This creates a vicious cycle, where each condition exacerbates the other.

Improving oral health in diabetic patients may lead to better blood sugar control, while proper diabetes management can help reduce the severity of gum disease (Seymour GJ et al., 2013; Borgnakke WS et al., 2013). As such, clinicians managing diabetes should include oral health in their care strategies, emphasizing the importance of routine dental visits, professional cleanings, and good oral hygiene practices.

Respiratory and Systemic Infections

Oral health is also linked to respiratory conditions, particularly pneumonia. The mouth is home to millions of bacteria, some of which can be aspirated into the lungs, leading to infections. This risk is heightened in individuals with poor oral hygiene or periodontal disease, as the inflammation and bacteria from the gums can spread through the respiratory system, contributing to conditions such as pneumonia, chronic obstructive pulmonary disease (COPD), and even exacerbations of asthma (Scannapieco FA et al., 2001; El-Solh AA et al., 2008).

For individuals who are hospitalized or in long-term care facilities, maintaining oral hygiene becomes even more critical in reducing the risk of ventilator-associated pneumonia and other serious respiratory infections. Hospitals and care homes are increasingly recognizing the importance of oral health as part of broader infection control practices.

Preterm Births and Low Birth Weight

Pregnant women with periodontal disease may face an increased risk of adverse pregnancy outcomes, including preterm birth and low birth weight. Inflammation from periodontal disease can trigger systemic responses that negatively affect fetal development, and oral bacteria may enter the bloodstream, contributing to the premature rupture of membranes and other complications (Boggess &Madianos, 2002).

Given the potential risks, it is essential for healthcare providers to consider oral health as part of prenatal care. Pregnant women should be educated about the importance of maintaining healthy gums and teeth during pregnancy and encouraged to seek regular dental care to prevent and manage any existing periodontal disease (Xiong X et al., 2006).

Cognitive Decline and Alzheimer's Disease

Emerging evidence also suggests a link between oral health and cognitive function. Research indicates that people with periodontal disease may have a higher risk of developing Alzheimer's disease and other forms of dementia. Inflammation and oral bacteria have been found in the brains of patients with Alzheimer's, and some studies suggest that periodontitis could accelerate the progression of neurodegenerative diseases (Jiang Q et al., 2016; Kamer AR et al., 2015).

While this area of research is still in its infancy, the findings point to the need for further investigation into how oral health influences brain health. Early intervention and management of periodontal disease could potentially reduce the risk of cognitive decline in older adults.

Public Health Implications

The growing recognition of the periodontal-systemic link calls for a broader, more integrated approach to healthcare. Dentists, physicians, and other healthcare providers must collaborate to ensure that oral health is not overlooked in the management of chronic conditions. Routine dental check-ups should become a standard part of healthcare for individuals with chronic diseases like heartdisease, diabetesand respiratory conditions, as well as pregnant women and the elderly.

Public health campaigns should emphasize the importance of good oral hygiene practices-such as regular brushing and flossing, avoiding tobacco, and eating a balanced diet-while highlighting the potential risks of periodontal disease beyond the mouth. Education efforts must target all of the at-risk populations.

Conclusion

The periodontal-systemic link is a compelling reminder that health is a holistic and interconnected experience. As science continues to uncover the far-reaching effects of periodontal disease on systemic health, it becomes clear that oral hygiene should be viewed not just as an aesthetic or dental concern but as a critical component of overall health. By addressing oral health proactively, we have an opportunity to reduce the burden of systemic diseases, improve quality of life, and promote longevity. The time has come to break down the silos between oral and systemic health and embrace a more integrated approach to healthcare-one that recognizes the profound impact of the mouth on the body as a whole.

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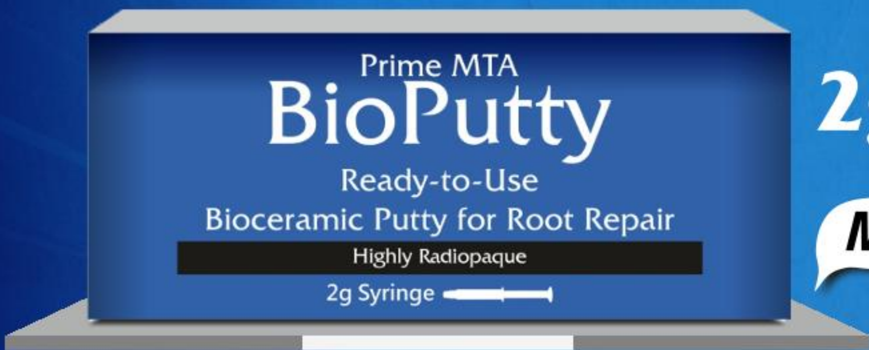

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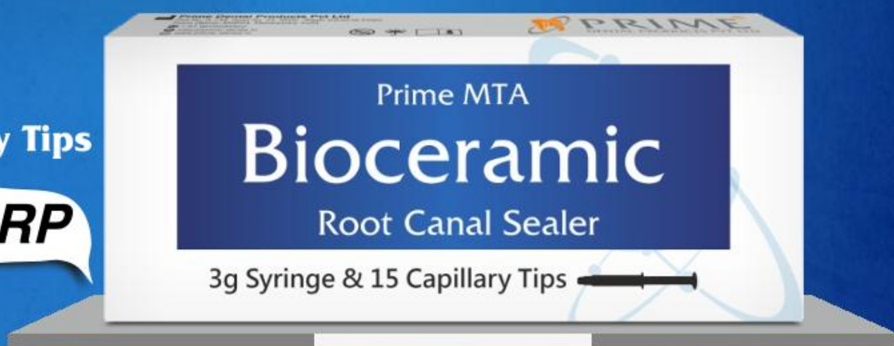

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Oral Max Talk

Via Weber Ferguson Approach Subtotal Maxillectomy Performed

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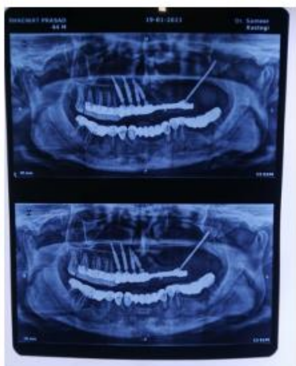
Patient admitted to Anand Hospital with a diagnosis of Mucormycosis of left maxilla, extending to left infra temporal region, involving the buccal pad of fat area, so operated for left partial Maxillectomy via Weber Ferguson Approach by Senior Maxillofacial Surgeon **Dr Puneet Kalra**, Left Maxillary Sinus was debrided by Senior ENT Surgeon **Dr. Puneet Bhargava**, procedure was performed under General Anaesthesia under the supervision of Senior Anesthesiologist **Dr Sanjay Agarwal** and following this Patient received Amphotericin treatment for 21 days, and discharged uneventfully.

Post maxillectomy rehabilitation was performed after 8 months, via Zygomatic and Cortico-basal Implants under the supervision of Senior Implantologist **Dr Rahul Vaid & Dr Puneet Kalra**

Via Weber Ferguson Approach, Subtotal Maxillectomy Performed

Immediate Post -Op Picture



Via Cortico Basal Implants, Fixed Prosthesis Fabricated

Maxillectomy Defect Can Be Appreciated On Left Side

6 Month Post Dental Rehabilitation

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Consultant Maxillofacial Surgeon
Anand Hospital, Meerut

Dr. Puneet Bhargava
Senior Consultant ENT Surgeon
Anand Hospital, Meerut

Dr. Sanjay Agarwal
Senior Anesthesiologist
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Teacher of Corticobasal Implants
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Dental Lasers in Advancing Facial Aesthetics

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Abstract

Facial aesthetics have undergone significant advancements over the current years. The integration of lasers into facial aesthetics represents a remarkable advancement in the field. The diverse array of wavelengths caters to various skin concerns, providing dental practitioners with a versatile tool for personalized treatments. This article dwells into understanding the mechanism of action of various laser wavelengths commonly used in dentistyand its power to elevate facial aesthetics and fulfill the evolving demands of individuals seeking non-invasive solutions.

Keywords : Diode Lasers, Facial esthetics, Er:Yag, CO2 lasers

Introduction

In the dynamic landscape of facial aesthetics, lasers technology is emerging as a transformative and valuable tool, providing practitioners with effective solutions for a range of cosmetic concerns. Lasers have revolutionized various medical fields, and has become an important armamentarium in a dental office. In the realm of facial aesthetics, Dental Lasers play a pivotal role in achieving non-invasive skin rejuvenation. Understanding the different types of laser wavelengths, their mechanisms of action, indications, and associated advantages and disadvantages is crucial for practitioners seeking to enhance facial aesthetics.

Different Types of Wavelengths for Facial Esthetics

Lasers used in facial aesthetics encompass a range of wavelengths, each serving specific purposes. For better understanding we can classify them to:

- Ablative lasers like CO2 (10,600 nm) and Er:YAG (2,940 nm) are known for their efficacy in treating wrinkles and scars by removing layers of skin.
- Non-ablative lasers like Nd : YAG (1,064 nm) and diode lasers (405-980 nm) work by heating the tissue without causing visible damage, promoting collagen production and tightening.

Role of Lasers in Facial Aesthetics

Lasers contribute significantly to facial aesthetics by addressing a myriad of concerns. They can improve skin texture, reduce wrinkles, lighten pigmentation, and treat vascular lesions. Moreover, lasers are versatile tools, allowing customization based on the patient's specific needs and skin type.

Mechanism of action of various laser wavelengths on human skin

The mechanism of action of laser wavelengths on human skin varies depending on the specific characteristics of each wavelength. Here's a brief overview of how different laser wavelengths interact with the skin:

- **CO2 Laser (10,600 nm)**

Mechanism : CO2 lasers are ablative, meaning they vaporize tissue. The wavelength of 10,600 nm is highly absorbed by water molecules in the skin. When the laser is applied, it heats and vaporizes the water within the skin cells, causing controlled damage. This process leads to the removal of superficial layers of skin, stimulating collagen production and promoting skin renewal.

Er : YAG Laser (2,940 nm)

Mechanism : Similar to CO2 lasers, Er:YAG lasers are ablative and target water absorption. The 2,940 nm wavelength is

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specifically absorbed by water molecules, resulting in precise removal of thin skin layers. This controlled ablation triggers the body's natural healing response, leading to collagen remodeling and improved skin texture.

Nd:YAG Laser (1,064 nm)

Mechanism : Nd:YAG lasers are non-ablative and penetrate deeper into the skin. The 1,064 nm wavelength is less absorbed by melanin, making it suitable for various skin types. The laser energy is selectively absorbed by hemoglobin and water, heating the tissue without causing visible damage. This process stimulates collagen synthesis, promoting skin tightening and rejuvenation.

Diode Laser (405-980 nm)

Mechanism : Diode lasers, often used for hair removal and skin tightening, have variable wavelengths within the 800-980 nm range. The energy is absorbed by melanin in the hair follicles or targeted tissue, generating heat that damages the follicles or stimulates collagen production. Diode lasers are versatile and effective for different aesthetic applications.

Mechanism of Action in Skin Rejuvenation : The mechanism of laser-induced skin rejuvenation involves precise targe-ting of specific chromophores within the skin. The energy emitted by the laser is absorbed by these chromophores, leading to controlled thermal damage. This process stimulates collagen synthesis, elastin production, and cellular turnover, resulting in improved skin texture and tone.

Indications : Lasers find applications in various facial aesthetic concerns. They are commonly employed for treating fine lines, wrinkles, acne scars, pigmentation irregularities, and vascular lesions. Additionally, lasers can be used for overall skin resurfacing, imparting a youthful and refreshed appearance.

Procedure : The laser procedure for facial aesthetics typically begins with a thorough assessment of the patient's skin type, concerns, and medical history. After adequate preoperative preparations, the laser device is calibrated based on the desired outcomes. Local or topical anesthesia may be applied to enhance patient comfort. The laser wavelength is then systematically applied to the targeted areas, with the energy settings adjusted accordingly. Like traditional microneedling, the laser also stimulates new collagen formation and tightening of existing collagen to contribute to facial rejuvenation and improved elasticity, minimizing surface lines, wrinkles, and sagging and improving moisture and color of the skin. This therapy can be combined with PRP or PRF (Platelet rich plasma or Platelet rich Fibrin) to have additional benefits. Post-treatment care includes the application of soothing creams, sun protection, and adherence to specific guidelines to optimize healing.

Advantages : The advantages of using lasers in facial aesthetics are multifaceted. They offer precision, allowing practitioners to selectively target specific skin concerns. Non-invasiveness reduces downtime, making lasers an attractive option for individuals seeking minimal disruption to their daily lives. Additionally, the controlled thermal injury induced by lasers triggers collagen remodeling, contributing to long-lasting results.

Disadvantages : While lasers offer numerous benefits, they are not without limitations. Potential side effects include erythema, edema, and temporary pigmentation changes. Ablative lasers may involve a longer recovery period and carry a higher risk of complications. It's crucial for practitioners to carefully assess patient candidacy and educate them on the potential risks associated with laser treatments.

While lasers are versatile, their efficacy may vary based on the specific wavelength and parameters used. Careful patient selection, proper calibration of the laser, and adherence to recommended guidelines are crucial for optimizing outcomes and minimizing potential side effects.

As technology advances, ongoing research and innovations will further refine and expand the applications of diode lasers in enhancing facial aesthetics.

Conclusion

The mechanisms of action, indications, and procedural nuances contribute to the overall efficacy of laser-based skin rejuvenation. Understanding these mechanisms allows practitioners to choose the most appropriate laser for specific skin concerns and tailor treatments to individual patient needs. The interaction of laser wavelengths with human skin is a nuanced process that involves careful consideration of factors such as skin type, target chromophores, and treatment goals. While the advantages are evident in achieving desirable outcomes, it is imperative to acknowledge and manage the potential disadvantages. By staying abreast of emerging technologies and maintaining a patient-centric approach, practitioners can harness.

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Osseointegration In Implants - An Update

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Abstract

The process of bone-implant interface formation refers to osseointegration. Unlike natural dentition, the anchorage is formed directly by bone to implant contact, which can be appreciated microscopically. It occurs within 4-6 months and is mandatory for long term success of implant therapy. This review article hence, explores the discovery, mechanism, criteria for assessing the success of osseointegrated implants, among other things, in detail.

Keywords : Osseointegration, implants, bone-implant interface

Introduction

The last five decades have seen the evolution of implant therapy, making it the most probable option for replacement of missing teeth. The reason behind its popularity as a treatment modality for edentulous and partially edentulous patients is that not only does it provide biological and functional advantages, but also produces long term results as observed by various authors in a 10 year follow up period. *(Buser D et al., 2012 ,Degidi M et al., 2012 , Fischer K et al., 2012 , Gotfredsen K et al., 2012)[1]*

Professor P. I. Brånemark[1] from the University of Gothenburg (Sweden), who performed the first preclinical and clinical studies in the 1950s, is considered as the foremost pioneer of modern implant dentistry. Another pioneer in the field is **Professor Andre Schroeder**[1] from the University of Bern (Switzerland), who in the late 1960s,examined tissue integration of numerous implant materials and along with his team was the first to document bone-to-implant contact for titanium implants.

The word osseointegration consists of "os" the Latin word for "bone" and "integration" derived from the Latin words meaning 'the state of being combined into a complete whole.'

Concept development

Per- Ingvar Brånemark[2], conducted a study in the 1950s on microcirculation of rabbit bone and discovered that chambers made of metal titanium became permanently anchored in bone. The bone became so infused with metal that the two couldn't be separated withhold fracture. Hence the concept was introduced. The term "osseointegration" was proposed by him in 1976 to describe this stable fixation between bone and titanium.

Definition

Brånemark defined it "as a direct contact between the bone and metallic implants, without interposed soft tissue layers" (1969). Later it was altered to "a direct structural and functional connection between ordered, living bone and the surface of a load carrying implant"[3]

Dorland's illustrated Medical Dictionary 28th Edition[4] : "Os-seo-in-te-gra-tion is direct anchorage of an implant by the formation of bony tissue around the implant without the growth of fibrous tissue at the bone-implant interface."

"Contact established without interposition of non-bone tissue between normal remodeled bone and an implant entailing a sustained transfer and distribution of load from the implant to and within the bone tissue." - American Academy of Implant Dentistry (1986)[5]

"The apparent direct attachment or connection of osseous tissue to an inert, alloplastic material without intervening

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connective tissue." -G.P.T. 8[6]

Mechanism of Osseointegration

It consists of[7]

A. Wound healingpost surgical placement of implants depending on presence of adequate cells, adequate nutrition and stimulus for bone repair

B. Inflammatory phase comprises vascular events wherein platelets after coming in contact with synthetic surface releases serotonin and histamine leading to platelet aggregation and thrombosis. This is followed by cellular events wherein neutrophils peak during 3-4 days and by the end of the first week the inflammatory response becomes more specific and there is an increase in T cells, B cells and NK cells.

C. Proliferative phase consists of neovascularization. Local inflammatory cells create an area of relative hypoxia leading to differentiation of mesenchymal cells into fibroblasts, chondroblasts and osteoblasts. An extracellular matrix is laid down which converts into fibrocartilaginous callus and finally into bone callus, giving rise to woven bone.

D. Maturation phase is when concurrent to formation of fibrocartilaginous callus, woven bone is laid down on scaffold of necrotic bone in peri-implant space. Simultaneous resorption and deposition, results in complete bone remodelling.

Thus mechanism of osseointegration can be subdivided into three biologic phenomena as described by J.E. Davies (1998), they are

A. Osteoconduction

Wilson-Hench, has suggested that "osteoconduction is the process by which bone is directed so as to conform to a material's surface." Formation of bone on the implant surface is either done by the pre-existing pre osteoblasts/osteoblasts or through primitive mesenchymal cells via osteoinduction. (Frost HM (1989))[8]

Bone growth factors and a proper blood supply are necessary for bone formation. Simultaneous process of osteoconduction and osteoinduction leads to osseointegration. Only the cells which reach the implant surface and then differentiate will lead to de novo bone synthesis. This ceases their migration. Other migratory cells continue to secrete bone along the implant surface as and when they come in contact. This histologically appears as "spreading" of bone over the implant surface.

B. Osteogenesis (De novo bone formation) and bone bonding :

J.E. Davies et al (1996)[9] described the cascade of new bone formation in four different stages.

Stage 1 : The differentiating osteogenic cells initially secrete collagen free organ matrix with two non-collagen proteins osteopontin and bone sialoprotein.

Stage 2 : The organic matrix provides a nucleation site for calcium phosphate mineralization. The nucleation will be found at the calcium binding sites of one or both of the prot-eins of the organic matrix.

Stage 3 : Calcium phosphate crystal growth takes place after nucleation and concomitantly there will be initiation of collagen fibre assembly at the developing interface.

Stage 4 : Finally calcification of individual collagen fibrils and collagen compartments take place and they are sep-arated by a collagen free calcified tissue layer containing non collagen protein. This layer is 0.5 m thick and described by Davies (1998) as a cement line which was first described by a German histologist Von Ebner as 'Kittlinin or Cement lines', 123 years ago. This is the calcified interfacial matrix laid down between old and new bone.

C. Bone remodeling

The Stage of remodeling starts around 3rd month & becomes highly active for several weeks , then slows down again. It is of extreme importance for the long term stability of the transcortical plate of the endosseous implant, since cortical bone will necrose as a result of the surgical trauma to the tissue. As proposed by Forst, remodeling takes place as a discrete unit in both cortical and cancellous bone. Remodeling starts with osteoclastic resorption followed by lamellar bone deposition, so resorption and deposition of bone goes side by side to maintain the healthy skeletal mass.

Theories of bone-implant interface

Fibro-osseous integration

The American Academy of Implant Dentistry (1986)[5] defined fibrous integration as "tissue-to-implant contact with healthy dense collagenous tissue between the implant and bone". According to this theory the function portrayed by Sharpey's fibers in natural dentition, is fulfilled by collagen fibers between implant and bone surface. he difference between compression and tension of the connective tissue components results in a bioelectric current, and this current (a piezoelectric effect) induces differentiation into connective tissue components associated with bone maintenance.

Failure of theory : There was no real evidence to support the fact that the fibrous membrane present between the implant surface and bone, acted similarly to the periodontal ligament. Also, remodeling is not expected in fibrous integration as no forces are transmitted through the fibres. Absence of Sharpey's fibers at bone-implant interface leading to no transmission of load and hence no bone remodeling, is the primary reason this theory is not accepted currently.

Theory of Osseointegration

This theory was described as early as 1939 by Stroke, but gained recognition when documented by Braenmark in 1952. According to this theory the bone is formed in close contact to the immobile resting implant.

According to *Meffert et al (1987)*[7] osseointegration maybe categorized into :

1. **Adaptive osseointegration** is where osseous tissue approximates the implant surface without the presence of soft tissue interface, as observed at light microscopic level
2. **Biointegration** is where a direct biochemical bone contact is observed at electron microscopic level.

   It was observed that distribution of vertical and slightly inclined forces was achievzed with osseointegration. If it fails to occur or is lost due to some reason, a fibrous connective tissue forms around the implant. In such conditions, the organization process continues against the implant material, possibly resulting from chronic inflammation and granulation tissue formation & osseointegration will never occur (Albrektsson et al, 1983)[10]. A connective tissue interface may result due to premature loading of implant, too much pressure applied while placing the implant, overheating the bone during site

Osseointegration vs. Biointegration

According to *De Putter*[11] implant anchorage may be of the following types :

A. Mechanical anchorage

- Seen in metallic implants
- Generated by interfacial tension of surface undercuts
- Anchorage is purely physical
- Direct contact between bone and metal surface

B. Bioactive retention

- Aachieved when surface coated with bioactive material, such as hydroxyapatite
- Induces osteogenesis
- Physico chemical bond between metal surface and bone
- Similar to ankylosis

Implant Tissue Interface

Implant and Bone Interface[12]

- At the light microscopic level, close adaptation of regularly organized bone next to the implant surface can be observed.
- Parallel alignment of lamellae of the Haversian system can be seen at SEM level.
- Absence of connective tissue and dead space at interface.
- Amorphous coats of glycoproteins on implants, to which collagen fibres are arranged at right angles and partly embedded in, can be observed at the interface, at ultra microscopic levels
- Cells do not bind directly to foriegn materials, but attach via extracellular macromolecules. The glycoprotein layer is hence adsorbed on the implant surface by adhesive macromolecules like fibronectin, laminin, epinectin etc.
- Fibroblasts and other connective tissue cells contain a binding element known as integrin, through which they bond to the macromolecules.

Implant and connective tissue interface[12]

- The attachment between connective tissue and implant is similar to bone-implant interface, that is, arranged parallel to implant surface.
- The attachment is not as strong as that seen in natural dentition, but is strong enough to withstand occlusal forces and microbial invasions.

Implant and Epithelial Interface[12]

- Considered as biological sea
- Hemidesmosomes connect interface to plasma membranes of epithelial cells, making it closely similar to junctional epithelium.
- Sulcus depth for implants varies from 3-4 mm.

Factors Influencing Osseointegration

"There is a need to control these factors more or less simultaneously to achieve the desirable goal of a direct bone anchorage" (Albrektsson, 1983)

Implant biocompatibility

- Metals well covered with adherent, self-repairing and corrosion resistant oxide layers are well tolerated by bone. Eg. titanium, niobium.

A. Implant Design

- **Threaded implants -** Provide more surface area for stress distribution and better primary retention.[13]
- **V-shaped threads -** Transfer forces in angulated paths.
- Length - Longer the implant better the primary stability.
- **Diameter -** Wider the implant, ;esser the stress exerted on the crestal bone.
- Implant neck - providing micro threads helps maintain marginal bone.
- **Providing a Morse taper -** to reduce potential bacterial penetration atjunction.[14]
- **Platform switching -** Narrow diameter abutment over wide diameter implant, results in adequately dimensioned biological width, hence, reducing bone resorption.

B. Implant surface

- Related to degree of roughness and orientation of surface irregularities.
- Increased surface roughness ensures more bone on the implant leading to stronger anchorage.[15]

C. State of the host bed

- Bone quality helps predict the long term success of implants
- Misch[16] suggests "D1 and D2 bone densities show good stability and osseointegration compared to D3 and D4."
- Fugazzotto et al (1993)[17] documented that implants tend to fail more in D4 density bone as compared to D1, D2 or D3.

D. Surgical Considerations[18]

- Surgical technique opted should aim towards regenerative rather than reparative form of healing
- Sharp drills
- Appropriate cooling period to avoid necrosis of bone
- Slow drill speed with irrigation
- Use of moderate power at implant insertion.

E. Loading conditions[19]

- **Progressive or two stage loading :** According to Braenmark in order to attain osseointegration, loading of implant should be done post 3-6 months.
- **Immediate or one stage or non submerged loading** - here the implant is loaded with a provisional restoration immediately after placement or shortly thereafter.
- Fibrous integration may occur due to premature loading which may also result in loss of function.
- Methods of evaluation of osseointegration

Rigid fixation[7]

- Absence of observed clinical mobility
- Movement of < 73μ (clinically which appears as zero), is a sign of healthy implant.
- Checked with 2 rigid instruments applying a force labio lingually with a force of 500g
- Rated on a scale of 0-4 based on the criteria provided by Misch[16].
- It is a specific, but not a sensitive, clinical parameter to assess osseointegration. Presence of mobility represents a late sign of implant failure.

Clinical implant mobility scale.

Scale	Description
0	Absence of clinical mobility with 500 g in any direction
1	Slight detectable horizontal movement
2	Moderate visible horizontal mobility up to 0.5 mm
3	Severe horizontal movement greater than 0.5 mm
4	Visible moderate to severe horizontal and any visible vertical movement

Invasive Methods[7]

1. **Histological sections -** Considered gold standard. But due to its invasive procedure and ethical issues, other methods may be used.
2. Histomorphometric
3. Transmission electron microscopy
4. Pull out tests.
5. By using torque gauges

Non-invasive Methods[7]

1. **Percussion test -** Csseointegrated implant produces a ringing sound compared to a fibrous integrated implant which generates a dim sound
2. **Radiographic examination**
3. **Reverse torque test :** an unscrewing torque is applied and if the implant rotates, it is considered as a failure.
4. **Periotest**
5. **Resonance frequency analysis :** using vibration and structural analysis measures bone density and implant stability. The implant stability quotient (ISQ) varies between 40-80. Higher the value means higher the stability.

Evaluation of Success of Osseointegration

1. Schnitman and schulman 1979[20]
2. Cranin et al.1982[21]
3. McKinney et al.1984[22]
4. Albrektsson Success Criteria (1986)[23]
5. Smith D.E et al 1989[24]

Albrektsson Success Criteria (1986)

1. Clinically, implants should be immobile.
2. On radiographic examination, radiolucency should be absent.
3. Post loading, 0.2 mm vertical bone loss is admissible, after the first year.
4. There should be no signs of pain, inflammation or paresthesia.
5. Success rate : 85% - 5 years and 80% -10 years.

Factors responsible for failure of osseointegration

- Failures may occur due to "inadequacy of host tissue to establish or maintain osseointegration."[25]
- Esposito et al (1998)[26] defined "biological failures related to biological process, and mechanical failures related to fractures of components and prostheses."
- Koutsonikas (1998)[27] added the categories of "iatrogenic failure and failure due to patient adaptation."
- El Askaryet al (1999)[28] further defined failure as "ailing, failing, or failed implants."
- Factors responsible may be related to implants, patients local or systemic factors or due to the surgical technique or environmental conditions.[25]

Conclusion

Dental implants have paved the way for easy restoration of missing teeth and future advancements and technology should aim towards incorporating features ensuring osseointegration and hence achieving long term success of implants.

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Ozone - The Wonder Therapy In Dentistry - A Review

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Abstract

It's been over 10 years since Ozone has been introduced into the medical and dental fields for clinical application. The reason for its success and acceptance in the field is its multidimensional unique properties. Being non-invasive, painless and atraumatic makes it more promising and popular among all age groups, especially among the pediatric patients. The following review, hence, aims to highlight its application in various specializations of dentistry.

Keywords : O3, Dental application, oral cavity.

Introduction

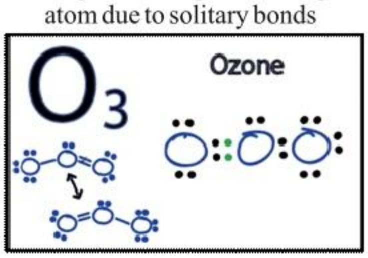
The Greek word 'ozein' gives birth to the word ozone, first used in 1840 by German chemist Christian Friedr-ich Schonbein "The father of ozone ther-apy."[1] The ozone layer in the stratosphere protects living org-anisms from the harmful UV rays. O3 has numerous uses in medical as well as dental fields. The first dentist to use O3 therapy in clinical practice was E.A.Fisch in the 1930s, for disinfection and wound healing after surgeries.[2]

Ozone therapy can be defined as, "a versatile bio-oxidative therapy in which oxygen/ozone is administered via gas or dissolved in water or oil base to obtain therapeutic benefits."[3]

Structure

It is composed of

- Triatomic particle of ozone
- An obtuse angle of 116 degrees between bonds
- Interior steric obstruction present which prevents formation of triangular structure[4]
- Negative charge all through ozone atom due to solitary bonds



Properties

- Achromatic gas
- Pervasive odour at room temperature
- Distinguishable even at amounts as low as 0.02-0.05 ppm
- Half life at 20 degrees C is 40 mins and at 0 degrees C it is 140 mins.[5]
- Antimicrobial
- Stimulates the immune system
- Pain relieving
- Detoxicating
- Biosynthetic

Ozone Production

Oxygen iotas existing naturally in air, consolidate under the impact of variables such as - UV rays, lightning electrical discharges, extreme physical tension on water etc.[6] For clinical use Ozone Generators are utilized for the same. Clinical evaluation oxygen is made to move through high voltage tubes with yields going from 4000 V to 14000 V. It takes a shot at one of the three standards:

- Ultraviolet light
- Corona release
- Cold plasma.[7]

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In dentistry, there are two generally utilized ozone units : the heal ozone and ozotop.[6]

Mechanism of Action

1. **Action against microbes :** O3 causes inactivation of infectious microorganisms by disrupting the bacterial cell envelope by oxidation of phospholipids and lipoproteins. It can cause cell envelope destruction at amounts as small as 0.1 ppm[8]. In fungi, it affects cell growth at various stages, budding cells being the target. The viral capsid is harmed in viruses, hence upsetting the reproductive cycle by blocking virus-to-cell contact by peroxidation[9]
2. **Activation of O2 metabolism**

   It stimulates

   - 2,3-diphosphoglycerate resulting in increased red blood cell glycolysis rate.
   - Production of ATP by activating Krebs Cycle
   - Oxidize cytochrome C
   - Reduction in NADH
   - Free radical scavengers and cell wall protectors.[10]
3. **Immunostimulant**

When administered at a concentration of between 30 and 55 µg/cc causes :

- ↑ production of interferons
- ↑ TNF and IL -2

Thereby launching many immunological reactions.[11]

Dental applications

1. **Ozone and oral pathogens**

   Microorganisms play an integral part in causing oral lesions and its elimination is a primary treatment moda-lity[12]. According to a study, an exposure of 60 seconds was effective against 99.9% cariogenic bacteria, though had a degrading effect on salivary proteins. Hence 10-30 seconds is considered sufficient for bactericidal activity.[13] Estrela et al.,[14] observed effectiveness of ozone as an adjunct to ultrasonic scaling against S.aureus and found it to be effective when compared to ultrasonic scaling alone. Certain studies[15,16] have observed reduction in microbial load after treatment with ozonated water, in vivo. Although

   Kshitishet al.[17] observed ozone's and chlorhexidine's antibacterial, antiviral and antifungal properties. They saw a 25% reduction in A.aand no effect against P.g or T.f. The antifungal properties were found to be significantly superior to chlorhexidine. But no effect against HSV-1 and 2, HCMV or EBV were observed.
2. **Ozone and oral cavity**

   O3 has numerous favourable applications on oral tissues such as remission of various mucosal alterations, enhanced wound healing and increased turnover rate of oral cells. In a study done by Huthet al.[18], biocompatibility of gaseous and aqueous forms of O3 was compared with established antimicrobials (chlorhexidine digluconate 2%, 0.2%; sodium hypochlorite- 5.25%, 2.25%; hydrogen peroxide 3%). They observed that O3 has antiseptic properties and that aqueous form is less cytotoxic than gaseous form and the other agents. Hence aqueous form fulfills the biological requirements which makes it eligible for use in the oral cavity. Filippi[19], studied the effect of ozonated water on wound healing in oral cavity and concluded that O3 accelerates the process, the maximum effect being in the first 2 days postoperatively.
3. **Ozone in treatment of dental caries**

   Owing to the antimicrobial properties of O3, it is highly effective against cariogenic bacteria. It also possesses the capability to oxidize pyruvic acid to acetate and carbon dioxide, thus lowering the capacity of cariogenic bacteria to initiate tooth destruction.

A. **Management of pit and fissure caries :** O3 application followed by application of remineralizing agents and sealants in deep pits and fissures has been observed to be an effective means to prevent pit and fissure caries. O3 aids in removing the smear layer, thereby exposing the underlying dentine which is then sealed using remineralizing agents. A study done by Huthet al.[20], concluded that in patients at high caries risk, showed improved results after ozone application over a period of 3 months.

B. **Management of root caries**

O3 used as an adjunct fluoride application, proper oral hygiene and less consumption of caries inducing carbohydrates, has been shown to be effective in preventing or arresting shallow non-cavitated root caries. Holmes J[21], has stated in his study that regular application of O3 for 40s is effective in arresting root caries, when used in combination with remineralizing products.

4. **Restorative dentistry**

   O3 can be used prior to application of etchant and sealant, as justified by multiple studies, observing its effect on dental materials. No changes in the physical properties of enamel or dentin were observed on application of O3.[22] Oxidation property of O3 can be utilized in the correction of crown discoloration of non vital teeth, when applied after placement of bleaching paste.[23]
5. **Endodontics**

   Owing to its antimicrobial property, O3 can be effectively used in endodontics, when delivered into the root canal in appropriate concentrations and time[6]. There is ample literature which supports the use of O3 in endodontics [24,25]. Ozonated oils can be used effectively to reduce the foul odor produced by infected teeth by applying it as an intracanal medicament. Whereas ozonated water can be used as an intracanal irrigant which aids in tissue regeneration and bone healing. When antimicrobial efficacy of O3 was compared to 2.5% NaOCL, it was found to be as good in disinfecting the root canal as NaOCL[26].
6. **Hypersensitive teeth**

   Hypersensitivity occurs due to wearing away of enamel and dentin as a result of abrasion, erosion or attrition. The property of ozone to remove smear layer on exposure for 40-60s, results in widening and unclogging of dentinal tubules, hence reducing pain instantly. Following O3z application, remineralizing agents when applied, are able to terminate sensitivity more effectively and for a longer period of time as compared to conventional methods, as fluoride and calcium ions are able to penetrate dentinal tubules better.

7. **Periodontics**
   - A study by Ebensbergeret al.,[27] states that avulsed teeth when irrigated with ozonated water for 2 min resulted in effective root surface decontamination without affecting periodontal cells.
   - Nagayoshiet al.,[28] studied the antimicrobial property of O3 on microbiota present in dental plaque and concluded that 4mL of ozonated water was highly effective in killing gram positive and negative bacteria and also C.albicans.
   - A study by Nagayoshiet al.,[29] compared 3 different concentrations of ozone water (0.5,2 and 4mg/ml) in time dependent inactivation of microbes causing periodontal diseases, caries and endodontic lesions, in cultures and biofilms. All 3 concentrations were effective against the microbes.
   - A study by Ramzyet al.,[30] studied the effect of 150ml of ozonated water in reduction of pocket depth, PI,GI and bacterial count in patients suffering from aggressive periodontitis. They achieved highly significant improvement.
8. **Oral medicine :** Owing to its healing properties, O3 has numerous applications in the treatment of various oral lesions such as aphthous ulcers, herpes labialis, mucositis due to chemotherapy or radiotherapy, oral lichen planus[31,32,33].
9. **Prosthodontics**

   O3 therapy benefits have also been tested on denture inhabiting microbes, focus being on C.albicans. It has also been suggested as a denture cleaner to prevent denture stomatitis[34].

   Karapetian el al.,[35] studied the effectiveness of O3 in treating peri implantitis comparing it to conventional and surgical methods. They concluded that the ozone treated group showed the most promising results.
10. **Oral Surgery**
    - Due to its acceleration in the wound healing process, O3 can be effectively applied in areas of extraction[36] and implant therapy, as it causes vasodilation, thus improving blood supply and rapid release of oxygen in the tissues.
    - In cases of chronic mandibular osteomyelitis, it aids in rapid healing owing to its accelerated normalization of nonspecific resistance and T-cellular immunity[37].
    - Due to its oxidation properties, O3 acts as an effective substitute for hyperbaric oxygen. Also ozone contacted microbes are better recognized and phagocytosed by PMN cells, granulocytes and the complement system[38].
    - In cases of treatment of TMJ arthrocentesis, O3 is an effective and conservative procedure.[39]
    - O3 may be used as a therapeutic treatment modality in cases of BRONJ.[40]
11. **Pedodontics**
    - The major area of concern in this specialization is of dental anxiety. O3 can be effectively used to combat this issue. A study done by Dahnhardt el al.,[41] treated carious lesions with O3 in children and found there was a reduction in dental anxiety upto 93%.
    - Trauma of the tooth is the most common finding. A high level of biocompatibility of aqueous ozone on human oral epithelial cells, gingival fibroblast cells, and periodontal cells has been observed.[18,27]
    - Avulsed tooth can also be reimplanted using O3 without any adverse effect on the tooth or supporting structures.
12. **Orthodontics**
    - Enamel opacity, visible white lesion following orthodontic treatment are common findings, which can be treated using O3 therapy. Ghobashyet al.,[42] studied the effects of ozonated olive oil gel as an adjunct to standard oral hygiene procedure in orthodontically treated patients and observed that significantly less decalcification was seen.
    - Orthodontic brackets pretreated by O3 have higher shear bond strength.[43]

Conclusion

O3 has a number of benefits and can be effectively used in all the specializations of dentistry. Its unique properties make it a choice of treatment modality for various age groups as well as different diseases.

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3D Printing In Dentistry : Revolutionizing Modern Oral Healthcare

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Abstract

3D printing has emerged as a groundbreaking technology in the field of dentistry, revolutionizing how dental professionals approach precision and customization. By transforming digital designs into tangible dental appliances, prosthetics, and surgical guides, 3D printing offers a new level of accuracy and personalization in dental care. This technology impacts various areas of dentistry, including prosthodontics, orthodontics, and implantology. It enables the creation of custom crowns, bridges, dentures, clear aligners, and surgical guides that fit patients' unique anatomical needs. The benefits of 3D printing are significant: it enhances the precision of dental treatments, reduces production time, and minimizes material waste. However, challenges such as material limitations, high initial costs, and the need for specialized skills and regulatory compliance remain. As 3D printing technology advances, its potential to further enhance dental care and patient outcomes continues to grow, marking a significant leap forward in the pursuit of precision in dentistry.

Keywords - 3- D Printing, stereolithography(SLA), digital light processing (DLP) , CAD/CAM .

Introduction

The advent of 3D printing, also known as additive manufacturing, has revolutionized various sectors, with dentistry being one of the most impacted fields. This cutting-edge technology allows for the precise creation of three-dimensional objects by adding material layer by layer based on a digital model. In dentistry, 3D printing facilitates the development of highly customized solutions, significantly enhancing the efficiency and accuracy of dental treatments while improving patient care. Historically, dental procedures involved time consuming and often uncomfortable techniques, with limited personalization in terms of dental devices such as crowns, bridges, and implants. However, 3D printing has reshaped this landscape by enabling the design and production of tailor-made dental appliances that fit patients' unique anatomical needs. This capability has led to faster turnaround times, reduced need for multiple visits, and improved overall treatment outcomes.

From the creation of highly detailed dental models to the fabrication of surgical guides and orthodontic aligners, 3D printing in dentistry encompasses a wide range of applications. The integration of this technology has not only improved the precision and customization of dental devices but has also opened doors for more advanced practices, including bioprinting and regenerative dental treatments. As 3D printing continues to evolve, it promises to further enhance the future of dentistry, making treatments more accessible, affordable, and patient-centric.By streamlining workflows, reducing material waste, and providing an enhanced patient experience, 3D printing is setting a new standard for the dental industry, fostering innovation, and transforming traditional practices into more effective and personalized solutions.[1]

Leveraging a computer model, three-dimensional printing permits us to create a three-dimensional object. 3D printing

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produces intricate shapes or geometries that would be impossible to manufacture using other technologies as compared to conventional subtractive manufacturing procedures. A number of industries have been adopting 3D printing technology to produce functioning prototypes as well as finished products for their specific applications in an economical and efficient way, since the advancements in precision, accuracy, and 3D printable materials. The development of 3D printing technology has also revolutionised the way clinical care is rendered in the fields of medicine and dentistry, presenting a number of applications that enhance therapeutic results.[2]

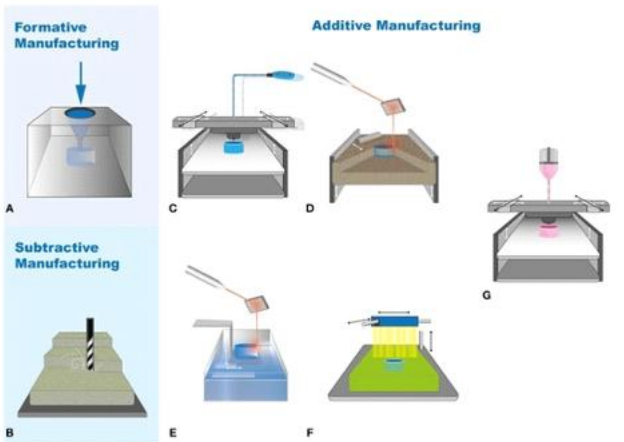

Figure 1. Overview on the different manufacturing approaches. Conventional approaches comprising (A) Formative, (B) Subtractive manufacturing; widely applied additive manufacturing methods including (C) Fused deposition modeling (FDM), (D) Selective laser sintering (SLS), (E) Stereolithography (SLA), (F) Polyjet and (G) Bioprinting.

Additive and subtractive manufacturing technologies are the two primary categories. 3D printing, a synonym for additive manufacturing technology, enables more specialised and adaptive uses than subtractive milling. In order to repair damaged tissues and to copy living tissues and organs for transplantation, researchers are investigating 3D bioprinting technology.[3] Dental workflows have undergone a paradigm shift as a result of some of these printing applications. Among the advances in technology that have contributed to this evolution are stereolithography (SLA) and digital light processing (DLP). Fused deposition modelling (FDM), selective laser sintering (SLS), selective laser melting (SLM), photopolymer jetting, power binder printing, and laser bioprinting are more 3D printing processes. However, the use of these 3D printing technologies in dentistry is limited due to a number of restrictions.[4]

Light-cured resin is the most widely used substance in 3D printing technology. The most significant influence on the development of useful dental 3D printing processes has come from resin curing techniques.[5] Four historical eras can be distinguished in the chronological evolution of curing processes.[5] In "The Early Years (2000–2010)," digital light processing (DLP) technology was first introduced. The technique of precise layer-by-layer printing was introduced using this technology.[6-7] High-resolution dental models came into focus in the second phase, "Advancements in Materials and Technologies (2011–2015)," which made use of the stereolithography (SLA) process.[8] The DLP 3D printer was introduced during the next phase, "Expansion of Applications (2016–2020)," which led to a greater variety of dental applications.[3]

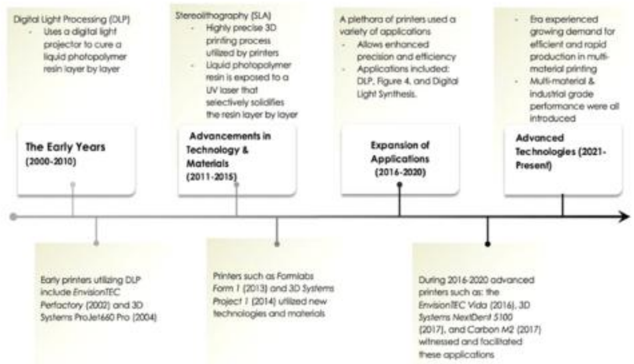

Figure 2. Historical Timeline of 3- D Printing

This paper will review the mechanisms of 3D printing technology and its applications in dentistry, including the development of printable dental materials. Additionally, an overview of the unique uses of 3D printing throughout various dental specialities will offer a comprehensive viewpoint on the technology's impact in the dental industry.

Methodology

A Literature Review were performed using theusing the Medline ,PubMed and Google Scholar databases with the following search keywords: “3D printing, digital light processing, stereolithography, digital dentistry, dental materials”, and combinations of the keywords.The reviewed articles were published between 2012 and 2023. For this review, only studies or review papers investigating 3D printing technology for dental or medical applications were included . Due to the nature of this review, no formal evidence-based quality assessment was performed, and the search was limited to the English language without further restrictions.

Advantages and Disadvantages of 3D Printing Technology

3- D Technology	**Advantages**	**Disadvantages**
1. Stereolithography (SLA)	Quick production speed Precise and highly accurate Can accommodate complex designs Numerous material options.	Production can be slower compared to other printers High post-processing requirements.
2. Digital light processing (DLP)	High speed Precise and highly accurate Can accommodate complex designs Numerous material options	Arguably lower quality than other printers Limited by voxel size.
1. Fused deposition modeling (FDM)	Cheaper technology Great layer bonding.	Only thermoplastic materials.
2. Selective laser sintering (SLS) and selective laser melting (SLM)	Can print polymers or metals Batch production No supports needed.	Requires high printing infrastructure Use of fine powders can he hazardous.
3. Photopolymer jetting	Extremely high resolution; Can print with multiple colors on one single print.	Low mechanical properties Limited heat resistance Costly maintenance of printer heads.
4. Powder binder printing	Wide range of unique materials High speed printing	Low mechanical properties Low resolution High waste of material.
5. 3D laser bio printing (LAB)	Only option to print living cells and other biomaterials Completely unique.	Costly Very specific conditions to produce viable biomaterials.

Applications of 3-D Printing In Dentistry

1. Prosthodontics

In prosthodontics, three-dimensional printing has long been an exceptionally valued technology. The fixed interim prosthesis is produced using direct as well as indirect techniques in the dental lab or office.[9] It may be manufactured manually, but the manual work's dependence on the worker's skill and several processing steps may serve as a weakness .On the other hand, processing error may be lowered because CAD/CAM systems are now accessible for prosthesis fabrication.[10] The use of 3D printers in dentistry is rapidly expanding, and different resins are used to create orthodontic models, surgical guides for implants, interim crowns, PFM (porcelain fused to metal) copings, and RPD (removable partial denture) frames. As a result, the production of prostheses utilising the 3D printing technique is steadily increasing.

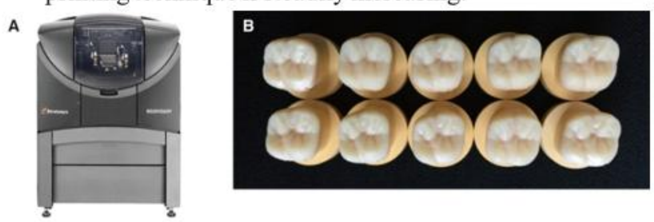

Figure 3. (A) 3D printing system (Stratasys), (B) Manufactured crown

Patients with severe gag reflex, tumour resection, temporomandibular joint disorders, or oral abnormalities may find the denture construction procedure difficult, despite the fact that denture materials and processes have advanced significantly.[11] The development of 3D printing and intraoral scanning technologies has made the process of fabricating dentures more patient-friendly and faster. In addition, it excludes conventional laboratory procedures, which may result in lesser errors and greater flexibility.[12]According to a recent in vitro investigation, RPD frameworks made using SLM printing fit better than those made using conventional lost-wax and metal casting methods.[13] Because 3D-printed frames offer more consistent contact pressure, residual ridge resorption may be less likely.More investigation and assessment of the prosthesis made using the 3D printing process are therefore necessary.[14] 3D-printing technology redefines the prosthesis fabricating procedures and also enhances patient care.

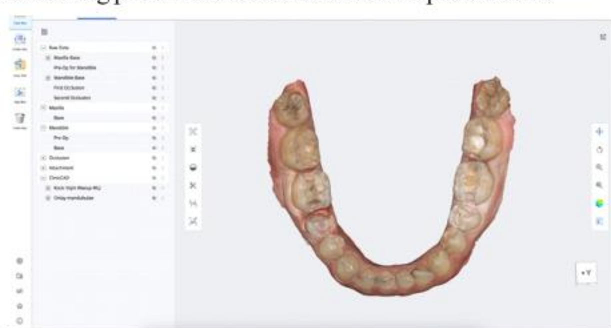

Figure 4. 3- D Printing In ProsthodonticsFor Inlay ,OnlayAnd Overlay

2. Orthodontics

In orthodontics nowadays, the main application of 3D printing technology is the creation of orthodontic aligners for the treatment of malocclusion. With better oral hygiene and aesthetics, removable, transparent aligners are an alternative to traditional orthodontic braces.In the past, aligners were made by a thermoforming process with thermoplastic materials, and 3D printing methods like SLA or FDM were only utilised for printing models.[15] However, the intraoral environment and the thermo forming process itself can change the material's characteristics, which ultimately impacts how effectively it performs.[16] Direct 3D-printed aligners have gained popularity recently because they provide a better fit, increased efficacy, and reproducibility without changing the material's characteristics.

In gnathology, three-dimensional printing technology is also used to treat temporomandibular joint disorders (TMDs). The kinematic tracing record is used to digitally plan the therapeutic position, and a 3D printer can be used to digitally design and produce customised intraoral appliances to improve the therapeutic position's precision.[17]

The American Society for Testing and Materials defines 3D printing as: “the creation of an object from 3D model data by adding layer upon layer, unlike subtractive manufacturing techniques".[18] The use of stereolithographic 3D printers in orthodontics has been documented for surgical guides, occlusal splints, retraction hooks, clear aligners, nasoalveolar moulding (NAM) devices, aligner attachments, removable appliances like activators, and craniofacial-dental tissue engineering.[19]

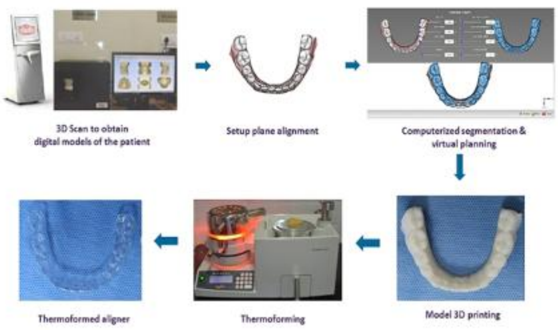

Figure 5. Integrated Manufacturing of Direct 3-D Printed Clear Aligners

3. Oral And Maxillofacial Surgery

In the field of oral and maxillofacial dentistry, additive manufacturing technology has been utilised for thirty years for the creation of models, diagnostics, surgery planning, surgical guide and template fabrication, and customised implant manufacture. Surgical guides and templates are created using the acquired CT picture and CAD software analysis of the maxillomandibular defect, much like 3D-printed surgical guides for implant surgery.[20] Using computer-aided design (CAD), a virtual three-dimensional model of the thing is created. Anatomy can be segmented to produce virtual 3D models (vectorial objects) using the virtual surgical planning (VSP) toolset. Advanced 3D analysis, planning, customised device design, finite element meshing, and 3D printing all begin with these models. In order to enable printing, the vectorial object is then exported as a Standard Triangle Language (STL) file. The printer receives instructions from the computer and builds the model piece by piece using a stack of extremely thin layers.[21]

For surgical assessment and planning in OMFS, cone-beam computed tomography (CBCT), 3D imaging software, and 3D printers are now crucial, improving treatment accuracy and dependability.

By improving fixation accuracy, restoring anatomic shapes, and lowering surgical morbidity, 3D printing has improved the results of maxillofacial injuries. However, cases of acute trauma are time-sensitive, and because of the short notice, using printed devices may not be appropriate. The amount of bone pieces, the degree of dislocation, and the site and direction of fractures can all be identified using virtual simulation. A number of models, guides, templates, and a predetermined fixing technique can be used to virtually minimise the broken bone segments prior to surgery and transfer the plans to the operating room. Grafts can also be proposed if any bone segments are lost.[22]

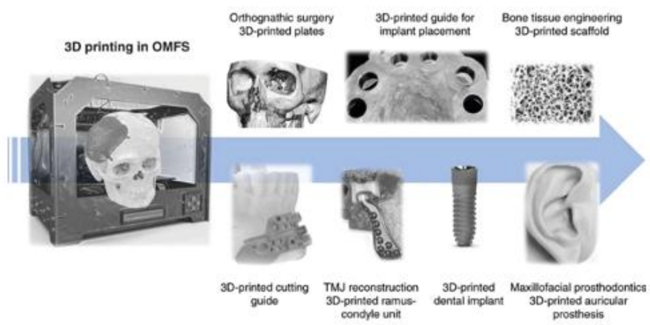

Figure 6.4 3D Printing in Oral Maxillofacial Surgery

4. Implantology

By optimising and streamlining surgical procedures with more accuracy and predictability, 3D printing technology is being used in implantology to lower surgical risks and increase efficiency. Many metal alloys can be printed to provide a variety of dental components, including superstructures, screws, abutments, and dental implant fixtures. The majority of metal parts are directly additively created using a variety of technologies, including SLS, SLM, EBM, and DMLS. The medical industry has embraced these promising technologies to create titanium and its alloys.Other technologies, including PolyJet printing and metal jetting, can indirectly produce metal through additive manufacturing. PBF primarily produces cobalt-chromium alloys for use as frameworks in dental implant superstructures.[23]

Through additive manufacturing, metal can be indirectly produced by other technologies, such as metal jetting and PolyJet printing. PBF's main product is cobalt-chromium alloys, which are used as frameworks in the superstructures of dental implants.The advent of advanced digital technology has led to the design of surgical guides using CAD software based on intraoral scans and cone beam computed tomography (CBCT), which are subsequently manufactured using a 3D printer. These 3D-printed surgical guides now have far higher accuracy attributable to this technology.[24]

Figure 7. 3D Printing Technology In Implant Dentistry

5. Periodontology

In periodontics, 3D printing can be used for guided gingivectomy and for the regeneration of both soft and hard tissues. The creation of 3D-printed scaffolds for the regeneration of both soft and hard tissues has been the subject of extensive investigation. The idea behind additive biomanufacturing with 3D printing technology is to provide a customised way to replace bone scarcity and resorbed periodontal tissue.

Custom scaffolds that can be loaded with stem cells and positioned precisely to allow for more intimate interaction with bone surfaces are made possible by three-dimensional printing. Compared to traditional scaffolds, these benefits may result in a better healing process and more aesthetically pleasing outcomes. Soft tissue regeneration is another application for 3D printing. For keratinised tissue augmentation, 3D-printed soft tissue grafts have recently been constructed.

An aesthetic gingivectomy surgical"guide' tailored to each patient can be created and produced with the aid of intraoral scanning and computer-aided design (CAD) software. Because of the surgical guide's accuracy, precision, and customisation, aesthetically pleasing outcomes can be obtained.[20]

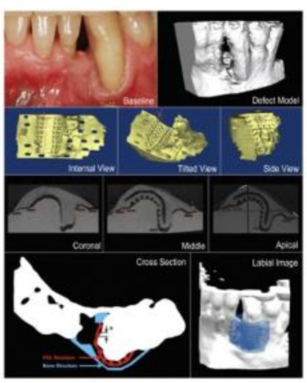

Figure 8. Use Of 3-D Printing As A Scaffold In Periodontology

6. Endodontics

3D printing technology has been used in endodontics for a number of procedures, such as autotransplantation, apicoectomy, access cavity preparation, teaching, and training. The great precision of guided cavity preparation with a 3D-printed access guide has been documented in numerous research.

Guided apicoectomy, endodontic microsurgery (EMS), requires a 3D-printed surgical guide to perform targeted osteotomy and root resection. As in other specialties, the surgical guide is designed and printed based on CBCT and CAD software. This application of 3D printing technology results in higher accuracy of osteotomies than the traditional freehand technique.[25] In addition, 3D-printed guides for apicoectomy allow for easier inspection of root apices, smaller osteotomies, lower risk of nerve or sinus perforation, better root-end preparation, better healing, and shorter surgical time .[20]

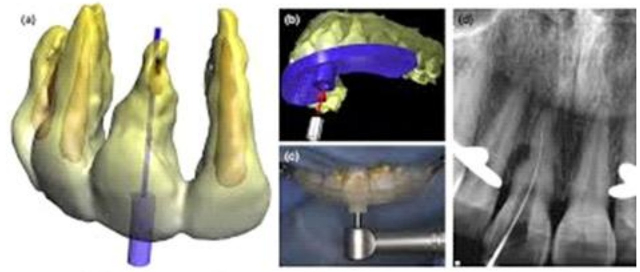

Figure 9. Endodontic Application of 3-D Printing

7. Oral And Maxillofacial Radiology

3D printing is experiencing significant growth in the teaching and learning process.

Anatomical structures, such as the periodontal ligament space, zygomatic process of the maxilla and intermaxillary suture, were represented. The use of 3D printed models is presented as an alternative to artificial commercial phantoms for the preclinical training of intraoral radiographic techniques through the combined benefits of superior radiographic projection quality, the possibility of model manipulation and an affordable price.[26]

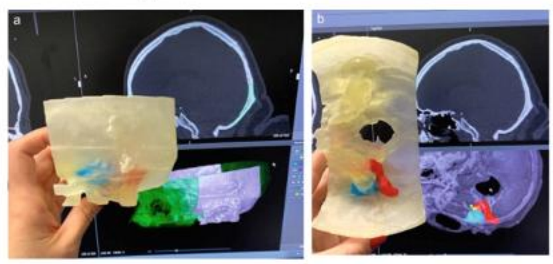

Figure 10. Advanced 3-D Model of Anatomic Structures In Oral Radiology

Future Directions

3D printing is becoming progressively more prevalent in the dental industry. 3D printing is rapidly taking the lead in the field of computer-aided manufacturing due to its increased precision, higher efficiency, and expanding accessibility. We may imagine a time when prostheses and even biomaterials can be infinitely tailored to meet the demands of patients as printing technology and printable materials continue to develop. There are currently initiatives undertaken to use 4D printing to the dental industry. react to outside stimuli like pressure, heat, light, or humidity to alter their shape or physical characteristics even after printing is finished.

The ability of 4D printing technology allows 3D-printed materials to change their shape over time in response to environmental stimuli like pressure, heat, light, or humidity. This allows the materials to change their physical qualities or form even after the printing process is finished. Applications might include printed biomaterials that conform to the precise shape of a complicated hard tissue defect or a restoration that, in reaction to temperature changes, expands and contracts in perfect harmony with the surrounding tooth structure. Depending on the directions in which the technology and materials evolve, 3D printing will continue to play a significant part in the dental field.[27]

Discussion

3D printing is currently widely used in dentistry and has the potential to provide a wide range of innovative and exciting procedures and methods for producing dental restorations. Although national regulatory agencies have not yet issued guidelines for the use of 3D printing in dentistry or surgery, they will eventually need to concentrate on this technology in order to establish suitable standards.[28] Ionita et al., 2014[29] stated that the printer with highest resolution that is commercially available is the polyjet printer , where the 3D model is created, one layer at a time, by the printer heads jetting layers of liquid photopolymer onto a build tray, followed by UV light curing. The advantages of polyjet printers are a wide choice of printing materials with varieties in density, hardness, flexibility, porosity, resolution as fine as 25 microns, fast printing process, and replication of complex geometries.

Murphy S. V et al ., 2014[30] concluded that with the ability to print cells into the required functional 3D complex, additive manufacturing has given the field of stem cell treatments a new face and is being used for regeneration and transplantation. Zhang et al., 2017[31] concluded in the studythat the technique of fusing cells with 3D-printed polymers to create 3D cell cultures for in vitro disease models or tissue engineering drug screening is growing increasingly popular in regenerative medicine .Revilla León et al., 2017[32] studies have shown that 3D printing can be successfully employed for metal implant prosthesis using selective laser melting and electron beam melting .

Tian Y et al , 2021[33] concluded in a recent study that crowns made using 3D printing fit less well than those made with the plaster model. This suggests that 3D printing technologies are new and untested, therefore processing 3D printed materials is still controversial. Di Fiore et al. 2020[34] compared pre- and post-ceramic firing edge gaps in 3D-printed Co-Cr frameworks and found that the edge gaps of post-ceramic firing were larger, however still lower than 120 μm within the clinically acceptable limit. Jang et al.2020[35] showed in the study that the accuracy of manufacturing fixed teeth on 3D printed models was lower than that of traditional plaster models; however, it was still sufficient for clinical research. Shah. P et al .2018[36] stated in the study that the paradigm shift from manual to digital workflow in endodontics has given rise to an unmatched streamlining of the procedure, greater precision and accuracy, ameliorating patient comfort, a breakthrough in regenerative endodontics and advancing the operator skills by training and education. Tregerman et al. 2019[37] found that when SLM Co-Cr alloy frames were compared with cast or milled RPD frames, the former is regarded as having improved organization and mechanical properties. Chatur-vedi et al. 2020[38] concluded in a study that 3D printing improved the coordination of the proximal end, edge, and interior of the temporary crown, and the effect is obvious in the occlusal area.

Conclusion

The emergence and revolutionary advancement of 3D printing technologies create favourable conditions for the production of sophisticated machinery in a variety of industries. 3D printing has several uses in the dental industry, enabling the development of innovative and more effective processes for producing dental products. Creating functioning models for diagnosis and surgery is the most significant use, followed by a range of implantable devices that can assist dentists in offering patients less invasive, more predictable, and more affordable procedures.With the ability to create complex geometric shapes and precisely meet the intricate and individualised needs in the dental field, 3D printing can employ a growing variety of material types and rely on digital data for products with intricate structures, fine structures, and drawbacks to using mechanical processing technology. High material utilisation and the ability to create intricate geometric patterns are two benefits of using 3D printing technology and CAD software that is based on 3D imaging and modelling.

3D printing has a great deal of educational potential in all of the main dental specialities. Compared to the stereotypical acrylic or typodont models, it provides the surgeon with a more subjective view of the bone and teeth. The freedom to modify the physical properties of additively created materials, along with technological and material advancements, gives trainees the chance to improve their operative and proprioceptive skills.Overall, 3D printing-based technologies have a tremendous potential to transform research, treatment methodology, and educational streams of dentistry ameliorating oral health care.

Source of Funding

None

Conflict Of Interest

None

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AI in Oral and Maxillofacial Surgery : A Review

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Abstract

The remarkable speed with which computer science has advanced over the last two decades, in recent decades, intelligent machines and computer programs have been developed and implemented with the ability to evaluate data and execute cognitive processes similar to those of human logic and reasoning, such as problem solving and decision making. In recent years, translational use of artificial intelligence in the field of medicine have attracted much interest. a subset of machine learning that has shown to be the most effective when applied to image processing and has been tested as a powerful diagnostic support tool through automated analysis of radiographic/photographic images, as well as potential future applications of artificial intelligence in the field of oral and maxillofacial surgery. The purpose of this study is to look at recent dental research that has studied at machine learning. We examine the current issues and solutions in the clinical use of machine learning in maxillofacial cysts and tumors, maxillofacial defect reconstruction, orthognathic surgery, dental implant, TMJ internal derangements, and mandibular canal detection in this study.

Keywords : Artficial Intelligence, Machine Learning, maxillofacial cysts and tumors, orthognathic surgery.

Introduction

In recent years, the use of deep machine learning, an artificial intelligence branch, has been a rising subject of interest in prognostic medicine. Deep machine learning has been employed to assess imaging and build models aiding doctors in making better decisions to enhance patient outcomes. Artificial intelligence (AI) and deep learning have tremendous potential in medicine and oral-maxillofacial surgery. The clinical use of AI in diagnostic and prognostic prediction may alter standard of care, much as current medical imaging transformed how clinicians see anatomy and disease[1].

Many important anatomical components such as the maxillofacial bone, parotid gland, facial nerve, and major vessels are found in the oral and maxillofacial region. To comprehend the 3D spatial relationships among these anatomical components, doctors regularly perform CT, MRI, and other radiological tests. Rapid expansion in the amount and complexity of medical imaging data is unavoidable, resulting in increased stress for physicians. The clinical application of AI in diagnostic and prognostic predictability may alter standard of care, just as current medical imaging transformed how doctors see anatomy and pathology1. Today, AI is employed to detect malignant tumors of the tongue, assess facial attractiveness for cosmetic surgery, and identify mandibular canal involvement in dentoalveolar surgery[2].

Even though these technologies have the potential to reduce variation in medical care and reduce medical errors, they are still to be shown in practice.

In terms of present AI uses in surgery, it is reasonable to predict that surgeons and AI will collaborate closely in the near future. In the case of orthognathic surgery, it's interesting considering how AI could help humans develop treatment plans and what its limitations are[3].

As a result, it is critical for surgeons to acquire a basic understanding of AI in order

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to comprehend how it may effect healthcare and to evaluate how they might interact with this technology. Introduction to artificial intelligence by highlighting four main subtypes, 1) machine learning, 2) natural language processing, 3) artificial neural networks, and 4) computer vision – as well as its limitations and future implications for surgeons.

Machine Learning (ML)

Machine learning systems are self-improving and learning programmes that can evaluate medical results automatically and present them with a probabilistic degree of accuracy. ML algorithms can make decisions using the following algorithms and methods: supervised learning, unsupervised learning, semi-supervised learning, and reinforced learning[4-5].

Natural Language Processing (NLP)

Speech recognition and language assessment using various approaches are referred to as NLP. This technology is effective for clinical decision trials, supporting and analysing unstructured data. It is also utilized for automated coding and maintaining patient clinical documentation[6].

Artificial Neural Networks (ANN)

Artificial Neural Networks (ANNs) draw inspiration from the human brain's neural structure, employing backpropagation and layers, including input, hidden, and output layers, to function.The best weight corresponding to bond strength in human brain neuron ensures that the optimal path is procured through ANN by training it with vast quantities of data[7].

Computer Vision

Computer vision refers to a machine's ability to comprehend photos and videos, and recent developments have allowed robots to achieve human-level capabilities in areas like object and scene recognition. 24 Image acquisition and interpretation in axial imaging, as well as computer-aided diagnostics, image-guided surgery, and virtual colonoscopy, are all examples of important healthcare-related computer vision work. 25 Initially motivated by statistical signal processing, the discipline has recently transitioned toward more data-intensive ML techniques, such as neural networks26, with adaptation into new applications8.

Implementation AI in oral and maxillofacial surgery

1.Mandibular canal detection

The IAN's position is critical for implant placement, third molar extraction, and a variety of other craniofacial operations, including orthognathic surgery. Any injury to the IAN might cause numbness and discomfort in individuals. The mandibular canal plays a crucial role in diagnosing vascular and neurogenic disorders related to the nerve, detecting lesions nearby, and planning oral and maxillofacial procedures. Gloria Hyunjung Kwa et al. in 2020 conducted a study, as preliminary research for a dental segmentation automation tool, he used work-in-progress automation software to conduct experiments with models based on 2D SegNet, 2D and 3D U-Nets. In comparison to earlier U-Net variations, the 2D U-Net with neighbouring photos has a worldwide accuracy of 0.82. The worldwide accuracy of the 2D SegNet was 0.96, and the global accuracy of the 3D U-Net was 0.99. Through deep learning, the automatic canal detection technology will help dentists plan more efficient treatments and reduce patient discomfort. The authors anticipate that automated and accurate detection of the mandibular canal by dental imaging software using deep learning, a topic for future research, will greatly enhance clinical diagnosis and treatment planning.This research might be seen as a preliminary report to inspire a new possibility to use deep learning to separate tiny and complicated structures using CBCT pictures9

The figure from Gloria Hyunjung Kwak et al. (2020) illustrates the segmentation outcomes for an image slice of the 2nd molar using various models. The first image (A) presents the ground truth mask, which serves as the reference standard for accurate segmentation. The second image (B) shows the segmentation result generated by a 2D SegNet model, highlighting its approach to delineating the molar structures. Following this, the third image (C) displays the segmentation result from a 2D U-Net model, known for its encoder-decoder architecture that aims to capture fine details and spatial context. Lastly, the fourth image (D) depicts the segmentation result from a 3D U-Net model, which extends the U-Net architecture to three dimensions, thereby leveraging volumetric information to potentially enhance segmentation accuracy and continuity across image slices. Each model's segmentation performance can be visually compared to assess their respective strengths and weaknesses in accurately identifying and delineating the molar structure[9].

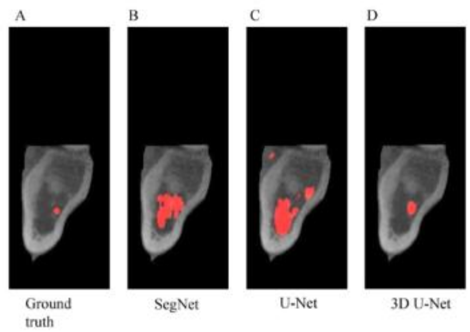


Figure 1: Displays the segmentation outcomes for an image slice featuring the 2nd molar. From left to right, the figure includes: (A) the ground truth mask; (B) the segmentation result from a 2D SegNet model; (C) the segmentation result from a 2D U-Net model; and (D) the segmentation result from a 3D U-Net model.

2. Temporomandibular Internal Derangements

Internal derangements of the temporomandibular joint (TMJ) have historically posed diagnostic challenges, making them a suitable candidate for assessing the effectiveness of artificial neural networks in subgroup diagnosis. Burcu Bas et al. trained neural networks to perform the job using the clinical symptoms and eventual diagnoses of hundreds of similar derangements. The findings convincingly demonstrated the utility of these networks. ANN found eight examples that were clinically normal on both sides. The sensitivity and specificity of ANN were 80 percent and 95 percent, respectively, for detecting unilateral anterior disc displacement with reduction (ADDwR; clicking). ANN has a sensitivity and specificity of 69 percent and 91 percent, respectively, in identifying unilateral anterior disc displacement without reduction (ADDwoR; locking). ANN had a sensitivity of 37% and a specificity of 100% in identifying bilateral ADDwoR. ANN has 100% sensitivity and 89 percent specificity in identifying bilateral ADDwR. The sensitivity and specificity of ANN were 44 percent and 93 percent, respectively, in recognizing instances of ADDwR on one side and ADDwoR on the other side. The use of artificial neural networks (ANNs) to diagnose TMJ ID subtypes might be a beneficial complementary diagnostic approach, especially for dentists. It is advised that more research be conducted, including complex network models that integrate clinical data and radiographic images[10]

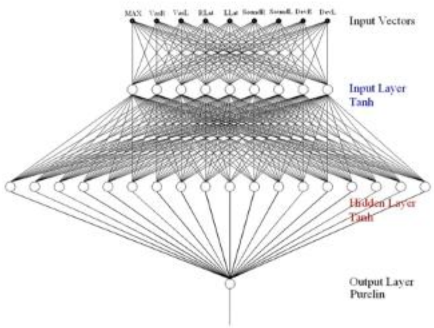


Figure 2 : This figure shows the structure of a feed-forward, back-propagation artificial neural network. The labels indicate various inputs and outputs related to jaw movement and joint conditions: DevL and DevR represent deviations to the left and right sides, respectively; LLat and RLat refer to left and right lateral movements; MaX denotes maximal mouth opening; Purelin indicates a purely linear value; SoundL and SoundR signify the presence or absence of clicking sounds in the left and right joints; Tanh stands for the tangent sigmoid function; and VasL and VasR represent the visual analog scale values for the left and right temporomandibular joints.

Figure 2 illustrates an artificial neural network (ANN) designed with three layers: an input layer, a hidden layer, and an output layer. The input layer has 9 neurons, each corresponding to one of the 9 inputs the network needs to classify. The hidden layer contains 18 neurons, which process the information received from the input layer. Finally, the output layer has a single neuron, which provides the final classification decision based on the processed input. This specific architecture was chosen because it is capable of approximating any function, even if the function has a finite number of abrupt changes or discontinuities. This means the network can learn and model complex relationships within the data with high precision. The network was used to make 9 distinct decisions, each corresponding to one of the 9 inputs, effectively classifying them based on the learned patterns and relationships[10].

3. Malignant Tumors

As the past due-degree ailment has poor analysis, early detection is important in Oral Cancer patients. The records acquired from cytology photos, fluorescent snap shots, CT snap shots, and depth of invasion may be utilized in AI studying gear, and OC may be recognized speedy with greater accuracy. From our amassed listing of articles, 6 articles suggested the utility of AI-based automated models for diagnosing Oral Cancer. Multiple studies have achieved early-stage detection of oral cancer, which can originate from various sub-sites in the oral cavity like the tongue and buccal mucosa. This heterogeneity of oral malignant increase makes it difficult to be analyzed.

Sunny et al. carried out a study by using Artificial neural networks for early detection of Oral Cancer, using tele cytology (TC), that's digitization of the cytology slides11. The efficacy of AI was as compare with traditional cytology and histology; eleven,981 prepossessed pix have been loaded for AI analysis, primarily based on the hazard stratification version. outcomes showed an accuracy of 80–84% in diagnosis. The ANN-Implied version showed improved malignant detection accuracy to ninety three percent and a potentially malignant lesion to seventy three percent. The study employed a less invasive brush biopsy method for pattern collection, which should also be considered when detecting cancer.

details the workflow for using image processing and a neural network (ANN) to automate diagnosis. The process begins with the complete workflow (a), which outlines the system used to analyze tele-cytology images. In this system, cells are first extracted from the images and then processed by a neural network. The network aggregates the data from all the cells of a patient to develop a risk stratification model, which helps in assessing the patient's condition.

The pre-processing steps (b) are crucial for preparing the images for analysis. This involves several stages: first, the Field of View (FOV) is extracted from the tele-cytology images to focus on the relevant areas. Next, cellular masses that contrast with the background are identified. Connected Regions of Interest (ROIs) are then separated, and any artifacts outside these ROIs are removed. Finally, cell ROIs are isolated to ensure that only relevant data is used for analysis.

The graph (c) provides insights into the performance of the ANN during its training phase. It shows the validation accuracy of the network over 4,000 training epochs, reflecting how well the model learned to process and classify the data from the images. This training accuracy is a key indicator of the system's effectiveness in diagnosing based on the processed images.

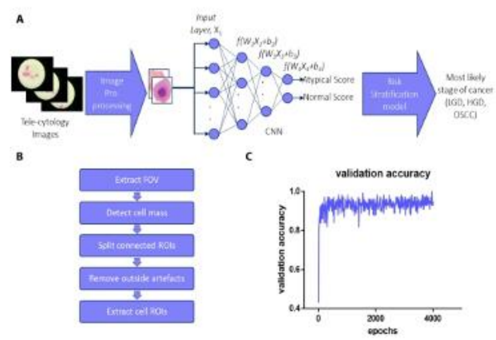


Figure 3 : Outlines the process of using image processing and a neural network (ANN) for diagnosis. First, cells are extracted from images and analyzed by the neural network to create a risk model. The pre-processing steps include cropping the images, finding and isolating cell regions, and removing unwanted artifacts. The graph shows how accurate the ANN was during training over 4,000 cycles.

Jeyaraj et al. conducted a study wherein Oral Cancer was identified based totally on a regression-based deep-studying algorithm for the characterization of oral malignant growth[12]. A CNN-based deep learning algorithm was developed for a computer-aided oral cancer detection device, and it analyzed 100 hyperspectral images (HIS). The study observed a 91.4% sensitivity in detecting cancerous lesions using a regression-based algorithm, comparing the results to a traditional algorithm with the same images.The excellence of diagnosis was advanced for the proposed version of the algorithm, as compared to the conventional

4. Maxillofacial cysts and benign tumors

There is a need for precise computer-assisted diagnostic techniques to relieve clinicians effort and potentially lower the price of various expert diagnostic opinions[13].

The majority of research on odontogenic cyst classification has been based on histological characteristics and other clinical considerations[14].

Li et al. quantified PCNA+ cells in odonotogenic keratocysts and radicular cysts using image analytic techniques[15].

Using a semi-automated image processing method, Landini segmented H&E stained histopathology pictures of odontogenic keratocysts and radicular cysts into theoretical cell areas to derive various morphometric characteristics of individual cells that have been shown to be effective in identifying radicular cysts from odontogenic keratocysts (accurate classification 95% of the time), although not keratocyst subtypes (60 percent accurate classification)[16].

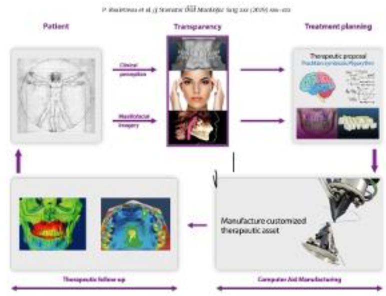
Han et al. compared two types of odontogenic keratocysts and radicular cysts, using a cascade of Haar classifiers[17]. They reported similar categorization rates to that of Landini's earlier trial, i.e. 100 percent for recognizing the difference between keratocysts and radicular cysts and 60 percent for the difference between the two forms of keratocysts.

5. Orthognathic Surgery

Preparing patients for orthognathic operations can be a time-consuming process that involves both clinical and laboratory investigations. The classic procedures necessitate the creation of acrylic splints that surgeons utilize as intraoperative guidance. This is prone to errors due to dimensional changes in the materials utilized as a result of intrinsic qualities or may fracture as a result of pressure. Woo et al.[18] designed a set of surgical robotic arms that transported data from the virtual screen to the operating room. The robotic arm was created largely to help the surgeons during the surgery. The arm of the robot could undergo movements at 6 degrees. On-screen movements that focused on a single spot were called tool centre points. The axis movements were performed around a virtual replica of the maxillomandibular complex. Overall, the jawbone movements were extremely precise and predictable.

During repositioning of the segments, mandibular operations are frequently linked with movement of the condylar heads. They have the potential to lead to the development of he condylar sags after surgery. Lee et al.[19] developed an electromagnetic tracker that could record condylar head movements in real time. 3D coronal and sagittal scans were also useful for determining the position of the condylar heads in the fossa.

Artificial intelligence has also been investigated for the production of surgical splints. Elnagar et al.[20] constructed a 3D diagnostic model for diagnosis as well as a virtual orthodontic-orthognathic treatment plan in their study. The model was created by combining scanning and CBCT pictures to create a single model. As a result of the findings, a 3D splint was created using 3D printing as an intraoperative reference for surgeons.



The impact of digital solutions on surgical-orthodontic protocols spans four key domains (Figure 4). Firstly, AI-enhanced maxillofacial imagery improves diagnostic precision, allowing for better analysis and visualization of patient data. Secondly, treatment planning benefits from the use of 3D models, which provide a comprehensive view of the patient's anatomical structures and help in creating detailed treatment plans. Thirdly, CAD/CAM technology facilitates the manufacture figure 4. Digital workflow on surgical-orthodontic protocols. of custom orthodontic and surgical appliances, enhancing the precision and fit of these tools. Lastly, therapeutic follow-up is improved through the use of image superimposing techniques, which allow for finer interval comparison of treatment results. The following part is taken from Bouletreau P, et al.'s article Artificial Intelligence: Applications in Orthognathic Surgery.[21]

a. Maxillofacial Imagery

AI plays a significant role in optimizing the acquisition and processing of maxillofacial data. It enhances the quality of images by improving the signal-to-noise ratio and reducing radiation doses. AI also aids in the interpretation of these images by enabling efficient 3D reconstructions and superimposing various diagnostic tools like CBCT, digital photography, and intra-oral scanners. This helps in identifying and

calculating dimensions, crucial for treatments such as obstructive sleep apnea. AI can also automate cephalometric analyses, providing a comprehensive 3D view of a patient's dento-facial characteristics, which is essential for accurate diagnosis and treatment planning.[21]

b. Treatment Planning

Surgical-orthodontic planning requires collaboration between the surgeon and orthodontist, taking into account both long-term orthodontic and short-term surgical processes. Digital treatment planning software, enhanced by machine learning, facilitates this process by replacing traditional methods with dynamic virtual setups. These tools enable the visualization of therapeutic objectives and the role of each intervention, improving communication and planning among multidisciplinary teams. They also help in explaining procedures to patients, enhancing their understanding and involvement in the treatment process.[21]

c. CAD/CAM Technology

In orthognathic surgery, CAD/CAM technology has advanced treatment planning and transfer methods. Virtual Surgical Planning (VSP) extends traditional methods, providing a powerful tool for complex cases like facial asymmetries. CAD/CAM technology also includes surgical splints, patient-specific titanium miniplates, and surgical navigation, all of which enhance the precision and effectiveness of clinical applications.[21]

d. Treatment Follow-up

AI significantly enhances treatment follow-up by allowing for the superimposition of digital images, which helps in visualizing and quantifying treatment impacts on anatomical structures. This aids practitioners in validating treatment plans and evaluating alternatives. AI tools also enable the superimposition of dental arch movements and the combination of digital photography with 3D models, providing a dynamic view of treatment progression. In orthognathic surgery, AI's ability to automate geometric morphometric tools and superimpose X-ray images is particularly useful, especially in procedures like mandibular advancement surgery, where accurate and detailed imaging is critical.[21]

6. Dental Implants

Artificial intelligence algorithms can be used to identify dental implants using radiographic images, forecast implant survival, and assist in the design of dental implants.

Lee and Jeong22 trained a deep CNN model using a data set of 10 770 radiographic pictures from three different implant types. The authors contrasted the examiners' implant recognition abilities (board-certified periodontists and the AI model) as well as the radiographic picture used: periapical, panoramic, or both images. Implant recognition accuracy varied across the three types of implants studied, however when both periapical and panoramic photos were used for both the AI model and the periodontists, higher specificity and sensitivity were reported.

Li et al[23] used an AI system to calculate the stress at the implant-bone contact by taking into account three implant design variables: implant length, thread length, and thread pitch. The AI model aimed to reduce stress at the implant-bone interface by optimizing implant design variables. When compared to the FEA model, the stress at the implant-bone interface was reduced by 36.6% in this study.

By substituting FEA computations with an artificial neural network (ANN) paired with genetic algorithms, Roy et al24 intended to optimise implant design porosity, length, and diameter.

7. Robotic Surgery

The FDA approved Transoral Robotic Surgery (TORS) in 2009, marking a significant shift in the treatment approach for head and neck cancers.TORS has become the primary treatment for early-stage oropharyngeal cancer and can also be recommended for minimally invasive resections of laryngeal and hypopharyngeal tumors.

Costantino A et al conducted a study in which Six machine learning prediction models were created and tested to predict the likelihood of surgical margin positivity in TORS patients, utilizing the clinical features of 14 patients. The ML algorithms demonstrated strong specificity and negative predictive value (NPV), enabling the preoperative identification of patients at lower risk of positive margins. External validation cohorts are essential to validate our findings and enhance the accuracy of these ML models in the future. Furthermore, prospective studies are necessary to assess the potential of these models to personalize patient treatment based on individual risk estimates within the precision medicine framework in head and neck oncology.[25]

8. Surgical Simulation

Recent advancements in artificial intelligence (AI) technology have significantly improved surgical simulators, elevating their precision and functionalities. These simulators are now more commonly integrated into contemporary medical practice to aid in preoperative planning and enrich the hands-on training of surgeons. The integration of state-of-the-art AI technology enables simulators to offer personalized feedback to users and automate an immersive surgical environment for visualizing patient anatomy.

Park JJ et al in their review concluded that AI has the potential to improve surgical simulators and expand their capabilities. They have discussed how AI enhances various aspects of surgical simulation, reviewed existing literature and FDA/CE-approved products, and outlined the current status of AI in surgical simulations with suggestions for future clinical use. It's promising to see clinical evidence and technological reports confirming the effectiveness of AI-supported surgical simulators. However, challenges to widespread commercialization, such as high implementation and production costs, limited evidence demonstrating superiority, and inherent technological limitations, persist. Therefore, we emphasize the need for further clinical assessment of AI-supported surgical simulators to support the development of approved devices and advance surgical education into a new era.[26]

Discussion

The majority of artificial intelligence algorithms developed by numerous authors over the years were created to address diverse clinical problems in various sectors of medicine. The establishment of an integrated digital workflow system for the dental business that uses artificial intelligence is planned to be the next initiative[26,27,28]

These AI systems are capable of automatically producing patient specific analysis and treatment on entering valid datasets which include history, 2D and 3D scans and photographs. The clinician can thus obtain a large database updated in real time improving the quality of work[29].

Although AI-based algorithms cannot completely replace the clinicians function in the diagnosis of oral diseases, clinicians might certainly benefit from using artificial intelligence to get a second opinion in a matter of seconds and assist patients[30,31].

To ease the testing of this novel technology in clinical practice, more clinical trials should be sponsored in the future[32,33,34].

Conclusion

Artificial intelligence has a lot of promise in OMFS. Artificial intelligence is highly valuable in OMFS for early diagnosis and treatment planning, especially when assessing clinical photographs, dental X-rays, and various intra-oral and extra-oral images. In practice, OMFS greatly benefits from technological support. Because there is still no standard of quality: In reality, if patients see many clinicians, they might have different perspectives. All of this will result in an individual treatment plan for each patient. From planning to therapy and follow-up, the patient is assisted by software. This program will be able to learn autonomously and, as a result, increase its performance from time to time As a result, AI assists clinicians in improving the accuracy of their diagnoses and saving time.

To properly utilize the benefits of AI, it is necessary to combine intellect, objectivity, and common sense, into an adequate learning process.

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Pink Aesthetics-A Case Report of Gingival Depigmentation Using Electrocautery Method

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Abstract

The color of gingiva varies in different individuals and is assumed to be correlated to ethnic and racial backgrounds. Melanin is the natural pigment causing gingival pigmentation. Gingival hyperpigmentation is common in most of the individuals. Though it is harmless but it is a serious aesthetic concern in individuals especially with gummy smile. In such cases gingival depigmentation is a treatment of choice when individuals demand it for their aesthetic satisfaction. This article shows gingival depigmentation for the correction of hyperpigmented gingiva using electrocautery.

Keywords: Melanin, Hyperpigmentation, Gingival depigmentation , Aesthetic dentistry.

Introduction

A beautiful smile is not only accompanied by a beautiful dentition but also by an aesthetic gingiva. Hence, gingival tissues are very crucial part of a pleasing smile[1]. Gingival hyperpigmentation is very common in most of the individuals. It may range from physiologic reasons (racial pigmentation) to pathologic reasons (Addison's disease, melanoma, Kaposi sarcoma etc.)[2]. The gingival color primarily depends upon size and number of vasculature, degree of keratinization, epithelial thickness and the pigments within the gingival epithelium.[3] Melanin is the most frequent brown colored , non-hemoglobin derived natural pigment resulting in gingival pigmentation. Carotene, reduced hemoglobin and oxyhemoglobin are also the pigments contributing to the normal color of the oral mucosa[4]. The degree of pigmentation varies from one individual to another and is mainly governed by the melanoblastic activities. Melanocytes are the dendritic cells of neuroectodermal origin present in the basal layer and the spinous layer of the gingival epithelium[5]. The process of pigmentation includes an activation phase, synthesis phase and expression phase. In the activation phase, melanocytes are stimulated by factors like sunlight, stress hormones etc. and leading to the production of melanocyte stimulating hormone(a chemical messenger). In the synthesis phase, these melanocytes synthesize melanin in the organelles called melanosomes. This process takes place when the enzyme tyrosinase converts the amino acids into dehydroxyphenylalanine(DOPA) molecule. Tyrosinase then converts DOPA into secondary chemical dopaquinone. Dopaquinone ,after a series of reactions converted into eumelanin (dark) or pheomelanin(light). In the expression phase, the melanosomes transferred to keratinocytes which are the skin cells located above melanocytes in the epidermis.After this, the melanin color eventually become visible on the surface[4,5,6]. The earlier studies have shown that there is no significant difference exists in the density of distribution among the light skinned individuals and dark skinned individuals[7,8].Gingival pigmentation is presented as a diffuse, purplish discoloration or brown and light brown or black patches or striae of irregularly shaped. The attached gingiva is the most common site of such pigmentation[9,10].Gingival hyperpigmentation is harmless but its correction is demanded by most of the individuals for their aesthetic satisfaction as many individuals consider their dark colored gums to be unesthetic[11]. Gingival depigmentation is a periodontal plastic procedure which include removal or reduction of hyperpigmentation of gingiva by using various methods such as conventional methods like

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surgical scalpel technique, gingival abrasion, chemical methods using chemical agents like phenols, alcohols, ascorbic acid, cryosurgery, by electrocautery and laser depigmentation. By understanding the distribution of pigmentation , one can help in deciding the better treatment strategies[11,12]. In this article gingival depigmentation was done to achieve satisfactory aesthetic outcome by using electrocautery.

Case Report

A 22 year old male patient reported to the Department of Periodontology with the chief complain of blackish gums while smiling owing to poor aesthetics (fig A). Patient's historical accounts indicated that it had existed since childhood. Overall, the patient's oral hygiene was healthy& good. Initially, scaling was done and gingival depigmentation using electrocautery was opted as treatment modality. Following the administration of local anesthetic solution loop, diamond shaped electrode and needle electrodes were used (fig B). Coagulation was done using ball electrodes. Controlled brushing strokes were used with light gradual movement of the tip. Repeated and prolonged application of electrode to the tissues was avoided as it causes undesired tissue destruction. A clean field with minimal bleeding was maintained (fig C). The surgical area was covered with a periodontal dressing(coe-pack) for 1 week (fig D) and postoperative instructions were given. For the management of pain, analgesic was prescribed. The pack was removed after 1 week and the surgical area was examined. The healing was uneventful without any postoperative complications (fig E). The gingiva appeared pink and healthy giving a normal appearance (fig E). The patient was very much impressed with the pleasing aesthetic outcome.

Figures (A-E)

A. Pre- Operatively

B. During Surgery

C. After Surgery

D Coe-pack Placed

E. Post Operatively (after 1 week)

Discussion

Esthetic dentistry is a recently emerging branch[13]. In normal healthy persons, gingival color has wide variations[14]. The foremost indication for depigmentation is individual's demand for the improvement of esthetics[15]. It can be achieved using various methods such as scalpel scraping method, gingivectomy, chemical cauterization, gingival abrasion, cryosurgery, electrosurgery and laser therapy[5,7,16]. The use of scalpel for depigmentation is most economical but causes unpleasant bleeding[17]. Electrocautery has its own limitations as its prolonged use causes undesired tissue destruction due to heat accumulation. However, minimal bleeding is there while using electrocautery[18]. The technique selection should be based on the clinical experience and patient's acceptance & affordability[18,19]. In this particular case, the depigmentation was done using electrocautery and gave satisfactory results. We found this method relatively simple, versatile , effective and required minimum time and effort.

Conclusion

Hyperpigmentation of gingiva is a common aesthetic problem[4,7].Various treatment modalities available for depigmentation of gingiva which yields better results[11]. However, the most important factor for determining the treatment of gingival hyperpigmentation is the type of pigmentation, expertise of clinician, patient's acceptance of treatment procedure, its prevalence and its aesthetic importance[19,20]. In future, even if gingival repigmentation occurs in this patient, the same procedure could be repeated as repigmentation is a common problem in such cases[20]. However, the depigmentation performed in this case was successful and patient was also fully satisfied with the results. Hence, it can be concluded that depigmentation of gingiva using electrocautery is simple, easy and provides minimal discomfort to the patient with aesthetically pleasing results.

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Enhancing Anterior Maxillary Esthetics: A Case Report

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Abstract

Implant therapy is today widely regarded as a reliable treatment option to replace missing teeth, both for function and aesthetics. Dental implants may be used to replace single teeth, replace multiple teeth, or provide abutments for complete dentures or partials. This topic focuses on the placement of single-tooth dental implants. The correct surgical placement of a dental implant is mandatory to obtain the ideal aesthetic result. Only through proper treatment planning can the correct position and number of implants be determined. Before surgical placement of a dental implant, the adequate hard and soft tissue must be available. The clinician must consider the time needed for implant integration and soft-tissue healing, creation of emergence profiles, occlusal forces in relationship to progressive loading, and occlusal forces on the final restoration.

Keywords-Implant, Aesthetic Zone, Abutment, Prosthesis

Introduction

Rehabilitation of esthetic zone with dental implants is a venerable challenge. Compared to traditional methods, implants offer distinct advantages. Implants allow for the creation of restorations that closely mimic natural teeth, enhancing both aesthetics and functionality[1].

Previously, limited bone availability, especially in the anterior mandible, impeded implant placement. Today, prosthetic requirements primarily guide implant positioning, reflecting the evolving approach of implant dentistry in addressing esthetic concerns in the anterior zone[2].

Advancements in dental implant therapy have led to consistent success rates, ensuring predictable treatment outcomes. These innovations represent a significant evolution in the field, characterized by improved techniques and materials. Patients can now confidently opt for implant treatment, knowing they can rely on dependable results. This progress underscores the growing trust in dental implants as a reliable solution for tooth replacement, marking a significant milestone in modern dentistry's quest for excellence[3,4].

The importance of anterior maxilla is amplified due to its prominent visibility. With a high lip line, the smile becomes more exposed, heightening the demand for esthetic perfection. Certain experts highlight the necessity of balancing the function and esthetics in this area. Achieving an ideal outcome here not only restores functionality but also significantly enhances the individual's confidence and overall quality of life[5,6,7,8].

Developing and optimal emergence profile for implant supported prosthesis in aesthetic zone necessitates employing bone regenerative materials, soft tissue augmentation and appropriate abutments.

This case report underscores the ideal implant positioning in the maxillary aesthetic region yielding enhanced structural integrity and prosthetic appear-ance that integrate with the natural dentition.

Case Report

A 70-year-oldfemale patient presented to clinic with chief complaint of loss of upper front teeth due to trauma since 2 year back. On detailed intra oral examination revealed that missing teeth on 21 regions.Patient was

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wearing removable partial denture for last 2 years. The patient was in good health with non-contributory medical history, normal oral hygiene and a strong desire to restore the area with a permanent fixed prosthesis. Implant Swiss implant w.r.t 21was planned.(Fig. 1)

Figure 1: Pre-operative IOPA

Surgical Procedure

The surgical procedure was performed in sterile surgical field. Preoperative decontamination of oral cavity with chlorhexidine 0.2% mouth rinse for 1 min and perioral skin disinfection with 5% povidone-iodine solution was done. Site was anesthetized using 2% Lidocaine with 1:80000 adrenaline.

Flapless surgery was carried out. Meanwhile, one Implant Swiss implant was placed on 21 of size 3.7 X 12 to restore that segment with fixed prosthesis. Around 30 NCM Insertion torques was achieved. ISQ measurements was in range of 80-82, thereafter cover screw was placed. Patient was asked to

wear RPD again. Post operative instructions were given to the patient.(Fig. 2a, 2b, 3c)

2b

Figure 2 :Implant Placement

Post-operative after 2 months ISQ test was done again, which showed excellent biological stability with reading measuring in between 84-87 ,thereby showing excellent secondary stability or osseointegration. Thereafter healing abutment was placed.(Fig. 3)Crown cutting was also done w.r.t 11

Figure 3: Post -operative IOPA

Digital impression was made by CEREC Workflow (PRIMESCAN). CEREC scan bodies were used & it was planned to give screw retained crown by using Implant Swiss implant Ti-Base. E-max MESO block of A3 shade was used in PRIMEMILL machine. Crystallization and glazing of MESO done using SPEEDFIRE. (Fig. 4a, 4b, 4c)

4a

Figure 4a,4b,4c: Screw Retained Crown

Now Implant Swiss implant Ti -Base Swiss was cemented extraorally with resin-based cement to prepared crown.OPG showed Implant & Prosthesis in perfect 3-D position ensuring very good prognosis. Occlusion & proximal contacts were verified.(Fig. 5a, 5b, 5c)

5a

Figure 5: Post -Operative OPG & Photographs

Discussion

This report highlights the importance of meticulous planning and precise execution in achieving esthetic perfection in maxillary anterior region[9]. Opting for dental implants in this region offers significant benefits, with fixed implant-supported prosthetics showcasing multiple advantages over conventional crown and bridge or removable tooth-supported options[10].

Among the treatment options considered were removable partial dentures, fixed partial dentures, and resin-bonded bridges, each with drawbacks. Removable dentures risked bone loss and dissatisfaction, fixed options posed threats to adjacent teeth, and resin-bonded bridges had a higher failure rate. Consequently, implant placement emerged as the most advantageous solution. Adhering to correct prosthetic principles aimed to enhance implant-supported restoration success. Thus, implant placement offered superior functional and aesthetic outcomes while preserving adjacent dentition integrity[11,12,13,14].

Conclusion

Placing dental implants in the maxillary anterior region demands meticulous planning, precise surgery, and expert prosthetic treatment. This study outlines steps for optimal aesthetics, emphasizing comprehensive treatment planning and collaborative efforts between surgeons and dentists. Achieving desired aesthetics relies on careful prosthetic design. The report underscores the importance of a holistic approach to treatment in the anterior maxillary region.

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Methods of Uprighting Molars- A Review Article

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Abstract

Molar uprighting is a common orthodontic procedure aimed at correcting tilted or inclined molars. This paper reviews the clinical techniques and outcomes of molar uprighting, highlighting the indications, contraindications, and treatment strategies.

Various uprighting methods are discussed, including the use of T-loops, springs, and miniscrews. The paper also examines the effects of molar uprighting on occlusal relationships, tooth stability, and patient satisfaction.

The findings suggest that molar uprighting can be an effective and predictable procedure, offering improved occlusal function and aesthetics. However, careful case selection, precise treatment planning, and meticulous execution are essential for optimal outcomes.

Introduction

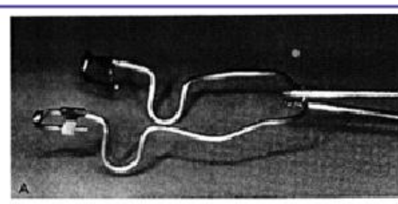
There are many ways of uprighting impacted molars. Many techniques of molar uprighting have been described. Several of them involve removable appliances which require patient coopera tionand/or surgical exposure of the impacted molar,or removing part of the alveolar bone.

Through the advancement of wire materials and TADs (temporary anchorage devices), the method of molar uprighting has been greatly simplified.

Appliances and Techniques

Lingual arch is a simple appliance for uprightingmesially tipped molars .

The appliance needs two well fitting molar bands, a pair of half-round tubes and shafts, and 0.036 stainless steel wire. The arch must be contoured properly to provide full three-point contact at the molar bands and to provide optimum tooth support throughout the arch. The vertical loop is placed just mesial to the affected molar. Every three to four weeks the rounded vertical loop is opened sufficiently, and the simple opening of the vertical loop will induce both a distal and a rotational movement on the molar (Fig 2). The net effect is to upright the molar and to move it distally. This is a method of choice where we wish to reopen a space



Open coil Spring

The open coil spring is used when there is a minimal tipping of the teeth or for final uprighting after use of the helical spring or box loop mechanisms. A straight wire is passed through the molar tube, premolar and canine brackets; then an open coil spring is compressed between the molar tube and the most distal premolar and the archwire is tied in (Fig 3). It will exert a distally directed force in the molar crown and a reciprocal mesially directed force on the premolars and canine, resulting in tipping movements of the teeth

The Helical Uprighting Spring

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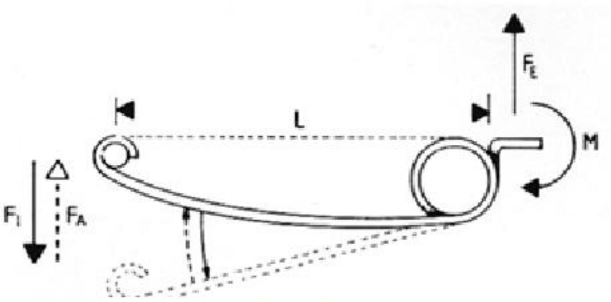
The helical uprighting spring is the first appliance for uprighting molar teeth. This appliance is indicated to upright a single terminal molar. This appliance uses an elas-tically deformed wire to exert forces on the teeth; the active wire is inserted into the bracket that is affixed to the tipped molar.



The box Loop

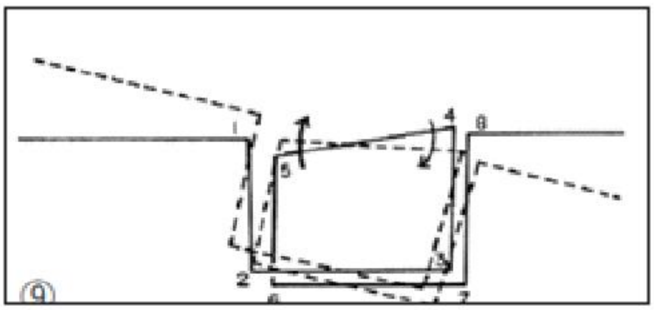
The box loop is fabricated of 0.019 ×0. 025 stainless steel wire. This appl-iance is indicated when two terminal mol-ars require uprighting.

Section between bends 4-5 crosses the bracket of the second molar to be uprighted.

The distal end inserts into the terminal molar tube, and the mesial end into the premolar and canine brackets.

The box loop is activated by forcing the section between bends 4 and 5 into the second molar bracket; make the mesial bend down and the distal bend .

The result is the extrusion and distal tipping of the terminal molar.



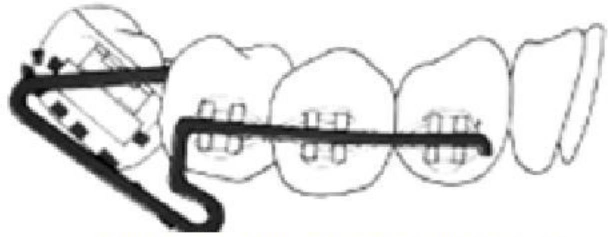
Single T-loop Segmental Molar Uprighting Spring

The indication of the single T-loop is that a single terminal molar has migrated and tilted mesially to a position next to or within 2 mm of the distal premolar.

The 17×25 stainless steel wire or 19×25 beta-Ti wire is used.

The T-loop portion is fabricated with the vertical legs 1 to 2 mm apart, and the T-loop component should not impinge on the cheek or vestibular tissues .When mesial movement of molars is not desired, the distal end of the wire is bent gingi-vally without opening the legs of the T-loop.

Occasionally, the terminal molar is rotated severely. The design of the T-loop is modified so that the distal end of the wire is inserted into the molar tube from the distal aspect



Paired Segmental T-loop Molar Uprighting Spring

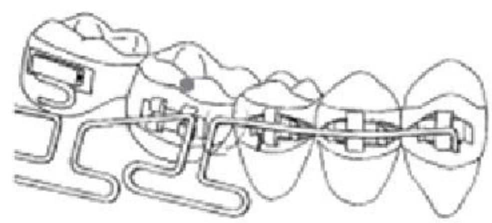
The paired segmental T-loop spring is used when two terminal functioning molars require uprighting.

The prepared procedure is the same as single T-loop spring. The distal T-loop is fabricated in an identical fashion as the single T-loop except that the vertical legs are 2 to 3 mm apart 4 .

The spring is activated by first inserting the distal spring extension into the terminal molar tube, and then the activated middle section is inserted into the bracket slots and secured with a ligature wire.

After complete engagement of the appliance, the angled distal segment creates forces that intrude the terminal molar and cause the roots of the terminal molar

Burstone Upright Spring



This method is a modification of Burstone root spring. The spring is composed of 0.018×0.025 stainless steel wire.

The Advantages of This Appliances

1. Symmetrical preactivation is an extraoral procedure. Force levels are easy to determine and to check periodi-cally.
2. Few adjustments are necessary during treatment because of load/deflection considerations in spring design.
3. In the edentulous span, the wire is not disturbed by normal function because it is positioned at the level of the gingival.
4. Patient discomfort is minimized by offsetting the spring over the edentulous ridge.

Crossed Tipback Spring

This method is described by Dr. Weiland in 1992.

The tipback mechanics use a spring made of 0.016× 0.022 stainless steel with two and one-half helices, or of 0.017×0.025 TMA.

The appliance consists of two tip back springs: one from the second molar tube and the other from the vertical slot of the canine bracketor ligated to the stabilizing wire at the first premolar area.

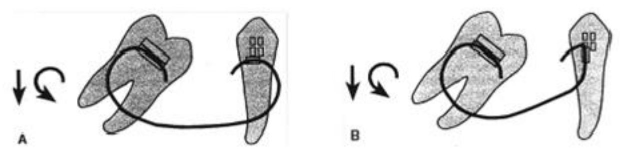
Molar Uprighting Simple Technique (MUST)

The Molar Uprighting Simple Technique (MUST) was designed and reported for uprighting molar without extrusion by Dr. Capelluto, in 1997. In the MUST , a double molar tube should be bonded to the tipped molar, parallel to the occlusal plane. A shorter 0.018×0.025 tube is soldered horizontally to the distocervical wing of the premolar bracket. The active component of the uprighting spring is a superelastic 0.016×0.022 NiTi wire.

This wire extends from the mesial of the premolar tube to the distal of the molar tube.

The MUST appliances are easy to use, patient is comfortable, no occlusal interference, no wire deformation from mastication, and intraoral activation is fast so that the treatment time is relatively short.

The superelasticNiTi wire delivers constant and light forces, and the deformation of the wire delivers an uprighting moment to the tipped molar.



Molar Uprighting with Temporary Anchorage Device

There are numerous approaches for uprightingmesially tipped molars. Most of these have had problems with molar extrusion and movement of the anchorage unit. The only sure way to obtain absolute anchorage is with implants.

Conventional dental implants have some disadvantages in orthodontic treatment, including the need to wait for osseointegration, difficultly of removal after treatment and high cost.

In the mandibular arch, the microscrew is placed buccal and distal to the lower second molar .

In the maxillary arch, the microscrew is placed in the maxillary tuberositySix methods of molar uprighting with detailed diagrams by Dr. Rungsi.

1. Yao-Qiang Miao's Method

A-1. A mini-hook is fabricated from a .014" stainless steel wire. Bend the wire into a circle with a diameter of 1.5mm extending in a perpendicular arm 1.5mm in length. At the top of the soldering push-spring arm, bend a hook parallel to the circle. Bond the mini hook at the disto-occlusal side of the impacted molar, with the hook opening mesially.

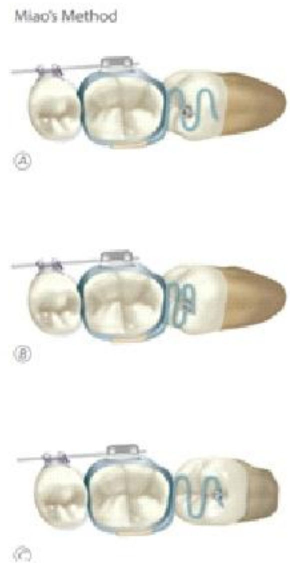
A-2. Solder an .018" stainless steel wire about 60mm in length, to the middle of the lingual surface of the mesially adjacent molar band. Fabricate a double or triple bend push spring.

B. Activation: Compressing the double or triple loop spring to engage the mini-hook. C. During treatment: The impacted molar can be uprighted distally. Advantages This procedure is only appropriate when only the disto-bucal part of the molar is impacted applied. Disadvantages (1) Need to construct a push spring and mini-hook. (2) Need to band the adjacent molars and cement it.

Advantages This procedure is only appropriate when only the disto-bucal part of the molar is impacted applied.

Disadvantages

1. Need to construct a push spring and mini-hook.
2. Need to band the adjacent molars and cement it



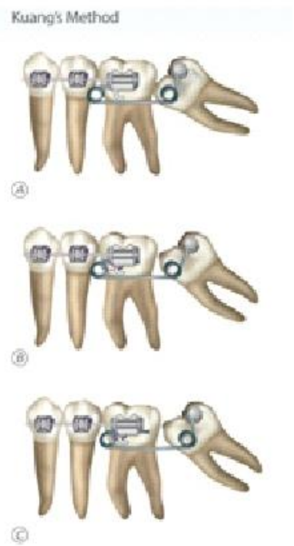
2. Shou-Hsin Kuang's Method

A-1. Bond a lingual button over the disto-buccal of the impacted molar.

2. A-2. It needs an additional auxiliary .018" x .025" gingival tube on the adjacent molar.
3. A-3. Use a .017" x .025" TMA wire to bend double helix one at the mesial side of the adjacent molar, one at the distal side, and engage the distal hook over the lingual button.
4. B. Tie the mesial helix with the hook of the adjacent molar to activate the distal pushing and uprighting force.
5. C. The impacted molar was not only pushed distally but also uprighted by the pushing spring.
6. D-1. Put lingual buttons over the disto-buccal side of the impacted lower 2nd molars.

D-2. AIPS stands for Anterior Inserting Pushing Spring. The .017" x .025" TMA AIPS was engaged on the gingival tube of the lower 1st molar, and were activated by tying the ligature wire.

D-3. After about 6 months in treatment, the impacted 2nd molars were uprighted with AIPS.



E-1. The pushing springs were engaged in the gingival tube of the lower 1st molar and activated by tying the ligature wire.

E-2. The occlusal view of the AIPS has been engaged and activated.

E-3. About 5 months in treatment, the impacted 2nd molars were uprighted, despite the presence of the impacted 3rd molars.

Advantages

1. The technique is suitable only when a very small disto-occl-usal part of the impacted molar partially erupted.
2. The double helix push spring applies very gentle force on the .017" x .025" TMA wire.

Disadvantages

1. It is time consuming to bend a double helix push-spring.
2. Sometimes the helix will impinge on the soft tissue around the narrow vestibular space buccal to the impacted molar.
3. It may catch food debris easily, hygiene instruction is needed.

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Maxillary Expansion – A Review Article

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Abstract

Maxillary expansion is an orthodontic procedure designed to increase the transverse width of the maxilla, addressing skeletal or dental discrepancies such as posterior crossbites, narrow palates, or airway obstruction. The procedure can be performed using appliances like rapid maxillary expanders (RME), slow maxillary expanders (SME), or surgically assisted techniques (SARPE) in skeletally mature patients. This treatment facilitates improved occlusion, enhanced nasal airflow, and better facial aesthetics. Advances in technology, including 3D imaging and CAD/CAM appliances, have optimized treatment planning and outcomes. This articlereviews the indications, mechanisms, and outcomes of maxillary expansion, emphasizing its role in comprehensive orthodontic and craniofacial therapy.

Keywords : Maxillary expansion, rapid maxillary expansion, slow maxillary expansion, surgically assisted maxillary expansion.

Introduction

For over a century, maxillary transverse deficit has been corrected with maxillary expansion therapies. E.C. Angell's study, which was published in Dental Cosmos in 1860, is the first often quoted report.[1]

Although the method was rejected at the time, it is now widely acknowledged as a rather straightforward and reliable orthodontic treatment.

The palate must typically be expanded using a mix of orthodontic and orthopaedic tooth motions in order to correct the transverse disparity. Today, there are three methods of treating maxillary expansion: surgically aided maxillary expansion, slow maxillary expansion (SME), and rapid maxillary expansion (RME). The use of each therapeutic approach is controversial because they each have benefits and drawbacks. Based on their individual experiences, the patient's age, and their malocclusion, practitioners choose therapy appliances.[2,3]

By the ages of 6 and 9, normal palatal growth is almost finished, and after puberty, separation becomes more challenging due to growing suture interdigitation. 10 to 15 Transverse stresses tip the buccal segments laterally4 during treatment, and third-order moments will cause body translation if the application is designed correctly.[4]

The maxillary suture separates if the force is high enough. Crossbites, distal molar movement, functional appliance treatment, surgical cases (such as bone grafts or arch coordination) to support maxillary protraction, and mild crowding are clinical symptoms that indicate maxillary expansion.[5]

Rapid Maxilary Expansion

Emerson Angell initially described rapid maxillary growth in 18601, and Haas later popularized the idea.[5] RME's primary goal is to narrow the maxillary arch, but because it affects ten bones in the face and head, its effects extend beyond the maxilla.[6] Rapid maxillary expansion proponents contend that it causes maximum skeletal mobility and minimal dental movement, or tipping.[7]

There is insufficient time for tooth movement to occur when strong, quick forces are applied to the rear teeth, and the forces are then transmitted to the sutures. The

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sutures open up and the teeth move very little in relation to their supporting bone when the force applied by the appliance beyond the threshold required for orthodontic tooth movement and sutural resistance. The midpalatal suture and the other maxillary sutures eventually open as a result of the appliance's compression of the periodontal ligament, bending of the alveolar process, and tipping of the anchor teeth.[5]

Effect of RME on Maxillary and Mandibular Complex

Maxillary skeletal effect : Inoue discovered that the midpalatine suture's aperture was nonparallel and triangular when seen occlusally. It was largest in the incisor area and progressively shrank toward the back of the palate.

The maxillary suture splits superoinferiorly in a nonparallel fashion when seen frontally. It has a pyramidal form, with the base of the pyramid situated on the bone's oral side.[8]

Maxillary halves: Haas 9 and Wertz10 found the maxilla to be frequently displaced downward and forward.

Alveolar process: Early in RME, the alveolar processes flex laterally because to the resilience of bone, but this reverts within a few days.[11]

Maxillary anterior teeth : From the perspective of the patient, the opening of a diastema between the maxillary central incisors is one of the most striking alterations that come with RME. Although the amount of separation between the central incisors should not be interpreted as a measure of the amount of suture separation, it is estimated that during active suture opening, the incisors separate by about half the distance the expansion screw has been opened.[10]

Maxillary posterior teeth : The maxillary molars extend and have buccal tipping.

Because to the resistance created by the pterygoid plates and zygomatic buttress, the posterior maxilla extends less easily.

Mandibular effect of RME : The mandible has a propensity to swing backward and downward concurrently.[12]

RME and nasal airflow: Anatomically, the nasal cavity widens immediately after expansion, which facilitates better breathing. Although it may be as big as 8 to 10 mm, the nasal cavity width increase typically averages 1.9 mm.13

Indications/Contraindications of RME

When the maxillary molars are already buccally inclined to adjust for the transverse skeletal disparity and the transverse discrepancy is equivalent to or more than 4 mm, rapid maxillary growth is recommended. Patients with cleft lip and palate who have collapsed maxillae are also candidates for rapid palatal expansion (RME), which has been utilized to promote maxillary protraction in class III therapy by interfering with the suture system that connects the maxilla to the cranial base. Lastly, some medical professionals employ the technique to help patients with mild maxillary crowding by lengthening their arches. Patients who have had growth spurt regression, anterior open bite, convex profiles, steep mandibular plane, recession on the buccal face of the molars, and poor compliance should not use it.[5]

Rapid palatal expanders have several drawbacks, such as pain from the high force used, traumatic separation of the midpalatal suture, difficulty correcting rotated molars, needing patient or parent cooperation to activate the appliance, bite opening, relapse, microtrauma of the midpalatal suture and temporomandibular joint, root resorption, tissue impingement, pain, and a labor-intensive fabrication process.[5]

Clinical Management of RME

During the growth period, the patient or parent should be made aware of the upper midline diastema beforehand.

During the retention period, this is probably going to shut on its own. Twice daily (am and pm), patients should be told to turn the expansion screw a quarter turn. There can be some slight discomfort connected to this. Force levels can reach 10 kg after several turns and tend to build up over several turns. To make sure the midpalatal suture has split, some physicians advise taking an upper occlusal radiograph one week into therapy and reviewing patients every week. There is a danger of alveolar fracture and/or periodontal injury, thus it is crucial to discontinue appliance activation if there is no sign of this. In order to allow for the bone infilling of the split suture, active therapy is often needed for two to three weeks, followed by a three-month retention period.[14]

Appliances In RME

These appliances are bonded and banded. The maxillary first molar and first premolar teeth have bands that secure the banded device to them. Because there is no palatal covering, the banded appliances are sanitary. There are two kinds of banded RME:

1. Tissue and tooth-borne
2. A tooth-borne

Tooth Borne RME

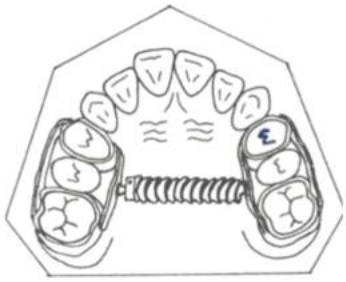
1. Hyrax Expander

They consist of only bands and wires without any acrylic covering.

William Biederman first presented the Hyrax expander, a tooth-borne device, in 1968. This kind of device uses a unique screw known as Hyrax, or Hygenic Rapid Expander. In essence, the Hyrax Expander is an all-wire jackscrew that is not spring loaded.[12] The screws' thick gauge wire extensions are soldered to the premolar and molar bands and are designed to fit the palatal curves. This expander's primary benefits are its ease of cleaning and lack of irritation to the palatal mucosa. In a very little amount of use, it may provide sutural separation of 11 mm, and a maximum of 13 mm can also be accomplished. Each activation of the screw produces approximately 0.2 mm of lateral expansion and it is activated from front to back.

2. Issacson Expander

With no palatal covering, it is a tooth-borne device. This expander uses a spring-loaded screw known as the Minne expander, which was created by the University of Minnesota's dentistry school and is soldered straight to the bands of molars and first premolars.[12] The Minne expander is a precisely calibrated coil spring that is compressed by rotating a nut. The bands on the abutment teeth are soldered to two metal flanges that are perpendicular to the coil. Unless they are partially disengaged, the Minne expander may still apply expansion pressures after the expansion phase is over.



Tooth And Tissue Borne RME

They are made up of acrylic that abuts alveolar ridges and an expansion screw. The following benefits of tooth and tissue RME were listed by Haas in 1970:

- Produces more parallel expansion
- Less relapse
- Greater nasal cavity and apical base gain
- More favorable relationship of the denture bases in width and frequently in the anteroposterior plane as well
- Creates more mobility of the maxilla instead of teeth.

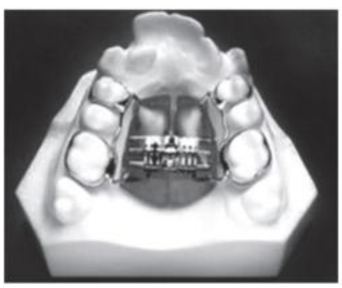
Disadvantage of Tooth and Tissue Borne RME

These tooth and tissue borne RME tend to have higher soft tissue irritation.

Types of Tooth and Tissue Borne RME

1. Haas: The fast expansion procedure's foundation is the destruction of the sutural connective tissue, which results in instantaneous midpalatal suture separation. According to Haas, the quick palatal expander is a stiff device made for maximal dental anchoring that creates expansion in 10–14 days using a jackscrew.[9]

   According to him, this will optimize the orthopedic effects, and reports of the forces this equipment produces range from three to ten pounds.



2. **Derichsweiler :** Both the molars and the first premolar have bands.

   These bands are soldered to wire tags, which are subsequently put into the screw-containing split palatal acrylic.

Bonded Rapid Palatal Expander

Cohen and Silverman originally described the Bonded RPE in 1973. Except for how it is attached to the teeth, it is comparable to the banded version.

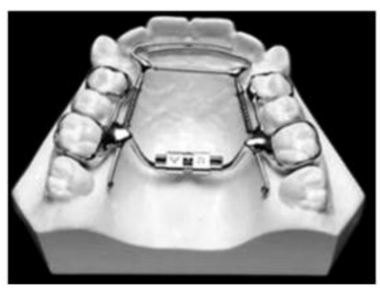
The acrylic covering that covers the posterior parts of this device is attached straight to the teeth.

The bonded appliance has become increasingly popular because of its advantages:

1. It can be easily cemented during the mixed dentitionstage, when retention from other appliances can be poor.
2. Number of appointments are reduced.
3. There is reduced posterior teeth tipping and extrusion.The buccal capping limits molar extrusion during treatment and, therefore improves the vertical control,which is particularly useful in class II conditions, as molar extrusion would cause autorotation of themandible backward and downward resulting in increase in facial convexity and the vertical dimension of the lower face.
4. It provides Bite block effect to facilitate the correction of anterior crossbite.[5]

IPC Rapid Palatal Expander

IPC is intended for both labial alignment of the incisors and orthopedic expansion . The NiTi open coil spring force delivered to the anterior teeth's lingual surface is managed by the IPC while expansion takes place. The midline diastema that frequently happens after RPE treatment is limited by a wire around the distal end of the lateral incisors.[5]



Slow Maxillary Expansion

SME procedures produce less tissue resistance around the circummaxillary structures and, therefore improve bone formation in the intermaxillary suture, which theoretically should eliminate or reduce the limitations of RME.

Slow maxillary expansion involves the use of relatively lesser forces over long time period.

Results are more stable when the maxillary arch is expanded at the rate of 0.5 to 1mm per week.

It delivers a constant physiologic force until the required expansion is obtained

Indications of SME

- Unilateral or bilateral crossbites.
- To correct minimal crowding by gaining space.
- To correct dental crossbite in permanent dentition.
- To correct mild maxillary deficiency in cleft lip and palate patients by providing slow continuous forces.

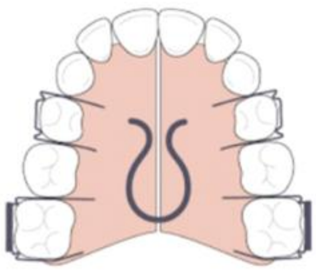
Contraindications of SME

- Adult patients who have completed their growth.

Appliances In SME

Coffin Appliance

Given by Walter Coffin–1875. It is a removable appliance capable of slow dento alveolar expansion. The appliance consists of an omega-shaped wire of 1.25 mm thickness, placed in the midpalatal region. The free ends of the omega wire are embedded in acrylic covering the slopes of the palate. The spring is activated by pulling two asides apart manually.



Magnets

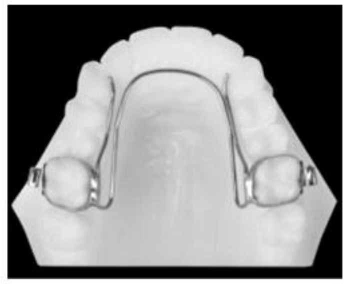
Repulsive magnetic forces for maxillary expansion were first described by Vardemon et al 1987.[15]

In contrast to general expansion effects, banded magnets caused more noticeable skeletal effects. A constant 250–500 g strain may cause skeletal and dental motions, to varying degrees depending on the patient's condition (growth, age, etc.). Due to the possibility of corrosive compounds forming, magnets have a tendency to oxidize in the oral environment. However, this may be avoided by covering the magnets. These magnets have the benefit of imparting measurable constant force over an extended period of time, which reduces the chance of external root resorption. Because they need to be well stabilized and have strong guide rods to keep the magnets from going out of line and producing undesired rotational motions, these magnets are rather large.

W-Arch

Rickets and his associates16 first employed the "W" expansion device to treat individuals with cleft palates (Fig. 6). Made of 36 mm steel wire soldered two molar bands, the W-arch is a permanent prosthetic. The lingual arch should be built to rest 1-1.5 mm off the palatal soft tissue in order to prevent irritation of the soft tissue. It may be readily modified to allow more anterior than posterior expansion, or vice versa, if desired. It is triggered by simply opening the apices of the W-arch. Before being inserted, the appliance should be set to the right force levels, which are delivered when it is opened 3–4 mm wider than the passive width.

Up to the cross bite, expansion should continue at a rate of 2 mm each month.



Quadhelix

Ricketts described the quadhelix appliance, which is a variation of Coffin's W-spring (Fig. 7). The W-spring's flexibility and activation range were improved with the addition of four helices. Depending on which teeth arch in a crossbite, the appliance's palatal arms might have different lengths. More recently, a new generation of prefabricated appliances made of nickel titanium have been released. Using nickel titanium provides several benefits over stainless steel, including better force delivery due to its superelastic qualities. This might result in more fast crossbite correction and greater physiological tooth movement.

Mode of Action

In prepubertal youngsters, the quadhelix appliance functions by combining skeletal growth with buccal tiping in a 6:1 ratio.

Clinical Management

By activating the appliance by 8 mm, or roughly one molar width, the desired force level of 400 gm may be provided. Every six weeks, patients should be reassessed.[3] The device may occasionally leave an impression on the tongue, but this will quickly go away after treatment. Continue expanding until the buccal cusps of the mandibular molars and the palatal cusps of the upper molars meet edge-to-edge. Since relapse is unavoidable, some overcorrection is preferable. After expansion is accomplished, a three-month retention period with the quadhelix in place is advised. After the stainless steel wires are installed, the quadhelix can be taken off if fixed appliances are being utilized.

Benefits include : cost-effectiveness, non-compliance, molar rotation/torque, orthopaedic impact, differential expansion, habit breaker, good retention, and a wide spectrum of action.

Drawbacks include : restricted skeletal change, bite opening, and molar tilting.

Spring Jet

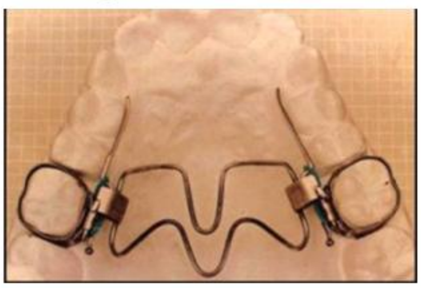
Soldering or attaching the spring jet's active components to the molar bands is done (Fig. 8). To ensure that the forces pass near the maxillary teeth's center of resistance, the telescoping unit is positioned up to 5 mm from the center of the molar tubes; nevertheless, it should be 1.5 mm from the palatal tissue.

The permanent dentition receives 400 gm of force, while the mixed dentition receives 240 gm. The lock screw must be moved horizontally along the telescopic tube to activate. The spring can be squeezed thanks to a ball stop on the transpalatal wire.

NiTi Expander

Wendell V17 introduced the Nickel Titanium Palatal Expanders (Fig. 9). It produces consistent, ideal expansion forces. The remainder of the component is composed of stainless steel, while the core is composed of a thermally activated NiTi alloy. With just an extra lingual sheath on the molar bands, the expander can be utilized in conjunction with traditional fixed appliances.

The shape memory and transition temperature effects of nickel titanium cause the appliance to function.[18] The transition temperature of the nickel titanium component is 94º F. The expander is too rigid to bend for insertion at room temperature. The expander's primary component becomes softer when chilled, making handling simpler. stiffens and starts to regain its former shape after placement. A 3 mm increment of expansion exerts only about 350 gm of force 31 and the nickel titanium alloy provides relatively uniform force levels as the expander deactivates.



Surgical Techniques

As people age, the impact of the dental arch on the maxillary base decreases, thus medically aided expansion procedures may be an option. The following are signs of surgical expansion:

1. To make the arch wider
2. When a significant degree of expansion (>7 mm) is necessary to rectify a posterior crossbite and prevent the possible elevated risk of segmental osteotomies.
3. In situations when there is extensive buccal gingival recession in the canine-bicuspid area of the maxilla, highly thin and fragile gingival tissue, or severe nasal stenosis, the arch should be widened after maxillary collapse linked to a cleft palate.

Among the methods are

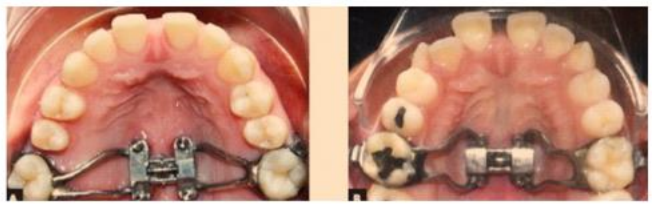
- Rapid palatal expansion with surgical assistance (SARPE)[19]
- Maxillary segmental surgery

Surgically aided rapid palatal expansion, or SARPE, has become more and more well-liked as a means of treating maxillary transverse deficiency (MTD). It enables medical professionals to effectively expand the maxilla in a patient with a mature skeleton.

Segmental Maxillary Surgery : By making an extra surgical incision along the midpalatal suture, a Le Fort 1 osteotomy might result in transverse extension.

After that, the maxillary halves are split apart and held in their new place. The amount of expansion that may be accomplished is restricted by the palatal mucoperiosteum's relative inelasticity.

In order to ease surgical access to the osteotomy site, orthodontic therapy entails separating the maxillary central incisor roots prior to surgery. When a patient needs expansion and has concurrent sagittal and/or vertical maxillary inconsistencies, this is the preferred method.



Conclusion

There are several methods for achieving maxillary dentition and maxilla expansion. The choice of expansion is heavily influenced by the skeletal and dental patterns, and the expansion type can significantly support the overall goals of therapy.

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Mechanobiology of Orthodontic Tooth Movement

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Abstract

Orthodontic tooth movement (OTM) is a biologically driven process initiated by mechanical forces that remodel the periodontal ligament (PDL) and alveolar bone. Governed by mechanotransduction, these forces convert into biochemical signals, triggering cellular responses, extracellular matrix remodeling, and inflammation. Key players, including osteocytes, fibroblasts, and osteoclasts, mediate bone resorption and deposition essential for repositioning teeth.The mechanisms underlying OTM involve pressure-tension responses and bioelectric signaling, both critical for tissue adaptation and cellular activity. Achieving optimal force magnitude and duration is vital to ensure efficient movement while minimizing adverse effects, such as pain, root resorption, or periodontal damage. Advances in anchorage control, including temporary anchorage devices (TADs), and the use of biochemical agents have significantly improved treatment precision and outcomes. This review underscores the interplay between mechanical forces and biological systems in orthodontics, with a focus on the PDL's role in stabilizing teeth and adapting to forces. Additionally, it examines the effects of orthodontic forces on alveolar bone height, root integrity, and skeletal structures. Insights from foundational research and clinical practice highlight the importance of controlled force application to optimize treatment strategies while minimizing complications. By integrating biological principles with innovative approaches, this overview aims to refine orthodontic treatment and improve patient outcomes.

Introduction

Orthodontic tooth movement occurs as a direct result of mechanical forces applied to teeth, leading to remodeling in both mineralized and non-mineralized paradental tissues. The process is a complex interplay of mechanical stimuli and biochemical responses that involve cellular activation, signal transduction, and tissue remodeling. Orthodontic forces influence the extracellular matrix (ECM), alveolar bone, periodontal ligament (PDL), and gingiva, triggering a cascade of cellular events that allow for the repositioning of teeth within the dental arch .

This dynamic process relies on mechanoresponses the conversion of physical forces into biochemical signals and inflammation, both of which are essential for effective tooth movement. Cellular mechanisms underlying these responses include cytoskeletal reorganization, gene expression, and the synthesis of signaling molecules. Research in mechanobiology has revealed the critical roles of osteocytes, fibroblasts, and other cells in sensing and responding to mechanical loads, thereby regulating tissue remodeling. For example, osteocytes, embedded within the alveolar bone, act as key mechanosensors, releasing anabolic signals and orchestrating the balance between bone resorption and formation. Similarly, fibroblasts in the PDL contribute to ECM remodeling by synthesizing proteins like collagen, which influence tissue structure and function.

Current studies highlight the importance of understanding the interactions between mechanical forces and biological systems to optimize orthodontic treatment outcomes. Advances in this area could enable orthodontists to modulate the speed of tooth movement using adjunctive therapies such as biochemical agents, surgical

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interventions, or physical techniques. This review aims to provide an expanded perspective on the cellular and molecular mechanisms involved in orthodontic tooth movement, emphasizing both mineralized and non-mineralized tissues. By exploring the intricate processes of mechanotransduction, inflammation, and ECM remodeling, this overview seeks to bridge clinical practice with foundational research, offering insights into the biological responses elicited by orthodontic forces.

Periodontal and Bone Adaptations to Functional Stimuli

Orthodontic tooth movement relies on the principle that applying prolonged light pressure to a tooth leads to its movement. This occurs as bone surrounding the tooth remodels, with bone being resorbed in some areas and deposited in others. The tooth moves within the bone while maintaining its attachment apparatus, largely mediated by the periodontal ligament (PDL), making tooth movement primarily a PDL-driven process .

Orthodontic forces can influence bone remodeling not only around the teeth but also in distant skeletal regions, such as maxillary sutures and the temporomandibular joint. Forces applied to implants in the jaw can impact skeletal growth without significant tooth movement. While bones cannot be moved like teeth, distraction osteogenesis can stimulate new bone formation and modify growth patterns .

Periodontal Structures and Orthodontic Force

This section focuses on the periodontal response to orthodontic forces and associated risks, such as enamel decalcification. Growth modification and distraction osteogenesis are explored in detail in subsequent sections.

Anatomy and Role of the Periodontal Ligament (PDL)

The PDL anchors each tooth to the alveolar bone via collagenous fibers, which resist normal functional forces. The ligament includes cellular elements, such as fibroblasts andosteoblasts, as well as vascular and neural components. The PDL space also contains fluid that acts as a shock absorber, critical for its functional adaptability .

Fibroblasts and osteoblasts within the PDL maintain collagen turnover and bone remodeling. Bone and cementum resorption are facilitated by osteoclasts and cementoclasts, derived from hematogenous precursor cells or local stem cells. These cellular processes enable continuous adaptation to mechanical demands.

Responses to Normal Functional Forces

During chewing, teeth endure intermittent forces, ranging from light to heavy loads. The incompressible fluid in the PDL space prevents quick displacement, transmitting force to the alveolar bone, which bends in response. This bending generates piezoelectric currents, stimulating bone repair and adaptation to functional stresses .

Short-term forces are effectively absorbed by the PDL's tissue fluid, preventing pain. However, sustained forces cause fluid expression, ligament compression, and eventually, bone remodeling. Prolonged low-magnitude forces, whether from orthodontic appliances or natural pressures from surrounding tissues, can move teeth over time'.

Contribution of the Periodontal Ligament to Tooth Eruption and Stability

The eruption process highlights the periodontal ligament's (PDL) ability to generate forces that facilitate tooth movement. Post-eruption, further movement depends on metabolic activities within the PDL, such as collagen formation, cross-linking, and shortening. This process persists into adulthood, as evidenced by re-eruption of teeth in the absence of antagonists .

This mechanism not only supports tooth eruption but also stabilizes teeth against prolonged, light forces. The PDL generates counterforces that contribute to the equilibrium of tooth positioning, explaining why minor imbalances in soft tissue pressures do not result in continuous movement. The stabilization threshold for orthodontic forces varies but is typically low, often resisting forces of 5 to 10 gm/cm^2 .

Periodontal Ligament and Bone Adaptation to Prolonged Force

The reaction of the PDL to sustained forces is force-dependent. Heavy forces cause pain, cellular necrosis, and "undermining resorption" of alveolar bone. In contrast, light forces allow cellular survival and promote "frontal resorption," enabling painless remodeling of the tooth socket. Orthodontic treatment aims to maximize frontal resorption while minimizing necrosis and undermining resorption .

Mechanisms Governing Tooth Movement

Two key mechanisms govern orthodontic tooth movement

1. **Bioelectric Response :** Changes in bone metabolism due to electric signals generated by light forces.
2. **Pressure-Tension Response :** Alterations in blood flow within the PDL, causing chemical messenger release.

Both mechanisms play roles in controlling tooth movement, although chemical signaling is more dominant.

Role of Bioelectricity in Tooth Movement

Bioelectric signals, particularly piezoelectricity, occur when crystalline structures like collagen in the PDL generate electric currents under deformation. These signals decayrapidly and are not sustained under continuous force, making their role in orthodontic movement minimal. Although piezoelectricity is critical for maintaining skeletal health, its impact on tooth movement remains limited .

Research into electromagnetic fields and vibration-based interventions has shown mixed results. While such methods might accelerate initial tooth movement phases in animals, they have yet to demonstrate significant effects in human orthodontics.

Chemical Signaling in the PDL: The Pressure-Tension Mechanism:

Sustained force shifts the tooth within the PDL, compressing some areas and stretching others. This mechanical effect triggers the release of cytokines, prostaglandins, and other chemical mediators. These messengers initiate remodeling processes:

Compression reduces blood flow, decreasing oxygen levels and increasing carbon dioxide.

Tension maintains or increases blood flow, creating a contrasting environment.

The release of prostaglandins, interleukins, and other mediators stimulates osteoblast and osteoclast activity, enabling bone resorption and formation .

Cellular Response and Tooth Movement Dynamics

Light sustained forces reduce blood flow, altering the chemical environment within hours. Increased cyclic AMP levels and chemical messengers like prostaglandins and RANKL activate bone-resorbing osteoclasts. Osteoblasts follow, forming bone on the tension side.

In contrast, heavy forces occlude blood vessels, causing PDL necrosis ("hyalinization"). Tooth movement is delayed as cells invade necrotic areas, and osteoclasts resorb bone from beneath the lamina dura ("undermining resorption"). This delay contrasts with the efficiency of frontal resorption, which is more desirable in orthodontics.

Clinical Implications of Force Magnitude

Tooth movement is more effective and less painful with lighter forces. However, small avascular areas are often unavoidable, resulting in a stepwise progression rather than continuous movement. Intermittent release of pressure, such as chewing, can reduce necrotic areas and alleviate pain, highlighting the importance of controlled force application in orthodontic treatment.

Influence of Force Distribution

Optimal orthodontic tooth movement requires forces sufficient to stimulate cellular activity without completely occluding blood vessels in the periodontal ligament (PDL). Both the magnitude of the applied force and the PDL area over which it is distributed are critical. The biological response depends not merely on the force but on the pressure, defined as force per unit area. Since different tooth movements alter pressure distribution, it is essential to specify both the type of movement and the applied force to understand the ideal force levels.

Tipping occurs when a single force, such as from a spring, acts on a tooth crown. This creates a tipping moment around the center of resistance, approximately halfway along the root. The PDL experiences maximum pressure at the alveolar crest and root apex, with progressively less pressure approaching the center of resistance. As only half of the PDL area bears the load, forces for tipping must remain low. Studies suggest tipping forces for a single-rooted tooth should not exceed 50 gm, with lighter forces preferable for smaller teeth .

When forces are applied such that no tipping occurs, the tooth undergoes bodily movement, where the crown and root move uniformly. This evenly distributes pressure across the PDL. To generate the same biological response as tipping, double the force is required. Partial tipping and translation require forces between those needed for pure tipping and bodily movement .

Rotation theoretically allows force distribution across the entire PDL, permitting larger forces. However, rotation often induces tipping, compressing areas of the PDL. Thus, appropriate forces for rotation align with those for tipping. Extrusion ideally generates tension without PDL compression. However, minor tipping during extrusion can cause compressed areas, making light forces similar to those for tipping suitable. Intrusion, on the other hand, requires extremely light forces since the force is concentrated at the root apex. Excessive force during intrusion may damage the PDL.

Impact of Force Duration and Decay

Sustained force is crucial for effective orthodontic tooth movement, though it need not be continuous. Research suggests that forces must persist for at least 4 hours to stimulate the cellular differentiation required for movement. Clinical observations indicate that forces maintained for 4 to 8 hours daily yield better outcomes, with efficiency increasing as force duration lengthens.

Concept and Significance of Anchorage

In orthodontics, anchorage is defined as "resistance to unwanted tooth movement," reflecting the need to control reactionary forces generated during desired tooth movements. Reaction forces, if uncontrolled, can affect adjacent teeth or structures. Common anchorage sources include teeth, the palate, the head or neck (via extra oral forces), and increasingly, temporary anchorage devices (TADs) like screws implanted in the jawbone.

Effective anchorage management involves maximizing desired movements while minimizing adverse side effects. An essential strategy is distributing reaction forces across multiple teeth to keep periodontal ligament (PDL) pressure below the threshold required for movement. Research suggests tooth movement is proportional to applied pressure up to an optimal range. Forces exceeding this range can increase trauma without enhancing movement efficiency.

In reciprocal anchorage, equal forces act on opposing segments, distributing pressure evenly across the PDL. For example, connecting two teeth with an active spring applies equal forces on both teeth. Similarly, in a premolar extraction case, anterior teeth (e.g., incisors and canines) might oppose posterior teeth (e.g., molars) using equal forces. However, true reciprocal movement depends on the total PDL area of each segment. Teeth with larger root surfaces exert greater resistance, leading to slightly uneven movement despite equal force distribution.

To achieve differential movement, additional teeth can be added to the anchorage unit, increasing root surface area and reducing PDL pressure. For instance, adding a second molar to a posterior anchorage unit increases resistance and minimizes forward movement of posterior teeth while retracting anterior teeth. Using light forces optimizes this method by keeping anchor teeth in the lower response range of the pressure–response curve . Excessive force risks destabilizing anchorage, termed "slipping" or "blowing" anchorage.

Stationary anchorage contrasts bodily movement of one tooth group with tipping of another. For instance, tipping anterior teeth lingually while ensuring bodily posterior movement reduces reaction forces and enhances anchorage control. However, success depends on applying light forces. Excessive force negates this advantage, moving anchor teeth excessively and undermining anchorage control.

Skeletal and Cortical Anchorage

Cortical bone, being denser and more resistant to resorption, slows tooth movement compared to medullary bone. This can complicate movement near dense cortical structures, such as old extraction sites or areas with missing teeth.

Additionally, excessive force against cortical plates can cause root resorption, particularly in maxillary incisors during torque movements. This underscores the need for careful force application to avoid adverse effects.

Advancements in skeletal anchorage techniques, including bone screws and plates, have revolutionized orthodontics. Unlike extra oral devices like headgear, skeletal anchorage offers consistent resistance without patient compliance issues. Temporary anchorage devices (TADs) such as titanium screws provide reliable fixation, minimizing unwanted movements. These devices are now standard in clinical orthodontics, often replacing traditional extra oral methods.

Orthodontic Force and Skeletal Effects

Orthodontic forces not only influence teeth and alveolar bone but can also affect jaw growth. Sustained light forces can modulate maxillary and mandibular growth by influencing sutures and condylar development. Implants allow direct application of forces to the maxilla or mandible, enabling targeted growth modifications with minimal force.

Negative Impacts of Orthodontic Forces

Orthodontic tooth movement involves not only the remodeling of surrounding bone but also changes within the periodontal ligament (PDL). Collagen fibers detach from bone and cementum and reattach later, leading to a temporary widening of the PDL space, which in turn causes a slight increase in tooth mobility.

An increase in mobility is normal during orthodontic treatment, with greater force resulting in more resorption and increased mobility. Excessive mobility can indicate that excessive force is being applied, possibly due to habits like clenching or grinding. If a tooth becomes excessively mobile, it should be taken out of occlusion, and the force should be discontinued until mobility decreases to acceptable levels. Excessive mobility usually resolves without permanent damage, unlike root resorption.

Pain from orthodontic forces develops quickly when pressure is applied to the tooth, as the PDL is compressed. Immediate pain should be avoided, as it signifies excessive force. However, mild aching or sensitivity to pressure may occur within a few hours of treatment, typically lasting for 2 to 4 days. Pain varies among patients, with some experiencing more discomfort than others, even with similar forces.

Pain is primarily caused by ischemic areas (hyalinized areas) in the PDL, which lead to sterile necrosis. Additionally, mild pulpitis may contribute to discomfort. There is a direct correlation between the amount of force and the severity of pain, as stronger forces cause larger ischemic areas.

To reduce pain, light forces are recommended, and patients may benefit from chewing sugarless gum during the first 8 hours after activation, as this can temporarily relieve pressure on the PDL and help restore blood flow, preventing pain receptor stimulation .

Root Resorption during Orthodontic Tooth movement

Orthodontic forces cause remodeling not only of the bone but also of the cementum on the root surface. Studies have shownthat cementum adjacent to necrotic PDL areas is affected by the resorption process, which explains the root resorption that can occur with excessive orthodontic force. Even with careful force management, hyalinized areas are inevitable, leading to resorption of cementum and, in some cases, dentin.

Root resorption can occur in different forms. It is not always permanent unless large defects appear, particularly at the apex. Root remodeling typically involves the resorption of cementum followed by its replacement, but severe root resorption can occur in certain cases, often involving the apex of the root.

Effects of Orthodontic Treatment on Alveolar Bone

Orthodontic treatment can lead to changes in alveolar bone height, with pressure in the PDL space being most prominent at the root apex. However, excessive loss of alveolar bone height is rare, and the greatest changes typically occur at extraction sites. The relationship between tooth movement and alveolar bone height is complex, but in most cases, moving a tooth brings the alveolar bone with it .

In cases of periodontal disease, orthodontic treatment can be used to support bone regeneration if the disease is well controlled. Intrusion or extrusion of teeth can result in changes to the alveolar bone height, either enhancing or reducing bone support, depending on the direction of movement and force levels used.

Extrusive forces typically stimulate bone formation, while intrusive forces may lead to bone loss at the alveolar crest. When orthodontic treatment is conducted with reasonable force and speed, bone height generally remains stable or is slightly enhanced. In some cases, intrusive treatment can improve periodontal support, although it is primarily used to manage periodontal issues rather than to promote significant bone regeneration.

Conclusion

Orthodontic forces initiate complex interactions between the periodontal ligament (PDL) and alveolar bone, driving tooth movement through controlled bone remodeling. Periodontal and bone adaptations to functional stimuli maintain equilibrium and support orthodontic treatment goals. Proper force magnitude and distribution are essential for minimizing adverse effects like pain, root resorption, or mobility while ensuring efficient, stable tooth movement.

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Hypersensitivity to Metals in Orthodontics : A Review Article

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Abstract

This study evaluates short-term hypersensitivity reactions to metal components in orthodontic appliances. A cohort of patients was monitored for allergic responses, with clinical assessments and patch testing when needed. Nickel was the most common allergen, followed by chromium and cobalt. Mild reactions, including erythema and itching, were observed in a small percentage of patients and managed with material adjustments or topical treatments. While metal hypersensitivity is uncommon, early detection and material selection are crucial for minimizing reactions. Further research is needed to assess long-term effects.

Keywords : Metal hypersensitivity, nickel allergy, patch test, orthodontic materials

Introduction

Metal hypersensitivity is a growing concern in the field of orthodontics, with the biocompatibility of dental materials being a critical factor in patient care[1,2]. Orthodontic appliances, commonly fabricated using metals such as nickel, chromium, cobalt, and titanium, are integral to treatment but may elicit adverse reactions in susceptible individuals[3]. Among these, nickel is particularly known for its allergenic potential, frequently causing contact dermatitis and other hypersensitivity responses[4]. Such reactions not only affect patient comfort but also pose challenges to treatment continuity and outcomes [5].

The prevalence of metal hypersensitivity appears to be increasing, potentially due to heightened awareness and improved diagnostic techniques[6]. However, the exact relationship between orthodontic appliances and the development or exacerbation of hypersensitivity reactions remains underexplored[7]. This study by Menezes et al. aims to investigate hypersensitivity reactions to various metals commonly used in orthodontic practice. By employing patch tests both before and after the placement of fixed orthodontic appliances, the study provides valuable insights into the incidence and intensity of these reactions[8]. It also examines potential differences in sensitivity based on sex and evaluates whether orthodontic appliances contribute to sensitization over time [9].

Through its findings, the study seeks to enhance our understanding of material biocompatibility in orthodontics, ultimately informing material selection and improving patient care practices [10]. This review will analyze the study's objectives, methodology, key findings, and implications for clinical practice.

Objective

The primary objective of this study is to evaluate the hypersensitivity reactions to eight metals commonly used in orthodontic appliances, including nickel sulfate, potassium dichromate, cobalt chloride, and titanium oxide. By conducting patch tests both before and after the placement of fixed orthodontic appliances, the study aims to determine whether these appliances sensitize patients to the tested metals or affect their tolerance over time. Additionally, the study seeks to assess the relationship between metal hypersensitivity and factors such as sex, providing a comprehensive understanding of its implications for orthodontic treatment.

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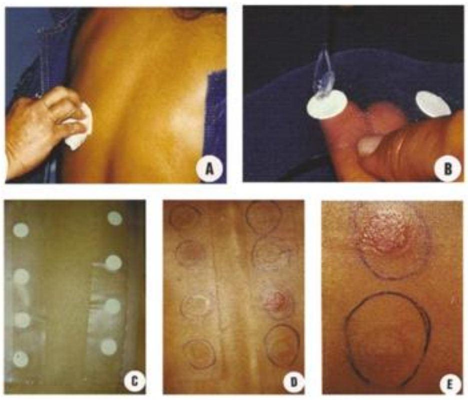

Fig 1. Stages of patch test: A, cleaning selected area with alcohol-soaked cotton; B, test substance being placed over strip; C, pads and strips in position on patient's back; D, E, outlining areas with skin-marking pencil for reading of results.

Materials and Methods

This study involved 38 patients (17 male and 21 female) aged 9 to 25 years who requ-ired orthodontic treatment. Patch tests were conducted to evaluate hypersensitivity to eight metal compounds: nickel sulfate, potassium dichromate, cobalt chloride, titanium oxide, copper sulfate, iron sulfate, manganese chloride, and molybdenum salt. The tests were carried out twice for each patient: before the placement of fixed orthodontic appliances and two months after appliance placement.

Patch tests were applied to the scapular and infrascapular areas of the patients' backs using sterile, hypoallergenic adhesive strips containing the test substances. The patches were left in place for 48 hours, during which patients were instructed to avoid moisture and physical activity that could displace the patches. Dermatological evaluations were conducted 48 hours and 72 hours after patch application to record the intensity of hypersensitivity reactions. Reactions were scored according to International Research Contact Dermatitis Group guidelines, with scores ranging from 0 (no reaction) to 4 (severe reaction).

The study adhered to ethical guidelines, obtaining informed consent from all participants or their guardians. Statistical analysis was performed using the chi-square and McNemar's chi-square tests to evaluate differences in hypersensitivity reactions before and after appliance placement, as well as any association with sex.

Key Findings

The study revealed that nickel sulfate and potassium dichromate were the most allergenic metals, with both eliciting positive reactions in 21.1% of patients. Among these, nickel sulfate caused the most intense reactions, with some patients displaying severe hypersensitivity. Manganese chloride also triggered positive responses in 7.9% of participants, though its effects were less pronounced. Importantly, the placement of fixed orthodontic appliances did not significantly alter hypersensitivity reactions over the two-month study period, indicating that these appliances did not sensitize patients to the tested metals. While no statistically significant differences in hypersensitivity were observed based on sex, there was a tendency for female patients to be more sensitive to nickel sulfate and male patients to potassium dichromate. Other tested metals, such as cobalt chloride, titanium oxide, copper sulfate, iron sulfate, and molybdenum salt, showed minimal allergenic potential, reaffirming their suitability for orthodontic use.

Discussion

The findings of this study contribute valuable insights into the ongoing debate regarding metal hypersensitivity in orthodontics. Nickel sulfate emerged as the most allergenic metal, consistent with its widely recognized status as a major sensitizer in dental materials [4,7]. The observed prevalence of nickel hypersensitivity (21.1%) aligns with previous research, such as the study by Blanco-Dalmau et al., which found an incidence of 28.5% using similar patch testing methods [11]. This highlights the need for clinicians to remain vigilant in assessing patients for potential hypersensitivity before initiating orthodontic treatment.

Janson et al. explored the prevalence of nickel hypersensitivity before, during, and after orthodontic treatment and found no statistically significant difference in hypersensitivity reactions across these phases [12]. Their results align with our findings, suggesting that fixed orthodontic appliances do not induce or exacerbate hypersensitivity reactions within a short-term exposure period. Furthermore, they reported a gender disparity in hypersensitivity rates, with females showing a higher prevalence a trend also observed in our study and supported by other literature [12].

Kerosuo et al. investigated nickel hypersensitivity in adolescents and noted that orthodontic treatment did not increase the risk of sensitization[13]. Interestingly, their study proposed that exposure to nickel-containing appliances before sensitization events, such as ear piercing, might reduce hypersensitivity rates by inducing oral tolerance[13]. While this finding differs from our short-term analysis, it suggests an intriguing avenue for future research into long-term desensitization effects of orthodontic materials.

Despite the consistency across studies in demonstrating that orthodontic appliances do not significantly increase hypersensitivity risk, variations in methodologies, such as differences in patch test concentrations and patient demographics, could influence results. Our study's short follow-up period limits its ability to evaluate chronic exposure effects, a limitation also noted by Blanco-Dalmau et al. and Janson et al. [11,12].

Overall, these comparisons underscore the importance of individualized patient care in orthodontics. Pre-treatment screening for hypersensitivity, especially in females and individuals with a history of metal allergies, remains crucial. Further longitudinal studies are warranted to explore the potential for orthodontic appliances to influence hypersensitivity over extended periods.

Conclusions

This study highlights nickel sulfate and potassium dichromate as significant allergens in orthodontic practice, with nickel sulfate eliciting the most intense hypersensitivity reactions. Despite these findings, the use of fixed orthodontic appliances did not contribute to increased sensitization over the two-month study period, indicating their short-term safety for most patients. The study also observed trends in sex-based differences, with female patients showing higher sensitivity to nickel sulfate and male patients to potassium dichromate, though these differences were not statistically significant. Minimal hypersensitivity to metals such as cobalt chloride, titanium oxide, and molybdenum salt supports their suitability for orthodontic applications.

Clinicians should prioritize pre-treatment screening for hypersensitivity and consider individual patient histories when selecting materials for orthodontic appliances. While the short-term safety of these materials is evident, further research with extended follow-up periods is necessary to provide a comprehensive understanding of their long-term effects on metal hypersensitivity.

Strengths and Weaknesses

One of the strengths of this study lies in its systematic approach to evaluating hypersensitivity to multiple orthodontic metals, providing a comprehensive analysis. The use of standardized patch testing methods and ethical compliance ensured reliable results. Additionally, the study's focus on both pre- and post-treatment hypersensitivity offers valuable insights into the short-term effects of orthodontic appliances on metal sensitivity. However, the study is limited by its small sample size and short follow-up duration, which may not capture the long-term effects of metal exposure. The absence of diverse demographic representation further restricts the generalizability of the findings.

Clinical Relevance

This study highlights the importance of considering metal hypersensitivity in orthodontic practice. The findings suggest that fixed orthodontic appliances do not significantly increase sensitization to metals, offering reassurance about their short-term safety. However, clinicians should remain cautious when treating patients with known metal allergies, particularly to nickel and potassium dichromate. Pre-treatment screening for hypersensitivity and selecting materials with lower allergenic potential, such as titanium or cobalt-based alloys, can enhance patient outcomes and comfort.

Future Directions

Future research should focus on larger, more diverse patient cohorts and extend follow-up periods to better understand the long-term effects of orthodontic metal exposure. Studies investigating the molecular mechanisms underlying metal hypersensitivity could offer insights into preventive strategies. Additionally, exploring alternative materials with lower allergenic potential and developing hypoallergenic orthodontic appliances could further reduce the risk of adverse reactions. Emphasizing patient-specific approaches to material selection and incorporating hypersensitivity screening into routine orthodontic practice are critical areas for advancement.

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Functional Matrix Theory – A Review Article

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Abstract

Functional matrix theory extends classical matrix analysis by incorporating functions of matrices, enabling advanced applications in differential equations, control theory, and quantum mechanics. It explores functional calculus for matrices, spectral theory, and operator functions, providing tools for solving matrix-valued differential equations, stability analysis, and optimization problems. Key topics include matrix exponentials, logarithms, and fractional powers, along with their applications in linear and nonlinear systems. This framework bridges algebraic and analytic techniques, offering deeper insights into the structure and dynamics of complex systems.

Keywords : Matrix functions, spectral theory, operator functions, matrix calculus, matrix exponentials

Introduction

The process of craniofacial development is intricate. The majority of treatment strategies have been founded on the basic biological processes that underlie the form-ation and growth of teeth and craniofacial bones. For many years, there has been disc-ussion and investigation over the precise mechanism governing craniofacial devel-opment.[1] Growth is the extension or incre-ase of any particular tissue. Growth, accord-ing to Moyers, may be characterized as the typical variations in the quantity of living material. According to Moss, growth is any morphological change that falls within a quantifiable range. From the start of fetal life to the end of senility, growth is characterized by a sequence of successive anatomical and physiological changes.[2]

Theories Of Bone Growth

Sir John Hunter's 18th-century studies on the development of the jaws and the eruption of the teeth are credited with conducting the first scientific investigation of craniofacial growth. The hypotheses are predicated on the location of the growth center or innate genetic potential.[3,4]

The various theories of growth are

- Bone remodelling theory
- Genetic theory
- Sutural hypothesis
- Cartilaginous theory
- Functional matrix theory
- Servo system theory
- Composite hypothesis by von Limborgh Rate limiting ratchet hypothesis
- Growth relativity hypothesis

Functional matrix hypothesis

The concept that "forms follow function" was first proposed by Vander Klaaw (1948-52). The functional matrix hypothesis is actually an extension.[4]

The Essence of the Theory

The functional matrix hypothesis has a straightforward core idea. The concept's craniofacial framework. The "functional matrix hypothesis" was created by Melvin Moss and his colleagues based on the form and function idea. He evaluated and improved it in the 1990s after it was first launched in the 1960s.Expands in direct reaction to the external epigenetic environment after first developing. According to Moss, "bonesdo not grow, they are grown."

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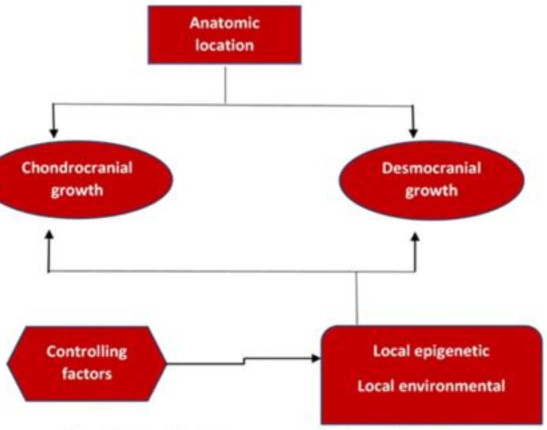


Figure 2. Controlling influences on growth according to Moss

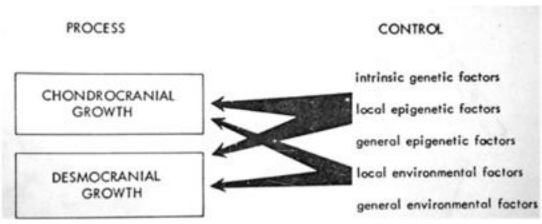
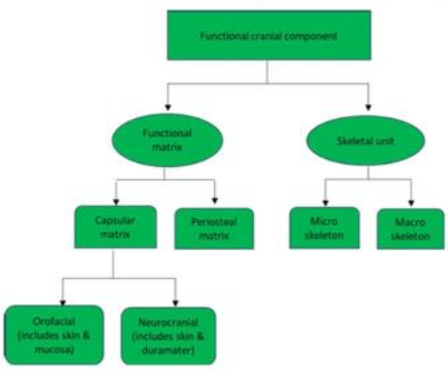


Figure 3. Moss's view on control of cranial growth

Skeletal Units

Micro skeletal unit

Micro skeletal units are the word used to describe bone that is made up of several continuous skeletal units. Periosteal matrices control its development. This comprises the masseter, teeth, alveolar bone, and temporalis-coronoid process.



These micro skeletal units undergo size and form changes that are unrelated to changes in spatial location. Moss described this using two terms: intraosseous expansion or trans-formation. Mandible, for instance[5]

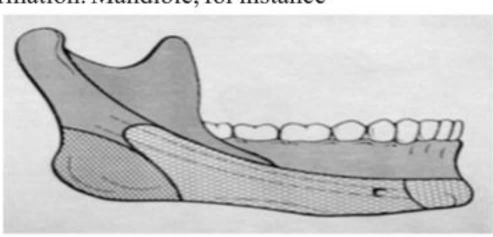


Figure 5. Mandible as a micro skeletal unit

Macro-skeletal unit

When the adjacent parts of many nearby bones come together to form a single cranium component. The growth of the capsular matrix results in a shift in the location of the macro-skeletal unit. We refer to this process as translational growth. For example, inner calvarium surface[6]

In this A - Resorption
B - Deposition

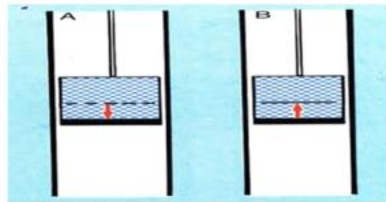


Figure 6. Diagrammatic representation of resorption and deposition

Functional Matrix

Periosteal Matrix

Consists of glands, blood vessels, muscles, and nerves; they alter the skeletal units to which they belong. takes immediate and proactive action. the osseous deposition and resorption process. Transformative growth, or a change in size and structure, is the outcome.[7]

Capsular Matrix

An envelope with functioning cranial components positioned between the covering layers is called a capsule. It does not work via resorption or deposition, but rather passively and indirectly. These affect the placement of skeletal units in space rather than their size and shape. "Translation" is the term for this kind of development process.[7]

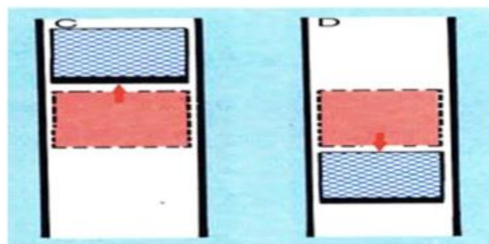


Figure 7. Diagrammatic representation of transformation and translation

Limitations of F. M. H

- Methodological constraint
- Hierarchical constraint

1. Methodological constraint

Only met-hod-specific descriptions that are not structurally detailed might be made using macroscopic measurements.

Individual cephalometric follow-up served as the experimental foundation for FMH.

This approach supplemented the previous qualitative explanation of development dynamics with quantitative elements of localized cephalic growth kinematics.[9]

2. Hierarchical constraint

The process by which extrinsic, epigenetic functional matrix inputs are converted into cellular, multicellular, or molecular regulatory signals is not explained by F.M.H.

It was unable to explain the upward (multicellular) or downward (cellular, subcellular) processes that occur during growth.[9]

Functional Matrix Hypothesis Revisited

Revised statement : 1997(Melvin Moss)

The developmental origin of all cranial skeletal elements (e.g., skeletal units) and all their subsequent changes in size and shape (e.g., form) and location, as well as their maintenance in being, are always, without exception, secondary, compensatory, and mechanically obligatory responses to the temporally and operationally prior demands of their related cephalic non-skeletal cells, tissues, organs, and operational volumes (e.g., the functional matrices).

1. **F.M.H. Revisited 1** : The role of mechanotransduction.
2. **F.M.H. Revisited 2** : The role of an osseus connected cellular network.
3. **F.M.H. Revisited 3** : The genomic thesis
4. **F.M.H. Revisited 4** : The epigenetic antithesis and the resolving synthesis.

The Functional Matrix Hypothesis Revisited[1]

1. The Role of Mechanotransduction

The process by which a mechanical input is transformed into a biological signal to influence cellular response is known as mechano-transduction.All vitals cells respond to alternations in their external environment, by a process called:

- **Mechanoreception :** "Transmit an extracellularly physical stimulus into a "receptor cells".
- **Mechanotransduction :** Transform the stimulus "informational content" into an intracellular signal.
- The osseous mechanotransduction has four unique properties:
- Bone cells are not cytologically specialized like other mechanosensory cells.
- Single bone loading stimulus evokes three adaptational responses, whereas non-osseous process generally evokes one.
- Osseous signal transmission is aneural, it doesn't involve a neural pathway, unlike other mechanosensory signals.
- The adaptational response is confirmed within the individual bone.

2. The Role of an Osseus Connected Cellular Network

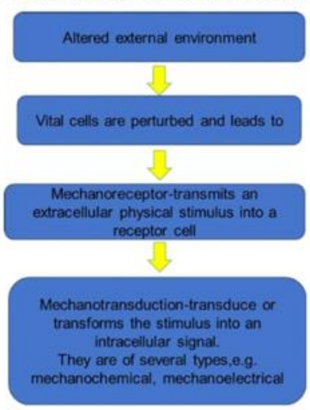


Figure 10. The functional matrix hypothesis revisited

Both static and dynamic stress are continuously applied to bone. This is necessary for bone homeostasis to function normally.

The loaded problem uses the triad of bone cell adaptation to react to the stimulus when the force threshold value is surpassed.

The Triad Includes

1. Bone deposition
2. Maintenance
3. Boneresorption[7]

1. F.M.H. Revisited 3

The Genomic Thesis

According to the genomic thesis, the genome includes all the information required to govern (cause, control, and direct) from the time of conception.

1. The intranuclear formation and transcription of mRNA
2. To regulate also all the internuclear and inter- cellular process of subsequent and structurally more complex, cell tissue, organ and organismal morphogenesis. Succinctly all features are ultimately determined by the DNA sequence of the genome.

In this case, morphogenesis is the predetermined reading out of an inherent and inherited genomic organismal blueprint, where the genome controls the geometric properties of cells, tissues, and organs as well as the size, shape, and placement of the organism in addition to molecular synthesis.

Classical Mendelian genetics is where the genomic thesis first emerged.

The premise was recently expanded to include the control of all ontogenetic processes by molecular genetics.[10]

Drawbacks of Genomic Thesis

The genomic thesis is rejected due to its reductionist and molecular nature, which reduces explanations of mechanisms at the molecular (DNA) level to descriptions of the causation (control, regulation) of all structurally more complicated and hierarchically higher morpho-genetic processes.

For instance, the genomic thesis of craniofacial ontogenesis ignores the role of the numerous epi-genetic processes and mechanisms that are capable of regulating a large number of intervening, and progressively more structurally complex, developmental stages, and instead goes straight from molecules to morphogenesis: from DNA molecules to adult gross morphology.

The integrated epigenetic antithesis aims to elucidate the causal connection between genome and phenotype by describing both processes and mechanisms.

At every hierarchical level of increasing structural and operational complexity, it seeks to discover and thoroughly characterize the sequence of beginning biological processes and the underlying (biochemical, bio-physical) response mechanisms that underlie them.

2. The Epigenetic Antithesis and The Resolving Synthesis

The idea that the genome, or the whole of DNA molecules, is the primary source of developmental information that is, that there is a genetic program or blueprint that could potentially create a full organism is a misconception.[11]

Biological Mechanisms and Processes

The dialectic process concludes here with an epigenetic antithesis and a resolving synthesis, following two additional definitions:

1. A process is a series of actions or operations that lead toward a particular result.
2. A mechanism is the fundamental physical or chemical process involved in, or responsible for, an action, reaction, or other natural phenomena. That is, mechanisms underlie processes.

Epigenetic Regulation of Higher Structural Levels

The control of bone tissue and bone organ growth, development, and shape is significantly influenced by the epigenetic process of extrinsic loading.

At the tissue level, the microstructure of bone tissue varies depending on a number of strains. All connective tissues, including cartilage, exhibit adaptational responses to loading that follow very similar epigenetic pathways and processes.

At the organ level, mechanisms related to physical activity control the skeletal adaptations of organisms. Local vascular factors are among the several epigenetic mechanisms that impact bone tissue.

A Resolving Synthesis

The foundations for further discussion will be made clear by a concluding synthesis.

This suggests that both genomic and epigenetic mechanisms and processes control morphogenesis.

Only their combined actions offer the adequate and essential reasons of growth and development, even if both are vital causes.

Conclusion

The F.M.H. has shortcomings in the past, such as failing to explain growth at the molecular end subcellular level. Moss then updated this theory in 1997 and provided a microscopic explanation of growth. According to Moss, signals are sent via Osseo receptors and mechanoreceptors. Examples of completely distinct forms of causality include genomic and epigenetic mechanisms. Epigenetics is an effective cause.

Both are required causes on their own, but none is adequate on its own. When combined, they offer the adequate and essential reasons for morphogenesis control. However, the main agents are epigenetic events and processes, which are the causes of development that are closest to the surface.

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Obstructive Sleep Apnea and Its Relationship with Oral Habits : Diagnosis and Management

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Abstract

Obstructive sleep apnea (OSA) is a prevalent sleep disorder marked by repeated interruptions in breathing during sleep. Sleep apnea has well-known systemic effects, such as problems with metabolism and cardiovascular disease, but it also has a major impact on oral health. This review investigates the connection between sleep apnea and widespread oral health concerns, including dental caries, gum infections, and dry mouth (xerostomia) that raises the risk of tooth decay and oral infections. Apneic episodes cause spasms of the jaw muscles, which can lead to bruxism and abnormalities of the temporomandibular joint (TMJ). Additionally, the review emphasizes how dental practitioners can help manage these oral health issues by using night guards, oral appliances, and routine dental exams. For complete patient care, it is essential to comprehend and treat the effects of sleep apnea on dental health because early detection and treatment can greatly enhance quality of life and avoid long-term oral issues.

Keywords : Obstructive sleep apnea, Orthodontics, Bruxism.

Introduction

Sleep apnea is a prevalent sleep condition defined by repeated interruptions in breathing during sleep. These pauses, known as apneas, may occur multiple times throughout the night, lasting from a few seconds to several minutes. Obstructive sleep apnea (OSA) (Fig. 1) and central sleep apnea are the two primary forms of sleep apnea. The most common type, OSA, happens when the back of the throat muscles relax too much while you sleep, temporarily blocking your airway. Conversely, central sleep apnea happens when the brain does not communicate with the breathing muscles in the proper way.[1,2]

Fig. 1 : Obstructive sleep apnea

Prevalence

It is estimated that 4–8% of persons in India have sleep apnea. It is more common in men; perhaps 5–10% of adult males have it. Women, particularly those who have gone through menopause, may have a lower prevalence, but it is nonetheless noteworthy at around 2–5%.

Obesity is a significant risk factor; in India, up to 30–40% of obese individuals may also have sleep apnea.[3,4]

Pathophysiology[5,6]

According to certain theories, people with OSA have problems with the genioglossus muscle, a tongue muscle. During sleep, this results in the tongue prolapsing against the posterior pharyngeal wall during inspiratory effort. The airway obstructs and the pharyngeal wall invaginates while you sleep. Increased air flow resistance due to obstruction of the nasal airway results in increased effort for inspiration and increased negative pressure in the pharyngeal

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wall airway. This suction raises the risk of airway collapse in the pharynx. (Fig. 2).

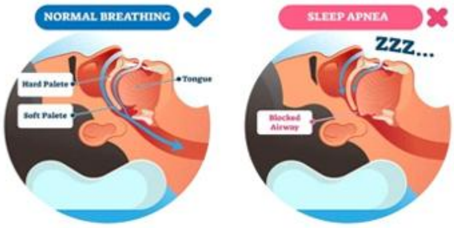

Fig. 2 : Pathophysiology

Predisposing Factors[7,8,9]

Non-Modifiable

1. Genetics
2. Age 40 and above
3. Male Gender
4. Anatomical factors (Fig. 3)
   - Adenoids

Fig. 3 : Adenoids

   - Deviated Nasal Septum
   - Macroglossia
   - Micrognathia
   - Enlarged uvula
5. Neurological disorders

Modifiable

1. Obesity
2. BMI>30
3. Alchols
4. Sedatives
5. Smoking
6. Nasal congestion (Fig. 4)

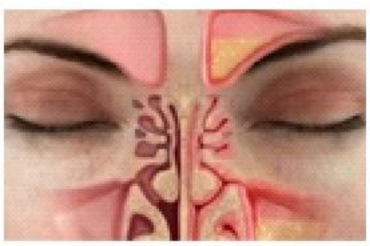

Fig. 4 : Nasal Congestion

Symptoms of Obstructive Sleep Apnea[10,11]

- Snoring
- Apneic pauses, such as gasping, coughing, or snoring at night. Increased body movements and restless sleep
- Night time teeth grinding, or bruxism; enuresis during the day and at night
- Hyperextension of the neck and limitation of growth failure
- Mouth breathing as a result of dry mouth
- Prolonged congestion of the nose
- Walking while you sleep, being obese, and breathing through your lips because it's dry
- Weariness
- Mood swings, include irritability, impatience, irritation, despair, and anxiety.
- Hyperactivity and aggression
- Poor academic performance
- Distraction and poor attention
- Venous congestion in the infraorbital region
- Day time sleepiness and fatigue (Fig. 5)
- Wrong position while sleep
- Poor sleep hygiene

Fig. 5 : Daytime Sleep in OSA Patient

Effects of Obstructive Sleep Apnea[12,13] (Fig. 6)

1. CVS Problems
   - Hypertension
   - Coronary artery disease
   - Stroke

Fig. 6 : Effects of Obstructive Sleep Apnea

2. Cognitive impairment
   - Interrupted decision making and breathing
   - Depression

3. Metabolic Issues
   - Obesity
   - Type 2 DM
4. Day time sleepiness
5. Increased risk of accidents
6. Loss of libido
7. Increased mortality risk

Diagnosis of Obstructive Sleep Apnea[14,15,16]

A combination of objective diagnostic testing, patient history, physical examination, and clinical evaluation is used to diagnose sleep apnea. Being a complex condition, sleep apnea requires a precise diagnosis in order to be effectively treated. This is a summary of the steps taken to diagnose sleep apnea:

1. **Clinical Evaluation**
   - Symptom assessment – loud snoring, excessive day time sleepiness
   - Observed breathing interruptions
   - Morning headaches
   - Dry mouth
   - Difficulty in concentrations
2. **Physical Examination**
   - BMI > 30
   - Neck circumference > 17 inches in males and > 16 inches in females
3. **Screening Questionaries**
   - STOP – BANG Questionaire
   - Berlin Questionare
   - Epworth sleepiness scale (Fig. 7)
4. **Diagnostic sleep studies**

- Polysomnography (PSG): This serves as the definitive method for diagnosing sleep apnea. It is conducted in a sleep clinic or sleep center and monitors various physiological parameters during sleep, including:
  - i. Brain activity (EEG)
  - ii. Eye movement (EOG)
  - iii. Muscle activity (EMG)
  - iv. Heart rate and rhythm (ECG)
  - v. Breathing patterns (nasal airflow and respiratory effort)
  - vi. Oxygen saturation levels (pulse oximetry)
  - vii. Leg movements
  - viii. Snoring

Diagnostic Tools[17,18]

1. **Oximetry :** Affordable pulse oximeters are widely accessible, making oximetry the primary screening tool for OSAHS. These spectrophotometric devices measure and analyze the varying absorption of light caused by oxygenated and deoxygenated hemoglobin in the blood. This method effectively detects and monitors blood oxygen saturation levels.
2. **Apnea-Hypopnea Index (AHI):**

   Purpose : AHI is a diagnostic tool used in polysomnography to quantify the severity of sleep apnea. It measures the number of apneas (complete obstruction) and hypopneas (partial obstruction) per hour of sleep.

Interpretation:

- Normal: AHI < 5
- Mild sleep apnea: AHI 5–15
- Moderate sleep apnea: AHI 15–30
- Severe sleep apnea: AHI > 30

3. **Epworth Sleepiness Scale (ESS)**

   Purpose: The ESS assesses daytime sleepiness and the likelihood of falling asleep in various situations. While not specific to sleep apnea, high scores can indicate the presence of sleep-related disorders, including sleep apnea. Scoring: Participants rate their likelihood of dozing off in 8 common situations (e.g., sitting and reading, watching TV). A score of 10 or above typically signifies excessive daytime sleep-iness, potentially indicating sleep apnea or other sleep-related disorders.

EPWORTH SLEEPINESS SCALE (ESS)

Situation	Chance of dozing (0-3)			
Sitting and reading	0	1	2	3
Watching television	0	1	2	3
Sitting inactive in a public place-for example a theatre or meeting	0	1	2	3
As a passenger in a car for an hour without a break	0	1	2	3
Lying down to rest in the afternoon	0	1	2	3
Sitting and talking to someone	0	1	2	3
Sitting quietly after lunch (when you've had no alcohol)	0	1	2	3
In a car while stopped in traffic	0	1	2	3
Total Score				

0=would never doze, 1=sligth chance of dozing, 2=moderate chance of dozing, 3=high chance of dozing

Reference: Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. Sleep. 1991 Dec;14(6):540-5.

Fig.7 : Epworth Sleepiness Scale

4. **Stop-bang Questionnaire :**

   Purpose : The Stop-bang questionnaire is a screening tool to assess the risk of obstructive sleep apnea. It evaluates a person's likelihood of having sleep apnea based on their symptoms and certain risk factors.

   Scoring:
   - S: Snoring (Do you tend to snore loudly while sleeping?)
   - T: Tiredness (Do you frequently feel exhausted, fatigued, or drowsy during the day?)
   - O: Observations (Has someone noticed you stop breathing during your sleep?)
   - P: Pressure (Are you currently being treated for or do you have high blood pressure?)
   - B: BMI > 35 (Do you have a BMI greater than 35?)
   - A: Age > 50 (Are you over the age of 50?)
   - N: Neck circumference > 40 cm (Is your neck circumference greater than 40 cm?)
   - G: Gender (Are you male?)

   Scoring Interpretation:
   - A score of 3 or higher indicates a high risk for sleep apnea and warrants further diagnostic evaluation.

5. **Berlin Questionnaire**

   Purpose : The Berlin Questionnaire is a tool used to assess the risk of sleep apnea. It focuses on symptoms like snoring, daytime sleepiness, and the presence of other risk factors like obesity.

   Scoring : It is divided into three categories: snoring, daytime sleepiness, and hypertension or obesity. A person is considered at high risk for sleep apnea if they answer "yes" to questions in two or more categories.

6. **The Modified Mallampati Score**

   Purpose: Although primarily used in anesthesia to assess airway difficulty, the Mallampati score can also serve as an indicator of the likelihood of obstructive sleep apnea. It looks at the visibility of the back of the throat and the oral airway.

   Scoring:

   - Class I : Full visibility of the uvula
   - Class II : Partial visibility of the uvula
   - Class III : Only the base of the uvula is visible
   - Class IV : No visibility of the uvula

   Interpretation : A higher class (III or IV) often correlates with a higher risk of sleep apnea.

7. **Sleep Apnea Clinical Score (SACS)**

   Purpose : This tool combines various factors such as age, snoring, neck circumference, and BMI to estimate the probability of a person having obstructive sleep apnea.

   Scoring : The score is based on clinical parameters, with a higher score suggesting a greater likelihood of sleep apnea.

8. **Karolinska Sleep Questionnaire (KSQ)**

   Purpose : This tool is a sleep evaluation questionn-aire that helps assess sleep quality and sleep disorders, including sleep apnea. It includes questions related to snoring, choking, and daytime sleepiness.

   Scoring: Based on the responses, a score is calculated that helps determine the likelihood of sleep apnea, though it is typically used in clinical settings alongside other diagnostic methods.

9. **Snoring Severity Scale (SSS)**

   Purpose : This scale specifically evaluates the sever-ity of snoring, which is one of the primary symptoms of obstructive sleep apnea. It can help clinicians determine whether further investigation into sleep apnea is warranted.

   Scoring : The severity of snoring is rated on a scale, and higher scores correlate with a greater likelihood of sleep apnea.

Management[19,20]

1. **Behavioural Intervention**
   - Weight loss
   - Positional therapy – avoid sleeping on the back
   - Avoiding alcohol and sedatives
   - Smoking cessation
   - Exercise

2. **Non Surgical Intervention**
   - **Continuous Positive Airway Pressure (CPAP)**
   - CPAP is an airway pressure device that includes a mask fitting snugly over the patient's nose. It delivers a continuous flow of air, keeping the throat open throughout the night. Acting like a pneumatic splint, it helps maintain an open airway during sleep, supporting normal breathing.
   - **Bilevel Positive Airway Pressure (BiPAP)**
   - Used for more complex sleep apnoea or those who find CPAP uncomfortable. It provides different pressure levels for inhalation and exhalation.

3. **Oral Appliance Therapy**

   Orthodontic appliances are designed to be worn by the patient in either a permanent or removable manner. These devices are typically crafted to reposition the lower jaw and tongue, helping to keep the airway open and ensuring continuous breathing during sleep.

   Eg: Tongue Retaining Device (TRD) (Fig. 8)

Fig. 8 : Tongue Retaining Device (TRD)

Advantage of Oral Appliances

- Non invasive and comfortable
- Portable and convenient
- Improved quality of life
- Easy to use and maintain
- High patient compliance

Disadvantage of Oral Appliances

- Takes time to adjust
- Minor movement of teeth that can change the bite
- Discomfort to the TMJ
- Gum soreness
- Expensive

Surgical Interventions : In case of severe Obstructive Apnoea

1. **Uvulopalatopharyngoplasty (UPPP) (Fig. 9)**

   This procedure entails the removal of excess tissue from the throat to expand the airway.

2. **Genioglossus advancement**

   Surgery focussed on repositioning the muscle around the tongue to prevent the collapse of airway

3. **Maxillomandibular advancement**

   Procedure involves repositioning the upper and lower jaw forward thus helping in enlarging the airway

4. **Septoplasty and turbinate reduction**

   Procedure correcting structural issues in the nose that leads to nasal obstruction

5. **Bariatrick surgery**

   In cases where obesity is major contributing factor

6. **Inspired therapy**

   Newer option where a device is implanted to stimulate the hypoglossal nerve to keep the airway open

7. **Tracheostomy**

   In severe refratory cases this procedure might be considered.

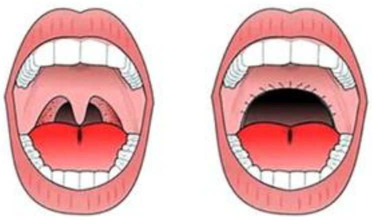

Fig. 9 : Uvulopalatopharyngoplasty.

Conclusion

Obstructive sleep apnea (OSA) is a prevalent and serious sleep disorder marked by repeated breathing interruptions during sleep, caused by a blockage in the airways. Among other health problems, these interruptions can lead to poor sleep quality, lower blood oxygen levels, and an increased risk of heart disease, stroke, and blood clots. Early diagnosis and treatment are key to managing OSA and improving quality of life. Treatment options include lifestyle changes, CPAP therapy, dental treatment, and sometimes surgery. Treating your condition can lower the risk of health issues and enhance your overall well-being.

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    These references will provide a comprehensive backg-round for understanding the impact of sleep apnea on oral health and dental management strategies. Make sure to check the latest available research for updates in this rapidly evolving field.

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The Role of Autogenous Bone Grafts in Maxillofacial Reconstruction : A Literature Review

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Abstract

Maxillofacial reconstruction often requires the use of bone grafts to restore form and function following trauma, tumor resection, or congenital defects. Autogenous bone grafts, obtained from the patient's own skeletal tissue, are considered the gold standard for reconstructive procedures in the maxillofacial region. This review examines the current evidence on the application of autogenous bone grafts in maxillofacial reconstruction. The review explores the biological properties and advantages of autogenous bone grafts, including their osteogenic, osteoinductive, and osteoconductive capabilities. It also discusses the various donor sites commonly used for harvesting autologous bone, such as the iliac crest, calvarium, and intraoral sites, and compares their clinical outcomes and morbidity profiles. Furthermore, the review highlights the use of autogenous bone grafts in specific maxillofacial reconstructive procedures, including alveolar ridge augmentation, sinus floor elevation, reconstruction of mandibular and maxillary defects, and craniofacial deformities. The integration of autologous bone grafts with other materials, such as barrier membranes and growth factors, is also examined. The review concludes by discussing the current limitations, challenges, and future trends in the use of autogenous bone grafts for maxillofacial reconstruction and findings also provide valuable insights for clinicians and researchers in the field of oral and maxillofacial surgery.

Keywords : Maxillofacial reconstruction, autogenous bone grafts, osteoinduction, alveolar ridge augmentation, barrier membranes, growth factors, bone tissue engineering

Introduction

Advanced techniques for treating diseases like jaw tumors, mouth malignancies, congenital abnormalities, and traumatic injuries like fractures are all included in maxillofacial surgery. From minor periodontal problems to intricate segmental jaw deformities requiring the restoration of mechanical function and facial attractiveness, bone grafting is essential for rebuilding these defects.

Allogenic, autologous, or synthetic bone transplants are essential for supporting structural integrity and bone regeneration. The proper integration of a graft depends on methods such as osteoconduction and osteoinduction, which direct the formation of new bone.

Microvascular surgery is one of the latest developments, improving results with accurate soft tissue and bone repair. Adequate vascular supply, infection management, and patient-specific characteristics including health and nutritional state are also important success factors.

In general, successful maxillofacial reconstruction seeks to return bone integrity, facial dimensions, and functional results customized to each patient's requirements. This all-encompassing strategy highlights the continuous improvements in surgical methods and patient care in this specialized area.[1-3]

Discussion

Autogenous Grafts

When utilizing autologous bone grafting, the recipient of the graft's bone is used for the transplant. Since the bone used in this technique comes from the patient, there is less chance of graft rejection, which makes it the ideal option for block graft procedures. Because they are osteoind-

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uctive, osteogenic, and osteoconductive, autologous grafts encourage the formation and fusion of new bone tissue. But one disadvantage of autologous grafts is that they require a second surgical site, which may cause discomfort after the procedure. A blood supply is necessary for every bone graft at the transplant site. To achieve sufficient vascularization, more blood vessels may need to be added to the donor bone and periosteum, depending on the size and location of the graft. With this kind of transplant, the periosteum and related blood arteries, in addition to donor bone, are necessary. This type of graft is referred to as an essential bone graft.[4]

Classification

Classification According To Its Use In Maxillofacial Surgery

Calvarial Bone Graft

- **Cranial bone chips**
  - Alveolar bone reconstruction (adolescent repair)
  - Alveolar cleft
  - Outer table of the cranium reconstruction
- **Outer table partial thickness/potato chip graft**
  - Orbital wall
  - Orbital floor
- **Outer table full thickness**
  - Facial Augmentation
- **Inner table or full thickness graft**
  - Mandibular contour defects
  - Defects of the mentum
  - Zygoma/malar eminence reconstruction
  - Total zygomatic deformities reconstruction (Trea-cher Collins syndrome)
  - TMJ Reconstruction
- **Costochondral Graft**
  - Zygomatic arch
  - TMJ Reconstruction
  - Ear Reconstruction

ILIAC Bone Graft

- **Iliac bone chips**
  - Alveolar bone reconstruction(newborn)
- Non-vascularised iliac graft (Anterior/Posterior)
  - Full thickness defects of mandible
  - Vertical mandibular asymmetry
  - TMJ Reconstruction
- **Vascularised iliac graft (Anterior/Posterior)**
  - Mandibular reconstruction

Scapular Flaps

- Class Ia and IIb Maxillary defect
- Orbital
- Maxillary sinus front wall
- Large craniofacial defects.
- **Tibial Bone Graft**
  - Pathology defect
  - Sinus Augmentation
  - Alveolar cleft
  - Continuity defect of mandible

Fibular Myocutaneous Flaps

- **Non-vascularised**
- **Vascularised**
  - Craniofacial cancer defect reconstruction
  - External orbit
  - Zygoma
  - Condyle
  - Mandible
  - Class II Maxillary defect
  - TMJ Reconstruction

Calvarial Bone Graft

Craniofacial bone grafting is pivotal for reconstructing defects in the craniofacial skeleton, with surgeons generally agreeing that facial bone defects should be addressed with bone grafts and soft tissue defects with soft tissue reconstru-ction.

Cranial bone grafts are widely favoured among craniofa-cial surgeons globally due to their reliability and effective-ness. They are considered the gold standard for craniofacial reconstruction, particularly when excluding vascularized free bone flaps and nonvascularized iliac bone grafts used in man-dibular reconstruction. Composed of membranous bone, cranial grafts are believed to maintain their volume better than other types, especially when securely fixed due to their rigid nature.

The cranial vault is increasingly preferred as a bone donor site due to its proximity to the surgical area, ease of access for harvesting, and ample bone availability. This makes it partic-ularly suitable for various applications such as repairing orbi-tal defects, filling osteotomy gaps, and reconstructing facial cleft deformities. The dense cortical consistency of cranial bone and its robust haversian network facilitate rapid revascu-larization and minimal resorption, making it ideal for reshap-ing the craniomaxillofacial skeleton.

Advantages of cranial bone grafts include their excellent integration, minimal post-operative pain, and absence of vis-ible scarring. However, limitations include the risk associated withthin calvarial bones less than 5mm, which heightens the potential for dural or cerebral injury. Additionally, they are not recommended for cases with significant sagittal misalig-nment between the maxilla and mandible .[5]

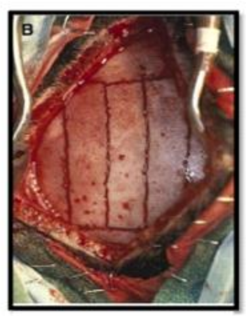

Figure 1 Scalp Dissection With Self Retained Retractors In Place

Figure 2 Multiple struts of corticocancellous bone removed from the outer table of the skull

Figure 3 Intraoperative view of the cranial vault following removal of several split thickness grafts.

Costochondral Rib Graft

Costochondral rib grafts are crucial in mandibular reconstruction, particularly for rebuilding the temporomandibular joint. They mimic the size of the native condyle and their cartilaginous covering supports continued growth, preventing ankylosis at the skull base. This procedure aims to restore ramus length, vertical face height, occlusion, and normal TMJ function, essential for mastication, speech, and growth in children.[6]

When a child has active growth centers, the temporomandibular joint (TMJ) is rebuilt using costochondral rib grafts to treat deformities caused by rheumatoid arthritis, trauma, neoplasms, infections, and congenital dysplasias. When other treatments are not appropriate, they treat adult patients with rheumatoid arthritis, osteoarthritis, and idiopathic condylar resorption that causes TMJ problems. They are also used in cranioplasty, craniomaxillofacial defect reconstruction, nasal dorsum defect correction (saddle nose abnormalities), and costochondral cartilage rebuilding of the ear's helical framework. Recent pulmonary infections, cardiac instability, and a history of restrictive lung disease are all contraindications because they increase risk during surgery and recovery.[7]

Figure 4 : Rib Graft Figure **5 : Removal of Rib**

Iliac Bone Graft

Because autogenous grafts combine structural support with all three of the characteristics of a bone graft-osteogenetic, osteoconductive, and osteoinductive-they remain safe and widely used.[8,9]

The best source of autogenous bone transplant is iliac crest bone graft (ICBG).[10] The iliac crest can be used to harvest both cancellous alone and tricortical transplants.[11,12] Whereas posterior ICBG is obtained for posterior spinal fusion surgeries, anterior ICBG is taken for anterior procedures such as anterior cervical corpectomy and fusion (ACCF) and anterior cervical discectomy and fusion (ACDF).[13-15] We outline the advantages of this method of ICBG harvesting over the traditional approach for patients undergoing ACDF/ACCF.

Figure 8. 10 Incision Site For The Posterior Iliac Crest

Figure 8.11 A Full-thickness Flap, Including The Dorsolumbar Fascia Gluteus Maximus Muscle, And Periosteum, Is Elevated To Expose The Outer Cortex Of The Posterior Ilium.

Anterior Iliac Graft

Key landmarks are noted and the patient is put supine with the hip raised. A lateral incision is made around 2 cm above the iliac crest, starting from above the external iliac vessels. Palpation of the iliac crest and anterior superior iliac spine is used to advise the location of the incision. The incision is placed laterally and inferiorly to lessen pain following surgery along the beltline.

A 4- to 6-cm incision is made along the iliac crest, obliquely aligned, 1-2 cm posterior to the iliac tubercle and 1 cm inferior to the anterior superior iliac spine. The lateral femoral cutaneous nerves, subcostal, and iliohypogastric nerves are circumvented by this method.

An osteotome is used to harvest the corticocancellous block graft, and hemostasis is established before the abdominal wall layers are carefully closed. In order to relieve pain, drains and an epidural catheter are inserted, and the skin is sealed with clips.[16]

Posterioriliaccrest

The patient is placed in a prone posture with 20° of reverse hip flexion, and bone landmarks are highlighted using a hip roll. The superior and middle cluneal nerves are not cut; instead, the incision is made over the gluteus maximus insertion, a triangular fossa.

In order to avoid the cluneal nerves, a 6-to 8-cm curvilinear incision is made after the posterior ilium, centered above the gluteus maximus insertion. The incision goes to the gluteal crease 3 cm laterally and paramedianly. The gluteus medius is gently reflected for more exposure after the lumbodorsal fascia is transected and lifted to reveal the posterior iliac crest.

On the posterior iliac crest, a 5.5 cm osteotomy is done, with additional cancellous bone removed using curettes, following the ridge of the gluteus maximus insertion. Bone wax or collagen is used to produce hemostasis, and the skin, subcutaneous tissue, lumbodorsal fascia, and periosteal layer are closed. To avoid aspirating the marrow, a drain is frequently set to low suction[17]

Scapular Flap

The descending branch of the circumflex scapula artery is used in the parascapular flap, which Nassif first described in 1982. Teot et al. initially demonstrated harvesting the scapula's lateral border on this artery, and they also showed that both the parascapular and scapula flaps, supplied by this artery, could be elevated simultaneously.[18]

Using skin paddles aligned with the transverse or descending branch of the CSA, flap elevation is performed on a prone or lateral decubitus patient. Outlining the scapular flap involves maintaining margins of 2 cm around important features. Above the triangle where the CSA flows, the lateral skin paddle needs to be drawn. The scapular lateral border is where bone is removed, and the flap width should be between 8 and 10 cm. In order to elevate the skin paddle, dissection is carried out medially to laterally, detaching the flap from the underlying muscles until the CSA is reached and exposed.

The CSA's deep segment exhibits three branches that reach the proximal lateral edge of the scapula in the close-up view. For the skin paddles, the cutaneous branch splits into descending and horizontal branches. The infraspinatus and teres minor muscles are sliced 3 cm parallel to the lateral border in order to gain access to the scapular bone. A muscle cuff is left in place. Up to the bone feeders, the muscle is completely transected from the inferior angle.[17]

Reconstructing complex midfacial abnormalities of the orbit, maxilla, skull base, and mandible is accomplished with the use of the chimera flap.[19] It is appropriate for older patients with vascular problems and has minimal donor site morbidity, good scarring, thin, hairless skin, low risk of peripheral vascular disease, and reasonable bone quality. It also permits the use of numerous separate skin paddles. But the quality of the bone is not as good as with DCIA or fibula flaps, and the patient must be repositioned, making it impossible for two teams to operate simultaneously. Furthermore, simultaneous flap harvesting and ablation are not possible.[20]

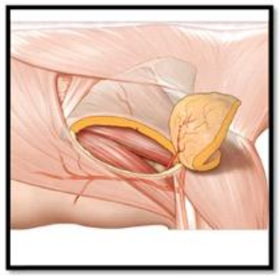

Figure 8 : Flap Location

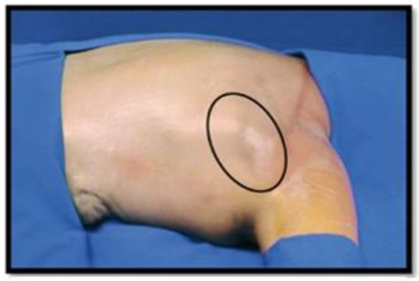

Figure 9 : Elevation of Parascapular Skin Paddle

Free fibula flap

For free-flap mandible repair, the fibula is the chosen donor site because of its uniform shape, sufficient length, and low donor-site morbidity. It can be elevated with a skin island for composite-tissue repair and permits a two-team approach.[21]

Using bone holding forceps, the distal cut end of the fibula is gently dragged out to expose the interosseous border. In order to preserve neurovascular structures, a periosteal stripper is subsequently inserted, leaving the anterior slit laterally and the circular stripper medially. To prevent traction damage to the neurovascular structures, the periosteum is gently rotated around the fibula, especially the medial section that is merged with the interosseous membrane. To reduce neurovascular injury, the graft is administered through the distal incision and rotated to guarantee dissociation from surrounding tissues. Range-of-motion exercises for the knees and ankles are performed after a compression bandage with a plaster slab is worn for a maximum of two weeks. Depending on the wound, gradual weight-bearing is allowed after three to four weeks.[22]

Reconstructing significant defects following oncologic surgery, trauma, or congenital anomalies-especially in the maxilla and mandible-are among the Indications for the fibula flap. It provides enough bone for dental implants, a lengthy bone segment, a dependable skin paddle, and possible innervation .Contraindications include hypercoagulable states, medical illnesses such as vasculitis, connective tissue disorders, and peripheral vascular disease, as well as circumstances not appropriate for prolonged surgery. Implications may include nerve injury, numbness, blood vessel damage, muscular weakness, compartment syndrome, ankle instability, infection, persistent discomfort, and even limb loss.[23-26]

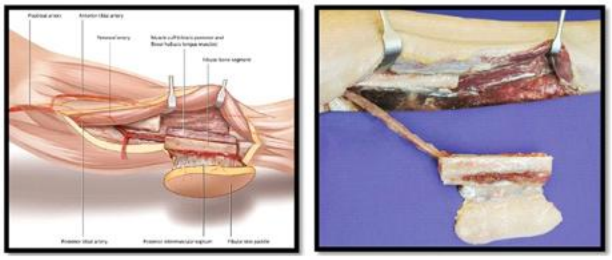

Figure10 : Flap raising completed

Tibialbone graft

Catone and colleagues first described the use of the tibia as a donor graft site for maxillofacial reconstruction in 1992, describing 20 examples in detail. Since then, it has attracted new attention and has been applied to significant jaw reconstructions as well as orthognathic, cleft, and preprosthetic operations.[27]

Defect size and form are the most crucial factors in determining how much bone graft needs to be collected when choosing a donor site.[28]

Numerous publications have recommended tibial bone harvesting for oral surgical repair because the proximal tibia is a good supply of cancellous bone [29,30,31,32,33]

The literature states that the tibia has several benefits as a donor location, including high availability of cancellous bone, a less invasive procedure, and a low rate of complications.[34, 35] It is also a quick and easy process from a technical standpoint, and it permits both recipient site augmentation and simultaneous harvesting.[29]

The process is recommended for various diseases, non-union of jaw fractures, consequences of orthognathic surgery, and bone volume augmentation in oral implantology. Its benefits include a low rate of complications, a significant volume of cancellous bone, and ease of technical execution.[36] But there's a chance for problems, such hemorrhage, tibia fractures, big hematomas, ecchymosis, excruciating pain, deep infection, and transient loss of sensation. Gait abnormalities and paresthesia are examples of late problems; unsightly scarring is an example of a long-term problem.[37]

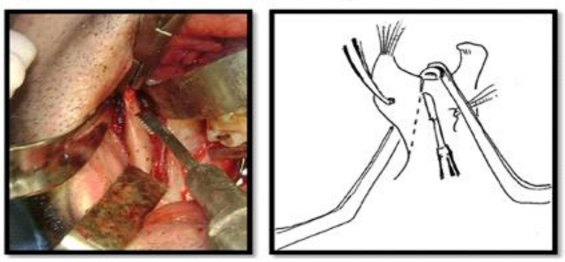

Figure 11 : The can cellous bone is removed with the orthopedic curettes.

Intraoralgrafts

Following orthognathic surgery, jaw fractures, non-union of jaw fractures, multiple pathologies, and bone volume augmentation in oral implantology are among the conditions for which the operation is suggested. Its benefits include having a low rate of complications, being technically simple, and offering a significant volume of cancellous bone. Early problems including bleeding, tibia fractures, massive hematomas, ecchymosis, excruciating pain, deep infection, and transient sensory loss are examples of potential complications that could occur. Long-term problems could include unsightly scarring, while late concerns could include paresthesia and abnormalities in gait.[37]

Figure 12 : Exposed parasymphysis region for grafting

Autologous bone is considered the best material to use for bone grafting in atrophic mandibles. The mandibular ramus and coronoid process are especially preferred because of their favorable qualities. The bone from these regions has numerous advantageous qualities that make it a popular option for successful grafting treatments, despite the fact that no grafting material is flawless.[36]

Figure13 : Coronoid bone graft harvesting

Through transoral incisions, small cortical grafts can be obtained with little morbidity to the donor site from the retromolar areas of the maxilla and mandible. Retromolar bone transplants are appropriate for the same causes as chin bone grafts, despite being more difficult to reach and having less bone accessible overall. In addition, if the patient has their wisdom teeth out, this location should be taken into account.[37]

Figure14 : Retromolar area of the mandible

Conclusion

The best option for correcting bone abnormalities in oral and maxillofacial, spinal, and trauma operations is autogenous bone transplants; the graft location is chosen based on anatomical considerations and individual requirements. Understanding the dangers of autogenous bone harvesting, including uncommon but serious consequences, is still essential even when bone substitutes are becoming more widely used. Vascularized bone flaps are especially useful in maxillofacial reconstruction because they can tolerate masticatory stresses and adequately repair the oromandibular complex, even in damaged areas. Donor sites such the scapula, iliac crest, and fibula offer sufficient soft tissue for covering and enough bone for implants; the osteocutaneous flap in the fibula is the most versatile. Novelties such as the double free flap with tensor fascia-lata, the pedicled myoosseous flap with a free skin flap.

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I.T.S Dental College, Ghaziabad

Prosthodontist Day was celebrated with great enthusiasm by the Department of Prosthodontics and Crown & Bridge at I.T.S Dental College, Ghaziabad on 22nd January, 2025. The celebration aimed to raise awareness about the specialized field of Prosthodontics and its significant role in oral health. To mark this occasion, various events such as were organized. The celebration started with an educational webinar for the students and faculty of the college on the topic 'Prosthodontic Treatment Options in Implants' by renowned Prosthodontist and academician, Dr. Vibha Shetty, Professor in the Department of Prosthodontics, Faculty of Dental Sciences, Ramaiah University of Applied Sciences, Bangalore.

Various engaging events like Best out of Dental Materials, rangoli competition and cast painting competition were organized for the students of the college who showed their literary, artistic and creative skills with their participation. Nukkad Natak was conducted which emphasized the role of a prosthodontist in the society and which treatments are covered under the specialty of Prosthodontics

The highlight of the Prosthodontist Day celebration was the distribution of free dentures by Secretary, I.T.S – The Education Group, Mr. B.K. Arora and Director Principal Sir, Dr. Devi Charan Shetty, to the under privileged patients as a part of a Free Denture Camp condu-cted by the Department of Prosthodontics and Department of Public Health Dentistry under the noble initiative “Muskaan: An Initiative to Reach the Unreached” started by I.T.S Dental College, Ghaziabad. Also present were Dr. Pankaj Datta, HOD, Department of Prosthodontics, Prof. Dr. Siddhi Tripathi, Dr. Gita, Dr. Karvika, Dr. Deepika, Dr. Arjita, Dr. Sunil, Dr. Niharika and Dr. Prachi. The event was appreciated by the Deans, Head of Departments and faculty members of the college. The event witnessed an overwhelming response from the community with more than 100 dentures delivered to the patients and marked a significant milestone in advancing dental care accessibility and awareness. The celebration concluded with the felicitation of the volunteers and winners of the various competitions. The celebration witnessed huge media coverage. Our heartfelt gratitude to our respected Chairman, I.T.S-The Education Group, Dr. R.P Chadha and Honorable Vice Chairman, I.T.S-The Education Group, Shri Arpit Chadha, for their unflinching support and guidance towards the celebration of Prosthodontist Day.

Kalka Dental College, Meerut

Celebrating Pioneering Spirit in Prosthodontics

January 22nd, 2025, was a landmark day at Kalka Dental College as the Department of Prosthodontics and Crown and Bridge commemorated Prosthodontics Day with unwavering enthusiasm. This momentous occasion honours the ground breaking contributions and advancements in the realm of prosthodontics.

The festivities commenced with an inaugural address by PG students of the Department of Prosthodontics and Crown and Bridge. In their address, they underscored the paramount importance of prosthodontics in reinstating oral function, aesthetics, and overall quality of life.

The celebration showcased an array of activities, including a tooth preparation competition, which witnessed fervent participation from students. The competition aimed to assess the students' proficiency in preparing teeth for various prosthodontic procedures.

Furthermore, the department organized an assortment

DJ Dental College, Modinagar

Prosthodontic Day Celebration at the Department of Prosthodontics, DJ College of Dental Science & Research, Modinagar (UP) on 22nd January 2025.The Prosthodontic Day was celebrated in the Department of Prosthodontics, DJ College of Dental Science & Research with great joy. The event featured various activities and competitions for students. Day commenced with lamp lightening and then Fun Dental Quiz was organised. Enthusiasm of undergraduates participation in slogan writing and fireless cooking competition made this day more special. Free Denture Camp was organised in the Department providing essential oral healthcare services to the old age people. A 'Nukkad Natak' was performed by the post graduates demonstrating the requirement for replacement of missing teeth, Post insertion instructions including maintenance of removable prosthesis.In the last cake cutting ceremony was held and eatables were distributed among the patients.This thoughtful combination of event not only showcased the department's commitment to the professional excellence but also it's dedication to community engagement and social responsibility.Happy Prosthodontist Day

of competitions, including a Glass Painting competition, a Selfie stand-making competition, and a Prosthodontic models-making competition. Our students created breathtaking masterpieces that showcased their artistic flair and technical expertise.

The event culminated with the distribution of prizes to the winners of the tooth preparation competition and a vote of thanks.

The Prosthodontics Day celebrations at Kalka Dental College served as a testament to the institution's unwavering commitment to fostering excellence in prosthodontic education and patient care. The department's endeavors to remain at the forefront of the latest advancements in the field will undoubtedly yield benefits for students and patients alike.

IDST Dental College, Modinagar

Celebrated Prosthodontic Day with an engaging series of events aimed at raising awareness about the critical role prosthodontics plays in dental care. Held at the college campus, the celebration brought together students, faculty, and dental professionals for a day of learning and fun.

The event started with a keynote speech by Dr. Gaurav Mathpal, a renowned prosthodontist, who highlighted the advancements in prosthodontic techniques, including digital dentistry, 3D printing, and implantology. He emphasized on the topic of nutrition in the elderly patients and the challenges faced by the elderly in the various aspects of life.

More than 50 dentures were distributed free of cost to elderly patients and they were given all the instructions to how should they use and take care of the prosthesis. The patients were provided with denture cleaning brushes and cleansers and also were educated on how to use them.

Throughout the day, several workshops and demonstrations were cond-ucted. Students participated in various competitions such as soap carving, slogan writing and best out of dental materials, Under graduate and post graduate students readily participated in the competition and winners were distributed with prizes and certificates at the department. The highlight of the celebration was a key note lecture for the geriatric patients, where stud-ents and faculty members showed their keen interest. The patients had an elaborated discussion with the guest speaker Dr. Gaurav Mathpal, discus-sing various aspects of elderly challenges and how to deal with them.

The event also featured a friendly competition, where students showcased their knowledge of prosthodontic procedures and competed in quizzes, fostering a spirit of collaboration and learning. Awards were given to the top performers.

The celebration concluded with a networking session, allowing post graduate students and professionals to discuss emerging trends and career opportunities in the field of prosthodontics. It was an enriching experience for all involved, reinforcing the importance of prosthodontics in modern dentistry.

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Shree Bankey Bihari Dental College Ghaziabad

On the auspicious occasion of Oral and Maxillofacial Surgery Day, the Department of Oral Surgery at Shree Bankey Bihari Dental College organized a special program centered around the theme of oral cancer.

Dr. Alok Bhatnagar, Head of the Department, delivered a comprehensive review of the program, followed by an awareness video presentation.

On this occasion Dr. Balram Garg (Prof), Dr. Pallavi Srivastava (Reader), Dr. Karan Sublok (Reader), Dr. Ashish kumar Kushwaha (Reader), Dr. Tapan Kumar Singh (Senior Lecturer) We were honored to have Dr. Piyush Garg, a highly renowned oncosurgeon, as our chief guest, whose inspiring words left a lasting impact on the audience.

The event featured an internal quiz competition and a face painting contest, adding an element of engagement and creativity. A high tea was arranged for all attendees, fostering interaction and discussion.

The program concluded with a powerful nukkad natak (street play), effectively spreading awareness about oral cancer. Additionally, awareness pamphlets were distributed to the public to further educate them on the importance of early detection and prevention.

Subharti Dental College Meerut

Celebrating Oral and Maxillofacial Surgery Day with Service and Care on the occasion of Oral and Maxillofacial Surgery (OMFS) Day, the Department of Oral and Maxillofacial Surgery at Subharti Dental College organized a special initiative to serve the commu-nity. As a part of this celebration, free medication was prov-ided to all patients who had undergone dental extractions, ensuring their post-operative comfort and recovery.

Oral and Maxillofacial Surgery Day is observed to recognize the vital role of maxillofacial surgeons in treating a wide range of conditions, including facial trauma, oral cancer, congenital anomalies, and complex dental procedures. The event was graced by our esteemed faculty and dedicated postgraduate students, who are committed to advancing patient care and surgical excellence.

Through this initiative, we reaffirm our dedication to providing accessible and high-quality surgical care, while also raising awareness about the specialty of Oral and Maxillofacial Surgery.

IDST Dental College Modinagar

The Department of Oral And Maxillofacial Surgery at Institute Of Dental Studies And Technologies, Modinagar celebrated the International Oral And Maxillofacial Surgeons' Day on 13th Feb 2025. The theme of this year was early detection and prevention of oral cancers. The department organized a guest lecture inviting Dr. Sowrabh Arora, director of surgical oncology, head and neck surgeon from Max Vaishali and Patparganj. The program was graced by Principal Dr. Nidhi Agarwal addressing the crowd and giving a brief about the institution. Dr. Gaurav Mittal, Director of post-graduation Studies introduced the guest speaker to the gathering, the program was attended by all the head of the departments, faculties from various departments, postgraduate students, interns and undergraduate students from the college. The lecture delivered by Dr. Sowrabh Arora gave us an insight about the importance and need for the early detection of oral cancers, he explained about the various techniques and methodology to perform an early detection. The lecture was very informative and the share of knowledge we received from our guest lecturer was over-whelming, it lead us to do more brainstorming about the newer aspects of oral cancers from various perspectives. The lecture was followed by a open quiz where we saw huge participation from the students. The program was concluded by showing a short video depicting the achievements and work done by OMFS dept during the past year.

DJ College of Dental Modinagar

The Department of Oral and Maxillofacial Surgery at DJ College of Dental Sciences, Modinagar celebrated International Oral and Maxillofacial Surgeon's Day on February 13th, 2025 with a series of impactful events. The main theme of the programme was "early Detection And Prevention Of Oral Cancer."

The Celebrations included various engaging student activities such as Best out of Waste, Quiz, Salad Platter Decor followed by NukkadNatak. The undergraduate and postgraduate students participated enthusiastically showcasing their creativity and skills. Winners were awarded at a special ceremony which was attended by key dignitaries, including Honourable CEO, Dr. Smiti Jassar, Principal Dr. Pradeep Shukla, Dean- PG and UG Studies, Head of Departments and faculty members.

Aa Nukkadnatak was also organised in Raj Chopla, Modinagar and Government High School, Niwaridemonstrating the cause, early detection and prevention of oral cancer to create awareness among the community.

The Day culminated with a cake-cutting ceremony to mark the occasion and celebrate the contributions of Oral and Maxillofacial Surgery to the field of Dentistry.

The celebrations were a resounding success, highlighting the Department commitment to community welfare, student engagement and patient care and upgrading to keep abreast with the latest technologies.

Save The Girl Child

"Girls are Diamonds. Shape them for the Betterment of the Generation" - Afzal A. Zaidi

I am **Sehba Zaidi**, and I aspire to write an exceptional article on "Save the Girl Child." My journey begins with the profound influence of my parents, both esteemed government servants. My mother, a dedicated educator in the Home Science Department, and my father, an Assistant Librarian at Chaudhary Charan Singh University in Hisar, instilled in me the unwavering values of love, respect, and the pursuit of knowledge.

Their unwavering support guided me towards a Master's degree in Mass Communication. I found my life partner in **Afzal Abbas Zaidi**, a successful businessman from Bijnor. Our family is blessed with two children - a son, **Ali**, and a daughter, **Shiri**.

Following in my parents' footsteps, I have nurtured **Shiri** with the same love and unwavering belief in her potential.

I enrolled **Shiri** in an ICSE board school, fostering an environment of academic excellence. Alongside my husband, I have actively contributed to our flourishing business, now expanding across the Asian market.

Our dedication to advancing the field of dentistry is evident through the publication of two esteemed International Journals : **Updent** (www.updent.in) and **Heal Talk Dental Journal** (www.healtalk.in), both of which have been illuminating the path for dental professionals for the past 18 years.

However, I am acutely aware that my daughter's journey has been privileged. Many girls in India face formidable obstacles in accessing quality education. Deep-rooted societal norms often prioritize the education of boys, while poverty forces many girls into domestic responsibilities, hindering their academic pursuits.

The lack of accessible and safe schools, particularly in rural areas, further exacerbates the issue. The threat of child marriage and early pregnancies casts a long shadow, prematurely ending the educational journeys of countless young girls.

Yet, education is not merely a right; it is the key to unlocking a girl's true potential. An educated girl is empowered to make informed choices, break free from the shackles of poverty, and become a catalyst for positive change within her community.

Let us strive to dismantle the barriers that hinder girls' education. Let us invest in their future, nurture their dreams, and ensure that every girl child has the opportunity to shine.

Sehba Zaidi
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Editor - Heal Talk Dental Journal
Managing Editor - Updent Dental Journal

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