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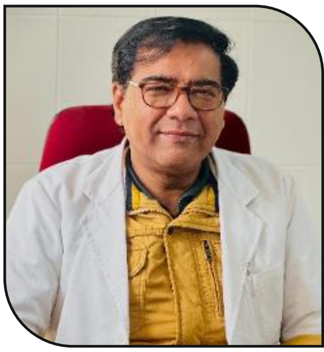

Editorial

From The Desk of Guest Editor.....

Geriatric Care in Dentistry

Restoring Function, Dignity, and Quality of Life

"Prosthodontic care for the elderly is not merely tooth replacement; it is life rehabilitation."

Abstract

The global rise in life expectancy has led to a rapidly expanding geriatric population, presenting dentistry with unique clinical, ethical, and functional challenges. Elderly patients often exhibit complex oral conditions influenced by systemic diseases, polypharmacy, reduced neuromuscular control, and psychosocial factors. Geriatric dentistry therefore demands a shift from conventional treatment centered approaches to patient centered, function oriented care. Prosthodontics plays a pivotal role in this transition by restoring mastication, speech, esthetics, and overall quality of life. This editorial highlights the importance of comprehensive geriatric dental care, emphasizes prosthodontic considerations in aging patients, and underscores the need for empathy, adaptability, and interdisciplinary collaboration in managing the elderly population.

Keywords

Geriatric Dentistry; Prosthodontics; Edentulism; Aging population; Quality of life

The Changing Demographics and Oral Health Burden

The world is witnessing a profound demographic transition characterized by a steady increase in the elderly population due to advances in healthcare and improved life expectancy. As a result, dental professionals are increasingly required to manage oral health needs of older adults who present with complex medical, functional, and psychosocial profiles. Unlike younger patients, geriatric individuals often exhibit cumulative oral disease burden, including extensive tooth loss, periodontal breakdown, attrition, erosion, and multiple restorations of varying quality and longevity.

Although complete edentulism has declined in recent decades, it remains a significant concern among the very old and socio-economically disadvantaged groups. Additionally, the retention of natural teeth into old age is frequently accompanied by compromised periodontal support and reduced adaptability to functional stress. Age related changes such as thinning of oral mucosa, reduced vascularity, diminished bone density, and delayed healing further complicate dental treatment. These biological changes, combined with systemic illnesses like diabetes, cardiovascular disease, and osteoporosis, demand careful risk assessment and modification of treatment strategies.

From a geriatric dentistry perspective, the emphasis must shift from idealized restorative goals to realistic, function preserving care. The challenge lies not only in treating disease but also in maintaining oral comfort, preventing further deterioration, and ensuring that dental interventions contribute positively to the patient's overall well being.

Prosthodontic Challenges in the Elderly Patient

Prosthodontic management of elderly patients is uniquely challenging due to anatomical, physiological, and functional alterations associated with aging. Severe residual ridge resorption, loss of vertical dimension, reduced salivary flow, and compromised neuromuscular control significantly influence the prognosis of removable and fixed prostheses. Xerostomia, often induced by polypharmacy, adversely affects denture retention, increases frictional irritation, and predisposes patients to mucosal trauma and candidiasis.

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Complete denture fabrication in geriatric patients requires meticulous attention to impression techniques, occlusal schemes, and polished surface contours to enhance stability and minimize tissue injury. Similarly, removable partial dentures must be designed to distribute forces optimally, considering weakened abutments and reduced periodontal support. While implant supported prostheses offer superior retention and function, their use in elderly patients must be carefully evaluated in light of systemic health, bone quality, surgical tolerance, and economic feasibility.

Equally critical is the patient's ability to adapt to prostheses. Cognitive decline, reduced manual dexterity, and impaired motor coordination can affect prosthesis handling, hygiene maintenance, and follow-up compliance. Therefore, prosthodontic success in geriatric patients depends not only on biomechanical principles but also on simplicity of design, patient education, and long-term maintainability.

Function, Nutrition, and Quality of Life

Oral health in the elderly is directly linked to nutrition, speech, social interaction, and self-esteem. Poorly fitting prostheses can lead to inadequate mastication, resulting in avoidance of fibrous and protein rich foods, thereby contributing to malnutrition and systemic decline.

Prosthodontic rehabilitation has been shown to significantly improve oral health related quality of life (OHRQoL). Restoration of vertical dimension, occlusal harmony, and facial support not only enhances function but also restores dignity and confidence. Thus, the success of geriatric prosthodontic treatment should be measured not solely by clinical parameters, but by patient comfort, satisfaction, and daily functionality.

The Need for a Holistic and Interdisciplinary Approach

Geriatric dental care inherently requires a holistic and interdisciplinary approach due to the close interrelationship between oral health and systemic well-being. Elderly patients often suffer from multiple chronic conditions and are on long-term medications that influence oral tissues, healing capacity, and treatment outcomes. Conditions such as dementia, Parkinson's disease, arthritis, and stroke can significantly affect a patient's ability to cooperate, adapt to prostheses, and maintain oral hygiene.

Effective prosthodontic care for geriatric patients frequently necessitates collaboration with physicians, caregivers, nutritionists, and other healthcare professionals. Caregiver education becomes particularly important for dependent elderly individuals, ensuring proper prosthesis maintenance and timely reporting of oral discomfort or pathology. Regular recall visits and preventive protocols must be emphasized to detect early signs of tissue trauma or prosthesis related complications.

Dental education and clinical practice must evolve to incorporate geriatric specific training, focusing on empathy, communication, and adaptability. Simplified treatment plans, minimally invasive procedures, and realistic expectations are essential components of successful care. Ultimately, managing geriatric patients is not solely a technical endeavor but a compassionate commitment to improving their quality of life through thoughtful and patient-centered prosthodontic care.

Conclusion

Geriatric dental care represents one of the most humane and impactful domains of dentistry. Prosthodontics, in particular, stands at the forefront of restoring not just teeth, but function, nutrition, confidence, and social well being in the elderly. As the aging population continues to grow, the dental profession must evolve to embrace minimally invasive, patient centered, and dignity preserving treatment philosophies. Ultimately, successful geriatric prosthodontic care lies in recognizing that every prosthesis delivered is not merely a clinical service, but a means of enhancing the final chapters of a patient's life.

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CONTENTS

II Updent Publication
III Coltene-I
IV Guest Editorial
Dr. Varun Kumar
V Trihawk
VII Prime Dental - I
VIII Star Editorial Team
IX Prime Dental - II
X Indexing

12 Salivary and Gingival Crevicular......
Dr Poonam Yadav
15 Full Arch Implant Rehabilitation...
Dr Nawab Zaan
19 Enhancing Orthodontic Treatment ...
Dr Alapan Banerjee
23 Modified Vestibular Incision...
Dr Diksha Gupta
26 Suture Materials in Dental Practice...
Dr Junaid Ahmad
30 Management of a Circumferential...
Dr Soumya Parmar
34 Designing and Fabricating ...
Dr Shivani Anand
38 Occlusal Veneers...
Dr Shefali Singla
42 Proteomic Analysis of Periodontal ...
Dr Aditi Dhama
47 Caries Risk Assessment...
Dr Sreelakshmi Jayalal
51 Role of Digital and AI based...
Dr Ahana Sharma
54 Aesthetics In Implants...
Dr Kamaldeep Singh
59 Contemporary Controversies....
Dr Puja Kumari
61 Laser Therapy in Periodontics...
Dr Shipra
63 Comparision of Healing ...
Dr Shweta Gupta
66 Comparative Evaluation ...
Dr Aamina Nisar
68 Effects of Non-Steroidal...
Dr Aayushi Asthana
72 Campus Talk - News
80 Updent Publication
81 Swadeshi Instrument
82 Editor’s Notes
83 Industry Talk
85 Coltene - II
86 PYRAX
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Salivary and Gingival Crevicular Fluid Biomarkers in the Early Diagnosis of Periodontitis: A Narrative Review

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Abstract

Background: Periodontitis is a chronic inflammatory condition characterized by progressive destruction of periodontal supporting tissues. Conventional diagnostic tools such as probing depth and radiographs primarily reflect historical tissue damage and do not adequately indicate current disease activity. Biomarkers present in saliva and gingival crevicular fluid (GCF) have emerged as potential tools for early detection and monitoring of periodontal disease.

Objective: This review aims to critically evaluate host derived, microbial, and genetic biomarkers in saliva and GCF that may facilitate early diagnosis and risk assessment of periodontitis.

Methods: A structured literature review was conducted using electronic databases including PubMed and Scopus. Articles published between 2005 and 2025 focusing on salivary and GCF biomarkers for periodontal diagnosis were analysed. Clinical trials, cohort studies, and systematic reviews were considered.

Results: Among the various biomarkers studied, inflammatory mediators such as IL-1β, IL-6, TNF-α, and matrix metalloproteinases particularly active MMP-8 demonstrate significant diagnostic value. Biomarkers associated with bone metabolism (RANKL/OPG ratio) and specific periodontal pathogens also show promising correlations with disease activity.

Conclusion: Biomarker based diagnostics represent a paradigm shift toward predictive and personalized periodontal care. Although promising, further standardization and longitudinal validation are necessary before routine implementation in clinical practice.

Keywords: Periodontitis, Saliva, Gingival crevicular fluid, Biomarkers, Early diagnosis, MMP-8.

1. Introduction

Periodontitis is a biofilm associated inflammatory disease that leads to destruction of the periodontal ligament and alveolar bone. The disease progresses in a site-specific and episodic manner, making early detection particularly challenging[1]. Traditional clinical parameters including probing pocket depth, bleeding on probing, and radiographic bone levels identify cumulative tissue loss rather than ongoing inflammatory activity.[2,3]

The contemporary classification system proposed by the American Academy of Periodontology and the European Federation of Periodontology emphasizes staging and grading of periodontitis, incorporating risk factors and rate of progression [4,5]. However, reliable biological indicators capable of identifying active disease at an early stage remain limited.[6]

Saliva and gingival crevicular fluid offer accessible biological media that reflect both local and systemic inflammatory responses.[7] Advances in molecular diagnostics and proteomics have accelerated research in this domain, highlighting the potential of biomarkers as adjunctive diagnostic tools.[8]

2. Biological Basis for Biomarker Utilization

Periodontitis develops as a consequence of dysbiosis within the subgingival microbiome and an exaggerated host immune inflammatory response. Bacterial virulence factors stimulate the release of cytokines, chemokines, and enzymes that mediate connective tissue degradation and bone resorption.[9,10]

During this process, inflammatory mediators and degradation products are released into GCF and subsequently mix with whole saliva. These measurable substances provide insight into ongoing biological activity within periodontal tissues, thereby forming the rationale for biomarker based diagnostics.[11]

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3. Classification of Periodontal Biomarkers

3.1 Inflammatory Mediators

Pro-inflammatory cytokines play a central role in periodontal tissue destruction.

- Interleukin-1β (IL-1β): Strongly associated with initiation and amplification of inflammatory response. Elevated levels correlate with disease severity.[12]
- Interleukin-6 (IL-6): Contributes to B-cell activation and osteoclast differentiation.[12,13]
- Tumor Necrosis Factor-α (TNF-α): Promotes connective tissue breakdown and bone resorption.[14]

Among these, IL-1β in GCF consistently demonstrates high sensitivity for identifying early periodontal inflammation.[15]

3.2 Matrix Metalloproteinases (MMPs)

Matrix metalloproteinases are proteolytic enzymes responsible for extracellular matrix degradation.[15,16]

- MMP-8 (collagenase-2)
- MMP-9 (gelatinase-B)

Active MMP-8 (aMMP-8) has been extensively investigated and shows strong association with active periodontal breakdown. Chairside assays detecting aMMP-8 provide rapid results and have demonstrated favorable diagnostic accuracy in clinical studies.[17]

3.3 Biomarkers of Bone Turnover

Bone resorption is a defining feature of periodontitis. Several markers reflect osteoclastic activity:[17,18]

- RANKL (Receptor Activator of Nuclear Factor- kB Ligand)
- Osteoprotegerin (OPG)
- RANKL/OPG ratio
- Osteocalcin
- ICTP (cross-linked carboxyterminal telopeptide)

An increased RANKL/OPG ratio is indicative of enhanced bone resorption and correlates with disease progression.[18]

3.4 Microbial Biomarkers

Specific periodontal pathogens are strongly associated with disease activity. Detection methods such as polymerase chain reaction (PCR) enable identification of key bacteria including:[19,20]

- Porphyromonas gingivalis
- Tannerella forsythia
- Treponema denticola

Quantification of these pathogens, combined with host-response markers, may improve diagnostic precision.[20]

3.5 Genetic and Epigenetic Markers

Genetic susceptibility contributes to variability in disease progression. Polymorphisms in cytokine genes particularly IL-1have been investigated as potential risk indicators. Additionally, epigenetic modifications and microRNAs (e.g., miR-146a, miR-155) are emerging as novel biomarkers with potential prognostic value.[19]

4. Comparison Between Saliva and Gingival Crevicular Fluid

Feature	Saliva	Gingival Crevicular Fluid
Invasiveness	Non-invasive	Minimally invasive
Specificity	Reflects whole mouth status	Site-specific information
Collection complexity	Simple	Technique sensitive
Screening suitability	High	Moderate

Saliva is advantageous for population based screening due to ease of collection. In contrast, GCF provides localized information about specific periodontal sites, making it more suitable for monitoring disease activity.[20]

5. Clinical Applications

Biomarker analysis offers several potential benefits:[19,20]

- Early detection before clinical attachment loss becomes evident
- Monitoring therapeutic response following scaling and root planing
- Risk stratification in medically compromised patients
- Adjunctive support for staging and grading decisions

Point of care technologies, including lateral flow immunoassays and biosensors, are increasingly being developed to facilitate chairside application.

6. Limitations and Challenges

Despite promising findings, several limitations persist:[11,12,19]

- Lack of universally accepted diagnostic thresholds
- Variability in sampling and laboratory methods
- Influence of systemic inflammatory conditions
- Economic considerations in routine practice

Standardization of methodologies and large scale longitudinal studies are required for clinical translation.

7. Future Directions

Emerging technologies such as multiplex biomarker panels, salivary proteomics, and artificial intelligence assisted diagnostics may enhance predictive accuracy[18]. Integration of biomarker analysis into routine periodontal assessment could contribute to personalized treatment planning and improved patient outcomes.[15,16,20]

8. Conclusion

Biomarkers present in saliva and gingival crevicular fluid represent promising adjuncts for early identification of periodontal disease activity[17,18]. Among the currently studied markers, active MMP-8 demonstrates strong clinical applicability[19]. However, further validation and consensus on diagnostic criteria are essential before widespread adoption in routine periodontal practice[20].

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Full-Arch Implant Rehabilitation: Conventional vs Digital Workflow - A Narrative Review

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Abstract

Full-arch implant rehabilitation has emerged as a predictable and transformative treatment modality for completely edentulous patients. Traditionally performed using analog workflows involving conventional impressions, facebow transfer, and laboratory driven prosthesis fabrication, the advent of digital dentistry has significantly altered treatment paradigms. Digital workflows incorporating intraoral scanning, CBCT guided implant planning, CAD/CAM fabrication, and 3D printing have enhanced precision, reduced chairside time, and improved patient comfort.

This narrative review aims to comprehensively compare conventional and digital workflows in full-arch implant rehabilitation, analyzing clinical steps, accuracy, efficiency, prosthetic outcomes, cost considerations, and biological implications. Clinical evidence suggests that while both approaches yield predictable outcomes, digital workflows offer superior reproducibility, streamlined communication, and enhanced prosthetic accuracy. However, limitations such as equipment cost and learning curve remain relevant.

Digital protocols represent a paradigm shift but should be integrated judiciously based on clinical expertise and case complexity.

Keywords: Full-arch rehabilitation, Digital workflow, Conventional workflow, CAD/CAM, Guided surgery, Implant prosthodontics.

Introduction

Full arch implant rehabilitation restores function, phonetics, esthetics, and patient confidence in completely edentulous individuals. Historically, treatment relied heavily on conventional analog techniques including elastomeric impressions, articulator mounting, and lost wax prosthetic fabrication.

The integration of digital technologies CBCT imaging, intraoral scanners, virtual implant planning, and CAD/CAM prostheses has revolutionized implant dentistry. Digital dentistry enhances precision, reduces human error, and allows prosthetically driven implant placement.

This review analyzes and compares conventional and digital workflows in full-arch implant rehabilitation.

Conventional Workflow in Full-Arch Rehabilitation

Clinical Steps

1. Diagnostic impressions (alginate/ elastomeric)
2. Facebow transfer
3. Mounting on articulator
4. Radiographic stent fabrication
5. Open/closed tray implant level impressions
6. Master cast fabrication
7. Verification jig
8. Wax try-in
9. Metal framework casting
10. Final prosthesis delivery

Figure X. Conventional workflow in full-arch implant rehabilitation.

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Clinical Representation – Conventional Workflow

Figure X. Conventional Impression for Full-Arch Implant Rehabilitation

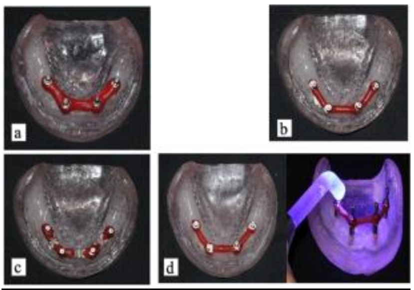

Figure X. Verification Jig Fabrication and Intraoral Validation in Full-Arch Implant Rehabilitation

Advantages

- Established long-term evidence
- Lower initial investment
- Familiarity among clinicians

Limitations

- Technique sensitive
- Dimensional distortion of impressions
- Increased chairside time
- Multiple laboratory steps
- Risk of misfit in long-span prostheses

Digital Workflow in Full-Arch Rehabilitation

Clinical Steps

1. CBCT acquisition
2. Intraoral scanning
3. Virtual implant planning
4. 3D surgical guide fabrication
5. Guided implant placement
6. Scan body placement
7. Digital impression
8. CAD design of prosthesis
9. CAM milling or 3D printing
10. Delivery (often immediate loading possible)

Clinical Representation - Digital Workflow

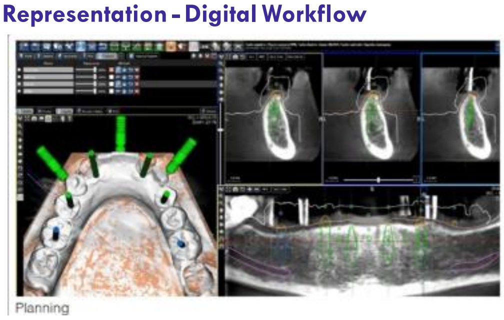

Figure X. Digital Implant Planning in Full-Arch Rehabilitation Using CBCT-Based Workflow

Figure X. Intraoral Scanning in Digital Workflow for Full-Arch Implant Rehabilitation

Advantages

- Enhanced accuracy
- Reduced clinical appointments
- Immediate loading capability
- Improved patient comfort (no impression material)
- Streamlined communication

Limitations

- High equipment cost
- Learning curve
- Scanner limitations in edentulous arches
- Dependence on software accuracy

Comparative Analysis

Parameter	Conventional Workflow	Digital Workflow
Impression	Elastomeric material	Intraoral scanning
Implant Planning	2D radiographs	CBCT-based 3D planning
Surgical Guide	Manual fabrication	CAD/CAM 3D printed
Framework	Cast metal	Milled titanium/zirconia
Appointments	Multiple	Reduced
Immediate	Loading Limited	More predictable

Table 1: Step-by-Step Workflow Comparison

Factor	Conventional	Digital
Dimensional Stability	Risk of distortion	High precision
Framework Passive Fit	Technique dependent	CAD accuracy
Error Source	Human/lab errors	Software calibration
Long-span Accuracy	Variable	Improved

Table 2: Accuracy and Fit

Parameter	Conventional	Digital
Chairside Time	Longer	Reduced
Lab Communication	Physical models	Digital files
Remakes	Higher Risk	Reduced
Patient Comfort	Moderate	High

Table 3: Clinical Efficiency

Biological and Prosthetic Considerations

Conventional

- Impression inaccuracies may cause misfit
- Micro-gap formation peri-implant bone loss
- Increased laboratory variability

Digital

- Improved passive fit
- Enhanced marginal integrity
- Prosthetically driven implant placement reduces biomechanical stress

Cost Analysis

Component	Conventional	Digital
Initial Setup	Low	High
Per Case Cost	Moderate	Reduces over time
Long-term Efficiency	Moderate	High
ROI	Slow	Faster in high -volume practice

Table 4: Economic Comparison

Digital systems require significant initial investment in CBCT, scanners, software licenses, and milling units. However, long-term benefits include increased productivity and reduced remakes.

Immediate Loading Protocols

Digital workflows facilitate same day prosthesis fabrication through virtual planning and prefabrication of provisional prostheses.

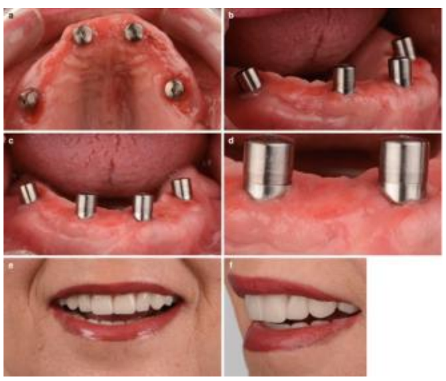

Figure X. Clinical Sequence of Multi-Unit Abutment Placement and Definitive Full-Arch Prosthesis Delivery

Figure X. Definitive Full-Arch Implant-Supported Hybrid Prosthesis

Discussion

Full-arch rehabilitation demands high precision due to long-span frameworks and biomechanical loading patterns. Conventional workflows have demonstrated decades of clinical success. However, inherent limitations such as impression distortion and laboratory variability may compromise passive fit.

Digital workflows reduce cumulative error by eliminating multiple analog steps. CBCT guided surgery ensures prosthetically driven implant placement, while CAD/CAM milling enhances framework accuracy. Clinical studies indicate comparable survival rates between the two approaches, though digital methods demonstrate improved patient satisfaction and efficiency.

However, digital workflows are not devoid of challenges. In edentulous arches, intraoral scanners may struggle with soft tissue landmarks. Additionally, incorrect merging of CBCT and scan data may propagate errors.

Thus, clinician expertise remains paramount irrespective of workflow choice.

Conclusion

Full arch implant rehabilitation has undergone a profound transformation with the integration of digital technologies. Conventional workflows, grounded in decades of clinical evidence, continue to demonstrate predictable long-term success and remain a dependable option, particularly in settings with limited access to advanced technology. Their biological reliability and established prosthodontic principles provide a strong foundation for full-arch reconstruction.

However, digital workflows have introduced a paradigm shift by minimizing cumulative procedural errors, enhancing prosthetically driven implant placement, and improving passive fit through CAD/CAM milled frameworks. The integration of CBCT based planning, intraoral scanning, guided surgery, and digitally fabricated prostheses has significantly improved precision, reduced chairside time, and enhanced patient comfort. Immediate loading protocols have become more predictable due to improved surgical prosthetic coordination within virtual planning environments.

Despite these advantages, digital workflows are not without limitations. High initial investment costs, the need for technical expertise, scanner limitations in edentulous arches, and potential software related inaccuracies must be carefully considered. Furthermore, long-term evidence although increasingly supportive still does not surpass the extensive historical data available for conventional methods.

Rather than viewing conventional and digital workflows as competing approaches, contemporary implant dentistry should embrace a hybrid philosophy that integrates digital precision with fundamental prosthodontic principles. The clinician's diagnostic acumen, case selection, and biomechanical understanding remain the most critical determinants of treatment success.

Future research should focus on long-term randomized controlled trials comparing survival rates, biological complications, prosthetic longevity, and cost effectiveness between workflows. As digital technology continues to evolve, its role in full-arch rehabilitation is expected to expand, ultimately refining accuracy, efficiency, and patient centered outcomes.

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Enhancing Orthodontic Treatment Efficiency Through Periodontally Accelerated Osteogenic Orthodontics (PAOO): A Case Report

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Abstract

Background: Orthodontic space closure in adult patients is often challenging due to reduced bone remodelling capacity, prolonged treatment duration, and increased risk of periodontal complications. Periodontally Accelerated Osteogenic Orthodontics (PAOO) is a surgically assisted orthodontic technique that combines selective alveolar corticotomy with bone grafting to enhance regional acceleratory phenomenon (RAP), thereby facilitating faster and more stable tooth movement.

Case Presentation: A 26 year old female patient presented with spacing in the maxillary left premolar region requiring orthodontic space closure. Considering the patient's age and the need to reduce overall treatment time while maintaining periodontal health, PAOO was planned as an adjunct to fixed orthodontic therapy. Following full thickness flap reflection, selective corticotomy was performed around the involved teeth. Orthodontic force application was initiated two weeks post surgery.

Results: Rapid orthodontic tooth movement was observed with efficient space closure achieved within a significantly reduced treatment period compared to conventional orthodontics. Clinical evaluation revealed satisfactory alignment, stable occlusion, and improved periodontal parameters. Adequate alveolar bone levels with no evidence of root resorption or periodontal breakdown during follow-up was noticed.

Conclusion: PAOO technique proved to be an effective and safe adjunctive procedure for accelerated orthodontic space closure in adult patients. This technique has reduced treatment duration, enhanced alveolar bone support, and predictable clinical outcomes, making it a valuable interdisciplinary approach in selected orthodontic cases.

Keywords: Periodontally Accelerated Osteogenic Orthodontics, PAOO, Accelerated Orthodontics, Space Closure, Corticotomy.

Introduction

The demand for orthodontic treatment among adult patients has increased significantly in recent decades due to growing esthetic awareness and advancements in dental care. However, orthodontic treatment in adults presents unique biological and clinical challenges. Reduced cellular activity, increased bone density, and diminished vascularity of the alveolar bone result in slower orthodontic tooth movement compared to adolescents. Consequently, prolonged treatment duration may lead to compromised patient compliance and increased risks of root resorption, periodontal breakdown, and relapse.[1,2]

In order to overcome these limitations, various techniques have been proposed to accelerate orthodontic tooth movement, including low level laser therapy, vibration devices, pharmacological agents, and surgically assisted orthodontic procedures. Among these modalities, corticotomy assisted orthodontics has gained considerable attention due to its predictable biological response and clinical effectiveness.[3]

The concept of corticotomy facilitated tooth movement was first introduced by Köle in 1959, who proposed that selective alveolar decortication could enable rapid movement of blocks of bone containing teeth. Although his technique demonstrated reduced treatment time, it involved extensive surgical intervention and was therefore limited in routine clinical application. Subsequent studies clarified that orthodontic tooth movement following corticotomy occurs primarily through bone remodeling rather than en bloc movement.

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The biological foundation for accelerated tooth movement following surgical injury is explained by the regional acceleratory phenomenon (RAP), a concept described by Frost. RAP refers to a localized, transient increase in bone turnover and remodeling activity in response to noxious stimuli such as surgical trauma. This phenomenon leads to temporary osteopenia, reduced bone density, and increased metabolic activity, thereby facilitating faster orthodontic tooth movement during the healing phase.[6,7]

Based on these principles, Wilcko and colleagues introduced Periodontally Accelerated Osteogenic Orthodontics (PAOO) in the early 2000s. This technique integrates selective alveolar corticotomy, particulate bone grafting, and conventional orthodontic mechanics to accelerate tooth movement while simultaneously enhancing alveolar bone density.[8,9] PAOO not only shortens overall treatment time, it also improves periodontal support, reduce the risk of dehiscence and fenestration, and enhance long-term stability.[10]

Clinical studies have reported that PAOO can reduce orthodontic treatment time by approximately 30–70% when compared with conventional orthodontic therapy.[11,12] The technique has been successfully employed for various orthodontic indications, including rapid space closure, arch expansion, resolution of crowding, intrusion and extrusion of teeth, and management of borderline surgical cases.[13]

Despite its advantages, PAOO is technique sensitive and requires careful case selection, interdisciplinary coordination between orthodontist and periodontist, and thorough evaluation of periodontal health.[14]

The present case report aims to highlight the clinical efficacy of PAOO in achieving successful orthodontic space closure within a reduced treatment duration while maintaining periodontal health and alveolar bone integrity.

Materials and Methods

A 26 year old female patient was referred from the Department of Orthodontics to the Department of Periodontology for evaluation and management of localized spacing between the maxillary left canine (23) and second premolar (25) requiring accelerated orthodontic space closure (Figure 1). The patient was systemically healthy with no relevant medical history. No history of smoking or deleterious oral habits was reported.

Comprehensive intraoral examination revealed an edentulous space corresponding to the maxillary left first premolar region with adequate attached gingiva and clinically healthy periodontal tissues. The gingiva exhibited normal color, contour, and consistency with no signs of inflammation. Probing pocket depths were within physiological limits (≤3 mm), and no clinical attachment loss or tooth mobility was noted in the adjacent teeth (23 and 25). Oral hygiene status was satisfactory, with full-mouth plaque and gingival index scores of less than 1 following phase I periodontal therapy. Preoperative radiographic evaluation was carried out using OPG to assess alveolar bone morphology, root proximity and the presence of any periodontal or periapical pathology prior to orthodontic space closure.

Phase I periodontal therapy consisting of scaling and root planning was performed. The patient was instructed regarding meticulous oral hygiene maintenance. Re-evaluation after two weeks confirmed healthy periodontal parameters suitable for surgical intervention. Written informed consent was obtained.

The surgical procedure was performed under 2% lignocaine hydrochloride with 1:80,000 adrenaline. A full thickness mucoperiosteal flap was elevated on the buccal aspect extending from the maxillary left lateral (22) to the first molar (26) (Figure 2). Selective alveolar corticotomy was performed using piezo surgical unit (Figure 3). Vertical corticotomy cuts were placed in the interradicular areas extending approximately 2–3 mm beyond the root apices. Care was taken to avoid damage to the periodontal ligament and root surfaces. The flap was repositioned and secured using 4-0 black monofilament polyamide sutures, ensuring tension free primary closure (Figure 4).

Postoperative instructions were given, and the patient was prescribed with amoxicillin 500 mg three times daily for 5 days followed by ibuprofen 400 mg three times daily for 3 days and chlorhexidine gluconate 0.12% mouth rinse twice daily for 2 weeks. Mechanical plaque control in the surgical area was avoided for 10 days. Sutures were removed after 10 days, and uneventful healing was observed.

Orthodontic force application was initiated two weeks following surgery to coincide with the regional acceleratory phenomenon. Controlled orthodontic mechanics were used for space closure between 23 and 25. Activation was performed at shorter intervals compared to conventional orthodontic therapy.

The patient was reviewed at 1 week, 1 month , 3 months, and 6 months postoperatively for accessing the rate of space closure.

Results

The postoperative healing phase was uneventful, with no signs of infection, flap dehiscence, or patient discomfort beyond the immediate postoperative period. Orthodontic space closure between the maxillary left canine (23) and second premolar (25) was initiated two weeks after the PAOO procedure. A marked increase in the rate of tooth movement was observed during the early phase of orthodontic activation, corresponding to the period of regional acceleratory phenomenon. Complete closure of the edentulous space was achieved within a significantly reduced duration compared to conventional orthodontic mechanics. Progressive reduction in space was evident at monthly follow-up visits (Figure 5,6 & 7), with efficient bodily tooth movement and no evidence of tipping or anchorage loss. Clinical periodontal evaluation throughout the treatment period revealed stable probing pocket depths (≤3 mm) around the involved teeth, with no bleeding on probing, gingival recession, or loss of clinical attachment. Tooth mobility remained within physiological limits. Radiographic assessment at follow-up demonstrated adequate alveolar bone fill in the previously edentulous region, with maintenance of crestal bone height. No signs of root resorption, periodontal ligament widening, or periapical pathology were detected. At the completion of space closure, the patient exhibited satisfactory alignment, improved occlusal relationship, and harmonious gingival architecture. The achieved results remained stable during subsequent follow-up visits, confirming the effectiveness and periodontal safety of PAOO assisted orthodontic space closure.

Discussion

Orthodontic space closure in adult patients presents a biological challenge due to reduced bone turnover, increased cortical bone density, and diminished cellular activity. These factors often result in prolonged treatment duration and increased risk of undesirable effects such as root resorption and periodontal compromise.[1] The present case report demonstrates the successful use of Periodontally Accelerated Osteogenic Orthodontics (PAOO) for rapid space closure between teeth 23 and 25 in a 26-year-old female patient, achieving favorable orthodontic and periodontal outcomes within a reduced treatment period.

The biological rationale behind PAOO is based on the regional acceleratory phenomenon (RAP), a localized tissue response characterized by transient osteopenia and accelerated bone remodeling. Frost et al first described RAP as a key mechanism that facilitates rapid skeletal healing and bone turnover.[7] Subsequent studies have confirmed that corticotomy induces increased osteoclastic and osteoblastic activity, thereby enhancing orthodontic tooth movement without compromising periodontal support.[6]

Köle originally proposed corticotomy-assisted orthodontics in 1959, suggesting that tooth movement occurred through mobilization of alveolar bone segments.[4] However, later experimental studies by Duker demonstrated that orthodontic movement following corticotomy occurs through bone remodeling rather than en bloc movement, supporting the biological foundation of modern PAOO techniques.

Wilcko and Wilcko further refined this concept by combining selective alveolar decortication with particulate bone grafting, introducing the term Periodontally Accelerated Osteogenic Orthodontics.[8] Their studies emphasized that the addition of bone graft not only enhances the rate of tooth movement but also increases alveolar bone volume, thereby reducing the risk of fenestrations and dehiscence commonly associated with orthodontic space closure in adults.[9]

Several clinical studies have supported the effectiveness of PAOO in significantly reducing orthodontic treatment time. Hassan et al. reported treatment acceleration of approximately 30–50% compared to conventional orthodontic therapy.[11] Similarly, Shoreibah et al., in their systematic review, concluded that corticotomy assisted orthodontics results in faster tooth movement with minimal periodontal side effects when proper case selection is followed.[12]

The findings of the present case are consistent with those reported by Aboul-Ela et al., who observed significantly increased rates of canine retraction in corticotomy assisted orthodontic patients without additional root resorption or attachment loss.[13] The absence of root resorption in the present case may be attributed to transient osteopenia created by RAP, which reduces resistance to tooth movement and minimizes excessive force requirements.

Murphy et al. highlighted the importance of timing orthodontic force application within the peak RAP phase, typically occurring between one and two weeks post-surgery.[10] In the current case, orthodontic activation was initiated two weeks after surgery, which likely contributed to the efficient and controlled space closure observed.

Radiographic evidence of increased alveolar bone thickness following PAOO has been reported by Wilcko et al. and Sebaoun et al., supporting the osteogenic potential of this technique.[15,16] In the present case, postoperative radiographs demonstrated adequate bone fill in the edentulous region with maintenance of crestal bone height, reinforcing the regenerative advantage of PAOO.

More recently, minimally invasive alternatives such as piezocision have been introduced; however, Dibart et al. reported that although such techniques accelerate tooth movement, they do not provide the alveolar augmentation benefits achieved with conventional PAOO.[14] This highlights the advantage of PAOO in cases requiring both space closure and enhancement of alveolar housing, as seen in the present patient.

The favorable periodontal response observed in this case aligns with findings by Wilcko and Ferguson, who reported improved periodontal stability and reduced relapse following PAOO assisted orthodontic therapy.[17] The maintenance of probing depths, absence of gingival recession, and stable attachment levels in the current report further support the periodontal safety of this technique.

Despite its advantages, PAOO requires meticulous surgical execution and close interdisciplinary collaboration. Patient selection remains critical, as active periodontal disease or poor oral hygiene may compromise outcomes. When performed in appropriately selected cases, PAOO serves as a reliable adjunct for managing adult orthodontic cases involving space closure, alveolar deficiency, and the need for reduced treatment time.

Conclusion

Periodontally Accelerated Osteogenic Orthodontics (PAOO) is a safe and effective adjunct for achieving rapid orthodontic space closure in adult patients. In this case, PAOO facilitated efficient tooth movement, enhanced alveolar bone support, and maintained periodontal health, resulting in predictable and stable outcomes. The technique demonstrates significant potential for reducing treatment duration while providing interdisciplinary benefits, highlighting its value in adult orthodontic therapy.

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Fig 1: Pre operative view

Fig 2: Flap elevation

Fig 3: Selective corticotomy

Fig 4: Suturing

Fig 5: 1 month Post operative

Fig 6: 3 months post operative

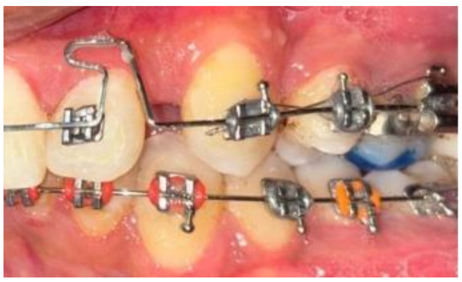

Fig 7: 6 months post operative

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Modified Vestibular Incision Subperiosteal Tunnel access technique using advanced Platelet rich fibrin membrane for the treatment of Miller's Class II/ III Gingival Recession: A Case Report

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Abstract

Gingival recession presents a major problem in clinical practice due to jeopardized root coverage outcomes. The Modified Vestibular Incision Subperiosteal Tunnel Access (Modified VISTA) technique offers a minimally invasive solution for enhancing soft tissue. Incorporating autologous materials like Advanced Platelet Rich Fibrin (A-PRF) may enhance regenerative potential. This case report describes the management of Miller's Class II/ III gingival recession defects in the lower anterior region in a 25-year-old patient. The Modified VISTA method was used to create a subperiosteal tunnel through vestibular incisions, into which an A-PRF membrane was inserted to improve soft tissue regeneration. Healing progressed smoothly, with notable root coverage and increased gingival thickness observed after one month. Combining the Modified VISTA technique with A-PRF appears effective for addressing complex gingival recession cases. This method results in improved patient comfort with acceptable aesthetic outcomes. However, more clinical research is required to establish long-term success.

Keywords: Gingival recession, Miller's Class II/ III, Modified-VISTA, Advanced Platelet Rich Fibrin (A-PRF), Periodontal Regeneration.

Introduction

Gingival recession is a frequent dental issue that causes discomfort for patients, resulting in tooth sensitivity and an unesthetic appearance.[1] As patients' aesthetic demands increase, clinicians must hone their skills and introduce newer, more innovative techniques to meet these demands. While conventional surgical methods allow access to the underlying bone for complete debridement, the usage of large flaps can result in undesirable outcomes, including crestal bone resorption, loss of interdental papilla, loss of gingival height and contour, and increased root sensitivity. Additionally, prolonged surgery can cause tissue impaction, leading to increased postoperative pain, swelling, edema, and delayed healing.[2] As more individuals show interest in patient centered procedures that undergo peer review, clinical researchers are developing less invasive techniques. These techniques aim to diminish soft tissue damage and boost blood flow, which in turn leads to superior results in covering exposed roots.[3]

Combining blood derivatives with a minimally invasive approach for managing marginal tissue recession would overcome the drawbacks associated with a second donor site in autogenous grafting, providing faster and more favorable healing outcomes. This approach offers the benefits of an autogenous and biologically enhanced procedure.

Therefore, the present case intends to use the Modified Vestibular Incision Subperiosteal Tunnel Access (M-VISTA) technique along with the Advanced platelet rich fibrin (A-PRF) membrane to manage Miller's Class II/III gingival recession defects in the lower front teeth region.

Case Presentation

A 25 year old systemically healthy female came to the Department of Periodontology with the chief complaint of receding gums in the lower front teeth region for the past few years. On clinical examination, Miller's Class III recession defect[4] with recession height of 2-3 mm was found around 31 and 41 along with Class II (Nordland & Tarnow's classification)[5] interdental papilla loss around 31,41, and Miller's Class II recession defect around 32,42 having adequate width of attached gingiva and vestibular depth. Also, generalized gingival hyperpigmentation with a thick gingival biotype was present (Figure 1a). Following this, the patient underwent phase I therapy,

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including instructions to maintain oral hygiene, occlusal adjustment, scaling, and root planing. After thoroughly explaining the procedure to the patient, written informed consent was obtained before the commencement of surgery.

Surgical Procedure

The surgical site was anesthetized using a solution of 1: 1,00,000 lignocaine combined with adrenaline. Two separate incisions were created in the vestibular area using a number 15 blade, positioned along the distal angles of 32 and 42, to provide access to the entire anterior mandible region (Figure 1b). The incision is made through the periosteum to elevate a subperiosteal tunnel, exposing the facial osseous plate and root dehiscence. Specialized microsurgical VISTA instruments were utilized to prepare the subperiosteal tunnel. The radicular gingival margin was elevated from 32 to 42 using blunt dissection (Figure 1c). Additionally, the tunnel was extended towards the interproximal area under each papilla as much as the embrasure space allows, without cutting through the papilla (Figure 1d). The dissection was carefully extended beyond the mucogingival junction to prevent tension during coronal advancement.

To prepare the A-PRF, 10 mL of venous blood was collected from the patient's antecubital vein using a syringe, promptly transferred to a sterile glass tube, and centrifuged at 1500 rpm for 14 minutes, as described by Ghanaati et al.[6] Following the centrifugation process, the A-PRF plug was carefully separated from the red blood cell layer using scissors and placed into the PRF box to create the A-PRF membrane (Figures 1e).

A freshly made A-PRF membrane was cut into smaller pieces and put under the prepared tunnel, covering the exposed roots (Figure 2a). Following that, the membrane and mucogingival complex were advanced coronally and secured in the new position using 5-0 black silk sutures and coronally anchored suturing technique, which entails placing a horizontal mattress suture at approx. 2 to 3 mm apical to the gingival margin of each tooth and kept in position using composite buttons at the middle portion of the buccal surface of each tooth (Figure 2b). The surgical area was then covered with tin foil, and then a periodontal pack was placed over it (Coe-pak™) (Figure 2c).

Post-operative care

The patient was given a five day treatment that included antibiotics and non-steroidal anti-inflammatory drugs (NSAIDs) and advised to use 10 ml of chlorhexidine (0. 2%) mouth rinse twice daily instead of brushing their teeth for 2-3 weeks in the surgical area. Sutures were removed after 10 days, and the patient was scheduled for weekly follow-up appointments for one month after surgery. After suture removal, healing was satisfactory, with 90% root coverage and an increase in gingival thickness, which remained stable during follow-up visits, one month after surgery (Figure 2d).

Discussion

Gingival recession resulting from improper toothbrushing technique or high frenum attachment is becoming increasingly common and requires aesthetic treatments. Over time, various minimally invasive surgical methods have been created to address gum recession, utilizing specific tools and equipment. One method was suggested by Allen in 1994. He improved Raetzke's "Envelope Technique"[7] and introduced the "Tunnel or Supraperiosteal Envelope Technique" for treating multiple adjacent gingival recessions. Tunneling is a widely used but highly sensitive and blind technique that causes trauma to the sulcular epithelium, leading to unsatisfactory results.

To overcome the technicality, Homayoun H. Zadeh in 2011 introduced a novel minimally invasive approach popularized as Vestibular Incision Subperiosteal Tunnel Access (VISTA), which utilizes a smaller vestibular incision and avoids Supraperiosteal Tunnel preparation incision, reducing the risk of traumatizing the gingiva of the teeth being treated.[8] VISTA allows both direct access and an opportunity to reposition the gingival margins of all involved teeth coronally. Najafi further redesigned this method and developed the Modified Vestibular Incision Subperiosteal Tunnel Access (M-VISTA) technique to address intraosseous defects in the aesthetic region.[9]

In this case report, the minimally invasive Modified VISTA approach was combined with blood derived wound healing growth factors to provide unique advantages for the successful management of multiple adjacent recession defects in the lower front teeth region, resulting in satisfactory healing and stable 90% root coverage.

Advanced Platelet rich fibrin (A-PRF) favours a higher growth factor release than conventional PRF, and this may have a direct impact on tissue regeneration by boosting levels of collagen mRNA and fibroblast migration and proliferation.[10] Furthermore, gel-like A-PRF contains collagen fibres that serve as a natural component, inducing vascularization, supporting the immune system, and providing a three dimensional scaffold for cell proliferation. A-PRF membrane is more flexible and a great alternative to free or connective tissue graft, avoiding donor site morbidity and increasing patient comfort.

Some of the limitations of the M-VISTA technique cannot be overlooked including every gingival recession defect is not suitable for VISTA, and performing VISTA requires a high level of surgical skill to precisely dissect the subperiosteal tunnel and manage tissue manipulation. Also, special microsurgical instruments are required for this technique.

In conclusion, many different surgical methods exist for treating multiple recession defects, but they often provide less effective root coverage in areas with multiple adjacent defects compared to cases involving a single defect. VISTA technique, therefore employed in our case report to overcome the limitations of other treatment options and give better results, especially when combined with an A-PRF membrane. To gain a more comprehensive understanding of the VISTA technique when combined with A-PRF enhancement for covering exposed root surfaces, further long-term clinical and histological studies are necessary to assess its effectiveness and predictability.

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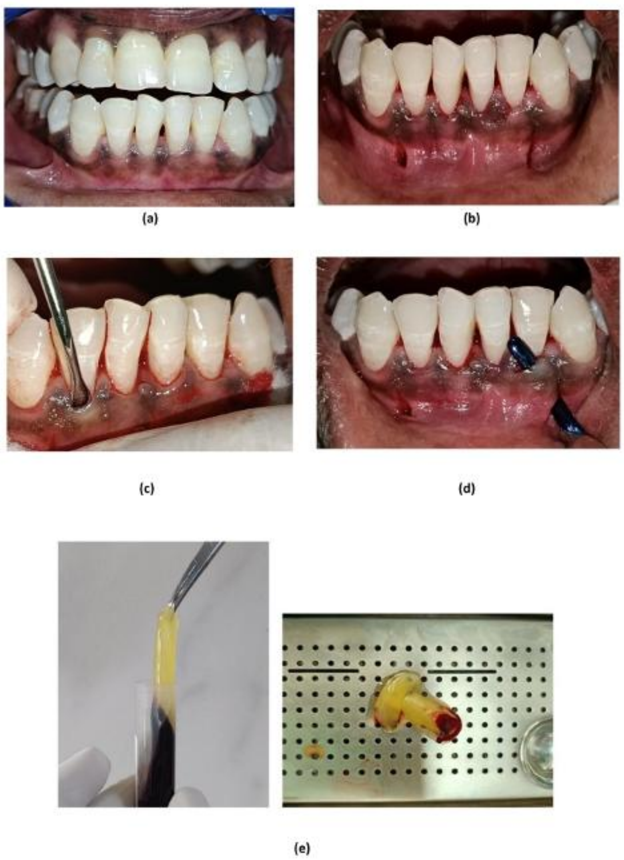

Figure 1

a. Clinical image shows pre-operative frontal view depicting gingival recession and loss of interdental papilla concerning 31,41,32, and 42.
b. Clinical image shows two vertical incisions made in the vestibule along distal line angles of 32 and 42.
c. Clinical image shows the radicular gingival margin elevated from 32 to 42 using blunt dissection utilizing a microsurgical papilla elevator.
d. Clinical image shows the subperiosteal tunnel extending interproximally under each papilla without splitting of the papilla with crevicular incisions.
e. Clinical image shows A-PRF plug being prepared and placed in PRF box to prepare A-PRF membrane.

Figure 2

a. Clinical image shows a freshly prepared A-PRF membrane placed beneath the subperiosteal tunnel.
b. Clinical image shows the mucogingival complex advanced coronally and stabilized with coronally anchored suturing technique utilizing composite buttons.
c. Clinical image shows the surgical site being covered by a periodontal dressing.
d. Clinical image shows post-operative frontal view after one month, depicting satisfactory healing and stable 90% root coverage.

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Heal Talk

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Suture Materials in Dental Practice: A Scoping Literature Review

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Abstract

Background: Sutures are artificial fibers used in medical practice to hold tissues together after injury or surgical procedures. Their main purpose is to bring wound edges into proper alignment, control bleeding, reduce the risk of infection, and support healing by primary intention. Improper suturing can result in complications such as pain, tissue necrosis, exposed bone, flap failure, and delayed wound healing.

Aim: To provide an overview of suturing materials, their classification, properties, instruments, techniques, and recent advancements used in surgical wound closure.

Overview: The use of sutures dates back to ancient times, when natural materials such as horsehair, silk, wool, and flax were used by early surgeons including Sushruta, Hippocrates, Galen, and Ibn Sina. The Edwin Smith Papyrus (1600 BCE) described early wound closure techniques. With advancements in science, sutures evolved into modern synthetic materials such as polyglycolic acid and polyglactin. Sutures are classified based on their origin, structure, absorbability, coating, and diameter. An ideal suture material should be easy to handle, have good tensile strength, cause minimal tissue reaction, and provide secure knotting. Proper selection of suturing instruments, adherence to suturing principles, and use of appropriate techniques are essential for successful wound healing. Recent developments such as antimicrobial coated, drug eluting, stem cell seeded, shape memory, and electronic sutures aim to improve healing and reduce post-operative infections.

Conclusion: Although alternatives like staples, tissue adhesives, and steri-strips are available, sutures remain the most dependable method for wound closure due to their precision, flexibility, and ability to provide stable tissue approximation.

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Introduction

In the pantheon of surgical interventions, few elements embody the delicate interplay between human ingenuity and biological resilience as profoundly as the suture. Defined as artificial or natural filaments employed to ligate tissues post-trauma or incision, sutures facilitate the restoration of anatomical integrity, curtail hemorrhage, and scaffold the reparative cascade. Their deployment traces an arc from prehistoric expedients to nanoscale engineered constructs, reflecting broader advancements in biomaterials science and surgical praxis. This review, penned from the vantage of a senior PhD scholar with decades immersed in wound healing dynamics, aims to dissect the multifaceted domain of sutures through a structured lens: historical genesis, taxonomic frameworks, material heuristics, instrumental ecology, sutural axioms, technical repertoires, substitutive modalities, innovative frontiers, and prospective horizons.[1]

The imperative for such an exegesis arises amid escalating surgical volumes global procedures surpassing 300 million annually and attendant complications like surgical site infections (SSIs), which afflict up to 5% of cases and exact a toll of $3.2 billion in U.S. healthcare expenditures alone. Inadequate suturing precipitates flap necrosis, dehiscence, and protracted convalescence, underscoring the need for materials that harmonize tensile fortitude with biocompatibility.[2] Herein, we

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interrogate sutures not merely as mechanical adjuncts but as bioactive interfaces modulating inflammation, angiogenesis, and extracellular matrix remodeling. By aggregating empirical syntheses from ancient papyri to 2025 biomaterials patents, this discourse furnishes clinicians and researchers with a scaffold for evidence based selection and innovation.

Historical Evolution of Sutures

The saga of sutures commences in antiquity, emblematic of humanity's primordial quest to defy corporeal rupture. Archaeological vestiges from circa 3000 BCE in ancient Egypt evince linen and papyrus strips for wound coaptation, as chronicled in the Edwin Smith Papyrus (ca. 1600 BCE), which prescribes linen sutures for cranial lacerations alongside incantatory rites.[3] This text, the oldest extant surgical treatise, delineates closure paradigms prioritizing edge apposition to avert suppuration a presage to contemporary primary intention healing.

In the Indian subcontinent, Sushruta's Samhita (ca. 600 BCE) elevates sutural artistry, advocating ant antennae for intestinal anastomoses and horsehair for dermal repairs, infused with herbal antiseptics like turmeric to forestall putrefaction. Sushruta's 120-chapter compendium classifies 101 rudimentary instruments, including barbed needles forged from iron, and extols silk and cotton for tensile resilience, foreshadowing multifilament designs.[4] Paralleling this, Greek luminaries Hippocrates (460–370 BCE) and Galen (129–216 CE) harnessed flax, wool, and linen, with Galen pioneering catgut from ovine submucosa for visceral ligatures, albeit sans sterilization, yielding frequent erysipelas.[5]

The Islamic Golden Age (8th–13th centuries) catalyzed refinements; Al-Zahrawi (936–1013 CE) in his *Kitab al-Tasrif* details silk sutures for oculoplastic repairs, while Ibn Sina (Avicenna, 980–1037 CE) refines catgut processing via submersion in wine for rudimentary antisepsis. Medieval Europe, shadowed by miasmatic doctrines, regressed to gold wire for dental fixtures, yet Renaissance polymaths like Ambroise Paré (1510–1590) reintroduced linen and silk, pioneering vessel ligatures to supplant cauterization.[6]

The 19th century heralded asepsis via Joseph Lister (1827–1912), who chromic-treated catgut with iodine to attenuate reactivity, slashing postoperative mortality from 50% to 15%. Halsted's 1889 advocacy for fine silk in herniorrhaphy presaged microvascular suturing. The 20th century's polymer revolution polyglycolic acid (PGA, 1960s) and polyglactin 910 (Vicryl, 1975) ushered absorbables, dissolving via hydrolysis to obviate secondary interventions.[7] By the 1980s, monofilament polypropylene (Prolene) minimized drag induced trauma, while barbed variants (2000s) eliminated knot tying in endoscopic arenas. Today, sutures encapsulate millennia: from Sushruta's horsehair to CRISPR edited silk fibroin scaffolds, embodying iterative fidelity to healing imperatives. This phylogeny not only contextualizes extant paradigms but illuminates adaptive pressures sterility, resorption, biointegration propelling biomaterials toward sentience.[8]

Classification of Sutures

Taxonomic rigor underpins suture selection, mitigating mismatch induced failures. Primordially, sutures bifurcate by origin: natural (e.g., catgut, silk) versus synthetic (e.g., nylon, polydioxanone [PDS]).[9] Naturals, derived from collagenous or proteinaceous sources, elicit brisk resorption yet heightened antigenicity; synthetics, polymer engineered, afford predictability in degradation kinetics.[10]

Structurally, monofilaments (e.g., polypropylene) manifest unitary filaments, gliding sans snags but prone to knot slippage; multifilaments (e.g., braided polyester) enhance pliability and security via interlacing, though capillary wicking risks empyema.[11] Absorbability delineates further: absorbables (e.g., Vicryl, 60–90-day hydrolysis) for internal strata, non-absorbables (e.g., Ethibond) for dermal or tensile bastions. Coatings modulate: chromic salts temper catgut's pH lability; Teflon or silicone lubricate multifilaments.[12]

Diametric gradation adheres to USP nomenclature: 7-0 (0.05 mm, ophthalmic) to #2 (0.5 mm, orthopedics), where escalating zeros denote attenuation, balancing fragility against reactance.[13] Needles append classificatory nuance: eyed (requiring threading) versus swaged (pre-attached for sterility); straight for superficial access, curved (1/4 to 1/2 circle) for profundity. Cutting edges conventional (tri-faceted for dermis) or reverse (keel based for tendon) optimize penetration sans laceration. This matrix, evolving from binary to multidimensional, empowers bespoke tailoring: PDS for fascial resilience, nylon for vascular patency.[14]

Functions and Attributes of Suturing Materials

Sutures transcend mere ligation, orchestrating hemostasis, edge eversion, and fibroblastic ingress to foster cicatrix minimization. Core functions encompass: (1) precise apposition for collagen bridging; (2) tensile equilibration to counter dehiscence; (3) sanguineous occlusion via compression; (4) anti-infectious bulwarking; (5) ergonomic palliation; and (6) cosmesis via scar attenuation.[15]

Attributes bifurcate physical and biological. Monofilaments, sleek and inelastic, traverse subcutis with alacrity but demand supple dexterity for knotting; multifilaments, voluminous and compliant, secure via friction yet potentiate biofilm via interstices mitigated by polydioxanone braiding. Tensile strength, quantified in Newtons, gauges rupture threshold: polypropylene endures 50 N, ideal for sternotomy. Flexibility and elasticity measured by Young's modulus accommodate edema induced strain, with elastomeric polybutester recoiling 20% sans fracture.[16] Diametric and longitudinal metrics calibrate to locus: 4-0 for neurovascular, 1 for myofascial. Biological interplay implicates reactivity: silk's sericin evokes histiocytosis, supplanted by inert PTFE. Collectively, these heuristics ensure sutures as symbiotic prosthetics, amplifying endogenous repair.[17]

Ideal Properties of Suture Materials

The Platonic suture eludes absolutism, yet asymptotic ideals persist: sterility sans degradation; manipulability sans fatigue; hypoantigenicity to forestall anaphylaxis; non-irritance for fibroblastic harmony; oncologic inertness; tensile parity with host tensile (e.g., 10–20 N/cm² for dermis); knot tenacity exceeding 4 throws; muted reactance (<5% inflammation); acapillary architecture; sterilizability via ethylene oxide or gamma; and fiscal viability (<$0.50/meter). Biodegradables must hydrolyze predictably (e.g., 21–42 days for mucosa), while permanents resist proteolysis. Empirical proxies, like ISO 10993 assays, validate these, yet trade offs abound: monofilaments sacrifice knot security for asepsis.[18]

Suturing Instruments

Instrumental armamentarium amplifies precision. The needle, suture's vanguard, classifies by: ocularity (eyed for reusability, swaged for disposability); geometry (straight for planar, curved for volumetric); acuity (round for yielding viscera, cutting for keratinized); and body (tapered for vascular, tapercut hybrid).[19] Alloyed from 300 series stainless, needles span 5–50 mm, with FS-2 (17 mm, 3/8 circle) ubiquitous for laparotomy.

Adjuncts include Adson forceps (toothed for traction sans perforation), Mayo-Hegar holders (ratcheted for grip), and Potts-Smith scissors (curved for subsurface severance). Ergonomics pistol-grip holders reducing carpal strain enhance endurance in marathon procedures. Sterile orchestration via autoclave or VHP ensures fidelity, transforming instruments from tools to extensions of surgical volition.[20]

Principles of Suturing

Axiomatic tenets govern efficacy: needle grasp at swage body juncture (1/3 from eye) for torque; perpendicular ingress orthogonal to grain; equidistant bites (3–5 mm) for isotropy; pronation/supination tracing arc; and eversion sans constriction to nurture granulation. Tension modulates: 0.5–1 kg/cm² averts ischemia. These heuristics, rooted in Peer's 1956 cadaveric validations, minimize shear and ischemia, yielding 95% primary union rates.

Suturing Techniques

Technical polymorphism adapts to topography. Simple interrupted discrete loops affords modularity, ideal for contaminated fields (e.g., 4-0 nylon in lacerations), with 80% strength retention. Continuous variants running or locked expedite (2x velocity) for enteric, distributing load via 360° encirclement. Mattress sutures (vertical for everted lips, horizontal for undermined) bolster undermined flaps, augmenting vascular ingress by 30%. Subcuticular intradermal (6-0 Monocryl) yields imperceptible scars in aesthetics; figure of eight cinches friable edges in hepatorrhaphy; pulley and half-buried variants finesse tension gradients. Barbed iterations obviate knots, slashing time 50% in mastopexies. Mastery hinges on locus-specific heuristics, from Halsted's subtlety to robotic augmentation.

Suture Substitutes and Alternatives

Diversification attenuates suture hegemony. Staples (e.g., TA-55) accelerate dermal closure (3x) sans needling trauma, yet falter in irregular contours. Cyanoacrylates (Dermabond) polymerize ex vivo, sealing superficially in 60 seconds, though exothermic peaks risk burns and tensile yields 70% of nylon. Steri-Strips buttress low-tension, fostering epithelial creep; sealants (fibrin) coagulate avascular beds; lasers weld via photothermal denaturation. Hybrids adhesive staple optimize cosmesis in pediatrics. Limitations: adhesives' allergenicity (2%) and staples' palpability necessitate judicious deployment.

Advancements in Suturing Technology

Paradigmatic leaps reconfigure sutures as therapeutic vectors. Triclosan-coated polyglactin (Vicryl Plus) curtails SSIs 30% via efflux inhibition. Silver nanoparticles engender ROS-mediated bacteriolysis, potent against MRSA. Drug-eluting paradigms hot-melt extruded tacrolimus sustain immunosuppression, slashing rejection in xenografts. Tetracycline impregnation thwarts staphylococci; stem cell seeded PGA scaffolds accelerate angiogenesis 2-fold. Shape memory alloys (nitinol) conform dynamically; polydioxanone polyurethane hybrids amplify elasticity. Electronic sentinels pH/thermochromic fibers telemetrize inflammation, heralding IoT surgery. These biohybrids, per 2025 patents, portend infection rates <1%.[21]

Future Directions

Prospects gleam with smart sutures: CRISPR-silk for oncogene silencing; 3D-bioprinted lattices for organoids; robotic barbed for telesurgery. Market projections: $6.65B by 2030, buoyed by biodegradables. Challenges: scalability, equity.[22-41]

Conclusion

Suturing remains a fundamental component of surgical practice despite continuous advancements in wound closure technologies. From ancient natural fibers to modern biofunctional materials, sutures have evolved to improve healing outcomes and patient comfort. Proper selection of suture material and technique plays a crucial role in minimizing complications and ensuring optimal wound healing. Emerging innovations such as antimicrobial, drug eluting, stem cell based, and electronic sutures show promising potential for the future of surgical wound management.

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Management of a Circumferential Infrabony Defect Using Freeze Dried Bone Allograft and Platelet Rich Fibrin: A Case Report

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Abstract

Background: Periodontitis is a chronic inflammatory disease characterized by progressive destruction of the periodontal supporting tissues, often leading to the formation of deep infrabony defects. These defects pose significant functional and esthetic challenges and are commonly resistant to non-surgical periodontal therapy alone. While conventional surgical approaches such as open flap debridement improve access and pocket reduction, true periodontal regeneration remains limited. Hence, regenerative modalities using bone grafts and biologic agents like platelet rich fibrin have gained prominence to promote restoration of the lost periodontal apparatus.

Aim: The aim of this study was to evaluate the role of a Freeze Dried bone graft substitute in the management of a circumferential infrabony defect in a mandibular left second molar in a patient diagnosed with localised periodontitis.

Methodology: A circumferential defect of 6 mm around the mandibular molar was evident after debridement. The defect was filled up with a FDBA bone graft substitute and covered with a PRF membrane.

Results: The site showed significant bony fill at the end of 9 months with reduction in probing depth to normal. The results were well maintained at the time of last follow- up at 12 months post-operatively.

Conclusion: The use of freeze dried bone allograft in combination with platelet rich fibrin demonstrated predictable and stable periodontal regeneration in the management of a circumferential infrabony defect, with sustained clinical and radiographic improvements observed up to 12 months post-operatively.

Keywords: Circumferential infrabony defect, Localized Periodontitis, FDBA bone allograft

Introduction

Periodontitis is a complex inflammatory condition that results in the progressive destruction of the supporting periodontal structures, ultimately leading to alveolar bone loss.[1] One of the common sequelae of periodontal breakdown is the formation of deep infrabony defects (IBDs), which are strongly associated with disease progression and eventual tooth loss.[2] These defects compromise masticatory efficiency and also adversely affect speech, facial aesthetics, and overall quality of life.[3] Goldman and Cohen classified intrabony defects based on the number of remaining osseous walls into one wall, two wall, and three wall defects.[4]

Following effective supragingival plaque control, which constitutes the first phase of periodontal therapy, scaling and root planing (SRP) is performed as the second phase of active treatment. SRP aims to remove subgingival plaque and calculus, thereby eliminating primary etiological factors.[5] Nevertheless, residual deep pockets often persist, particularly in areas exhibiting infrabony bone loss, thereby necessitating surgical intervention.[5,6]

Open flap debridement (OFD) is a widely used surgical approach that enhances access to deep periodontal defects and facilitates reduction in probing pocket depth. However, histologic evidence suggests that healing following OFD predominantly occurs through the formation of a long junctional epithelium rather than true periodontal regeneration.[7]

In contrast, regenerative periodontal therapy seeks to restore the lost attachment apparatus, including alveolar bone, periodontal ligament, and cementum.[8,9] Healing characterized by epithelial attachment,

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fibrous adhesion, ankylosis, or root resorption is considered periodontal repair rather than regeneration. Various regenerative techniques, such as modified Widman flap procedures with or without bone grafts and guided tissue regeneration (GTR), have been employed to achieve this objective. Although autogenous bone is considered the gold standard graft material, its clinical use is limited by donor site morbidity and insufficient availability. To address these limitations, bone allografts such as freeze dried bone allograft (FDBA) have been introduced as alternatives.[11,12]

FDBA provides an osteoconductive framework and has shown favorable outcomes in periodontal regenerative procedures. More recently, platelet rich fibrin (PRF), introduced by Choukroun and colleagues, has gained attention as a second generation platelet concentrate due to its ease of preparation and fully autologous nature.[13,14]The present study was aimed to evaluate the role of a Freeze Dried bone graft substitute in the management of a circumferential infrabony defect in a mandibular left second molar in a patient diagnosed with localised periodontitis.

Case Report

A 45 year old male patient reported with the chief complaint of bleeding and swelling of gums in relation to left lower tooth since 10 days. On examination there was a periodontal pocket of 6 mm in mandibular left second molar (Figure 1). The probing depth was 5 mm on mesial aspect and 6mm on distal aspect of second molar (Figure 2), and 5 mm on third molar. There was no tenderness or pus discharge. Radiograph revealed infrabony defects on distal aspect of 37 (Figure 3). The treatment plan was to carry out a complete debridement in 36-38 region and place a PRF membrane alone with the FDBA bone graft substitute to fill the defect.

Surgical Technique

A mucoperiosteal flap was raised from 36 to 38 region by using Kirkland crevicular flap to ensure maximum coverage of the grafted site. The flap was extended to include one tooth on either side of the defect site so as to allow adequate reflection without giving a vertical incision. After complete removal of the granulation tissue and complete debridement, a circumferential defect of 6 mm was present around 37 (Figure 4). The freeze dried bone graft substitute was placed in the defect to fill it completely (Figure 5) and then covered with a resorbable PRF membrane (Figure 6). The flap was sutured approximating it on both buccal and lingual aspects to completely cover the membrane (Figure 7).

Figure 1: Pre-operative

Figure 2: Probing Depth 6mm

Figure 3: OPG

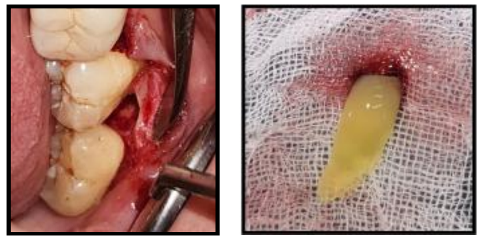

Figure 4: Circumferetial Defect

Figure 5: FDBA Placement

Figure 6: Placement of PRF Membrane

Figure 7: Suture Placement

Post-surgical treatment and follow-up

The patient was given plaque control instructions that included use of 0.12% Chlorhexidine rinse twice daily and to avoid tooth brushing in the operated quadrant. The sutures were removed 10 days following surgery. The Chlorhexidine rinse was advised for 2 weeks. The patient was advised to brush in the operated segment using a soft toothbrush. The patient was put on regular recall at 1, 3, 6, 9 & 12 months. The symptoms of bleeding and swelling had disappeared with a reduction in probing depth of 3mm at 3 months and after 6 months recall. Patient was comfortable with no recurrence of symptoms (Figure 8). At the 9 month recall, radiograph showed significant bony fill, evident as increase in radioopacity and these results were maintained at the time of the last recall at 12 months (Figure 9).

Figure 8: Probing Depth Reduction

Figure 9: 12 Month Recall

Discussion

Regeneration of periodontal infrabony defects remains a biologic and clinical challenge due to the complex architecture of the periodontal attachment apparatus. As stated by Melcher[15], true periodontal regeneration requires the coordinated formation of new alveolar bone, periodontal ligament, and cementum, which is difficult to achieve consistently with conventional therapy. Cortellini and Tonetti[16] emphasized that defect morphology, particularly deep and contained defects, plays a crucial role in determining regenerative outcomes. In the present case, the circumferential infrabony defect around mandibular second molar provided a favorable environment for regenerative intervention.

Bone grafting has long been considered a cornerstone of periodontal regenerative therapy. Histologic studies by Mellonig and Bowers[17] demonstrated that bone grafts can promote new bone and attachment formation under optimal conditions. Reynolds et al[18] reported that alloplastic and some allogenic grafts primarily act as space fillers rather than true osteoinductive materials. Freeze dried bone allograft (FDBA), although predominantly osteoconductive, has shown predictable clinical improvements in probing depth reduction and radiographic bone fill, as described by Mellonig.

The addition of platelet rich fibrin (PRF) introduces a biologically active component to the regenerative approach. Choukroun et al[13] first described PRF as a second generation platelet concentrate capable of releasing growth factors such as PDGF, TGF-β, and VEGF over a sustained period. Dohan Ehrenfest et al[14] highlighted that PRF acts as a fibrin scaffold facilitating cell migration, angiogenesis, and wound stabilization. Furthermore, in vitro studies by He et al. demonstrated enhanced proliferation of osteoblasts and periodontal ligament fibroblasts in the presence of PRF.

Clinical studies have supported the adjunctive use of PRF with bone grafts. A randomized clinical trial by Thorat et al[19] showed significantly greater probing depth reduction and radiographic defect fill when PRF was combined with FDBA compared to FDBA alone. Similarly, Pradeep et al[20] reported superior clinical attachment gain in infrabony defects treated with PRF and bone graft combinations. The synergistic effect observed may be attributed to PRF's ability to accelerate soft tissue healing while stabilizing the graft material. The favorable clinical and radiographic outcomes observed in this case over a 12-month follow-up are consistent with findings reported by Cortellini et al[16], who emphasized the importance of patient plaque control and regular maintenance in sustaining regenerative results. Thus, the combined use of PRF and FDBA appears to be a predictable and biologically sound approach for managing periodontal infrabony defects.

Conclusion

This case report highlights the successful management of a circumferential infrabony defect associated with localized periodontitis using freeze dried bone allograft in combination with platelet rich fibrin. The regenerative approach resulted in significant probing depth reduction and satisfactory radiographic evidence of bone fill. The use of PRF likely enhanced wound healing and graft stabilization due to its biologically active growth factors. Clinical outcomes were favorable and well maintained throughout the follow-up period. The patient exhibited good periodontal stability with no signs of disease progression. This case supports the effectiveness of combining bone graft substitutes with autologous biologic modifiers in periodontal regeneration. However, long-term studies with larger sample sizes are required to validate these findings and establish definitive clinical protocols.

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Designing and Fabricating Implant Prosthesis For a Single Missing Tooth

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Abstract

Implant supported single tooth restorations have become a predictable and widely accepted treatment option for the replacement of missing teeth, offering improved functional, biological, and esthetic outcomes compared with conventional fixed dental prostheses. Unlike traditional restorations, implant supported crowns preserve adjacent tooth structure and help maintain peri-implant bone and soft tissue architecture, contributing to long-term stability and patient satisfaction. The success of these restorations depends not only on accurate implant placement but also on precise prosthetic planning and meticulous laboratory procedures.

This article reviews the design and laboratory fabrication processes involved in implant prostheses for single tooth replacement. It discusses the three principal restoration types: cement retained crowns, screw retained crowns, and screw cement retained prostheses. Both conventional and digital workflows are described, including implant impression procedures, master cast fabrication, abutment selection or customization, and definitive crown fabrication. The role of different abutment systems such as stock titanium abutments, UCLA abutments, and CAD-CAM milled customized abutments is also highlighted.

Advances in digital dentistry, including intraoral scanning and CAD–CAM technology, have enhanced the precision, efficiency, and reproducibility of implant prosthesis fabrication while improving communication between clinicians and dental laboratories. A well coordinated clinical and laboratory workflow is essential to achieve accurate fit, optimal emergence profile, esthetic integration, and long-term success of single tooth implant restorations.

Introduction

Single tooth implant restorations are recognized as a predictable treatment option for replacing missing teeth, demonstrating high long-term survival and excellent esthetic outcomes [1]. Unlike conventional fixed partial dentures, implant-supported crowns preserve adjacent tooth structure and help maintain peri-implant bone and soft-tissue architecture, resulting in superior functional and biological outcomes [2]. Successful rehabilitation depends on accurate three dimensional implant positioning, precise emergence profile design, stable soft-tissue contours, and appropriate selection of prosthetic components, including the choice between cement retained, screw retained, or screw cement retained prostheses [3,4]. With the integration of digital workflows, CAD–CAM fabrication, and customized abutment design, clinicians can achieve a highly accurate fit and natural morphology, enhancing peri-implant tissue stability and long-term esthetic predictability [2,5]. This article reviews contemporary principles and techniques involved in the design and fabrication of implant prostheses for single tooth replacement.

Single Tooth Replacement Options

Single tooth implant restorations may be delivered in three principal designs:

1. Cement Retained Crowns (CRC)
2. Screw Retained Crowns (SRC)
3. Screw Cement Retained Prostheses (SCRP)

Abutment Options

- Stock Titanium Abutments Prefabricated components used with minimal or moderate laboratory modification.
- Customized Abutments
- UCLA (Castable) Abutments – plastic, Co–Cr, gold base, or Ti-base
- CAD–CAM Milled Abutments – titanium or zirconia, designed digitally to optimize emergence profile, soft-tissue support, and restorative space

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1. Cement Retained Single Tooth Implant Restorations

1 (a). Conventional Laboratory Workflow

The laboratory workflow begins with receipt of the implant level impression, opposing cast, bite registration, and prescription [6]. For prefabricated abutments, the implant analog is attached to the coping, and a master cast is poured with Type IV die stone and a gingival mask to simulate soft tissue [7]. The cast is mounted on an articulator, and the abutment is selected and adjusted for margin position, retention, and occlusal clearance. Die spacer is applied, and a crown wax-up is performed. Definitive crown fabrication can be via metal ceramic casting or CAD–CAM milling of monolithic ceramics, followed by finishing, glazing, and quality verification [8].

For customized abutments (UCLA or CAD–CAM), the abutment is designed to optimize emergence profile, soft-tissue support, retention, and occlusal clearance [9]. The abutment is cast or milled, verified on the master cast, and the crown is fabricated and finished. The final prosthesis, along with the abutment, retaining screw, and delivery instructions, is returned to the clinician. Common UCLA abutments include fully castable plastic, Co–Cr alloy, gold base, and Ti-base [6].

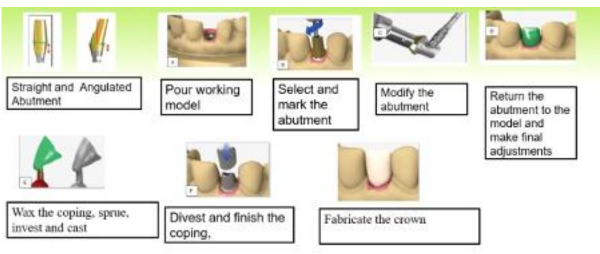

Figure 1: Conventional Laboratory Workflow for screw Retained Crown

1(b). Digital Workflow for Cement Retained Single Tooth Implant Restorations

The digital workflow improves precision and efficiency in fabricating cement-retained single tooth implant restorations. Intraoral scans capture the implant site, opposing arch, and bite registration. The data is exported in STL format to create a virtual model. For prefabricated abutments, the technician selects an appropriate component from the digital library and makes minor digital adjustments to optimize the emergence profile, margin placement, occlusion, and interproximal contacts. The crown is then digitally designed and fabricated via CAM milling from monolithic ceramics such as zirconia or lithium disilicate, followed by sintering, staining, glazing, and verification on a printed or milled model prior to clinical cementation [10].

For customized abutments (CAD–CAM), digital scanning captures implant position and surrounding tissue anatomy. CAD software is used to design the abutment considering soft-tissue support, margin location, emergence profile, retention, and occlusal clearance. The abutment is milled or 3D-printed from titanium, zirconia, or hybrid materials, followed by post-processing including sintering, polishing, and margin finishing. The crown is then digitally designed, fabricated as a monolithic or layered ceramic restoration, and checked for passive fit and esthetics before cementation [11].

This workflow reduces manual errors, ensures precise abutment crown fit, enhances efficiency, and is particularly advantageous in esthetic zones.

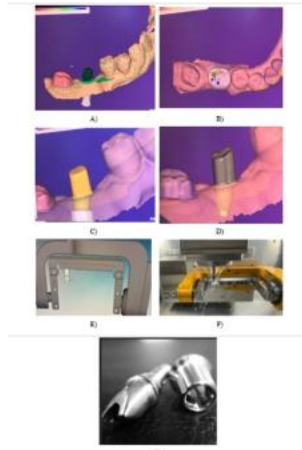

Figure 2: Diagram illustrating digital Workflow Images for Cement Retained Crown Fabrication, (A)Scan Body Capture and Digital Impression, (B) Crown Alignment and Abutment Angulation Correction, (C) Digital abutment designing, (D) Custom grooves or channels are digitally added to the axial walls of the abutment to improve the mechanical interlocking, (E) Designing in the Milling Software, (F) Milling of Titanium Abutment in a 5-Axis CNC Milling Machine, (G) Final milled titanium abutment.

2. Screw Retained Crowns for Single Tooth Restorations: Conventional and Digital Workflows

Screw retained crowns are a predictable option for single tooth implant restorations, offering retrievability, ease of maintenance, and reduced risk of peri-implantitis compared to cement-retained restorations (Priest, 2017). The choice of abutment is critical, with UCLA abutments (Plastic, Gold Alloy, Titanium) and Multi-Unit Abutments (MUA) being widely used depending on implant angulation, esthetic requirements, and restorative space.

2 (a). Conventional Workflow of Screw Retained Crowns

The conventional workflow for screw retained implant crowns begins with obtaining an accurate elastomeric impression using polyether or polyvinyl siloxane, incorporating an open or closed tray implant transfer coping to capture implant position precisely (12). A master cast is fabricated by pouring die stone around the implant analog and incorporating a gingival mask to replicate peri-implant soft tissue contours (13). The abutment framework is then created using traditional waxing techniques, followed by spruing, investing, burnout, and casting to produce a metal structure with adequate support for veneering materials (14). After casting, the framework is tried intraorally to verify marginal integrity, passive fit, and proximal contacts, as inadequate fit may induce mechanical complications such as screw loosening or fracture(15). Porcelain layering or composite veneering is subsequently performed, and the finished crown is finally secured to the implant using a prosthetic screw with controlled torque, ensuring retrievability and reduced risk of residual subgingival cement (16).

2 (b). Digital Workflow of Screw Retained Crowns

The digital workflow integrates intraoral scanning, CAD design, and CAM fabrication to streamline screw retained crown production while minimizing inaccuracies inherent to conventional impressions (17). Implant position is recorded using scan bodies, enabling precise three dimensional capture of implant geometry and surrounding soft tissues (18). The digital data are exported into CAD software, where emergence profile, occlusal morphology, and screw access positioning are virtually designed, ensuring optimal biomechanics and esthetics (19). Additive manufacturing or subtractive milling is then used to fabricate the crown, commonly utilizing materials such as monolithic zirconia, titanium bases (Ti-bases), or hybrid ceramic polymers, each offering high precision and reduced production time [20]. The digitally fabricated crown undergoes a clinical try-in to evaluate fit, occlusion, and soft tissue compatibility before being screw retained with appropriate torque. Digital workflows have demonstrated improved accuracy, reproducibility, and patient comfort, while facilitating efficient communication between clinician and laboratory [21].

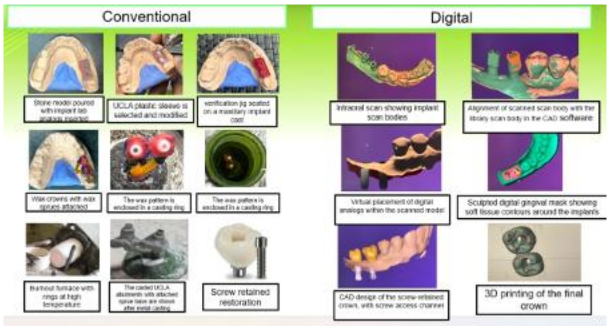

Figure 3: Conventional and Digital Workflow of Screw Retained Crowns

3. Screw Cement Retained Prosthesis

3a. Conventional Workflow of Screw Cement Retained Prosthesis The conventional workflow for screw cement retained implant prostheses begins with implant placement, followed by a definitive impression using elastomeric materials to accurately transfer implant position [22]. A master cast incorporating a gingival replica is then fabricated to facilitate proper abutment selection or customization, ensuring optimal emergence profile and soft-tissue support [23]. A metal framework is subsequently waxed, cast, and tried intraorally to confirm passive fit, a crucial factor for minimizing mechanical complications such as screw loosening or component strain [24]. The definitive crown is cemented onto the framework extraorally to reduce the potential for subgingival cement extrusion, which is associated with peri-implant inflammation. Finally, the unified prosthesis is screw retained intraorally, and the screw access channel is sealed following application of the recommended torque value to ensure long-term stability [25].

3 b. Digital Workflow of Screw Cement Retained Prosthesis In the digital workflow, implant positions are captured using intraoral scan bodies, enabling precise three dimensional recording of implant geometry and peri-implant tissues [26]. CAD/CAM software is then used to design custom abutments and definitive crowns with enhanced accuracy, allowing controlled morphology and ideal screw access positioning. The crown is luted extraorally onto a screw retained base commonly a titanium base (Ti-base) to eliminate the risk of residual subgingival cement and to enhance the precision of the interface [26]. The assembled prosthesis is then screw retained intraorally, and the access channel is restored with composite resin after applying manufacturer recommended torque values. Digital workflows offer improved reproducibility, reduced chairside time, and enhanced communication between clinician and laboratory, supporting predictable long-term outcomes [27].

Figure 4: Sketch of the proposed SRCR ISFPD guideline showing design concept

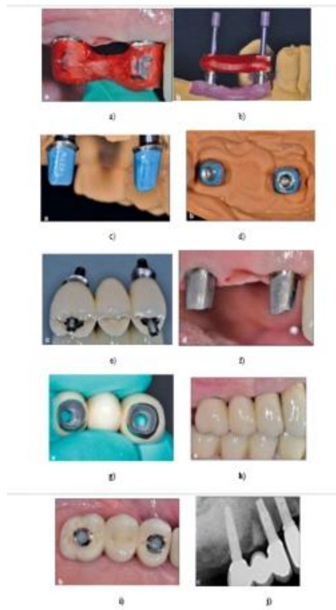

Figure 5: (a) Prefabricated trial cementation jig used to assess implant angulation and determine the appropriate ISFPD design during the custom abutment try-in stage. (b) Two splinted impression copings on the master cast before removal. c) Die spacer applied on custom abutments, avoiding the cervical region to maintain a primary cervical cement seal and reduce risks of cervical cement degradation. (d) A 0.5–1 mm zone around the abutment screw-access channel was left uncoated to establish a secondary occlusal cement seal and prevent coronal cement film breakdown . (e) Final porcelain fused to metal SRCR ISFPD components with engaging abutments. (f) Titanium milled custom abutments sandblasted (excluding finish line) and placed intraorally for cementation. (g) Intaglio surface of the sandblasted ISFPD prior to cementation. (h) Lateral clinical view of the final SRCR ISFPD. (i) Occlusal clinical view of the definitive prosthesis. (j) Final radiograph showing completed ISFPD in position.

Conclusion

Laboratory procedures play a critical role in the success of single tooth implant restorations, directly influencing the accuracy, fit, and esthetic outcome of the final prosthesis. A systematic workflow from precise implant impression or digital scan acquisition, to the fabrication of a master cast or digital model, abutment design, framework fabrication, and definitive crown fabrication is essential for achieving predictable results. Careful attention to emergence profile development, soft-tissue modeling, occlusal morphology, and material selection helps ensure long-term peri-implant stability and functional harmony. With the integration of CAD–CAM technologies and customized abutment fabrication, laboratory processes have become more precise, efficient, and reproducible, reducing human error and enhancing the overall quality of implant-supported single crowns. Ultimately, a well coordinated collaboration between clinician and laboratory technician is key to delivering highly esthetic, biologically compatible, and durable single tooth implant restorations.

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Occlusal Veneers: A Minimally Invasive Restorative Option for Posterior Tooth Rehabilitation – A Narrative Review

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Abstract

Occlusal veneers are gaining widespread recognition as a conservative and biomimetic treatment modality for restoring posterior teeth affected by wear, erosion, or structural compromise. Unlike traditional full coverage crowns, occlusal veneers require minimal tooth reduction and allow preservation of enamel and dentin, thereby enhancing the longevity and biomechanical performance of restorations. This narrative review presents a comprehensive examination of occlusal veneers, discussing their classification, indications, preparation techniques, material options, biomechanical behavior, clinical limitations, and future prospects based on the current literature.

Introduction

Preserving tooth structure is critical for the longevity of teeth and restorations. It is advantageous to preserve pulp vitality and delay the need for invasive interventions such as endodontic therapy, posts, and cores, which negatively affect the long-term success of restored teeth. With advancements in optical and mechanical properties of ceramics, CAD/CAM techniques, and adhesive systems, the philosophy of restoration has shifted from aggressive reduction to a more conservative, pathology driven approach.[1]

The minimally invasive dentistry (MID) approach is pivotal in modern prosthodontics, especially for posterior teeth susceptible to attrition, erosion, and parafunctional habits. Full coverage crowns, while once the gold standard, necessitate excessive removal of tooth structure. In contrast, occlusal veneers are extra-coronal restorations with minimal preparation requirements and provide superior biological, mechanical, and esthetic benefits.[2]

Background

Occlusal veneers, also termed veneerlays or vonlays, are fabricated from ceramic, hybrid, or composite materials and restore occlusal morphology without encroaching excessively on axial tooth surfaces.[3] Studies have demonstrated that occlusal veneers preserve more dentin and enamel than crowns, with as little as 1 mm of reduction necessary for success (Edelhoff & Sorensen, 2002). Their long-term survival has been reported as 88.7% over 17 years and 84% over 12 years[5], supporting their durability. They are particularly advantageous for young patients, esthetically demanding cases, and post endodontic restorations.[6]

Occlusal Veneers

These are extra coronal restorations demanding an easy preparation determined by occlusal anatomy and provision of adequate interocclusal clearance, they were first described by Pascal Magne.[1] They may be also called tabletop restorations. Ultrathin CAD-CAM occlusal veneers which are about 1 - 1.3 mm at the cusp tip and 0.4 - 0.6 mm thick at the central grooves; had been recognized as a better substitute to full crowns. One study used occlusal veneers as re enameling process for replacement of missed enamel in cases with sever erosion.[7]

Three preparation designs of occlusal veneers have been described by Samaa Kotb et al 2019[8].

In the conventional planar occlusal veneer preparation, the occlusal surface is reduced by 1.5 mm at the cusp tips and 1 mm at the central fossae, without any intra-coronal cavity, axial wall preparation, margin preparation, or defined taper.(Figure 1a 2a)

In the modified occlusal veneer preparation with a circumferential finish line the occlusal reduction remains the same (1.5 mm at cusp tips and 1 mm at central fossae), but in addition, 1 mm axial walls are prepared with

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a 1 mm deep chamfer margin, and the axial walls are given an 8° taper.(figure 1b, 2b)

In the modified occlusal veneer preparation with an intra-coronal cavity, the occlusal reduction is again 1.5 mm at cusp tips and 1 mm at fossae, but here a 2 mm intra-coronal cavity is prepared with 8° occlusal divergence, without axial wall or margin preparation.(Figure 1c, 2c)

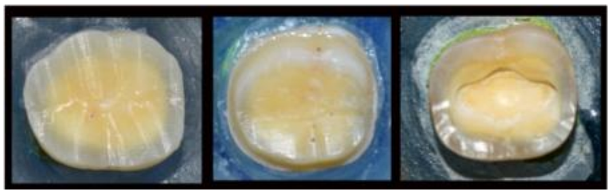

Figure 1: Preparation Design for Occlusal Veneer

Figure 2 : Cemented Occlusal Veneer

Clinical Indications

- To manage progressive enamel loss due to physiological aging or accelerated by pathological conditions like bio-corrosion, erosion, and bruxism.
- When there is significant tooth structure loss that may or may not be associated with a reduction in vertical occlusal dimension.
- To preserve remaining tooth structure, as invasive treatments may disrupt the biological and biomechanical balance, risking long-term failure.

In cases of severe tooth wear, where there is compromise in:

- Masticatory function
- Esthetics
- Occlusal vertical dimension
- Facial profile
- When conservative, additive adhesive techniques are preferred, offering minimally invasive alternatives.
- For partial or total cusp coverage depending on the degree of tooth destruction, especially in scenarios where pulp health and occlusal stability are at risk.

Contraindications

1. **Insufficient Enamel for Bonding:** Occlusal veneers rely on adhesive bonding, which requires an adequate enamel substrate for long-term success. In cases with severe enamel loss or exposed dentin, bonding strength may be compromised.
2. **Uncontrolled Parafunctional Habits (e.g., Severe Bruxism):** Patients with untreated or severe bruxism are at higher risk of restoration fracture or debonding, especially with glass-ceramics. While some materials like zirconia are more resistant, occlusal veneers may still not be the best option without a protective protocol (e.g., night guards).
3. **Poor Oral Hygiene and High Caries Risk:** Patients with poor plaque control or a history of recurrent caries may experience marginal leakage, secondary decay, and restoration failure
4. **Severe Tooth Malposition or Inadequate Occlusal Clearance:** In cases where teeth are malaligned or occlusal space is limited, proper veneer placement and function may not be achievable without prior orthodontic or occlusal adjustment.
5. **Extensive Tooth Destruction:** When the remaining tooth structure is severely compromised, a full-coverage crown or other restorative option may offer better protection and function than a partial occlusal veneer.
6. **Incompatible Occlusal Schemes (e.g., unstable posterior support):** Occlusal veneers may fail in patients with unbalanced or unstable occlusions, particularly if posterior support is lacking.

Materials Used for Occlusal Veneers

The selection of restorative material is a critical factor in determining the success, durability, and esthetic outcome of occlusal veneers. Several material options are available, each with unique mechanical and clinical properties suited for different clinical scenarios.

Lithium disilicate, commercially known as IPS e.max, is widely used due to its excellent esthetics, translucency, and high flexural strength of approximately 470 MPa.[9] Its optical properties closely mimic natural enamel, making it ideal for restorations in esthetically demanding regions. Lithium disilicate also allows for thin restorations (as low as 1.0 mm) while maintaining sufficient mechanical integrity, making it a popular choice for both posterior and anterior occlusal veneers.

Zirconia, particularly in its monolithic form, is another highly favored material for occlusal veneers due to its exceptional strength and resistance to fracture. It exhibits a flexural strength of around 800 MPa, which makes it suitable for high load posterior areas where masticatory forces are significant.[10] Although slightly less translucent than lithium disilicate, newer generations of translucent zirconia have improved in esthetic performance, expanding their indications.

The principal limitation of zirconia with respect to adhesive bonding lies in its polycrystalline, silica-free structure, which lacks a glassy phase. As a result, zirconia does not respond to conventional acid etching or silane coupling agents, rendering traditional bonding strategies ineffective and necessitating alternative surface treatments and adhesive systems for durable adhesion.[11,12]

Composite resins are also utilized, particularly for their favorable elastic modulus, which closely approximates that of natural dentin (around 16–20 GPa vs. dentin's 17.7–29.8 GPa). This biomechanical compatibility contributes to better stress distribution and fatigue resistance under occlusal load.[3] In addition, composite veneers offer advantages such as ease of intraoral repair, reduced cost, and chairside adaptability, making them a practical option in many clinical settings.

A key limitation of composite resin in bonded restorations is its comparatively low wear resistance, with annual volumetric wear rates reported in the range of 20–50 µm, which is significantly higher than ceramics (<10 µm/year) and natural enamel (~10–20 µm/year). This susceptibility to wear can adversely affect occlusal stability, surface morphology, and the long-term clinical performance of restorations.[13-15]

Advancements in CAD/CAM technology and hybrid materials have further broadened the scope for occlusal veneers, offering enhanced accuracy, strength, and conservative preparation protocols. The selection among these materials should be guided by the clinical situation, esthetic requirements, functional demands, and the patient's parafunctional habits.

Sherif Sultan et al. (JIDMR)[16] proposed a classification based on restoration extent:

- Porcelain laminate veneer: a thin, bonded ceramic restoration that restores the facial, incisal, and part of the proximal surfaces of teeth requiring esthetic restoration;
- Inlay: a fixed intracoronal restoration; a dental restoration made outside of a tooth to correspond to the form of the prepared cavity, which is then luted into the tooth
- Table top: covers only the occlusal surface
- Vonlay/Veneerlay: First described by Edward McLaren et al, vonlays are hybrid restorations made of monolithic lithium disilicate combining features of an onlay and a buccal veneer, typically used in posterior teeth with occlusal and buccal surface damage or wear. Their key advantages include reduced technique sensitivity, minimal invasiveness, and improved repairability compared to full-coverage crowns.[17]
- Onlay: - a partial-coverage restoration that restores one or more cusps and adjoining occlusal surfaces or the entire occlusal surface and is retained by mechanical or adhesive means
- Overlay: overlay is prosthesis that tends to restore the occlusal cusp integrity of a tooth. It crosses beyond the occlusal table in cervical direction.
- Minimally invasive posterior indirect restoration (MIPIR): this is a restoration that does not have a specific shape or preparation and it is not an onlay, partial coverage crown or endocrown.

Bonded onlays and vonlays are indicated in extensive occlusal wear, cracked tooth syndrome, or large restorations. Unlike conventional MOD onlays, these follow defect specific, non-retentive designs with rounded internal forms. Specific kits such as Komet's 4665 facilitate precise reduction. Vonlays offer functional and esthetic benefits, particularly in posterior wear.

Endocrowns: introduced by Bindl and Mormann (1999)[18], are monolithic, pulp-chamber retained restorations ideal for post-endodontic molars with inadequate ferrule. They provide better stress distribution and require less time and cost.[19] Resin ceramics and lithium disilicate are preferred materials.[20]

Figure 3: Different types for minimally invasive restorations

Marginal Adaptation and Adhesion

The success and longevity of occlusal veneers are heavily dependent on the precision of marginal adaptation and the effectiveness of the adhesive protocol. With the advent of advanced CAD/CAM technologies, it is now possible to achieve highly accurate restorations with marginal gaps measuring less than 120 μm, which are well within clinically acceptable limits.[21] Such precision minimizes the risk of microleakage, secondary caries, and marginal discoloration.

Among various preparation designs, rounded shoulder margins have demonstrated superior marginal integrity compared to chamfer or feather edge margins. This design supports the ceramic material evenly and enhances the fit of the restoration at the tooth restoration interface.

Adhesion plays an equally critical role in the success of occlusal veneers. The use of total etch or self-etch adhesive protocols, combined with high quality resin cements, ensures strong and durable bonding. However, achieving a predictable bond depends heavily on proper moisture control during the bonding procedure. Studies have shown that both over dried and excessively wet dentin surfaces can compromise bond strength, leading to increased risk of adhesive failure.[22] Thus, optimal surface conditioning and controlled isolation are imperative during the adhesive cementation of occlusal veneers.

Biomechanical Guidelines for Preparation of Bonded all Ceramic Restoration[23,24]

1. **Simplicity of Preparation Geometry:** The cavity or preparation design should remain as simple and conservative as possible, avoiding unnecessary retentive features or complex internal geometry
2. **Adequate and Uniform Material Thickness**: The restorative material must be provided with sufficient and uniform thickness in all areas, particularly in the occlusal and axial regions, to ensure structural durability and resistance to fracture.
3. **Smooth Internal Line Angles and Transitions**: All internal line angles should be rounded and transitions between surfaces should be gradual, thereby minimizing stress concentration within the restoration.
4. **Optimization of Stress Distribution:** The preparation should be designed to reduce tensile stresses and, where feasible, to redirect occlusal forces into more favorable compressive stresses.
5. **Avoidance of Stress Concentration Zones**: Sudden changes in wall inclination, thickness reduction, or sharp edges should be avoided, as these create localized stress peaks detrimental to the longevity of the restoration.
6. **Elimination of Notch Effects**: Any notches, sharp indentations, or irregularities that could act as crack initiation sites must be eliminated from the preparation design.
7. **Maximization of Adhesive Bonding Surface**: A broad and continuous bonding interface between the restoration and the tooth structure should be ensured in order to enhance adhesion and improve biomechanical stability.
8. **Placement of Margins in Enamel Whenever Possible**: Preparation margins should be located within enamel, wherever clinically feasible, to maximize adhesive effectiveness and ensure long-term marginal integrity.

Discussion

In restorative dentistry, two principal paradigms guide clinical decision making: the conventional approach, which relies on mechanical or frictional retention, and the minimally invasive (MI) or adhesive approach, which emphasizes tooth preservation and relies on adhesive bonding. While conventional restorations, such as full crowns, have long-standing clinical success, they often necessitate extensive tooth reduction and are typically fabricated from both esthetic and non-esthetic materials. In contrast, minimally invasive restorations are almost exclusively fabricated from esthetic materials like ceramics or composites and aim to preserve as much natural tooth structure as possible.[3]

A significant challenge in minimally invasive dentistry lies in nomenclature and classification, which often causes confusion among clinicians and dental technicians. Terms such as overlay, tabletop, ceramic onlay, bonded onlay, occlusal veneer, and ultra-thin veneer are frequently used interchangeably, despite variations in preparation design, extent of coverage, and restorative intent. For example, vonlays a hybrid of veneer and onlay are used to restore occluso-buccal surfaces in posterior teeth and are particularly suitable for esthetic and functional rehabilitation with minimal invasiveness (McLaren et al., 2015). Other evolving terms like endocrowns, crownlays, and sharonlays have emerged to describe specific combinations of coverage types, highlighting the dynamic evolution of minimally invasive prosthodontics.[18]

While these terminological distinctions may appear academic, they have practical implications for treatment planning, communication, and education. An agreed upon classification would streamline case selection, preparation design, and material choice. Until then, clinicians must rely on a thorough assessment of the individual clinical situation to select the appropriate minimally invasive restoration.

Key factors to evaluate during planning include:

- Adhesive potential: The quality and quantity of remaining enamel are crucial for successful bonding.
- Parafunctional habits: Bruxism or clenching can compromise the longevity of bonded restorations.
- Posterior bite force: Molars are subjected to higher masticatory loads, influencing material selection.
- Opposing dentition: The wear pattern of opposing teeth must be considered to avoid excessive wear or failure.
- Isolation feasibility: Achieving a dry, contaminant free field is essential for effective adhesive bonding.
- Bonding protocol reliability: Strict adherence to adhesive protocols ensures long-term restoration success.

In conclusion, while minimally invasive restorations present an exciting alternative to traditional crowns, their success relies on meticulous clinical judgment, case selection, and adherence to evolving material science and adhesive techniques.

Conclusion

When a posterior tooth requires cuspal coverage, full crowns should not be the default choice. PMI FDPs like onlays, vonlays and occlusal veneers offer conservative alternatives with adequate success rates. Proper planning, material selection, and adhesive techniques are critical. Full crowns should be limited to crown replacement, implants, or post-core scenarios.

Limitations and Future Research

Despite in vitro support, occlusal veneers lack long-term clinical validation:

- Few RCTs or prospective clinical trials
- Limited data on failure modes
- Need for periodontal and biofilm studies
- Standardized digital protocols yet to be defined

Future research should focus on long-term follow-up, digital workflows, and bioactive materials to further validate occlusal veneer therapies.

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Proteomic Analysis of Periodontal Diseases: Current Status and Future Directions

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Abstract

Proteins are fundamental components of cellular metabolic pathways and govern the structural and functional integrity of living systems. A wide range of protein molecules play critical roles in the initiation, progression, and severity of periodontal disease. Population-scale proteomic analysis is revolutionizing the understanding of periodontal disease by elucidating underlying molecular mechanisms and enabling the identification of novel biomarkers and therapeutic targets. Proteomics, the study of expression of proteomes and their functions, has significantly advanced periodontal research by facilitating the early detection of disease through the identification of biomarkers present in oral secretions. Beyond diagnostics, proteomic approaches offer substantial potential to enhance the management of periodontal diseases by enabling risk assessment, rapid diagnosis, disease prevention, and monitoring. This review discusses the role of proteomics in periodontology, from basic proteomic concepts and technologies to their applications in understanding periodontal tissues, disease mechanisms, microbial interactions, biomarker discovery, tissue engineering and the future potential of proteomics in improving periodontal diagnosis and therapy, highlighting ongoing efforts to harness its potential for improving clinical outcomes and developing effective treatments for periodontal diseases.

Introduction

Proteins are vital molecules that drive cellular processes like catalysis, structural support, and signal transduction. The term "proteome" was coined by Marc Wilkins in 1996, combining "protein" and "genome". The proteome is the complete set of proteins in a cell, reflecting changes over time and responses to environmental stresses. The term "proteomics" emerged in 1997, analogous to genomics,[3] and involves studying the entire protein set, including their abundance, distribution, functions, and interactions under specific conditions. Proteomics helps understand disease mechanisms at the protein level by analysing protein properties on a large scale. Proteomics provides a more accurate measure of protein abundance than genomics and accounts for post-translational modifications that influence protein function. The field advanced significantly in 1975 with O'Farrell's separation of over 1,000 Escherichia coli proteins using two-dimensional gel electrophoresis. Key milestones followed in 1995 with the first complete genome sequence of Haemophilus influenzae Rd and the protein mapping of Mycoplasma genitalium, and in 1997 with the publication of the first textbook on proteome research by Wilkins et al. Proteome analysis of bone and dental structure (enamel, periodontal ligament, and cementum) and oral fluid diagnostics (saliva and GCF) are the primary areas where dental proteomics has shown promising outcomes.[4]

Proteomics has been applied to study periodontitis, dental caries, oral cancers, and oral mucosal diseases, providing insights into disease specific protein biomarkers, host microbial interactions and molecular mechanisms. Periodontitis is an inflammatory disease caused by infectious agents and host factors, affecting the periodontium, a complex tissue supporting teeth.[5] Proteomics has emerged as a powerful approach in periodontitis research by enabling the identification of protein biomarkers that reflect disease activity, host microbial interactions and tissue responses, thereby improving early diagnosis, risk assessment, and clinical management of periodontal disease.

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Proteomics has transformed periodontology, enabling analysis of protein expression, function, and interactions in periodontal tissues. Recent advances in proteomics hold promise for improving our understanding of periodontal physiology and pathology.[6] A primary challenge in periodontology is the appropriate adoption of proteomic approaches to investigate unresolved molecular and biological questions concerning the diverse cell populations of the periodontium. Gaining a deeper understanding of the cellular and extracellular matrix protein components of periodontal tissues is essential for advancing future research. This review examines the applications and limitations of proteomic profiling in the study of periodontitis, with particular emphasis on large scale analyses and their integration with genomic data to enhance understanding of periodontal inflammation.

Types of Proteomics

Overall proteomics can be divided into three main types such as: Structural Proteomics, Interaction Proteomics and Functional Proteomics.

Structural Proteomics - Structural proteomics focuses on determining the three dimensional structures of all proteins encoded by a genome. It aims to analyze unknown proteins, including those bound to ligands or cofactors, to better understand their functions. Major challenges include identifying proteins on a genome wide scale, establishing structure function relationships, and describing their 3D architecture. This approach also reveals functional and evolutionary relationships between proteins that may not be evident from sequence data alone.

Interaction Proteomics - Interaction proteomics studies protein protein interactions that regulate biological systems. Since cellular functions depend on these interactions, understanding them helps explain regulatory mechanisms encoded by the genome. Common techniques include the yeast two hybrid system, microarrays, and affinity purification. This approach has been widely applied, for example, in identifying novel substrates of matrix metalloproteinases involved in inflammation.

Functional Proteomics - Functional proteomics examines how proteins operate within molecular networks and complexes to control cell behavior. It focuses on analyzing the spatial and temporal dynamics of proteins in living cells. The main goals are to determine the functions of previously unknown proteins and to understand cellular activities at the molecular level.

Proteomics and Dentistry

Proteomics is a rapidly evolving postgenomic science with significant potential in modern dentistry. It is widely used in oral fluid diagnostics to identify biomarkers and to study the structure of bone and dental enamel. Salivary proteomic analysis enables early disease detection and monitoring of oral health, as saliva contains a complex mixture of proteins derived from host tissues, microorganisms, serum, and gingival crevicular fluid, including biomarkers associated with periodontitis.

Proteomics has important applications in oral cancer research, dental caries, implantology, and periodontal disease. In periodontitis, it aids in identifying specific protein biomarkers in saliva and periodontal tissues, improving early diagnosis, understanding disease mechanisms, and supporting the development of targeted therapies.

Proteins of the Periodontium

The periodontium provides constant support, attachment, proprioception, and physical protection. The functions of the proteins present in the periodontium include cell matrix adhesion, signalling, regulating the diffusion of nutrients, waste products and soluble signalling molecules. These proteins, along with periodontal ligament, is made up of the intermediate filament network, that plays a role in providing the structural integrity of the periodontium. A wide range of salivary and gingival crevicular fluid (GCF) biomarkers reflect the inflammatory, connective tissue, and bone remodeling processes involved in periodontitis. These include specific markers such as immunoglobulins (IgA, IgG, IgM, sIgA), which increase in response to periodontal pathogens, and nonspecific markers such as enzymes, mucins, histatins, lactoferrin, and lysosomal proteins. By-products of tissue breakdown such as collagen telopeptides (ICTP), osteocalcin, osteopontin, and bone collagen fragments serve as indicators of bone turnover and active tissue destruction. Host-derived factors including neutrophils, macrophages, cytokines (IL-1β, TNF-α, PGE_2), matrix metalloproteinases (especially MMP-8 and MMP-9), cathepsin B, AST, alkaline phosphatase, and nitric oxide further reflect disease severity and activity. Microbial components from key pathogens such as P. gingivalis, T. denticola, and A. actinomycetemcomitans, along with phenotypic markers (keratins, fibronectin), volatile sulfur compounds, cortisol, calcium, lactoferrin, and platelet activating factor, collectively contribute to the periodontal proteome, providing a non-invasive basis for diagnosis, monitoring, and risk assessment of periodontal disease.[7]

Application of proteomics in periodontics

Proteomic technology has widespread applications in the field of periodontology, leading to disease diagnosis, prognosis and treatment planning. The conventional methods employ subjective measures such as pocket probing depth, bleeding on probing etc. But most recently, the biomarker identification and quantification has provided more objective measures for periodontal disease diagnosis, risk determination, evaluating disease progression, monitoring of therapy outcomes, and drug discovery. Proteins specific to periodontal diseases may be found in saliva, GCF, periodontal ligament fibroblasts and periodontal microbes.

Proteomic Insights into the Clinical Complexity of Periodontitis

Periodontal diseases are classified into gingivitis, a reversible inflammation confined to the gingiva, and periodontitis, which involves deeper periodontal tissues and leads to irreversible attachment loss. [8] The progression from gingivitis to periodontitis reflects a shift from a protective host response to plaque toward a dysregulated, destructive inflammatory reaction. In susceptible individuals, persistent microbial challenge disrupts tissue homeostasis, resulting in apical migration of the junctional epithelium, periodontal pocket formation, and deeper biofilm invasion.[9] Disease progression occurs in episodic phases of activity and remission. Identified independent and modifiable risk factors include smoking, alcohol use, diabetes mellitus, obesity, metabolic syndrome, osteoporosis, and deficiencies in calcium and vitamin D.[10] Increasing evidence also supports mechanistic links between periodontitis and systemic diseases through dissemination of pathogens and inflammatory mediators, contributing to chronic low-grade inflammation.[11]

Despite advances, the molecular mechanisms underlying periodontal disease remain incompletely understood, limiting early diagnosis and precise assessment of disease activity. Traditional biomarkers alone cannot fully capture the complex inflammatory processes. Consequently, proteomics comprehensive analysis of the entire protein complement of cells or tissues has gained importance, as it enables simultaneous identification and quantification of proteins and elucidates functional pathways and interactions.[12]

Proteomic research in periodontology is challenging due to its biological complexity and host microbiome interactions; thus, no single stable oral proteome exists. Instead, the concept of a dynamic "proteotype" has been introduced to describe time-specific protein expression patterns.[13] Proteins for analysis can be derived from enamel, gingiva, periodontal ligament, saliva, and gingival crevicular fluid, and even ancient dental calculus has provided evolutionary insights.[14-16] Sample selection depends on the research objective, with local tissues and fluids reflecting periodontal processes and serum or plasma used to investigate systemic associations and risk assessment.[17-18]

Establishing reliable associations between proteomic profiles and periodontal disease progression requires large, longitudinal cohort studies utilizing high-throughput proteomic technologies.

Proteomics of Dental Enamel

Recently isolation and characterization of enamel matrix and dentin proteins has been accomplished. The matrix proteins associated with enamel formation are dentin sialo phosphor protein (DSPP, a gene normally linked with dentin formation), the structural enamel proteins amelogenin (AMELX), enamelin (ENAM), and ameloblastin (AMBN) and a matrix metalloproteinase, enamelysin (MMP20). Zilm et al did the proteomic identification of proteinase inhibitors, fetuin A and alpha1-antichymotrypsin, in the porcine enamel matrix derivative (EMD).

Proteomics of Mesenchymal stem cells

The science of tissue engineering has finally emerged and has opened up a new vista for treating various pathological conditions. This technology mainly includes stem cell procurement, storage, differentiation and transplantation, requiring different proteins. Park presented a list of mesenchymal stem cell (MSC) proteins for producing a reference map of proteome.[28] However future possibilities lie in expanding the list of (MSC) proteins further with known as well as unknown gene products.

Proteomics in periodontal ligament fibroblasts

To understand PDL physiology and disease related protein markers, the analysis of the entire complement of PDL fibroblast proteome is of utmost importance. Although immunological methods have been tried to study the protein expression of PDL fibroblast, but this is limited to only previously identified proteins for which antibodies are available. Characterization of periodontal ligament (PDL) fibroblast proteome is an important tool for understanding PDL physiology and regulation and for identifying disease related protein markers. PDL fibroblast protein expression has been studied using immunological methods, although this technique is limited to previously identified proteins for which specific antibodies are available. A total of 117 proteins have been identified from PDL fibroblasts which can serve as a reference map for future clinical studies as well as basic research.[19] Proteomic armamentarium contains a broad array of technical approaches, for analysis of dissected periodontal tissues sections through periodontium or cultured periodontal cells, fractionation of cell and matrix followed by protein separation are the initial steps to proteomic study.

Proteomics in gingival crevicular fluid (GCF)

GCF was also used to study the biomarkers in healthy individuals and periodontitis patients, which is an inflammatory exudate from the gingival margin. The main component of GCF is composed of soft tissue inflammatory products, some of which are considered a biomarker specific to alveolar bone destruction. The products include, cytoskeleton related proteins, immune related protein, circulating blood proteins, enzymes, inflammation related protein, lipid-related protein. Mass spectrometry can be used for analysing the components of GCF.

Proteomics and Periodontal Pathogens

The oral environment contains various colonies of micro-organisms comprising of bacteria, fungi, protozoa, and viruses. Oral ecology studies have reviewed the complexity of the interactions that these microorganisms have with their host in both health and disease. In spite of this, dental caries and periodontal diseases are still worldwide oral diseases, resulting in a high level of morbidity among humans. Proteomics offers a new approach to comprehending these holistic changes, as oral micro-organisms adapt to environmental change within their habitats in the mouth. Various microorganisms are present in subgingival plaque, of which only few play a etiological role in the pathogenesis of periodontal diseases in the susceptible host. Specific microorganisms involved in the periodontal pathogenesis are Tannerella forsythia, Porphyromonas gingivalis, Treponema denticola, and Aggregatibacter actinomycetemcomitans. BANA activity (benzoylDLargininenaphthylamide) was exhibited by the members of the red complex of periodontal pathogens (T. forsythia, P. gingivalis, and T. denticola) are strongly correlated with periodontal activity.

Proteomic approaches for the discovery of salivary biomarkers for periodontal diseases

Virulence factors released by periodontopathic bacteria contribute to tissue destruction either directly through enzymatic degradation or indirectly by triggering an exaggerated host inflammatory response.[21,22] Bacterial enzymes such as collagenases, elastase like enzymes, trypsin like proteases, aminopeptidases, and dipeptidylpeptidases play key roles in connective tissue breakdown. Both host and bacteria derived proteins and inflammatory mediators have therefore emerged as promising salivary biomarkers for periodontal diagnosis. Proteomic studies have identified biomarkers related to three major pathogenic processes: inflammation, collagen degradation, and bone turnover.

Bacterial components such as lipopolysaccharides activate innate immune responses, promoting recruitment of neutrophils and macrophages and release of pro-inflammatory mediators including prostaglandin E_2, TNF-α, IL-1β, and IL-6. These cytokines stimulate matrix metalloproteinases (MMPs), particularly MMP-8, a प्रमुख neutrophil derived collagenase central to periodontal tissue destruction. Elevated salivary and gingival crevicular fluid levels of MMP-8 and other MMPs (MMP-1, -2, -3, and -9) correlate strongly with disease severity and activity.[23,24]

Increased levels of IL-1β and TNF-α further promote osteoclast activation and bone resorption, enhancing the predictive value of MMP-8 in assessing disease risk. Salivary proteomic analyses have identified numerous enzymes, immunoglobulins, growth factors, and host-response proteins influenced by systemic conditions such as smoking and diabetes, reflecting the dynamic nature of the periodontal proteome. Using mass spectrometry based techniques to analyse saliva and gingival crevicular fluid, proteomics enables identification and quantification of key biomarkers, facilitating early diagnosis, monitoring of disease progression, and risk assessment in periodontitis.

Proteomics and Tissue Engineering

Tissue engineering has evolved in recent years as efficient means for treating various pathological conditions. This scientific knowledge mainly constitutes stem cell procurement, storage, differentiation as well as transplantation which is performed by using specific biomarkers such as proteins. However, the absence of knowledge regarding these prospective markers for stem cells and their specific differentiation remains a considerable limitation for these applications. In future, the proteomic and transcriptomic analyses may pave way to obtain new and hopefully fundamental insights into the protein expression, and cellular biology of mesenchymal stem cell.

Proteomic Technologies

A few approaches are obtainable for analytical separation and identification of proteins from complex mixtures.

ELISA (Enzyme Linked Immunosorbent Assay) is a well established and widely used method for the isolation, detection, and quantification of specific proteins. In proteomic studies, ELISA is commonly employed to validate protein biomarkers identified through high throughput techniques such as mass spectrometry. It is highly sensitive, specific, cost effective, and suitable for analysing large numbers of clinical samples. ELISA works on the principle of antigen antibody interaction, where a target protein is captured by a specific antibody and detected using an enzyme linked secondary antibody that produces a measurable colorimetric, fluorescent, or chemiluminescent signal. In periodontal research, ELISA is frequently used to quantify inflammatory mediators, cytokines, enzymes, and other biomarkers in saliva, serum, or gingival crevicular fluid, thereby aiding in disease diagnosis, monitoring progression, and evaluating treatment outcomes.

Two dimensional gel electrophoresis: Advancements such as the immobilized ph gradient (IPG), that separates proteins by charge in one dimension before separating them by size in the second dimension, have made it possible to reproduce this technique in laboratories. Another important advance is the use of IPG with a single pH unit to improve isolation and intracellular fractionation. Apart from improving sensitivity it determines the localization of proteins in the cell. It is a high powered technique, but one disadvantage is that the 2D gel electrophoresis has a relatively low throughput to detect small amounts of proteins such as cytokines and signalling molecules. For the analysis of complex protein mixtures derived from biological samples, two dimensional polyacrylamide gel electrophoresis (2D-PAGE) remains an important and widely used technique. Advancements such as immobilized pH gradients (IPGs), which separate proteins by charge in the first dimension and by molecular weight in the second, have significantly improved reproducibility and laboratory applicability. The use of narrow range IPGs with a single pH unit further enhances protein isolation, intracellular fractionation, sensitivity, and determination of protein localization within the cell. In addition, Protein Topography and Migration Analysis Platform (PROTOMAP), which integrates SDS-PAGE with shotgun proteomics, enables the detection of changes in protein gel migration caused by proteolysis or post-translational modifications. Despite its high resolving power, 2D-PAGE is limited by relatively low throughput and reduced sensitivity for low abundance proteins such as cytokines and signalling molecules.[25]

Mass spectrometry: In 1995, Randall Nelson introduced mass spectrometry based immunoassays (MSIA), which utilize modification specific antibodies to identify post-translationally modified proteins. In mass spectrometry, proteins are enzymatically digested into peptides, and their masses are measured to generate unique peptide mass fingerprints for database based protein identification. Advances in MS instrumentation now allow ion separation and fragmentation for precise sequence analysis. To reduce sample complexity, MS is commonly coupled with multidimensional liquid chromatography, enabling large scale proteomic studies with the identification of over 1,400 proteins in a single experiment. Imaging mass spectrometry further permits spatial mapping of protein expression in normal and diseased tissues, revealing disease-specific protein patterns. Such proteomic profiles have demonstrated prognostic value, as shown in glioma patients, and ongoing improvements in data analysis are supporting the clinical application of this technology.[26,27]

Non gel based proteome separation techniques have been developed to overcome the limitations of two-dimensional electrophoresis while retaining high resolution separation of complex protein and peptide mixtures prior to mass spectrometry analysis. Among these, capillary electrophoresis serves as an effective alternative to two dimensional gel electrophoresis for protein separation and to chromatographic methods for peptide analysis.

Protein chips: Currently, the main advantage of this technology over conventional protein separation tools is the capacity to analyse protein protein, protein DNA, or protein RNA interactions, based on the substrate cross-linked to the chip. This technique is important for proteins that are not suitable for 2D gel electrophoresis. Apart from this, the analysis of serum samples is significantly improved using this technique, as the inherent "masking" of serum proteins by the abundant albumin species on 2D gels is significantly reduced.[28]

Tissue Microarrays

Over the past century, pathological evaluation of tissue is of paramount importance in the diagnosis of cancer. Improvements in array technology have made it possible to adapt traditional immuno-histochemical detection of protein expression in tissue sections in the high-throughput array format. Through studies it has been evident that the use of immuno-histochemistry of tissue microarray, expressed about 26 selected proteins in more than 1,600 cancer samples from 552 consecutive early stage breast cancer patients.[29] Hierarchical clustering identify the associated clusters of co-expressed proteins and tumour clusters. Importantly, in multivariate analysis, 21 protein sets are the strongest independent predictors of clinical outcome. More recent techniques such as matrix assisted laser desorption/ionization have been employed for rapid determination of proteins in particular mixtures.

Limitations of Proteomics in periodontics

Despite its considerable potential, proteomics in periodontology faces several limitations. The complexity and heterogeneity of periodontal tissues, along with the dynamic nature of inflammatory processes, make it challenging to obtain standardized and representative samples. Variability in sample collection methods such as gingival crevicular fluid, saliva, or tissue biopsies can significantly influence protein profiles and affect reproducibility. Additionally, low abundance proteins, post-translational modifications, and protein degradation in inflammatory environments may be difficult to detect with current technologies. High costs, technical expertise requirements, and the need for sophisticated bioinformatic analysis further limit widespread clinical application. These challenges highlight the necessity for standardized protocols and improved analytical platforms to enhance the reliability and translational value of proteomic studies in periodontology.

The Future of Proteomics

The future of proteomics in periodontitis focuses mainly on salivary diagnostics and the analysis of mineralized tissues such as bone and enamel. Saliva, being easily accessible and non-invasive, serves as a valuable diagnostic fluid that reflects systemic and periodontal biomarkers. Advances in sensor technology are enabling portable, chairside devices for early detection and improved clinical decision making.

Proteomics also shows promise in predicting disease risk by identifying susceptible individuals based on inflammatory protein patterns. However, the dynamic nature of protein expression and post-translational modifications limits reliance on protein identification alone. Future progress will require advanced analytical methods, improved quantification techniques, and integration with other "omics" technologies. Despite current challenges, these developments are expected to support personalized care, non-invasive diagnostics, and better understanding of periodontal disease mechanisms.

Conclusion

Proteomics has emerged as a powerful tool in periodontology, offering new insights into the composition and behaviour of dental tissues and oral fluids. Its application enables early diagnosis, risk assessment, monitoring of disease progression, and evaluation of treatment outcomes through the identification of specific protein biomarkers. Advances in proteomic technologies and their integration with other OMICS approaches have expanded research from small scale studies to large interdisciplinary investigations, strengthening our understanding of periodontal inflammation and its link to systemic health. Overall, overcoming current challenges in proteomics holds great promise for developing precise, non-invasive diagnostic and therapeutic strategies, ultimately transforming periodontal disease management.

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Heal Talk

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Caries Risk Assessment in Pediatric and Preventive Dentistry: Contemporary Concepts and Recent Technological Advances

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Abstract

Dental caries remains one of the most prevalent chronic diseases affecting children worldwide. The contemporary understanding of caries as a biofilm mediated, multifactorial, and dynamic disease has shifted clinical focus from traditional restorative approaches toward early detection, risk assessment, and prevention. Caries risk assessment (CRA) forms the cornerstone of modern pediatric and preventive dentistry by enabling identification of susceptible individuals and implementation of individualized preventive strategies. This review discusses the biological basis of dental caries, principles and conventional models of CRA, and provides an in-depth analysis of recent technological advances including artificial intelligence, Internet of Medical Things (IoMT), biosensors, machine learning models, and advanced imaging techniques that are transforming caries risk assessment and early detection in pediatric dentistry.

Keywords: Dental caries; Caries risk assessment; Pediatric dentistry; Preventive dentistry; Artificial intelligence; Early caries detection.

Introduction

Dental caries is among the oldest and most prevalent diseases affecting humans and continues to pose a significant public health challenge, particularly among children from lower socio-economic groups [1]. It is a pathological condition influenced by multiple etiological factors, leading to progressive destruction of dental hard tissues and resulting in local as well as systemic complications [2]. Traditional caries management relied largely on operative intervention after cavitation; however, this approach fails to address the underlying disease process and often results in recurrent lesions.

Advances in cariology have established caries as a chronic, dynamic disease characterized by cycles of demineralization and remineralization. This understanding has led to a paradigm shift toward preventive and minimally invasive dentistry, emphasizing early diagnosis and individualized caries risk assessment [3].

Biological Basis of Dental Caries

Miller's chemoparasitic theory describes dental caries as a process initiated by acids produced through bacterial metabolism of dietary carbohydrates, resulting in dissolution of the mineral phase of teeth [3]. The caries process involves continuous cycles of demineralization and remineralization, and when demineralization predominates, carious lesions develop [4].

These changes are driven by ecological shifts within dental biofilms. Under neutral conditions, a diverse microbial population exists; however, frequent carbohydrate exposure lowers plaque pH, favoring acidogenic microorganisms and accelerating mineral loss [5]. Mutans streptococci, which dominate pits and fissures, play a critical role in caries initiation under these conditions [5].

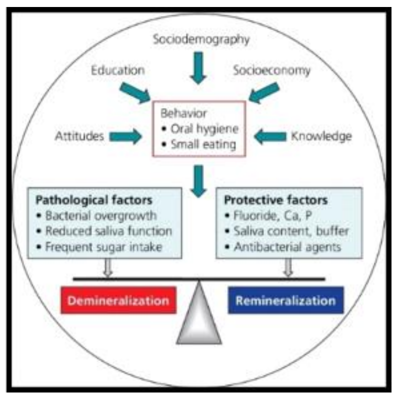

Fig 1: Caries Balance

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Concept and Importance of Caries Risk Assessment

Caries risk assessment is defined as the process of estimating the likelihood of developing new carious lesions or progression of existing lesions over a defined period [6]. Earlier approaches focused on detection and surgical management of lesions; however, re-liance on operative treatment without addre-ssing etiological factors results in treatment failure and disease recurrence [5].

CRA emphasizes prevention rather than treatment of conseq-uences. Identification of non-cavitated lesions allows impleme-ntation of remineralization strategies and arrest of disease progression [6]. CRA also serves as a motivational tool for behavior modification and optimizes utilization of preventive resources [7].

Conventional Caries Risk Assessment Models

Conventional caries risk assessment methods form the backbone of preventive dentistry by enabling clinicians to systematically evaluate an individual's susceptibility to dental caries. These methods integrate clinical findings, behavioral factors, and biological determinants to guide preventive and therapeutic decision-making, particularly in pediatric patients.

1. AAPD's Caries Risk Assessment Form

The American Academy of Pediatric Dentistry emphasizes that assessment and management of caries risk, along with appro-priate treatment protocols or care pathways, are essential components of contemporary clinical care for infants, children, and adolescents. The AAPD caries risk assessment forms have been specifically developed to assist clinicians in evaluating caries risk in children aged 0–5 years and 6 years and older, acknowledging age related differences in caries etiology.

These structured forms evaluate a combination of biological factors (such as dietary habits and socio-economic status), protective factors (including fluoride exposure and oral hygiene practices), and clinical findings (such as existing carious lesions or enamel defects). Based on the prevalence and severity of these factors, children are categorized into low, moderate, or high caries risk groups. This classification supports individualized preventive planning, determination of recall intervals, and selection of appropriate treatment strategies, thereby promoting evidence based pediatric dental care [6].

2. The Cariogram Model

Cariogram is an interactive computer based program deve-loped for educational, preventive, and clinical applications. Its primary objective is to graphically represent an individual's caries risk as the “chance to avoid new caries” over a defined period, thereby illustrating the multifactorial nature of dental caries [5].

The original Cariogram model consisted of three major components representing bacterial factors, dietary sugar intake, and host susceptibility. Subsequently, the model was expanded to include circumstantial factors, such as previous caries experience and general health status, along with a distinct segment repre-senting the percentage chance of avoiding new caries. By demonstrating how modification of individual risk factors can improve the likelihood of remaining caries-free, Cariogram serves as an effective motivational and educational tool in preventive dentistry [7].

3. Cariometer Application

The Cariometer application is a digital caries risk assessment tool that estimates the likelihood of caries development based on daily dietary intake and oral hygiene practices reported by patients or caregivers. The app is designed to support early prevention of dental caries, particularly in children, by providing continuous feedback on cariogenic risk [7].

The application calculates a dietary score using the cariogenic index described by Palmer et al. Parents can record the type and timing of foods consumed by the child, allowing the application to generate and update a cumulative risk score throughout the day. Oral hygiene practices such as brushing, rinsing, or flossing reset the score, reinforcing positive behaviors. Based on combined dietary and hygiene inputs, the child's caries risk is categorized as excellent, average, or poor, with automated alerts generated when risk levels increase. The option to share reports with dental professionals further facilitates personalized dietary counseling and preventive guidance [8].

4. Lactic Acid Impression Technique

The lactic acid impression technique evaluates caries risk by measuring lactic acid production, a critical indicator of cariogenic bacterial activity. This method utilizes materials such as Clinpro™ (3M ESPE), which consist of a powder, setting agent, and sugar solution. During the setting period, bacterial metabolism of the sugar produces lactic acid, resulting in a color change that reflects the level of acid production.

A related method, Clinpro™ Cario L-Pop, involves collecting a tongue swab and immersing it in a lactic acid reactive solution. The intensity of the color change indicates the cariogenic potential of the oral environment. These techniques provide a rapid, chairside assessment of caries activity, allowing early identification of high risk individuals and timely implementation of preventive strategies [7].

Recent Advances In Caries Risk Assessment and Detection

Conventional CRA methods depend heavily on clinical exami-nation, radiographs, and subjective behavioral assessment. Recent advances emphasize objective, technology driven approaches that improve early detection, risk prediction, and individualized preventive care.

1. Artificial Intelligence and Deep Learning Based Techniques

1a. Convolutional Neural Networks (CNNs)

Convolutional neural networks are deep learning algorithms specifically designed for automated image analysis. In dentistry, CNNs are trained using large datasets of annotated bitewing and periapical radiographs to identify subtle features associated with early enamel and dentinal caries [8,9].

CNNs analyze images through multiple layers, extracting hierarchical features that allow lesion classification, localization, and pixel-level identification. Studies have demonstrated higher sensitivity of CNNs for approximal caries detection compared to conventional visual examination and, in some cases, superior per-formance to experienced clinicians [9].

YOLO based CNN models enable real time object detection, allowing rapid identification of multiple carious lesions simulta-neously. Their computational efficiency makes them suitable for mobile devices and chairside screening, particularly beneficial in pediatric dentistry [8].

1b. Videa health's AI platform

VideaHealth, the leading dental AI platform, has received 510 (k) clearance from the U.S. Food and Drug Administration (FDA) for its Videa Dental Assist technology in Jan 2024. This platform utilizes over 30 AI algorithms to broaden its capabilities in detecting the most prevalent dental conditions, making it a comprehensive tool for dental disease diagnosis. VideaHealth's AI system uses a vast and diverse dental image dataset, annotated by expert clinicians, to detect disease patterns with high accuracy. This enables real time, precise diagnostics that improve patient outcomes. [11]

2. Internet of Medical Things (IoMT) and Smart Dentistry

The Internet of Medical Things integrates dental devices, imaging systems, and patient data through internet enabled platforms, enabling real time data exchange and remote monitoring [11]. In caries management, IoMT facilitates centralized storage of diagnostic data, remote assessment of radiographs, and longitudinal monitoring of disease progression.

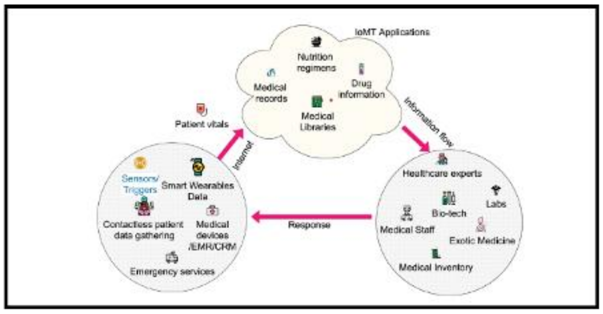

Fig 2: Internet of Medical Things

Integration of AI with IoMT has enabled mobile based caries detection systems capable of analyzing radiographic images captured via smartphones, improving access to preventive dental care in underserved pediatric populations [12].

Blockchain technology addresses data security concerns in IoMT systems by providing decentralized, tamper proof storage of health records. Encrypted data blocks ensure secure sharing, traceability, and protection of pediatric dental records [13–15].

3. Nanotechnology and Biosensors

Nanotechnology has enabled development of highly sensitive biosensors for early detection of caries related biomarkers. Salivary biosensors are particularly suitable for pediatric patients due to their non-invasive nature [16].

Graphene based and quantum dot based biosensors demonstrate high sensitivity and rapid response. Recent studies report portable saliva biosensors capable of detecting Streptococcus mutans across a wide concentration range, enabling biological caries risk prediction before clinical lesion development [16–18].

4. Machine Learning Models: Support Vector Machines (SVMs)

Support vector machines are supervised machine learning algorithms effective in handling high dimensional and nonlinear datasets. In caries detection, SVMs integrate radiographic features, clinical findings, and patient history to classify teeth as carious or non-carious [19].

Studies using smartphone images and radiographs report high accuracy, sensitivity, and specificity, demonstrating feasibility of SVM based systems for early caries detection [20].

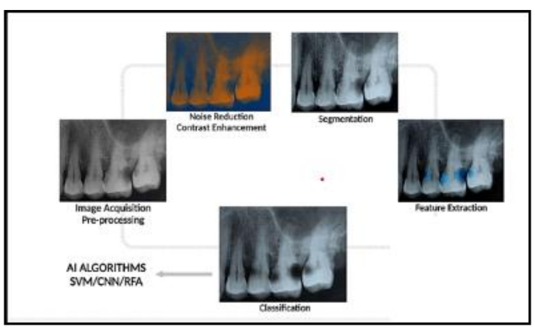

Fig 3: The Process of Analyzing Dental Radiographs And Identifying Dental Caries Through Artificial Intelligence. [20] SVM = support vector machine; CNN = convolutional neural network; RFA = random fores

Advanced Imaging Techniques

1. Near Infrared Light Transillumination (NILT)

Near infrared light transillumination is a radiation free imaging technique that uses long wavelength light to visualize differences between sound and demineralized enamel. Devices such as DIAGNOcam™ enhance detection of proximal and occlusal lesions without ionizing radiation, making them suitable for pediatric patients [21–23].

2. Intraoral Scanners with AI Integration

Modern intraoral scanners extend beyond digital impressions to include caries detection using fluorescence and near-infrared technologies. Systems such as Trios 4 and Planmeca Emerald S enable real time visualization of early lesions, while integration with CNN-based analysis improves diagnostic accuracy and allows longitudinal monitoring [24–26].

Future Perspectives

The future of caries risk assessment lies in integrated diagnostic ecosystems combining artificial intelligence, IoMT, biosensors, and advanced imaging technologies. These approaches enable predictive, personalized, and minimally invasive care. Addressing ethical, legal, and data security challenges is essential for widespread clinical implementation in pediatric dentistry [19].

Conclusion

Caries risk assessment is central to contemporary pediatric and preventive dentistry. Advances in artificial intelligence, smart healthcare systems, nanotechnology, machine learning, and imaging techniques have significantly enhanced the ability to predict, detect, and prevent dental caries at an early stage. Integration of these technologies into routine pediatric dental practice has the potential to shift caries management from a restorative to a preventive, patient centered model, improving long-term oral health outcomes in children.

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Role of Digital and AI based Innovations in Pediatric Dentistry- A Review

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Abstract

Technological advancements have substantially transformed pediatric dentistry by enhancing diagnostic accuracy, treatment precision, patient safety, and behavioral management. Children present unique challenges due to their developing anatomy, heightened sensitivity to radiation, anxiety, and limited cooperation. This narrative review evaluates key technological innovations in pediatric dentistry, focusing on digital imaging and radiography, laser applications, conscious sedation and general anesthesia, and teledentistry. Digital radiography has improved diagnostic efficiency while significantly reducing radiation exposure. Laser technology supports minimally invasive, child friendly procedures with enhanced patient comfort. Conscious sedation and general anesthesia remain indispensable for managing extensive treatment needs and behavioral challenges, ensuring comprehensive care. Teledentistry has emerged as a valuable adjunct for improving access to pediatric oral healthcare, particularly in underserved populations. Collectively, these technologies contribute to improved clinical outcomes, reduced treatment related stress, and positive dental experiences, promoting lifelong oral health. Continued research, training, and evidence based implementation are essential to maximize their potential in pediatric dental practice.

Keywords: Pediatric dentistry, digital radiography, laser dentistry, conscious sedation, general anesthesia, teledentistry.

1. Introduction

Pediatric dentistry requires specialized approaches due to children's anatomical, physiological, and psychological characteristics. Developing tissues, increased cellular mitotic activity, longer life expectancy, and heightened anxiety necessitate careful diagnostic and therapeutic decision-making. Conventional dental techniques often pose challenges related to radiation exposure, invasiveness, and behavioral management. [1] Advances in technology have addressed many of these concerns, enabling safer diagnostics, minimally invasive interventions, and improved patient cooperation. [2]This review synthesizes current evidence on major technological innovations shaping contemporary pediatric dentistry, emphasizing their clinical applications, benefits, limitations, and future implications.

2. Digital Imaging and Radiography in Pediatric Dentistry

2.1 Rationale for Digital Radiography

Radiographic examination is fundamental to pediatric dental diagnosis, aiding in the detection of caries, traumatic dental injuries, developmental anomalies, and pathological lesions. However, children are more susceptible to the biological effects of ionizing radiation due to higher cellular turnover and longer post exposure lifespan. [3] Consequently, radiographic prescriptions must be individualized, adhering to the principles of justification and optimization.

2.2 Advantages of Digital Imaging

Digital radiography has largely replaced film based systems in pediatric dentistry owing to several advantages.(4) These include a substantial reduction in radiation dose reported to be up to 70–80% immediate image availability, superior image resolution, and enhanced diagnostic capability through image manipulation. [5] Digital storage also facilitates longitudinal monitoring of dental development, which is essential during mixed dentition and growth phases.[6]

2.3 Diagnostic Applications

Digital imaging supports early caries detection, orthodontic assessment of dental

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and skeletal maturity, endodontic evaluation of root canal morphology, and diagnosis of dental trauma in primary and young permanent teeth.[7] It is also invaluable in identifying developmental anomalies such as supernumerary teeth, oligodontia, macrodontia, and dens invaginatus, as well as odontogenic and non-odontogenic cysts and benign tumors.[8]

2.4 Intraoral and Extraoral Radiography

Intraoral techniques including bitewing, periapical, and occlusal radiography remain the cornerstone of pediatric imaging due to their low radiation exposure and high diagnostic yield. Extraoral modalities such as panoramic and cephalometric radiography provide comprehensive views of craniofacial structures with minimal discomfort. Cone beam computed tomography (CBCT) offers three dimensional visualization and has expanded diagnostic capabilities for complex cases, including impacted teeth, craniofacial anomalies, orthodontic planning, and endodontic assessment. (7)Despite its advantages, CBCT use in children must be judicious, reserved for situations where two dimensional imaging is insufficient.

3. Application of Laser Technology in Pediatric Dentistry

3.1 Overview and Professional Guidelines

Laser dentistry has gained acceptance as an adjunctive tool for both diagnostic and therapeutic procedures in pediatric dentistry. [9]The American Academy of Pediatric Dentistry supports the prudent use of lasers for restorative and soft tissue procedures in children, including those with special healthcare needs.[10]

3.2 Diagnostic Applications

Laser based caries detection systems complement conventional visual and tactile examination. Technologies such as optical coherence tomography (OCT), near infrared imaging, and fibreoptic transillumination enhance diagnostic precision, particularly in early or equivocal lesions. Among these, OCT demonstrates higher sensitivity but remains limited in routine clinical availability.

3.3 Clinical Applications and Advantages

Lasers facilitate minimally invasive caries removal, soft tissue surgeries with excellent hemostasis, and reduced need for sutures. Their bactericidal properties reduce postoperative infection risk and may decrease antibiotic requirements. [11] Laser procedures often eliminate the need for local anesthesia, shorten chair time, and minimize discomfort. The absence of noise and vibration significantly reduces anxiety, improving cooperation in pediatric patients. Clinical evidence supports the use of lasers in pulpotomy procedures, periodontal therapy, and minor oral surgeries, often demonstrating outcomes comparable or superior to conventional techniques.

3.4 Limitations

Despite clinical benefits, laser technology presents limitations, including high equipment costs, the need for wavelength specific devices, extensive training requirements, and modification of conventional operative techniques.[12] These factors may limit widespread adoption, particularly in low resource settings.

4. Conscious Sedation and General Anesthesia in Pediatric Dentistry

4.1 Indications

Dental caries remains the most prevalent chronic disease in children, disproportionately affecting socioeconomically disadvantaged populations. [13] Extensive disease, young age, anxiety, uncooperative behavior, and special healthcare needs often necessitate pharmacological behavior management strategies such as conscious sedation or general anesthesia.

4.2 Conscious Sedation

Conscious sedation, commonly achieved using nitrous oxide-oxygen inhalation, reduces anxiety, enhances cooperation, elevates pain threshold, and suppresses gag reflex. [14] It is particularly useful for mildly anxious children and moderately complex procedures. However, its effectiveness depends on patient cooperation and it may be insufficient for extensive treatment needs.

4.3 General Anesthesia

General anesthesia enables comprehensive dental rehabilitation in a single visit, minimizing psychological trauma and ensuring optimal treatment outcomes for uncooperative or medically compromised children.[13] While highly effective, it requires specialized facilities, trained personnel, and strict adherence to safety protocols.

4.4 Safety Considerations

Professional guidelines emphasize continuous monitoring, emergency preparedness, and the ability to rescue patients if sedation depth exceeds intended levels. Adherence to these standards ensures safe and effective delivery of sedation and anesthesia in pediatric dental practice.

5. Teledentistry in Pediatric Dental Care

5.1 Concept and Evolution

Teledentistry applies telemedicine principles to oral healthcare, utilizing digital communication technologies for remote consultation, diagnosis, education, and monitoring.[15] Since its early development, teledentistry has gained prominence, particularly during public health emergencies.[16]

5.2 Applications

In pediatric dentistry, teledentistry supports oral health education, behavioral guidance, remote diagnosis, triage of emergencies, and follow-up care. It is particularly beneficial for children in rural or underserved regions, reducing barriers related to travel and access.[17]

5.3 Benefits and Challenges

Teledentistry enhances accessibility, reduces costs, improves interdisciplinary collaboration, and optimizes clinical efficiency. However, challenges include limited technological infrastructure, data security concerns, reimbursement issues, lack of regulatory clarity, and the need for professional training.[17]

6. Future Perspectives

Integration of artificial intelligence with digital imaging, laser diagnostics, sedation monitoring, and teledentistry platforms is expected to further enhance diagnostic accuracy, personalize treatment planning, and improve efficiency. Continued research, education, and policy development are essential to ensure evidence based adoption of these technologies in pediatric dentistry.

7. Conclusion

Technological advancements have redefined pediatric dentistry by enabling safer diagnostics, minimally invasive treatments, effective behavior management, and expanded access to care. Digital imaging, laser applications, sedation techniques, and teledentistry collectively improve clinical outcomes and patient experiences. Their thoughtful integration into routine practice fosters positive dental encounters in childhood and supports the establishment of lifelong oral health.

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Aesthetics In Implants: An Advanced Narrative Review of Biological, Surgical, and Prosthetic Determinants Influencing Long-Term Esthetic Outcomes

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Abstract

The anterior maxilla represents the most esthetically demanding region in implant dentistry due to high patient expectations, complex anatomical limitations, and dynamic soft tissue behavior. While osseointegration is now a predictable biological phenomenon, long-term esthetic success remains multifactorial and technique sensitive. This narrative review presents an in depth synthesis of the biological principles, hard and soft tissue determinants, three-dimensional implant positioning concepts, implant abutment design considerations, and prosthetic strategies that collectively influence pink and white esthetic outcomes. Emphasis is placed on peri-implant tissue stability, biologic width establishment, gingival phenotype modification, and prosthetically driven treatment planning. An interdisciplinary, biologically guided approach is essential for achieving natural-appearing and durable esthetic implant restorations.

Keywords: Esthetic zone, anterior maxilla, dental implants, peri-implant soft tissue, biologic width, pink esthetics.

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1. Introduction

The evolution of implant dentistry has shifted the definition of success from mere implant survival to the achievement of optimal esthetic and functional integration within the oral environment [1–3]. This transition is most apparent in the anterior maxilla, where even minimal discrepancies in gingival margin position, papillary height, or crown emergence profile are immediately noticeable and often unacceptable to patients [4].

Despite excellent long-term survival rates exceeding 95%, implants placed in the esthetic zone demonstrate a disproportionately higher incidence of soft tissue complications compared to posterior regions [5]. These complications are frequently unrelated to osseointegration failure but are instead the result of biological and prosthetic mismanagement.

Esthetic implant therapy must therefore be regarded as a biologically driven, prosthe - tically guided, and surgically executed procedure, rather than a purely mechanical replacement of missing teeth [6].

2. Esthetic Risk Assessment in the Anterior Maxilla

Principles of Implant in Esthetic Zone

1. Patient – Doctor Harmony - Regardless of the specific procedures or final results, maintaining transparency, both with the patient and oneself, builds trust, stream lines treatment, and preserves the integrity of the patient clinician relation-ship. The temptation to oversell potential outcomes or downplay the complexity of treatment can lead to unmet expectations.
2. Evaluation of Implant spacing - Although the preservation of crestal bone comp - ared to conventional designs is relatively modest, approximately 0.37 mm. Recent meta-analyses suggest that a platform-abutment offset of 0.4 mm or greater may enhance bone stability. When placing a single implant between natural teeth, maintaining at least 1.5 mm of bone between the implant shoulder and adjacent roots is essential to protect periodontal health and preserve inter proximal bone.
3. Evaluation of bone - At least 1 mm of bone on both the buccal and lingual sides is required to achieve primary stability, while a minimum of 2 mm of buccal bone is necessary to minimize the risk of facial soft

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tissue recession which often occurs apically. Through careful ridge analysis, clinicians can determine the necessity and timing of hard tissue grafting. For bone defects that extend beyond the natural contour classified as non–space-making defects procedures such as ridge splitting, onlay grafts, or guided bone regeneration should be completed and given adequate healing time before implant placement is considered.

Figure 1: Radiographic analysis

4. Evaluation of soft tissue - Adequate alveolar housing and good bone quality ensure the longevity of dental implants. However, achieving a pleasing aesthetic result depends mainly on the morphology of the surrounding soft tissues. Firm, broad bone supports the buccal free gingival margin (FGM) and papilla physically. Interestingly, the average height of the papilla located between an implant and an adjacent tooth measure approximately 3.85 mm.
5. Implant placement - Successful implant placement should align with key anatomical guidelines, all of which emphasize positioning the fixture to follow an ideal emergence profile. In the anterior region, placing the platform with a facial inclination can compromise the alveolar plate and lead to gingival recession.

Successful esthetic outcomes begin with accurate risk assessment. Several patient-specific and site-specific factors influence predictability

- Smile line and lip dynamics
- Gingival phenotype
- Buccal bone thickness
- Tooth position and root angulation
- Interdental papilla morphology

Patients with high smile lines and thin gingival phenotypes exhibit significantly increased risk of posttreatment recession and esthetic failure [7,8].

Figure 1. Esthetic Risk Assessment Parameters

Figure 2 A: Adequate mesio-distal space

Figure 2B: illustrates the ~4.5 mm rise of the papilla from the interproximal bone to its tip, which is essential for achieving natural-looking interdental aesthetics in implant restorations.

Implant Postioning In Esthetic Zone

Tischler introduced a set of principles aimed at optimizing outcomes in the esthetic zone.

According to his approach, the surgeon should strategically align implant placement with the prosthetic plan to ensure ideal functional and esthetic integration.

1. Utilize a minimally invasive and tissue-preserving flap design to reduce trauma and support optimal healing conditions.
2. Careful evaluation of the existing bone and soft tissue architecture is essential before initiating treatment.
3. Choosing the appropriate timing for implant placement requires precise clinical judgment.
4. The implant's three-dimensional positioning must be clearly envisioned prior to surgery.
5. A proper healing phase should be prioritized before functional loading of the implant.
6. Special attention should be paid to the emergence profile; when necessary, soft tissue grafting should be considered post-placement to establish ideal gingival contours.
7. Meticulous planning of both the final prosthesis and abutment is vital. If indicated, a custom abutment may be fabricated to achieve a more harmonious and esthetic outcome.

3. Hard Tissue Biology and Alveolar Ridge Remodeling

3.1 Post-Extraction Bone Dynamics

Following tooth extraction, the alveolar ridge undergoes rapid dimensional changes due to loss of bundle bone and vascular supply [9]. The buccal plate, often <1 mm thick in the anterior maxilla, is particularly vulnerable [10].

Horizontal resorption exceeds vertical loss and can reach up to 50% of ridge width within 12 months [11].

These changes compromise implant positioning and soft tissue support.

3.2 Buccal Bone Thickness and Esthetic Stability

Multiple studies have confirmed that buccal bone thickness ≥2 mm is critical for long-term soft tissue stability and reduced recession risk [12–14]. Thin buccal bone is strongly associated with mid-facial recession and gray shine-through of implant components.

4. Soft Tissue Biology and Gingival Phenotype

4.1 Gingival Biotype and Healing Response

The gingival phenotype determines vascularity, collagen density, and tissue resilience [15]. Thin phenotypes show greater recession following surgical manipulation and are less forgiving of prosthetic errors [16].

4.2 Soft Tissue Thickness and Marginal Bone Loss

Clinical and histologic evidence demonstrates that insufficient soft tissue thickness (<2.5–3 mm) results in crestal bone remodeling as the body attempts to recreate biologic width [17].

Connective tissue grafting at implant sites has been shown to:

- Increase mucosal thickness
- Reduce recession
- Improve esthetic scores

Rationale of Soft Tissue Integrity Around Implants

The long-term success of an implant relies heavily on maintaining healthy surrounding tissues. Implants interface with oral structures at two primary levels:

The peri-mucosal (biological) seal, which serves as a soft tissue barrier at the mucosal surface.

The endosseous interface, which anchors the implant in bone, offering mechanical support and contributing to implant longevity. This connection is reinforced by a band of soft tissue that seals the implant trans-gingivally, protecting against microbial invasion and promoting a stable, hygienic environment.

Factors affecting soft tissue integrity

- Influence of mucosal thickness
- Effect of abutment material and design
- Impact of abutment disconnection on soft tissue

5. Peri-Implant Biologic Width and Soft Tissue Seal

Unlike natural teeth, implants lack Sharpey's fiber insertion, making the peri-implant mucosa more susceptible to bacterial ingress [18]. The peri-implant biologic width averages 3–4 mm and consists of:

- Junctional epithelium (~2 mm)
- Connective tissue attachment (~1–1.5 mm)

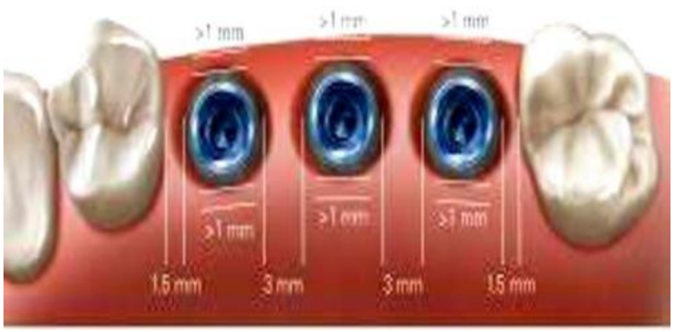

Figure 3: illustrate clearance between implant and adjacent teeth

Failure to respect this dimension results in apical migration of soft tissues and marginal bone loss [19–21]. Repeated abutment disconnection disrupts epithelial attachment and should be minimized using oneabutment-one-time protocols [22].

6. Prosthetically Driven Three-Dimensional Implant Placement

6.1 Buccolingual Position

Facial implant placement leads to buccal bone loss and recession, while excessive palatal placement results in over-contoured crowns and hygiene difficulties [23].

6.2 Mesiodistal Position and Papilla Formation

Papilla height depends on interproximal bone levels. Tarnow et al. demonstrated that papilla presence is predictable when the distance from bone crest to contact point is ≤5 mm[24].

6.3 Apicocoronal Position

Implants placed too coronally produce elongated crowns, whereas excessive depth compromises hygiene and increases peri-implantitis risk [25].

7. Implant Abutment Design and Esthetic Implications

Internal connections and Morse taper designs reduce micro movement and bacterial leakage, resulting in improved crestal bone stability [26,27].

Platform switching moves the inflammatory cell infiltrate away from the bone crest and is associated with reduced marginal bone loss [28].

Zirconia abutments improve esthetics in thin biotypes but require careful case selection due to fracture risk [29,30].

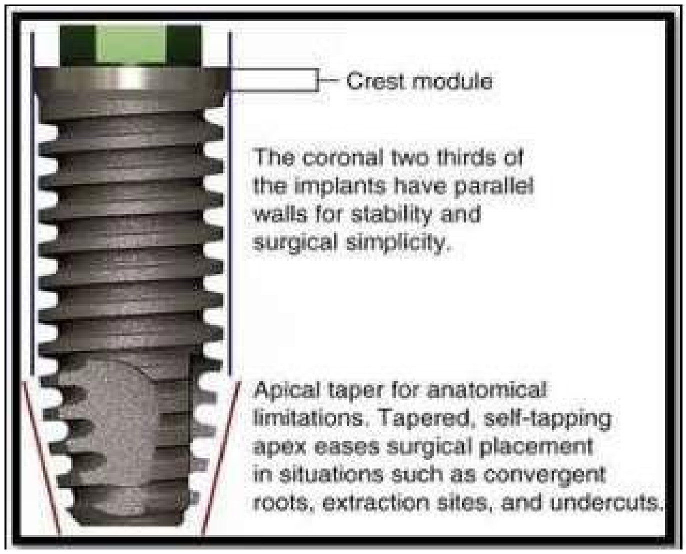

Figure 4: Implant Design

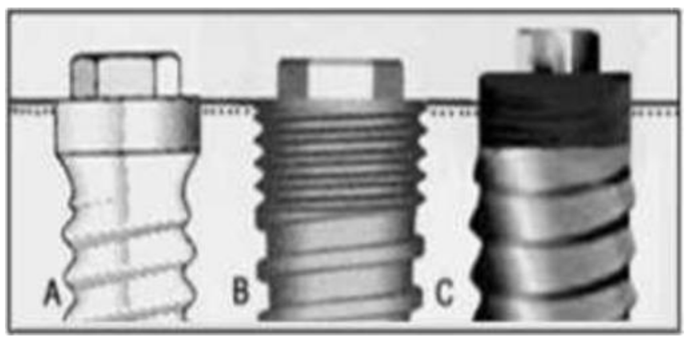

Figure.5. Different Implant Neck Designs. (A) Turned Neck Implants, (B) Micro-Threaded Implant (C) Micro-Grooved Implant

8. Provisionalization and Soft Tissue Sculpting

Provisional restorations are essential for:

- Establishing emergence profile
- Supporting papillae
- Conditioning peri-implant mucosa

The primary objective of dental implant therapy, particularly within the esthetic zone is to preserve the prosthesis's visual appeal, functional performance, and long-term stability, beginning from the provisionalization phase. Early integration of provisional restorations supports soft tissue shaping and sets the foundation for an optimal final outcome. It has always been difficult for clinicians to maintain or create attractive margins around implant prostheses in the esthetic zone. In addition to adhering to the aesthetic harmony of the other teeth, a good implant restoration is one that preserves the health of the peri-implant tissues.

In implant dentistry, provisional restorations are typically fabricated using two main techniques: the direct method, which involves creating the provisional restoration directly in the patient's mouth, and the indirect method, which is carried out in a laboratory setting and often results in enhanced esthetic results. In implant dentistry, various techniques are available for provisionalizing single implants. However, immediate provisionalization is often preferred in the anterior maxillary region due to high esthetic expectations.

Immediate provisionalization improves patient satisfaction and esthetic outcomes when primary stability is achieved and occlusal loading is controlled [31].

For immediate implant provisionalization, clinicians may opt to use either a metal or preformed zirconia temporary abutment, such as those offered by Nobel Biocare which are shaped outside the oral cavity and then hand-tightened onto the implant. To adapt the temporary shell, light-cured acrylic resin (e.g., from Ultradent Products, South Jordan, UT, USA) is applied to capture the gingival contours around the extraction site. The provisional restoration is carefully adjusted to eliminate all functional occlusal contacts, both centric and eccentric, to prevent undue loading on the implant.

Second Stage Surgery

Each implant exposure is different, important, and technique-sensitive. The second step of surgery in the aesthetic zone aims to produce a healthy marginally connected mucosa surrounding dental implants in addition to exposing the implant interface for carrying out the necessary restorative procedures. The success of the final restoration is heavily influenced by the periodontist's expertise in preserving, adjusting, and enhancing soft tissue architecture. Soft and hard tissue management can be addressed at four key stages: during implant placement, throughout the healing phase, during the second-stage surgery, and as part of ongoing maintenance.

Simple equation was developed by Hertel RC

Based on the amount of fixed mucosa-

1. When fixed mucosa > 4mm, Excisional technique
2. When fixed mucosa 1 mm to 4mm, Incisional technique
3. When too little mucosa is present then free gingival graft preceding the incisional technique

9. Pink and White Esthetic Integration

True esthetic success requires harmony between:

- Tooth form, color, and translucency
- Gingival contour and papillary architecture

For individuals who wish to avoid surgical intervention, the use of prosthetic gingiva offers a practical and visually pleasing alternative to address ridge deformities in fixed partial implant restorations. Rather than reserving this approach solely for corrective or remedial purposes, clinicians can consider implementing it proactively during the treatment planning stage to achieve more favorable outcomes.

Gingival architecture functions as the visual framework for the dentition. Without appropriate medical or prosthetic reconstruction, the final aesthetic result, especially in three dimensions may be compromised. A skilled clinician should give as much attention to the contours and forms of the gingiva as they do to the intricate elements of tooth anatomy, including color gradients, morphology, and surface texture. Successful restorative outcomes depend on a thoughtful evaluation of the gingiva's configuration, coloration, and consistency, particularly in patients with a high smile line, where such nuances become more pronounced.

In cases of severe tissue deficiency, prosthetic gingiva may provide superior esthetic predictability compared to extensive surgical reconstruction [32].

Immediate Implants After Extraction

Assessing the possibility of immediate provisionalization at the time of implant surgery plays a vital role in effective prosthetic planning. With increasing patient expectations regarding both esthetics and functionality, clinicians must also prioritize streamlined treatment timelines and enhanced comfort during recovery. Balancing these demands calls for careful preoperative evaluation and coordinated surgical restorative strategies.

The concept of non-functional immediate provisionalization refers to the placement of a temporary restoration that avoids contact with opposing teeth in both centric and eccentric movements. This approach minimizes functional loading during the critical early healing phase. Terminologies such as "immediate," "delayed-immediate," "early," "recent," and "mature" were used variably and often interchangeably, making comparison and interpretation of findings difficult. Clinically, this terminological ambiguity led to confusion in determining the optimal timing for implant placement following tooth extraction.

In Volume 3 of the ITI Treatment Guide series (Fig. 57), Chen and Buser expanded upon the four implant placement categories (Type I–IV) initially outlined by Hämmerle and colleagues by incorporating more descriptive terminology for improved clarity. Today, the classifications "immediate," "early," and "late" placement following tooth extraction have become widely accepted in clinical practice and will be used consistently throughout this review.

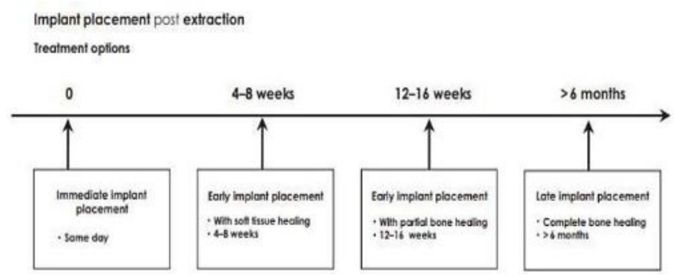

Fig.6. The four treatment options for post-extraction implant placement as defined by the ITI in two ITI Consensus Conferences (2003 and 2008).

ITI developed clear clinical guidelines for immediate implant placement (Type I), recommending it only under ideal anatomical conditions.

These include:

- An intact facial bone wall with a thickness greater than 1 mm
- A thick gingival biotype
- Absence of active infection
- Adequate apical and palatal bone to achieve optimal 3D implant positioning and primary stability.

Clinical evidence shows that dental implants placed immediately into fresh extraction sockets or healed ridges have comparable survival rates, with meta-analyses reporting figures of approximately 97.4% and 97.5%, respectively. When immediate placement is combined with provisional loading, the success rate slightly decreases but remains high, averaging around 96.4%.

10. Conclusion

Esthetic implant therapy in the anterior maxilla is biologically complex and technically demanding. Longterm success depends on respecting peri-implant biology, achieving prosthetically driven implant positioning, managing soft tissue phenotype, and utilizing appropriate implant abutment designs. An interdisciplinary, evidence-based approach is essential to achieve stable and natural esthetic outcomes.

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Contemporary Controversies in Orthodontics: A Comprehensive Narrative Review

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Abstract

Orthodontics is a dynamic specialty characterized by continuous evolution in diagnostic philosophies, treatment modalities, and biomechanical concepts. Despite significant advancements, numerous controversies persist regarding growth prediction, etiology and classification of malocclusion, diagnostic tools, treatment timing, appliance selection, biomechanics, extraction decisions, retention protocols, and emerging modalities such as clear aligner therapy. These debates arise due to biological variability, methodological limitations, and differences in clinical interpretation. This narrative review aims to succinctly synthesize and critically discuss the major controversies across the entire spectrum of orthodontics, as described in contemporary literature, to aid clinicians in evidence based, patient centered decision making.

Keywords: Orthodontic controversies, malocclusion, growth prediction, treatment timing, biomechanics, clear aligners.

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Introduction

Orthodontics uniquely addresses variations of normal craniofacial growth rather than pathological conditions [2]. Since its inception, the specialty has been shaped by differing philosophies, many of which coexist today [3]. While scientific research has expanded, clinical decision-making often remains influenced by experience, tradition, and personal belief systems[12]. Controversies in orthodontics are therefore persistent and evolving. Understanding these controversies is essential for integrating evidence-based principles with individualized patient care [1,2].

Controversies in Growth Prediction

Growth prediction forms the cornerstone of orthodontic diagnosis and treatment planning [11]. Estimating the direction, magnitude, and timing of craniofacial growth is inherently challenging due to individual variability. Traditional cephalometric analyses rely on reference planes and landmarks that are susceptible to error [4,5]. Differences in head orientation, reference systems, and super imposition techniques can lead to divergent interpretations of growth [9,14]. Although computerized growth prediction models assist clinicians, their predictive accuracy at an individual level remains limited. Consequently, growth prediction should guide but not dictate treatment decisions [11].

Controversies in the Etiology of Malocclusion

Malocclusion arises from a complex interplay of genetic and environmental factors [12]. Twin and familial studies demonstrate a strong genetic influence on skeletal patterns, particularly in Class II and Class III malocclusions [8]. Dental arch form and tooth position are more environmentally influenced. The role of nasal obstruction, mouth breathing, and tongue posture has been extensively debated [13]. Current evidence suggests these factors act as contributing or modifying influences rather than primary etiological causes. Tongue thrusting is now widely considered an adaptive response to existing dental discrepancies rather than a causative factor [2].

Controversies in Classification of Malocclusion

Angle's classification remains the most widely used system due to its simplicity and universal acceptance [1]. However, it has been criticized for its exclusive focus on sagittal dental relationships and failure to account for vertical, transverse, and skeletal components. Subdivision malocclusions further complicate

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classification due to inconsistent interpretation. Alternative systems such as the Ackerman Proffit classification provide a more comprehensive framework, yet no system has achieved universal adoption[10].

Controversies in Orthodontic Diagnosis

Cephalometric analysis has been integral to orthodontic diagnosis, yet its limitations are well recognized [4]. Errors arise from projection distortion, landmark identification variability, and population-specific norms [5,14]. Numerous analyses exist, often producing conflicting interpretations and treatment plans for the same patient. Studies have demonstrated limited reliability of cephalometric predictions, particularly in orthognathic surgery cases [9]. Therefore, cephalometrics should complement, not replace, thorough clinical examination and facial analysis [2].

Controversies in Treatment Timing

The debate between early (two-phase) and late (single-phase) orthodontic treatment remains unresolved [7]. Early treatment proponents cite benefits such as growth modification and psychosocial improvement. However, long-term studies indicate that early intervention does not consistently yield superior skeletal or occlusal outcomes compared to treatment initiated during permanent dentition [15]. Early treatment may increase overall treatment duration and cost. Current evidence supports selective early intervention for specific indications rather than routine two-phase therapy [7].

Controversies in Treatment Modalities

Functional appliances have been extensively debated regarding their ability to modify mandibular growth beyond genetic potential [10]. While short-term skeletal changes have been reported, many studies attribute these effects to dentoalveolar adaptation and normal growth patterns [8]. Controversies also persist regarding self-ligating versus conventional brackets and biomechanical approaches. Evidence suggests that appliance selection plays a secondary role to sound biomechanics and case selection[3].

Controversies in Extraction Decisions

Extraction versus non-extraction therapy remains one of the most enduring debates in orthodontics [2]. While extractions may facilitate crowding relief and profile correction, concerns persist regarding facial esthetics and airway implications. Conversely, non-extraction approaches risk instability and periodontal compromise in certain cases. Contemporary consensus emphasizes individualized treatment planning based on facial esthetics, periodontal health, stability, and patient expectations [17].

Root Resorption and Orthodontic Treatment

Root resorption is a recognized adverse effect of orthodontic treatment [18]. Factors such as treatment duration, force magnitude, individual susceptibility, and previous trauma contribute to risk. Although light continuous forces are recommended, complete prevention remains unrealistic. Early detection and risk assessment remain essential[18].

Orthodontics and Temporomandibular Disorders

The relationship between orthodontic treatment and temporomandibular disorders has been widely debated. Current evidence does not support a direct causal relationship between orthodontic therapy and TMD development. Orthodontic treatment neither reliably prevents nor causes TMD, emphasizing the multifactorial nature of these disorders [19].

Retention and Relapse Controversies

Post-treatment stability remains unpredictable [17]. Biological memory, growth changes, and soft-tissue pressures contribute to relapse. While long-term or permanent retention is increasingly advocated, consensus regarding ideal retention protocols is lacking. Retention strategies must therefore be individualized and evidence-informed [17].

Controversies in Clear Aligner Therapy

Clear aligner therapy has gained widespread popularity due to esthetic appeal and patient comfort. However, controversy exists regarding its effectiveness in complex malocclusions and three-dimensional tooth movements. Evidence suggests that aligners are effective for mild to moderate cases, while fixed appliances may be superior for complex movements[20].

Conclusion

Controversies in orthodontics reflect the complexity of craniofacial biology and the limitations of existing evidence. No single diagnostic method or treatment philosophy is universally applicable. A balanced, evidence-based, and patient-centered approach remains essential for optimal orthodontic outcomes [2,3].

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Laser Therapy in Periodontics: A Review

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Abstract

Laser therapy has emerged as a promising tool in periodontics, offering a minimally invasive alternative to traditional surgical methods. This review explores the history, uses, mechanisms, and benefits of laser therapy in periodontics, highlighting its potential advantages and challenges. The integration of laser technology in periodontal treatment protocols holds the potential to enhance patient outcomes and improve overall dental health.

Keywords: Laser therapy, periodontics, periodontal disease, low-level laser therapy (LLLT), photo biomodulation, dental lasers, gingivectomy, frenectomy, scaling, root planing, tissue regeneration.

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History

The concept of laser therapy in dentistry dates back to the early 1960s when Theodore Maiman invented the first working laser. Initially used for hard tissue procedures, lasers have since evolved to include soft tissue applications. In the 1980s and 1990s, advancements in laser technology led to the development of dental lasers designed specifically for periodontal procedures. Low-level laser therapy (LLLT) began gaining attention for its potential in promoting tissue healing and reducing inflammation in the late 1990s.[1,2]

Uses

Gingivectomy and Frenectomy

Lasers are used to remove excess gum tissue (gingivectomy) and frenum attachments (frenectomy) with precision and minimal bleeding. This results in faster healing and reduced post-operative discomfort compared to traditional methods.[3,4]

Scaling and Root Planing

Lasers enhance the effectiveness of scaling and root planing by targeting and removing plaque and calculus from tooth surfaces and root surfaces. The bactericidal properties of lasers help in reducing bacterial load in periodontal pockets.[5,6]

Decontamination

Laser therapy is effective in reducing the bacterial load in periodontal pockets, promoting a healthier environment for tissue regeneration. This is particularly beneficial in treating peri-implantitis and other periodontal infections.[7,8]

Tissue Regeneration

Low-level laser therapy (LLLT) promotes tissue healing and regeneration through photo biomodulation. This process involves the absorption of laser light by cellular chromophores, leading to increased cellular metabolism and tissue repair.[9,10]

Pain Management

Lasers are used to manage pain and inflammation in periodontal treatments. LLLT, in particular, has been shown to reduce post-operative pain and discomfort, enhancing patient comfort and compliance.[11,12]

Mechanism of Action

The primary mechanism of laser therapy in periodontics is photobiomodulation, which involves the absorption of laser light by cellular chromophores, leading to increased cellular metabolism and tissue repair. Laser therapy stimulates ATP production, promotes cell proliferation, and reduces inflammation. Different types of lasers, such as diode, Nd:YAG, Er:YAG, and CO_2 lasers, interact with tissues in specific ways based on their wavelengths.[13,14]

Types of Lasers and Their Applications

1. Diode Lasers: Commonly used for soft tissue procedures, diode lasers offer precise cutting with minimal thermal damage. They are effective in decontam-

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ination and biostimulation.[15,16]

2. Nd:YAG Lasers: These lasers are used for deep pocket decontamination and have strong bactericidal effects. Nd:YAG lasers are also effective in promoting tissue regeneration.[17,18]
3. Er:YAG Lasers: Er:YAG lasers are versatile, used for both hard and soft tissue procedures. They are particularly effective in scaling and root planing, as well as in promoting bone regeneration.[19,20]
4. CO2 Lasers: CO2 lasers are used for soft tissue surgeries, offering precise cutting with minimal bleeding. They are effective in gingivectomy and frenectomy procedures.[21,22]

Benefits of Laser Therapy

1. Minimally Invasive: Laser therapy offers a minimally invasive alternative to traditional surgical methods, resulting in less pain and faster healing.[23,24]
2. Precision: Lasers provide precise cutting and coagulation, reducing the risk of damage to surrounding tissues.[25,26]
3. Reduced Bleeding: The coagulative properties of lasers result in reduced bleeding during and after procedures.[27,28]
4. Bactericidal Effects: Lasers effectively reduce bacterial load in periodontal pockets, promoting a healthier healing environment.[29,30]
5. Enhanced Patient Comfort: Laser therapy reduces post-operative pain and discomfort, enhancing patient compliance and satisfaction.

Challenges and Future Directions

While laser therapy offers numerous benefits, challenges remain in standardizing protocols and optimizing clinical outcomes. Continued research and clinical trials are necessary to establish evidence-based guidelines for the use of lasers in periodontics. Future advancements in laser technology and a better understanding of laser-tissue interactions will further enhance the efficacy of laser therapy in periodontal treatments.

Conclusion

Laser therapy in periodontics offers a versatile and minimally invasive approach to managing periodontal disease. While it presents several advantages, including reduced pain and faster healing, further research is needed to standardize protocols and optimize clinical outcomes. The integration of laser therapy into periodontal practice holds great potential for improving patient care and advancing the field of periodontics.

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Comparision of Healing After Gingival Depigmentation following Application of Recombinant Epidermal Growth Factor Gel and Chlorhexidine Containing Gel: A Case Report

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Abstract

Gingival hyperpigmentation is defined as the darkening or discoloration of the gingiva due to excessive deposition of melanin within the basal and suprabasal layers of the gingival epithelium. Gingival depigmentation is a perio-plastic procedure aimed at restoring a lighter gingival appearance; however, it results in a denuded wound that heals by secondary intention and may lead to postoperative pain and discomfort. Topical medicaments are advocated not only to enhance healing and but also for patient comfort. In this present case report, a 23-year-old female patient with deeply pigmented gingiva underwent gingival depigmentation using a ceramic soft tissue trimmer/bur. Postoperatively, the depigmented surgical site was topically applied with REGEN-D® 60 gel on the right side and Hexigel™ on the left side. Clinical evaluations were conducted on the 3rd, 10th, and 30th postoperative days using the Visual Analogue Scale (VAS) for pain and epithelization tests using hydrogen peroxide and toluidine blue. Both topical agents demonstrated satisfactory healing outcomes and reduction in postoperative discomfort was observed. This case report has shown that REGEN-D® 60 gel has comparatively faster epithelialization, improved angiogenesis, enhanced granulation tissue formation, and greater patient satisfaction.

Introduction

Esthetics plays a vital role in enhancing smile attractiveness and positively influences patient perception, emotional satisfaction, and psychosocial well-being.[1] Gingival hyperpigmentation, caused by excessive melanin deposition in the basal and suprabasal layers of the gingival epithelium, presents an unesthetic appearance that may arise from various physiological or pathological factors.[2] Gingival depigmentation is a perio-plastic procedure aimed at restoring a lighter, more esthetic gingival appearance, with several modalities available, among which the gingival ceramic trimmer/bur offers effective depigmentation with minimal bleeding, good hemostasis, and enhanced operator control.[3,4] However, the surgical procedure results in a denuded wound that heals by secondary intention and may cause postoperative pain and discomfort. Topical medicaments play a significant role in promoting healing and reducing post operative infection.

Epidermal Growth Factor (EGF) promotes cell proliferation and wound healing, while oxygen-releasing gels accelerate healing through reduction of free radicals, anti bacterial action, angiogenesis, and re-epithelization of the surgical wound.[5]

Chlorhexidine is considered as the gold standard in the field of nonsurgical periodontal therapy. The topical medicament (Hexigel™) has been significantly used as a part of intraoral medicament. It effectively supports secondary intention healing, reduces bacterial load at the surgical site.[6]

Limited literature has compared a growth factor gel -Recombinant Epidermal Growth Factor Gel (REGEN-D® 60 gel) with gold standard like Chlorhexidine containing gel (Hexigel™) as topical agents following gingival depigmentation. So, the present case report was undertaken to clinically compare their efficacy in accelerating epithelial healing and improving patient satisfaction.

Case Report

A 23-year-old female patient reported to the Department of Periodontics, Institute of Dental Studies and Technologies, Modinagar with a chief complaint of poor esthetics due to the dark pigmented gums. Her oral examination revealed that she had deeply pigmented gingiva from right first premolar to

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left first premolar. The patient requested for any kind of esthetic treatment which could make her "black" coloured gums look better (Figure 1).

Surgical Procedure

The hyperpigmented gingival area was suitably anesthetized with 2% lignocaine hydrochloride with adrenaline 1:80000 after extra-oral disinfection of face around oral cavity and neck with povidone-iodine 5% and intra-oral disinfection with 0.2% chlorhexidine mouth wash. Sterilized ceramic soft tissue trimmer/ bur was utilized on dried gingival area having pigmentation with a high rotary instrumentation (3,00,000-4,50,000 rpm) without water spray. Tissue ablation was started from mucogingival junction and moved in an apico-coronal direction toward the free gingival margin; interdental papillae were included for depigmentation using the overlapping circles and a continuous contact mode, the least amount of pressure, and feather-light brushing strokes avoiding prolonged contact of bur at a single place to prevent removal of large tissue and gingival surface pitting. The entire procedure required extremely controlled pressure and precise expertise. The depigmented site was copiously irrigated using normal saline after completion of surgical procedure (Figure 2). This was followed by division of the ceramic soft tissue bur ablated sextant into two halves (right and left). On the right side Recombinant Epidermal Growth Factor Gel (REGEN-D® 60 gel) was applied while on left side Chlorhexidine containing gel (Hexigel™) was applied (Figure 3). Patient was recalled after 3rd, 10th and 30th day for Visual Analogue Scale Score and Epithelization test with H_2O_2 and Toluidine blue (Figure 4 & 5).

Discussion

Gingival depigmentation is a perio-plastic procedure aimed at removing this pigmentation to achieve a lighter and more pleasing gingival appearance and aesthetic appearance.[1,2] Numerous treatment modalities have been designed for depigmentation including the use of scalpel, chemotherapy, bur abrasion, electrosurgery, cryosurgery, LASER and FGG graft. The soft tissue/gingival ceramic trimmer/ bur is a reliable and satisfactory treatment which includes high rotatory instrumentation without the usage of a water-cooling spray and provides lesser bleeding, adequate hemostasis, minimal thermal damage and improved operator control.

Periodontal dressings and tissue conditioners had been widely used to minimize the patient discomfort, postoperative infection and to enhance healing in cases of gingival depigmentation. Application of any topical obtunding medicament onto the exposed surgical site aids in the post-surgical healing thus reducing occurrence of an infection.[7]

In the present case report, both the materials were comparable in all the aspect but REGEN-D® 60 gel was intended to improve wound healing by promoting angiogenesis, epidermal cell regeneration, formation of granulation tissue as well as increasing the motility of fibroblasts.[8] According to Buckley A et al[8], Laato M et al[9], application of different formulations of epidermal growth factors onto experimentally induced open wounds improves epithelization with simultaneously accumulating granulation tissue. Brown GL et al[10] also promote the application of epidermal growth factor gel as it plays a significant role in healing of open surgical wounds.

However, Chlorhexidine (CHX) incorporated gel-based dressing also resulted in rapid wound healing due to less accumulation of plaque which maintains the anti-bacterial environment around the surgical site. [11] This was supported by Bakaeen GS et al[11] who compared the effects of 1% CHX and Placebo gels during the healing phase following mucogingival flap surgery.

Conclusion

REGEN-D®-60 gel and Hexigel™ both contribute effectively to better healing and diminished post-operative discomfort after gingival depigmentation. Clinically Recombinant Epidermal Growth Factor Gel (REGEN-D®-60 gel) has been proved as an excellent therapeutic modality for topical application of open intraoral surgical wounds. The ability of accelerated epidermal growth and differentiation, reduced healing time and enhanced patient satisfaction make (REGEN-D®-60 gel to be treatment of choice for surgical depigmented sites.

Figure 1: Bur Tip At Hyperpigmented Site

Figure 2: Surgical Site After Soft Tissue Ceramic Bur Ablation

(a) (b)

Figure 3: Application Of Gel

3rd Day Recall 10th Day Recall 30th Day Recall

Figure 4: Epithelization Test By Hydrogen Peroxide

3rd Day Recall 10th Day Recall 30th Day Recall

Figure 5: Epithelization by Toluidine Blue

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Heal Talk

A Journal of Clinical Dentistry

Open Access Full Text Article

Comparative Evaluation of All on 4 versus All on 6 Implant Supported Full Arch Prostheses: A Review of Clinical Outcomes, Biomechanics, and Prosthetic Considerations

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Abstract

Full arch implant-supported prosthetic rehabilitation has become the standard of care for edentulous patients. The All-on-4 and All-on-6 implant concepts are widely practiced techniques designed to provide immediate function and long-term stability. This review critically compares both concepts in terms of biomechanics, implant survival, prosthetic design, complications, and patient-centered outcomes. Evidence suggests that while both protocols offer high success rates, All-on-6 demonstrates superior stress distribution and prosthetic support in patients with adequate bone volume.

Keywords: All on 4, All on 6, Full arch rehabilitation, Dental implants, Prosthodontics

Introduction

Edentulism significantly compromises oral function, esthetics, and quality of life. Implant supported fixed full arch prostheses have revolutionized prosthodontic rehabilitation. The All on 4 concept, introduced by Malo et al., utilizes four implants with posterior angulation to avoid anatomical structures and eliminate the need for bone grafting. The All on 6 protocol employs six implants to enhance biomechanical stability and reduce cantilever forces.

Rationale for Full Arch Implant Rehabilitation

Conventional complete dentures often fail to provide adequate retention and stability. Implant-supported prostheses offer improved masticatory efficiency, phonetics, and patient satisfaction. Immediate loading protocols further reduce treatment time and enhance patient acceptance.

All on 4 Implant Concept

The All on 4 concept involves placement of two anterior axial implants and two posterior tilted implants angled between 30° and 45°. This design maximizes anterior bone utilization and reduces distal cantilever length.

All on 6 Implant Concept

The All on 6 concept incorporates six implants distributed evenly across the arch. This configuration increases the anterior-posterior spread and enhances load sharing, resulting in improved biomechanical performance.

Biomechanical Considerations

Finite element analysis studies indicate that All on 6 prostheses demonstrate lower stress concentration on peri-implant bone and prosthetic components compared to All on 4. Increased implant number reduces bending moments and improves force dissipation.

Clinical Outcomes and Survival Rates

Long term studies report implant survival rates exceeding 95% for both protocols. Prosthetic complications such as screw loosening and acrylic fracture are more commonly reported in All-on-4 prostheses due to longer cantilever arms.

Prosthetic Design Considerations

Framework material selection, occlusal scheme, and cantilever length are critical factors. All on 6 allows shorter cantilevers and improved prosthetic stability, particularly in patients with parafunctional habits.

Patient-Reported Outcomes

Both treatment concepts demonstrate high patient satisfaction. Improved comfort, speech, and chewing ability are consistently reported. Cost effectiveness favors All on 4, whereas biomechanical longevity favors All on 6.

Limitations

The majority of available data is derived from retrospective studies. There is a lack of randomized controlled trials directly comparing the two protocols over extended follow-up periods.

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Conclusion

Both All on 4 and All on 6 implant protocols are predictable treatment options for edentulous patients. The selection should be individualized based on bone availability, functional demands, and patient expectations. All on 6 offers enhanced biomechanical advantages and may be preferred when anatomical conditions permit.

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AJOCD

Heal Talk

A Journal of Clinical Dentistry

Open Access Full Text Article

Effects of Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) in Periodontology: A Narrative Review

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Abstract

Background: Periodontitis is a chronic inflammatory disease characterized by progressive destruction of the periodontal ligament and alveolar bone. While microbial biofilm initiates disease, the host inflammatory response largely determines tissue breakdown. Prostaglandins particularly prostaglandin (PGE) are key mediators of periodontal inflammation and osteoclast activation. Non-steroidal anti-inflammatory drugs (NSAIDs), through inhibition of cyclo-oxygenase (COX) enzymes, reduce prostaglandin synthesis and have therefore been investigated as host-modulatory agents in periodontal therapy.

Objective: To provide an expanded, structured, PubMed-style narrative review of the role of NSAIDs in periodontology based on the submitted dissertation, including biological rationale, pharmacology, experimental and clinical evidence, therapeutic implications, safety considerations, and future directions.

Methods: A detailed synthesis and academic restructuring of the dissertation content was performed, organizing evidence into mechanistic pathways, animal studies, human trials (systemic and topical), combination host-modulation approaches, implantology considerations, and adverse-effect analysis.

Results: NSAIDs consistently reduce gingival inflammatory mediators, particularly PGE levels in gingival crevicular fluid (GCF), and demonstrate the capacity to reduce alveolar bone resorption in experimental models. Human clinical trials show modest short-term improvements when NSAIDs are used adjunctively with scaling and root planing (SRP). Long-term systemic administration shows variable benefits and is limited by adverse effects. Topical delivery systems (e.g., ketorolac rinse, subgingival gels, NSAID incorporated membranes) appear promising due to localized action and reduced systemic risk.

Conclusion: NSAIDs represent biologically sound host-modulatory adjuncts in periodontal therapy. However, routine chronic systemic use is not currently justified due to safety concerns and inconsistent long-term outcomes. Localized delivery systems and short-term adjunctive use offer the most clinically rational application pending further high-quality trials.

Keywords: NSAIDs, cyclooxygenase, prostaglandins, PGE, periodontitis, host modulation therapy, topical NSAIDs, bone resorption.

Introduction

Bacterial biofilms play a primary etiological role in the development of periodontal diseases, which include gingivitis and periodontitis. Periodontitis is a chronic, non-communicable, multi-factorial inflammatory disease characterized by clinical attachment loss and alveolar bone destruction, ultimately leading to tooth mobility, tooth loss, and impaired masticatory function. It is one of the most prevalent diseases worldwide and a major cause of tooth loss in adults, significantly affecting quality of life and contributing to substantial socioeconomic and healthcare burdens.[1]

The initiation and progression of periodontitis are largely attributed to the accumulation of dental biofilm, which interacts with an individual's susceptibility profile. In addition to microbial factors, several risk factors such as genetics, tobacco and alcohol use, diabetes, obesity, poor nutrition, and impaired host response influence disease progression. Recent research highlights the critical role of the host's immunoinflammatory response in periodontal tissue destruction.[2]

According to the European Federation of

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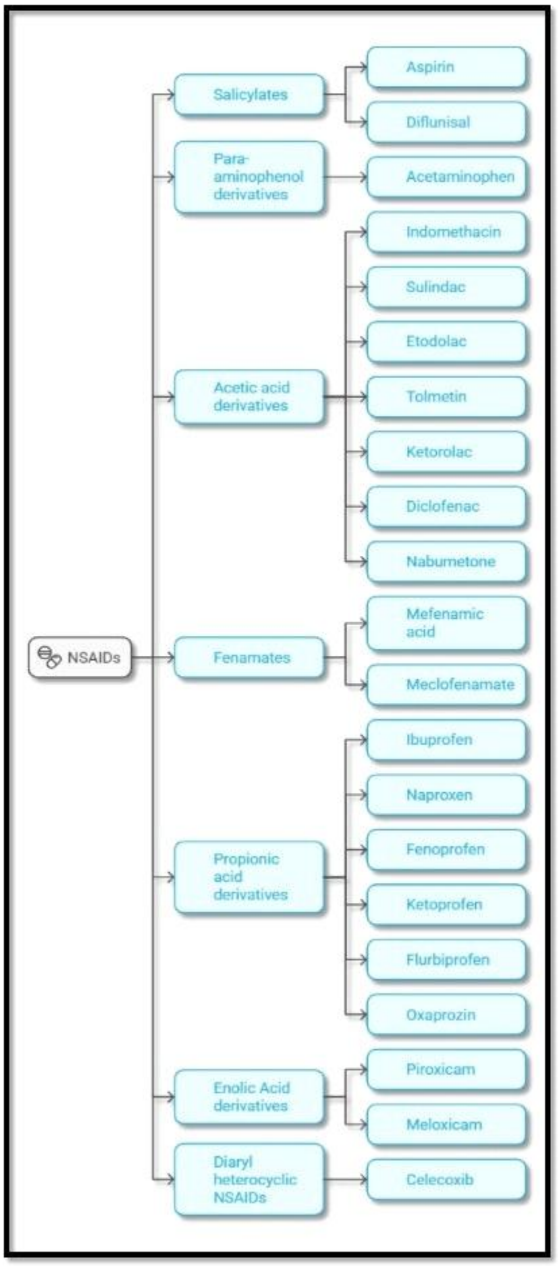
Periodontology (EFP) 2020 S3-level clinical practice guidelines, periodontal therapy is structured into four sequential steps: behavior change and risk factor control, cause-related therapy, surgical intervention, and supportive care. While initial therapy focuses on controlling risk factors, subsequent phases aim at reducing subgingival biofilm and inflammation through mechanical and adjunctive approaches.[3]

Given the significant role of host response in disease progression, host modulation therapy has gained attention as an adjunct to conventional periodontal treatment. Among these, non-steroidal anti-inflammatory drugs (NSAIDs) are widely studied. NSAIDs exert their effects by inhibiting cyclooxygenase (COX) enzymes, thereby reducing prostaglandin synthesis and controlling inflammation, pain, and tissue destruction. Selective COX-2 inhibitors offer similar benefits with fewer systemic side effects, making them a promising adjunct in periodontal therapy.[4]

Classification of NSAIDs



Mechanism of NSAIDs in Periodontitis

Non-steroidal anti-inflammatory drugs (NSAIDs) act by inhibiting the arachidonic acid (AA) pathway, a key mechanism in inflammation. Cellular injury leads to the release of AA, which is metabolized by cyclooxygenase (COX) enzymes into prostaglandins (PGs). NSAIDs inhibit both COX-1 and COX-2, thereby reducing prostaglandin synthesis and controlling inflammation in periodontal tissues .[5]

Prostaglandins, especially PGE , are major mediators in periodontitis. They promote vasodilation, vascular permeability, and inflammatory cell recruitment, contributing to gingival inflammation and tissue destruction . PGE is produced by various periodontal cells and is strongly associated with disease severity. It enhances matrix metalloproteinase (MMP) activity and stimulates osteoclasts, leading to connective tissue breakdown and alveolar bone resorption via pathways such as RANKL/RANK/OPG.[6]

NSAIDs reduce these effects by decreasing PGE levels, thereby limiting inflammation, collagen degradation, and bone loss. They also reduce pain by inhibiting prostaglandin-mediated sensitization of nociceptors [7]. However, inhibition of protective COX-1-derived prostaglandins may lead to systemic side effects.

Thus, NSAIDs play a significant role in host modulation by suppressing inflammatory mediators and slowing periodontal disease progression

Figure- Periodontal flap surgery and postoperative tissue response. NSAIDs placed into the open flap and sutures are being placed

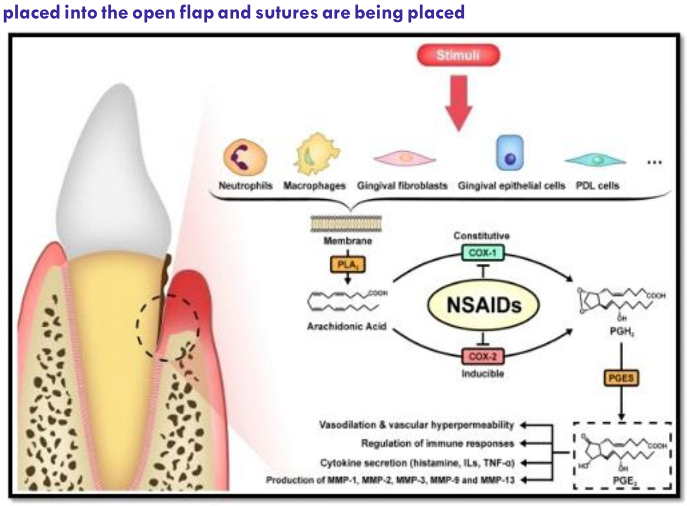


Figure: The synthesis and effects of PGE2 in periodontitis. COX-1, cyclo-oxygenase-1; COX-2, cyclooxygenase-2; ILs, interleukins; MMPs, matrix metalloproteinases; NSAIDs, nonsteroidal anti-inflammatory drugs; PGE synthase; PGE2, prostaglandin E2; PGES, PGH2

Choice of NSAIDs in Periodontology

Non-steroidal anti-inflammatory drugs (NSAIDs) play an important adjunctive role in periodontal therapy by modulating inflammation and reducing alveolar bone resorption. Among them, aspirin (acetylsalicylic acid) is one of the oldest and most widely used agents. It acts by inhibiting cyclooxygenase (COX) enzymes, thereby reducing prostaglandin synthesis. In periodontology, low-dose aspirin (81–100 mg/day), especially when combined with omega-3 fatty acids, has shown improved clinical attachment levels, reduced inflammatory cytokines, and better glycemic control in diabetic patients. It also promotes the formation of anti-inflammatory mediators such as lipoxins and resolvins, enhancing resolution of inflammation .[8]

Diclofenac and aceclofenac, which exhibit relative COX-2 selectivity, are effective in reducing pain and inflammation. Diclofenac additionally reduces neutrophil activity, while aceclofenac may offer chondroprotective benefits. Nimesulide, another COX-2 selective drug, exerts multiple actions including inhibition of superoxide radicals, TNF- , and matrix metalloproteinases, thereby reducing gingival inflammation; however, concerns regarding hepatotoxicity limit its use.[9]

Etoricoxib and celecoxib are highly selective COX-2 inhibitors that provide effective anti-inflammatory action with reduced gastrointestinal side effects, though cardiovascular risks must be considered. Celecoxib has shown reduced alveolar bone loss and inflammatory cell infiltration in experimental periodontitis, although disease progression is not completely halted due to alternative inflammatory pathways.[10]

Indomethacin, a potent non-selective NSAID, has been extensively studied in periodontology. It reduces prostaglandin levels, suppresses inflammation, and inhibits bone resorption, though its clinical use is limited by significant gastrointestinal and central nervous system side effects. Similarly, flurbiprofen has demonstrated strong efficacy in reducing gingival inflammation and slowing alveolar bone loss, both systemically and topically.[11]

Ibuprofen, considered one of the safest NSAIDs, is effective for postoperative pain and inflammation but shows limited long-term benefits in altering periodontal disease progression. Naproxen provides sustained anti-inflammatory effects and may help reduce bone resorption, though further evidence is needed for periodontal applications.[12]

Ketorolac, particularly in topical form (0.1% mouth rinse), reduces inflammatory mediators like PGE and IL-1 , helping control inflammation and bone loss with minimal systemic effects. Meloxicam, with COX-2 selectivity, has shown promising results in reducing gingival inflammation, matrix metalloproteinase levels, and alveolar bone loss with fewer gastric side effects.[13]

Overall, while NSAIDs demonstrate significant benefits in controlling inflammation and bone resorption, their long-term use is limited by systemic side effects. Therefore, their use in periodontology is best considered as an adjunct to conventional therapy, with careful patient selection and preference for targeted or short-term applications.[14]

Effects of NSAIDs on Various Aspects of Periodontology

NSAIDs influence multiple aspects of periodontal health by modulating inflammation, tissue destruction, healing, and regeneration. Gingival inflammation is primarily initiated by microbial plaque, with host immune responses playing a key role in disease progression. Although NSAIDs inhibit prostaglandin synthesis, their effect on gingival inflammation alone is limited because they do not significantly block leukotriene B4 (LTB4), an important mediator released by neutrophils. However, when used as adjuncts to mechanical plaque control, NSAIDs such as aspirin and naproxen enhance resolution of inflammation, reduce probing depth, and decrease inflammatory mediators like TNF- and IL-6 .[15]

In periodontal regeneration and tissue engineering, NSAIDs especially aspirin have shown promising results. Aspirin not only reduces inflammation but also promotes osteogenic differentiation, inhibits osteoclastogenesis, and enhances bone formation. Advanced delivery systems such as hydrogels and scaffolds improve localized drug delivery, minimize systemic side effects, and support periodontal regeneration. NSAIDs also modulate macrophage activity, shifting from pro-inflammatory to anti-inflammatory phenotypes, thereby promoting tissue repair and improving clinical outcomes .[16]

During periodontal surgery, NSAIDs have both beneficial and adverse effects. While they are effective in controlling postoperative pain and inflammation, drugs like ibuprofen can increase intraoperative bleeding due to inhibition of platelet aggregation. Therefore, temporary discontinuation before surgery is recommended in certain cases. Postoperatively, naproxen provides longer-lasting pain relief, whereas ibuprofen offers rapid but short-term analgesia .[17]

Regarding healing, NSAIDs can positively influence wound repair by reducing excessive inflammation, promoting re-epithelialization, and accelerating wound closure. However, they may also impair bone healing and osseointegration by inhibiting COX-2 activity, which is essential for osteoblast differentiation and bone formation. This dual effect necessitates cautious use, particularly in regenerative procedures .[18]

NSAIDs significantly affect gingival crevicular fluid (GCF), an important indicator of periodontal inflammation. They reduce levels of key inflammatory mediators such as PGE , IL-1 , and MMP-8, thereby limiting collagen breakdown and tissue destruction. NSAIDs also decrease GCF volume by reducing vascular permeability, reflecting improved inflammatory control. When combined with scaling and root planing, these effects are enhanced, leading to better clinical outcomes .[19,20]

Finally, NSAIDs play a crucial role in reducing alveolar bone loss. Drugs such as indomethacin, flurbiprofen, naproxen, ketorolac, meloxicam, and aspirin inhibit osteoclast activity and prostaglandin-mediated bone resorption. Clinical and experimental studies have shown significant preservation of bone height and reduced disease progression with NSAID use.

Overall, NSAIDs serve as valuable adjuncts in periodontal therapy by controlling inflammation, reducing bone loss, and enhancing treatment outcomes, although their long-term use requires careful consideration due to potential systemic and healing-related effects.

Conclusion

NSAIDs play a significant adjunctive role in periodontology by modulating host inflammatory responses, reducing prostaglandin-mediated tissue destruction, and limiting alveolar bone loss. While they enhance therapeutic outcomes when combined with conventional treatment, their long-term use requires caution due to potential systemic effects, highlighting the need for targeted and individualized periodontal therapy.

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SAVING SMILES WITH SKILL & SPIRIT: ENDODONTIC DAY CELEBRATED WITH CREATIVITY AT DJ COLLEGE

The Department of Conservative Dentistry and Endodontics at DJ College of Dental Sciences and Research enthusiastically celebrated Endodontic Day, highlighting the vital role of endodontists and dentists in preserving natural teeth and promoting oral health.

The celebration was marked by a series of engaging and creative activities that showcased both talent and passion among students. Events included a lively Reel Making Competition on the theme "Why I Love Endo", Fireless Cooking, Soap Carving, Live Sketching, and Slogan Writing, all centered around the same theme.More than 60 undergraduate and postgraduate students actively participated, making the event vibrant and memorable.

The activities not only fostered creativity but also deepened students' appreciation for the field of endodontics. The department expressed heartfelt gratitude to the Management, CEO Madam, COO Sir, and Principal Sir for their constant support and encouragement in promoting such enriching academic and co-curricular initiatives.

News

CONS ENDO WEEK 2026
TOOTH FOR HEALTH-FIT SQUAD

The Department of Conservative Dentistry and Endodontics enthusiastically celebrated Cons Endo Week 2026 under the vibrant theme "Tooth for Health-Fit Squad." The week-long celebration was aimed at promoting oral health awareness, academic excellence, environmental responsibility, and overall well-being among students and the community.

The event commenced with a Dental Health Camp, where faculty members, postgraduate students, and undergraduates actively participated in screening and educating patients about preventive oral care and the importance of maintaining good dental hygiene.

Keeping in line with the spirit of sustainability, a Tree Plantation Drive was organized within the campus, symbolizing our commitment towards a healthier environment and a greener future.

The week also witnessed enthusiastic participation in sports activities, including a fitness race and badminton matches, encouraging students and faculty to embrace an active and healthy lifestyle.

Academic enrichment formed the core of the celebration. Undergraduate students presented insightful academic presentations, showcasing their knowledge and research aptitude, while postgraduate students delivered engaging case presentations, reflecting their clinical expertise and evidence-based approach to endodontic practice.

Adding an element of excitement and team spirit, the Grand Finale featured a Treasure Hunt, where participants solved clues and challenges related to dentistry and teamwork, making it both intellectually stimulating and enjoyable.

The celebrations concluded with a Prize Distribution Ceremony, recognizing and appreciating the outstanding performances of students across all academic and extracurricular events.

The Department extends its sincere gratitude to the management for their unwavering support and encouragement in providing a platform to conduct such meaningful activities. Their guidance and commitment continue to inspire us to strive for excellence in academics, clinical practice, and community service.

Cons Endo Week 2026 truly embodied the spirit of the theme ***"Tooth for Health-Fit Squad,"*** bringing together learning, service, teamwork, and wellness in a memorable celebration.

Dr. Panna Mangat
Professor and HOD
Conservative Dentsitry & Endodontics
Kalka Dental Collage
Meerut

HEALTHY GUMS, HEALTHY LIFE: I.T.S DENTAL COLLEGE MARKS PERIODONTIST WEEK WITH IMPACTFUL INITIATIVES


The Department of Periodontics at I.T.S Dental College, Hospital and Research Centre, Greater Noida, celebrated National Periodontist Week 2026 (Feb 23–27) with great enthusiasm, focusing on raising awareness about gum health and its link to overall well-being.

The week featured expert lectures by Dr. Gunjan Gupta and Principal Dr. Sachit Anand Arora, along with insightful international webinars by Dr. Nymphea Pandit and Dr. Torres Carranza on advanced periodontal and implant therapies. An interdepartmental Clinical Pathological Conference on "Endo-Perio Lesion" enhanced interdisciplinary learning.Engaging activities like poster and reel-making, nukkad natak, and patient education programs were conducted.

Free dental camps offered oral screenings, hygiene kits, and brushing demonstrations to patients.The event concluded with a valedictory ceremony, earning appreciation from Vice Chairman Mr. Sohail Chaddha. The initiative successfully promoted awareness of periodontal health and preventive dental care among students and the public.

LASER PRECISION MEETS GUM CARE: SANTOSH DENTAL COLLEGE CELEBRATES PERIODONTIST DAY WITH INNOVATION

Santosh Dental College & Hospital marked National Periodontist Day (Feb 23, 2026) with a dynamic program themed “Healthy Gums, Healthy Body.” Organized by the Department of Periodontics and Oral Implantology, the event saw active participation from faculty and 37 students.

The highlight of the day included expert lectures by Dr. Meenu Taneja on advanced periodontal concepts and Dr. Shikha Tripathi on laser applications in dentistry, along with a hands-on laser demonstration session. An engaging E-poster competition further promoted awareness on gum health. The program emphasized modern, minimally invasive laser techniques, enhancing clinical precision, patient comfort, and treatment outcomes. Participants appreciated the initiative, which successfully combined education, innovation, and preventive care in contemporary dentistry.

Campus Talk
About all Campus

EMPOWERED SMILES, STRONGER WOMEN: DJ DENTAL COLLEGE CELEBRATES WOMEN'S DAY WITH ORAL HEALTH DRIVE

The Department of Periodontology and Implantology at DJ College of Dental Sciences and Research, Modinagar, celebrated International Women's Day 2026 with great enthusiasm under the theme "Empowering Women through Oral Hygiene Awareness." The event, held on March 6–7, was organized in collaboration with the Indian Society of Periodontology and supported by Group Pharmaceuticals Ltd.The celebration focused on spreading awareness about oral and periodontal health among women while recognizing their vital role in society. A major highlight was a school outreach camp for young girls, where students were educated on proper oral hygiene practices, common dental diseases, and the importance of preventive care.Live demonstrations of correct brushing techniques, along with the distribution of oral hygiene kits and educational materials, made the initiative impactful and engaging. The program successfully combined awareness, education, and empowerment, reinforcing the message that healthy women build healthier communities.


KALKA DENTAL COLLEGE CELEBRATES ORAL PATHOLOGIST DAY WITH ACADEMIC EXCELLENCE AND ENTHUSIASM

The Department of Oral Pathology and Microbiology Kalka Dental College Meerut proudly celebrated Oral Pathologist Day on 25th February with great enthusiasm and academic zeal. The event was organized to recognize and highlight the indispensable role of oral pathologists in the diagnosis, prevention, and research of oral diseases, especially oral cancer.

The celebration began with an inaugural session by Dr Lalita Yadav Professor and Head of the Department where significance of early detection and accurate diagnosis in improving patient outcomes was emphasized. Faculty members shared their insights on recent advances in oral pathology and the growing importance of interdisciplinary collaboration in patient care.

A series of academic and co-curricular activities were conducted as part of the celebration. A poster presentation competition was organized, where students showcased their knowledge and research skills on various topics related to oral pathology and oral health awareness. The presentations were evaluated based on scientific content, creativity, and clarity of communication.

Adding a creative dimension to the event, a soap carving competition was also held, encouraging students to demonstrate their artistic skills.

The program also included case discussions and awareness sessions focusing on the identification of precancerous lesions and the importance of timely intervention. Students and faculty actively participated, making the event both informative and interactive.

On this occasion, Principal Sir, Dr. Rakesh Krishan Gupta, congratulated the department for successfully organizing the event and appreciated the active participation of students and staff. He encouraged everyone to continue striving for excellence in academics, research, and patient care, while emphasizing the importance of dedication and innovation in the field of oral pathology.

The celebration concluded with a valedictory session, where winners of the competitions were awarded and appreciated. The event successfully reinforced the department's commitment to academic excellence, research, and community awareness, while also acknowledging the significant contributions of oral pathologists in the field of healthcare.







Celebrating Oral Pathologists' Day 2026: Inspiring Creativity and Clinical Insight at IDST, Modinagar







Oral Pathology, a vital specialty within dentistry, bridges the gap between basic sciences and clinical practice. It encompasses the study and diagnosis of diseases affecting the oral and maxillofacial region through clinical, radiographic, histopathological, and molecular investigations. From identifying precancerous lesions and oral cancers to diagnosing infections, cysts, tumors, and systemic diseases with oral manifestations, oral pathologists play a pivotal role in patient care. Their expertise not only aids in accurate diagnosis but also guides treatment planning, prognosis, and research advancements. In an era of evolving diagnostic technologies, oral pathologists remain integral to multidisciplinary healthcare, contributing significantly to early detection and improved patient outcomes.

Marking Oral Pathologists' Day 2026, the Department of Oral Pathology and Oral Microbiology at IDST, Modinagar organized a vibrant and intellectually enriching program aimed at undergraduate students. The celebration seamlessly blended academic orientation with artistic expression, reinforcing both the scientific and creative dimensions of the specialty.

The event commenced with an insightful orientation lecture designed to introduce undergraduate students to the scope, relevance, and career opportunities within oral pathology. The lecture emphasized the critical role of histopathology in diagnosing oral diseases and highlighted how foundational knowledge of tissue morphology underpins clinical excellence.

A unique highlight of the celebration was the "Sketch in H and E" competition, where participants were encouraged to creatively interpret histological patterns using the iconic pink and blue hues of Hematoxylin and Eosin staining. This innovative activity not only tested the students' artistic abilities but also deepened their appreciation for microscopic architecture-transforming routine histology into an engaging and memorable experience.

The program was conducted under the esteemed patronage of Dr. Vikram Gandhi (Secretary, DMET), with blessings of Dr. Nidhi Agarwal (Principal, Professor, Dept of Pedodontics). Their continued support underscores the institution's commitment to fostering academic excellence and holistic student development.

The proceedings were formally inaugurated by Dr. Nutan Tyagi (Professor and Head, Oral Pathology), who warmly welcomed the participants and guests and set the tone for the day. The event was meticulously organized and executed under her able guidance by Dr. Akansha Misra (Professor), along with Dr. Nazifa Javaid and Dr. Anjali Chauhan (Senior Lecturers), whose efforts ensured a smooth and engaging experience for all participants.The competition entries were evaluated by distinguished judges, Dr. Rishi Manan (HOD, Dept of Conservative Dentistry and Endodontics) and Dr. Radhika Chopra (HOD, Dept of Pedodontics), who appreciated the creativity and innovative ideas demonstrated by the students through their sketches. Certificates were awarded to deserving participants in recognition of their talent and dedication.

The celebration concluded on a warm and collegial note with a Hi-tea gathering, bringing together professors and heads from various departments. This informal interaction fostered interdisciplinary bonding and reflected the collaborative spirit essential in modern dental practice.

Overall, the event served as a meaningful platform to inspire undergraduate students, encouraging them to explore oral pathology beyond textbooks and microscopes. By integrating creativity with scientific learning, the program successfully highlighted the indispensable role of oral pathologists in dentistry and reinforced their contribution to patient care, education, and research.

The day ended on a positive and motivating note, leaving participants with a renewed appreciation for the specialty and a deeper understanding of its significance in shaping the future of dental science.




ORAL SURGEONS' DAY MARKED WITH ACADEMIC EVENT AT IDST MODINAGAR






Modinagar, February 13, 2026

The Department of Oral and Maxillofacial Surgery at the Institute of Dental Studies & Technologies (IDST), Modinagar, commemorated International Oral and Maxillofacial Surgeons Day by organizing a Continuing Dental Education (CDE) program, bringing together faculty members, postgraduate students, interns, and undergraduates for an engaging academic session.

The highlight of the event was a guest lecture delivered by noted oral and maxillofacial surgeon, Dr. Anmol Agarwal.

In his address, Dr. Anmol Agarwal elaborated on the expanding scope of the specialty, emphasizing areas such as trauma management, implantology, surgical advancements, and multidisciplinary patient care. His insightful lecture provided valuable clinical perspectives and inspired to students to pursue excellence in the field.

As part of the ceremony, Dr. Anmol Agarwal was felicitated by the institute in recognition of his significant contribution to academics and dedication to oral and maxillofacial surgery. He was presented with a token of appreciation and a certificate by the faculty members.

The program witnessed enthusiastic participation, with attendees actively engaging in discussions, making the session both interactive and informative. The event concluded with a group photograph featuring the guest speaker, faculty members, organizing team, and students.

The celebration successfully highlighted the vital role played by oral and maxillofacial surgeons in modern healthcare while fostering knowledge sharing and professional interaction. The program ended with a formal vote of thanks, expressing gratitude to all contributors for making the event meaningful and memorable.









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EDITOR'S NOTES

BEYOND THE SMILE: THE NEUROLOGICAL IMPERATIVE OF DAILY ORAL HYGIENE

In the realm of contemporary dentistry, our understanding of oral health has definitively transcended the anatomical boundaries of the mouth. For decades, the toothbrush has been championed primarily as an instrument of aesthetic preservation and localized disease prevention-a daily shield against dental caries and gingival inflammation. However, a profound paradigm shift is currently unfolding within medical and dental literature. We are now confronting a critical realization: the bristles of a toothbrush may actually serve as one of our most potent weapons in safeguarding cognitive longevity. The oral-systemic nexus is no longer a peripheral theory; it is a central, undeniable pillar of holistic healthcare.

The focal point of this scientific revelation lies in the complex microscopic ecosystem of the human oral cavity. When daily hygiene routines are compromised, pathogenic biofilms are allowed to flourish unabated. Among these microscopic inhabitants, *Porphyromonas gingivalis* a keystone anaerobic bacterium responsible for chronic periodontitis has recently garnered unprecedented attention from neurologists and microbiologists alike. Far from remaining comfortably confined to the gingival sulcus, *P. gingivalis* exhibits a highly insidious systemic mobility. Through ulcerated and bleeding gum tissues, these bacteria easily bypass local defenses and gain direct entry into the bloodstream.

Once circulating within the vascular system, these oral pathogens embark on a destructive trajectory that allows them to ultimately breach the heavily guarded blood-brain barrier. Recent, groundbreaking post-mortem analyses of brain tissue from individuals afflicted with Alzheimer's disease have startlingly revealed the presence of *P. gingivalis* alongside its toxic enzymatic byproducts, known as gingipains. This bacterial infiltration is not a benign, accidental presence; it acts as a direct and aggressive catalyst for neurological damage.

The mechanism of this cognitive disruption is deeply rooted in the body's inflammatory response. Chronic periodontal disease establishes a continuous state of low-grade systemic inflammation. As inflammatory mediators, such as circulating cytokines, disseminate from the infected oral cavity, they can trigger neuro-inflammation a well-documented precursor to cognitive decline. Furthermore, the localized presence of these oral pathogens in neural tissue appears to stimulate the defensive, yet destructive, overproduction of beta-amyloid proteins. The pathological accumulation of these amyloid plaques is a definitive hallmark of Alzheimer's disease, strongly suggesting that untreated periodontal infections may actively accelerate neuro-degenerative decline.

Supporting this microbiological data, longitudinal epidemiological studies consistently demonstrate a stark correlation between dentition retention and cognitive health. Patients who suffer severe tooth loss, predominantly driven by advanced, untreated periodontal destruction, exhibit a statistically significant increase in dementia risk as they age. Conversely, the strict maintenance of a healthy periodontium correlates strongly with the preservation of mental acuity in later stages of life.

As dental professionals, educators, and advocates for public health, we are obligated to internalize and actively broadcast this critical narrative. Our clinical mandate extends far beyond saving teeth; we are, in fact, active participants in preventative neurology. The dialogue surrounding the humble toothbrush must be immediately elevated. We must rigorously educate the public that their daily oral hygiene regimen is not merely about preserving a radiant smile or avoiding restorative dental work it is a fundamental, daily medical intervention required to protect the human mind. Routine brushing and interdental cleaning are, in their most profound essence, acts of cognitive preservation.

Afzal A Zaidi
Managing Editor

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SWADESHI INNOVATION IN DENTISTRY:

THE JOURNEY OF MR. SYED JUNED HUSSAIN

Mr. Syed Juned Hussain
Innovative Co-Founder
Swadeshi Instruments and DentalMall.in

Please tell us about your professional journey and what inspired you to enter the dental industry.

My professional journey began in 2012 with a deep interest in understanding the science behind dental instruments rather than viewing them merely as commercial products. I immersed myself in studying metallurgy, angulation science, precision engineering, and ergonomic biomechanics.

During this journey, I realized that India has extraordinary manufacturing capability and skilled craftsmanship. However, the dental instrument ecosystem remained largely unorganized and heavily dependent on imported brands due to perception gaps rather than capability gaps.

This realization inspired me to work towards organizing and elevating indigenous dental manufacturing. My goal became clear to build a structured ecosystem where Indian-made instruments can stand confidently on global quality benchmarks.

How did the idea of establishing Swadeshi Instruments (DentalMall.in) originate?

The idea originated from observing two major gaps in the dental industry.

First, India had strong manufacturing clusters producing high-quality instruments, but there was a lack of structured branding, standardization, and organized manufacturing systems.

Second, dentists across India lacked a reliable, transparent, and organized digital platform for purchasing dental products.

To address these gaps, we built two complementary ecosystems:

Swadeshi Instruments: A structured Indian manufactur-ing initiative focused on innovation, standardization, and indigenous excellence.

DentalMall.in: A digital infrastructure platform design-ed to organize dental product distribution across India with transparency, efficiency, and technology integration.

Together, they create a bridge between-manufactur-ing excellence and digital accessibility.

What is the core vision and mission behind your company?

Our vision is to establish India as a globally respected hub for dental instrument manufacturing while strengthening the country's self-reliant healthcare ecosystem.

Our mission focuses on three pillars:

- Organizing and modernizing Indian dental instrument manufacturing.
- Reducing unnecessary import dependency through indigenous innovation.
- Building a structured digital marketplace for dentists across India.
- Through Swadeshi Instruments and DentalMall.in, we aim to bring structure, quality discipline, and technologi-cal advancement to the dental ecosystem.

How do you define the role of Swadeshi Instru-ments in the Indian dental market today?

Swadeshi Instruments represents a movement toward organized indigenous manufacturing.

Historically, many Indian instruments were produced through fragmented cluster systems without standardiz-ed design or branding frameworks. Our role is to transform that ecosystem into a structured manufacturing model based on:

- Scientific Design Principles
- Standardized Pattern Systems
- Advanced Metallurgy and Finishing
- Ergonomic Intelligence

Today, Swadeshi Instruments stands as a symbol of Indian manufacturing confidence and innovation in the dental sector.

What challenges did you face while building a homegrown dental brand, and how did you overcome them?

The biggest challenge was perception.

For decades, many dentists associated quality with imported brands, even when Indian manufacturers were producing comparable products.

Another challenge was the lack of structured manufacturing standards within traditional clusters.

We addressed these challenges through:

- Scientific Product Development
- Standardized Instrument Series
- Compliance with Regulatory Frameworks
- Transparent Warranty Policies
- Direct Engagement with Dental Professionals

Over time, trust grows when quality consistently speaks for itself.

How do you ensure quality, affordability, and reliability in your products for Indian dentists?

Quality assurance begins at the design stage itself.

We focus on:

- Metallurgical Consistency
- Precision Angulation Engineering
- Ergonomic Handle Design
- Controlled Finishing Processes

From a regulatory standpoint, our operations comply with Indian Medical Device Rules (MDR 2017) for Class A devices, along with CDSCO licensing and other regulat-ory frameworks.

By optimizing manufacturing efficiency and working closely with production clusters, we are able to maintain global-grade quality while keeping products accessible and affordable for Indian dentists.

In your view, how is the Indian dental industry evolving, especially with the rise of indigenous manufacturers?

The Indian dental industry is entering a transformative phase.

We are witnessing three major shifts:

1. Increasing acceptance of indigenous brands.
2. Greater regulatory discipline in medical device manufacturing.
3. Strong policy support for MSMEs and local manufacturing.

With initiatives promoting self-reliance, Indian manufacturers are now investing more in research, design, and quality systems, which will significantly strengthen the industry's global standing.

What strategies has your company adopted to compete with international dental brands?

Our strategy is not simply to compete it is to redefine value creation.

We focus on:

- Scientific Instrument Design
- Structured Product Series Development
- Competitive Pricing without Compromising Quality
- Strong Warranty Policies
- Digital Distribution through DentalMall.in

International brands often dominate through legacy perception. Our approach is to build trust through innovation, transparency, and consistent performance.

How important is innovation and technology in your company's future planning?

Innovation is the backbone of our growth strategy.

We are continuously working on:

- Biomechanically Optimized Instrument Handles
- Advanced Surface Finishing Technologies
- Standardized Design Series
- AI-driven Digital Marketplace Infrastructure through DentalMall.in

Technology will help us integrate manufacturing, distribution, and customer engagement in a more efficient and intelligent ecosystem.

What are your short-term and long-term plans for Swadeshi Instruments?

Short-term Goals Include:

- Expanding Structured Manufacturing Capabilities
- Strengthening Dealer and Institutional Networks
- Launching New Scientifically Designed Instrument Series
- Scaling DentalMall.in's Digital Infrastructure

Long-term Vision:

- Establish Swadeshi Instruments as a Global Dental Instrument Brand
- Expand Exports to International Markets
- Position India as a Recognized Global Hub for Dental Instrumentation

How do you see the role of "Make in India" in shaping the future of dental equipment and instruments?

Make in India is a transformative national initiative that empowers domestic manufacturing ecosystems.

In the dental sector, it encourages:

- Indigenous product development
- MSME growth
- Export potential
- Reduced dependency on imports

With the right combination of policy support, innovation, and manufacturing discipline, India has the potential to become a global supplier of dental instruments.

What advice would you like to give to young entrepreneurs entering the dental business sector?

My Advice Is Simple: Focus on Depth, Not Just Scale.

Understand the science behind the product you are working with. Build systems, maintain compliance, and prioritize quality over quick profits.

The healthcare sector demands responsibility. If entrepreneurs combine innovation, integrity, and long-term vision, the opportunities in this industry are immense.

Why did you choose Heal Talk Dental Journal as a platform for advertisement and industry communica-tion?

Heal Talk Dental Journal is a respected platform that connects dental professionals, educators, and industry stakeholders.

For us, it represents an opportunity to communicate directly with the dental fraternity in a professional and knowledge-driven environment.

Such platforms play a vital role in bridging the gap between innovation, industry developments, and clinical professionals.

Any message you would like to share with dental professionals and readers of Heal Talk Dental Journal?

India has the talent, craftsmanship, and manufactur-ing strength required to lead in the dental industry.

What we need now is collective belief in structured indigenous innovation.

When dentists support quality-driven Indian manu-facturing, they are not just purchasing instruments they are contributing to a stronger healthcare ecosystem and a self-reliant nation.

Together, we can build a future where Indian dental instruments are trusted not only in India but across the world.


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