Index Copernicus ID 6818
ISSN 2231- 1823

JSPIK

Vol. 18 • Issue 1 • MARCH 2026

www.spik.in

Journal of the Society of Periodontists and Implantologists of Kerala

Vol. 18 | Issue 1 | March 2026

Index Copernicus ID 6818

ISSN 2231-1823

Contents

President's message

Dear members of the SPIK family,

As we bring this year to a close with the final issue of our journal this term, I take a moment to reflect with deep gratitude on the journey we have shared as a professional community.

It has been both an honour and a privilege to serve as the President of the Society of Periodontists and Implantologists of Kerala. This year has been marked by meaningful academic exchanges, collaborative growth, and a continued commitment to excellence in patient care and clinical practice. None of this would have been possible without the unwavering support and dedication of our members.

I extend my sincere appreciation to our executive committee, office bearers, and organizing teams whose tireless efforts have ensured the success of our scientific programs and initiatives. My gratitude also goes to our esteemed faculty, contributors, and reviewers who have enriched our journal with their knowledge and insights, maintaining its high academic standards.

To our members, both senior and young professionals, thank you for your enthusiasm, participation, and commitment to advancing our specialty. Your engagement is the true strength of this society.

I would like to express my appreciation of the sincere and hard work done by our editor Dr Anjhana in bringing out all the issues of JSPIK in time this year.

As we look ahead, I am confident that the foundation we have strengthened this year will continue to support even greater achievements in the future. Let us carry forward this spirit of learning, collaboration, and service.

I wish you all continued success, good health, and fulfilment in your professional and personal endeavours.

With sincere regards,

Regards,

Dr Arun Sadasivan
President -SPIK
Mob: 98472 46961
Email address: sadasivan_arun@hotmail.com

Secretary's Message

Dear Members,

Happy to share that the latest edition of our JSPIK is now out!

A big thank you to Dr Anjana, our Journal Editor, for her hard work and dedication in curating this edition. Grateful to President Dr Arun Sadasivan for his guidance and support throughout.

Sincere appreciation to all executive members and college faculties who contributed genuine articles and made this possible through their tremendous effort.

Wishing you and your families a blessed Eid,

Happy Easter, and a prosperous Vishu.

Let's keep the academic spirit alive!

Dr. Deepak Thomas
Secretary, SPIK

Editorial

Dear Members and Colleagues,

This term has been a remarkable chapter of learning, collaboration, and growth, made possible by the collective effort of our academic community. Each contribution has strengthened our vision and inspired us to strive for greater excellence.

As we step into another promising term, I look forward to continuing this journey with your continued support, encouragement, and active participation. Together, we can achieve even greater milestones. It is with immense pride and joy that I present the release of our next issue at my alma mater—an occasion that holds deep personal and professional significance. May this new issue stand as a testament to our shared passion for academic excellence and progress.

Thank you once again for being an integral part of this journey. Here's to another successful term ahead.

With sincere regards,

Dr Anjhana Narayanan
Editor, JSPIK

JSPIK

Lip Repositioning as a Conservative Approach for Gummy Smile Correction: A Case Series

Silpa Jayan V[1], Sanjeev Raveendran[2], Shyamala Devi K P[3], Anania Thottapilly[4]

ABSTRACT

Excessive gingival display (EGD), commonly referred to as a "gummy smile," is an esthetic concern characterized by the exposure of more than 3 mm of maxillary gingiva during smiling. Its etiology may include vertical maxillary excess, hyperactive or short upper lip, altered passive eruption, or a combination of these factors. Accurate diagnosis of the contributing causes is essential for appropriate management. Various surgical and non-surgical techniques have been employed to correct EGD. Among these, lip repositioning is a minimally invasive and conservative surgical technique that limits the upward movement of the upper lip during smiling, thereby reducing gingival display and enhancing smile esthetics. This technique is an effective alternative to orthognathic surgery in mild to moderate cases and offers fewer complications with faster recovery. This case report describes the successful management of a patient with EGD using the lip repositioning technique.

Keywords: Lip repositioning, gummy smile, smile harmony, excessive gingival display, esthetic dentistry

Introduction

Excessive gingival display (EGD), or gummy smile, is an esthetic condition where more than 3 mm of gingiva is visible during smiling.[1] While the perception of gingival display varies among individuals and populations, overexposure of the gingiva is generally considered unattractive. EGD can arise due to multiple etiologies, including vertical maxillary excess, a hyperactive upper lip, a short upper lip, altered passive eruption, or anterior dentoalveolar extrusion.[2,3]

Effective treatment planning hinges on the accurate identification of all contributing factors. Several treatment modalities have been employed depending on the etiology—ranging from crown lengthening and orthodontic intrusion to orthognathic surgery and botulinum toxin injections.[4,5] However, in cases with minor vertical discrepancies or a hyperactive upper lip, less invasive alternatives such as lip repositioning may be preferable due to lower morbidity and cost.

Originally introduced in plastic surgery by Rubinstein and Kostianovsky in 1973, the lip repositioning procedure was later adapted for dental applications and modified by Rosenblatt and Simon in 2006. The technique involves excising a strip of mucosa from the maxillary vestibule and suturing the lip mucosa to a more coronal position, thereby limiting the elevator muscles of the lip (e.g., zygomaticus minor, levator labii superioris, levator anguli oris, orbicularis oris) and reducing gingival display.[3,4,5]

Case series

CASE 1

A 22-year-old patient presented with the chief complaint of a "gummy smile" that was affecting esthetics and self-confidence. Extraoral examination revealed a well-balanced facial profile. Intraorally, an excessive gingival display of approximately 5 mm was

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noted during a full smile. The gingival tissues appeared healthy, with no signs of inflammation or enlargement. Tooth proportions and gingival zeniths were normal, ruling out altered passive eruption or dentoalveolar extrusion. The upper lip was of adequate length at rest but demonstrated excessive mobility on smiling.

CASE 2

A 38-year-old female, systemically healthy with no relevant medical history, presented with a complaint of a "gummy smile" that negatively impacted her confidence and esthetic appearance. Extraoral examination showed a balanced facial profile. Intraorally, the gingival tissues were healthy with normal tooth proportions and gingival zeniths. Excessive gingival display was attributed to upper lip hypermobility, as the lip length was adequate at rest but elevated excessively during smiling.

CASE 1

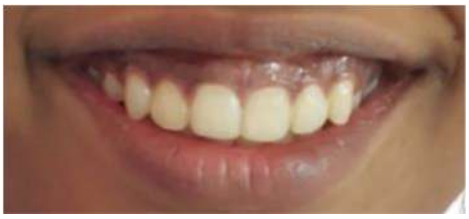


Figure 1 pre operative

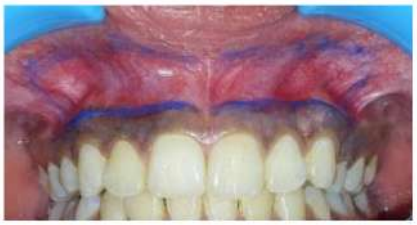


Figure 2 marked area for excision

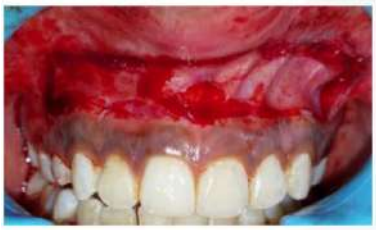


Figure 3 Partial thickness incision placed

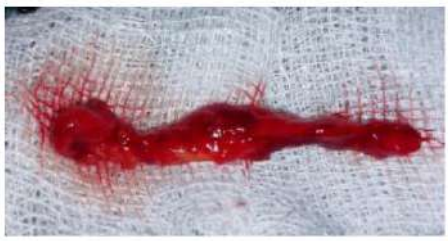


Figure 4 The band of tissue removed

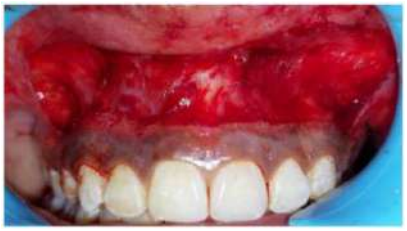


Figure 5 After exposing the underlying connective tissue

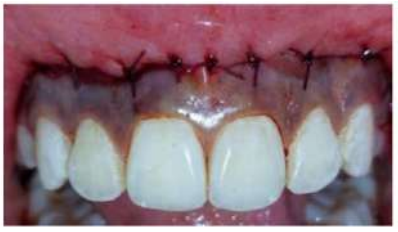


Figure 6 After placing sutures

CASE 2

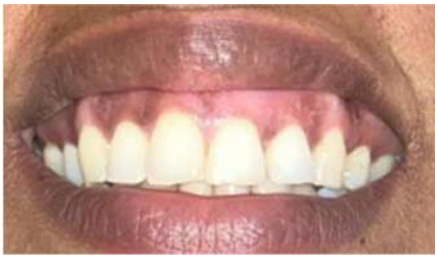


Figure 1 pre operative

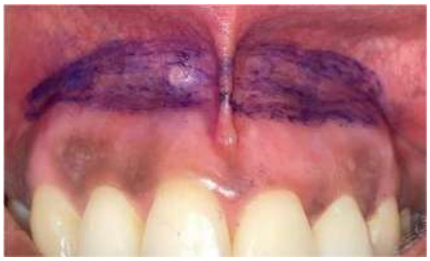


Figure 2 marked area for excision

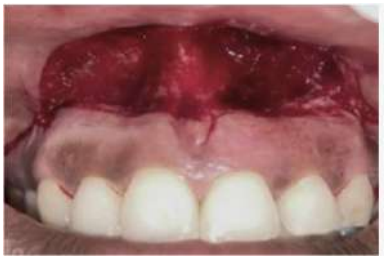


Figure 3 Partial thickness incision placed

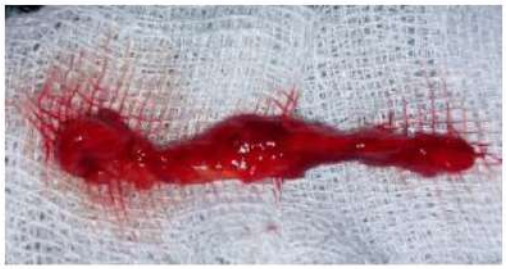


Figure 4 The band of tissue removed

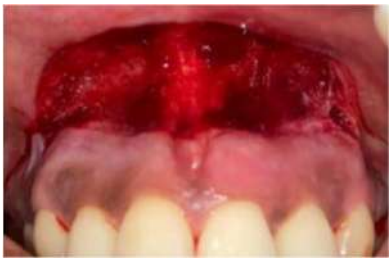


Figure 5 After exposing the underlying connective tissue

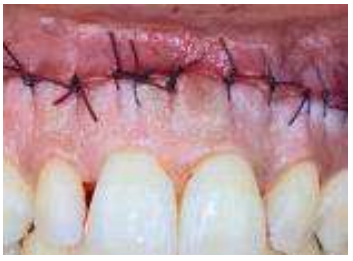


Figure 6 After placing sutures

CASE 3

A 32-year-old patient reported to the clinic with concerns about excessive gingival exposure while smiling. Extraoral examination revealed a harmonious facial profile. Intraoral examination showed 7 mm of gingival display during smiling. The gingiva was healthy, with no evidence of hypertrophy or inflammation. Tooth proportions and gingival zeniths were within normal limits, excluding altered passive eruption or dentoalveolar extrusion as possible causes. The upper lip length at rest was normal, but excessive mobility was observed upon smiling.

Surgical Procedure:

CASE 3

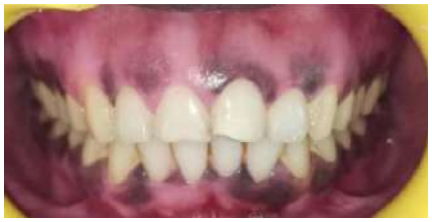


Figure 1 pre operative

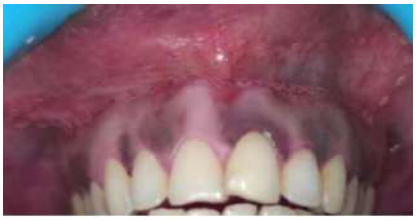


Figure 2 marked area for excision

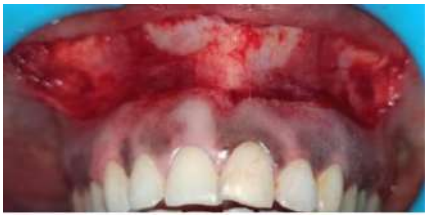


Figure 3 Partial thickness incision placed

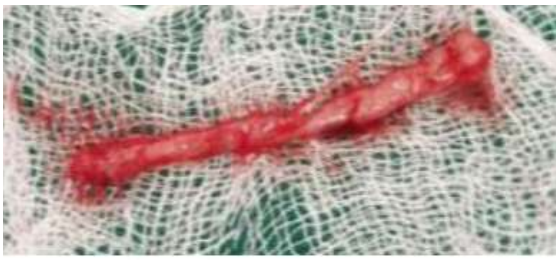


Figure 4 The band of tissue removed

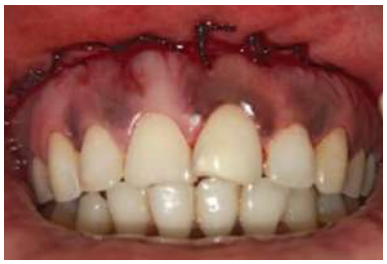
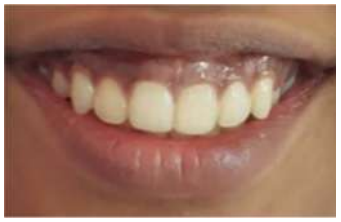


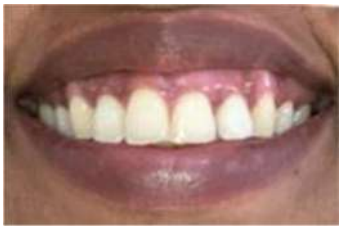
Figure 6 After placing suture



Pre Operative

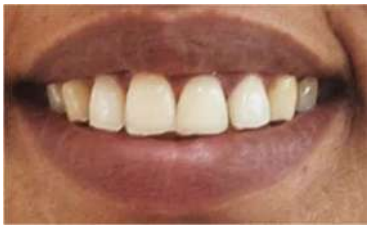
CASE 1

3 month review

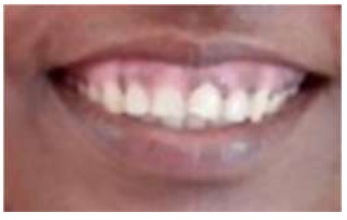


Pre Operative

CASE 2

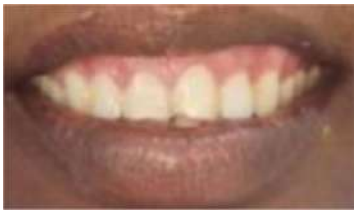


3 month review



Pre Operative

CASE 3



3 month review

In all three cases, after obtaining informed consent, the procedure was performed under local anesthesia (2% lignocaine with 1:100,000 epinephrine). The surgical sites were disinfected with 0.2% chlorhexidine. An elliptical outline was marked in the maxillary labial mucosa, and a partial-thickness incision was made along the markings, taking care to avoid injury to the underlying muscle fibers, particularly the elevator muscles of the upper lip. The epithelial strip of mucosa was carefully excised to expose the underlying connective tissue. The labial mucosa was then advanced in a coronal direction and sutured to the mucogingival junction using interrupted resorbable sutures placed with uniform tension to ensure flap stability and avoid ischemia. The surgical sites were inspected for bleeding and closure stability before completion of the procedure. Postoperative instructions were given, including: Avoid excessive lip movements such as smiling, laughing, or speaking excessively for at least one week. Adhere to a soft, non-spicy diet to minimize lip movement and trauma to the surgical site. Use cold compresses intermittently for the first 24 hours to reduce swelling. Maintain oral hygiene with gentle brushing in the non-operated areas and 0.12% chlorhexidine mouth rinse twice daily for 7 days. Analgesics and antibiotics were prescribed as needed.

Postoperative Outcome

Healing was uneventful in all three cases. At the 3-month follow-up, gingival display was reduced to approximately 1–2 mm during smiling in each patient. All patients expressed high satisfaction with the esthetic outcome, reporting improved confidence in their smiles. No postoperative complications, such as infection, wound dehiscence, or scarring, were observed.

Discussion

Excessive gingival display (EGD), commonly known as a "gummy smile," is a multifactorial condition that can significantly impact smile esthetics and patient self-esteem. The correction of a gummy smile requires a customized treatment plan tailored to the underlying etiologic factors, which may include vertical maxillary excess (VME), hyperactive upper lip, short upper lip, altered passive eruption, or anterior dentoalveolar extrusion[3,4]. The success of treatment depends heavily on accurate diagnosis, which often involves a combination of clinical evaluation, photographic analysis, and cephalometric measurements.

The primary aim of this article is to present the lip repositioning technique as a minimally invasive and effective approach to reduce excessive gingival display (EGD), commonly known as a "gummy smile." Compared to orthognathic surgery, this technique is shorter in duration, less aggressive, and associated with fewer postoperative complications, making it a preferred option in appropriately selected cases[5,6].

Accurate diagnosis of the underlying etiology is critical for selecting the appropriate treatment modality. EGD may stem from various etiological factors, both extraoral (e.g., vertical maxillary excess, hypermobile upper lip) and intraoral (e.g., altered passive eruption, dentoalveolar extrusion). Lip repositioning is most suitable when EGD is primarily due to upper lip hypermobility or mild vertical maxillary excess.[8] The procedure is contraindicated in patients with a minimal zone of attached gingiva, which compromises flap design, stability, and suturing. Moreover, in patients with moderate to severe vertical maxillary excess, lip repositioning alone is often insufficient, and interdisciplinary approaches including orthognathic surgery may be warranted.[7] Several anatomical parameters should be evaluated during the diagnostic phase. Facial proportions should appear harmonious across the upper, middle, and lower thirds. Disproportion in the lower third can indicate excessive vertical maxillary growth. Intraorally, the distance between the gingival margin and the cemento-enamel junction (CEJ) is critical; measurements exceeding 1.5 mm may suggest altered passive eruption.[13] Additionally, the crown width-to-length ratio of the maxillary anterior teeth should be assessed. Ideally, the central incisors should have a width approximately 80% of their length, with an accepted variation between 65% and 85%; lateral incisors should measure around 70%.[1]

The surgical technique used in the current cases is a modified adaptation of the method first described by Rubinstein and Kostianovsky. In one variation, the maxillary labial frenulum is preserved by removing bilateral mucosal strips, which helps maintain the labial midline and reduce postoperative morbidity.[5]

Some clinicians advocate a reversible trial procedure prior to definitive surgery, especially in esthetic

cases. This involves marking the proposed excision zone and simulating the surgical outcome with temporary sutures. The upper mucosal flap is repositioned downward to the mucogingival junction, mimicking the anticipated post-operative appearance. Clinical photographs and patient feedback help in decision-making and enhance predictability (Polo et al. 2008). Although high-quality evidence on long-term outcomes is limited, the available literature demonstrates promising results. A systematic review by Tawfik et al. (2018) reported an average gingival display reduction of approximately 3.4 mm post-lip repositioning[11]. Similarly, Silva et al. (2017) and Mazzuco & Hexsel (2010) have documented high levels of patient satisfaction and esthetic improvement, with stable outcomes reported at 6–12 months follow-up[3,12]. However, some degree of relapse due to muscle memory or scarring remains a consideration in long-term prognosis. Among the various available treatment options, lip repositioning surgery has gained popularity as a conservative alternative, particularly when EGD is due to a hyperactive upper lip or mild VME[8,3]. This technique involves the removal of a strip of mucosa from the maxillary labial vestibule and the repositioning of the labial mucosa to restrict the superior retraction of the upper lip during smiling. This reduces the gingival display and results in a more harmonious smile without altering the underlying bone or dentition.[9]

Compared to more invasive procedures like Le Fort I maxillary impaction surgery, which is the gold standard for moderate to severe VME, lip repositioning offers the benefits of reduced surgical time, minimal trauma, decreased morbidity, and faster recovery 4. Additionally, while botulinum toxin type A injections offer a non-surgical and temporary solution to reduce lip mobility, they require repeated applications every 3–6 months and may have unpredictable results. In contrast, lip repositioning provides a more permanent solution in appropriately selected cases, enhancing long-term patient satisfaction.[10]

However, not all patients are suitable candidates for lip repositioning. This technique is contraindicated in individuals with a short upper lip (<10 mm at rest), very thin gingival biotype, or severe skeletal discrepancies (e.g., VME > 8 mm), where orthognathic surgery is more appropriate[8]. Additionally, overcorrection during flap advancement must be avoided, as it can lead to undesirable outcomes such as limited lip mobility, flattened smile arc, mucosal scarring, or patient dissatisfaction due to an unnatural appearance.

In the present case series, the diagnosis of a hyperactive upper lip with normal lip length and minimal vertical maxillary excess made the patients an ideal candidates for lip repositioning. The surgery was performed successfully with meticulous flap design and tension-free closure, resulting in a reduction of gingival display from 5 mm to 1.5 mm postoperatively. The postoperative course was uneventful, with no complications such as hematoma, mucocele formation, or relapse. At 1-month follow-up, the patient reported high esthetic satisfaction, confirming the effectiveness of this technique in selected cases. Ultimately, lip repositioning offers a conservative, effective, and esthetically pleasing treatment option for patients seeking smile enhancement without undergoing invasive skeletal surgeries. Its growing popularity in periodontal and esthetic dentistry is supported by increasing clinical evidence and positive patient-reported outcomes.

Conclusion

Lip repositioning is a simple, conservative, and well-tolerated surgical technique for the correction of excessive gingival display, particularly in cases of upper lip hypermobility or mild vertical maxillary excess. While not universally applicable, careful patient selection and comprehensive diagnosis enable predictable and esthetically pleasing outcomes. Further longitudinal studies with larger sample sizes are needed to assess long-term stability and patient satisfaction.

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JSPIK

Periimplant Diseases- An overview on its Classification and Management

Nanditha Chandran[1], Anil Melath[2], Arjun MR[3], Varshna[4], Swedha G.[5]

ABSTRACT

Dental implants are a reliable solution for tooth loss; however, soft tissue deficiencies such as reduced keratinized mucosa, mucosal thickness, and supracrestal tissue height can impair osseointegration, esthetic outcomes, and patient satisfaction. Peri-implantitis (PI) further complicates treatment when soft tissue deficiencies are present. Alveolar ridge changes post-extraction lead to significant soft and hard tissue loss, making soft tissue grafts vital for peri-implant stability and esthetics. This review explores the role of peri-implant soft tissue phenotypes on implant success, focusing on their impact on health, esthetics, and functionality. It also examines treatment strategies for soft tissue deficiencies and their interaction with PI to provide evidence-based guidance for diagnosis and management in implant therapy. Hence the present review focuses on various periimplant diseases,its etiology,classification and management.

Keywords: Peri-implant soft tissue, Soft tissue defects, Peri-implant mucosa, Soft tissue recession.

Introduction

Dental implants being a cornerstone in modern dentistry, offers a reliable solution for tooth loss across a variety of clinical scenarios. Their success is highly dependent on proper treatment planning, precise three-dimensional placement, and the successful reconstruction of lost tissues to ensure long-term stability and function.[1] However, despite the success rates of dental implant treatments, certain esthetic and functional complications can arise, particularly involving soft tissue deficiencies. These deficiencies compromise the stability of peri-implant mucosa and can impact both the biological integration and esthetic outcomes of dental implants.[2]

Peri-implant soft tissue complications, such as deficiencies in keratinized mucosa or mucosal thickness, can impair osseointegration, disrupt esthetic harmony, and reduce patient satisfaction. Moreover, biological complications like peri-implantitis (PI) are commonly observed, with prevalence rates reported as 18% associated with patient factors and 12% associated with implant factors according to recent studies.[3] Such conditions not only affect the success rate of implants but may also complicate the treatment when soft tissue deficiencies coexist with PI.

Following tooth extraction, the alveolar ridge undergoes both biological and clinical changes that results in significant soft and hard tissue loss.[4] These changes can lead to compromised esthetics and stability if soft tissue augmentation of the defect is not carried out prior to implant placement. Modern implant dentistry now recognizes that success is not limited to achieving osseointegration alone but also depends on maintaining peri-implant health and optimizing esthetic outcomes by addressing soft tissue morphology and phenotype.

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This narrative review seeks to provide a comprehensive, evidence-based perspective on how phenotypical features of peri-implant soft tissues such as keratinized mucosa width, mucosal thickness, and supracrestal tissue height play a vital role in influencing the health, esthetics, and overall success of implant therapy. It will also examine treatment approaches to correct these soft tissue deficiencies and evaluate how they influence implant success, with the goal of achieving long-term biological stability and improved patient satisfaction.[5]

Terminology

Periimplant health:

Peri-implant health is defined by the absence of clinical signs of inflammation, including erythema, swelling, and bleeding on probing. It is characterized by a tight mucosal seal around the implant, with probing depths that can vary but generally do not exceed 5 mm, and no further bone loss following initial healing.[6]

Peri implant mucositis

Peri-implant mucositis is defined as an inflammatory lesion of the peri-implant mucosa in the absence of continuing marginal bone loss.[5]

The American Academy of Periodontology defines peri-implant mucositis as a disease in which inflammation of the soft tissues surrounding a dental implant is present without additional bone loss after the initial bone remodeling that may occur during healing following the surgical placement of the implant.6

Periimplantitis

Peri-implantitis has been defined as an inflammatory lesion of the mucosa surrounding an endosseous implant and with progressive loss of supporting peri-implant bone.[2,6]

Considerations while placing implants:

Soft tissue

The soft tissue around an implant plays a crucial role in determining the success rate of implant treatment. Not only does it provide functional support, but it also ensures an aesthetically pleasing outcome. Proper management and preparation of the soft tissue are essential to prevent complications, promote healing, and achieve optimal prosthetic stability.

Role of Healthy Soft Tissue

- Ensures treatment success.
- Contributes to the aesthetic outcome of the procedure.

Mucosa Characteristics Around the Implant

- Should envelop the neck of the prosthesis for functional and aesthetic benefits.
- Ideal mucosal thickness: 3-4 mm.

Insufficient thickness leads to:

- Bone resorption.
- Formation of angular defects.

Thickness Distribution

- Crown portion of mucosa: 2-2.2 mm.
- Apical part of mucosa: 1.1-1.7 mm.
- Vertical thickness between teeth: 1-1.5 mm, crucial around the implant.[5]

Keratinized and Attached Mucosa

Adequate keratinized mucosa is critical for prosthesis stability. 2 mm of keratinized mucosa and 1 mm of attached gingiva is required. High frenal attachment must be relieved to prevent tissue tension post-surgery.[7]

Hard tissue

The quality and quantity of hard tissue play a vital role in the success of implant placement. Sufficient bone volume is essential to provide primary stability and long-term support for the implant. The ideal bone width and height must be assessed to ensure proper osseointegration. In cases of inadequate bone, ridge augmentation procedures are recommended before implant placement as the approximation to vital structures such as the maxillary sinus or inferior alveolar nerve should also be evaluated to avoid complications. Moreover, ensuring a bone thickness of at least 1.5–2 mm around the implant is essential to minimize the likelihood of bone resorption and implant failure.[5]

Etiology of peri implant soft tissue deficiency

Prior to implant placement

Tooth loss

Tooth loss leads to changes in both the alveolar bone and soft tissues, often resulting in resorbed ridges. Studies of 24 maxillary and 99 mandibular completely edentulous skulls have identified resorption patterns:

the mandible shows centrifugal resorption, whereas the maxilla exhibits centripetal resorption. In severe cases, the mandible may have a more buccal circumference than the maxilla. Such conditions require bone augmentation for implant placement. Ridge resorption begins after tooth extraction and continues for up to 12 months, as observed in longitudinal studies involving 24 patients.Vertical and horizontal pattern of bone loss is also noted following extraction and spontaneous healing.[6,8]

Periodontal disease

Chronic periodontitis is an inflammatory disease of the supporting tissues that results in progressive bone loss and eventual tooth loss. Implant placement in patients with periodontitis often requires bone augmentation because of inadequate bone volume. In contrast, individuals who lost teeth due to trauma, aplasia, or endodontic infections typically have sufficient bone, allowing implant placement without the need for additional augmentation.[6]

Systemic disease

- Some systemic diseases like osteogenesisi mperfecta,osteoporosis, diabetes mellitus,usage of anti-bone resorptive medications, immune deficiency and behavioral factors such as substance abuse, in particular tobacco and alcoholmay compromise bone and soft tissue healing after implant insertion and require consideration and/or management when contemplating implant therapy. In such cases, bone augmentation becomes necessary to provide adequate support for implants. However, these procedures may be complicated by insufficient soft tissue to cover the newly augmented bone.[9]

After implant placement

Papillary height

Reduced papilla height between adjacent implants is a common soft-tissue deficiency, causing esthetic issues in the visible area. Studies have found that the mean papilla height between implants is around 3.4 mm, significantly lower than the 5-6 mm seen between natural teeth. This height is influenced by the bone crest between implants, with less favorableoutcomes in the presence of bone loss.[10]

Keratinized tissue

The role of width of keratinized tissue around implants has been a subject of debate. The relationship between keratinized tissue width and clinical parameters like plaque accumulation, gingivitis, and peri-implantitis has been extensively studied.Implantsplaced in areas with insufficient keratinized mucosa may experience higher plaque scores and gingival recession, indicating the importance of adequate keratinized tissue in maintaining implant health.[11,12]

Classification of Periimplant defects[13]

1. STUART F, PAUL F

Early periimplantitis - PD ≥ 4 mm, Bleeding and/or suppuration on probing, Bone loss <25% of the implant length.

Moderate periimplantitis - PD ≥ 6 mm, Bleeding and/or suppuration on probing, Bone loss ranging from 25% to 50% of the implant length.

Advanced periimplantitis -PD ≥ 8 mm, Bleeding and/or suppuration on probing, Bone loss >50% of the implant length.

2. BOGAERDE ET AL - CLASSIFICATION OF BONE DEFECTS ADJACENT TO DENTAL IMPLANTS FOCUSSING ON DEFECT ANATOMY IN REGENERATVE PROCESS

Closed defect intact surrounding bone wall

Open defect lacking one or more bone wall

3. NISHIMURA ET AL - CLASSIFICATION BASED ON AMOUNT OF BONE LOSS AND SHAPE OF THE DEFECT

CLASS 1: Slight horizontal bone loss with minimal periimplant defects

CLASS 2 : moderate horizontal bone loss with isolated vertical defects

CLASS 3 : moderate to advanced horizontal bone loss with broad, circular bony defects

CLASS 4 : advanced horizontal bone loss with broad, circumferential vertical defects, including loss of oral/ vestibular bony wall.

4. SCHWARZ ET AL - CLASSIFICATION BASED ON CONFIGURATION OF BONY DEFECTS

CLASS I: Intraosseous defects

CLASS II :Supraalveolar defect in the crestal implant insertion area

5. SPIKERMANN ET AL - CLASSIFICATION BASED ON BONE RESORPTION PATTERN

CLASS I: Horizontal bone resorption

CLASS II : Hey shaped bone resorption
CLASS IIIa : Funnel shaped bone resorption
CLASS IIIb : Gap- like bone resorption
CLASS IV : Horizontal - circular bone resorption

Management and treatment planning

1. Non surgical
2. Surgical
   - Conservative
   - Resective
   - Reconstructive
3. Combined
   - CIST Protocol
   - ACUT protocol

Non-Surgical

Non-surgical management of peri-implantitis aims to stop disease progression, reduce inflammation, and maintain the function of the implant along with the health of surrounding tissues. It primarily involves mechanical debridement using hand instruments, as well as sonic or ultrasonic devices and air-polishing systems, while ensuring that the implant surface is not damaged or roughened. Instruments such as Teflon, carbon, or titanium-coated curettes are typically preferred to prevent surface alterations that could encourage plaque accumulation.[14] Adjunctive therapies, including antiseptics or antibiotics, may be used, but these should only support not replace effective mechanical removal of the biofilm.[15] Despite these measures, non-surgical treatment alone is often insufficient for managing advanced peri-implant bone defects.[2]

Surgical

Surgical treatment is intended to allow direct access for effective decontamination of the implant surface and, based on the defect configuration, to either reduce peri-implant pocket depths or rebuild lost bone support. Defects that are non-contained or associated with significant horizontal bone loss generally have poor regenerative capacity and are therefore more appropriately managed with resective therapy.[16] These procedures focus on eliminating pockets, repositioning the flap apically, and often include implantoplasty to smooth exposed implant surfaces and minimize plaque accumulation. As a result, they are typically indicated in non-esthetic regions or in patients with minimal esthetic concerns.[17] On the other hand, contained defects or those that are mainly infraosseous have a higher potential for regeneration and are better suited for augmentative or regenerative techniques. In situations where defects have both supra- and infraosseous components, or where there is partial buccal dehiscence, a combined approach may be used.[16] This involves implantoplasty of the supracrestal portion along with bone grafting to address the infraosseous component.

Regenerative surgical therapy

Regenerative surgical therapy focuses on rebuilding lost peri-implant bone and encouraging re-osseointegration of the implant surface. Guided bone regeneration (GBR) involves the use of barrier membranes to prevent the ingrowth of fast-proliferating soft tissue cells, support clot stability, and create a protected space for new bone formation. These membranes may be either resorbable or non-resorbable. GBR techniques often incorporate different types of bone graft materials, such as autografts, allografts, xenografts, and alloplastic substitutes.[18] Autogenous bone is considered the gold standard because of its osteogenic, osteoinductive, and osteoconductive capabilities; however, its use is limited by factors such as donor-site morbidity and a tendency for resorption.[19] Deproteinized bovine xenografts are commonly utilized due to their excellent biocompatibility, osteoconductive nature, and slow resorption rate, which helps maintain long-term volume stability.[20] To further improve their biological effectiveness, these xenografts are sometimes combined with hyaluronic acid or hyaluronate, which can enhance angiogenesis, stimulate osteoblastic activity, and support bone regeneration.[21]

Resectivesurgical therapy

Resective procedures aim to eliminate peri-implant pockets and reshape the implant or surrounding tissues to create a stable and maintainable environment. Implantoplasty, a resective technique, smoothens and modifies the implant surface to reduce bacterial adhesion.[22] Although this method has been shown to improve probing depth and reduce bleeding indices, it may lead to gingival recession, particularly in cases involving extensive soft tissue removal.

CIST Protocol

The CIST protocol (Cumulative Interceptive Supportive Therapy) is a stepwise approach for managing peri-implantitis, progressing from mechanical debridement to antiseptics, antibiotics, and surgery based on disease severity. It aims to control inflammation and prevent further bone loss around implants through tailored interventions at each stage.[22]

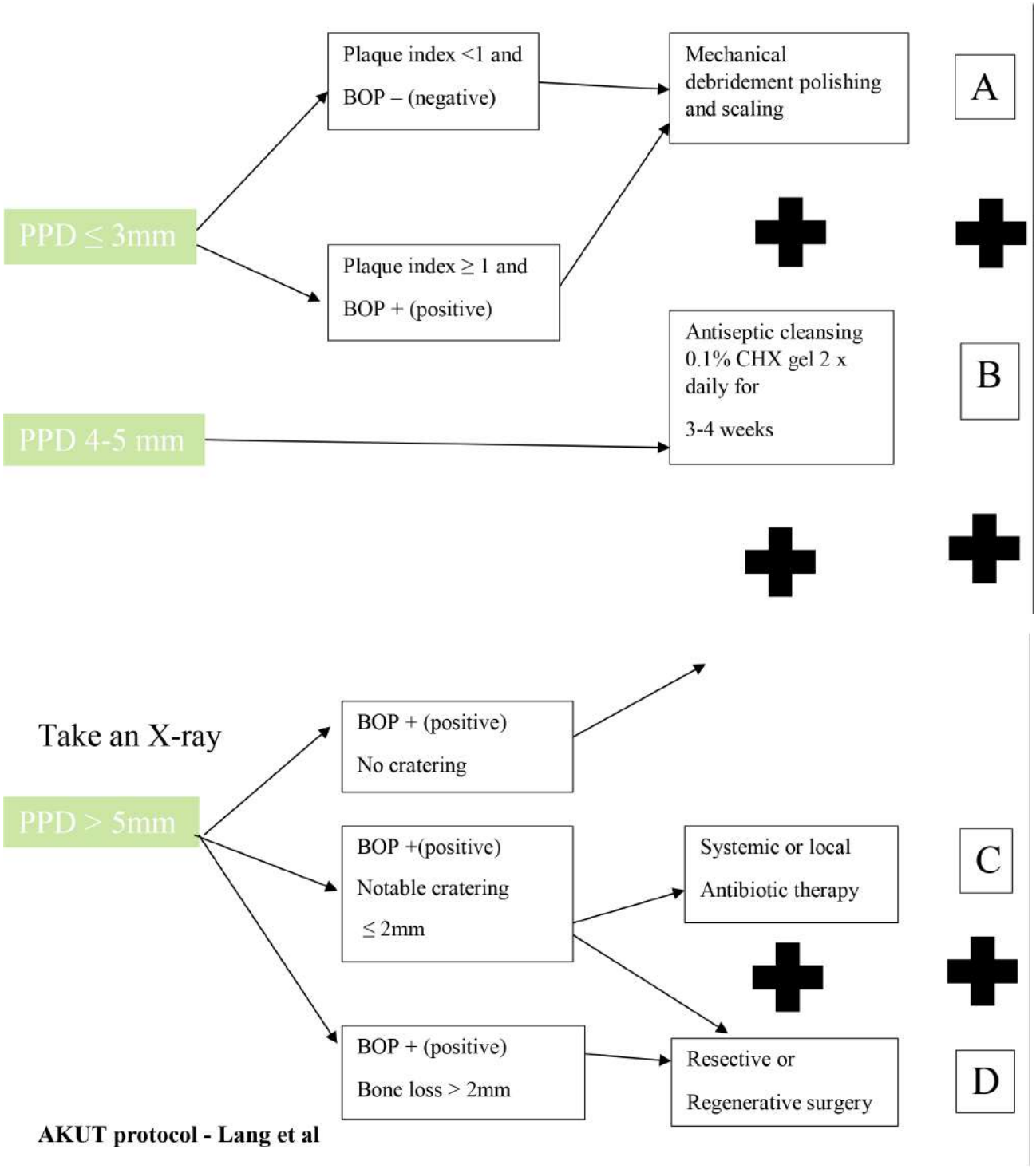

FIGURE 1- CIST PROTOCOL FOR PERIIMPLANTITIS

This approach focuses on a systematic method of decontaminating the implant surface, managing the surrounding soft tissues and effectively treating peri-implant pockets to re-establish tissue health.It integrates both mechanical and chemical cleaning methods, while also taking into account the need for surgical intervention when necessary.[22]

STAGE	RESULT	THERAPY
	Pocket depth [PD]<3mm, no plaque or bleeding	No therapy
A	PD <3mm, plaque and/ or bleeding on probing	Mechanically cleaning, Polishing Oral Hygiene Instructions
B	PD 4-5mm, radiologically no bone loss	Mechanically cleaning, Polishing .Oral Hygiene Instructions plus local antiinfective therapy[Eg.Chx]
C	PD >5mm, radiologically < 2mm bone loss	Mechanically cleaning, polishing,microbiologicaltest,local and systemic antiinfective therapy
D	PD >5mm, radiologically > 2mm bone loss	Resectiveor Regenerative therapy

TABLE 1- ACUT PROTOCOL FOR PERIIMPLANTITIS

Conclusion

Peri-implant soft tissue defects represent a significant clinical challenge as they not only compromise esthetics but also affect peri-implant health and long-term treatment success. Accurate diagnosis and classification of such defects are essential for selecting the most appropriate surgical or prosthetic intervention. Techniques such as connective tissue grafting, coronally advanced flaps, and prosthetic modifications have shown predictable outcomes when applied according to defect type and severity. A clear understanding of the biological principles governing soft tissue integration around implants, along with careful treatment planning, can greatly improve both functional stability and esthetic predictability. Continued research and refinement of surgical techniques are necessary to enhance long-term outcomes and provide patient-centered, minimally invasive solutions.

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Awareness of Periodontitis and Its Interrelationship with Systemic Health among the General Population: A Cross-Sectional Questionnaire Study

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ABSTRACT

Background: Periodontal health is an essential component of overall systemic well-being, as the oral cavity often reflects and influences general health; however, the interrelationship between periodontal diseases and systemic conditions is frequently overlooked by the general population.

Aim: The present study aimed to assess the awareness regarding periodontitis and its interrelationship with systemic health among the general population.

Materials and Methods: A cross-sectional questionnaire-based survey was conducted using a structured questionnaire comprising 25 questions assessing awareness of periodontal disease, its systemic implications, and dental visitation history. Participants responded using a three-point Likert scale (Agree, Disagree, Partly Agree), and awareness levels were analysed based on age, gender, educational status, and dental visit history.

Results: The results demonstrated comparatively higher awareness among female participants, individuals with postgraduate education, and those belonging to the 35–50-year age group, although notable gaps in knowledge regarding the periodontal–systemic link were observed among a considerable proportion of participants.

Conclusion: The study concludes that while moderate awareness regarding periodontal disease and its impact on systemic health exists, this important relationship remains underrecognized, emphasising the need for large-scale studies and community-based oral health education programs to enhance public awareness and promote overall health.

Key words: Periodontitis, Systemic health, Awareness, Oral–systemic link

Introduction

Oral health is an integral and indispensable component of general health and plays a significant role in maintaining systemic well-being. The oral cavity acts as both a gateway to the body and a mirror reflecting systemic health status. Poor oral hygiene and untreated oral diseases can adversely influence systemic health by increasing the inflammatory burden and facilitating microbial dissemination into the bloodstream.[1] The oral cavity harbours a diverse and complex microbial ecosystem, and disruption of the host–microbial balance may lead to periodontal disease.

Periodontal disease is a chronic inflammatory condition affecting the supporting structures of the teeth. If left untreated, it can result in gingival recession, loss of periodontal attachment, alveolar bone destruction, tooth mobility, and eventual tooth loss.[2] Increasing scientific evidence suggests that periodontal inflammation may contribute to the pathogenesis or progression of several systemic diseases.[3]

Epidemiological studies have reported a high global prevalence of periodontal disease. Severe periodontitis has been identified as one of the most prevalent chronic diseases worldwide, ranking sixth

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among all diseases, thereby posing a substantial public health challenge.[5]

Over the past two decades, a steadily growing body of evidence has demonstrated associations between periodontal disease and systemic conditions such as diabetes mellitus, cardiovascular diseases, adverse pregnancy outcomes, and respiratory diseases.[3,6,7] Systematic reviews and meta-analyses have consistently supported a bidirectional relationship between diabetes mellitus and periodontal disease, wherein poor glycemic control exacerbates periodontal destruction and periodontal inflammation negatively affects metabolic control.[8]

Advances in medical management have led to increased life expectancy and a growing population with chronic systemic diseases and long-term medication use. Several commonly prescribed drugs, including antihypertensives, antidepressants, anticoagulants, and immunosuppressants, are associated with adverse oral effects such as xerostomia and mucosal changes, which may predispose individuals to periodontal disease.[9] Consequently, careful oral examination may provide valuable clues to underlying systemic conditions and facilitate early diagnosis and intervention.[10]

Despite substantial scientific evidence supporting the oral–systemic relationship, awareness among the general population remains inadequate. Hence, the present study was undertaken to assess the level of awareness regarding periodontitis and its interrelationship with systemic health among the general population.

Objectives

Primary Objective

- To assess public awareness regarding the relationship between periodontitis and systemic health conditions.

Secondary Objectives

- To evaluate knowledge related to the impact of smoking, diet, diabetes, cardiovascular disease, pregnancy, and stress on periodontal health.
- To determine whether demographic variables such as age, gender, education level, and dental visitation patterns influence awareness.
- To identify specific areas where public awareness is lacking to guide targeted oral health education programs.

Materials and Methods

Study Design and Setting

The present study was designed as a cross-sectional questionnaire-based survey conducted in the Department of Periodontics and Oral Implantology, Educare Institute of Dental Sciences. Data collection was carried out among patients attending the outpatient department as well as among the general population using both printed questionnaires and Google Forms.

Study Population

A total of 303 adult participants aged 18 years and above were included in the study. Participation was voluntary, and informed consent was obtained from all participants prior to enrollment. Sex as a biological variable was considered in the study design and analysis. Both male and female participants were included, and gender-based differences in awareness were evaluated.

Inclusion Criteria

- Adults aged ≥18 years
- Patients attending the outpatient department of Periodontics
- Individuals from the general population responding through Google Forms
- Individuals with formal education (school level and above)
- Participants with postgraduate qualifications in non-medical, non-dental, and non-paramedical disciplines

Exclusion Criteria

- Individuals without formal schooling
- Medical, dental, and paramedical professionals or students
- Individuals unwilling to participate in the study

Questionnaire Design

A structured questionnaire was developed based on previous literature to assess awareness of periodon-

titis and its interrelationship with systemic health. The questionnaire consisted of 25 questions, including demographic details and awareness-based questions.

Demographic variables included age, gender, educational status, and dental visitation history.

For better comprehension, the questionnaire was distributed in both English and the regional language Malayalam, in printed form as well as through Google Forms.

The awareness-related questions were categorised into the following groups:

- **Group A:** Awareness of periodontitis
- **Group B:** Interrelationship between smoking and periodontitis
- **Group C:** Effects of nutrition on periodontal health
- **Group D:** Influence of diabetes mellitus on periodontium
- **Group E:** Cardiovascular system-related effects associated with periodontitis
- **Group F:** Effects of pregnancy on periodontal health
- **Group G:** Influence of stress on periodontal health
- **Group H:** Overall perception of the interrelationship between periodontitis and systemic health

Response Format

Participants were instructed to select one of the following responses for each question: Agree, Disagree, or Partly Agree. The questionnaire was framed in simple language to ensure ease of understanding.

Sample Size

The sample size was calculated based on the prevalence reported in a previous study, where the overall awareness regarding the interrelationship between periodontal and systemic health was 74% (p = 0.74).4

Considering an absolute precision of 5% (d = 0.05) and a 95% confidence level, the sample size was determined using the standard formula:

$$n = 4pq/d^2$$

Where:

n = required sample size

p = expected prevalence (74%)

q = 1 − p (26%)

d = absolute precision (5%)

Substituting the values, the calculated sample size was approximately 296 participants. Therefore, the final sample size was rounded off to 300 participants.

Data Collection

Participants completed the questionnaire independently. Responses obtained through printed forms and Google Forms were compiled and tabulated for analysis.

Ethics Statement

The present study was a non-interventional, questionnaire-based survey conducted among adult participants. Participation was voluntary, and the questionnaire was completed anonymously. Informed consent was obtained from all participants prior to data collection. Ethical Committee clearance was obtained from the Institutional Ethics Committee.

Statistical Analysis

The data were entered into Microsoft Excel spreadsheets and subjected to statistical analysis using IBM SPSS Statistics version 25 software. Demographic characteristics and awareness items were summarised using frequency and proportions. Chi-square tests were used to find out the association between awareness levels of participants and demographic characteristics. The p-value was set at 0.05 to analyze the level of significance.

Results

The present cross-sectional study 303 individuals from the general population. The responses obtained from all participants were considered for analysis.

Of the 303 participants, 156 (49.2%) were females and 161 (50.8%) were males. Based on age distribution, 147 individuals (46.4%) were below 35 years, 109 (34.4%) belonged to the 35–50 years age group, and 61 (19.2%) were above 50 years. With respect to educational qualification, 127 participants (40.1%) had completed high school education, 172 (54.3%) were graduates, and 18 (5.6%) were postgraduates.

Gender-wise comparison showed that females exhibited higher awareness levels than males across all categories of questions.

Overall Awareness of Periodontitis and Systemic Health

Evaluation of overall awareness among the study population demonstrated that a greater proportion of participants exhibited awareness regarding the interrelationship between periodontal disease and systemic health. Assessment of awareness regarding periodontitis showed that 54.7% of participants agreed that periodontitis is a gum disease capable of damaging the bone supporting the teeth, while 25.0% disagreed and 20.3% partly agreed. A similar response pattern was observed regarding the silent progression of gum disease without obvious symptoms. A high level of awareness was noted for the role of regular dental check-ups, with 84.7% agreeing that routine dental visits help in early detection of periodontal disease (Table 2).

78% of the participants strongly believed that good oral health is essential for maintaining good general health. 85% participants have an interest of learning more about how gum disease affects the rest of the body.

Table 1: Demographic Characteristics

Characteristics		N(%)
Age groups	18-25	63(21.0)
	26-35	103(34.3)
	36-45	53(17.7)
	46-55	49(16.3)
	above 50	32(10.7)
Gender	Male	130(43.3)
	Female	170(56.7)
Education level	primary	6(2.0)
	secondary	4(1.3)
	higher secondary	54(18.0)
	graduate	147(49.0)
	postgraduate	89(29.7)
Previous history of dental visit in last one year	Yes	152(50.7)
	No	148(49.3)

SMOKING AND NUTRITION

Regarding the effects of smoking on periodontal health, 66.0% of participants agreed that smoking reduces blood flow to the gums and worsens gum disease. Awareness that smoking may suppress early signs of inflammation was reported by 65.7% of participants. A notably high proportion (81.3%) agreed that cessation of smoking improves overall oral health and healing capacity.

More than 70% of the participants believed that a balanced diet was needed toimprove gum health and resistance to periodontal disease. (Table 3)

DIABETES AND CARDIOVASCULAR EFFECTS

Fifty seven percent of the participants completely agreed that uncontrolled diabetes is at a higher risk of developing severe gum disease. Further more 10% participant not aware of the importance of frequent dental check-ups. Around fifty percent of the participants totally agreed on the interrelation ship of

Table 2: Awareness of Periodontitis among the General Population

SL NO	AWARENESS OF PERIODONTITIS		N(%)
1	Periodontitis is a gum disease that can damage the bone supporting the teeth.	Agree	164(54.7)
		Disagree	75(25.0)
		Partly Agree	61(20.3)
2	Gum disease can progress silently without obvious symptoms.	Agree	164(54.7)
		Disagree	75(25.0)
		Partly Agree	61(20.3)
3	Regular dental check-ups help in the early detection of gum disease	Agree	254(84.7)
		Disagree	6(2.0)
		Partly Agree	40(13.3)

Table 3: Awareness of the Relationship between Smoking and Nutrition to Periodontitis

	SMOKING AND PERIODONTITIS		N(%)
4	Smoking reduces blood flow to the gums and worsens gum disease	Agree	198(66.0)
		Disagree	46(15.3)
		Partly Agree	56(18.7)
5	Smokers may not notice early signs of gum disease due to suppressed inflammation.	Agree	197(65.7)
		Disagree	55(18.3)
		Partly Agree	48(16.0)
6	Stopping smoking improves overall oral health and healing ability	Agree	244(81.3)
		Disagree	4(1.3)
		Partly Agree	52(17.3)
	NUTRITION AND PERIODONTITIS		
7	Poor dietary habits can weaken gum tissues and increase the risk of infection	Agree	213(71.0)
		Disagree	31(10.3)
		Partly Agree	56(18.7)
8	Deficiency of essential nutrients may worsen gum disease	Agree	222(74.0)
		Disagree	25(8.3)
		Partly Agree	53(17.7)
9	Eating a balanced diet can help improve gum strength and resistance to disease	Agree	218(72.7)
		Disagree	31(10.3)
		Partly Agree	68(22.7)

Table 4: Awareness of Relation between Diabetes and Cardiovascular Effects to Periodontitis

	DIABETES AND PERIODONTITIS		N(%)
10.	People with uncontrolled diabetes are at higher risk of developing severe gum disease.	Agree	173(57.7)
		Disagree	65(21.7)
		Partly Agree	62(20.7)
11.	Treating periodontitis can help improve blood sugar control.	Agree	137(45.7)
		Disagree	90(30.0)
		Partly Agree	73(24.3)
12.	Diabetic patients should get their gums checked more frequently.	Agree	184(61.3)
		Disagree	30(10.0)
		Partly Agree	86(28.7)
	CARDIOVASCULAR EFFECTS		
13.	Gum disease increases the body's overall inflammation, which may affect heart health.	Agree	168(56.0)
		Disagree	69(23.0)
		Partly Agree	63(21.0)
14.	Bacteria from infected gums can enter the bloodstream and contribute to heart disease.	Agree	158(52.7)
		Disagree	83(27.7)
		Partly Agree	59(19.7)
15.	Maintaining good gum health may help lower the risk of heart-related conditions.	Agree	178(59.3)
		Disagree	42(14.0)
		Partly Agree	80(26.7)

cardiovascular disease and periodontitis. (Table 4)

PREGNANCY AND STRESS

Only 43.7% participants had knowledge of untreated gum disease in pregnant women is a risk factor for preterm labour. More than 75% of the people thought that gum disease checkup should have to be done for pregnant ladies as part of their antenatal check-up. (Table 5)

Awareness level towards the interrelationship between periodontal health and systemic disease is depicted in Figure 1. Approximately half of the (52.7) participants had a low awareness level.

DISCUSSION

The present study assessed awareness regarding periodontitis and its interrelationship with systemic health among the general population. Overall, the find-

Table 5: Awareness of the Relationship between Pregnancy and Stress to Periodontitis and Overall Perception of Gum Health

	PREGNANCY AND PERIODONTITIS		N(%)
16	Hormonal changes during pregnancy can make gums more sensitive and prone to infection.	Agree	172(57.3)
		Disagree	63(21.0)
		Partly Agree	65(21.7)
17	Untreated gum disease in pregnant women may increase the risk of preterm birth.	Agree	131(43.7)
		Disagree	82(27.3)
		Partly Agree	87(29.0)
18	Pregnant women should have their gums evaluated as part of routine antenatal care.	Agree	166(55.3)
		Disagree	69(23.0)
		Partly Agree	65(21.7)
	STRESS AND PERIODONTITIS		
19	High stress levels can affect immunity and make gum disease worse.	Agree	170(56.7)
		Disagree	70(23.3)
		Partly Agree	60(20.0)
20	Stress can lead to habits like teeth grinding, which harms gums.	Agree	183(61.0)
		Disagree	48(16.0)
		Partly Agree	69(23.0)
21	Managing stress can support better oral and general health.	Agree	183(61.0)
		Disagree	66(22.0)
		Partly Agree	51(17.0)
	OVERALL PERCEPTION		
22	Good oral health is essential for maintaining good general health.	Agree	233(77.7)
		Disagree	9(3.0)
		Partly Agree	58(19.3)
23	I am interested in learning more about how gum disease affects the rest of the body.	Agree	256(85.3)
		Disagree	10(3.3)
		Partly Agree	34(11.3)
24	I believe regular dental check-ups help in managing systemic complications linked to gum disease	Agree	262(87.3)
		Disagree	9(3.0)
		Partly Agree	29(9.7)

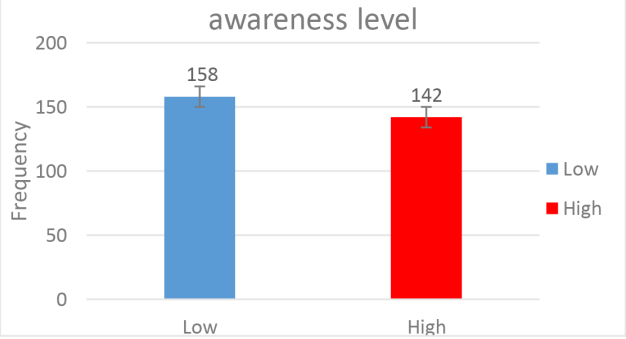

Figure 1:Awareness level towards Periodontitis and Systemic Health

ings revealed moderate awareness, with significant gaps in knowledge regarding specific systemic associations.

Awareness of the basic nature of periodontal disease was comparable to findings from earlier studies conducted in different populations[11,12]. The higher awareness observed among females may be attributed to better health-seeking behaviour and preventive attitudes, as reported in previous literature[13]. Educational status also played a significant role, with higher awareness levels among individuals with higher educational qualifications, underscoring the importance of health literacy[14].

The association between smoking and periodontal disease was relatively well recognised, likely due to widespread public health campaigns. However, misconceptions regarding the masking effect of smoking on gingival inflammation persisted among a subset of participants, highlighting the need for continued education[15,16]. This finding aligns with earlier reports indicating that while smoking is widely recognised as a risk factor, its specific biological effects on periodontal tissues are poorly understood by the general public[15].

Despite strong scientific evidence linking periodontitis with diabetes mellitus and cardiovascular disease, awareness of these associations was limited. Previous studies have similarly reported inadequate public knowledge regarding the bidirectional relationship between diabetes and periodontitis[17,18,19]. This lack of awareness may contribute to poor disease control and delayed diagnosis. Thus, increasing collaboration between dental and medical professionals is essential.

Awareness of the association between periodontal disease and cardiovascular health was only moderate. Although bacteremia and systemic inflammation have been implicated as potential mechanisms linking periodontal disease to cardiovascular conditions, these concepts remain largely unfamiliar to the general population[20,21]. This lack of awareness may limit patient motivation toward maintaining periodontal health as part of cardiovascular disease prevention strategies.

Knowledge regarding pregnancy-associated periodontal changes and adverse pregnancy outcomes was notably lower. As hormonal fluctuations during pregnancy are known to exacerbate gingival inflammation, and untreated periodontal disease has been associated with adverse pregnancy outcomes such as preterm birth and low birth weight[22,23]. Incorporating oral health screening and education into routine antenatal care may therefore be beneficial.

The present study had a relatively small sample size, which may limit the generalizability of the findings to the wider population, and its cross-sectional design restricts the ability to establish causal relationships between awareness of periodontitis and its systemic interrelationship; therefore, the results reflect awareness at a single point in time and should be interpreted with caution.

However, the findings of the present study emphasise the need for integrating oral health education into general health promotion programs. Mass media campaigns and collaboration between dental and medical professionals are essential to improve public understanding of the oral–systemic health relationship and promote holistic health care.

CONCLUSION

The present study concludes that although moderate awareness regarding periodontitis exists among the general population, understanding of its interrelationship with systemic health remains limited. Periodontal disease continues to be perceived primarily as a localised oral condition rather than a contributor to systemic health. Targeted community-based oral health education programs, integration of oral health into general health initiatives, and interprofessional collaboration are essential to improve public awareness and promote preventive oral health behaviours.

CONFLICT OF INTEREST

There are no conflicts of interest related to this study.

AKNOWLEDGEMENT

We would like to express our sincere gratitude to all the participants who voluntarily took part in this study. We also acknowledge the support and cooperation extended by the Department of Periodontics and Oral Implantology, Educare Institute of Dental Sciences, for facilitating the conduct of this research.

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P. Gingivalis: Bridging Periodontitis and Rheumatoid Arthritis Pathogenesis

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ABSTRACT

Rheumatoid arthritis (RA) is a chronic systemic autoimmune disease characterized by persistent synovial inflammation, progressive joint destruction, and the presence of specific autoantibodies such as anti-citrullinated protein antibodies (ACPAs). In recent decades, increasing evidence has highlighted a strong association between periodontal disease (PD) and RA, particularly implicating the periodontal pathogen1-5. Porphyromonas gingivalis as a key etiological factor. This bacterium possesses a unique virulence mechanism involving the expression of peptidylarginine deiminase (PPAD), which catalyzes the conversion of arginine residues into citrulline. This post-translational modification plays a central role in the breakdown of immune tolerance and the generation of neoantigens in RA.

This comprehensive review integrates epidemiological, molecular, and structural evidence to explore the mechanistic pathways linking P. gingivalis to RA pathogenesis. It discusses the role of chronic inflammation, molecular mimicry, systemic immune activation, and genetic susceptibility in mediating disease progression. Furthermore, findings from meta-analyses and experimental studies are synthesized to provide a holistic understanding of this bidirectional relationship. Understanding the oral-systemic link offers new opportunities for early diagnosis, prevention, and targeted therapeutic interventions in rheumatoid arthritis.

Keywords: Porphyromonas gingivalis; rheumatoid arthritis; citrullination; periodontitis; PPAD; autoimmunity; inflammation

Introduction

Rheumatoid arthritis (RA) is a debilitating autoimmune disease affecting approximately 1% of the global population[6,7]. It is characterized by chronic inflammation of synovial joints, leading to cartilage destruction, bone erosion, and functional disability. The etiology of RA is multifactorial, involving a complex interplay of genetic predisposition, environmental triggers, and immune dysregulation.

Periodontal disease (PD), particularly chronic periodontitis, is one of the most prevalent inflammatory conditions worldwide. It is initiated by dysbiosis of the oral microbiota and sustained by an exaggerated host immune response. Interestingly, PD and RA share several pathological features, including chronic inflammation, bone resorption, and elevated systemic inflammatory markers[1,2,8].

Over the past few decades, numerous studies have demonstrated a significant association between PD and RA.[1,2,8]. Among periodontal pathogens, Porphyromonas gingivalis has gained particular attention due to its unique ability to produce peptidylarginine deiminase (PPAD), an enzyme capable of citrullinating host proteins. This ability provides a direct mechanistic link between oral infection and systemic autoimmunity, making P. gingivalis a critical focus in understanding RA.

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Discussion

Rheumatoid arthritis is a chronic systemic autoimmune disorder characterized by persistent synovial inflammation, progressive joint destruction, and various extra-articular manifestations.[30] Central to its pathogenesis is the production of autoantibodies, particularly rheumatoid factor (RF)—an IgM antibody directed against the Fc portion of IgG—and anti-citrullinated protein antibodies (ACPA)[31]. ACPA demonstrates high specificity (up to 98%) for Rheumatoid arthritis and can be detected years before the onset of clinical symptoms, often predicting more severe, erosive disease and poorer therapeutic outcomes.[32,33]

Periodontitis is a chronic microbially induced inflammatory condition that leads to the destruction of periodontal tissues[34]. Increasing evidence supports a bidirectional relationship between periodontitis and Rheumatoid arthritis.[35] Meta-analyses have demonstrated a modest but significant increase in the risk of periodontitis among RA patients (relative risk [RR] 1.13; 95% confidence interval [CI] 1.04–1.23), along with greater clinical attachment loss and increased bleeding indices36

Immunopathogenic Overlaps

The association between Rheumatoid arthritis and periodontitis is underpinned by shared immunopathogenic mechanisms. Both conditions exhibit dysregulated immune responses characterized by elevated levels of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), and interleukin-17 (IL-17).[37,38] Additionally, receptor activator of nuclear factor kappa-B ligand (RANKL)-mediated osteoclastogenesis contributes to bone destruction in both diseases[39]. Genetic predisposition also plays a role, particularly the presence of HLA-DRB1 shared epitope alleles.[40]

A key mechanistic link involves the periodontal pathogen Porphyromonas gingivalis, which uniquely expresses the enzyme peptidylarginine deiminase (PPAD)[41]. This enzyme catalyzes the citrullination of host proteins, leading to the generation of neoantigens and subsequent ACPA production[42]. This process may trigger autoimmune responses through molecular mimicry and epitope spreading, thereby linking periodontal infection to the initiation and progression of Rheumatoid arthritis.[43]

As specific plaque hypothesis underlies the importance of the qualitative composition of the resident microbiota, the pathogenicity of dental biofilm depends on the presence of or an increase in specific microorganism[45]. The concepts encapsulates that biofilm harboring specific pathogens may provoke periodontal disease because key organisms produce substances that mediate the destruction of host tissues. the concept of "key stone pathogens" indicates that certain low-abundance microbial pathogens that orchestrate inflammatory disease by remodeling a normally benign microbiota into a disbiotic one[45,46]. P. gingivalis is especially known to subvert the host immune system and change the microbial composition of dental biofilms, ultimately leading to periodontal bone loss on this basis P. gingivalis was labeled as a "key stone pathogen"[46]. P. gingivalis produces components such as lipopolysaccharides (LPS), fimbriae, and haemagglutinins, which help it attach to, invade, and survive within periodontal pockets. Because of its ability to interfere with and manipulate the host's immune balance, it is often called a "master manipulator"[10] ..One of its most powerful tools is a group of enzymes called gingipains—extracellular cysteine proteases. These enzymes allow the bacterium to exploit the host's innate immune system for its own survival.[11,12] Gingipains can make P. gingivalis resistant to the complement system, meaning the bacterium actually benefits from immune activation, which sustains inflammation[13]. Additionally, gingipains break down antimicrobial peptides, enabling other harmful bacteria associated with P. gingivalis to survive in the gum tissues. They also influence inflammatory responses by activating proteinase-activated receptor-2 (PAR-2) on neutrophils.

As the immune system repeatedly tries—and fails—to eliminate the infection, this ongoing response leads to damage of connective tissues, including destruction of alveolar bone.[16,17]

Role of Citrullination :

It is now well established that most cases of rheumatoid arthritis (RA) are driven by an autoimmune response against citrullinated proteins. Citrullination is a post-translational modification in which the amino acid arginine is converted into citrulline through enzymatic deamination, changing it from a positively charged to a neutral form.[29]

Under normal conditions, this process is important for several physiological functions, including skin cell maturation (involving proteins like keratin), brain development (myelin basic protein), and regulation of gene expression through chromatin remodeling.[19,20]

However, citrullination also increases during inflammatory and pathological states such as apoptosis, necrosis, and NETosis. During NETosis, excessive citrullination of histone proteins is necessary for the formation of neutrophil extracellular traps, which help the body fight bacterial infections.[20]

When this process becomes dysregulated, it can trigger abnormal immune responses. As a result, protein deimination has been associated not only with RA but also with other diseases like multiple sclerosis, psoriasis, Alzheimer's disease, glaucoma, and kidney disorders.

Citrullination changes the normal structure and interactions of proteins that contain arginine residues. This can disrupt their three-dimensional shape and affect their solubility, leading to the formation of new antigenic sites (neo-epitopes). These changes may cause the immune system to lose tolerance and start recognizing these altered proteins as foreign.

In genetically susceptible individuals, this can trigger a series of immune reactions that eventually lead to rheumatoid arthritis (RA).[14,15,21]

Antibodies against citrullinated proteins (ACPA) are highly sensitive and specific markers of RA, and they can appear years before the disease shows clinical symptoms. Their levels also tend to increase with disease severity.

Recent studies have shown that patients with aggressive periodontitis have higher levels of ACPA22. Additionally, RA patients who are ACPA-positive are more likely to have moderate to severe periodontitis compared to those who are ACPA-negative[23]

Citrullination by PPAD as a Putative Mechanistic Link between PD and RA

Porphyromonas gingivalis produces PPAD, which can trigger loss of immune tolerance to citrullinated proteins in periodontal sites, potentially leading to rheumatoid arthritis (RA). Higher ACPA levels in both RA and periodontitis patients support this link24 .

Porphyromonas gingivalis has the ability to citrullinate its own proteins very efficiently. Most of these modified proteins are found in areas like the periplasm and the inner and outer bacterial membranes.

Although PPAD mainly targets arginine residues at the end (C-terminal) of proteins, an interesting discovery is that PPAD can also modify itself—a process known as autocitrullination. Studies using mass spectrometry showed that 7 out of the 18 arginine residues within the PPAD protein itself are citrullinated, and these are located internally within the protein.

This self-modification makes PPAD a strong antigen (something that can trigger an immune response). Because it is already citrullinated, it may disrupt the body's normal immune tolerance and lead the immune system to attack citrullinated proteins in the body.

Supporting this idea, researchers have found IgG antibodies in rheumatoid arthritis (RA) patients that specifically recognize citrullinated PPAD. In contrast, a modified strain of P. gingivalis that produces an inactive form of PPAD (and therefore cannot undergo autocitrullination) did not trigger this antibody response. This confirms that the immune system is reacting specifically to the citrullinated form of PPAD.

Additionally, RA patients show a much higher antibody response to PPAD compared to control groups and patients with periodontitis, suggesting that PPAD plays a role in the development of RA. Further evidence comes from studies using synthetic citrullinated PPAD peptides, where antibodies in RA patients reacted with most of the tested peptides. Two specific peptides (CPP3 and CPP8) showed reactivity in about 40% of RA samples, indicating their potential use in future screening tests for anti-PPAD antibodies.

In Vivo Role of PPAD

Recent research increasingly shows a strong link between periodontitis and rheumatoid arthritis (RA). The severity of gum disease appears to be associated with how RA progresses. Animal studies using the collagen-induced arthritis (CIA) model have provided important insights. Infection with Porphyromonas gingivalis not only worsens arthritis but may also make the body more susceptible to developing the disease in the first place. Mice infected with this bacterium showed more severe joint damage, including greater destruction of bone and cartilage. The disease also appeared earlier and progressed more aggressively compared to non-infected mice.

Notably, these effects were observed only when live P. gingivalis was used. Other conditions—such as infection with Prevotella intermedia, exposure to heat-killed P. gingivalis, or its isolated cell membrane components—did not influence the development or severity of arthritis. This highlights the importance of active bacterial infection, suggesting that live P. gingivalis releases specific factors that either directly or indirectly trigger immune responses leading to autoimmunity.

Supporting this, immune responses against P. gingivalis (but not against other oral bacteria like P. intermedia or Fusobacterium nucleatum) have been linked to the presence of RA-related autoantibodies in individuals at risk of developing the disease.

Further studies show that chronic oral infection with P. gingivalis enhances Th17 immune responses. This includes increased production of inflammatory cytokines such as IL-1β, IL-6, IL-22, TNF-α, TGF-β, and IL-23[28].These findings suggest that chronic infection may promote RA development mainly through activation of Th17-mediated inflammatory pathways.

Finally, the production of anti-citrullinated protein antibodies (ACPA), a hallmark of RA, depends on deiminase enzyme activity. Since P. gingivalis produces its own peptidylarginine deiminase (PAD), it is considered a potential risk factor in the development of RA.

Conclusion

The exact pathogenic role of Porphyromonas gingivalis is still debated. While animal studies have shown changes similar to rheumatoid arthritis (RA) after exposure to this bacterium, translating these findings to humans is challenging. Human disease is much more complex, and current evidence shows associations rather than a clear cause-and-effect relationship.

Since RA mainly affects the joints, studying the disease directly in humans is difficult due to ethical limitations. Most research is therefore restricted to examining the oral cavity and blood samples, which limits our understanding of what happens at the actual site of joint involvement. Although some studies have detected periodontal bacteria in joint fluid and tissues, the exact mechanisms—such as how these bacteria travel from the mouth to the joints and the molecular factors involved—are still not fully understood.

Future research should focus on well-designed clinical trials with larger sample sizes and longer follow-up periods to generate stronger evidence. In addition, more detailed studies exploring the underlying biological mechanisms are necessary to establish a causal link between oral bacteria and RA. Targeting the oral microbiome may also open new possibilities for preventing and managing RA, potentially leading to more personalized treatment approaches.

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Dynamic Navigation in Dental Implantology: Bridging Technology and Precision

Rumana Nizar[1], Anil Melath[2], Subair K[3], Jilu Jessy Abraham[4]

ABSTRACT

Background: Digital technologies have significantly transformed dental implantology, shifting clinical workflows from conventional freehand protocols toward precision-driven systems. Among these innovations, Dynamic Navigation (DN), Virtual/Augmented Reality (VR/AR), and Robotic Implantology (RI) have emerged as key tools enabling minimally invasive and highly accurate implant placement.

Objective: This review synthesizes current evidence on DN, VR/AR, and robotic systems. It evaluates accuracy, clinical applications, benefits, and limitations while also exploring future integration with artificial intelligence.

Methods: A narrative review was conducted using PubMed, Scopus, Web of Science, and Google Scholar for studies published between 2010 and 2025. Included literature comprised systematic reviews, randomized clinical trials, comparative studies, cohort studies, and relevant clinical reports. Editorials and non-peer-reviewed sources were excluded.

Conclusions: DN demonstrates consistently high accuracy and intraoperative adaptability, outperforming many static and freehand techniques. VR/AR systems enhance training, patient communication, and surgical visualization, while robotic systems, most notably Yomi®,show superior precision and reduced operator variability. Despite barriers such as cost, training requirements, and regulatory challenges, technological convergence supported by AI is expected to create a fully integrated digital implantology ecosystem. This evolution promises personalized, predictive, and highly reliable implant rehabilitation.

Keywords: dynamic navigation, dental implants, virtual reality, augmented reality, robotic implantology, digital dentistry, surgical accuracy, artificial intelligence

1. Introduction

Digital dentistry has catalyzed a paradigm shift in implantology, transforming traditionally operator-dependent procedures into predictable, technology-assisted workflows. Increasing patient expectations for comfort, efficiency, and esthetic outcomes have accelerated the adoption of imaging, navigation, simulation, and robotic systems.[1] Dynamic Navigation (DN), often described as analogous to GPS-guided surgical navigation, enables real-time visualization of drill position, improving precision and safety.[2] This review examines DN's principles, evidence base, and applications, followed by its integration with VR/AR and robotic technologies that collectively represent the next frontier of digital implant surgery.

2. Dynamic Navigation in Dental Implantology

2.1 Principles and Workflow

Dynamic Navigation employs real-time optical tracking to monitor both patient anatomy and instrument position. The typical workflow includes:

1. Data Acquisition: CBCT imaging to obtain 3D anatomical datasets.

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2. Virtual Planning: Prosthetically driven implant planning through specialized software.

3. Tracking Setup: Infrared cameras and fiducial markers applied to the patient and drill handpiece.

4. Real-time Guidance: Continuous feedback on drill trajectory, depth, and angulation relative to the plan.

Multiple clinical studies report accuracy values of 0.3–0.5 mm at the entry point and apex, with angular deviations ranging from 2–4°, generally superior to static guides or freehand surgery[11,12].

Figure 1 illustrates:

(a) Operatory setup showing a navigation camera tracking the instrument and patient via optical trackers, with real-time feedback displayed on a monitor.

(b) Intraoperative navigation screen depicting the jaws and teeth with real-time visualization of instrument position, angulation, and depth to guide precise clinical procedures

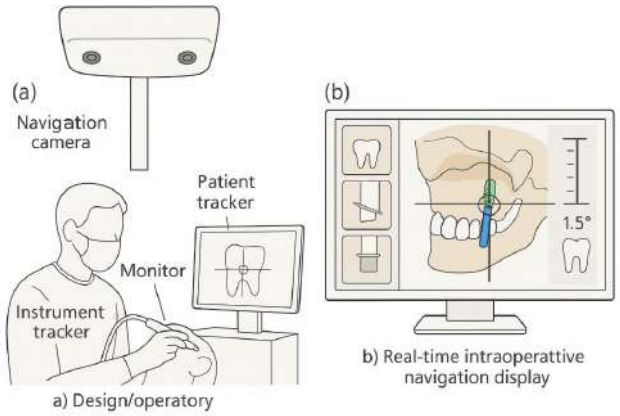

Figure 1 Dynamic navigation system

2.2 Clinical Applications

2.2.1 Zygomatic Implants

In severely atrophic maxillae, DN enhances safety by delineating critical structures such as the orbit and sinus (Figure 2). Comparative studies showreduced complications and improved trajectory control when DN is used for extra-maxillary implant paths. [5,12]

2.2.2 Pterygoid Implants

DN facilitates access to the posterior maxilla by guiding long, angulated drills. Evidence shows improved prosthetic alignment and reduced sinus violation compared to freehand approaches. Figure 3 illustrates the planned trajectory of a pterygoid implant extending from the maxillary tuberosity toward the pterygoid plate of the sphenoid bone.[5] Implant diameter and length, insertion angulation, and linear measurements are indicated to achieve bicortical anchorage while avoidingadjacent anatomical structures. The schematic emphasizes accurate angulation and depth control for stable posterior maxillary rehabilitation.

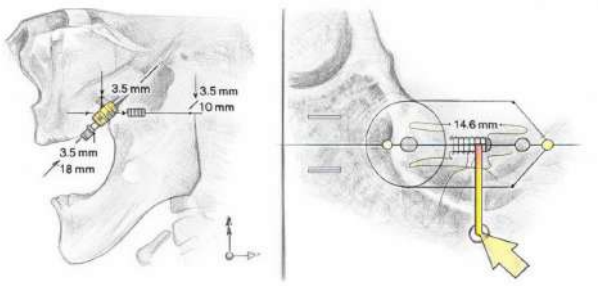

Figure 2 Zygomatic implant placement

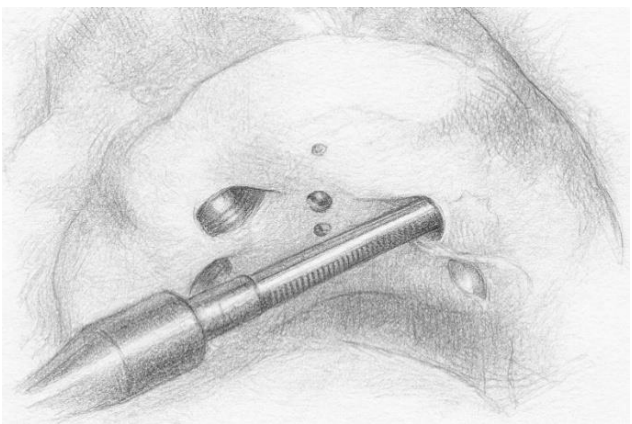

Figure 3 Pterygoid implant placement

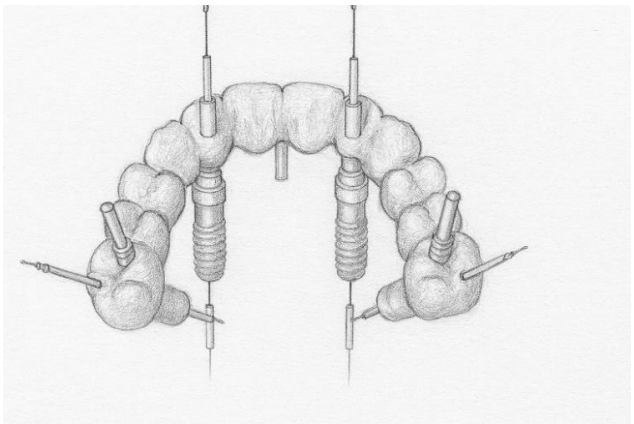

Figure 4 Full-Arch Rehabilitation

2.2.3 Immediate Implants

DN assists in differentiating socket walls, root remnants, and adjacent teeth during immediate placement, reducing buccal plate perforation and improving estheticpredictability.[5]

2.2.4 Full-Arch Rehabilitation

For All-on-4/All-on-6 workflows, DN improves implant parallelism and reduces the need for extensive surgical flaps or printed guides, thereby decreasing morbidity and chairside time[12] (figure 4).

2.3 Advantages Over Conventional Techniques

DN provides:

- Real-time visual feedback with intraoperative adjustability
- Reduced surgical invasiveness via reliable flapless workflows
- High accuracy in regions with limited visibility
- Digital documentation for postoperative validation
- Lower long-term dependence on laboratory-fabricated guides[11,12]

2.4 Limitations and Learning Curve

Limitations include:

- Sensitivity to calibration errors and marker displacement.
- Optical interference from blood or operator movement.
- High acquisition and maintenance costs.
- Steep learning curve in CBCT interpretation and software calibration.
- Smaller clinics and low-resource settings may struggle with financial and technical barriers.[5,10]

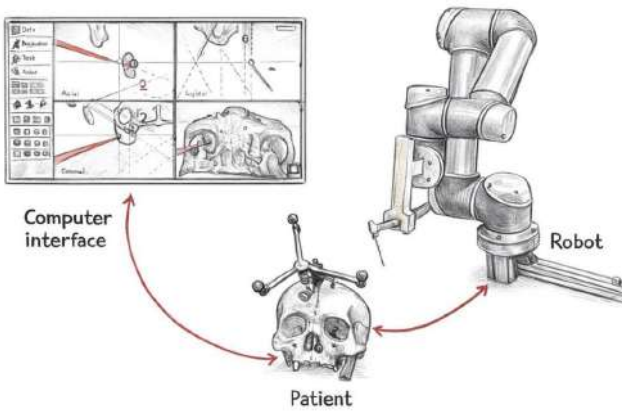

Figure 5 Virtual and Augmented Reality in Implantology

3. Virtual and Augmented Reality in Implantology

3.1 Role in Training and Education

VR simulation offers immersive environments replicating anatomical variability, bone densities, and procedural challenges. Randomized educational studies demonstrate improved psychomotor performance and clinician confidence before performing live surgeries.[1]

3.2 Preoperative Planning and Intraoperative Guidance

VR overlays planned implant axes onto the surgical field through head-mounted displays. Preliminary maxillofacial studies show angular accuracy improvements and enhanced orientation, although lag and calibration inconsistencies remain challenges[1,8] (figure 5).

3.3 Patient Communication and Pain Management

VR distraction therapy has been shown in several randomized clinical trials to reduce intraoperative anxiety and perceived discomfort, supporting its value in patient-centered care.

3.4 Limitations

- Limited haptic realism
- Device weight and visual fatigue
- Motion tracking lag
- High equipment costs
- Lack of standardized calibration protocols

4. Robotic Implantology

4.1 Evolution of Robotics in Dentistry

Robotic systems that have succeeded in orthopedics and neurosurgery are increasingly adapted for oral implantology, offering tremor elimination and reproducible precision.

4.2 Application in Dental Implantology

The Yomi® , robotic systemthe first FDA-cleared dental robotic assistant—uses haptic control to guide

the operator while maintaining real-time adjustability, providing precision without full automation.[5]

4.3 Clinical Outcomes and Evidence

Studies report positional deviations under 1 mm and angular deviations under 3°, outperforming free-hand surgery and equaling or surpassing DN in controlled environments.[14] Robotics improves prosthetic alignment by stabilizing drill trajectory and maintaining consistent angulation across multiple implants.

4.4 Future Directions

Next-generation systems may include:

- Semi-autonomous drilling with real-time bone density sensing
- AI-enhanced planning with predictive risk analysis
- Automatic calibration
- Miniaturized robotic arms for chairside portability[5,16]

5. Comparative Advantages and Limitations[14,16]

Technology	Advantages	Limitations
Dynamic Navigation	Real-time feedback, high accuracy, flexibility, no guide required	Expensive setup, calibration sensitivity, training requirement
Static Guides Preplanned accuracy, no tracking needed	Inflexible, time-consuming fabrication, no intraoperative adjustment	
Freehand	Low cost, quick setup	High variability, limited precision, operator-dependent
VR/AR Systems	Immersive training, improved skill transfer, patient education	Limited haptics, high cost, potential visual fatigue
Robotic Systems	Superior precision, movement compensation, reproducible outcomes	High investment, limited accessibility, evolving regulatory framework

Dynamic Navigation: Strengths and Limitations in Clinical Context

Dynamic navigation offers real-time intraoperative flexibility, which is a major advantage over static guides. Unlike printed templates, DN allows adjustment for unexpected anatomical findings, minor patient movement, or soft tissue discrepancies.[12] This adaptability is particularly valuable in immediate implant placement and anatomically complex regions such as the posterior maxilla.

However, the system is highly sensitive to calibration accuracy and optical tracking stability. Marker displacement, limited line-of-sight, or blood contamination may compromise tracking precision. Additionally, the learning curve is not negligible. Studies indicate that surgical time and deviation values improve significantly after multiple cases, suggesting operator proficiency strongly influences outcomes.[13] Quantitative assessments of the learning curve remain limited, and standardized training protocols are not universally established.

6. Challenges and Barriers to Adoption

6.1 Economic Barriers

High costs of DN, VR/AR, and robotics impede adoption, especially in low-resource regions.[11]

6.2 Training and Learning Curve

Digital workflows require multidisciplinary expertise in imaging, software planning, and hardware calibration.

6.3 Technical and Regulatory Challenges

- Lack of cross-platform interoperability
- Cybersecurity risks for network-connected robotic systems
- Unclear liability in robotic or AI-assisted errors
- Limited long-term cost–benefit analyses [6]

7. Future Perspectives

7.1. Integration With Artificial Intelligence (AI)

- Real-time decision support: AI algorithms will evaluate bone density, anatomical boundaries, and drill angulation during surgery, offering automated alerts and optimized drill paths.
- Predictive planning: AI-assisted virtual planning will automatically recommend implant diameter, length, and position based on prosthetic design and anatomical data.[13]
- Error minimization: Machine learning can identify deviations early, reducing human error.[18]

7.2. Seamless Integration With Robotics

DN will form the control system for robotic-assisted implant placement.

Robots guided by DN will:[5,12]

- Maintain drill stability
- Adjust for micro-movements
- Improve accuracy in sinus lifts, ridge augmentation, and narrow ridges
- Reduces surgeon fatigue and improves reproducibility.

7.3. Cloud-Based Data and Remote Collaboration

- Surgeons can share live surgical data, enabling:
  – Remote mentorship
  – Global case discussion
  – AI-based outcome analysis from large datasets
- Improves education and standardizes implant surgery worldwide.

8. Accuracy of Dynamic Navigation

- Multiple systematic reviews and clinical investigations have demonstrated that DN significantly improves implant placement accuracy compared with freehand surgery. Wei et al. (2021)[11] reported mean coronal and apical deviations of approximately 0.5 mm with angular deviations around 3°, confirming high precision under clinical conditions. Similarly, Pellegrino et al. (2021)[12] concluded that DN reduces positional errors compared to conventional approaches, although heterogeneity among included studies was substantial.
- In a randomized clinical trial, Jorba-García et al. (2023)[13] found that DN-assisted implant placement resulted in significantly lower angular deviations compared with freehand placement, particularly in posterior regions where visibility is limited. Prospective clinical data from Edelmann et al. (2021)[14] further demonstrated consistent accuracy using a fully digital workflow, reinforcing the reproducibility of DN in real-world settings.
- However, in vitro analyses such as those by Matvijenko and Borusevičius (2025)[15] and Chen et al. (2023)[16] often report slightly superior accuracy values compared to clinical studies. This suggests that controlled laboratory conditions may overestimate performance relative to dynamic intraoral environments involving patient movement, soft tissue interference, and bleeding.

9. Conclusion

Dynamic Navigation represents a major advancement in precision-driven implantology, offering real-time visualization and high surgical accuracy. When integrated with VR/AR and robotics, it supports comprehensive digital workflows that enhance clinician confidence and patient outcomes. Although high costs, learning curves, and regulatory issues remain, ongoing innovationsincluding AI integration and device miniaturizationare steadily overcoming these barriers. The future of implantology is poised to be personalized, predictive, and exceptionally precise.

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Applications of Periodontology in Forensic Science

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ABSTRACT

Forensic periodontology represents an emerging interdisciplinary approach that extends the application of periodontal science into medico-legal investigations. Evaluation of periodontal tissues aids in age and sex estimation, and assists in post-mortem interval assessment. When used as an adjunct to established forensic methods, forensic periodontology can enhance the accuracy and reliability of forensic conclusions.

Keywords: Forensic periodontology; Periodontal tissues; Age estimation; Sex determination; Human identification

Introduction

Forensic dentistry is a specialized branch of forensic science that utilizes dental evidence such as dental records, bite marks, lip prints, tooth morphology, palatal rugae patterns, and periodontal tissues for the comparison of ante-mortem and post-mortem data.[1] Dental characteristics have long played a crucial role in human identification and medico-legal investigations, with forensic odontology providing reliable and well-established identification methods.

In recent years, growing attention has been directed toward the forensic relevance of periodontal tissues, thereby expanding the scope of dental evidence beyond traditional markers. The assessment of periodontal structures provides additional biological insight that aids in age estimation, comparison of clinical records, and refinement of identification procedures.[2]

History

- The earliest recorded instance of dental identification dates back to 66 A.D., when Agrippina ordered the execution of Lollia Paulina, whose identity was confirmed by her distinctive dental alignment.[3]
- In 1453, John Talbot was identified after his death at the Battle of Castillon using dental characteristics.
- The foundations of modern forensic odontology were established in 1775, when Paul Revere identified the remains of Joseph Warren using a dental prosthesis he had fabricated.
- In 1835, dental evidence played a decisive role in a murder trial when Nathan Cooley Keep identified George Parkman through dentures, leading to the conviction of John Webster.3
- In 1897, Oscar Amoedo, regarded as the Father of Forensic Odontology, published L'Art Dentaire en Médecine Légale, giving academic recognition to the discipline.
- During World War II, the routine maintenance and use of dental records for identifying deceased soldiers marked a major advancement in forensic identification practices.
- In 2001, forensic odontology proved indispensable in mass disaster victim identification, particularly during the September 11

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attacks in the United States, highlighting its continued relevance in modern forensic investigations.[3]

Role of Periodontal Tissues in Forensic Science

Periodontology is the branch of dentistry concerned with the study of the periodontium in both health and disease, and its principles can be effectively applied in forensic identification. The anatomical and pathological characteristics of the periodontal tissues exhibit considerable individual variation, thereby contributing to personal identification. Distinctive features such as alterations in gingival color, contour, consistency, surface texture, position, presence of interproximal craters, and alveolar bone patterns can be compared with ante-mortem dental records to establish identity.[4] In addition, clinical parameters related to the periodontal ligament, including widening of the periodontal ligament space, lateral periodontal cysts, and periodontal abscesses, serve as valuable markers in the identification of individuals. The characteristics of periodontal tissues can be utilized in forensic science to aid in different investigative procedures like:

i. Estimation of time of death

ii. Age estimation

iii. Sex determination

I. Estimation of Time of Death

Estimation of the post-mortem interval (PMI) is a fundamental aspect of forensic science. Conventional methods rely on parameters such as body temperature, rigor and livor mortis, decomposition changes, biochemical alterations, and environmental factors; however, their accuracy may be influenced by external variables. Consequently, periodontal tissues have gained attention as supplementary indicators due to their rich vascularity, high mitotic activity, and predictable post-mortem changes.[5]

Histological Changes

Cellular degradation in gingival tissues begins within minutes after death as metabolic activity ceases. Autolytic changes usually become evident within 24 hours, initially affecting the superficial epithelial layers and later the basal layer. Histological features such as chromatin clumping, nuclear vacuolation, karyopyknosis, widening of intercellular spaces, cytoplasmic homogenization, and loss of epithelial architecture progress in a time-dependent manner, making them useful markers for the post-mortem interval estimation.[6]

Ultrastructural Changes

Ultrastructural analysis reveals early post-mortem changes at the subcellular level. These include mitochondrial swelling, disruption of cristae, dilation of endoplasmic reticulum, nuclear membrane breakdown, and loss of intercellular junctions. The sequential progression of these alterations aids in early the post-mortem interval assessment.[6]

Electrolyte Alterations

After death, failure of cell membrane pumps leads to loss of ionic balance. Time-dependent changes in electrolytes such as sodium, potassium, calcium, and chloride occur, with a progressive rise in potassium due to cellular leakage.[6] These measurable changes provide quantitative support for the post-mortem interval estimation.

Immunohistochemical and mRNA Expression of HIF-1α

Hypoxia-inducible factor-1α (HIF-1α) responds to post-mortem hypoxia and exhibits time-dependent changes in tissue expression. Immunohistochemical staining intensity and Messenger Ribonucleic Acid (mRNA) expression levels gradually decrease due to protein and RNA degradation. These molecular changes serve as supportive markers for estimating the time since death.[6]

II. Age Estimation

Periodontal and periapical structures provide valuable parameters for forensic age estimation due to their progressive and measurable changes over time. Dental cementum plays a significant role through the presence of incremental lines that are deposited annually. These lines can be visualized in mineralized cross-sections using differential interference contrast microscopy or appropriate histological stains.[7] Age estimation is achieved by adding the number of cementum incremental lines to the average eruption age of the tooth, with improved accuracy obtained by averaging multiple counts. A study by Dias et al (2010)[8] demonstrated a strong correlation between cementum

annulations and chronological age in periodontally healthy teeth, whereas teeth affected by periodontal disease showed significantly reduced accuracy, indicating that cementum-based age estimation is dependable only in healthy periodontal conditions.

The periodontal ligament (PDL) also exhibits age-related changes attributable to physiologic tooth movement, particularly mesiocclusal drifting and continuous cementum deposition. With advancing age, narrowing of the mesial PDL space occurs due to differential deposition of cementum and functional adaptation to occlusal forces.7 These changes can be assessed radiographically and have been proposed as indicators of age, especially in young adults. Radiographic studies evaluating PDL visibility in mandibular third molars have demonstrated a significant association between PDL maturation stages and chronological age.[9]

Alveolar bone changes represent another reliable indicator for age estimation. Progressive alterations in alveolar bone height and morphology occur with increasing age and can be quantified radiographically or directly on skeletal remains. A cone beam computed tomography- based study by Koh et al. (2017)[9] reported that buccal alveolar bone level showed the strongest correlation with chronological age when compared with other dental parameters.

Other Associated Factors For Age Estimation

Root Transparency and Root Length

Root translucency and root length are important dental parameters used for age estimation in adults. Root translucency increases progressively with age due to mineral deposition within dentinal tubules, beginning at the apical region and extending coronally, and is relatively resistant to post-mortem changes. Root length provides a stable reference for proportional assessment of translucent dentin.[4] A method combining root translucency with periodontal attachment loss has been proposed for adult age estimation, particularly in situations where growth-related indicators are absent. The technique was subsequently enhanced through the development of sex- and ancestry-specific formulas, resulting in improved accuracy.[10] However, advanced periodontal disease and root pathology may affect reliability therefore, this method is best used in conjunction with other age-estimation techniques.

Saliva

Saliva is a valuable biological fluid in forensic investigations due to its ease of collection and rich cellular and molecular content. It contains exfoliated epithelial cells that serve as an important source of deoxyribonucleic acid, making saliva particularly useful for human identification and sex determination.[4] Sex determination from saliva can be achieved through the detection of sex chromatin, with Barr bodies indicating female origin and F bodies (also called fluorescent Y bodies) indicating male origin, as well as by assessing salivary sex hormone profiles, including the ratios of 17β-estradiol and testosterone. Salivary DNA can be recovered from a wide range of objects such as clothing, food items, drink containers, tobacco products, oral hygiene devices, dental prostheses, and envelopes, enhancing its forensic applicability.[3] In addition to identification, saliva is useful in toxicological analysis, as salivary drug concentrations often correlate with blood levels, and in bite mark investigations and mass disaster victim identification, further reinforcing its forensic significance.

III. Sex Determination

Periodontal structures also exhibit sex-related variations that may assist in forensic sex determination when used in conjunction with other skeletal and dental indicators. The periodontal ligament demonstrates differences in aging patterns between males and females, with males generally showing a more rapid rate of PDL narrowing and recession.[4] These differences are attributed to variations in occlusal forces, physiologic tooth movement, and cementum deposition.

Radiographic evaluation of PDL visibility has shown promising results in identifying sex-specific aging trends. A study by Sequeira (2014)[11] observed significant differences in PDL disappearance stages between males and females in mandibular third molars. Complete loss of PDL visibility reliably indicated an age above 21 years in males but not in females, highlighting sexual dimorphism in periodontal ligament aging. These findings support the adjunctive role of periodontal parameters in sex determination, particularly in young adult populations.

Dental Implants as Forensic Identifiers

The widespread adoption of implant dentistry has significantly enhanced the scope of forensic

odontology. Dental implants generate extensive ante-mortem (AM) documentation, including clinical records and radiographic images obtained during diagnosis, treatment planning, placement, and follow-up.[12] These records provide valuable reference data for post-mortem (PM) comparison. Radiographic features such as implant morphology, thread design, length, diameter, and spatial positioning within the jaw can be reliably matched with post-mortem findings to establish identity.

Dental implants exhibit exceptional resistance to extreme environmental conditions, particularly high temperatures encountered in fire-related deaths. Titanium implants can withstand temperatures exceeding those that cause fragmentation of teeth and alveolar bone (800–1000 °C), allowing them to remain identifiable even in severely charred remains. The presence of associated prosthetic components and the morphology of the surrounding alveolar bone can further aid in comparative identification.[13]

Advancements in implant manufacturing, including laser-etched batch numbers and distinct manufacturer-specific designs, have introduced additional parameters for forensic comparison. Implant morphology alone, when combined with other dental findings such as endodontic anatomy and impacted tooth patterns, can support positive identification. Accurate documentation and long-term preservation of implant-related clinical and radiographic records are therefore essential responsibilities of clinicians.

In conclusion, dental implants represent highly durable and distinctive forensic markers. Their integration into forensic identification protocols significantly enhances the accuracy and reliability of human identification, particularly in challenging cases where traditional methods are ineffective.

Limitations of Forensic Periodontology

Forensic periodontology has several limitations that affect its reliability and applicability in investigations. There is considerable inter-individual and population variability, which makes standardization of findings challenging across different demographic groups. In addition, soft periodontal tissues are highly susceptible to post-mortem degradation, often reducing the availability of usable evidence over time. The field also depends on advanced laboratory techniques and the availability of well-preserved samples, which may not always be feasible in all forensic settings. Furthermore, the absence of universally accepted protocols and the limited availability of population-specific reference data continue to restrict the broader application and consistency of forensic periodontal analysis in practice.

Future Directions

- Integration of advanced molecular techniques: The application of next-generation DNA sequencing and salivary biomarkers may enhance the accuracy of individual identification.
- Development of digital dental databases: Establishing centralized digital repositories of dental records and radiographs can facilitate faster ante-mortem and post-mortem comparisons.
- Use of artificial intelligence and machine learning: AI-based image analysis may improve the efficiency and reliability of dental record matching in forensic investigations.
- Improvement in implant identification systems: Standardized implant coding, laser markings, or RFID-based systems could assist in rapid identification of implant types and manufacturers.

Conclusion

Forensic periodontology represents a promising adjunct in forensic science by utilizing the unique anatomical and pathological features of periodontal tissues for human identification, age and sex estimation, and post-mortem interval assessment. Although influenced by biological variability, periodontal disease, and post-mortem factors, periodontal evidence can significantly strengthen forensic conclusions when integrated with conventional dental, skeletal, and molecular methods. Continued research, standardization of techniques, and development of population-specific reference data are essential to enhance the accuracy, reliability, and legal acceptability of forensic periodontology in future forensic investigations.

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JSPIK

Hyaluronic Acid in Periodontics: Biological Mechanisms and Clinical Applications – A Review

Preetha D.[1], Nagasurthi K.J.[2], Kadhiresan R.[3], Arunmozhi U.[4]

ABSTRACT

Hyaluronic acid (HA) is a naturally occurring glycosaminoglycan widely distributed in connective tissues and extracellular matrices. It plays a crucial role in tissue hydration, cellular migration, angiogenesis, and wound healing. In dentistry, HA has gained attention as a therapeutic adjunct because of its anti-inflammatory, bacteriostatic, and regenerative properties. Clinical studies have reported beneficial effects of HA in periodontal therapy, peri-implant disease management, and oral wound healing. Recent systematic reviews and clinical trials suggest that the adjunctive use of HA may improve periodontal clinical parameters such as probing depth and bleeding on probing. Furthermore, HA has demonstrated promising outcomes in implant dentistry due to its ability to enhance peri-implant soft tissue healing and reduce inflammation. Despite encouraging evidence, variations in dosage, formulations, and treatment protocols limit definitive conclusions. Therefore, further well-designed randomized clinical trials are required.

Key Words: Hyaluronic Acid, Periodontal Regeneration, Wound Healing, Periodontal Diseases

1. INTRODUCTION

Hyaluronic acid is a high molecular weight polysaccharide belonging to the glycosaminoglycan family and is a major component of the extracellular matrix[1]. It contributes to tissue hydration, structural integrity, and cellular signalling in biological tissues[2].

In dentistry, HA has gained increasing interest due to its excellent biocompatibility and regenerative properties[3]. Studies have demonstrated that HA plays an important role in modulating inflammatory responses, promoting angiogenesis, and enhancing wound healing following periodontal therapy and oral surgical procedures[4,5].

Recent systematic reviews and meta-analyses have shown that HA used as an adjunct to conventional periodontal therapy may improve clinical parameters such as probing depth and attachment levels[6,7]. Additionally, emerging research indicates potential applications of HA in implant dentistry and regenerative dental procedures[8].

2. HISTORY OF HYALURONIC ACID

Hyaluronic acid was first described as an essential component of the extracellular matrix responsible for maintaining tissue hydration and structural stability[1]. Early studies highlighted its biological role in connective tissues and its involvement in physiological processes such as lubrication and cell migration[2].

Further research demonstrated that HA also participates in morphogenesis, wound healing, and tissue repair[9]. With advances in biotechnology, HA-based biomaterials were developed for clinical use in medicine and dentistry[4]. Over time, HA became widely used in periodontal regeneration, implant therapy, and oral surgical wound management[5]. Recent reviews have emphasized that HA has become an important biomaterial in dental therapeutics because of its regenerative and anti-inflammatory properties[8].

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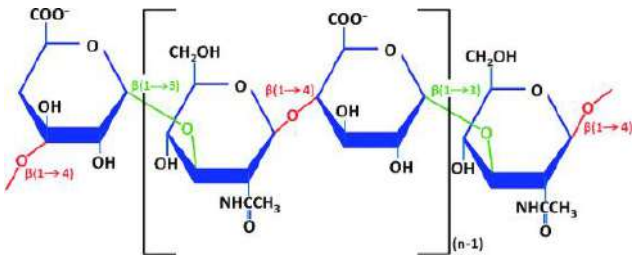
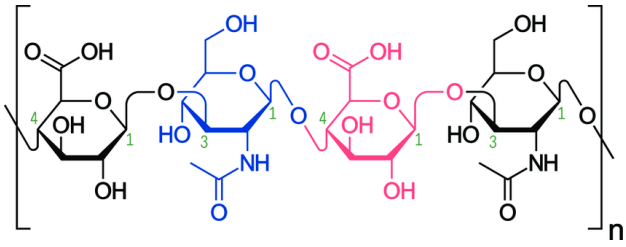
3. HA Molecular Structure





Hyaluronic acid is a linear non-sulfated glycosaminoglycan composed of repeating disaccharide units of D-glucuronic acid and N-acetyl-D-glucosamine linked by β-1,3 and β-1,4 glycosidic bonds[1]. The polymer forms long chains with molecular weights ranging from thousands to several million Daltons.

This highly hydrophilic structure allows HA to bind large quantities of water, creating a viscoelastic extracellular matrix that supports tissue hydration, lubrication, and cellular migration[9]. These physicochemical characteristics contribute significantly to its biological functions in connective tissues and periodontal structures.

4. Biological Properties of Hyaluronic Acid

- WOUND HEALING PROPERTY
- ANTI-INFLAMMATORY EFFECT
- ANTIMICROBIAL ACTIVITY
- REGENERATIVE POTENTIAL
- BIOCOMPATABILITY

4a. Wound Healing Property:

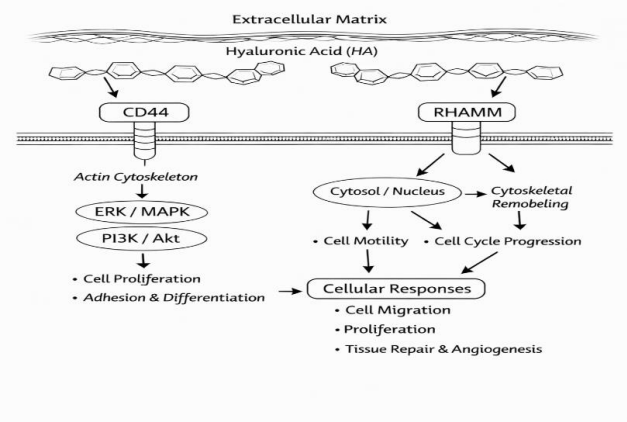
HA enhances fibroblast proliferation, epithelial cell migration, and angiogenesis, thereby accelerating tissue repair[9]. HA accelerates soft tissue healing by enhancing epithelialization, angiogenesis, and reducing postoperative inflammation and pain[10]. Through its interaction with hyaluronanbinding proteins and cellsurface receptors, HA promotes cell adhesion, migration, and differentiation[11].

Hyaluronic acid plays a critical role during periodontal wound healing. During the inflammatory phase, HA regulates inflammatory mediators and reduces oxidative stress.

During the proliferative phase, HA stimulates fibroblast proliferation, epithelial migration, and angiogenesis, which are essential for connective tissue repair[9].

In the remodelling phase, HA contributes to extracellular matrix formation and collagen deposition, thereby enhancing periodontal tissue regeneration.

HA exerts its biological effects through multiple cellular and molecular pathways. It interacts with cell surface receptors such as CD44 and RHAMM, which regulate cell proliferation, differentiation, and migration during tissue repair[5].

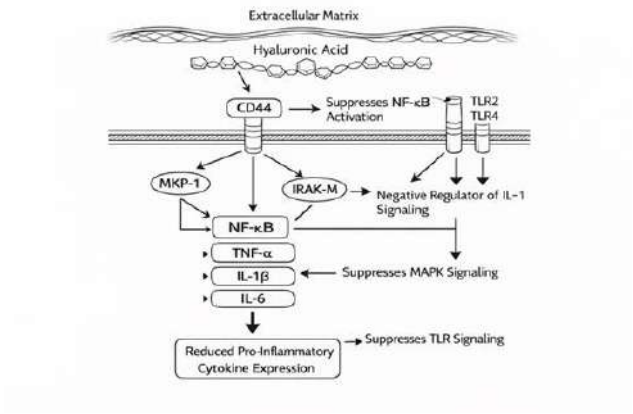


4b. Anti-inflammatory Effect:

HA modulates inflammatory responses by regulating cytokine activity and reducing inflammatory cell infiltration[3]. HA exhibits anti-inflammatory and anti-edematous effects, reducing tissue swelling and promoting healing[12].

Hyaluronic acid plays an important role in regulating inflammatory cytokines. It modulates by reducing the expression of pro-inflammatory mediators such as TNF-α, IL-1β, and IL-6, which are involved in periodontal tissue destruction. HA forms a hydrated extracellular matrix that facilitates nutrient transport and cellular migration[1]. It also scavenges reactive oxygen species and inflammatory mediators, thereby reducing tissue damage during inflammation[13].

High-molecular-weight HA generally exhibits anti-inflammatory effects, whereas fragmented HA molecules may stimulate immune responses during early inflammation. Through interaction with CD44 receptors, HA regulates immune cell activity and promotes resolution of inflammation.



4c. Antimicrobial Activity: HA effectively reduce microbial load, particularly targeting key periodontal pathogens such as Prevotella intermedia, Aggregatebacter actinomycetemcomitans, Propionibacterium species, and Staphylococcus aureus[14]. Hyaluronic acid exhibits antimicrobial effects indirectly through host immune modulation and directly by interfering with microbial colonization, thereby reducing pathogenic biofilm load and promoting periodontal wound healing. Mechanism of antimicrobial action of HA include following actions :

I. Neutrophil Recruitment and Activation

HA is a key extracellular matrix component during inflammation. Low-molecular-weight HA fragments act as danger-associated molecular patterns (DAMPs), stimulating immune cells and promoting neutrophil migration to infected periodontal sites. HA also enhances granulocyte locomotion, phagocytosis, and metabolism, strengthening antimicrobial defense.

II. Enhancement of Phagocytosis

HA binds to CD44 receptors on neutrophils, macrophages, fibroblasts, and epithelial cells. This interaction improves leukocyte adhesion and bacterial engulfment, increasing clearance of pathogens such as Porphyromonas gingivalis and Aggregatibacter actinomycetemcomitans.

III. Modulation of Inflammatory Cytokines

HA modulates inflammatory mediators including IL-1β, TNF-α, and IL-8. IL-8 promotes neutrophil chemotaxis, while controlled cytokine regulation supports microbial elimination with minimal collateral tissue destruction.[9]

IV. Barrier Against Bacterial Invasion

High-molecular-weight HA forms a viscoelastic hydrated coating over wounds and mucosa, limiting bacterial penetration and reducing microbial adhesion to exposed connective tissues.[1]

V. Direct Bacteriostatic Effect

HA directly inhibits several oral pathogens by altering membrane permeability, reducing nutrient diffusion, suppressing biofilm maturation, and preventing bacterial adherence. It is active against Prevotella intermedia, Aggregatibacter actinomycetemcomitans, Propionibacterium species, and Staphylococcus aureus.

VI. Promotion of Wound Healing Reduces Secondary Infection

HA accelerates angiogenesis, fibroblast migration, collagen deposition, and epithelialization. Faster wound closure decreases the chance of secondary bacterial contamination after periodontal therapy or extraction.[9]

VII. Regulation of Oxidative Burst

HA modulates neutrophil oxidative burst and reactive oxygen species release, enhancing bacterial killing while minimizing host tissue damage.[14]

4d. Regenerative Potential: HA Acts as a biological scaffold thereby enhancing Extracellular matrix formation, Collagen synthesis. stimulates Mesenchymal cell differentiation[15]. It promotes extracellular matrix formation and bone regeneration, making it beneficial in periodontal and implant therapy[16]. Recent research suggests that HA can function as a biological scaffold in regenerative dentistry, promoting angiogenesis and tissue regeneration[8].

4e. Biocompatibility: HA is naturally present in connective tissues and exhibits excellent compatibility with oral tissues, minimizing the risk of immunologic reactions.

5. APPLICATIONS OF HYALURONIC ACID IN PERIODONTICS

HA is not a singlemechanism agent; it modulates inflammation, cellular behaviour, and extracellular matrix dynamics together to support periodontal healing[17].

The biological outcome in periodontal therapy reflects a balance between antiinflammatory effects and regenerative cues mediated through receptor interactions and molecular weightdependent signalling.

5a. Gingivitis

Hyaluronic acid has been shown to reduce gingival inflammation when used as an adjunct to conventional plaque control measures. Topical HA gel significantly reduces gingival bleeding and inflammation due to its anti-inflammatory properties[2]. Recent randomized clinical trials have also reported improved gingival health when HA is used as an adjunct in periodontal maintenance therapy.[18]

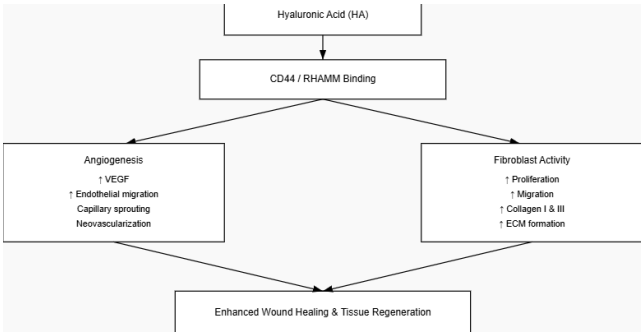
5b. Periodontitis

In periodontitis management, HA is commonly used as an adjunct to scaling and root planing (SRP). Clinical studies have shown that local delivery of HA significantly improves clinical parameters such as probing depth and clinical attachment levels[19]. Recent systematic reviews confirm that HA can provide additional benefits when combined with non-surgical periodontal therapy[20, 21].

Hyaluronic acid improves periodontal outcomes post-SRP by reducing inflammation, inhibiting bacterial recolonization, enhancing extracellular matrix stability, and promoting fibroblast-mediated tissue regeneration via CD44 receptor interaction.

5c. Periodontal Plastic Surgery

Hyaluronic acid is frequently used in periodontal plastic surgery to enhance wound healing and tissue regeneration. Its ability to stimulate angiogenesis and fibroblast proliferation contributes to improved healing outcomes following mucogingival procedures[4].



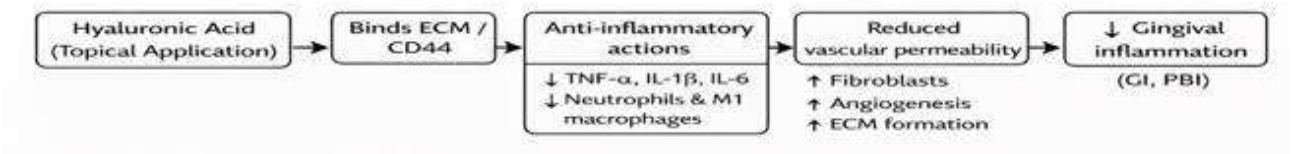
5d. Furcation Defects

HA has been investigated as a regenerative biomaterial in the treatment of furcation defects. Studies suggest that HA may enhance bone formation and periodontal ligament regeneration in periodontal defects[22].

HA promotes bone regeneration in furcation defects by binding to CD44 receptors on osteoblast precursor cells, which activates intracellular signaling pathways such as MAPK and Wnt/β-catenin[20]. This signaling cascade leads to increased expression of key osteogenic growth factors, including BMP-2 and TGF-β, thereby enhancing osteoblast proliferation and differentiation. As a result, there is increased synthesis and deposition of mineralized bone matrix, ultimately leading to new alveolar bone formation within the furcation area.

5e. Periodontal Abscess

Due to its antimicrobial and anti-inflammatory properties, HA may assist in the management of periodontal abscesses by reducing bacterial growth and inflammation[14]. HA aids in the management of periodontal abscesses through a combination of antimicrobial, anti-inflammatory, and tissue-protective actions



HA also promotes a shift toward a healing phenotype (M2 macrophages), facilitating resolution of inflammation. Additionally, its hydrophilic and viscoelastic properties help form a protective extracellular matrix barrier, reducing oedema and promoting tissue repair. Together, these effects result in reduced bacterial load, decreased inflammation, and improved healing of the periodontal abscess.

5f. Aphthous Ulcer

Topical HA formulations are used in the management of recurrent aphthous ulcers due to their protective barrier effect and ability to accelerate mucosal healing[4].

HA is highly hydrophilic and forms a viscous, gel-like layer over the ulcer surface. This physical barrier protects the ulcer from mechanical trauma, chemical irritants, microbial invasion[10]. This reduces pain and secondary infection, creating a favourable environment for healing.

5g. Desquamative Gingivitis

Topical hyaluronic acid has been reported to provide symptomatic relief in desquamative gingivitis by forming a protective barrier, maintaining tissue hydration, modulating inflammatory responses through downregulation of pro-inflammatory cytokines, and promoting epithelial and fibroblast proliferation via CD44mediated signalling, thereby accelerating mucosal healing[17]. HA forms a hydrated viscoelastic matrix across ulcerated or inflamed mucosa, this reduces direct mechanical irritation of exposed sensory nerve endings, lowering nociceptor activation threshold [23].

5h. Aesthetic Applications – Management of Black Triangles:

Black triangles, or open gingival embrasures, are aesthetic defects resulting from the loss of interdental papilla due to periodontal attachment loss, bone resorption, and increased distance between the contact point and alveolar crest. Hyaluronic acid (HA) has emerged as a minimally invasive approach for interdental papilla reconstruction due to its ability to enhance soft tissue volume and promote tissue regeneration. Clinical evidence supports its effectiveness, as "injection of hyaluronic acid resulted in improvement of the interdental papilla with reduction in the black triangle area"[24]. Furthermore, systematic reviews indicate that "hyaluronan injections may lead to a partial reconstruction of the interdental papilla volume"[25]. A significant increase in papilla height and reduction in black triangle dimensions can be achieved following hyaluronic acid application. These findings suggest that HA is a promising non-surgical modality for managing black triangles, particularly in mild to moderate cases, although long-term stability and standardized treatment protocols require further investigation.

5i. HA in Implant Osseointegration

Hyaluronic acid contributes to bone regeneration and implant osseointegration by regulating cellular activity at the bone-implant interface. HA enhances osteoblast proliferation and differentiation while promoting extracellular matrix formation[13].

Furthermore, HA stimulates angiogenesis[26] and improves soft tissue healing around implants, thereby enhancing implant stability and reducing peri-implant inflammation[8].

6. CONCENTRATION, PREPARATION AND METHOD OF APPLICATION OF HYALURONIC ACID

Concentration of Hyaluronic Acid

The concentration of hyaluronic acid (HA) used in periodontal and dental therapy varies according to the clinical indication and formulation. Topical HA gels used as adjuncts to scaling and root planing have commonly been reported in concentrations of 0.2% and 0.8%[27]. Clinical studies have shown that 0.2% HA gel may improve gingival inflammation, plaque control, and periodontal healing when used after non-surgical therapy[4]. In regenerative procedures, 0.8% HA gel combined with graft materials has demonstrated favourable clinical outcomes in furcation defect management[27]. Systematic reviews have also stated that variations in concentration among studies contribute to heterogeneity in outcomes and limit direct comparison of results[7]

Preparation of Hyaluronic Acid

HA is a naturally occurring non-sulfated glycosaminoglycan composed of repeating disaccharide units of glucuronic acid and N-acetylglucosamine[1]. For clinical use, HA is formulated into several preparations including topical gels, rinses, sprays, fibers, and injectable forms used in oral and periodontal therapy[19]. Re-

view articles in dentistry have described commercially available HA as sodium hyaluronate–based preparations designed for local application because of their biocompatibility, viscoelasticity, and water-retaining capacity.[5] Depending on the intended use, preparations may differ in molecular weight, viscosity, and delivery system, which may influence their clinical effect[21].

Method of Application

I. Topical Application

HA gel is directly applied to gingival tissues, mucosal lesions, extraction sockets, and surgical wounds. Topical administration has been reported to enhance wound healing, reduce inflammation, and improve patient comfort following oral surgical procedures[10,12]. In recurrent aphthous and inflammatory mucosal conditions, HA acts as a protective local barrier and promotes tissue hydration.[28]

II. Subgingival Application

Following scaling and root planing, HA gel may be placed subgingivally into periodontal pockets as a local adjunctive agent. Clinical trials have reported improvement in probing depth reduction and clinical attachment gain when HA was used locally after mechanical debridement[6].

III. Regenerative Application

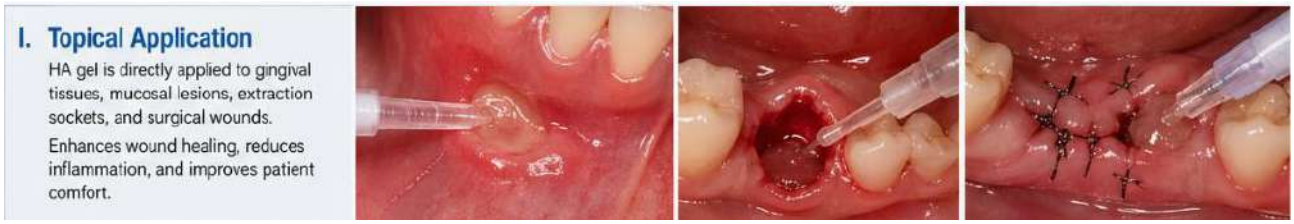
During periodontal surgery, HA may be placed within intrabony or furcation defects alone or in combination with graft materials. Studies have shown that HA may enhance soft tissue healing and support periodontal regeneration because of its scaffold-forming and biologic properties[22].

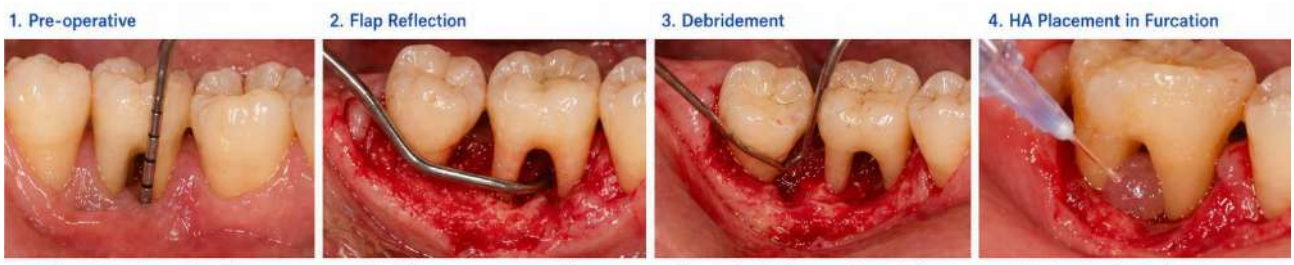
IV. Injectable Application

Injectable HA has been used in aesthetic periodontal therapy for reconstruction of deficient interdental papillae and reduction of black triangles. Clinical reports have demonstrated improvement in papillary fill following local HA injection[25]

V. Peri-implant Application

HA has also been applied around implant sites and peri-implant soft tissues to promote healing and reduce inflammation. Recent reviews suggest a potential supportive role of HA in implant dentistry and





peri-implant tissue management[28].

The clinical effectiveness of HA depends on concentration, formulation, molecular weight, and frequency of application. Current systematic reviews emphasize the need for standardized protocols regarding dosage and method of delivery for predictable outcomes[29].

7. DISCUSSION

HA is an integral component of periodontal tissues, particularly within the gingiva and periodontal ligament[27]. The application of hyaluronic acid in dentistry has expanded significantly due to its multifunctional biological properties. Studies have demonstrated that HA improves periodontal healing, reduces inflammation, and enhances regenerative outcomes[6]. HA apart from antibacterial effect also exhibit antifungal effect. It shows activity against fungal organisms, especially Candida species (important in oral infections). It reduces fungal adhesion and colonization[30].

HA exhibits potent antiinflammatory, antioedematous, and antibacterial properties[27]. HA facilitates leukocyte and macrophage recruitment to inflammatory sites and contributes to microbial clearance[14]. In addition, its osteo-inductive capability is attributed to its ability to induce chemotaxis, proliferation, and differentiation of mesenchymal cells, thereby enhancing bone formation[31]. HA enhances reparative dentin formation by stimulating osteoprogenitor cell differentiation[32].

Recent systematic reviews and umbrella analyses indicate that HA may provide additional benefits when used as an adjunct to conventional periodontal therapy. Furthermore, emerging research highlights the potential role of HA in implant dentistry and regenerative dental procedures[28]. The clinical effectiveness of HA depends on its concentration, molecular weight, and delivery system[21].

Despite promising findings, variations in HA concentration, molecular weight, and delivery systems limit the ability to standardize treatment protocols.

8. LIMITATIONS

Despite encouraging results, several limitations exist in current research. Many studies have relatively small sample sizes and short follow-up periods (6 months). Additionally, heterogeneity in HA formulations and treatment protocols makes it difficult to establish standardized clinical guidelines.

9. Conclusion

Hyaluronic acid is a promising biomaterial with multiple therapeutic applications in dentistry. Its anti-inflammatory, antimicrobial, and regenerative properties make it a valuable adjunct in periodontal therapy, implant dentistry, and oral wound healing. Recent studies further support the role of HA in improving periodontal and peri-implant clinical outcomes[7].

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Association News

National Periodontist day 2026

MAHE INSTITUTE OF DENTAL SCIENCES

National Periodontist day 2026 was organized and conducted by the Department of Periodontics, Mahe institute of dental sciences and hospital under the banner of SPIK and ISP I on 26-2-26. Series of programs were organized in the department from 23-02-26 to 26-02-26.

Dental quiz, Dumb Charades and Reels competition was organized for the undergraduates,post graduates and teaching staffs of the college. Mr and Mrs smile competition was organized for students, teaching and no teaching staffs.There was active participation from all the batches. A public awareness video on periodontal health and tips for oral hygiene maintenance was prepared by Dr Nanditha Chandran, Reader, Dept of Periodontics, MINDS. The chief guest of the program was Dr Arun Sadasivan, President SPIK and Prof and HOD, Dept of Periodontics at Sree Mookambika Dental college. The program commenced by an inaugural ceremony at 9.30am. Dr Anil Melath, Principal, Prof and Head of the Department and Dr Arjun MR,Reader were felicitated at the ceremony for their outstanding achievements in the field of corticobasal Implantology at the Masters course at AIM Academy, Switzerland. The inaugural ceremony was followed by a lecture on Importance of Periodontics in clinical practice for the undergraduates by Dr Mohammed Feroz TP, Professor Dept of Periodontics, MINDS. There was an interractive session between the faculty and the students.

Dental education kit consisting of tooth paste samples were distributed to the OP patients visiting the dept in association with the celebration. Prizes for the winners of the events were distributed during the inaugural ceremony. The program commenced by 12.00pm.

AZEEZIA COLLEGE OF DENTAL SCIENCES AND RESEARCH, KOLLAM

As part of the National Periodontist Day 2026, Department of Periodontology and Oral Implantology under the eminent leadership of HOD Dr Devisree RV and Dean Dr Nandakumar took the opportunity to spread awareness and importance of gum health in the community by conducting various activities at Azeezia College of Dental sciences and research, Kollam from 16th to 23rd February 2026. Several activities like Periodontal screening camp, health education, demonstration of brushing technique and pamphlet distribution were done by the faculty, interns and post graduate students. There were several competitions for the under graduates and post graduates as well which were well attended.

National Periodontist day 2026

PSM DENTAL COLLEGE, AKKIKAVU, THRISSUR

NATIONAL PERIODONTIST DAY REPORT 23/02/26

National Periodontology Day was celebrated at PSM Dental College on 23rd February 2026 with the aim of creating awareness about periodontal health and the importance of maintaining good oral hygiene. The programme was organized by the Department of Periodontology and witnessed enthusiastic participation from students and interns.

The celebration began with oral hygiene awareness talks, where students and patients were educated about the importance of maintaining healthy gums, proper brushing techniques, and the prevention of periodontal diseases. The session emphasized the role of periodontal health in overall systemic well-being.

As part of the celebration, several academic and skill-based competitions were conducted to encourage student participation and enhance their knowledge in the field of periodontology. The competitions included:

- Periodontology Quiz Competition
- E-Poster Presentation Competition
- Suturing Competition
- Slogan Writing Competition

Students from 3rd Year, Part I and interns actively participated in the events and

showcased their knowledge, creativity, and clinical skills. The competitions provided a platform for students to demonstrate their understanding of periodontal concepts and their practical abilities.

The event concluded with appreciation for all participants and organizers who contributed to the success of the programme. The celebration of National Periodontology Day served as an important initiative in promoting awareness about periodontal health and encouraging academic involvement among dental students.

KMCT DENTAL COLLEGE, KOZHIKODE

Minutes of the National Periodontist Day Celebration

The Department of Periodontology, KMCT Dental College, Kozhikode, commemorated National Periodontist Day with a series of academic, educational, and community outreach activities aimed at promoting

awareness about periodontal health and its significance in overall systemic well-being.

The celebration was organized from 23rd February to 26th February 2026, bringing together faculty members, postgraduate students, undergraduate students, and patients in a collective effort to highlight the importance of maintaining healthy gums and supporting structures of the teeth.

The official inauguration of the program was conducted on 23rd February 2026. The event was inaugurated by Dr. Manoj Vengal, Professor and Head, Department of Oral Medicine and Radiology, who addressed the gathering and emphasized the importance of periodontal health in preventing oral diseases and improving general health. Faculty members, postgraduate and undergraduate students, and interns actively participated in the inaugural session.

As part of the academic celebrations, an interactive and engaging activity session titled "Gumsense" was organized for students and faculty members. The program included a series of fun-filled yet knowledge-based activities such as Perio-bee, Perio-chain, and Perio-play. These activities were designed to enhance awareness and reinforce the concepts of periodontology in an enjoyable and participatory manner. The session encouraged teamwork, active learning,

National Periodontist day 2026

and academic engagement among participants.

In keeping with the department's commitment to social responsibility and community outreach, a one-day geriatric periodontal treatment camp was conducted at Home of Love, Calicut, on 25th February 2026 in association with Dept. of Public Health Dentistry. During the camp, elderly residents were provided with periodontal screening, basic dental treatment, and oral hygiene instructions. The initiative aimed to address the oral health needs of the geriatric population and improve their awareness regarding periodontal diseases and preventive oral care practices.

Furthermore, an OPD patient awareness program was conducted by the postgraduate students of the department from 23rd to 26th February 2026. Awareness sessions were organized in the outpatient department waiting area, where patients were educated about the importance of maintaining good oral hygiene, prevention of gum diseases, and the relationship between periodontal health and systemic conditions. Visual presentations and interactive discussions were used to effectively communicate the message to patients and attendants.

Overall, the National Periodontist Day celebration was successfully conducted with enthusiastic participation from faculty members, students, and patients. The program effectively combined academic enrichment, patient education, and community service, thereby reinforcing the significance of periodontal health in improving the overall quality of life.

Journal of the Society of Periodontists, Kerala (JSPIK)

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