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Research In Clinical Periodontology- Current Concepts And Future Perspectives- An Overview

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Abstract:

Periodontics as a specialty got little attention in the 1960s and 1970s, owing to a lack of understanding of the pathophysiology and therapy of periodontal disorders. Since then, scientific advancements have aided us in better understanding the disease and adapting our treatment accordingly. This review article examines current trends, recent advancements, and future prospects in the field.

I.Introduction

Periodontics as a specialty got little attention in the 1960s and 1970s, owing to a lack of understanding of the pathophysiology and therapy of periodontal disorders. Since then, scientific advancements have aided us in better understanding the disease and adapting our treatment accordingly. This review article examines current trends, recent advancements, and future prospects in the field.

II. Current concepts and future perspectives in understanding periodontal pathogenesis

Non-specific, particular, and ecological plaque hypotheses have all been favourably praised in the past. However, based on the notion of microbial dysbiosis, Hajeshengalis developed the keystone pathogen theory in 2012[1]. The goal of future study will be to learn more about the biology of this dysbiosis and how to regulate the keystone pathogen, P.gingivalis, in order to treat periodontal disease.

III. Current concepts and future perspectives in periodontal diagnosis

Existing diagnostic approaches are aimed at a thorough examination of the current disease situation and the extent to which periodontal disease has advanced. However, there will be a paradigm shift in diagnosis and molecular diagnostics in the future, with clinical diagnostics beginning to trump molecular diagnostics.

Molecular diagnosis

Genomics, transcriptomics, proteomics, and metabolomics studies aid in the identification and characterization of a molecular signature of periodontitis at the molecular level, which can hopefully predict the development of periodontal disease, its prognosis, and assess periodontal treatment follow-up.

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Peptide fingerprinting –methodology for determining which proteases and peptides are differentially expressed in distinct clinical manifestations of periodontitis and may be used to identify certain types or families of bacteria that are particularly virulent and damaging to the periodontium.**Glycoproteomics**– A tool to detect molecular targets for pathogen adhesins.**Metabolomics -** Defines characteristic patterns associated uniquely with different periodontal diseases.**Degradomics**- is the study of proteases, their substrates, and inhibitors, as well as their genetic, structural, and functional identification and characterization in living organisms. Some of the degradomics approaches used in our field include DNA microarray chips, protease-specific protein chips, substrate chips, and targeted isotope-coated affinity tags. In the future, new molecular patterns of bipolar disorder will be discovered.

Biomarkers - A diagnostic tool

Biomarkers are described as "a property that is objectively tested and analysed as an indicator of normal biological processes, pathogenic processes, or pharmacological responses to therapeutic intervention" by the National Institutes of Health. Proteomic, genetic, microbial, and other mineral and protein byproducts are some of the several types of biomarkers. MMP-8, TNF, IL-1, and other periodontal disease indicators can be detected in saliva or GCF using chairside tests. Chairside kits that detect periodontal risk factor molecules and subclinical infections, even before the start of the illness, are the way of the future. For periodontitis and periimplantitis detection, biosensors generate signals when they come into contact with an analyte, which allows them to detect and analyse chemical and biological interactions. The principle of lab-on-a-chip (LOC) is immunoassay. MMP-8, C-Reactive protein, and Interleukin-1 are all detected in saliva using this test. The IMPOD (Integrated Microfluidic Platform for Oral Diagnostics) identifies a wide range of salivary proteins in a tiny sample amount with great sensitivity. A PCR chip has also been discovered for quick detection of periodontal infections and to identify patients with an elevated risk of periodontal disease in the future.

Clinical diagnosis

Newer generation of probing system

For many decades, periodontal probing has been the standard procedure for clinical diagnosis. There are now five generations of probing systems. Conventional probes are in the first generation, pressure sensitive probes are in the second generation, computerised probes are in the third generation, 3D probes are in the fourth generation, and ultrasonographic probes are in the fifth generation. In the future, detailed 3-D information about the architecture of the periodontal pocket and the breadth of its soft problem base may be used to guide the use of periodontal probes, perhaps improving diagnosis directly or indirectly. X-ray-based imaging with radioopaque contrast agents, optical coherent tomography, photoacoustic imaging, and magnetic resonance imaging are all periodontal pocket imaging technologies.

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III.Current concepts and future perspectives in periodontal treatment modalities- "The upcoming and the future"

Periodontal therapy is divided into two categories: nonsurgical and surgical. The current scenario tries to keep tissue deterioration under control while also allowing for the restoration and regeneration of damaged periodontal tissues. However, the future appears to hold the promise of permitting effective control of illness onset and development. Less invasive nonsurgical modalities are becoming more popular, and even if the clinical situation requires surgery, the goal of periodontal therapy modalities is to achieve predictable regeneration with least patient discomfort and maximal efficacy.

IV. Current concepts and future prospects in nonsurgical modalities

Less invasive nonsurgical modalities are becoming more popular, and even if the clinical situation requires surgery, the goal of periodontal therapy modalities is to achieve predictable regeneration with least patient discomfort and maximal efficacy.

Local drug delivery (LDD)

Because some periodontal infections are tissue invasive, mechanical treatment alone is unsuccessful. As a result, developments in local drug delivery [LDD] targeting the periodontal pocket are a better strategy in 'Perioceutics,' as high drug concentrations at the target locations can be achieved with less systemic dose, fewer applications, low side effects, and a high potential acceptability. Tetracycline, doxycycline, minocycline, metronidazole, and chlorhexidine are the most commonly used local medication delivery agents. Subgingival administration of 0.5 percent clarithromycin (Clarithromycin gel) in combination with traditional scaling and root planing for the treatment of chronic periodontitis in smokers has recently shown to improve clinical outcomes. All clinical indicators for the clarithromycin group, such as probing pocket depth and clinical attachment degree, showed significant improvement after 6 months[2]. The medicine has not yet been patented and is undergoing testing. Herbal goods are a rich source of physiologically active molecules and are obtained from natural ingredients, which have paved the way for the development of new phasing lead drugs.[3] Herbal treatments are more readily accepted and tolerated by patients. Aloe vera, neem, tulsi, propolis, cocoa husk, pomegranate, and cranberry are among the many formulations available. are being investigated. PT-01, a subgingival release delivery method containing ofloxacin, is a recent addition[4]. Micelles, emulsions, liposomes, and nanoparticles are examples of colloidal drug carriers.

Probiotics in treatment of periodontal disease

Probiotics are defined as "live bacteria that, when given in sufficient proportions, confer a health benefit to the host." Organisms including *Lactobacillus gasseri* and *Lactobacillus fermentum* were discovered to be more numerous in the oral cavity of healthy people than in individuals with chronic periodontitis, and they had an anti-inflammatory impact.[5] The number of isolated periodontal pathogens is reduced when probiotic strains are introduced in periodontal dressings at an appropriate dose. However, because it is a young topic, there is still a lot of study to be done.

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Biofilm Inhibitors

Biofilm inhibitors work by either breaking up biofilms or preventing them from forming. Some bacterial biofilm inhibitors include autoinducer-2 inhibitors, iron-saturated lactoferrin inhibitors, and gingipain inhibitors, and further research is being done to develop additional inhibitors.

Ozone therapy:

In Periodontics, ozone gas is used in various forms for medicinal purposes. It affects the organic composition of mineralized tooth tissues, increasing their remineralization capacity and allowing dentinal tubules to "open." Gingivitis, periodontitis, periimplantitis, and prophylaxis are all treated with it.

Photobiomodulation

Photobiomodulation is the name for therapeutic low-intensity laser and LED irradiation. It possesses anti-inflammatory and analgesic properties, as well as improving the wound bed's biological capability for optimal healing.Coherent laser light with wavelengths ranging from red to near infrared is used because it has the potential to penetrate tissues optically, causing significant changes in cellular physiology and the release of extracellular signals such as nitric oxide, transforming growth factor-1 (TGF-1) and vascular endothelial growth factor (VEGF).

Photodynamic therapy (PDT)

A light source, an oxygen free radical, and a photosensitizer are all used in PDT. When the photosensitizer is activated, it produces oxygen free radicals that harm the tissue. This chemical gains features such as wound healing and antibacterial action after being exposed to light. PDT is used in conjunction with scaling and root planing (SRP) to improve the effectiveness of nonsurgical treatment.

Waterlase

Waterlase uses a unique mix of laser energy (Er, Cr: YSGG laser) and water (hydrophotonics) to perform dental treatments with less anaesthetic. It slices hard and soft tissue without the use of heat, vibration, or pressure, as well as reducing bleeding, post-operative pain, and oedema. It is used for periodontal minor surgical operations. Ozonated water can also be used to boost wound healing metabolic processes, as a mouth rinse for gingivitis, periodontitis, thrush, or stomatitis, and as a spray to clean and disinfect oral mucosa in cases of gingivitis, periodontitis, thrush, or stomatitis.

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V. Current concepts and future prospects in surgical modalities

In severe disease conditions, if the condition persists or worsens following nonsurgical treatment, additional surgical intervention is considered. There are two types of periodontal surgical techniques: resective and regenerative therapies.

Periodontal regeneration- 'maximum success with minimal invasion'

Periodontal regeneration has been a challenge since the dawn of civilization, and significant progress has been made. Time has now changed to a new molecular trifecta of cells, growth factors, and scaffolds, replacing the classic regeneration triad of bone transplants, Guided Tissue Regeneration membranes, and sutures.

Microsurgery

It is a refinement and modification of existing surgical techniques that makes use of magnification to better visualisation. Periodontal regeneration, treatment of marginal tissue recession, better aesthetics, mucogingival operations, implant therapy, and crown lengthening treatments are among procedures that can benefit from it. Minimally invasive surgical technique and its modifications were proposed by Cortellini and Tonetti.[6]

Future: Harrel et al.[7] reported great results using videoscope assisted minimally invasive surgery (Endoscopy-like procedure where the surgical site can be monitored over the screen for a better and clear image) at 36 to 58 months in their case series.

Tri-immunophasic periodontal therapy (TIP)

Periodontal disease can be treated using tri-immunophasic periodontal therapy, which does not require any invasive procedures. It works by regulating disease-causing factors and aiding repair through three immunological stages. a) alert preparedness, b) defence phase, and c) repair and regeneration.It changes pathogenesis and disease progression by switching from a defensive phase against bacteria and other microbes to a regeneration phase when new attachment can be achieved.

Tissue engineering in treatment of periodontal diseases

Combining cells, barrier membranes, and growth factors provides a new approach for the treatment of periodontal abnormalities. Growth factors were combined with gene therapies, and scaffolds are now custom created using 3D printing technologies. Autologous, expanded bone marrow-derived Mesenchymal Stem Cells combined with collagen were injected into periodontal osseous defects during periodontal surgery in a human clinical experiment.[8] Positive clinical results included a 4mm reduction in probing depths and a 4mm attachment gain, respectively. Cell-based treatments and scaffold-free regeneration models, such as pulp rebuilding with cell aggregates or pellets generated by one-step centrifugation or more recent

and accurate self-assembling technologies, are the future of tissue engineering.[9] Periodontal tissue engineering, like "cell sheet technology," uses a thermo-responsive polymeric substance called poly N-isopropyl acrylamide in a non-invasive method (PIPAAm). With a modest drop in temperature, a continuous monolayer of cells and extracellular matrix components can be formed.[10]

Stem cells

Damaged periodontal ligaments, pulp, dentin, and resorbed roots are all targets for stem cells. The gingival connective tissues, which have an osteogenic capacity to rebuild bone in mandibular abnormalities, have recently been used to apply adult mesenchymal stem cells. Various stem cells in use are:Stem cells from Human Exfoliated Deciduous Teeth (SHED): Miura et al, differentiated SHED into DPSCs, neural cells, adipocytes, osteoblast-like and odontoblast-like cells.[11]Dental Pulpal Stem Cells (DPSCs) are mesenchymal stem cells that are found inside the dental pulp. These stem cells exhibit osteogenic and chondrogenic potential in vitro and will differentiate into dentin, whereas they differentiate into a dentin-pulp-like complex in vivo. [12]

SCAP stands for stem cells from the apical papilla, which are found in the immature roots of permanent teeth. The SCAP produces odontoblast-like cells in the body, which make the root dentin[13]. Infected immature permanent teeth and abscessed teeth. Apexogenesis is aided by SCAP. Periodontal ligament stem cells (PDLSCs) will be discovered in the human PDL in the future. When transferred into rodents, they have the ability to produce cemental/periodontal ligament-like structures that aid in periodontal tissue repair.[14]

Gingival fibroblast stem cells: Zhang *et al* [15]first isolated cells possessing MSCs properties within the gingival tissue, these cells displayed a stable phenotype, normal karyotype and telomerase activity and non-tumorigenic in long-term cultures. Trials are being conducted with these stem cells in treating mandibular defects in animal models.

Nanotechnology in treating periodontal disease

Carbon nanomaterials, titanium nanotubes coated dental implants, nanoceramics and bioactive glass for bone regeneration and scaffold preparation, metallic nanoparticles in the form of toothpaste and mouth rinses for control of oral biofilm, nanoparticles for local drug delivery, and nanorobots for oral analgesia are currently being used in various aspects of periodontics. Future research is aimed at producing better, modified products for periodontal regeneration with the elimination of side effects and enhancing the biocompatibility of the product.

VI. Gene Therapy

Gene therapy is a technique that uses vectors to deliver genes to the desired location. They're utilised to deliver growth factors to the problem site in a regulated manner, assisting in the generation of induced pluripotent stem cells. For a better understanding of sustained PDGF signalling, Chen et al[16] were able to establish the long-term consequences of viral delivery of PDGF. Gene therapy is also being utilised to improve host modulation in order to resist disease, antimicrobial therapy in order to regulate disease development, and antibiotic

resistance in biofilms. In the future, for improvements in the outcomes in periodontal regenerative medicine, scientists will need to examine dual delivery of host modifiers or anti-infective agents to optimize the results of therapy.

VII. Periodontal therapy- The Future

PerioProtect

PerioProtect is a complete strategy for managing biofilms that build in the gaps or pockets between teeth and gum tissue that is personalised for each patient. To disrupt biofilm growth, a variety of therapies is performed, including a non-invasive chemical debriding therapy combined with standard mechanical debriding methods.

Vaccine for periodontal disease

The fact that periodontal disease is bacterial in origin, as well as other factors, prompted the idea of immunisation. Vaccines offer a lot of promise in terms of preventing periodontitis caused by periopathogenic bacteria and improving the quality of life for persons who can't afford periodontal care. There are still researches going on to find an antigenic component from various organisms to decrease the load of subgingival microflora.

Artificial intelligence

PerioSim, a robotic arm in the field of periodontics, assists students in analysing periodontal pockets by using a tactile feeling to distinguish between soft and hard tissues displayed on the monitor. The application of artificial intelligence (AI) in the identification and classification of malodors generated by volatile sulfuric compounds is possible. Soon, it would not be a surprise if AI plays a dominant role in periodontal therapy soon.

VIII. Implant therapy

Current research and observations evoked a change of paradigm in the field of dental implantology during the past decade: Rather than focusing solely on topographical features, such as surface roughness, the new paradigm also considers the role of wetting properties in interfacial biological responses, as well as the interplay between topography and wetting, such as microroughness and nano roughness-induced wetting phenomena.[17]Recent research has also discovered that nanostructured surfaces and hydrophilicity have a synergistic influence on biological response. Recent implant modifications include mini-implants, transitional implants, and one-piece implants. Newer methods of implant placement are also introduced recently, such as soft tissue punch technique, drill technique, guided implant surgery and minimally invasive implant microsurgery

IX. Challenges faced by researchers in India

Researchers in India face a number of challenges, including a lack of skilled, trained, competent, and willing technicians, the creation of an easily accessible research database, research funding, uniform modernization of laboratory facilities, and the need to conduct multicentred randomised controlled studies and systemic reviews.

X. Conclusion

In India, research is still in its infancy. In India, there is an immediate need to reorganise valid research data, which would aid in the formulation of national oral health care policy and evidence-based clinical practise. The majority of the research initiatives are short-term and academic in nature. Long-term research should be promoted. To support treatment decisions, the deductions coming from good research should be applied to good clinical practise. Clinicians must keep up with current research in the field and modify treatment strategies as new research with the highest level of evidence becomes available. Similarly, researchers must concentrate on the current gaps in our understanding of the topic and give solutions to improve practise. As a result, this defining research is a cornerstone of sound therapeutic practise.

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