Unlocking The Future of Dental Health: The Power of Precision Periodontics

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Abstract-
Precision Medicine is based on individualized patient care approach incorporating the four components-prediction, prevention, personalization, and participation for patient management. Accurate and precise diagnosis is the backbone of a successful treatment outcome.
Periodontal diagnosis requires consideration of following factors- pocket depth, clinical attachment loss, mobility and radiological parameters (alveolar bone loss) that provide restricted therapeutic information and for this reason biomarkers play a crucial role in diagnostic advancement in precision periodontics.
The periodontal biomarkers are the driving force of precision periodontics for their validated use in diagnostic and treatment plan.
But further implementation of these biomarkers for diagnostic use is required so as to adopt the precision periodontics in clinical practice.
Keywords- precision medicine, biomarker, individualized health care, periodontitis, personalized

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I. Introduction

Precision medicine has proven to be a key element in the modern delivery of healthcare. The aim is to deliver health care to individual patients, thereby improving care delivery and treatment outcomes in a cost-effective way. [1] Precision dentistry is linked with the precision medicine initiative—a modern approach in health care that considers every individual due to differences in genetic constitution, environmental factors, and lifestyles of all individuals. [2]

Precision dentistry is related to another term, P4 medicine: comprising of following components-
A) Precise (effective and efficient, safer)
B) personalized (targeted and individualized)
C) preventive (early intervention) and
D) participatory (involving the patient) care. [3]

P4 medicine includes comprehensive practices with participation of both patient and practitioner for maintenance of health.[4] This helps to determine the pattern of disease affecting the patient- the severity, progression, response of patient towards the treatment, success of the treatment.

Precision periodontics consists of clinical and biological markers that enable reliable prediction of periodontal disease by- diagnosis, prognosis, and treatment planning in an effective way meeting the individual patient needs. [5]

Principles

Personalized healthcare is the advanced and tailored delivery of care to an individual patient.

IVD (In vitro diagnostics) focuses on diagnostic needs in order to improve patient-specific diagnosis and treatment modality for a better-standard healthcare. It also minimizes overall healthcare expenses by reducing disease occurrence and progression and helps clinicians to record specific diagnostic information and to tailor a treatment strategy for the individual patient.

precision medicine is collection of various biomedical fields— genetics, microbiology, immunology and pathology and by combining the knowledge from all of the fields, it helps in development of reliable management strategy. Machine learning algorithms help to analyse clinical and biological parameters which further enables a reliable diagnostic information of the patient.[6]

Components-

It is an ecosystem that connects patients, clinicians, clinical laboratories and researchers with each other for the functioning, diagnosing and treatment planning.

Patients provide clinical history, lab samples, genomic data, electronic health records through hospitals which is stored as data source which is then analysed by certain tools to enable decision making. [7]
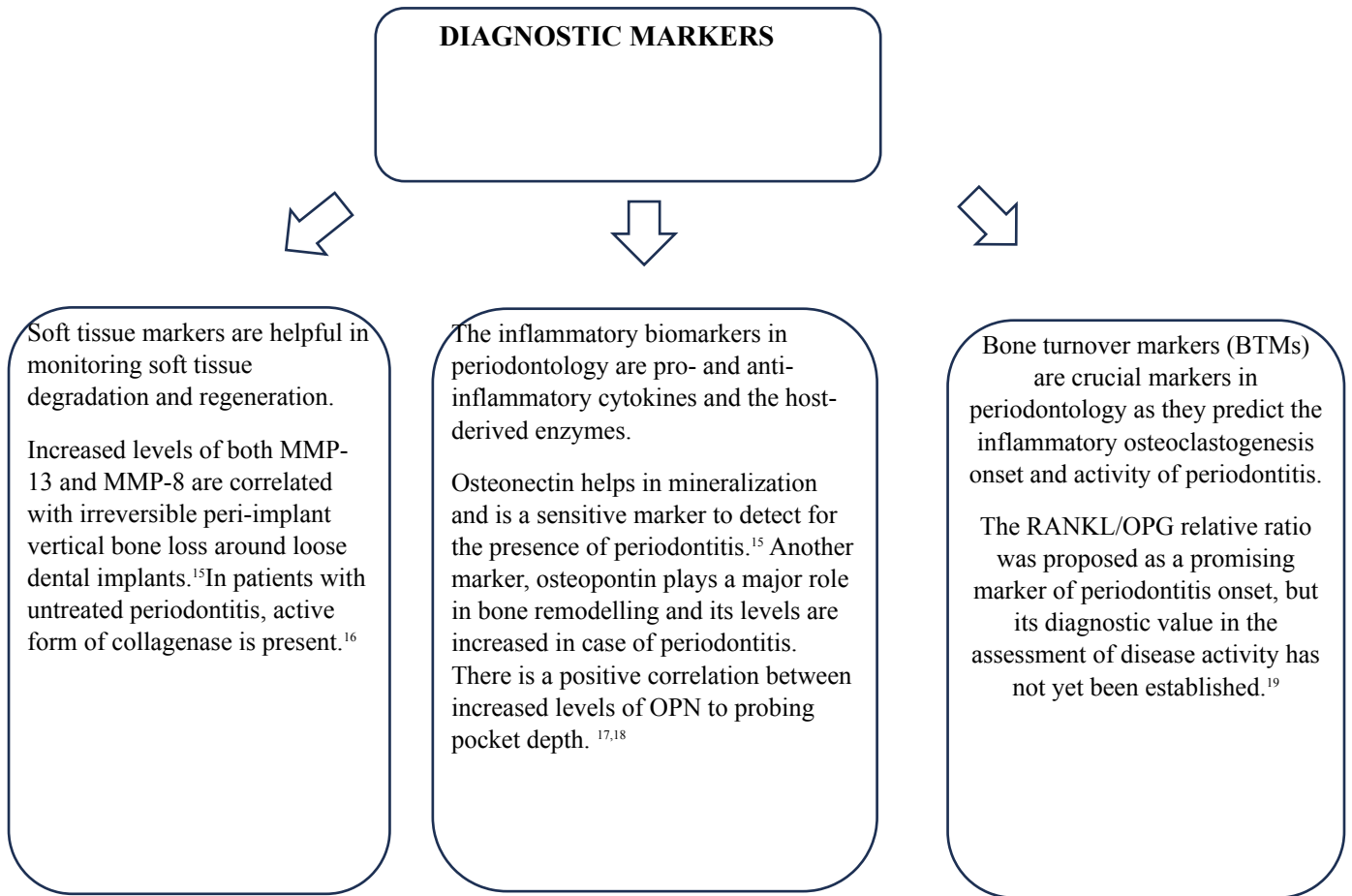
Biomarkers-

A biomarker is an objective measure which has been evaluated and confirmed either as an indicator of health, disease or as a pharmacologic response to therapeutic intervention. Various media like saliva, serum and gingival crevicular fluid act as biomarkers to detect both health and disease conditions of the periodontium. As a single biomarker is unable to predict disease activity and severity accurately, therefore combinations of biomarkers are helpful in prediction of the disease activity and severity. [8]

Depending on the size and frequency of genetic recombination in the gene chromosomal region, researchers need to evaluate the DNA variants in each of gene as a potential biomarkers of disease risk.

Salivary biomarkers are of utmost importance to check for presence of periodontal disease and can originate from both bacteria and the host. As periodontitis progresses it causes gingival inflammation, destruction of the periodontium sequentially thereby releasing associated proteins or metabolites into the saliva. [9]

Type of biomarkers	Predictive markers	Prognostic markers	Diagnostic markers
Description	detect disease occurrence by identifying risk factors and by estimating the overall patient risk. Single-nucleotide polymorphisms (SNPs) are the commonly studied type in periodontology, presenting as variations in single base pair components of DNA that help in determination of host responsiveness to environmental changes.	Are measurable when disease occurs. they do not change over time and estimate disease characteristics, stage, and grade. They are required to determine progression of disease. It guides the clinician in minimizing disease complications by selection of a suitable treatment protocol.	Consists of a group of indicators that detect disease onset, activity and progression. A specific subset of diagnostic markers includes surrogate endpoints intended for estimation of the patient's compliance to the administered treatment.
Examples	SNPs in IL-1β, IL1RN, FcϒRIIIb, VDR and TLR4 genes have susceptibility to more destructive forms of periodontitis [10] while polymorphisms in the IL1β, IL1RN, IL6, IL10, VDR, CD14, TLR4 and MMP1 genes might be responsible for general susceptibility to chronic periodontitis. [11]	IL-1α and IL-1β loci was found to be associated with severe periodontitis. [12] IL1A and IL1B genetic variations are significant contributors to chronic periodontitis in Caucasians. [13] TNFα gene located on chromosome 6 within the major histocompatibility complex (MHC) gene cluster at the location 6p21.3 and is associated with familial ability to produce higher or lower cytokine levels during periodontitis. [14]	

DIAGNOSTIC MARKERS

Soft tissue markers are helpful in monitoring soft tissue degradation and regeneration.

Increased levels of both MMP-13 and MMP-8 are correlated with irreversible peri-implant vertical bone loss around loose dental implants.[15]In patients with untreated periodontitis, active form of collagenase is present.[16]

The inflammatory biomarkers in periodontology are pro- and anti-inflammatory cytokines and the host-derived enzymes.

Osteonectin helps in mineralization and is a sensitive marker to detect for the presence of periodontitis.[15] Another marker, osteopontin plays a major role in bone remodelling and its levels are increased in case of periodontitis. There is a positive correlation between increased levels of OPN to probing pocket depth. [17,18]

Bone turnover markers (BTMs) are crucial markers in periodontology as they predict the inflammatory osteoclastogenesis onset and activity of periodontitis.

The RANKL/OPG relative ratio was proposed as a promising marker of periodontitis onset, but its diagnostic value in the assessment of disease activity has not yet been established.[19]

Merits Of Precision Dentistry

Precision periodontics represents the future of high-quality and personalized periodontal care.

1. The coordinated association of periodontist and patient could substantially improve the application of precision periodontics, allowing high-quality, reproducible research.
2. Customization of disease prevention strategies is according to each patient
3. Leads to shifting of the importance of medicine from reaction to prevention
4. Personalised treatment plan for every patient enhances the best treatment for individual patient
5. Improving the treatment outcomes

However, future studies should focus on the development of biomarkers and their assessment that would be useful in everyday practice, as it is still in the developmental stage in periodontology. [21,22]

Demerits Of Precision Dentistry

1)Data availability: there is less data available in support of precision in field of periodontics

2)Due to restricted drug alternatives, patients with gene variations may not be included due to paucity in treatment options

3)Bias, robustness- it is important to adhere to the clinical diagnostic criteria of periodontal conditions for accurate detection of presence of periodontal biomarkers to prevent bias.

4)Resources and sustainability- there is lack of resources regarding the advances in precision dentistry as there are differences in collection and storage techniques.

5)since there are lesser biomarkers in periodontology, it is less useful for diagnostic purpose

6) using diagnostic techniques such as ELISA for applying personalized medicine in clinical practice may be difficult to implement and can be expensive.

As stated, the crucial component of precision periodontology are the biomarkers and due to the lack of these markers for diagnosis, the implementation of the approach in periodontology remains in the very early stage and needs further research and advancement.

Is Precision Periodontics the Future of High-Quality Periodontal Care?

Precision periodontics represents the future of high-quality individualized periodontal care. Therefore, it is crucial for future research studies to follow the recommendations for the validation of biomarkers which would improve the process of implementation of biomarkers in routine clinical practice.

To implement precision medicine in periodontitis diagnosis and treatment, formulation of a database consisting of genetic information, biomarkers, and environmental factors of the individual that may cause the disease is necessary. The accuracy and precision of the database can be improved by use of machine learning and artificial intelligence. It is important that there are more of studies and researches conducted regarding the data collection be developed in the future. This will include obtaining extensive data and information across the health spectrum. With the use analytic technologies, interdisciplinary interventions along with active patient participation, a comprehensive healthcare strategy can be planned and implemented. This will preach early prevention and intervention of the disease and regenerative procedures consistent with reconstructing damaged tissues and restoring health.[23]

II. Conclusion-

Ultimately, there are many evidences in support of personalized patient-centered care and targeted treatment modalities. It can promote dental education and use of technology for healthcare of each patient leading to vast improvements in public oral health.[24]

There is an increasingly complex distribution of diseases between different age groups which requires larger number of available diagnostic and therapeutic options for the diagnosis. As there is a strong demand for individualized, ''tailored'' treatment approaches for the health of patients, hence the development of precision periodontics would enable both dentists and their patients to coordinate together to encourage health and well-being throughout the life course of disease experience.

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