DIAGNOSTIC TOOLS IN

PERIODONTOLOGY

1.What is Periodontium?

The periodontium consists of four components two soft tissue the periodontal ligament and gingival tissue and two hard tissue- alveolar bone and cementum, the periodontium plays many vital roles. These functions encompass tooth support, protection against oral microorganisms, and facilitating tooth attachment to the bone. To gain a deeper understanding of the periodontium's role, it's instructive to examine the functions of its individual constituents.

The periodontal ligament mainly consists of fibroblasts and type 1 collagen it acts as connecting link between cementum in the root area and gingiva. It also carries out bone remodelling of the alveolar bone and repair of the cementum. The periodontium has certain proprioceptors which helps the brain to react and regulate to any force being placed on the tooth. These receptors help to avoid any extreme forces on tooth. The periodontal ligament is attached to the cementum present on the root

2. Diseases of periodontium.

Periodontal conditions are widespread and can impact a substantial proportion, reaching around 90% of the global populace. [1]

Typical types of periodontal conditions have been linked to unfavourable pregnancy results, heart ailments, stroke, respiratory issues, and diabetes. However, the direct cause-effect relationships have not been definitively proven. Prevention and management efforts target the regulation of bacterial biofilm and mitigating other risk elements, halting the advancement of the ailment, and reinstating lost tooth support.[1]

Gingivitis

Gingivitis represents preliminary reaction to counter any insult to the periodontium. It involves inflammation, which results from aggregation of microbial plaque near the gingiva.[10] Gingivitis tends to be reversible and less destructive but some cases of gingivitis progress to become periodontitis which are more destructive in nature.[2]

Periodontitis

Periodontitis is the inflammation involving all components of periodontium (both hard and soft tissue components). The destruction caused by periodontitis is more severe than gingivitis and tends to be irreversible.

The pathophysiological mechanism of periodontitis encompasses the renewal and restructuring of alveolar bone that was initially in a healthy state, with a specific focus on the spongy bone. This phenomenon can manifest in individuals without pre-existing health issues, attributed to persistent inflammation. During inflammation, activation of white blood cells takes place, and there is an association between the osteoclast lineage and these particular white blood cells.

Reduction in the level of alveolar crest is seen radiographically

Periodontitis results in the degradation of both connective tissue and bone support, representing a significant factor contributing to adult tooth loss. Apart from the existence of harmful microorganisms within the biofilm, different hereditary and ecological elements, notably tobacco consumption, contribute to the onset of these issues. Additionally, manifestations of periodontal problems may manifest in persons with genetic, dermatological, haematological, granulomatous, immunosuppressive, and neoplastic conditions [2] [1].

The subgingival microbial biofilm associated with gingivitis and periodontitis is shaped by dynamic interactions within its microenvironment. Typically, this

microbial biofilm consists of commensal organisms coexisting in a state of relative balance. Gingivitis can be viewed as a non-specific inflammatory reaction to the indigenous subgingival microbial biofilm. However, as periodontitis progresses, there is a change in microbial composition, resulting in the emergence of potential pathogens and intensified tissue damage driven by the host. Therefore, to attain or sustain periodontal health, it is imperative to steer the composition of the subgingival microbial biofilm towards one that aligns with gingival well-being.

ANUG (Acute Necrotizing ulcerative gingivitis)

Necrotizing ulcerative gingivitis (NUG) stands out among periodontal diseases due to its distinctive features. It manifests acutely, marked by a swift appearance of gingival discomfort, interdental gingival tissue death, and haemorrhaging. This ailment has an extensive historical background and has been acknowledged under diverse names throughout its evolution, encompassing Vincent's disease, fusospirochete gingivitis, trench mouth, acute ulcerative gingivitis, necrotizing gingivitis, and acute necrotizing ulcerative gingivitis (ANUG), among several others.

The predisposing factors of NUG are increased psychological stress, heightened physical demands, and reduced nutrient intake, smoking .

What distinguishes necrotizing ulcerative gingivitis from other periodontal ailments is its unique manifestation, frequently marked by the presence of "punched out" ulcerated papillae, bleeding of the gums, and painful sensations. The necrosis of gingival tissue between teeth is easily observable in this particular condition. [4]

HALITOSIS

Halitosis, derived from the Latin words "halitus" (meaning breathed air) and "osis" (indicating a pathologic alteration), is a term employed to describe any unpleasant or disagreeable odor emanating from the breath and mouth air. Other terms used to characterize this condition include foetor oris, oral malodor, mouth odor, bad breath, and bad mouth odor. Halitosis is a common concern affecting individuals of all genders and age groups. It can lead to social and psychological challenges, impacting individuals' interactions with others [5]

Diagnostics

Presently, periodontal conditions are acknowledged as complex issues with origins that extend beyond simple bacterial infections. They are now recognized as intricate ailments with multifaceted beginnings, involving a sophisticated interplay among the microbiota beneath the gums, the immune and inflammatory responses of the host, and external influences. Hence, achieving optimal periodontal well-being necessitates a thorough evaluation that transcends merely assessing plaque and bacterial levels. It entails a comprehensive assessment of all elements contributing to the onset of the disease, as well as actions for restoring and preserving health.

Factors influencing periodontal health can be broadly grouped into three primary categories: microbiological, host-related, and environmental determinants.

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Indicators of Clinical Periodontal Health:

In its most ideal state, periodontal well-being is defined as the lack of histological indications of periodontal inflammation and the absence of structural alterations to the periodontium. However, it's important to recognize that achieving this level of health is improbable for most, if not all, adults. Consequently, the term "clinically healthy" should be employed to

portray the lack of, or a significant decrease in, evident periodontal inflammation.

Bleeding on probing (BoP) serves as a dependable measure for assessing the health of gingival tissues and the presence of inflammation. BoP is typically gauged by observing bleeding when a probe is gently applied to the base of a sulcus/pocket. The non-occurrence of BoP, especially at a consistent force not surpassing 0.25 N, signifies a state of periodontal health. This metric is widely regarded as highly dependable for regular patient monitoring.

Several elements, including probe specifications, angle of insertion, and the pressure applied, can impact the evaluation of gingival inflammation. Hence, establishing a standardized level of force for BoP is vital to guarantee uniform and precise assessments.

Periodontal Probing Depth:

While it might be instinctive to assume that shallow pockets imply health and deep pockets imply disease, evidence suggests that this is not always the situation. Deep pockets can remain stable and devoid of inflammation, especially with proper supportive periodontal care over extended durations. Therefore, deep pockets could indeed be considered as "healthy pockets."

Probing depth or attachment levels determined through probing should not be viewed as the exclusive indicators of gingival health or disease. They should be evaluated in conjunction with other clinical measures like BoP, as well as modifying and predisposing factors.

This underscores that the most reliable indicator of disease lies in the clinical presence of inflammation, and historical markers of disease (such as increased probing depth, recession, attachment loss, or bone loss) may hold less significance in the context of periodontal health within a diminished periodontium.

Probing

First-generation probing instruments (traditional or manual periodontal probes):

This category includes well-known probes such as the University of Michigan "O" probe, University of North Carolina Goldman Fox probe, and William's probe. These instruments are considered the benchmark method, providing tactile feedback on periodontal structures. However, they present concerns regarding accuracy and reproducibility, as they can both overestimate and underestimate pocket depths, potentially causing discomfort. Additionally, these probes lack the capability to capture three-dimensional (3D) information, necessitating the presence of a dental assistant for data recording.

Second-generation probing instruments (constant force probes):

Introduced by Hunter in 1994, these probes feature a disposable hemispheric tip with a 0.5mm diameter and a visual guide using a sliding scale with two indicator lines meeting at a specified pressure point. They offer consistency, reproducibility, and reduce operator error. Nevertheless, they can introduce errors in data readout and recording, still requiring a dental assistant for charting. These probes lack tactile sensation, may lead to pocket depth inaccuracies, and cannot provide 3D information.

Third generation probing instruments (constant force automated probes):

This group encompasses automated periodontal probes such as the Foster Miller probe, Florida probe, Goodson and Kondon fiber optic probe, and the Toronto automated probe. They offer consistency, reproducibility, and automation, eliminating data readout and recording errors. However, they lack tactile sensation, can occasionally overestimate or underestimate pocket depth, and cannot capture 3D information.

Fourth-generation probing instruments (ultrasonographic periodontal probe):

These ultrasonic probes utilize high-frequency ultrasonic beams projected into periodontal pockets. Echoes from the crest of the periodontal ligament are recorded by an internal transducer and analyzed by computer software to estimate pocket depth measurements. While these probes are non-invasive and automatically record and read data, interpreting echo waveforms for pocket depth can be challenging. They are also relatively costly, have limited contrast, and their feasibility for obtaining 3D information is uncertain.

Fifth-generation probing instruments:

These instruments aim to provide a 3D image without invasiveness. They project a narrow beam of ultrasonic energy down the pocket's depth between the tooth and bone using a manually scanned transducer.

Non-periodontal probing instruments: Calculus Detection Probe:

Designed to identify subgingival calculus through audio readings, this device produces an audible beep upon calculus detection. It features a lightweight, autoclavable handpiece but is relatively expensive and bulkier compared to standard periodontal probes.

Diamond Probe: This plastic instrument with black bands measures pockets and assesses the volatile sulfur content within the sulcus, indicating gram-negative bacterial activity. While it can detect early stages of periodontal disease and active sites for treatment, it lacks controlled probing pressure and may miss diseases caused by non-volatile sulfur-producing bacteria.

Periotemp Probe: A temperature-sensitive probe that detects early inflammatory changes in gingival tissues by measuring temperature variations. It can detect pocket temperature differences.as small as 0.1ºC compared to a referenced subgingival temperature, enabling early treatment initiation.

BANA Assay (N-benzoyl-DL-arginine-2-naphthylamide):

This quick diagnostic test conducted chairside offers insights into bacterial presence by breaking down a trypsin-like enzyme. During this breakdown, it produces a chromophore named naphthylamide, which, upon the addition of garnet, transitions to an orange-red hue. Faint blue traces on a pale red-brown background signify weak positive results, while prominent and darker blue patches indicate positive results. Absence of the blue coloration indicates negative results.

Organoleptic Evaluation: The most traditional method for detecting unpleasant odors is through olfaction. Evaluating unpleasant odors by inhaling the exhaled air from the mouth and nose is termed as sensory evaluation. This approach is straightforward in identifying halitosis. The evaluation process involves an olfactory test, wherein the patient takes a deep breath through the nostrils, holds for a moment, and then exhales through the mouth directly or using a pipette. Meanwhile, the examiner smells the odor from a distance of 20 cm.

Gas Chromatography: Measurement using gas chromatography is regarded as highly precise, reproducible, and dependable. Through gas chromatography, we can quantify Volatile Sulfur Compounds (VSCs). This method separates and analyzes compounds that can be vaporized without decomposition; samples are collected from saliva, tongue coating, or exhaled breath.

Sulfide Monitoring: While gas chromatography boasts accuracy and sensitivity, its application during chairside procedures proves challenging and costly. To mitigate these drawbacks, a new portable device called a sulfide monitor was developed to measure VSCs, providing a more accessible solution.

Quantifying β-galactosidase Activity: Deglycosylation involves the removal of glycosyl groups from glycoproteins, which serves as the initial step in oral malodor production. Proteolytic bacteria degrade proteins, especially salivary glycoproteins, causing halitosis. The proteolysis of glycoproteins depends on the initial removal of carbohydrate side-chains, including both O- and N-linked carbohydrates. β-Galactosidase, a vital enzyme, contributes to the removal of these carbohydrate side-chains.

Ammonia Monitoring: Apart from VSCs, ammonia is another significant factor in halitosis. While sulfur compounds can be detected using a portable

sulfide monitor, unfortunately, this method cannot measure ammonia. Ammonia is a major basic gas found in various crucial sample matrices, such as ambient atmosphere, indoor air, and human breath. Notably, breath contains elevated levels of ammonia, measuring at approximately 1 ppmv in a healthy individual's breath, potentially higher in individuals with renal failure.