

# Chairside Diagnostic Aids in Periodontics: A Review

Srishti Shankar<sup>1</sup>, Rashmita Nayak<sup>2</sup>, Rinkee Mohanty<sup>3</sup>, Gatha Mohanty<sup>4</sup>, Sourav Panda<sup>5</sup>, Abhaya Das<sup>5</sup>

<sup>1</sup>Post Graduate Trainee, <sup>2</sup>Professor, <sup>3</sup>Professor & Head, <sup>4</sup>Senior Lecturer, <sup>5</sup>Reader, Department of Periodontics and Oral Implantology, Institute of Dental Sciences, Siksha 'O' Anusandhan, (Deemed to be University), Bhubaneswar, Odisha, India

## Abstract

The need of the hour is an accurate and timely diagnosis for an effective treatment plan to cure or eliminate the disease. Clinical measurements, traditionally available, have their limitations in helping diagnose an “active” disease. Hence, novel chairside diagnostic kits are essential to detect active disease, predict its progression and help in the evaluation of response, of a patient, to therapy, thereby aiding in the management of periodontal patients. This review article, therefore, discusses the various chairside diagnostic aids available to aid Periodontists, in diagnosing and treating periodontal patients.

**Keywords:** *Diagnosis, Periodontal disease, Chairside, Diagnostic aids.*

## Introduction

Periodontitis is an inflammatory disease of the periodontium, that is, the supporting structures of the tooth, resulting in a gradual loss of it. This gradual degradation of the periodontium leads to exposure of tooth root causing sensitivity, esthetic concerns, gradual mobility and eventually loss of the tooth. Accumulation of dental plaque, due to various factors, leads to an increase in the microbial load in the oral cavity, which eventually, in combination to host's immune response, leads to gingivitis, which if not treated, turns into periodontitis. A diagnosis hence is achieved by clinical inspection of the gingiva surrounding the tooth with the help of instruments, such as the William's Probe or the UNC-15 Probe, examination of the radiographs, such as the IOPAs and OPG and other investigations if required. [1] The traditional clinical parameters and methods usually predict previous periodontal disease than active disease.

Therefore, diagnostic kits which can detect active disease and predict its progression are the need of the hour. [2,3]

The available 'Point of Care' diagnostics, are designed to measure microbiological, immunologic and genetic constituents in oral diagnostic media namely: saliva, gingival crevicular fluid (GCF) and plaque, indicative of health or disease. The main aim behind developing such kits is to diagnose active disease so that the following achievement:

- Less invasive treatment
- Reduced chair time
- Reduced expense
- Long term prognosis

**Armitage GC 1996, listed out the following purposes served by periodontal diagnostic aids: [4]**

- Screening of active disease
- Diagnosis
- Determining sites and/or subjects at a higher risk of disease progression
- Treatment planning
- Therapy monitoring

**Chairside diagnostic aids:**

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### Corresponding Author:

**Prof. Rashmita Nayak**

Professor, Department of Periodontics and Oral Implantology, Institute of Dental Sciences, Siksha 'O' Anusandhan, (Deemed to be University), Bhubaneswar, Odisha, India

e-mail: rashmitanayak@soa.ac.in

**The ideal diagnostic test should be (Chapple 1997)<sup>[5]</sup>:** forsythia.<sup>[6]</sup>

1. Non-invasive
2. Cost-effective
3. Adaptable to sample collection, storage and transportation.
4. Simple to perform at the chairside
5. Rapid, with 1-stage or 2-stage procedure
6. Highly specific, sensitive, reproducible and quantitative.

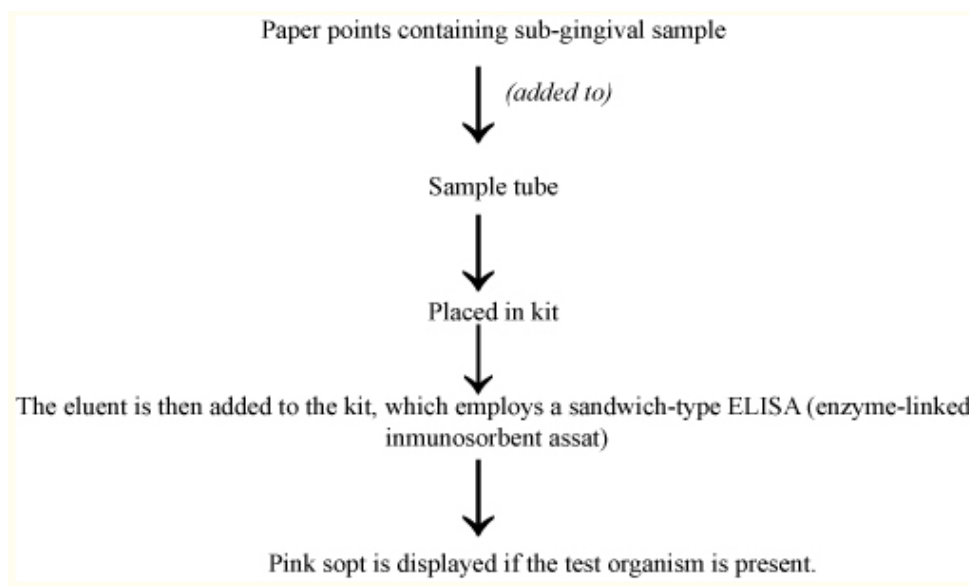
Hence, keeping these goals in mind, the following are the available or in the making, chairside diagnostic aids.

**Microbiological test kit:** The main bacteria associated with periodontal disease are Aggregatibacter actinomycetemcomitans, Prevotella intermedia, Porphyromonas gingivalis and Tannerella

**Presence, elevated levels or absence of these microorganisms may predict, indicate or monitor:**

- “Active” disease
- Loss in Clinical attachment level
- Disease initiation and progression
- Sites at higher risk for active destruction and;
- Response to periodontal therapy

**Evalusite (KODAK):** Evalusite is a diagnostic kit based on the principle of ELISA, which involves the linkage between the antigen and a membrane-bound antibody to form an immune complex that is assessed through a colorimetric reaction. It is mainly used for the detection of three principal microorganisms: Aa, Pi and Pg.<sup>[7]</sup>



**Figure 1: Evalusite (KODAK)**

**Omnigene:** Omni Gene Diagnostics, Inc. has produced a set of DNA probe systems, by applying the principle of genetic engineering. These are species-specific probes which tests for 8 periodontopathogens:

- Actinobacillus actinomycetemcomitans (Aa)
- Treponema denticola (Td)
- Porphyromonas gingivalis (Pg)
- Fusobacterium nucleatum (Fn)
- Prevotella intermedia (Pi)
- Eikenella corrodens (Ec)
- Campylobacter rectus (Cr)
- Bacteroides forsythus (Bf)

Subgingival plaque samples, collected from patients for analysis, are sent through the mail to OmniGene Diagnostics. Practitioners may receive the results through phone, fax, or mail.<sup>[8]</sup>

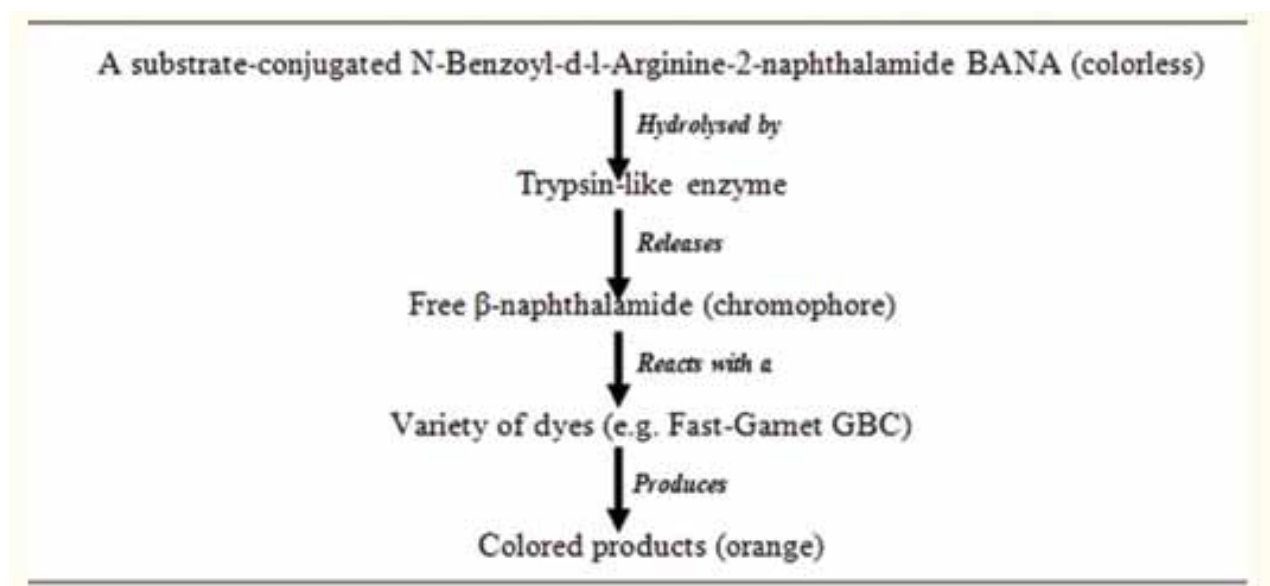
**BANA Test:** A trypsin-like enzyme is produced by only 3 specific anaerobic bacteria amongst the various species present in subgingival microbiota. Those are Porphyromonas gingivalis (Pg), Treponema denticola (Td) and Bacteroides forsythus (Bf). The test works by detecting the presence of these bacteria, as their enzyme hydrolyzes the synthetic peptide Benzoyl-DL-arginine-2-naphthylamide or BANA, present in the test. The test

may also be used to assess oral halitosis, by detecting the presence of 2 BANA positive species on the surface of the tongue:<sup>[9]</sup>

- Stomatococcus mucinigenus
- Rothia dentocariosa

It is a highly sensitive test, detecting the smallest quantity of pathogens. Studies have been performed, showing no significant difference in the sensitivity of DNA probes, immunological reagents and the BANA test, in the detection of these bacteria in dental plaque, of periodontally compromised patients.<sup>[10-12]</sup>

### Principle:



**Figure 2: BANA Test**

**Directions for use:** The test consists of a strip (plastic), to which two separate reagent matrices are attached. The upper matrix is a buff reagent, containing chromogenic diazo reagent. The lower matrix is impregnated with BANA. The subgingival plaque samples are applied to the lower matrix. A permanent blue colour is produced as a result of the reaction between

the chromogenic agent and hydrolytic product produced by the enzyme. It may be interpreted as a positive or weak reaction depending on the intensity of the colour.

**Perioscan:** Perioscan diagnostic kit, utilizes the same principle as the BANA test. At Least 4 teeth should be sampled in each subject.

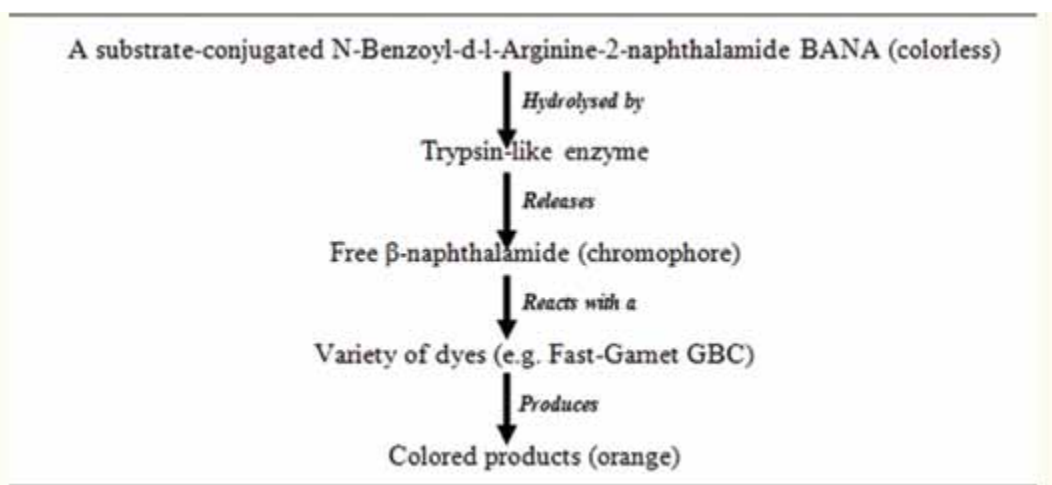


Figure 3: Perioscan

**Perio 2000:** This chairside diagnostic test is a combination of standard “Michigan O” style probe and advanced ion-selective electrode technology.<sup>[13]</sup>

**It is designed to:**

- Assess probing depths
- Assess bleeding on probing (present/absent)
- Assess periodontal pockets for sulfides

The system consists of:

- One time use sulfide containing sensor tips, which can be disposed
- Electronic control unit
- Probe handle, handpiece cable, foot-controlled pedal
- Solution provided to clean the equipment
- A stand
- System check

**It can be used for:**

- Assessment of patient’s oral health status as an adjunct to other measurements
- Supportive periodontal therapy
- At maintenance intervals
- Patient education and motivation.

**Biochemical test kits**

To monitor health status, disease onset, treatment response or outcome, the molecules which can be most

efficiently assessed are the ‘biomarkers’.<sup>[14]</sup>

**Biomarkers, present in the saliva or gingival crevicular fluid, can be measured, to monitor periodontal activity, under the following categories:**<sup>[15]</sup>

- Biomarkers to determine the presence or absence of periodontal pathogens.
- Biomarkers for determining gingival and periodontal inflammation
- Biomarkers to determine the host’s immune-inflammatory response to certain pathogenic microorganisms; and
- Biomarkers to determine host tissue destruction

**Biomarkers may be tested from saliva and gingival crevicular fluid. GCF is the choice of oral fluid for testing as :**

- Can be noninvasively collected
- Allows site-specific analyses
- Convenient measuring of destructive MMPs, by distinct immunoassays.

**Saliva too can be used as it possesses certain advantages**<sup>[16]</sup> :

- Easily accessible
- Noninvasive sampling
- Quick and reliable outcomes
- Consists of diagnostic biomarker molecules in abundance

Biomarkers in gingival crevicular fluid.

Inflammatory and immune products	Bacterial proteases	Host derived enzymes	Tissue breakdown products	Bone specific proteins
Prostaglandin E2 (PGE2)	Alkaline phosphatase	Alkaline phosphatase	Glycosaminoglycan	Pyridinium crosslink urine pyridinoline
Cytokines	Aminopeptidases	$\beta$ -Glucuronidase	Hyaluronic acid	Pyridinium cross-link collagen peptide fragment
Antibacterial antibodies	Chondroitin sulphatase	Elastase	Chondroitin-4-sulfate	Tartrate-resistant acid phosphatase
Acute phase proteins	Collagenase	Cathepsins	Chondroitin-6-sulfate	Hydroxyproline
Complement	Fibrinolysin	Serine protease (G)	Deratan sulfate	Galactosyl hydroxylysine
Vasoactive intestinal Peptide	Glucosidases	Nonspecific neutral proteinases	Hydroxyproline	Glycosaminoglycans
Neurokinin a	Hemolysin	Matrix metalloproteinase-1,3,8,13	Fibronectin fragments	Osteonectin and bone phosphoprotein
Neopterin	Hyaluronidase	Aspartate amino transferase	Connective tissue and bone proteins	osteocalcin
Platelet -activating factor	Phospholipase	Myeloperoxidases	Type I collagen peptides	
	Hydroxyproline	Lactate dehydrogenase	Polypeptide growth factor	

Figure 4: Biomarkers in gingival crevicular fluid

Table Demonstrating the biomarkers present in saliva.

Markers of periodontal soft tissue inflammation	Markers of alveolar bone loss	Collagen breakdown products
Prostaglandin E2	Alkaline phosphatase	Aspartate aminotransferase
$\beta$ -glucuronidase	Osteoprotegerin	Alanine aminotransferase
IL-1 $\beta$	Osteocalcin	TIMPs
IL-6	Collagen telopeptidase	MMPs
Tumor necrosis factor- $\alpha$	Pyridinoline cross-links of type I collagen	$\alpha$ 2-macroglobulin
Matrix Metalloproteinase (MMP-8,9 and 13)	RANKL	
	Osteonectin	

Figure 5 Demonstrating the biomarkers present in saliva

**Prognos-Stik:** It determines increased levels of elastases in GCF. The elevated levels may, hence, indicate the presence of underlying disease.<sup>[17]</sup>

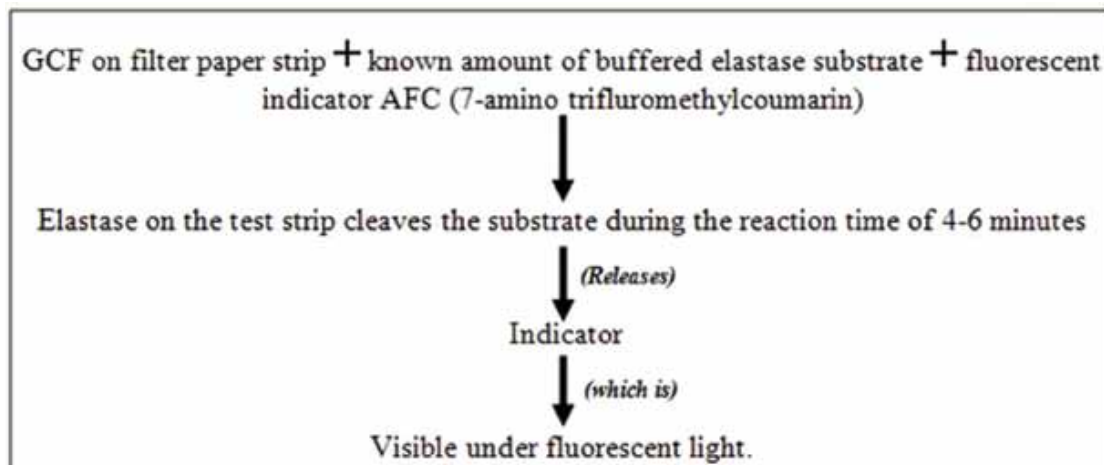


Figure 6: GCF

**Periocheck:** Periocheck is a chairside diagnostic test to evaluate the presence of neutral proteases. The elevated levels of these enzymes can be correlated to collagen destruction, implying the presence of periodontal disease.<sup>[18]</sup>

**Biolise:** Hermann et al. Developed a new test (SLT-Lab Instruments, Crailsheim, Germany) which is used to detect the elastase activity in GCF.<sup>[19]</sup>

**TOPAS (Toxicity Pre Screening Assay):** TOPAS is a diagnostic test kit for evaluating the presence of gingival infection, by indirect assessment of bacterial toxins and proteins. The principle for this test is the detection of the metabolic action of these pathogens, in

the GCF. The color intensity scale of the test helps to differentiate between an inactive and active periodontal disease, as the degree of color change signifies the level of metabolic activity thereby determining levels of toxins.<sup>[20]</sup>

**Periogard:** Aspartate aminotransferase (AST), is a soluble intracellular cytoplasmic enzyme, present in the GCF, which is released as a result of cell death. Periodontal tissue destruction causes cell death. Hence AST becomes a potential marker for the presence of periodontal disease. Periogard is a chairside test to detect this enzyme, and its levels, in the GCF. <sup>[21,22]</sup>

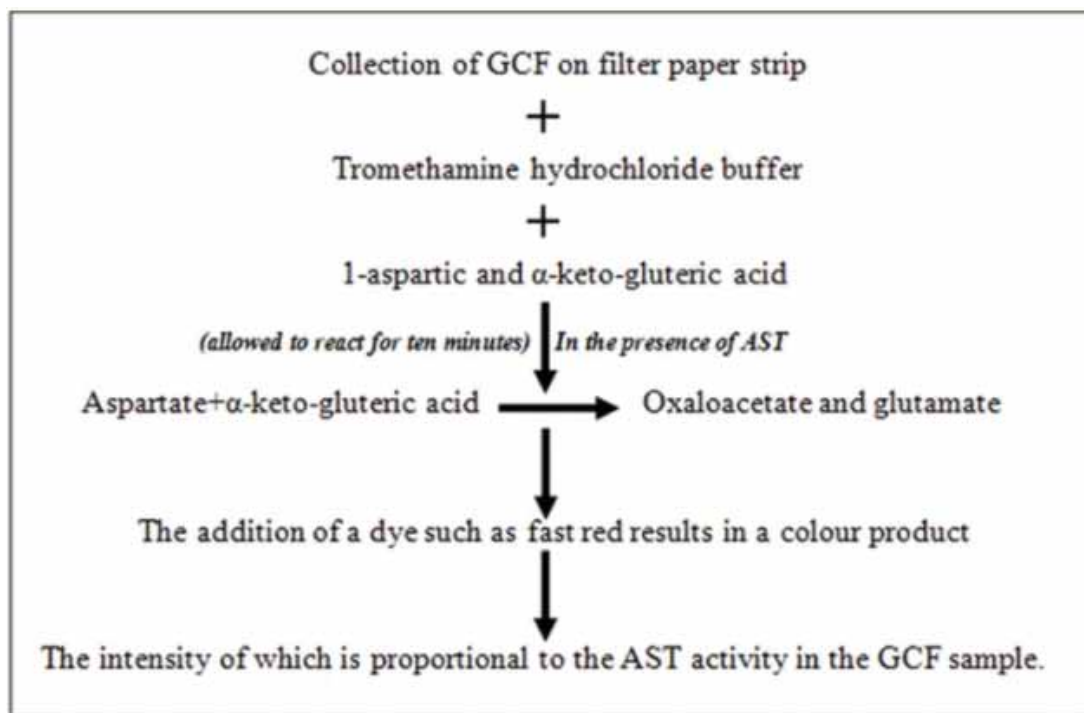


Figure 7: Periogard

**Periowatch:** The Perio Watch also analyzes aspartate aminotransferase (AST) at the chairside. It is an indicator of cell death, thus implying the severity of periodontal tissue destruction.

**Principle:** The conversion of cysteine sulfuric acid, belonging to an amino group, to alpha keto-glutaric acid to beta sulfinyl pyruvate, is accelerated by AST in the presence of pyridoxal phosphate. As a result of

the instant degradation of  $\beta$ -sulfinyl pyruvate, inorganic sulfite is produced. It reacts with malachite green, thereby producing pink-colored rhodamine B dye. The amount of conversion of malachite green determines the levels of AST.

#### Oral Fluid Nanosensor Test (OFNASET):

A chairside diagnostic device developed by Dr. David Wong has been developed to detect oral cancer

by assessing the presence of certain biomarkers in the saliva.<sup>[23]</sup> It detects the following biomarkers (mRNA):

- SAT
- ODZ
- Interleukin 8
- Interleukin 1b

Also detects the following salivary proteomics:

- Thioredoxin
- Interleukin 8

Electronic Taste Chips

A chip-based chairside test which will have the capability to distinguish healthy individuals from the periodontally compromised, based on levels of C-Reactive Protein, is under development. The microspheres containing a sensor-rich platform, present on the interior of this microchip system, will measure analytes, through chemical and immunological reactions.<sup>[24]</sup>

**Oraquick:** The first FDA approved the oral swab ‘in-home’ test which facilitates accurate screening and diagnosis of human immunodeficiency virus infection. It provides results within 20 minutes and is an easy to use stick-like device. On its one end is a fabric swab, which is used to collect the oral fluid and then inserted in the testing liquid to produce results on the device.<sup>[3]</sup>

**Integrated Microfluidic Platform for Oral Diagnostics (IMPOD):** It is a rapid chairside device to evaluate the levels of salivary biomarkers as indicators of oral disease. Salivary samples, in small amounts (10ml), can be rapidly analyzed, hands-free, for analyte concentrations and other salivary biomarkers, through electrophoretic immunoassays.<sup>[24]</sup>

**MMP Dipstick Test:** It is a chairside diagnostic kit, to detect MMPs, which are host-derived proteinases, to help differentiate between healthy and periodontally compromised individuals.<sup>[23]</sup>

**Genetic Test Kits:** Identification of genetic polymorphism, to detect periodontal disease, is now possible due to the availability of certain chairside diagnostic kits. The initiation and progression of periodontal disease is controlled by various genes, whose polymorphism is present as a risk factor for the

disease. In 1997, Kornman et al., “found an association between the polymorphism in the genes encoding for interleukin-1 $\alpha$  and interleukin-1 $\beta$  and increased severity of periodontitis.”

**Periodontitis Susceptibility Trait (PST) test:** It is the first of its kind chairside diagnostic kit to analyze 2 interleukin genes, IL-1 alpha and IL-1 beta, for mutations. It is highly useful in terms of early diagnosis of periodontal disease as it can differentiate between IL-1 genotypes, which are largely associated with various inflammatory responses.<sup>[25]</sup>

**Principle:**

**IL-1 gene cluster, according to studies, consists of 2 polymorphisms which possess a close relation to periodontitis. These are:**

- IL-1A gene, position -889
- IL-2B, position +3953

They both consist of alleles 1 and 2. Allele 1 carries cytidine and allele 2 carries thymidine at the respective positions. In cases where both genes (IL-1A and IL-2B) carry allele 2, IL-1 inflammatory mediator is released in abundance. The test hence, detects this mutation of allele sequence thereby granting early intervention and prevention of periodontal disease.<sup>[20]</sup>

**Clinically, it is used for the following:**

- New periodontal subjects
- To determine prognosis
- As an incentive for smoking cessation.
- Patients on maintenance.
- Specialist referral after detection.

**Nucleic Acid Probe:** It is a nucleic acid probe assay, developed by Microprobe corporation, to semi-quantitatively detect periodontal pathogens. The plaque samples are collected to test the bacterial load. The lysis of bacterial cells takes place by heating, in the presence of a detergent, to extract their DNA. The DNA thus obtained, is placed into a multi-well cassette, which is then placed in a machine with a programmable robotic arm. Finally, results are obtained digitally.<sup>[20]</sup>

**Conclusion**

To plan and treat any disease effectively, an accurate diagnosis is essential. The chairside diagnostic

tests, not only provides rapid, non-invasive and specific prediction of the disease, but also helps in early detection of the disease. As the saying goes, 'Prevention is better than cure', these tests help predict and detect an "active" disease thereby allowing early intervention, better prognosis and more effective treatment plan for the disease. The already available chairside tests help achieve these goals, despite having their limitations. Soon, better, more sensitive test kits shall be available to help diagnose and treat periodontal patients better.

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**Ethical Issues:** Approved

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