

Recent Advances in Diagnostic and Treatment Modality Related Periodontal Infection

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Abstract: *Since periodontal disease affects systemic health the need to eliminate oral infections is important for overall health. Diagnosis and management of periodontal disease related infections is main criteria for effective elimination of the disease. Early diagnosis and treatment planning are important as patients understands the importance of oral health. Periodontal disease leads to many systemic diseases in a large population such as cardiovascular disease, oral and colorectal cancer, gastrointestinal disease, pneumonia, pregnancy outcomes, diabetes, Alzheimer's disease. So, the importance of early intervention is a must in treating the disease. This review article will give various insights about the recent diagnosis and treatment modality that can arrest periodontal infections related to systemic disease.*

Keywords: recent diagnostic aids, treatment, BOST, tri-immune phase therapy

1. Introduction

The need to eliminate periodontal disease has become an important aspect to reduce the risk of systemic disease. Link between periodontal to systemic disease has started to emerge from late 1980's. The main area of interest in periodontal disease associated with systemic disease includes atherosclerotic cardiovascular disease, diabetes, pregnancy outcome, respiratory disease, rheumatoid arthritis, chronic kidney disease, cognitive impairment, obesity, metabolic syndrome and cancer. Two main mechanism contributes to systemic disease which include:

- 1) Direct mechanism: which says that as periodontal destruction progress the periodontal pocket lining gets ulcerated which becomes a direct entry point for bacteria into systemic circulation.
- 2) Indirect mechanism: the inflammatory response to periodontal bacteria and their byproducts may have indirect systemic effects. The C- reactive protein is a method to measure systemic inflammation. These levels are usually high in periodontitis patients. (0)

In order to prevent the periodontal destruction usually mechanical reduction of plaque and calculus through subgingival debridement is done which has served as gold standard treatment modality for more than decades. The recent diagnostic modalities for periodontal disease are usually categorized under:

- 1) Clinical: Optical coherence tomography, Endoscopic capillaroscopy, Photoacoustic imaging
- 2) Biochemical: Biomarkers
- 3) Biomechanical: Biosensors
- 4) Immunological assay: Integrated microfluidic platform for oral diagnosis (IMPOD)
- 5) Radiographs- Periodontal pocket imaging using radiopaque contrast agents

Optical coherence tomography (OCT):

It was first reported in 1991. Optical coherence tomography is an imaging technique where a low coherence infrared light is used to capture micrometer resolution in 3D image from within optical scattering media. It provides sections of tissues in noninvasive manner. It is used of medical imaging and also in dentistry. It has a long wavelength light which allows it to penetrate into the scattering medium. It can be

used in real time in situ imaging without the need for biopsy ([2]. It is done based on a modular device which contains software and 5 basic modules: a partially coherent light source, imaging apparatus, measurement head, module of data processing, image generation and computer control system. The imaging apparatus acts as measuring device which can measure the backscattered light. The resolution of OCT is 5-15 micrometer and penetration depth are 1-2 mm ([3]. The possibility of imaging gum margin, periodontal pockets, epithelia, connective tissue using an infrared beam of light can be done using this imaging technique.

Endoscopic Capillaroscopy:

It images the microcirculation of periodontal pocket. The changes in number and diameter of blood vessels connected with periodontal disease can be measured by visualizing directly into the periodontal pocket. It has a fiber optic image probe which is inserted into the periodontal pocket. A green light is used for illumination. The green light is absorbed by both oxygenated and deoxygenated blood. The red blood cells appear dark in the green background. ([6]

Photo acoustic imaging (PA):

It is a hybrid biomedical imaging that combines the high contrast optical imaging with high resolution ultrasound imaging. In PA imaging, absorption of optical energy from endogenous chromophore such as hemoglobin or exogenous contrast agents such as organic dyes give rise to thermoplastic expansion and generation of acoustic waves. These waves can be detected and converted to electrical signals that are then processed for imaging. PA imaging provide high resolution image with deeper imaging depth. The disadvantage of PA imaging is limited penetration into the tissues.

Biomarkers

GCF and saliva is the basic marker for diagnosis in periodontal disease. Early diagnosis even before the progression of disease can be done using biomarkers. ([5] The biomarkers can be classified as:

- a) Salivary biomarkers-
 - For periodontal inflammation- Prostaglandin E2, β -glucuronidase, IL-1 β , IL-6, TNF- α , MMP- 8,9,13

- For alveolar bone loss- alkaline phosphatase, osteoprotegrin, osteocalcin, collagen telopeptidase, RANKL, osteonectin
 - Collagen breakdown: aspartate aminotransferase, alanine aminotransferase, TIMPs, MMPs, α -macroglobulin
- b) GCF markers-
- For inflammatory and immune products- PGE2, cytokines, antibacterial antibodies, acute phase proteins, vasoactive intestinal peptide, neurokinin A, neopterin, platelet activating factor
 - For bacterial proteases- alkaline phosphatases, aminopeptidases, chondroitin sulphatase, collagenase, fibrinolysin, glucosidases, hemolysin, hyaluronidases, phospholipase, hydroxyproline
 - For host derived enzymes- alkaline phosphatases, β -glucuronidases, elastase, cathepsins, MMP-1,3,8,13, myeloperoxidases, lactate dehydrogenase
 - For tissue breakdown- glycosaminoglycan, hyaluronic acid, chondroitin-4-sulphate, chondroitin-6-sulphate, hydroxyproline, type 1 collagen peptides, polypeptide growth factor
 - For bone specific proteins- hydroxyproline, galactosyl hydroxylysine, glycosaminoglycans, osteonectin, bone phosphoprotein, osteocalcin

In order to detect these biomarkers, various chair side kits are available for detection of these biomarkers. The chair side kits are classified as:

1) Biochemical test

- a) Oral fluid nano sensor test- multiple salivary proteins detected
- b) Electronic taste chips- monitor several biomarkers in saliva simultaneously
- c) OraQuick- detects HIV1 and HIV2
- d) Periogard- AST
- e) Pocket watch- AST
- f) Periocheck- collagenase
- g) Prognostik- elastase
- h) MMP dipstick method- MMP
- i) Biolise- detects elastase

2) Microbiological test:

- a) My PerioPath- detects pathogens causing disease in saliva
- b) Omnigene- detects *Porphyromonas gingivalis*, *Prevotella intermedia*, *Aggregatibacter actinomycetemcomitans*, *Fusobacterium nucleatum*, *Eikenella corrodens*, *Campylobacter rectus*, *Bacteriodes forsythus* and *Treponema denticola*
- c) Perioscan (BANA)- *P. gingivalis*, *T. denticola*, *T. forsythia*
- d) Evalusite- detects antigen of *Aggregatibacter actinomycetemcomitans*, *P. intermedia*, *P. gingivalis* with antibodies
- e) Perio 2000- evaluation of volatile sulphure compounds for subgingival microbial load detection
- f) TOPAS (toxic oral pathology assay) – detects toxins from anaerobes and measures protein levels in GCF ([5])

3) Genetic test:

- a) My perioID- genetic susceptibility of the patient to periodontal disease is detected

Biosensors

Biosensors are molecules which detects and sense chemical and biological reactions by generating signals. These can also detect biomarkers for periodontitis and implant disease. Human odontogenic ameloblast associated protein (ODAM) is considered to be a potential biomarker recently in periodontal disease. This ODA on analysis has cognate pair of aptamers forming sandwich type binding. ([11]) This cognate pair of aptamers was utilized to develop sandwich type SPR and LFS biosensors. ([10])

Integrated microfluidic platform for oral diagnostics (IMPOD):

It is an immunoassay mediated lab-on-a-chip (LOC). It was introduced to detect various salivary proteins biomarkers in a sample volume of 10ml with high sensitivity. Samples of saliva is pretreated by electrophoretic immunoassay and made ready. The microfluidic chip is integrated with miniaturized electronics. When compared with common blood test these IMPOD is easier and there is noninvasive saliva collection and the testing becomes more essential when compared to normal blood test ([7]). When using saliva as a diagnostic method various diagnosis in cardiovascular disease, renal disease cancer and many more have been found under this technique of diagnosis. Detection of saliva with the help of semiportable instrument have been made where the operating specification includes:

- 1) It requires only less volume of saliva
- 2) It can be collected from trained and untrained personnel's
- 3) Many analytes can be diagnosed for accurate assessment
- 4) Many protein measurements can be taken
- 5) Low cost ([8])

Periodontal pocket imaging:

In a 2D image periodontal bone defect is usually hidden due to the superimposition of teeth. Bone loss cannot be identified by a 2D image. CBCT technique provides a 3D volumetric image in coronal, trans axial and sagittal planes without any magnification and a 3D model of the target area can be made using a CBCT software. CBCT shows greater diagnostic accuracy in assessing the amount of periodontal tissue lost in the furcation areas. Soft tissue imaging can be done with the help of radiopaque contrast dyes which facilitate the detection of periodontal lesion in incipient stage before progression into bone destruction.

According to Wiedmann et al a radiopaque composite material was introduced into the periodontal pocket of pig's jaws. The pockets were measured when compared to those obtained during probing. Another study where radiopaque nano-particles like gold and silver nanoparticles were inserted into periodontal pockets of patients. Zirconia solutions and BaSo4 solutions were also tested which resulted that these solutions had sufficient radiopacity to visualize periodontal pockets.

The above mentioned are the recent diagnostic tool which is ongoing in the field of periodontology. The newer treatment modalities include:

- 1) Nanotechnology
- 2) Bone one session treatment (BOST)
- 3) Tri immune phasic therapy
- 4) Perioprotect

Nanotechnology:

As the world is moving towards robotics, future of dentistry is also about how dentist utilize robotics. In periodontics, the use of robotics is vast area where in many places it can be used but has certain disadvantages. Nanorobotics is nothing but science and engineering which is involved in design, synthesis, characteristic and application of materials and devices which is measured in the scale of nanometers. The principal element in these nanorobots is usually carbon and other elements include hydrogen, sulfur, oxygen, nitrogen and fluoride ([9]). These nanorobots works under 3 process:

- 1) Powering – done by metabolizing glucose and oxygen and externally supplied acoustic energy controlled by computes
- 2) Communication- done by acoustic signaling navigational network which keeps track of various devices in the body
- 3) Excretion- after its work is done it is excreted via human excretory channels

In periodontology, these nanorobots can be used to maintain:

- 1) Oral hygiene and halitosis
- 2) Used as dentifrice
- 3) Used in dentinal hypersensitivity
- 4) Oral anesthesia induction
- 5) Tissue engineering
- 6) Surgery
- 7) Bone grafts
- 8) Local drug delivery
- 9) Quantum dots

Bone one session treatment (BOST):

BOST is one treatment which treats severe periodontal infections. It treats infections under the gums. The treatment is a noninvasive surgery which is usually fast and comfortable. When we compare with the traditional treatment, BOST is a single sitting procedure where the treatment of removing bacteria is removed within 5 hours but the traditional treatment takes at least a month for completion of procedure. The treatment forms strong adherence to the tooth bone and gums where the penetration of bacteria into the healthy tissue is sealed. The technique used is the STRETCHED FLAP TECHNIQUE. It allows access to deep roots to the surface of bone. It does not require any incisions. Obstructions are usually removed because it prevents healing and lead to contamination. Then reshaping of the bone craters is done. ([13])

Tri-immuno-phasic therapy:

This treatment modality includes three phases:

- 1) Defense mechanism where the after cleaning the bone in BOST immune reactions should be formed
- 2) Regeneration with the use of stem cells
- 3) New attachment healing with perio-aid

After the BOST procedure is done, healing should be proceeded. The pockets are usually very dense which is partially mineralized connective tissue and finally becomes acellular. The new mineralized acellular connective tissue (MAC) attachment will come to place in one month and the bone naturally heals. After bone healing there are 4 stages of therapy:

- 1) The stem cells inside the pocket move along the root surface at the rate of 0.5mm per day to thicken the layer of clot. A strict oral hygiene technique should be maintained that keeps the pocket open and keep the epithelial attachment away
- 2) As the healing progress on the root surface the pockets gradually get filled with mineralized connective tissue for a period of 4-6 weeks and becomes acellular
- 3) The bone later gradually heals as the connective tissue attachment is in place
- 4) Bone maturation can be observed in 9 months of time

The main advantage of this therapy is it is non-invasive and healing is faster. There is less of complications reported in this therapy and is relatively comfortable for the patient. This therapy is mainly for patients who are of esthetic concerns and patients who do not respond well for the treatment. ([12])

Perio-protect

Perio protect is a new generation treatment mainly for individuals to help manage biofilms growing pockets between teeth and gum tissue. This is mainly to protect oral cavity from biofilms. This was initially used in industrial sites for protection of various catheters from bacterial colonization so that the biofilm formation is minimized. Biofilm bacteria shows same susceptibility to non-specific oxidizing agents. The perioprotect uses this concept where it delivers peroxides and an antioxidant into the periodontal space at intervals to keep free from bacteria entering the periodontal space. There is reduction in colonization of bacteria in the periodontal space was recognized.

2. Conclusion

As the progress keeps going in the field of technology and science, the advancements in order to identify the etiology of the disease and its treatment modalities will also keep going in dentistry. Clinicians should continue to develop newer advancements in diagnosis and treatment modalities as it is the main criteria to prevent progress of periodontal infection. Early diagnosis at faster rate and its treatment should be the definite protocol for managing periodontal infections

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