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Dental Calculus: A Preliminary Culprit or Just a Synergist

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ABSTRACT
Periodontal diseases are among the most common oral diseases. Periodontal diseases are associated with multiple factors, both local as well as systemic. Earlier, dental plaque is considered as the main etiologic factor which harbors bacteria whereas dental calculus acts as a contributing factor by providing a fixed nidus for the attachment of plaque. Various advanced ways of calculus detection exist, which are discussed in the article. Certain studies do exist which contradict with this statement and claims that dental calculus consists of viable bacteria in the lacunae and channels of the calculus structure. Experiments are carried out which are in favor of this claim.
KEY WORDS: *calculus, dental plaque, periodontal diseases, viable bacteria.*

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INTRODUCTION

Periodontium consists of four components: Gingiva, Cementum, Periodontal ligament and Alveolar bone. Many factors are responsible for the commencement as well as development of periodontal diseases. In order to have a better knowledge about the etiopathogenesis, one must be well-versed with the various factors involved. When only the soft tissue component is involved in the process of inflammation, it is termed as Gingivitis while if any other component else than gingiva is involved it is considered as Periodontitis. Both the local as well as systemic factors are responsible for the generation of disease in the tissues. However, dental plaque which is a local factor is considered as the most prevalent of all [1-3].

Dental plaque comprised of bacteria which is responsible for generation of periodontal diseases [4]. Bacteria present in the plaque release toxins which could act as irritant to the tissues leading to tissue destruction. In order to provide better diagnosis and treatment planning to the patient, the clinician should have an understanding about the origin and development of the disease. Dental plaque is deliberated as the primary source of infection in case of periodontal diseases. When oral hygiene is neglected or not practiced appropriately by the person, the plaque undergoes mineralization and at this stage is denoted as dental calculus [5,6].

Dental calculus is nothing but the hard, calcified form of plaque. On the basis of its relationship with the margin of the gingiva, it could be supragingivalor subgingiva l[7].

Supragingival calculus being coronally present with respect to the gingival margin, so can be clearly detected in the oral cavity. The color is white or yellowing white with rigid claylike consistency. Subgingival calculus on the other hand being below the gingival margin can't be appreciated in routine clinical check-up. The color ranges from gray to greenish black, this is due to presence of blood in the sub gingival region. Various dental equipmentare required for the detection. It takes around 2 days for the mineralization of plaque to up to 50% and by the end of 12th day the amount of mineralization could reach up to 60% to 90%. Saliva is the ultimate source for the mineralization of dental plaque in case of supragingival calculus whereas in case of subgingival calculus the main culprit is Gingival Crevicular Fluid (GCF).

DETECTION OF CALCULUS

Many methods exist which can be considered for revealing the calculus. The methods are broadly categorized under 3 headings: Visual, Tactile, and Radiographic.

- **Visual Examination:** Proper lighting is required for visualization of supragingival calculus. For detection of calculus which is present in small amount sometimes get unrecognized when the surface is wet, so the drying of the site is done via compressed air using three-way syringe. The

compressed air can be used in case of sub gingival calculus as well after deflecting the marginal gingival from the surface of tooth [8].

- **Tactile Exploration:** This can be achieved by the skilful use of explorer. The explorer used should be fine and pointed with a modified pen grasp. After attaining a proper finger rest, the instrument is carefully placed into the pocket. Vertically, light vertical strokes are performed. When the tip detects presence of any calculus deposit, the tip is then inserted more apically in order to reach the root surface. Usually, the distance between the base of pocket and apex of the calculus edge is 0.2 to1.0mm. For proximal surfaces, in order to detect the presence of calculus, the tip should be introduced halfway past the contact area[8].
- **Radiographs:** IOPAs and Bitewing radiographs can be used for the detection of calculus in the interproximal area. Although the apical end of the calculus does not correlate with the base of the periodontal pocket so it can't be used to determine the extent of disease severity. Moreover, it is difficult to appreciate the presence of calculus on the labial and lingual surfaces of teeth with a radiograph, hence it is not a good method for calculus detection.

The above mentioned traditional methods of calculus detection lack interms of specificity as well as reproducibility. Thus while debriding the subgingival areas there exist chances of incomplete removal of subgingival calculus or excessive removal of cementum or both. In order to compensate for these limitations, new technologies are used for detection of calculus for better diagnosis and treatment.

Various systems are also readily available commercially for calculus detection:

PERIOSCOPY™ – It is a modification of medical endoscopes, which is used for periodontal purpose in an exclusive manner. This system uses fiberoptic bundles for better visualization and detection of calculus. It utilizes a digital monitor for better appreciation of presence of calculus [9].

DetecTar™ – It is a device which uses light emitting diode along with the technology of fiberoptics. Fiberoptic technology recognizes calculus via the ability of calculus to absorb, reflect and diffractthe red light.

DIAGNODENT™ – It is a device which uses In GaAsP Laser for detection of calculus, based on the property of fluorescence possessed by calculus. The laser of wavelength 655nm via an optical fibre is used to detect fluorescence.

Systems used for detection as well as removal of calculus:

PERIOSCAN™– Ascaler which uses Ultrasonic technology which removes as well as detects dental calculus. It follows the acoustic principle. Change in oscillations lead to generation of different voltages as per the hardness of the tooth surface.in the presence of calculus, the device emits blue light while in case of healthy tooth surface the device emits green light. The device has many power settings based on the tenacious nature of the calculus.

Keylaser3™– A technology which is laser based. Two different wavelengths and source is used. InGaAsP diode of 655nm wavelength is used for the detection purpose whereas for the removal of calculus Er: YAG is used. The score of more than 40 can be used as an indicator for calculus. After removal of the calculus the scores get down, indicating clean tooth surface. When the value goes down the threshold level the device is turned off, as optimal cleaning is achieved.

ROLE OF DENTAL CALCULUS IN PERIODONTAL DISEASE

It is challenging to discriminate the effects of dental calculus and dental plaque on gingivaltissues due to the presence of plaque in close proximity to the calculus. Even though the presence of dental calculus is closely related to the predominance of gingivitis, but the relationship between plaque and gingivitis is much stronger. The relationship between the periodontal disease and presence of plaque rather than calculus is strong in case of young individuals, however this correlation reverses as the person ages. The rough surface of the calculus acts as nidus for the accumulation of plaque[10]. Plaque acts as the primary factor responsible for the periodontal disease however, calculus act as contributing factor by proving a fixed nidus for plaque accumulation near gingiva. The elimination of plaque as well as calculus from sub gingival tissues is considered as foundation of periodontal therapy.

Earlier the calculus act as the secondary or the contributing factor in periodontal diseases. The main reason for this interpretation was the mineralization of plaque leading to entrapment of bacteria making them non-viable. As per x-ray diffraction, structure of dental calculus is crystalline with hydroxyapatite being the main constituent followed by whitlockite. Grenz ray examination of dental calculus revealed that the mineralization was granular in nature by the 7th day and complete mineralization can be appreciated by the 14th day.

In comparison with the previous reviews, there exist the evidence which indicate the role of dental calculus in induction and advancement is indecisive. There exist channels and lacunae in the structure of calculus which were not mineralized. In the year of 1999,Bergström found a positive correlation between

the gingival index and calculus, regardless of presence of plaque, with dental awareness of high standard in a population and even projected that in persons with little plaque scores, supragingival calculus can cause inflammation of gingival tissues[11].

The organic component forms 20% of the total mass of dental calculus. The unmineralized portions of the dental calculus harbors microorganisms and extracellular material which is like the soft tissue coating on the tooth surface. The highly specific technique which can be used to differentiate between live and dead bacteria is fluorescent staining. The stains used in this technique have the ability to penetrate through various biofilm so this technique can easily be used for the demonstration of viability of the oral microorganisms.

A study was carried out using supragingival calculus using a sample size of six, with the extent of severity ranging from moderate to advance in cases of chronic periodontitis as a part of periodontal therapy at the Periodontology Department, Eastman Dental Institute of Oral Health Care Sciences. Samples were selected on the basis of following criteria:

1. The disease should be in active state with considerable amount of calculus.
2. Antimicrobial therapy of any kind should be avoided.
3. Professional prophylaxis should not be performed at least 6 months prior to the collection of sample.
4. Systematically healthy patients.

Large chunks of calculus are collected and immediately placed at a temperature of -70 degree Celsius without using any fixative. Seventeen supragingival calculus samples are collected for examination. Out of these, sixteen samples showed positive results in terms of viability of microbes within the channels and lacunae[12].

Moolya et al conducted a study to explore the viability of microbes in the plaque sample in which calculus samples are collected and assigned into two groups: Group A and Group B. The samples in the group A are collected and exposed to UV radiation for half an hour in order to kill the microbes attached to the outer surface of the samples, while the Group B samples were not subjected to the UV radiations and they are used at such in the study. Four different methods are used to examine the samples microbiologically: Gram staining, Bacterial culture, staining with Acridine orange and Dark field microscopy.

On microscopic examination, samples confirmed for the presence of bacteria in the samples via the gram staining method. Acridine orange fluorescent stain revealed the presence of both viable and dead bacteria in the sample. Moreover, Acridine orange staining is more potent than Gram staining in terms of differentiating the bacteria. With the help of Dark field microscopy, the clinician can easily detect the presence of spirochetes in the samples, which are otherwise very difficult to detect but are most commonly associated with patients suffering from chronic periodontitis[13].

From the earlier mentioned information, that both viable as well as the dead bacteria are present in the calculus samples. The viable bacteria proliferate and release toxins thereby contributing to the pathologic changes occurring in the periodontal tissues. These bacteria act as reservoir that plays a significant role and not just a contributing factor in the etio-pathogenesis of periodontal diseases. Even the non-vital bacteria contribute in the destruction of periodontal tissues because the by –products formed due to the degradation of outer cell layer component i.e., lipopolysaccharide, released from the calculus enters the neighboring tissues causing damage to the tissues. Mandel and Gaffar named calculus as “slow releasing device releasing toxic and pathogenic products into the soft tissues[14].”

CONCLUSION

The result of different studies is shared which favors the presence of viable bacteria in the calculus samples obtained from patients. Different methods are used for the confirmation of this information. The study gives the explanation to contradictory results obtained from the epidemiological as well as clinical studies, emphasizing to ensure the cases for completely eliminating these deposits from tooth surface.

CLINICAL SIGNIFICANCE

In the earlier studies, it was concluded that once the plaque undergoes mineralization the bacteria are killed. The rough outer surface of the dental calculus act as the nidus for accumulation of plaque. The vitality of the bacteria in the calculus samples is considered as a major contributing factor. The viable bacteria in the channels and lacunae of the calculus mass act as reservoir as it releases its by products in the adjacent periodontal tissue leading to destruction of the tissues causing periodontal diseases. Thorough mechanical debridement which includes scaling as well root planing is required in order to ensure complete eradication of the local contributing factors of the disease.

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