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Microbiome of dental implants and its clinical aspect

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ABSTRACT

Although dental implants are most common prosthetic treatment used to replace missing tooth, it gained considerable importance over a decade owing to the availability of advanced imagery techniques that can help in achieving a greater success rate and much better osseointegration. However, the chances that the implanted tooth can be rejected due to inflammation caused by oral microflora still persist. This review gives the viewers an overall idea of the dental implants, role of advanced imaging in implantation and instances of peri-implantitis that occur after implantation process. This review also entails the latest research on the different treatment modalities against peri-implantitis documented in peer-review journals.

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1. Introduction

Dental implants are widely used by dentists as prosthesis to replace damaged or lost tooth. Dental implants are titanium cylinders that form interfaces with the jaw establishing a bond with the bone [1]. This process where the implant locks and attaches itself with the bone is termed as osseointegration. With success rates of more than 90%, implants are used by many dentists to substitute missing teeth. As the prospects outweigh the consequences, coupled with the help of developing radiography, teeth replacement has become much reliable. Despite high success rates of osseointegration, there exists more than 10% chances of implant failure. This implant failure has been mainly attributed due to peri-implantitis, where periodontal pathogens cause inflammation of the hard and soft tissues (sub-acute and chronic inflammation [2] surrounding the implants. Many Gram negative bacteria that

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fester in the tissues surrounding the osseoimplants are solely responsible for such implant rejection [1]. Several treatment modalities are helpful in reducing the inflammation around implants. These treatment include surgical removal, use of antibiotics, and laser therapy against the potential pathogens and facilitate re-osseointegration thereby preventing the further spread of the microorganisms.

This review article gives the consolidated view of the periodontitis and the microbial flora associated with such complications. This article also features the diagnostic imaging tools that are used by dentists in pre and post-operative follow-up procedures to check the integration of implants on the jaw.

2. Importance of imaging in dental implantation

Imaging not only plays an important role prior to implantation but also in the post-operative follow-up to check the efficiency of the endosseus implants. Several advanced techniques have proven to be useful in dentistry with a near 100% success rate of teeth implantation. Such techniques have been implemented by dentists to determine the sites where implants can be placed with ease and to check the success rate of the implants to osseointegrate weeks after prosthetic treatment.

Imaging techniques for diagnosis include high resolution radiographic techniques such as periapical radiography, occlusal radiography, lateral cephalometric radiographs, panoramic radiography etc., and tomographical techniques. Interactive computed tomography is being used as a conventional method to locate both hard and soft tissues in the oral cavity and to help dentists perform non-invasive operations [3–5]. Dentascan and Simplant are the CT image reformatting software used for the three-dimensional viewing of oral cavity. Although these software have a limited range, they provide in-depth and accurate information and have been a boon in disguise in the field of periodontology [6]. Panoramic X-rays are being used to get detailed view of the tissues around implants and to determine the stability of the implants. These techniques help to keep osseointegration in check and to know if the implant has any chances of inflammation due to periodontal pathogens. Magnetic resonance imaging provides dentists with wide applications through accurate tomography without any distortion [7]. Magnetic resonance imaging (MRI) is used most commonly in the valuation of the musculoskeletal system and associated pathology. MRI has ability to measure the signals from molecule like water and lipid protons enables it to be used in quantitative measurements of bone porosity. MRI analysis has no role to play in the preoperative bone volume or a post-operative peri-implantitis. In fact, this examination is never prescribed in the preoperative reports [8] However, its use in dentistry is limited as it cannot characterize bone mineralization [3]. Post dental implantation, these radiographic techniques are useful as they provide the dentists with long-term success rates by checking the osseointegration of the implants [9]. Although, the benefits and application range of these imaging techniques outweigh the associated risks, several factors still contribute to implant rejection. These factors include poor maintenance of the implants and the growing microbial flora in the soft tissues in the vicinity of the implants.

3. Microbial flora of dental implants

Normal microbiota of healthy implants include gram positive rods and cocci [10]. Peri-implantitis is caused by pathogens especially gram negative bacteria like *Veillonella* sp. and spirochetes including *Treponemadenticola* [11]. Rams et al. (1990) reported in a study that Staphylococci infections are prevalent in periodontal diseases. Microorganisms harbouring in the soft tissues near the dental implants include periodontal pathogens namely *Actinobacillus actinomycetemcomitans, Porphyromonas gingivalis, Prevotella intermedia, Bacteroides forsythus* and *Treponemadenticola* [12]. Periodontal pockets mainly harboured *Fusobacteriumnucleatum, Prevotella intermedia* and *Peptostreptococcus micros* [13].

Presence of spirochetes around ailing implants is in concordance with study, which describes 42% of spirochetes and motile rods around ailing implants due to infection [14]. Peptostreptococcus, Fusobacterium, enteric gram negative rods and yeasts are among the predominant class of microbiota encountered in cultures. On similar lines, organisms such as *P.micros*, *Camphylobacter rectus*, Fusobacterium sp, *Prevotella intermedia* and *Candida albicans* were recovered by Alcoforado et al., whereas *Porphyromonas gingivalis*, *P. intermedia*, Fusobacterium, *Actinobacillus actinomycetmcomitans* and spirochetes were identified in implants by Mombelli et al. and Leonhardt et al. Recent studies corroborating previous reports on the diverse microbiota associated with implantitis are also available [14]. The possibility and extent of peri-implant tissue destruction are insufficiently described in the available studies, however the fact that tissue destruction may progressively lead to aggressive periodontitis culminating into chronic periodontitis cannot be overlooked. A cross sectional split mouth study coupled with assessment of radiographic and clinical parameters are inevitable towards an elaborate analysis of implantitis (Table 1).

In terms of symptoms, implants in partial edentulous patients were more symptomatic than the implants in complete edentulous patients. The periodontal bacteria associated with the implantitis symptoms, often found in greater numbers around the implants include *P. micros*, Fusobacterium, and Eubacterium. Efficient antimicrobial treatment may be helpful in suppressing the periodontal implantitis. In one study, researchers have also found an unidentified herpes virus causing implantitis [15]. Another study reported the elevated levels of Campylobacter and *P. micros* in patients receiving amoxicillin due to the production of beta lactamases [16].

4. Biofilm and tooth

Quorum sensing (QS) is used among bacteria for chemical communication which are genetically governed in response to cell density and influence several functions of the bacteria, e.g., virulence, and the biofilm formation. The biofilm formation are directly regulated by QS activity and more formation of biofilm would affect the treatment via antibiotics as biofilm resist the external unfavourable condition and bacteria persist inside biofilm for long term [17]. Biofilm in the oral cavity is the result of a multistage process that involves formation of a thin pellicle covering the tooth enamel. This biofilm acts as a barrier for the microbes against host immunity and antimicrobial drugs. Saliva is the major source of nutrients for the bacteria in the oral cavity and invariably contains a substantial number of these microorganisms (approx. 10^7bacteria/ml). Bacterial aggregation on the tooth surface is facilitated by the protein and glycoprotein molecules on the tooth surface, implants etc. In response, bacteria express special adhesion structures like lectins and also produce extracellular polysaccharides, e.g., dextrans, levans, which aid in the formation of a thin multi-layered biofilm polymers [18,19]. Streptococci such as *S. viridens, S. mitis* and *S. oralis* are the initial colonisers to which the planktonic bacteria bind with the aid of the receptors. There are secondary colonisers also which include Actinomyces species, *S. mutans*, and *S. sobrinus*. Some bacteria like *Fusobacterium nucleatum* link the early and secondary colonisers by multiplying and co-aggregating with other species [20]. Major nutrients for these biofilms are