

IMPLANT AND OTHER PROSTHESIS RELATED MICROFLORA CHANGES – AN UPDATE

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ABSTRACT: Prosthodontic treatment using dental implants is one of the solutions for partially and completely edentulous patients. The peri-implant area is colonized by a large variety of oral microbial complexes. Various prosthesis may provide means of mechanical attachment to the microflora; this in turn allows their aggregation and colonization. There exists a relationship between the peri-implant microflora, the microbiota on the inner surface of removable superstructures, and the periodontal microflora within the same subject. The microbial leakage around the gap between superstructures and the abutment plays an important role in the bacterial colonization of the internal part of screw retained crowns and bridges. At least 10% implant failures have been suggested to be the result of peri-implantitis. The long term success directly depends on the microbiota around the prosthesis. Proper periodontal infection control before installment of dental implants may prevent early bacterial complications.

KEYWORDS: Biofilm, Dental implants, Peri-implantitis, Microbial leakage, Microflora, Prosthesis

INTRODUCTION

With an increased rate of defective teeth with age, there has been a necessity to provide prostheses such as bridges and removable dentures. The provision of implant retained prostheses is becoming more and more common because of the high survival rate of osseointegrated dental implants. Although placement and restorations is usually the field of the periodontal, oral and maxillofacial surgery or prosthetic specialist, given the increasing numbers of patients treated with osseointegrated fixtures it is increasingly likely that maintenance of these implants will become much more common by the general dentist. After the treatment, the maintenance of good oral environment is periodontally and prosthodontically important. The difficulty to maintain oral hygiene with different prostheses alters the microbiota of the oral environment. There exists a difference in cariogenic bacterial counts between subjects with fixed and removable prostheses as well as the anaerobic bacteria associated with peri-implantitis. It is becoming increasingly clear that successfully integrated implants are susceptible to disease conditions that may lead to the loss of the implant ¹.

Peri-implantitis is associated with complex microbiota and the most relevant species associated with the development of disease remain unclear. Although peri-implant microbiota have been studied previously,² relatively little is known about the microbial complexity, the presence of non-cultivable or unknown species, and the

relationships between microbial community composition and disease. The majority of studies on the oral microbiota with prostheses were cross sectional with a few longitudinally observed investigations of time-course changes³. The present article is a review and an update on microflora changes associated with implant and other prosthesis.

Microbial colonization of the mouth

The mouth harbours many microorganisms in an ecosystem of considerable complexity. The mouth was regarded as a single habitat for microorganisms but it is now realized that the teeth, gingival crevice, tongue, other mucosal surfaces, prosthesis and saliva all from different habitat or sites when microorganisms multiply. Each habitat contains its characteristic population with many different microbial species. Bacteria are the most predominant type of microorganisms present in human oral cavity. More than 30 genera of bacteria have been detected in human mouth of which 25 are regular members of the oral flora. These belong to both aerobic and anaerobic groups of bacteria. On average 750 million microorganisms are present in each ml of saliva.

Microbial adhesion and aggregation have been studied on different substrata, in vivo and in vitro ⁴. Growth

and maturation patterns (Fig. 1) of bacterial plaque have been studied on natural hard oral surfaces, such as enamel and dentin, or artificial surfaces, such as metal or acrylic, using light and electron microscopy and bacterial culture⁵. Despite differences in surface roughness, free energy, and charge, the most important features of initial plaque development (Fig. 2) are similar on all these materials (Siegrist et al. 1991).

Initial colonization and bacteriology of stable implants

The microbiota associated with healthy peri-implant tissues closely resembles that of the flora associated with gingival health. Tissue integration depends on eukaryotic cell compatibility and adhesion to the implant surface. Fundamental physical and molecular principles of cell attachment and adhesion apply to microbial colonization and host-tissue integration (Gristina, 1987). Thus, it is conceivable that implant materials, which are chosen because of their "friendliness" to tissue cells, offer particularly favourable grounds for bacterial adhesion. Although some irregularities may be encountered on oral implant surfaces, the attachment to commercially pure titanium generally is less intimate than to root surface structures. This in turn, would mean that calculus may be chipped off from oral implants without detriment to the implant surface (Matarasso et al. 1996).

Over the years, authors have addressed the interactions between bacteria and oral implant materials such as titanium (Nakazato et al., 1986; Fujioka-Hirai et al. 1987; Joshi and Eley, 1988; Wolinsky et al., 1989; A. Mombelli, 1993; Chang YY, 2012). General growth and maturation patterns of bacterial plaque have been studied by light and electron microscopy and bacterial culture [5]. From the descriptive literature largely, it could be concluded that increase in surface roughness and surface free energy facilitates biofilm formation on dental implant and abutment surfaces. Surface chemistry and the design features of the implant-abutment configuration also play a significant role in biofilm formation.⁶

Microbial colonization of stable osseointegrated implants supporting removable prostheses

In edentulous patients, the flora developing on successfully integrating one-stage trans-mucosal titanium implants was found to be very similar to the mucosal flora on the adjacent alveolar ridge⁷. This flora was established shortly after the installation of the implant. Over 85% of the micro-organisms were identified, in the microscope, as coccoid cells, and over 80% of the cultivated bacteria were Gram-positive facultative cocci. During the first six months after insertion, no significant longitudinal changes were noted in these proportions. Spirochetes were never detected; *Fusobacteria* and black-pigmenting Gram-negative anaerobes were found infrequently.

The microflora associated with stable osseointegrated implants serving successfully as abutments for overdentures was investigated in edentulous patients, two years after implantation⁸. Over 50% of the organisms cultured in their study were facultatively anaerobic cocci, and 17% were facultatively anaerobic rods, while Gram-negative anaerobic rods accounted for only 7%. *Fusobacterium* sp. and *Prevotella intermedia* were both found in 9% of the samples. *Porphyromonas gingivalis* and *spirochetes* were not found. Repeated microbiological and clinical data were collected in patients during the third, the fourth, and the fifth years after implantation. No significant time trends were noted. Separate samples taken within the same patient from different sites showed a similar composition of the microflora. The data of this study are in agreement with results reported by Lekholm et al. (1986), Apse et al. (1989), and Bower et al. (1989) from successful Branemark-type implants.

Microbial colonization of stable osseointegrated implants supporting fixed prostheses

Intra-individual topographical variation of the bacterial flora seems to be more pronounced in partially edentulous patients than in edentates. The microbiota of remaining teeth is probably the primary source of putative pathogens to colonize adjacent implants. Apse et al. (1989) found higher percentages of black pigmented Gram-negative anaerobes and "wet spreaders" (*Capnocytophaga*) on implants of partially edentulous patients than in edentulous patients. This means that the microbial status of remaining teeth influences the fate of newly incorporated implants. When the depth of sulci is normal (<4 mm), microflora in implant sulci is similar to the tooth sulci. As a result, implants' susceptibility to inflammation is the same as teeth⁹.

Bacteriology of the failing implant

An increasing number of studies suggest that anaerobic plaque bacteria may have an adverse effect on peri-implant tissue health¹⁰. As soon as an implant is exposed to the oral cavity plaque will form on its surface. The process may be identical to that seen on teeth, with the formation of pellicle and subsequent microbial colonization. In edentulous patients colonization of the peri-implant sulcus originates from the microflora found in saliva⁷. Pocket formation and loss of bone in the peri-implant area indicate detachment of host tissue cells and availability of "cell-friendly" surfaces for microbial colonization¹¹.

The first data on the microbiota associated with unsuccessful implants were presented by Rams and co-workers^{12,13}. While the samples from the successful implants yielded a predominantly coccoid microbiota, the failures showed significantly elevated levels of spirochetes. In the unsuccessful sites, a substantially different distribution of bacterial morphotypes was found in

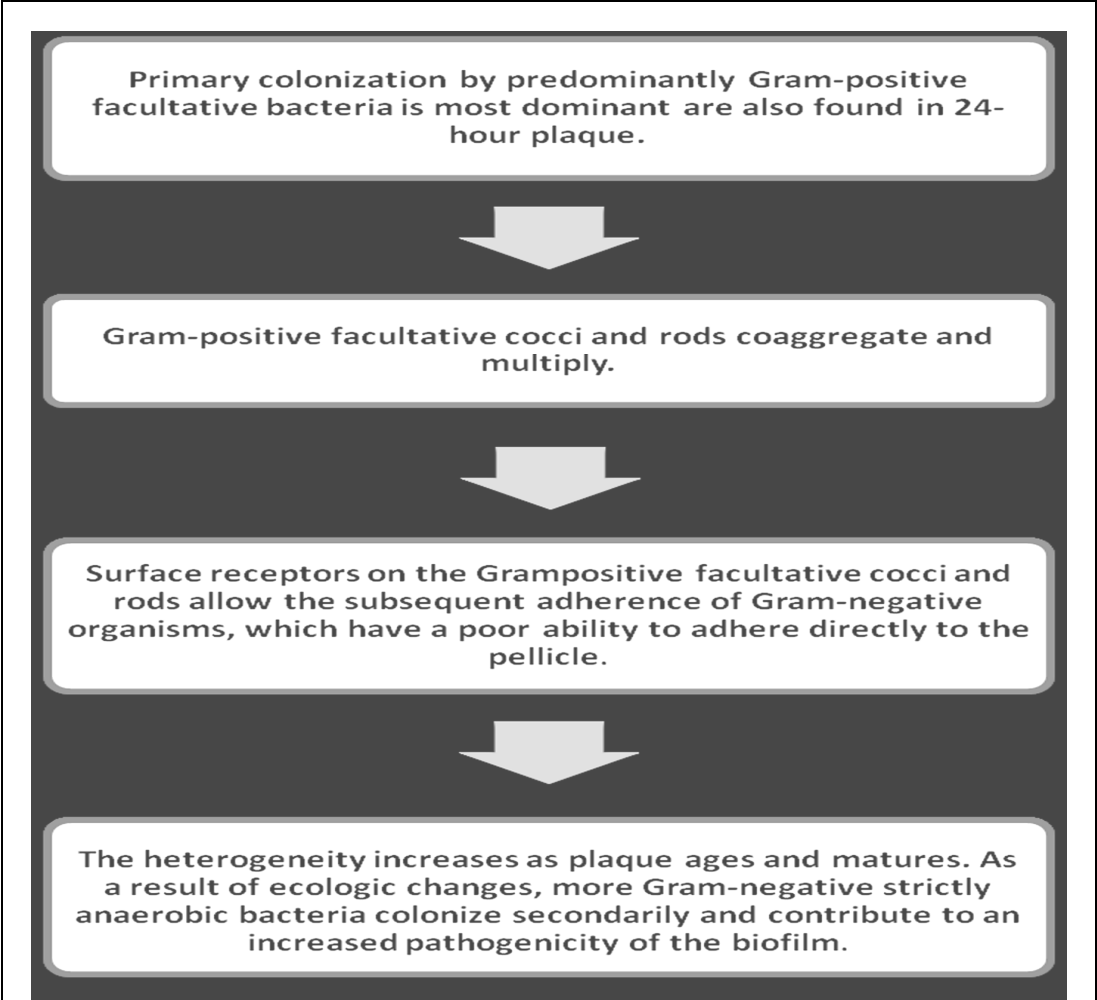


Fig.1. Growth and Maturation pattern of Bacterial plaque.

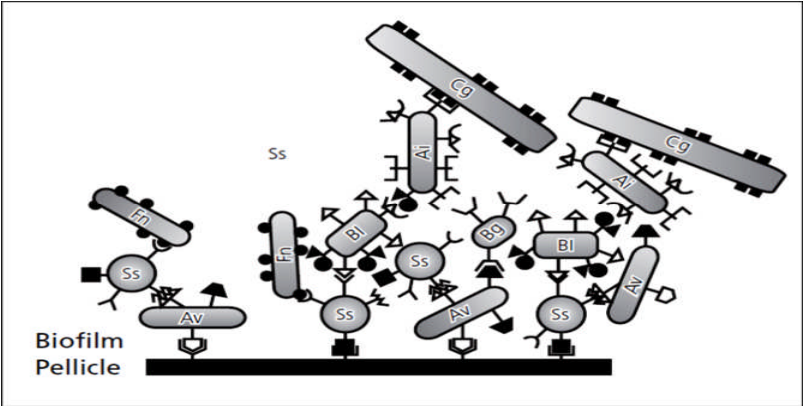


Fig.2. Initial Features of Plaque development

(Courtesy: Jan Lindhe, Periodontology and Implant dentistry, 5thed, 2008, Blackell Munksgaard, Oxford,page No-186, Fig.8.6)

comparison with healthy sites in both the same patients and in the successful patients¹⁴. The study showed that, while spirochetes were not found in any of the successful cases and in only two samples of the healthy sites of the unsuccessful patients, all but one failing site in these patients harboured spirochetes. Failing sites harboured significantly elevated numbers of motile rods and *fusiform* bacteria. The total count of colony-forming units, determined by anaerobic culture, was significantly higher in the failing sites than in the healthy sites. In the samples of the failing sites, 41% of the cultivated organisms were Gram-negative anaerobic rods. This number was significantly higher than that of the successful sites, where the group of facultative cocci predominated. Failing sites harbored significantly elevated numbers of *P. intermedia* and *Fusobacterium sp.* *P.gingivalis* was not found in any of the samples investigated in this study, neither culturally nor by indirect immunofluorescence.

These studies suggested that what was chosen to be called "peri-implantitis" was a site-specific disease process with micro-organisms associated in patterns known from chronic periodontitis of natural teeth. More recent studies have confirmed and extended these earlier findings. Sanz et al (1990) made comparisons between healthy and diseased and between implant and control sites in patients wearing endosteal sapphire ceramic implants¹⁵.

The microflora adjacent to failing osseointegrated implants supporting removable prostheses

There are relatively few studies that have investigated colonization in partially edentulous patients. The prevalence was significantly higher for *Lactobacillus*, *Prevotella spp.* and yeasts in subjects with removable prostheses than in subjects with fixed prostheses. No significant difference was registered in the pattern of microbial composition in subjects with the removable prosthesis when the peri-implant sulcus plaque and the biofilm on the corresponding mucosal side of their prosthesis were examined. The insertion of a removable reconstruction to cover the area of the osseointegrated implants gave rise to a progressive change in the peri-implant plaque towards a more aciduric microflora¹⁶.

Microbial colonization of dental implants in partially edentulous subjects

In comparison of peri-implant microflora of implants carrying either screw retained or cemented suprastructures, subjects showed significant relationship between the frequency of micro-organisms in peri-implant samples of screw retained and in samples from the inner surface of the suprastructures. Furthermore, there was a significant correlation between the incidence of micro-organisms in dental samples and in peri-implant samples of screw retained and from samples of the internal suprastructure surface. These findings indicate that the

microbial leakage through the gap between the suprastructure and the abutment plays an important role in the bacterial colonization of the internal part of screw retained crowns and bridges¹⁷.

The colonization of dental implants by periodontopathic bacteria in partially edentulous patients showed colonization of marginal implant plaque within 14 days, whereas subgingival colonization took longer and occurred within 28 days. It appears that dental implants placed in partially edentulous patients may be colonized by disease-associated bacteria within 14 days of second-stage surgery¹⁸.

In implants suspected of failing because of trauma, microbiological features are similar to those of periodontally healthy teeth, while many suspected periodontal pathogens were found if clinical signs suggested infection. The subgingival microflora of failing osseointegrated implants of various designs showed *Peptostreptococcus micros*, *Wolinella recta*, *Fusobacterium sp.*, and *P. intermedia*. It was also reported significant numbers of enteric rods or *Pseudomonads* in the microflora of failing implants. *A. actinomycetemcomitans*, non-pigmented *Bacteroides species*, *Capnocytophaga sp.*, and *staphylococci* were also detected in some implant failures. In addition, some cases were positive for *Candida albicans*. A limited number of patients demonstrated particularly high counts of *Staphylococcus sp.* implying that these organisms are possible pathogens under certain conditions¹⁹. The microbiota associated with the progression of experimental peri-implantitis and periodontitis occurring concurrently in partially edentulous mouths are similar^{20, 21}

CONCLUSION

Various prostheses may provide means of mechanical attachment to the microflora; this in turn allows their aggregation and colonization. There appears to be a very clear microbiological distinction between clinically stable implants and implants with peri-implant pathology. Undoubtedly, Gram-negative anaerobic bacteria are involved in pathological developments in the peri-implant region. These organisms are also suspected pathogens in periodontitis and orofacial infections. Spirochetes can be perceived as indicators for a flora with anaerobic characteristics which are evidently not a feature of the physiological flora of successful implants. The increasing acceptance of implant placement as a standard treatment option for patients will mean that more and more dentists will be involved in the long term care and maintenance of these implants.

References

1. Tonetti M. Risk factors for osseodisintegration. *Periodontol* 2000 1998;17:55-62. PMID:10337313
<http://dx.doi.org/10.1111/j.1600-0757.1998.tb00123.x>
2. Koyanagi T, Sakamoto M, Takeuchi Y, Ohkuma M, Izumi Y. Analysis of microbiota associated with peri-implantitis using 16S Rna gene clone library. *J Oral Microbiol* 2010;2:5104.
3. Junko Tanaka, Masahiro Tanaka, Takayoshi Kawazoe. Longitudinal research on the oral environment of elderly wearing fixed or removable prostheses. *J Prosthodont Res* 2009;53:83-88. PMID:19318078
<http://dx.doi.org/10.1016/j.jpor.2008.10.003>
4. Mergenhausen SE, Rosan B. Molecular basis of oral microbial adhesion. Washington (DC): American Society for Microbiology, 1985.
5. Theilade E, Theilade J. Formation and ecology of plaque at different locations in the mouth. *Scand J Dent Res* 1985;93:90-95. PMID:3858969
6. Subramani K, Jung RE, Molenberg A, Hammerle CH. Biofilm on dental implants: a review of the literature. *Int J Oral Maxillofac Implants*. 2009 Jul-Aug;24(4):616-26. PMID:19885401
7. Mombelli A, Buser D, Lang NP. Colonization of osseointegrated titanium implants in edentulous patients. Early results. *Oral Microbiol Immunol* 1988;3:113-120. PMID:3269993
<http://dx.doi.org/10.1111/j.1399-302X.1988.tb00095.x>
8. Mombelli A, Mericske-Stern R. Microbiological features of stable osseointegrated implants used as abutments for overdentures. *Clin Oral Impl Res* 1990;1:1-7. PMID:2099207
<http://dx.doi.org/10.1034/j.1600-0501.1990.010101.x>
9. Shahabouee M, Rismanchian M, Yaghini J, Babashahi A, Badrian H, Goroohi H. Microflora around teeth and dental implants. *Dent Res J (Isfahan)*. 2012 Mar;9(2):215-20. <http://dx.doi.org/10.4103/1735-327.95239>
10. Lang NP, Wilson TG, Corbet EF. Biological complications with dental implants: their prevention, diagnosis and treatment. *Clin Oral Implants Res* 2000;11 Suppl 1:146-155. PMID:11168263
<http://dx.doi.org/10.1034/j.1600-0501.2000.011S1146.x>
11. Mombelli. Microbiology of the dental implant. *Adv Dent Res* 1993;7(2):202-206. PMID:8260009
12. Rams TE, Link CC. Microbiology of failing dental implants in humans: electron microscopic observations. *Oral Implantol* 1983;11:93-100.
13. Rams TE, Roberts TW, Tatum H Jr, Keyes PH. The subgingival microbial flora associated with human dental implants. *J Prosthet Dent* 1984;51:529-534. [http://dx.doi.org/10.1016/0022-3913\(84\)90309-3](http://dx.doi.org/10.1016/0022-3913(84)90309-3)
14. Mombelli A, Van Oosten MAC, Schurch E, Lang NP. The microbiota associated with successful or failing osseointegrated titanium implants. *Oral Microbiol Immunol* 1987;2:145-151. PMID:3507627
<http://dx.doi.org/10.1111/j.1399-302X.1987.tb00298.x>
15. Sanz M, Newman MG, Nachnani S, Holt R, Stewart R, Flemmig T. Characterization of the subgingival microbial flora around endosteal sapphire dental implants in partially edentulous patients. *Int J Oral Maxillofac Implants* 1990;5:247-253. PMID:2098328
16. Smedberg, G. Svensäter, S. Edwardsson. The microflora adjacent to osseointegrated implants supporting maxillary removable prostheses. *Clin Oral Implants Res* 1993;4:165-171. <http://dx.doi.org/10.1034/j.1600-0501.1993.040401.x>
17. Keller W, Brägger U, Mombelli A. Peri-implant microflora of implants with cemented and screw retained suprastructures. *Clin Oral Implants Res* 1998;9(4):209-17. PMID:9760895
<http://dx.doi.org/10.1034/j.1600-0501.1998.090401.x>
18. Sreenivas Koka, Michael E. Razzoog, Thomas J. Bloem, Salam Syed. Microbial colonization of dental implants in partially edentulous subjects. *J Prosthet Dent* 1993;70:141-144. [http://dx.doi.org/10.1016/0022-3913\(93\)90009-D](http://dx.doi.org/10.1016/0022-3913(93)90009-D)
19. Alcoforado GAP, Rams TE, Feik D, Slots J. Aspects bacteriologiques des echecs des implants dentaires ostéointegres chez l'homme. *Parodontologie* 1991;10:11-18.
20. Eke PI, Braswell LD, Fritz ME. Microbiota associated with experimental peri-implantitis and periodontitis in adult *Macaca mulatta* monkeys. *J Periodontol* 1998;69(2):190-4. PMID:9526919
<http://dx.doi.org/10.1902/jop.1998.69.2.190>
21. Eke PI, Braswell LD, Fritz ME. Microbiota associated with experimental peri-implantitis and periodontitis in adult *Macaca mulatta* monkeys. *J Periodontol* 1998;69(2):190-4. PMID:9526919
<http://dx.doi.org/10.1902/jop.1998.69.2.190>

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