Review Article

Probiotics and Prebiotics in Periodontal Disease-Revisited

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Abstract

Treatment of periodontal disease in recent years has moved toward an antibiotic/antimicrobial model of disease management. Time has come to shift the paradigm of treatment from specific bacteria elimination to altering bacterial ecology by probiotics. With increase in the incidence of resistance to antibiotics, probiotics may be a promising area of research in periodontal therapy. Probiotics utilize naturally occurring bacteria to confer a healthy benefit when administered in adequate amounts. This paper reviews the evidences for the use of probiotics or prebiotics for the prevention of periodontal diseases. The role of probiotics in periodontics is still in infancy and a complete understanding of the broad ecological changes induced by probiotics is essential to assess their long term consequences for oral health and disease.

Key words: Probiotics, Prebiotics, Periodontal disease, Microorganisms, *Bifidobacterium*

Introduction

Mostly addressed as delicate microscopic specialty, periodontics has entered the saga of metamorphosis that explores and understands human body mechanisms at biomolecular levels. Altering the building blocks of life is a wise and precise way to correct flaws. There have been major shifts in treatment paradigm from nonspecific to specific approach. Now treatment options propose altering ecology of niches, in order to modify pathological plaque to a biofilm of commensalisms.[1]

Role of the resident microbiota: More than 700 species of oral microbiota have been detected in the human mouth and the resident microbiota of one individual may consist of 30-100 species.[2] Resident microbiota actively contributes to host protection through;

1. Blocking of colonization by pathogens[3]
2. Development of cell structure and function[4]
3. Development of the immune system and modulation of inflammatory responses[5]
4. Commensal bacteria influence expression of mediators such as intracellular adhesion molecule I (ICAM-I), E-selectin, and Interleukin(IL-8)[6]
5. Commensal bacteria also modulate immune responses and enhance cellular homeostatic mechanisms[7]

The application of selected beneficial bacteria, as an adjunct to scaling and root planing (SRP), would also inhibit the periodonto-pathogen recolonization of periodontal pockets and thus achieve and maintain periodontal health. With the number of bacteria-resistant diseases on the rise and the length of time it takes to develop new antibiotics, it might be time to consider another alternative, 'Probiotics' in the treatment of periodontal disease.[8]

Probiotics: Probiotics are live micro-organisms administered in adequate amounts with beneficial health effects on the host. Not all bacteria are bad. In fact, beneficial microbes could represent the future of medicine. Antibiotics destroy the harmful bacteria that can cause infection, while also destroying the good bacteria that help to fight infection. Probiotics, on the other hand, repopulate the beneficial bacteria which can help kill pathogenic bacteria and fight against infection. Oral administration of probiotics may also benefit oral health by preventing the growth of harmful microbiota or by modulating mucosal immunity in the oral cavity.[9]

The possibilities of applying probiotic therapy for other medical conditions are being investigated, including recovery from hemorrhagic shock, cholesterol reduction, protection from coronary heart disease, effects on breast cancer cells, liver conditions, skin infections, and reduction of obesity.[10-12]

Probiotics are broadly categorized in two genus *Lactobacillus* and *Bifidobacterium*. While other microorganisms also classified into this group include yeast and moulds e.g., *Saccharomyces cerevisiae, Aspergillusniger, Aspergillusoryzae, Sochromyces boulardii.*[1]

Mechanism of action of Probiotics: Probiotics can help prevent and treat disease through several mechanisms: a) Direct interaction: Probiotics interact directly with the disease-causing microbes, making it harder for them to cause the disease. b) Competitive exclusion: Beneficial microbes

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directly compete with the disease, developing microbes for nutrition or enterocyte adhesion sites. c) Modulation of host immune response- Probiotics interact with and strengthen the immune system and help prevent disease. Probiotics stimulate dendritic cells (antigen presenting cells) resulting in expression of helper T cell (Th1) response, which modulates immunity.[8]

Apoptosis is yet another proposed mechanism. Probiotics are also known to produce antioxidants, which in turn prevent plaque formation by neutralizing the free electrons which are needed for the mineralization of plaque.[13, 14]

Criteria of an ideal microorganism used as Probiotics: [15]

1. High cell viability, resistant to low ph and acids
2. Ability to persist
3. Adhesion to cancel the flushing effect
4. Able to interact or to send signals to immune cells
5. Should be of human origin
6. Should be non-pathogenic
7. Resistance to processing
8. Must have capacity to influence local metabolic activity

Prebiotics: These are non-digestible oligosaccharides that affect the proliferation of resident commensal bacteria, which may exert beneficial effects on the host.[16]

Mechanism of action of Prebiotics: a) Enhance the growth of resident commensal gut bacteria particularly *bifidobacteria* and *lactobacilli*.[17] b) Cellobiose has the additional property of downregulating virulence factors of *Listeria monocytogenes*.[18] c) May also exert a direct effect on the host by stimulating expression of IL-10, Interferon γ, enhancement of immunoglobulin (IgA) secretion, and modulation of inflammatory responses in pathogens.[16]

Studies of Probiotics in periodontal disease

Streptococcus oralis and *S. uberis* have been shown to inhibit the growth of pathogens both in vitro and in vivo. The presence of these organisms is an indicator of good periodontal health.[19]

On oral administration of *Lactobacillus salivarius* in tablet form, it was inferred that the plaque index and probing pocket depth was reduced in patients who were smokers when, compared to a placebo group.[9]

The subgingival application of beneficial bacteria *S. sanguis, S. salivarius, S. mitis* (replacement therapy), has been shown to delay re-colonization by periodontal pathogens, reduce inflammation and improve bone density and bone levels in beagle dogs.[20]

Koli-Klais et al observed that L. gasseri strains isolated from periodontally healthy subjects were more efficient at inhibiting the growth of *Aggregatibacter actinomycetemcomitans*, than strains from periodontally diseased subjects.[21]

Ishikawa et al. observed in vitro inhibition of *P. gingivalis, P. intermedia* and *P. nigrescens* by daily ingestion of *L. salivarius* in tablet form.[22]

Recently Van Essche et al. have reported that *Bdellovibriobacteriovorus*, attack prey on and kill *A. actinomycetemcomitans*, thus suggesting a potential scope for the role of *B. bacteriovorus* in the prevention and treatment of periodontitis.[23]

The inhibitory activity of homofermentive *lactobacilli* against periodontal pathogens was principally related to their production of acid, not hydrogen peroxide or bacteriocin.[22]

Hojo et al. suggested that *bifidobacterium* inhibit some black pigmented anaerobes by competing for an essential growth factor vitamin K.[24]

Harini PM found that probiotic mouth rinse was effective in reducing plaque accumulation and gingival inflammation.[25]

A study done by Vivekananda MR using *L. reuteri* Prodentis lozenges showed the plaque inhibition, anti-inflammatory, and antimicrobial effects of *L. reuteri* Prodentis. The study proposed that probiotics could serve as a useful adjunct or alternative to periodontal treatment when SRP might be contraindicated.[26]

Conclusion

With fast evolving technology and integration of biophysics with molecular biology, designer probiotics poses huge opportunity to treat diseases in a natural and non-invasive way. Periodontitis has established risk of various systemic diseases like diabetes, atherosclerosis, preterm low birth.[27-29] Thus, a critical need to establish good periodontal health for attaining good systemic health is of utmost importance and probiotics are promising, safe, natural, and side effects free option.

Considering the current critical methodological reviews and very few clinical trials, complete understanding of the broad ecological changes induced by probiotics is essential to assess their long term consequences for oral health and disease. Systematic studies and randomized controlled trials are needed to find out the best probiotic/prebiotic strains and means of their administration in different oral health conditions.

References

1. Chatterjee A, Bhattacharya H, Kandwal A. Probiotics in periodontal health and disease. J Indian Soc Periodontol 2011;15(1):23-28.
2. Aas JA, Paster BJ, Stokes LN, Olsen I, Dewhirst FE. Defining the normal bacterial flora of the oral cavity. J Clin Microbiol 2005;43:5721-32.
3. Mead GC, Barrow PA. Salmonella control in poultry by competitive-exclusion or immunization. Lett Appl Microbiol 1990;10:221-7.
4. Hooper LV, Falk PG, Gordon JI. Analyzing the molecular foundations of commensalism in the mouse intestine. Curr Opin Microbiol 2000:3:79-85.
5. Sansonetti PJ. War and peace at mucosal surfaces. Nature Rev Immunol 2004;4:953-64.
6. Dixon DR, Bainbridge BW, Darveau RP. Modulation of the innate immune response within the periodontium. Periodontol 2000 2004;35:53-74.
7. Hasegawa Y, Mans JJ, Mao S, Lopez MC, Baker HV, Handfield M, et al. Gingival and epithelial cell transcriptional responses to commensal and opportunistic oral microbial species. Infect Immun 2007;75:2540-7.
8. Deepa D, Mehta DS. Is the role of probiotics friendly in the treatment of periodontal diseases!!- J Indian Soc Periodontol 2009;13(1):30-31.
9. Shimauchi H, Mayanagi G, Nakaya S, Minamibuchi M, Ito Y, Yamaki K, et al. Improvement of periodontal condition by probiotics with Lactobacillus salivarius WB21: A randomized, double-blind, placebo-controlled study. J Clin Periodontol 2008;35:897-905.
10. Reid G, Jass J, Sebulsky MT, McCormick JK. Potential uses of probiotics in clinical practice. Clin Microbiol Rev 2003;16:658-66.
11. Geier MS, Butler RM, Howarth GS. Inflammatory bowel disease: Current insights into pathogenesis and new therapeutic options; probiotics, prebiotics and symbiotics. Int J Food Microbiol 2007;115:1-11.
12. Weng MQ, Walker WA. Bacterial colonization, probiotics, and clinical disease. J Pediatr 2006;149:5107-14.
13. Marco ML, Pavan S, Kleerebezem M. Towards understanding molecular modes of probiotic action. Curr Opi Biotechnol 2006;17:204-10
14. Nomoto K. Prevention of infections by probiotics. J Biosci Bioeng 2005;100:583-92.
15. Mackay AD, Taylor MB, Kibbler CC, Hamilton-Miller JM. Lactobacillus endocarditis caused by a probiotic organism. Clin Microbiol Infect 1995;5:290-2.
16. Forchielli ML, Walker WA. The role of gut-associated lymphoid tissues and mucosal defence. Br J Nutr 2005;93:541-8.
17. Gibson GR, McCartney AL, Rastall RA. Prebiotics and resistance to gastrointestinal infections. Br J Nutr 2005;93:531-4.
18. Park SF, Kroll RG. Expression of listeriolysin and phosphatidylinositol -specific phospholipase-C is repressed by the plant derived molecule cellobiose in Listeria monocytogenes. Molec Microbiol 1993;8:653-61.
19. Hillman JD, Socransky SS, Shivers M. The relationships between streptococcal species and periodontopathic bacteria in human dental plaque. Arch Oral Biol 1985;30:791-5.
20. Teughels W, Newman MG, Coucke W, Haffajee AD, van der Mei HC, Kaake SK, et al. Guiding periodontal pocket recolonization: a proof of concept. J Dent Res 2007; 86:1078-82.
21. Koll-Klais P, Mandar R, Leibur E, Marcotte H, Hammarstrom L, MIkelsaar M. Oral lactobacilli in chronic periodontitis and periodontal health: species composition and antimicrobial activity. Oral Microbiol Immunol 2005;20:354-61.
22. Ishikawa H, Aiba Y, Nakanishi M, Oh-Hashi Y, Koga Y. Suppression of periodontal pathogenic bacteria by the administration of Lactobacillus salivarius T12711. J Jap Soc Periodontol 2003;45:105-12.
23. Van Essche M, Quirynen M, Sliepen I, Van Eldere J, Teughels W. Bdellovibrio bacteriovorus attacks Aggregatibacter actinomycetemcomitans. J Dent Res 2009;88:182-6.
24. Hoju K, Mizoguchi C, Takemoto N, Ohshima T, Gomi K, Arai T, et al. Distribution of salivary Lactobacillus and Bifidobacterium species in periodontal health and disease. Biosci Biotechnol Biochem 2007;71:152-7.
25. Harini PM, Anegundi RT. Efficacy of a probiotic and chlorhexidine mouth rinses: a short term clinical study. J Indian Soc Pedod Prev Dent. 2010;28(3):179-82.
26. Vivekananda MR, Vandana KL, Bhat KG. Effect of the probiotic Lactobacilli reuteri (Prodentis) in the management of periodontal disease: a preliminary randomized clinical trial. J Oral Microbiol. 2010;2(2):5344.
27. Brian L. Mealey, Thomas W. Oates. Diabetes mellitus and periodontal diseases. J Periodontol 2006;77:1289-1303.
28. Beck JD, Offenbacher S, Williams R, Gibbs P, Garcia R. Periodontitis: a risk factor for coronary heart disease? Ann Periodontol. 1998 Jul;3(1):127
29. Offenbacher S, Katz V, Fertik G, Collins J, Boyd D, Maynor G, McKaig R, Beck J. Periodontal infection as a possible risk factor for preterm low birth weight. J Periodontol. 1996 Oct;67(10 Suppl):1103-13.