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Original Article

Effects of non-surgical periodontal treatment with probiotic supplementation on metabolic dysfunction in patients with periodontitis: a retrospective study

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ABSTRACT

Objectives: Probiotic supplementation, integrated into routine oral care, may improve periodontal status and metabolic function. In this retrospective longitudinal study, we evaluated the efficacy of probiotics added to non-surgical periodontal treatment (NSPT) in reducing the burden of oral pathogens and improving metabolic dysfunction. **Methods:** Twenty outpatients with chronic periodontitis and at least one metabolic abnormality underwent NSPT with daily probiotic supplementation for 12 weeks. Baseline and post-intervention assessments included clinical indices, blood pressure, and blood biomarkers (HbA1c, fasting glucose, and lipid profiles), with analysis of oral pathogens using qPCR. **Results:** Among the 13 eligible participants, probiotics with NSPT resulted in significant reductions in HbA1c (-0.3%, $p<0.001$), and systolic blood pressure (-9.6 mmHg, $p<0.001$), and *Tannerella forsythia* ($p<0.05$) levels, along with decreasing trends in other pathogens. However, no significant changes were noted in periodontal indices, including probing pocket depth and bleeding on probing, nor in lipid profiles. **Conclusions:** These findings suggest that probiotic supplementation with NSPT may improve glycemic control and systolic blood pressure but may have a limited effect on periodontal indices, warranting larger trials to confirm its potential.

Key Words: Blood glucose, Blood pressure, Periodontal therapy, Periodontitis, Probiotics

Introduction

Metabolic syndrome is characterized by the presence of any three out of five criteria: fasting blood glucose (FBG), increased waist circumference, elevated triglycerides (TG), reduced high-density lipoprotein cholesterol (HDL-C), and elevated blood pressure [1]. Inadequate management of these risk factors can lead to the development of chronic systemic diseases [1]. Optimal management of these risk factors primarily involves dietary changes to improve metabolic health. Emerging evidence highlights the central role of diet in modulating microbiota composition [2], while the oral-gut microbial axis has been shown to influence systemic immunomodulation [3,4]. In this context, probiotics appear to modulate the immune system through multiple mechanisms including competition for nutrients and adhesion sites in the gut, interference with colonization of pathogens, production of antimicrobial compounds like bacteriocins, alteration of colonic pH, and non-specific stimulation of host immune responses [5]. Furthermore, studies have demonstrated that probiotic consumption enhances gut microbiota composition and homeostasis,

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thereby reducing the production of reactive oxygen species (ROS) and inflammatory metabolites, which subsequently decreases the risk of systemic inflammation.

A recent systematic review and meta-analysis showed that probiotic supplementation can reduce the levels of cardiovascular risk factors, such as body mass index (BMI), FBG, and low-density lipoprotein cholesterol (LDL-C) in patients with metabolic syndrome [6]. In mild periodontitis, non-surgical periodontal treatment (NSPT) may worsen coronary artery disease and metabolic syndrome control [7]. Given this association, restoring the microbial balance in the oral cavity and the gut through NSPT combined with adjunctive probiotic therapy may positively impact systemic inflammation and, consequently, improve metabolic health outcomes.

Chronic periodontitis is a multifactorial inflammatory disease characterized by progressive destruction of the tooth-supporting structures, and affects a significant portion of the adult population worldwide [8]. In particular, periodontitis is increasingly recognized as a comorbid condition associated with several chronic systemic diseases, including diabetes mellitus (DM), cardiovascular disease, metabolic diseases, rheumatoid arthritis, certain cancers, respiratory diseases, and cognitive disorders including Alzheimer's disease [9-12]. Emerging evidence suggests that periodontitis and these chronic diseases share common risk factors and immunopathological mechanisms involving host-microbial dysbiosis, highlighting the potential for periodontal treatment to improve systemic health outcomes [12]. This intricate relationship between oral and systemic health has stimulated interest in exploring adjunctive therapies that extend benefits beyond local periodontal treatment [13].

Unlike antibiotics, probiotics restore microbial balance while suppressing the growth of pathogenic microbes in both the oral cavity and the gut. This makes them a promising adjunctive approach to periodontal treatment [14], particularly in the management of periodontal disease associated with systemic disease [15]. Sabatini et al.[16] demonstrated that probiotic supplementation in diabetic patients with gingivitis significantly improved both gingival health and glycemic control. In addition, consumption of probiotics produces short-chain fatty acids and bacteriocins, creating an unfavorable environment for pathogenic bacteria in the gut [17], and can reduce systemic inflammation through decreasing ROS and inflammatory metabolites [18]. These findings highlight the potential of probiotics to positively infuence both oral health and systemic health parameters.

Previous studies have primarily focused on evaluating the effects of individual probiotic strains or analyzing either periodontal or metabolic indices separately. However, studies that comprehensively analyze both periodontal and metabolic indices to assess whether multi-strain probiotics can influence systemic metabolic health remain limited. Therefore, this retrospective study aims to evaluate the clinical efficacy of multi-strain probiotics as an adjunct to NSPT, with a particular focus on their effects on chronic disease highly associated with periodontal disease, specifically DM and cardiovascular disease.

Methods

1. Study design

The study included a continuous cohort of outpatients at the Department of Oral and Maxillofacial Surgery at Apple Tree Dental Hospital between 1 June 2023 and 31 July 2024 who underwent non-pharmacological treatment after being diagnosed with chronic periodontitis and agreed to donate their biospecimens and the related clinical data to the Apple Tree Oral Biobank at the Apple Tree Medical Foundation, a part of Korea Biobank Network operated by Korea National Institute of Health. The study was approved by the Institutional Review Board of Apple Tree Medical Foundation (approval number: ATDH-2024-0007) and was conducted in accordance with the 1975 Declaration Helsinki (World Medical Association, revised in 2013).

2. Study procedures

Study participants underwent a comprehensive treatment regimen consisting of periodontal debridement, oral hygiene education, and daily administration of a probiotic supplement for 12 weeks <Fig. 1>. The use of other probiotic supplements was prohibited

during the treatment. Clinical and laboratory assessments, including periodontal examination, analysis of oral pathogenic bacteria, blood pressure measurements, and blood chemistry tests, were performed at baseline and post intervention by trained clinicians according to standardized protocols.

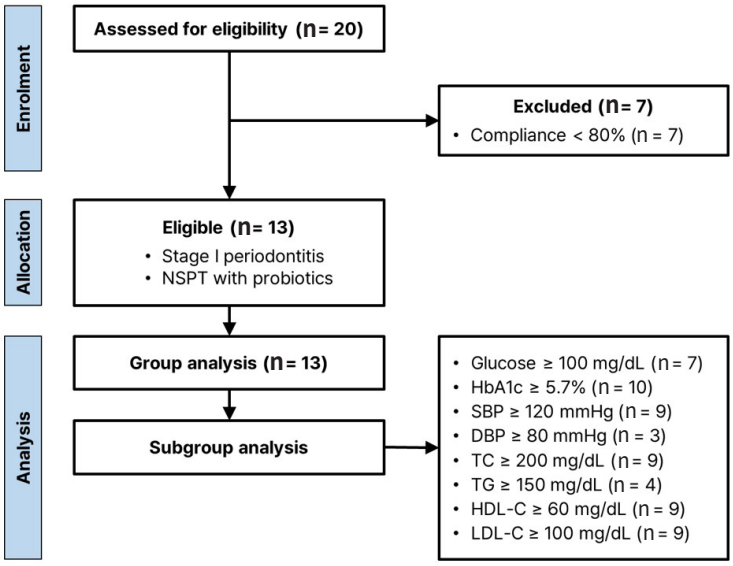

Fig. 1. Flowchart of the retrospective pilot study

3. Study population

The study included participants aged 19 to 79 years who had at least one of the following parameters above normal reference values: (i) FBG ≥100 mg/dL, (ii) glycated hemoglobin (HbA1c) ≥5.7%, (iii) systolic blood pressure (SBP) ≥120 mmHg, (iv) diastolic blood pressure (DBP) ≥80 mmHg, (v) total cholesterol (TC) ≥200 mg/dL, (vi) TG ≥150 mg/dL, (vii) HDL-C ≤60 mg/dL, and (viii) LDL-C ≥100 mg/dL. Patients were excluded if they had any serious systemic disease, including cardiovascular disease, immunological disorder, respiratory disease, gastrointestinal or biliary disease, neurological disorder, musculoskeletal disease, or malignant infectious disease. In addition patients with moderate to severe dental condition (e.g., periodontitis stage II-IV, caries, xerostomia, or peri-implantitis), uncontrolled hypertension (SBP/DBP ≥160/100 mmHg after 10 minutes of rest), or uncontrolled DM (FBG ≥180 mg/dL or initiation of DM medication within the previous three months) were excluded. Individuals with psychiatric disorders (e.g., schizophrenia, depression, substance abuse, or alcohol abuse) or a history of bleeding disorders, including current use of antiplatelet or anticoagulant medications, were also excluded. Women who were pregnant, planning to be pregnant, breastfeeding, or within six months of giving birth were not eligible to participation.

4. Data collection

Data were retrieved from the electronic medical record system of Apple Tree Dental Hospital, including demographic information and clinical outcomes. All data were anonymized, securely stored as PDF files, and encrypted to ensure patient confidentiality, to authorised researchers for study purposes only.

5. Clinical evaluations

The PPD and BOP indices were obtained by averaging the measurements at the mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, and distolingual sites of the Ramfjord teeth (maxillary right first molar, maxillary left central incisor, maxillary left first

premolar, mandibular left first molar, mandibular right central incisor, and mandibular right first premolar) [19]. A North Carolina periodontal probe (Hu-Friedy, IL, USA) was used with all measurements rounded to the nearest millimeter.

The periodontal pathogens were analyzed by extracting genomic DNA from mouthwash samples using the Bacteria Genomic DNA Isolation Kit (LaboPass™, Cosmogenetech, Korea), followed by quantitative PCR (qPCR) analysis of six bacterial species (*Porpyromonas gingivalis*, *Tannerella forsythia*, *Treponema denticola*, *Prevotella intermedia*, *Fusobacterium nucleatum*, and *Streptococcus mutans*) as previously reported [19].

Clinical diagnoses were performed by trained nurses and board-certified clinical pathologists. Blood pressure was measured using a calibrated sphygmomannometer after 5 minute of seate rest. Blood samples (4 mL) were collected by venupuncture into BD Vacutainer® SST™ tubes after an 8-hour fast. Samples were centrifuged at 3,000 rpm for 10 minutes using the DM0408 centrifuge (DLAB Scientific, China) to obtain serum. Biochemical analyses, including FBG, TC, TG, HDL-C, and LDL-C, were performed on an A25 automated analyzer (BioSystems, Spain). HbA1c levels were measured using the A1Care® analyzer (i-SENS, Korea) according to the manufacturer's instructions. All biochemical parameters were measured in duplicate, and the mean values were used for statistical analyses.

Adherence to the probiotic regimen was assessed by verbal confirmation and the number of remaining probiotic sachets remaining at the time of the final visit (second visit). Participants who reported having three or fewer sachets remaining at the final visit were considered eligible for inclusion in the analysis.

6. Interventions

The periodontal debridement included supra- and subgingival instrumentation at all sites using 11/12 and 13/14 Gracey curettes (Hu-Friedy, IL, USA) and ultrasonics (EMS, Switzerland). The oral health recommendations included brushing with a manual toothbrush for at least minimum of 3 min, twice a day, and using interdental brushes to clean between the teeth. Instructions were tailored to the patient's specific needs for optimal plaque control. The patients were then instructed to take one sachet (3 g) of powdered probiotics (DOCSmedi, Korea) daily for 12 weeks. The composition of the probiotic product is detailed in <Table 1>.

Table 1. Composition of the probiotic supplement

Probiotic regimen	Amount per sachet (3 g)
Lactobacillus strains (*L. plantarum* DM083, *L. fermentum* DM072, *L. fermentum* DM075, *L. rhamnosus* DM163)	10^9 CFU
Vitamin D	10 μg
Zinc	8.5 mg
Selenium	55 μg
Carbohydrates	3 g

7. Data analysis

The entire patient population was evaluated, with subgroups formed based on participants who exceeded normal reference values for disease-specific variables. Changes in these subgroup-defining variables were analyzed before and after the intervention. Data analysis was performed using R software (ver.4.4.2) with ggplot2 package (ver.3.5.1). Continuous variables were presented as mean and standard deviation (SD) or median with interquartile range (IQR), depending on the data distribution. Categorical variables were summarized as frequencies and percentages. Paired t-tests were used for normally distributed data, while the Wilcoxon signed-rank test was used for non-normally distributed data to assess changes in clinical outcomes after probiotic use. A $p<0.05$ was considered statistically significant for all analyses.

Results

1. Characteristics of the study population

A total of 13 out of 20 patients undergoing non-pharmacological treatment were included in the study. The study population comprised 11 women and 2 men, ranging in age from 43 to 68 years, with a mean age of 55.6 (±8.5) years. Of the enrolled participants, 15.4% were smokers. Participants attended the clinic a minimum of 2 times and a maximum of 3 times, with a mean of 2.46 visits. Follow-up time ranged from a minimum of 85 days to a maximum of 140 days, with an average of 107.7 days. Importantly, none of patients enrolled reported any treatment-emergent adverse events.

2. Clinical variables

Twelve weeks of NSPT with concomitant probiotic supplementation did not result in statistically significant improvements in PPD, the maximum PPD (PPD_{max}), or BOP <Table 2>; however, periodontal indices remained stable throughout the intervention period. However, blood tests showed a statistically significant reduction in HbA1c levels (0.25, 4.28%, $p<0.01$). In addition qPCR analysis of six oral pathogenic bacteria showed a significant reduction in *T. forsythia* levels ($p<0.05$) <Fig. 2>. Although statistically significant, reductions in other bacterial species, including *P. gingivalis*, *P. intermedia*, *F. nucleatum*, and *S. mutans* were also observed.

Table 2. Clinical outcomes after 12 weeks of NSPT with probiotic supplementation (N=13)

Variables	Baseline	12 weeks	*p*
PPD (mm)	2.08±0.36	2.02±0.32	0.588*
PPD_{max} (mm)	2.82±0.51	2.71±0.42	0.467*
BOP (%)	12.52±11.99	16.11±12.36	0.447*
Glucose	95.15±12.52	97.85±10.85	0.724**
HbA1c (%)	5.84±0.37	5.59±0.34	0.001*
SBP (mmHg)	124.23±13.01	118.38±12.75	0.139*
DBP (mmHg)	74.54±7.37	70.85±11.63	0.228*
TC (mg/dL)	227.08±41.94	234.08±49.60	0.354*
TG (mg/dL)	115.46±56.58	127.08±78.13	0.517*
HDL-C (mg/dL)	63.38±10.46	65.28±14.35	0.372*
LDL-C (mg/dL)	120.85±30.97	118.00±33.18	0.622*

*by paired t-test, **by Wilcoxon signed-rank test
Values are presented as Mean±SD.

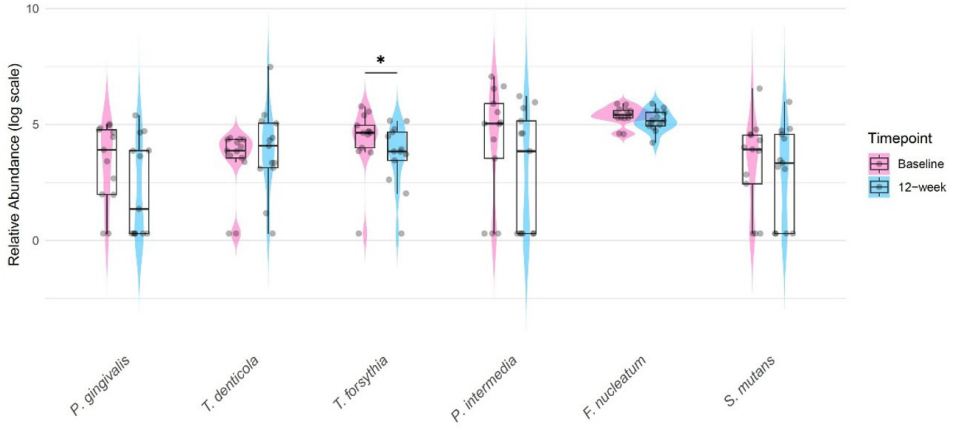

Fig. 2. Changes in oral pathogenic bacteria after 12 weeks of probiotic use as an adjunct to periodontal debridement in all patients (N=13). Superimposed violin, dot, and box plots with IQR were generated using R with the ggplot2 package. *$p<0.05$ by Wilcoxon signed-rank test on the raw data

3. Subgroup analysis

Subgroups were categorized on the basis of the normal reference values for blood test results. <Table 3> shows the demographic characteristics of these subgroups and the changes in the intervention outcomes. The HbA1c subgroup was the largest with ten participants, while the DBP subgroup was the smallest, with only three participants. The TG subgroup had the highest mean age, whereas the DBP subgroup had the lowest.

Analysis of metabolic syndrome-related variables after the intervention showed significant improvements in the HbA1c and SBP subgroups. In the HbA1c subgroup (N=10, HbA1c≥5.7%), mean HbA1c decreased by 0.3 (5%, p<0.001). In the SBP subgroup (N=9, SBP≥120 mmHg), mean SBP decreased by 9.6 (7.3%, p<0.01). No significant changes were observed in the other subgroups.

Table 3. Subgroup analysis according to the groups defined by baseline thresholds

Subgroup	N	Age	Sex (female)	Smoker	Intervention		p^*
			N(%)	N(%)	Baseline	12 weeks	
Glucose≥100 mg/dL	7	56.1±8.6	7(100.0)	1(14.3)	103.4±3.0	96.1±8.1	0.060
HbA1c≥5.7%	10	52.7±7.4	10(100.0)	2(20.0)	6.0±0.2	5.7±0.2	<0.001
SBP≥120 mmHg	9	54.8±8.9	8(88.9)	2(22.2)	131.3±7.3	121.7±10.7	0.007
DBP≥80 mmHg	3	51.7±14.2	3(100.0)	0(0.0)	84.3±4.0	73.3±19.3	0.381
TC≥200 mg/dL	9	56.0±8.8	8(88.9)	2(22.2)	248.3±28.8	256.0±42.1	0.489
TG≥150 mg/dL	4	59.5±7.9	3(75.0)	1(25.0)	185.0±18.3	183.0±63.0	0.961
HDL-C≥60 mg/dL	9	55.1±9.2	7(77.8)	1(11.1)	68.2±8.4	71.8±10.0	0.122
LDL-C≥100 mg/dL	9	56.6±8.4	8(88.9)	2(22.2)	137.7±18.6	129.8±30.0	0.268

*by paired t-test, Values are presented as Mean±SD.

Discussion

This retrospective study aimed to evaluate the clinical efficacy of NSPT combined with multi-strain probiotic supplementation and comprehensively analyze both periodontal and metabolic indices to explore its impact on systemic health. Current periodontal disease models emphasize the importance of host-microbial homeostasis, suggesting that adjunctive probiotic therapy with NSPT may aid in restoring microbial balance and positively influence systemic immune regulation. Unlike previous studies that primarily focused on improving periodontal health, this study sought to integrate the assessment of both periodontal and metabolic health to better clarify the effects of multi-strain probiotics on both oral and systemic health.

The minimal changes observed in periodontal indices might be attributed to both the relatively mild baseline periodontitis severity and the complexity of host-microbial interactions in metabolic syndrome patients, which corresponds to stage I periodontitis [21]. In this study, only patients with Stage I periodontitis or mild periodontal conditions were included to evaluate the effects of early intervention with probiotics in the initial stage. A recent systematic review shown that a greater reduction in PPD is associated with more substantial mean PPD reduction [22]. However, the lack of improvement in mean BOP suggests that NSPT combined with probiotic therapy was ineffective in reducing gingival inflammation within the 12-week intervention period. The chronic nature of periodontal tissue destruction and the complex inflammatory processes involved may require longer intervention periods to reverse these established clinical manifestations of periodontal disease with the therapeutic regimen used in this study. Future studies should consider evaluating the inflammatory cytokine profiles to better understand the immunomodulatory effects of probiotic supplementation.

Although periodontal indices such as PPD and BOP remained stable without significant improvements, the stability of these parameters over 12 weeks suggests that adjunctive probiotic therapy may have helped maintain periodontal health during NSPT, preventing further deterioration. Microbiological analysis showed a significant reduction in *T. forsythia,* while all six bacterial

species showed a decreasing trend following probiotic supplementation. *T. forsythia* is a key periodontopathogen associated with disease progression, and its reduction has been linked to improved periodontal outcomes. The significant reduction in *T. forsythia* levels in consistent with previous findings by Cho et al. [23] and Pudgar et al. [24] and may be due to the nature of *Lactobacillus* strains that can inhibit *T. forsythia* through competitive exclusion and the production of specific bacteriocin [25]. These findings suggest that probiotic supplementation may have played a role in suppressing periodontal pathogens, potentially contributing to microbial homeostasis in the oral cavity.

Recent systematic reviews and meta-analyses have shown that NSPT without any additional therapy significantly reduced HbA1c levels in periodontitis patients with DM (0.16) and without DM (0.31) at 12 weeks follow-up [26,27]. A recent systematic review meta-analyzed 21 randomized controlled trials and showed a significant reduction in SBP and other cardiovascular disease risk markers after NSPT [28]. This finding is clinically meaningful as it suggests that improvements in key metabolic health markers, such as blood glucose and blood pressure, can be achieved through non-pharmacological interventions, including periodontal care and probiotic supplementation. The observed metabolic improvements may be attributed to the ability of probiotics to enhance insulin sensitivity, modulate gut microbiota composition, and reduce systemic inflammation by suppressing pro-inflammatory cytokines such as TNF-α and IL-6 [29].

The oral cavity strain *L. fermentum* DM075 can reduce nitrate (NO_3-) to nitrite (NO_2-) [30] and may participate in the human nitrate-nitrite-nitric oxide pathway to promote vasodilation and improve endothelial function [31]. The strain *L. fermentum* DM072, also isolated from the oral cavity, can produce hydrogen peroxide and suppress the growth of *S. mutans* on the tooth surface [32]. In addition, an *in vivo* study using *L. plantarum* DM083 has been shown to reduce postprandial glucose levels, while *L. rhamnosus* DM163 has anti-inflammatory functions in vitro (both data to be published elsewhere). These findings suggest that the combination of different *Lactobacillus* strains with multiple functions in our probiotic supplement may provide complementary mechanisms for improving cardiovascular health, particularly in individuals with elevated blood pressure. However, the promising *in vitro* and *in vivo* data should be further evaluated in clinical trials.

The absence of significant changes in lipid profiles may be attributed to the strain-specific effects of probiotics, where some strains impact glucose metabolism and blood pressure regulation more than lipid metabolism. Some previous findings, such as the case report, showed improvements in cholesterol parameters with probiotic supplementation [23]. This discrepancy may be due to several factors, including the strain-specific effects of probiotics, with some strains appearing to affect glucose metabolism and blood pressure regulation more than lipid metabolism. Previous studies have suggested that while certain probiotic strains may affect lipid profiles through mechanisms such as bile salt hydrolase activity and cholesterol assimilation, results may require longer treatment durations or higher doses to become apparent [33]. Furthermore, the relatively short intervention period of 12 weeks may not have been sufficient to observe significant changes in lipid metabolism, suggesting the need for longer observation periods in future studies focusing on dyslipidemia.

This study was conducted in accordance with routine clinical protocols. As a result, research-specific parameters such as clinical attachment loss were not included due to practical limitations in data collection. The limitations of the study, particularly the small sample size and the recruitment of participants from a single hospital, should be noted, as they may limit the generalizability of the findings and reduce the statistical power to detect significant changes in all measured parameters. In addition, the study included a broad age range (19-79 years), which may have introduced variability in general health status and oral conditions. Given the small sample size, subgroup analyses, particularly in groups with very few participants (e.g., DBP subgroup, n=3), should be interpreted with caution due to the increased risk of statistical bias. Moreover, the absence of a control group limits the ability to establish a causal relationship between the intervention and observed effects. The lack of multivariate analysis further restricts the ability to account for potential confounding factors. Additionally, as this study was of relatively short duration, long-term follow-up studies are needed to determine the sustained effects of probiotics on periodontal and systemic health. To address this, inclusion criteria

were carefully defined, and efforts were made to design a multicenter study to capture a more diverse population. Larger-scale, randomized controlled trials are needed to confirm these results and to explore the full range of benefits that multi-strain probiotics can offer in both periodontal and systemic health management. Furthermore, optimizing the combination of strains, dosage, and duration of treatment is crucial for maximise the therapeutic potential of probiotics in different patient populations.

Conclusions

This retrospective study offers valuable insights into emerging periodontal approaches utilizing probiotic supplementation for both oral microbial modulation and metabolic improvement.

1. Probiotic supplementation with NSPT may improve glycemic control and blood pressure regulation
2. Limited effects on periodontal clinical parameters observed
3. Significant potential for managing metabolic co-morbidities in periodontal patients

This highlights the promising link between periodontal treatment approaches and systemic health outcomes.

Notes

Author Contributions

Conceptualization: MY Cho, HS Kim, IS Hwang; Data collection: MY Cho, JH Eom, EM Choi; Formal analysis: MY Cho, JY Hwang, IS Hwang; Writing-original draft: MY Cho, IS Hwang; Writing-review&editing: MY Cho, JY Hwang, JH Eom, EM choi, JH Lee, YJ Kim, JY Hwang, HS Kim, IS Hwang

Conflicts of Interest

H.-S.K holds stocks of DOCSmedi, Co., Ltd. The remaining authors have no conflict of interest to disclose.

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Ethical Statement

This study was approved by the Institutional Review Board (IRB) of Institutional Review Board of Apple Tree Medical Foundation (IRB No. ATDH-2024-0007).

Data Availability

Data can be obtained from the corresponding author.

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We used ChatGPT 4o to correct grammatical errors of the manuscript.

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프로바이오틱스 섭취를 동반한 비수술적 치주 치료가 치주염 환자의 대사 기능 개선 효과(후향적 연구)

초록

연구목적: 프로바이오틱스 보충제를 일상적 구강 관리에 통합하는 것은 치주 상태와 대사 기능을 개선할 수 있다. 이 후향적 종단 연구에서는 비외과적 치주 치료(NSPT)에 프로바이오틱스를 추가하여 구강 병원균 부담 감소 및 대사 기능 장애 개선에 대한 효능을 평가하였다. **연구방법:** 만성 치주염과 적어도 하나의 대사 이상을 가진 20명의 외래 환자들이 12주 동안 매일 프로바이오틱스 보충제와 함께 NSPT를 받았다. 기준선 및 중재 후 평가에는 임상 지표, 혈압, 그리고 혈액 생체지표(HbA1c, 공복 혈당, 지질 프로필)가 포함되었으며, qPCR을 사용하여 구강 병원균을 분석하였다. **연구결과:** 적격한 13명의 참가자 중, NSPT와 함께 프로바이오틱스 투여 결과 HbA1c (-0.3%, $p<0.001$), 수축기 혈압 (-9.6 mmHg, $p<0.001$), 그리고 *Tannerella forsythia* ($p<0.05$) 수준이 유의하게 감소했으며, 다른 병원균들도 감소 추세로 나타났다. 하지만 치주낭 깊이와 탐침 시 출혈을 포함한 치주 지표와 지질 프로필에서는 유의한 변화가 관찰되지 않았다. **결론:** 이러한 연구 결과는 NSPT와 함께 프로바이오틱스 보충제가 혈당 조절과 수축기 혈압을 개선할 수 있으나 치주 지표에 미치는 영향은 제한적일 수 있음을 시사하며, 이러한 잠재적 효과를 확인하기 위해 더 큰 규모의 임상 시험이 필요하다.

색인: 혈당, 혈압, 치주치료, 치주염, 프로바이오틱스

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