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ORIGINAL ARTICLE
Coronary Intervention

Effect of Periodontal Disease on Long-Term Outcomes After Percutaneous Coronary Intervention for De Novo Coronary Lesions in Non-Smokers

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Background: This study aimed to investigate the effect of periodontal disease (PD) on the outcomes of patients with coronary artery disease (CAD) treated with percutaneous coronary intervention (PCI).

Methods and Results: The study included 77 consecutive non-smoking patients with de novo coronary lesions treated with a drug-eluting stent (DES). Periodontal measurements, including the community periodontal index (CPI), were performed by independent periodontists. A CPI score of ≥3 was used to define PD. The occurrence of major adverse cardiac events (MACEs), which were defined as a composite of cardiovascular death, non-fatal myocardial infarction, target lesion revascularization, or non-target lesion revascularization, was compared between patients with and without PD. Of the 77 patients, 49 (63.6%) exhibited a CPI score of 3 or 4 and were assigned to the PD group. The remaining 28 patients (36.4%) were assigned to the non-PD group. Baseline clinical characteristics and angiographic findings were comparable between the 2 groups. MACEs occurred in 13 (26.5%) of the PD patients and 2 (7.1%) of the non-PD patients. Kaplan-Meier analysis showed a significantly lower MACE-free survival rate in the PD group than for the non-PD group (P=0.034).

Conclusions: PD at baseline was associated with an increased risk of MACEs in CAD patients who were treated with a DES for de novo coronary lesions.

Key Words: Coronary artery disease; Percutaneous coronary intervention; Periodontal disease

Over the past 2 decades, accumulated evidence from various aspects such as pathology, in vivo imaging, biomarkers, and basic sciences have suggested a prominent role of systemic inflammatory status throughout the human body for the initiation and development of atherosclerosis in major arteries, such as coronary arteries.[1–6] Coronary artery disease (CAD) is one of the leading causes of death worldwide. Risk factors for CAD have been extensively investigated and clinical practice guidelines recommend the strict management of known risk factors, including hypertension, dyslipidemia, diabetes mellitus, cigarette smoking, and obesity.[7] Lipid-lowering therapy, specifically for the reduction of low-density lipoprotein cholesterol (LDL-C), has become the mainstream of the primary and secondary prevention of CAD and has led to improved outcomes in CAD patients.[8] Nevertheless,

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the fact that some patients continue to suffer from CAD, despite having well-controlled known risk factors, has facilitated an increasing interest in residual risks, including systemic inflammation. Periodontal diseases (PDs) are defined as disorders of the periodontium, the connective tissue that surrounds and supports the teeth,[9] which result in chronic inflammation of the gingiva, periodontal ligaments, and alveolar bone.[10,11] Periodontal inflammation initiates local vascular inflammation, which induces the proliferation of inflammatory cells and release of cytokines into the periodontium, and thus further inducing systemic inflammation.[12,13]

Inflammation is a common underlying pathogenesis of

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Table 1. Prevalence of Cardiovascular Disease in the Total Registry Cohort (n=1,000)

Cardiovascular disease type	n
Ischemic heart disease	344
Acute coronary syndrome	37
Chronic coronary syndrome	307
Congestive heart failure	160
Arrhythmia	371
Aortic diseases	25
Implantable devices	100

both CAD and PD; consequently, the association between the 2 diseases has received research attention. A number of epidemiological studies have demonstrated an association between periodontitis disease status and the co-existence of CAD or risk factors.[10,14–17] However, there is a paucity of data regarding the relationship between PD status and the longitudinal outcomes of patients with CAD, especially those treated with contemporary percutaneous coronary intervention (PCI). Thus, we sought to assess the effect of baseline PD status on the clinical outcomes of patients with CAD who were treated with PCI.

Methods

Patient Population

One thousand consecutive patients who were admitted due to a cardiovascular disease to the Department of Cardiovascular Medicine at Tokyo Medical and Dental University Hospital between 2012 and 2015, and who provided written informed consent, were enrolled in the registry for the assessment of the association between cardiovascular disease and PD. The registry was approved by the local institutional review board (IRB) of Tokyo Medical and Dental University in 2012 (MD2000-1165 and D2014-012). All participants underwent a periodontal assessment upon admission, in addition to the standard care provided for cardiovascular disease. Clinical outcomes were evaluated by reviewing the patients' medical records in 2020; this supplementary protocol was approved by the IRB in 2020 (M2020-020). The prevalence of the diseases for which the patients in the registry were admitted is summarized in **Table 1**. Of the 344 patients who were admitted for ischemic heart disease, 144 patients underwent PCI within 30 days of periodontal assessment and were selected for the present study. Thereafter, the study excluded patients with in-stent restenosis (n=18), those who were treated without a drug-eluting stent (DES; n=32), those in whom PCI was unsuccessful (n=1), and current smokers (n=16) because of the significant effect of smoking status on periodontal status. Therefore, the final dataset included 77 patients with de novo coronary lesions who were treated with a DES (**Figure 1**). This study was performed in compliance with the tenets of the Declaration of Helsinki.

Clinical Characteristics

Information regarding patients' medical history, alcohol consumption, smoking habits, and medication was collected on admission. Laboratory data including blood cell count, estimated glomerular filtration rate (eGFR), and levels of creatinine, C-reactive protein (CRP), LDL-C, high-density lipoprotein cholesterol (HDL-C), triglyceride, and B-type natriuretic peptide (BNP) were routinely collected upon participant enrollment in the registry. Patients' statin use and LDL-C levels at the most recent clinical follow-up appointment were also recorded.

Clinical Periodontal Examination

A clinical periodontal examination was performed by 3 independent periodontists certified by the Japanese Society of Periodontology. The number of remaining teeth was

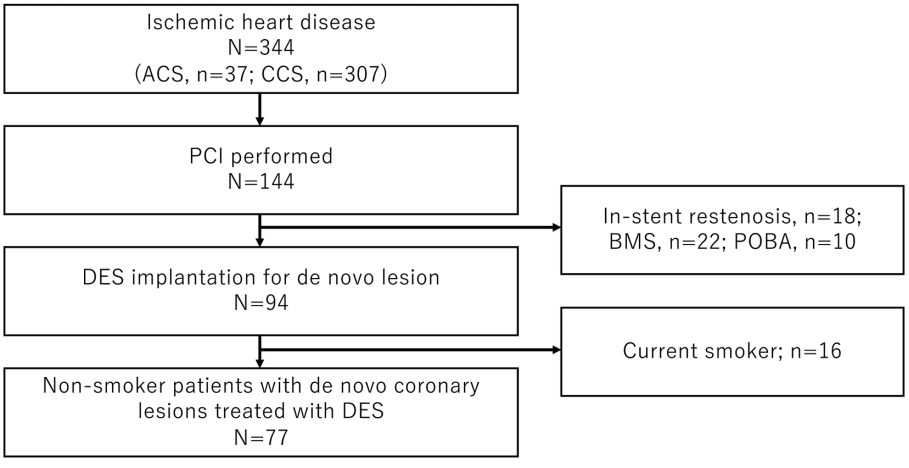

Figure 1. Study population. Among the 344 patients who were admitted for ischemic heart disease, 144 patients underwent PCI within 30 days of the periodontal assessment and were selected for the present study. We further excluded patients with in-stent restenosis (n=18), those who were treated without DESs (n=32), those in whom PCI was unsuccessful (n=1), and those who were current smokers (n=16), due to the significant effect of smoking status on periodontal status. Therefore, the final dataset included 77 patients with de novo coronary lesions treated with a DES. ACS, acute coronary syndrome; BMS, bare-metal stent; CCS, chronic coronary syndrome; DES, drug-eluting stent; PCI, percutaneous coronary intervention; POBA, percutaneous old balloon angioplasty.

counted, and the community periodontal index (CPI), probing pocket depth (PPD), clinical attachment level (CAL), and bleeding on probing (BOP) were recorded at 6 points (buccal-mesial, mid-buccal, buccal-distal, lingual-mesial, mid-lingual, and lingual-distal) on the right and left upper molar, upper and lower incisor, and right and left lower molar using a manual probe (PCP-UNC 15; Hu-Friedy, Chicago, USA). The CPI is a standard measure of periodontal disease severity recommended by the World Health Organization.[18] The CPI evaluates 3 indicators of periodontal condition; namely, gingival bleeding, tartar, and periodontal pockets, and classifies periodontal diseases on a 5-point scale, ranging from Code 0 to Code 4, according to severity (Code 0, Healthy; Code 1, Bleeding observed, either directly or using a mouth mirror, after probing; Code 2, Calculus detected during probing, but all of the black band on the probe visible; Code 3, Pocket 4–5 mm, gingival margin within the black band on the probe; and Code 4, Pocket ≥6 mm, black band on the probe not visible). In the present study, PD was defined as a maximal CPI code of ≥3, which is consistent with the definition used by previous researchers.[19–21] BOP was defined as bleeding from the gingiva at the probe tip. PPD was defined as the distance from the gingival margin to the bottom of the gingival pocket. CAL referred to the distance from the cemento-enamel junction (CEJ) to the bottom of the pocket. Furthermore, the presence or absence of periodontopathic bacterial antigens was examined, including *Prevotella intermedia (Pi), Porphyromonas gingivalis (Pg),* and *Aggregatibacter actinomycetemcomitans (Aa)* in each periodontal pocket. The adjacent tooth was used when the representative tooth was missing.

PCI Procedure

All patients included in the current analysis underwent DES implantation in a standard PCI procedure via the radial or femoral artery using a 6- or 7-Fr system and intravascular ultrasound (IVUS) or optical coherence tomography (OCT)

Table 2. Patient Demographic and Medical Characteristics

	PD	Non-PD	P value
N	49	28	
Age (years)	70.5±8.7	70.1±8.6	0.850
Male	41 (83.7)	24 (85.7)	1.000
Height (cm)	161.3±8.4	165.0±7.5	0.056
Weight (kg)	63.8±9.7	66.8±11.4	0.236
Body mass index (kg/m²)	24.6±3.3	24.5±3.4	0.889
Former smoker	30 (61.2)	18 (64.3)	0.812
Alcohol	30 (61.2)	17 (60.7)	1.000
ACS presentation	10 (20.4)	3 (10.7)	0.354
Medical history			
Hypertension	44 (89.8)	17 (60.7)	0.349
Diabetes mellitus	26 (53.1)	12 (42.9)	0.479
Chronic kidney disease	17 (34.7)	5 (17.9)	0.189
Prior MI	13 (26.5)	5 (17.9)	0.576
Prior PCI	18 (36.7)	11 (39.3)	1.000
Medications			
Aspirin	49 (100.0)	28 (100.0)	1.000
Clopidogrel	48 (98.0)	28 (100.0)	1.000
Dual antiplatelet therapy	48 (98.0)	28 (100.0)	1.000
Warfarin	1 (2.0)	1 (3.6)	1.000
DOACs	2 (4.1)	1 (3.6)	1.000
β-blockers	35 (71.4)	17 (60.7)	0.448
ACE inhibitors/ARBs	32 (65.3)	18 (64.3)	1.000
Calcium channel blockers	27 (55.1)	12 (24.9)	0.349
Statins at index PCI	40 (81.6)	26 (92.9)	0.310
Statins at follow up	41 (83.7)	23 (82.1)	1.000
Laboratory data			
White blood cells (×10³/μL)	5,934.7±1,481	6,028.7±1,666	0.799
Hemoglobin (g/dL)	13.4±1.5	13.2±1.6	0.637
Creatinine (mg/dL)	0.9 (0.8–1.1)	0.9 (0.8–1.0)	0.299
C-reactive protein (mg/dL)	0.3±0.6	0.3±0.8	0.902
Total cholesterol (mg/dL)	169.7±35.8	169.5±32.9	0.977
LDL cholesterol (mg/dL) at index PCI	103.1±35.1	99.0±27.4	0.597
LDL cholesterol (mg/dL) at follow up	82.1±19.8	86.7±25.0	0.372
Triglycerides (mg/dL)	139.1±57.9	124.1±56.5	0.277
LV ejection fraction (%)	59.7±11.5	64.5±10.6	0.076

(**Table 2** continued the next page.)

	PD	Non-PD	P value
Angiographic findings			
LMT, LAD	27 (55.1)	12 (42.9)	0.349
LCx	9 (18.4)	8 (28.6)	0.393
RCA	13 (26.5)	9 (32.1)	0.610
Type B2/C lesion	43 (87.8)	23 (82.1)	0.516
Multivessel disease	24 (49.0)	13 (46.4)	1.000
Multiple stents	17 (34.7)	6 (21.4)	0.302
Type of stent (n=100)			
CoCr-EES	27 (40.9)	16 (47.1)	0.538
PtCr-EES	30 (45.5)	11 (32.4)	
R-ZES	3 (4.5)	3 (8.8)	
BP-BES	6 (9.1)	4 (11.8)	
Stent diameter (mm)	2.83±0.38	2.96±0.43	0.138
Stent length (mm)	27.1±7.2	27.2±8.5	0.932
Quantitative angiographic analysis			
Reference vessel diameter (mm)	2.26±0.41	2.45±0.61	0.101
Stenosis length (mm)	15.07±8.03	15.38±8.85	0.875
MLD, pre-PCI (mm)	0.73±0.27	0.76±0.45	0.725
DS, pre-PCI (%)	69.14±13.45	70.10±17.04	0.785
MSD, post-PCI (mm)	2.59±0.31	2.72±0.46	0.162
DS, post-PCI (%)	8.49±2.60	9.41±4.42	0.254
Follow-up CAG	35 (71.4)	22 (78.6)	0.495

Categorical values are presented as n (%). Numerical values are presented as either the mean±standard deviation or median (25^{th}–75^{th} quartile), according to the normality of the distribution. ACE, angiotensin-converting enzyme; ACS, acute coronary syndrome; ARB, angiotensin II receptor blocker; BP-BES, biodegradable polymer biolimus-eluting stent; CAG, coronary angiography; CoCr-EES, cobalt chromium everolimus-eluting stent; DOAC, direct oral anticoagulant; DS, diameter stenosis; LAD, left anterior descending artery; LCx, left circumflex artery; LDL, low-density lipoprotein; LMT, left main trunk; LV, left ventricular; MI, myocardial infarction; MLD, minimum lumen diameter; MSD, minimum stent diameter; PCI, percutaneous coronary intervention; PD, periodontal disease; PtCr-EES, platinum chromium everolimus-eluting stent; RCA, right coronary artery; R-ZES, Resolute zotarolimus-eluting stent.

guidance. The present study excluded patients in whom bare-metal stents or drug-coated balloons were used in combination with DESs. The selection of DES types and the use of adjacent debulking devices was based on the operator's discretion. Follow-up coronary angiography (CAG) was performed at the physician`s discretion.

Clinical Outcomes

Clinical outcomes after PCI were evaluated in 2020 in a supplementary investigation of the registry. Clinical events including all-cause death, cardiac death, non-fatal myocardial infarction (MI), target-vessel revascularization, non-target vessel revascularization, and congestive heart failure requiring hospitalization were captured from medical records. Major adverse cardiac events (MACEs) were defined as the composite of cardiac death, non-fatal MI, target-vessel revascularization, and non-target vessel revascularization.

Statistical Analysis

Continuous variables were presented as mean±standard deviation or median (interquartile range), and categorical variables were expressed as proportions. For continuous data, the groups were compared by using either a Student's t-test or the Wilcoxon rank-sum test based on the distribution of the data. Distributions of continuous variables were tested using the Kolmogorov-Smirnov test. Categorical data were compared using either the chi-squared test or Fisher's exact test, as appropriate. Kaplan-Meier analysis and the log-rank test were used to compare MACE-free survival rates between the 2 groups. Statistical significance was set at $P<0.05$. All analyses were performed using R statistical software (version 4.0.1; The R Foundation for Statistical Computing, Vienna, Austria).

Results

Patient Characteristics

Of the 77 patients in the present study, 49 patients (63.6%) were diagnosed with PD, which was defined as having a maximal CPI ≥3. Patient characteristics were compared between patients with PD (PD group) and those without PD (non-PD group) (**Table 2**). There were no statistical differences in age, sex, and coronary risk factors such as diabetes mellitus, dyslipidemia, and hypertension, and medication at the time of enrollment between the 2 groups. Moreover, laboratory data showed no significant differences between the 2 groups, including the CRP level.

Angiographic Findings

The angiographic findings are summarized in **Table 2**. There was no significant difference in lesion location between the PD and non-PD groups. In addition, quantitative coronary angiography (QCA) and lesion complexity did not differ between the 2 groups.

Periodontal Status

The oral and periodontal conditions of the patients are summarized in **Table 3**. There were no significant differences in the numbers of lost and remaining teeth. The

Table 3. Rates of Oral and Periodontal Conditions in the PD vs. Non-PD Groups

	PD	Non-PD	P value
N	49	28	
Tooth loss	10.00 (5.00–14.00)	12.00 (6.75–15.50)	0.252
Caries (number/patient)	1.04±1.49	0.46±0.92	0.067
Pocket *Aa-Ag* (%)	8 (17.0)	8 (34.6)	0.131
Pocket *Pg-Ag* (%)	40 (85.1)	12 (52.2)	0.007
Pocket *Pi-Ag* (%)	11 (23.4)	1 (4.3)	0.088
Max CPI	3 (3–4)	1 (0–2)	<0.001
Max CAL	6 (5–8)	5 (3–6)	0.001
Max PPD	5 (4–6)	3 (2–3)	<0.001

Categorical data are presented as n (%). Numerical values are presented as the mean±standard deviation or median (25^{th}–75^{th} percentile). *Aa-Ag*, *Aggregatibacter actinomycetemcomitans* antigen; CAL, clinical attachment level; CPI, community periodontal index; *Pg-Ag*, *Porphyromonas gingivalis* antigen; *Pi-Ag*, *Prevotella intermedia* antigen; PD, periodontal disease; PPD, probing pocket depth.

Table 4. Occurrence Rates of Major Adverse Cardiac Events in the PD vs. Non-PD Groups

	PD	Non-PD	P value
MACE	13 (26.5)	2 (7.1)	0.034
Cardiac death	3 (6.1)	0 (0.0)	0.177
Non-fatal MI	0 (0.0)	0 (0.0)	1.000
TLR	3 (6.1)	2 (7.1)	0.869
Non-TLR	9 (18.4)	0 (0.0)	0.015
Congestive heart failure requiring hospitalization	2 (4.1)	1 (3.6)	0.777
All-cause death	9 (18.4)	1 (3.6)	0.091

MACE was defined as a composite of cardiac death, non-fatal MI, TLR, or non-TLR. Values are presented as n (%). MACE, major adverse cardiac events; MI, myocardial infarction; PD, periodontal disease; TLR, target lesion revascularization.

number of dental caries was greater in the PD group than in the non-PD group, but this difference was not statistically significant. Maximal CPI, maximal CAL, and maximal PPD were consistently greater in the PD group than in the non-PD group.

MACE-Free Survival

MACEs, defined as the composite of cardiac death, non-fatal MI, target lesion revascularization (TLR), and non-TLR, occurred in 15 patients (19.5%) at a median follow up of 1,635 (IQR 560-2,557) days after PCI. Adverse events are summarized in **Table 4**. MACEs were more frequently observed in the PD group than in the non-PD group. All-cause death was observed in 9 PD patients (18.4%) and 1 non-PD patient; however, this difference in rate did not reach statistical significance (P=0.091). In the PD group, the cause of death was cardiovascular disease in 3 patients, cancer in 4 patients, pneumonia in 1 patient, and unknown in 3 patients. The 1 death in the non-PD group occurred due to cancer.

Kaplan-Meier analysis showed a lower MACE-free survival rate in the PD group than in the non-PD group (P=0.034; **Figure 2**), which was mainly driven by more non-TLRs and more cardiac deaths in the PD group (**Figure 3**, **Table 4**).

Discussion

The present study investigated patients who were not currently smoking and underwent PCI using a DES for the treatment of de novo coronary lesions. Patients with PD at baseline showed a higher MACE rate after PCI than those without PD, after a median follow up of 4.5 years. To the best of our knowledge, this is the first study to report a significant association between PD status and longitudinal clinical outcomes after PCI using a DES.

Periodontal Disease and CAD

CAD is the most common cause of death worldwide, accounting for one-third of all deaths.[22] Meanwhile, PD is the 6^{th} most common disease in the global population.[23,24] The link between these 2 diseases has been extensively investigated in previous large cohort studies and case-control studies.[10,14–17,25,26]

In a case-control study conducted in Swedish hospitals, a total of 805 patients with a first episode of MI and periodontal examinations and were compared with age-, sex-, and area-matched controls without MI. The results revealed that PD was more common in patients with MI (43%) than in those without (33%), and PD was an independent predictor of MI (odds ratio 1.28; 95% confidence interval 1.03–1.60) after adjusting for patient background.[27] Moreover, Dietrich et al. investigated a subset of 1,231 subjects without recognized CAD from a cohort study consisting of 2,280 volunteers who underwent periodontal examinations. After a median follow-up of 24 years, 364 subjects (29.6%) suffered from CAD, and the severity of PD assessed by the cumulative probing depth was a significant predictor for the incidence of CAD.[28] Thus, ample evidence has suggested the frequent co-existence of PD and CAD, with a higher

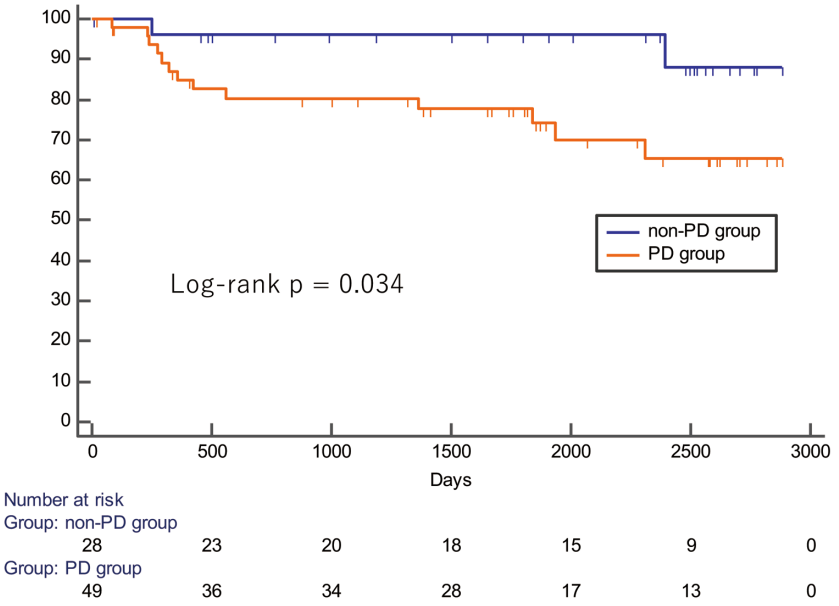

Figure 2. MACE-free survival rate in patients with and without periodontal disease. Kaplan-Meier analysis indicated that the MACE-free survival rate was significantly lower in patients with PD than in those without PD (73.5% vs. 92.9%, respectively; P=0.034). MACEs, major adverse cardiac events; PD, periodontal disease.

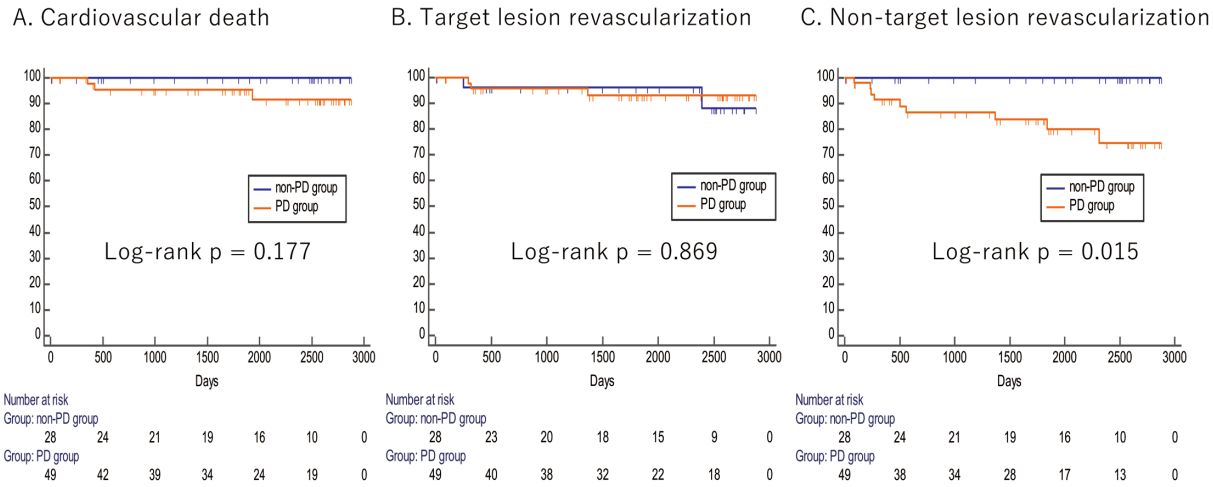

Figure 3. Adverse events in patients with and without periodontal disease. (**A**) Cardiovascular death-free survival rate was lower in the PD group than in the non-PD group; however, the results of a Kaplan-Meier analysis indicated that this difference was not statistically significant (P=0.177). (**B**) TLR-free survival rate was similar between the PD and non-PD groups (P=0.869). (**C**) Non-TLR-free survival rate was significantly lower in the PD group than in the non-PD group (P=0.015). PD, periodontal disease; TLR, target lesion revascularization.

incidence of CAD in subjects with PD in cohort studies including healthy subjects. Nevertheless, data regarding the impact of PD on the clinical outcomes of patients diagnosed with CAD remains limited. In a cohort study, which investigated 884 patients with MI who underwent periodontal examination,[29] PD defined by CAL was shown to be a significant predictor of recurrent cardiovascular events in non-smokers; this finding is consistent with our results. However, a study by Dorn et al[29] enrolled patients between 1996 and 2004, when bare-metal stents were the standard mode of PCI and detailed information on patient and lesion characteristics were lacking, given the protocol based on International Classification of Disease coding. The current study is the first to describe the association between periodontal status and the incidence of adverse cardiac events after PCI for CAD using a DES.

Potential Mechanisms Underlying the Association Between PD and CAD Outcomes

Previous studies have proposed both direct and indirect mechanisms underlying the progression of atherosclerosis following PD. Previous histopathological studies detected

periodontopathic oral bacteria in carotid arteries,[30] aortic aneurysms,[31] degenerated valves,[31] and coronary arteries.[32] Pucar et al investigated the histopathological specimens of 15 atherosclerotic coronary arteries obtained during coronary artery bypass graft surgeries.[32] They detected the bacterial DNA of *Pg, Aa*, and *Pi* in approximately 30–50% of the specimens, which may indicate the direct invasion of oral bacteria into the arterial intima. In the present study, *Pg* was significantly more frequently observed in the PD group than in the non-PD group, and *Pi* was more frequent in the PD group than in the non-PD group; however, this difference was not significant (**Table 3**). Although it may be difficult to prove the causal effect of these oral bacteria on the development of atherosclerotic plaques, it has been suggested that the existence of PD pathogens may directly provoke an inflammatory reaction within the artery, leading to progressive atherosclerosis. Indirect mechanisms linking PD and atherosclerosis have also been proposed. PD is a chronic infection of the periodontium, which can induce not only gingival inflammation but also systemic inflammation. When local and systemic inflammatory reactions are stimulated, inflammatory cytokines, such as interleukin (IL)-6 and tumor necrosis factor (TNF)-α, are increasingly released into circulation,[33–35] which may potentially trigger further inflammation in coronary arteries by affecting endothelial function, lipid metabolism, or oxidative stress.[36] This mechanism may explain the pan-vascular atherosclerosis represented by more frequent non-TLR in the PD group than in the non-PD group in the present study. Although the current study did not show significant differences in inflammatory biomarkers, such as CRP and white blood cell count, previous studies with greater sample sizes have shown increased levels of different inflammatory markers in subjects with PD.[33–35,37] Systemic circulation of inflammatory cytokines initiated by periodontitis may also induce a remote inflammatory response in the coronary arteries.

Clinical Implications

Despite the remarkable advancement in the secondary prevention of CAD in recent years, adverse cardiovascular events are not completely preventable; this is considered to be a consequence of residual and neglected risks. Our results showed that PD was a risk factor for poorer clinical outcomes in patients with CAD; PD may also be a part of the residual risk. As widely accepted, PD is largely preventable and modifiable with continuous oral care,[38,39] and dental treatment may potentially reduce cardiovascular risks. A prospective population-based study showed that in healthy adults without any history of cardiovascular disease, frequent tooth brushing and regular dental visits for professional cleaning reduced the risk of future cardiovascular events.[40] Nevertheless, PD treatment and general dental health care have been neglected in the management of patients with CAD. Given that the present study lacked follow-up data on periodontal status and dental intervention, further prospective studies are warranted to confirm the effect of PD treatment on the clinical outcomes of patients with CAD.

Study Limitations

Given that this study design was a retrospective analysis of pooled data from a registry composed of various diseases, several limitations exist. First, the current study was a single-center study, and the patients were prospectively enrolled but retrospectively analyzed, which may have led to a selection bias. Second, the number of patients was limited. Therefore, the association between the severity of PD and MACE rate could not be determined. These results should be interpreted with caution. Third, periodontal status was not subsequently followed up, which precluded the evaluation of changing periodontal status on CAD outcomes and may have largely affected the results. Fourth, all of the clinical decisions involving PCI procedures and medications were dependent on the operators, which may also have affected the clinical outcomes. Finally, longitudinal clinical data including lipid profile and medication were lacking, which may have affected the outcomes.

Conclusions

The presence of PD was associated with major adverse events following PCI for de novo coronary lesions in non-smoking patients. Further prospective studies are required to clarify whether chronological changes in the PD status, with or without intervention, may have a significant effect on the secondary prevention of CAD.

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Disclosures

The authors declare no conflicts of interest.

IRB Information

This study was approved by the Tokyo Medical and Dental University (MD2000-1165, D2014-012, M2020-020).

Data Availability

The deidentified participant data will not be shared.

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