

Article

Analysis of Chronic Periodontitis in Tonsillectomy Patients: A Longitudinal Follow-Up Study Using a National Health Screening Cohort

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Abstract: This study aimed to compare the risk of chronic periodontitis (CP) between participants who underwent tonsillectomy and those who did not (control participants) using a national cohort dataset. Patients who underwent tonsillectomy were selected from a total of 514,866 participants. A control group was included if participants had not undergone tonsillectomy from 2002 to 2015. The number of CP treatments was counted from the date of the tonsillectomy treatment. Patients who underwent tonsillectomy were matched 1:4 with control participants who were categorized based on age, sex, income, and region of residence. Finally, 1044 patients who underwent tonsillectomy were matched 1:4 with 4176 control participants. The adjusted estimated value of the number of post-index date (ID) CP did not reach statistical significance in any post-ID year (each of $p > 0.05$). In another subgroup analysis according to the number of pre-ID CP, it did not show statistical significance. This study revealed that tonsillectomy was not strongly associated with reducing the risk of CP. Even though the tonsils and periodontium are located adjacently, and tonsillectomy and CP may be related to bacterial inflammation, there was no significant risk of CP in patients undergoing tonsillectomy.

Keywords: tonsillectomy; chronic periodontitis; cohort; Korea

1. Introduction

Periodontitis is inflammation around the teeth and alveolar bone that causes destruction of the surrounding structures [1]. Bacterial microorganisms in the subgingival area are generally thought to be the main etiological factor in the development of periodontitis [2]. Bacterial microorganisms—such as *Tanarella forsythia*, *Treponema denticola*, and *Porphyromonas gingivalis*—are related to chronic periodontitis [3,4]. Socransky et al. reported that bacteria such as *Fusobacterium nucleatum*, *Peptostreptococcus micros*,

Campylobacter rectus, and *Eubacterium nodatum* could be factors for periodontitis [3]. Periodontal inflammation could be worsened by systemic factors such as general diseases and tobacco use [5–9]. Previous studies have shown that periodontitis can cause reactions in the immune system and a variety of diseases, including IgA nephropathy and glycosylated haemoglobin leading to diabetes onset [10–12]. Isola et al. reported that patients with chronic periodontitis (CP) exhibited significantly lower serum levels of vitamin D compared to the healthy controls [13]. The study showed that low serum vitamin D levels correlated with tooth loss and periodontitis, especially in CP patients. Evaluation of vitamin D levels should be recommended at the beginning of periodontal treatment as it can predict and decrease the risk of CP aggravation [13,14].

Periodontitis is difficult to control and can be managed with periodontal treatment to maintain the present condition and prevent further deterioration. Biofilms should be removed, and oral hygiene training should be conducted to reduce the production of new biofilms [15]. Regeneration for the loss of the alveolar bone and gingiva has been attempted with various types of surgical flaps, bone grafting, guided generation, enamel matrix protein, and laser treatment [16]. However, the attempts have not been satisfactory; therefore, many studies have been conducted from various perspectives attempting to assist with regeneration.

Several studies have been conducted that focus on periodontal treatment, including the use of pharmaceuticals, such as the application of topical antiseptics (povidone-iodine or chlorhexidine) [15,17]. Quirynen et al. proposed Full Mouth Disinfection (FMD), a treatment that focuses on the disinfection of all the intraoral niches including the periodontal pockets, dorsum of the tongue, and palatine tonsils [18]. According to the FMD proposal, it is vital to prevent microbial reinfection of the previously treated periodontium and niches. Therefore, meticulous scaling within 24 h was proposed, followed by repeated disinfection of all the intraoral niches [18].

A tonsillectomy is usually performed for the treatment of chronic tonsillitis or sleep apnea [19]. It is also recommended for periodic fever, peritonsillar abscess, guttate psoriasis, aphthous stomatitis, and tonsil cancer. There is sufficient evidence that tonsillectomy does not have a significant negative effect on the immune system [19,20]. The majority of studies have reported that the procedure does not appear to affect the long-term risk of infection [21]. On the contrary, some studies have demonstrated changes in immunoglobulin concentrations following tonsillectomy [19]. Bacterial activity determines the level of inflammation, ulceration, or necrosis of the palatine tonsils. These inflammatory or pathologic disorders related to the tonsils are common causes of tonsillectomy.

The palatine tonsils are located in the oropharynx, close to the intraoral area, and it is assumed that the transmission of bacteria can occur between these areas [22]. The relationship between the anatomic position of the tonsils and the intraoral area is believed to explain why tonsillectomy and periodontitis may exhibit similar bacteriologic and clinical properties. In a previous study, periodontal pathogens were detected in the tonsillar area of periodontitis patients [23]. The palatine tonsils have already been suggested as the source of reinfection for previously treated periodontal areas [17]. Biofilms in the subgingival area and saliva exhibited the highest similarity to that of the tonsils in the study [23]. Anaerobic bacteria of the intraoral area—such as *Porphyromonas gingivalis* and *Fusobacterium nucleatum*—was found to be similar to the bacteria of the oropharyngeal area in previous studies [8]. *Prevotella intermedia* and *Treponema denticola* were also found more frequently in infected subgingival pockets [24,25]. While these bacteria are rarely found in a normal periodontium, they are usually present in periodontitis. Similarly, these anaerobic bacteria were found in tonsils with recurrent inflammation [25]. The present study was designed based on the anatomic nearness and bacterial similarity indicated in previous studies, suggesting the possibility of an association between the palatine tonsil area and periodontitis [18,22,24–26].

Despite the validity of those previous studies, the clinical association between tonsillectomy and periodontitis has not been evaluated in detail. Due to these reasons, this study was designed to evaluate whether tonsillectomy significantly influenced CP. Based on these pivotal observations, we designed

the present study to assess whether periodontal parameters significantly influenced serum vitamin D levels.

The purpose of this study was to compare the risk of CP between participants who underwent tonsillectomy and those who did not (control participants) using a national cohort dataset. It was hypothesized that tonsillectomy would decrease the risk of CP. In this study, those who underwent tonsillectomy and the control participants were matched using a 1:4 ratio, adjusting for age, sex, region of residence, pre-index date CP treatment, obesity, smoking, alcohol consumption, and Charlson comorbidity index (CCI) score.

2. Materials and Methods

2.1. Study Population

The ethics committee of Hallym University (2019-01-003) approved this study. Written informed consent was waived by the Institutional Review Board. All analyses adhered to the guidelines and regulations of the ethics committee of Hallym University. A detailed description of The Korean National Health Insurance Service-Health Screening Cohort data is given elsewhere [27].

2.2. Tonsillectomy

Tonsillectomy was defined using operation code Q2300.

2.3. Chronic Periodontitis

Patients with CP were diagnosed based on ICD-10 codes (K05.3) and were treated by dentists. The number of CP treatments was counted from the date of tonsillectomy treatment (index date [ID]) to the date before the two-year period (pre-ID CP for 2 y). The number of CP treatments was also counted from the index date to the date after the first-year period (post-ID 1 y CP, post-operative 1–365 days), second-year period (post-ID 2 y CP, post-operative 366–730 days), third-year period (post-ID 3 y CP, post-operative 731–1095 days), fourth-year period (post-ID 4 y CP, post-operative 1096–1460 days), and fifth-year period (post-ID 5 y CP, post-operative 1461–1825 days).

2.4. Participant Selection

Patients who underwent tonsillectomy were selected from 514,866 participants with 497,931,549 medical claim codes ($n = 1321$). A control group was included if participants had not undergone tonsillectomy between 2002 and 2015 ($n = 513,545$). To select tonsillectomy patients who were diagnosed for the first time, we excluded those who were diagnosed from 2002 to 2003 (washout periods, $n = 228$). Patients who underwent tonsillectomy were matched 1:4 with control participants based on age, sex, income, and region of residence. To analyze the subgroups according to pre-ID CP for 2 y, tonsillectomy patients were additionally matched with pre-ID CP for 2 y with a categorical variable (0 times, 1 time, and ≥ 2 times). To minimize the selection bias, the control participants were selected in random number order. The index date of each tonsillectomy patient was set as the time of the tonsillectomy treatment. The index date of control participants was set as the index date of their matched tonsillectomy. Therefore, each tonsillectomy patient that was subsequently matched with the control participants had the same index date. During the 1:4 matching process, 509,173 un-matched control participants were excluded. Participants who were recorded in 2015 were excluded to calculate post-ID 1 y CP ($n = 49$ for tonsillectomy patients, $n = 196$ for control participants). Finally, 1044 patients who underwent tonsillectomy were matched 1:4 with 4176 control participants; see Figure 1.

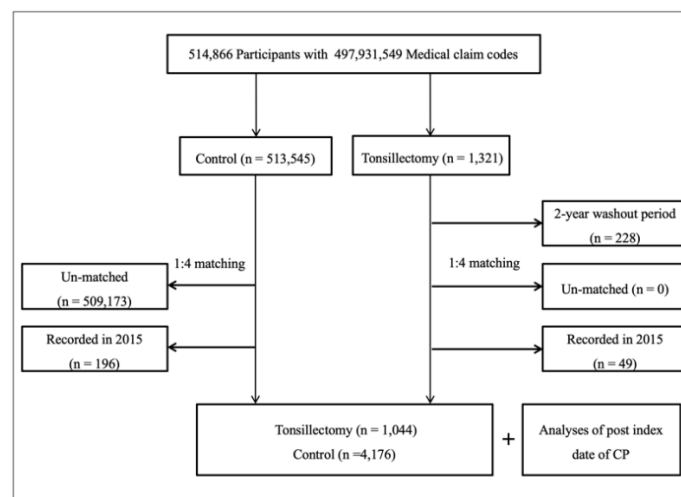


Figure 1. A schematic illustration of the participant selection process that was used in the present study. Of a total of 514,866 participants, 1044 of tonsillectomy participants were matched with 4176 control participants based on age, sex, income, region of residence, and pre-index date (ID) chronic periodontitis (CP) for 2 y.

2.5. Covariates

The age groups were divided by the following 5-year intervals: 40–44, 45–49, 50–54 . . . , and 85+ years old. Income groups were organized into five classes (class 1 [lowest income] to 5 [highest income]). The region of residence was classed as either urban (Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon, and Ulsan) or rural (Gyeonggi, Gangwon, Chungcheongbuk, Chungcheongnam, Jeollabuk, Jeollanam, Gyeongsangbuk, Gyeongsangnam, and Jeju).

Tobacco smoking was categorized based on the current smoking status of the participant (nonsmoker, past smoker, or current smoker). Alcohol consumption was categorized on the basis of the frequency of alcohol consumption (<1 time a week or ≥ 1 time a week). Obesity was measured using body mass index (BMI, kg/m²). Missing BMI variables were replaced by mean BMI from final selected participants. BMI was categorized as <18.5 (underweight), ≥ 18.5 to <23 (normal), ≥ 23 to <25 (overweight), ≥ 25 to <30 (obese I), or ≥ 30 (obese II) based on the Asia-Pacific criteria following the Western Pacific Regional Office (WPRO) 2000.

The Charlson Comorbidity Index (CCI) has been widely used to measure disease burden using 17 comorbidities. A score was given to each participant depending on the severity and number of diseases they presented with. CCI was measured as a continuous variable (0 [no comorbidities] through 29 [multiple comorbidities]) [28]. The scores were calculated and the final CCI score was used as a covariate in the analyses.

2.6. Statistical Analyses

The general characteristics between the tonsillectomy and control groups were compared using a Chi-square test.

A simple linear regression and a multiple linear regression were used to calculate the estimated values and 95% of the confidence intervals (CI) for post-ID 1 y CP, post-ID 2 y CP, post-ID 3 y CP, post-ID 4 y CP, and post-ID 5 y CP in the tonsillectomy group compared to the control group. Both the simple linear regression and the multiple linear regression were stratified by age, sex, income, and region of residence. In the multiple linear regression, the model was adjusted for obesity, smoking status, alcohol consumption, CCI score, and pre-ID CP for 2 y as a continuous variable.

For the subgroup analyses, we divided participants by age (<60 years old and ≥ 60 years old), sex (male or female), and pre-ID CP for 2 y (0 times, 1 time, and ≥ 2 times) using a crude model and an adjusted model.

Two-tailed analyses were performed, and significance was defined as p -value less than 0.05. The SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) was used for statistical analysis.

3. Results

Age, sex, income, and region of residence were matched between tonsillectomy and control participants exactly ($p = 1.000$), while obesity, smoking, and CCI were different ($p < 0.05$, Table 1). The number of CP treatments prior to the index date were matched as the categorical variable.

Table 1. General Characteristics of Participants.

Characteristics	Total Participants		p -Value
	Tonsillectomy (n, %)	Control (n, %)	
Age (years old)			1.000
40–44	74 (7.1)	296 (7.1)	
45–49	252 (24.1)	1008 (24.1)	
50–54	324 (31.0)	1296 (31.0)	
55–59	226 (21.7)	904 (21.7)	
60–64	100 (9.6)	400 (9.6)	
65–69	46 (4.4)	184 (4.4)	
70–74	13 (1.3)	52 (1.3)	
75–79	6 (0.6)	24 (0.6)	
80–84	3 (0.3)	12 (0.3)	
Sex			1.000
Male	720 (69.0)	2880 (69.0)	
Female	324 (31.0)	1296 (31.0)	
Income			1.000
1 (lowest)	114 (10.9)	456 (10.9)	
2	105 (10.1)	420 (10.1)	
3	127 (12.2)	508 (12.2)	
4	216 (20.7)	864 (20.7)	
5 (highest)	482 (46.2)	1928 (46.2)	
Region of residence			1.000
Urban	527 (50.5)	2108 (50.5)	
Rural	517 (49.5)	2068 (49.5)	
Pre index date of CP			1.000
0 time	701 (67.2)	2804 (67.2)	
1 time	145 (13.9)	580 (13.9)	
≥2 times	198 (19.0)	792 (19.0)	
Obesity [†]			<0.001 *
Underweight	6 (0.6)	61 (1.5)	
Normal	245 (23.5)	1436 (34.4)	
Overweight	286 (27.4)	1143 (27.4)	
Obese I	442 (42.3)	1427 (34.2)	
Obese II	65 (6.2)	109 (2.6)	
Smoking status			0.019 *
Nonsmoker	611 (58.5)	2483 (59.5)	
Past smoker	193 (18.5)	633 (15.2)	
Current smoker	240 (23.0)	1060 (25.4)	
Alcohol consumption			0.219
<1 time a week	647 (62.0)	2501 (59.9)	
≥1 time a week	397 (38.0)	1675 (40.1)	
CCI score			<0.001 *
0	713 (68.3)	3,275 (78.4)	
1	168 (16.1)	448 (10.7)	
2	85 (8.1)	240 (5.8)	
3	29 (2.8)	91 (2.2)	
≥4	49 (4.7)	122 (2.9)	

Abbreviations: CCI, Charlson comorbidity index; CP, chronic periodontitis. * Chi-square test. Significance at $p < 0.05$. [†] Obesity (BMI, body mass index, kg/m²) was categorized as <18.5 (underweight), ≥18.5 to <23 (normal), ≥23 to <25 (overweight), ≥25 to <30 (obese I), and ≥30 (obese II).

The adjusted estimated value (EV) of the number of post-ID CP did not reach statistical significance in any post-ID year (each of $p > 0.05$, Table 2). In the subgroup analyses according to age and sex, statistical significance was only reached in ≥ 60 -year-old men in post ID 2 y (EV = 0.561, 95% CI = 0.156–0.967, $p = 0.007$, Figure 2). In another subgroup analysis according to the number of pre-ID CP, statistical significance was not found in any analysis, see Figure 3.

Table 2. Simple and multiple linear regression model (estimated value [95% confidence interval]) for post-index date of CP (post-ID CP) periods in tonsillectomy group compared to control group.

Characteristics	Linear Regression			
	Simple [†]	<i>p</i> -Value	Multiple ^{†,‡}	<i>p</i> -Value
Post ID 1 y CP (n = 5220)				
Tonsillectomy	−0.068 (−0.153 to 0.018)	0.123	−0.073 (−0.158 to 0.012)	0.091
Post ID 2 y CP (n = 4920)				
Tonsillectomy	0.009 (−0.083 to 0.100)	0.853	0.021 (−0.069 to 0.111)	0.649
Post ID 3 y CP (n = 4610)				
Tonsillectomy	−0.055 (−0.163 to 0.052)	0.313	−0.040 (−0.148 to 0.067)	0.459
Post ID 4 y CP (n = 4245)				
Tonsillectomy	0.052 (−0.064 to 0.169)	0.377	0.059 (−0.058 to 0.176)	0.325
Post ID 5 y CP (n = 3825)				
Tonsillectomy	0.031 (−0.092 to 0.153)	0.623	0.054 (−0.069 to 0.177)	0.388

Abbreviations: CCI, Charlson comorbidity index; CP, chronic periodontitis. Linear regression model, Significance at $p < 0.05$. [†] Models stratified by age, sex, income, and region of residence. [‡] A model adjusted for obesity, smoking, alcohol consumption, CCI scores, and pre-index date of CP (pre-ID CP) for 2 y.

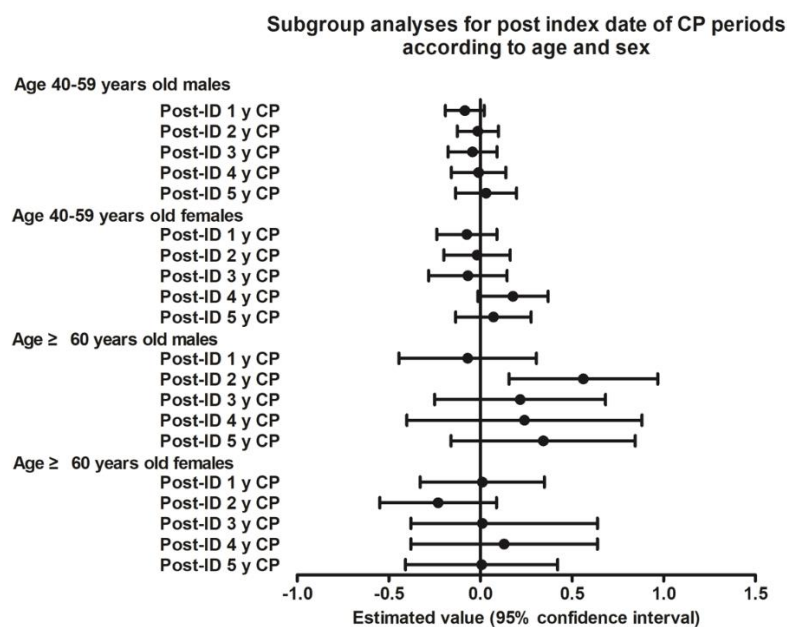


Figure 2. Subgroup analyses of simple and multiple linear regression models (estimated value [95% confidence interval]) for post-index date of CP (post-ID CP) periods in tonsillectomy group compared to control group according to age and sex.

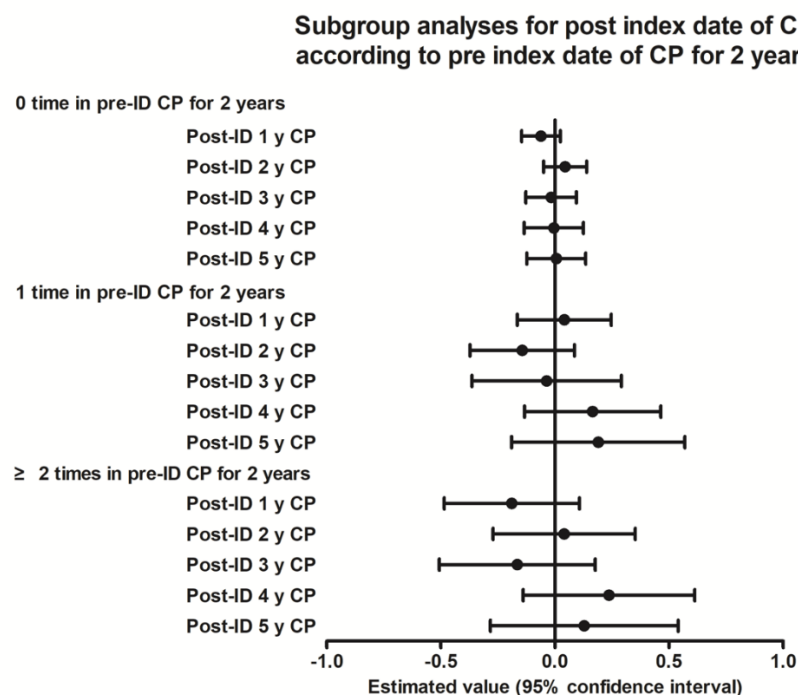


Figure 3. Subgroup analyses of simple and multiple linear regression models (estimated value [95% confidence interval]) for post-index date of CP (post-ID CP) periods in tonsillectomy and control groups according to pre-index date of CP (pre-ID CP) for 2 years.

4. Discussion

The hypothesis of this study, based on previous research that suggests a link between peritonsillar infection and periodontitis, was that the bacteriological and clinical outcomes of tonsillectomy could influence the diagnosis and treatment of CP [29]. It has previously been suggested that the niches around the palatine tonsils are the sources of bacterial infection for the periodontal area [18,23].

Unexpectedly, this study revealed that the adjusted EV of the number of post-ID CP did not reach statistical significance in any post-ID year. In another subgroup analysis according to the number of pre-ID CP, statistical significance was not found in any analysis. These findings oppose the assumption made by Quirynen et al., although limitations of this study should be further discussed [18].

Tonsillectomy, including removal of the biofilm, has a positive effect on the intraoral areas such as the gingiva and tongue. A previous study reported that the microorganisms in the tongue area were altered following tonsillectomy [26]. The study showed that *Tannerella forsythia* and *Porphyromonas gingivalis* levels decreased in samples taken from the tongue after tonsillectomy [26]. This result could be explained by how anatomically close the tongue and tonsils are, and the fact that saliva is exchanged between them while speaking and swallowing. On the contrary, the same study reported that lesser changes occurred in other bacteria levels in the periodontal pocket following tonsillectomy [26]. They suggested that, with regards to the tonsillar area, the periodontal pocket would be more distant and difficult to access than the tongue area. As such, other bacteria in the periodontal pocket may be less affected. We also believe that the risk of developing CP after tonsillectomy was not reduced in our study for this reason.

Another reason for the discrepancy between the diagnosis and treatment of CP and tonsillectomy is that the major bacteria in culture-dependent studies of tonsils and the microbiome in culture-independent 16 s sequencing studies are *Streptococcus* and *Haemophilus influenzae* [8,30]. However, the essential microbiome in CP was *Porphyromonas gingivalis*, which can increase the activity of biofilm bacteria by interrupting homeostasis in the host.

Our findings could be explained by the improvements that occur with regards to mouth breathing following tonsillectomy. Tonsillectomy can eliminate breathing problems such as snoring or mouth

breathing [31], which is likely to increase the risk of periodontitis. Kaur et al. have reported that a patient's periodontal condition is influenced by mouth breathing even after periodontal treatment such as scaling and root planning [32]. Mouth breathing also induces a dry condition in the intraoral area, which could increase the possibility of periodontitis. This hypothesis was explained in another study, suggesting that the salivary substitute had a positive effect on the periodontal condition in mouth breathing patients with CP [33]. According to these studies, tonsillectomy might reduce mouth breathing, and improved mouth breathing could have a beneficial effect on periodontitis.

This study has four advantages. The first is the large number of study participants ($n = 5220$). Participants were followed up for a maximum of 13 years following tonsillectomy, whereas a similar study only conducted a 3-year follow-up [29]. Secondly, the Korean National Health Insurance Service-Health Screening Cohort dataset is a large national survey that is representative of the Korean population. These cohort records were available for each participant, and the records used in our study were not distorted by the memory of participants. The data are also inclusive of all Koreans without exception; therefore, no participants were missed during the follow-up period. Thirdly, well-trained clinicians documented general health examinations and laboratory evaluations. Finally, adjusting factors showed a statistically significant independent association with tonsillectomy in our data, thus confirming the reliability of our study.

This study used a large population dataset; nevertheless, the findings have limitations. Firstly, the dataset included many factors such as alcohol consumption, obesity, smoking, and age. However, it was impossible to adjust for all systemic factors that were not included in the dataset. Secondly, this study could have been subject to surveillance bias. Tonsillectomy was more likely to be diagnosed for possibly unrelated CP, based on a higher number of visits to medical institutions. However, it is very unlikely that increased participant visits would induce the detection of CP. Dental examinations were conducted during regular visits that were covered by the Korean National Health Service (KNHS), which has exclusive characteristics, including low payment, widespread coverage, and easy access to medical institutions in Korea. In addition to these advantages, most Koreans undergo regular dental check-ups. Additionally, the large population dataset of this study was adjusted for many factors; thus, the surveillance bias was minimized by this adjustment. Therefore, this study prevented surveillance bias by adjusting the characteristics of the KNHS system. Furthermore, the present study analyzed the association using only code from data of the Korean National Health Service (KNHS), and thus the data did not indicate periodontitis severity. There may also be confounders that were not adjusted for. Finally, data were collected from individuals over the age of 40 years. Therefore, considering these limitations, further studies are required to validate our findings.

5. Conclusions

This study revealed that tonsillectomy was not significantly associated with reducing CP. Though the tonsils and periodontium are close in location, and tonsillectomy and CP may be related with regards to bacterial inflammation, the risk of CP in patients undergoing tonsillectomy was not statistically significant. However, further studies with a larger population should be considered to confirm, with greater plausibility, the influence of tonsillectomy on periodontal conditions in patients affected by CP.

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