

# Research Paper: Dental Caries and Plaque Accumulation in Patients Undergoing Removable Orthodontic Treatment: An Epidemiologic Study



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## ABSTRACT

**Introduction:** This study aimed to determine the prevalence of dental caries and plaque in patients undergoing removable orthodontic treatment.

**Materials and Methods:** In this cross-sectional study, 57 patients were selected and examined for dental caries (clinically and radiographically) and plaque (O'Leary Index) on permanent and primary teeth. Data were analyzed using chi-square and Fisher at the significance level of 0.05.

**Results:** The prevalence of dental caries in participants was 21.2%. The proximal surfaces were more commonly decayed. The most prevalent state of caries in permanent and primary teeth was incipient and advanced, respectively. The relation between dental caries and age was significant. ( $P < 0.001$ ) The most frequent teeth with dental caries were first molars in permanent and primary teeth. ( $P < 0.001$ ) Plaque accumulation in permanent teeth was 68.59% and in primary teeth was 61.24%. Labial surfaces had dental plaque more commonly. The most frequent teeth with dental plaque were incisors in permanent and primary teeth. ( $P < 0.001$ )

**Conclusion:** Dentists should make the necessary recommendations to the patients so they can maintain good oral hygiene during their orthodontic treatment.

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## Introduction

Tooth decay remains a public health problem in the world. It is important for public health organizations to be aware of the oral health condition and caries prevalence among people in order to prevent them. (1-5) Caries affect 35-50% of school-age children and a large proportion of adults. Tooth decay begins at the enamel surfaces where there is a change in the balance between demineralization and remineralization. (3,5-7)

Patients using orthodontic appliances are at a higher risk of developing future caries. (8-10) Orthodontic appliances in the mouth alter the microbial balance of the oral cavity and may reduce the ability to remove plaque and maintain good oral hygiene, leading to an increase in the number of *Streptococcus mutans* and *Lactobacillus*. *Streptococcus mutans* is considered an important factor for dental caries. (11-13)

All orthodontic appliances have the potential to damage the enamel by causing demineralization. Also, in the presence of a carious environment, the process of demineralization around orthodontic appliances progresses faster. (14-16) According to previous studies, patients with fixed orthodontic appliances are at high risk for dental caries. Although the presence of removable orthodontic appliances can increase plaque accumulation, since these devices are removable, maintaining their hygiene can be easier for patients. (17-18)

Previous studies have shown the prevalence of caries in orthodontic patients. (19-24) In addition, most patients undergoing orthodontic treatment are children and adolescents who have weaker cooperation in maintaining acceptable oral hygiene. Also, eating habits of this age group usually include low-value foods and high consumption of sweets and chocolate. These eating habits are an important factor for multifactorial diseases such as dental caries. When sucrose is widely available, it leads to the demineralization of enamel. Despite modern advances in caries prevention, preventing demineralization during orthodontic treatment

is one of the most important challenges for clinicians. It is recommended that dentists focus on increasing dental awareness and oral hygiene along with professional prophylaxis of patients. These patients can benefit from extensive prophylaxis programs before and during treatment. (19-24) Therefore, patients at high risk of demineralization and caries should be identified before starting orthodontic treatment. The high prevalence of caries can overshadow the success of orthodontic treatments; therefore, this study investigated the caries status in patients treated with removable orthodontic appliances.

## Materials and Methods

In this cross-sectional epidemiologic study, 57 patients with removable orthodontic appliances, with no caries and age range of 9 to 15 years old were included if they had been under orthodontic treatment for at least 6 months. Patients not willing to participate, patients with mental and physical disorders, and patients receiving fluoride therapy in the last 6 months were excluded from the study.

This study obtained an ethical approval code (IR.GUMS.REC.1395.316) from the ethical committee of the university. Written consent was obtained from the patients' parents. Demographic data (age and gender) was collected. The presence of dental caries was assessed in each patient clinically and radiographically. Bitewing radiographs were obtained to evaluate dental caries in the proximal surfaces. The presence of dental plaque was assessed in each patient using disclosing tablet and the O'Leary index was recorded for all tooth surfaces, one hour post toothbrushing.

The data was analyzed by SPSS 25 version (IBM Corp, Armonk, NY, USA) and Chi-square and Fisher tests were applied at the significance level of 0.05.

## Results

In the current study, 57 patients participated. 54.4% (31) of patients were female and 45.6%

Table 1: The prevalence of dental caries in permanent and primary teeth according to the number of teeth and surfaces.

Caries		Teeth	Buccal and lingual surfaces	Mesial and distal surfaces	Occlusal surfaces
Dental caries in permanent teeth	Without caries	88.6% (976)	98.2% (1982)	96.8% (2132)	97.1% (1069)
	With caries	11.4% (125)	1.8% (40)	3.2% (70)	2.9% (32)
	Total	100% (1101)	100% (2202)	100% (2202)	100% (1101)
Dental caries in primary teeth	Without caries	39.3% (108)	95.11% (523)	57.79% (317)	92% (253)
	With caries	60.7% (167)	4.89% (27)	42.21% (233)	8% (22)
	Total	100% (275)	100% (550)	100% (550)	100% (275)

Table 2: The relation of dental caries and age in the participants.

Age groups	Percent (number)	Caries		
		Teeth with caries	Teeth without caries	Total number of teeth
9 years old	14% (8)	8.7% (13)	91.3% (140)	100% (153)
10 years old	28.1% (16)	7.7% (23)	92.3% (281)	100% (304)
11 years old	28.1% (16)	6.1% (19)	93.9% (285)	100% (304)
12 years old	14% (8)	3.8% (6)	96.2% (147)	100% (153)
13 years old	8.8% (5)	4.7% (5)	95.3% (94)	100% (99)
14 years old	1.8% (1)	1.4% (1)	98.6% (27)	100% (28)
15 years old	5.3% (3)	3.3% (2)	96.7% (58)	100% (60)

Table 3: The prevalence of dental plaque in permanent and primary teeth according to the number of teeth and surfaces.

Dental Plaque		Teeth	Buccal and lingual surfaces	Mesial and distal surfaces
Dental Plaque in permanent teeth	Without plaque	31.41% (345)	36.59% (806)	33.98% (748)
	With plaque	68.59% (756)	63.41 (1396)	66.02% (1454)
	Total	100% (1101)	100% (2202)	100% (2202)
Dental Plaque in primary teeth	Without plaque	38.76% (106)	42.52% (234)	40.64% (224)
	With plaque	61.24% (169)	57.48% (316)	59.36% (326)
	Total	100% (275)	100% (550)	100% (550)

(26) were male. The mean age of patients was 11±1.5 years.

### Dental Caries:

The prevalence of dental caries in participants was 21.2%. 11.4% of permanent teeth and 60.7% of primary teeth were decayed.

(Table 1). The prevalence of dental caries in both permanent and primary teeth was most common on proximal surfaces and was the least common on the lingual surface. Also, the state of caries was recorded as incipient, advanced, recurrent, and arrested. The state of caries in 79.2% (99), 18.1% (22), 2.1% (3) and 0.7% (1) of permanent teeth were respectively incipient, advance, arrested and recurrent. The state of caries in 21.9% (37), 76% (127), 1.4% (2) and 0.7% (1) of primary teeth were respectively incipient, advance, arrested and recurrent. The most prevalent state of caries in permanent

and primary teeth was incipient and advanced, respectively.

The relation of dental caries with gender was assessed in this study. According to the results, dental caries had no significant relationship with gender. (P=0.256) The relation of dental caries with age was assessed in the current study. (Table 2) According to the results, dental caries was the most frequent in the 9-year-old patients and was the least frequent in the 14 years old patients. The relation between dental caries and age was significant. (P<0.001) So that the prevalence of dental caries in patients with removable orthodontic appliances had a reverse relationship with age.

Also, the relation of dental caries with the type of permanent teeth was evaluated. Results showed that the most frequent permanent teeth with dental caries were first molars, and the

least frequent teeth with dental caries were lateral incisors. The relation of dental caries with the type of permanent teeth was significant. ( $P < 0.001$ )

The relation of dental caries with the type of primary teeth was assessed. The most frequent primary teeth with dental caries were first primary molars and the least frequent primary teeth with dental caries were primary canines. The relation of dental caries with the type of primary teeth was significant. ( $P < 0.001$ )

### **Dental Plaque:**

The prevalence of dental plaque in participants is presented in Table 3. The prevalence of dental plaque in both permanent and primary teeth was most common on labial surfaces and was the least common on the lingual surface.

The relation of dental plaque with gender and age was assessed in this study. According to the results, no significant relation was observed between dental plaque and gender; and between dental plaque and age.

Also, the relation of dental plaque with the type of permanent teeth was evaluated. Results showed that the most frequent permanent teeth with dental plaque were lateral incisors, and the least frequent teeth with dental plaque were second premolars. The relation of dental plaque with the type of permanent teeth was significant. ( $P < 0.001$ )

The relation of dental plaque with the type of primary teeth was assessed. The most frequent primary teeth with a dental plaque were primary incisors and the least frequent primary teeth with dental caries were second primary molars. The relation of dental plaque with the type of primary teeth was significant. ( $P < 0.001$ )

## **Discussion**

Dental caries due to its high prevalence are one of the most important oral health problems in the world. (1-5) Several factors may be associated with the spread of caries. People who use removable orthodontic appliances are at a higher risk of caries. (14-18) The use of a re-

movable orthodontic appliance causes biofilm accumulation; increases the levels of Streptococcus mutans and lactobacillus in saliva; and can increase the risk of dental caries in these patients. (11-18) Therefore, it is important to determine the prevalence of plaque and dental caries in patients undergoing removable orthodontic treatments.

Methods of diagnosing dental caries include clinical examination and radiography examination. In the study of Lucchese et al., Enaia et al., Shrestha et al., and Gupta et al.; the clinical examination method was used. (19-22) In the current study, in addition to clinical examination, bite-wing radiography assessment was used to accurately diagnose interdental caries. Similarly, Baumgartner et al. and Soumas et al. used the same method of diagnosing dental caries as in the present study. (23-24)

In the present study, the prevalence of caries in patients undergoing removable orthodontic treatment was investigated. The frequency of caries in these patients in the age group of 9-15 years was 21.2%. 11.4% of permanent teeth and 60.7% of primary teeth were decayed. In the current study, the prevalence of dental caries in primary teeth was higher compared to permanent teeth. Since the primary teeth are present in the oral cavity for a longer period of time, the spread of dental caries in primary teeth is more than in permanent teeth. Also, the enamel of primary teeth has less mineralization, more opacity, and more porosity than the enamel of permanent teeth, therefore, it is less resistant to dental caries. Similar to this study, in the study of Soumas et al., caries in primary teeth were reported to be more than caries in permanent teeth. The presence of decayed primary teeth in the oral cavity can exacerbate the caries formation in other permanent teeth. (24-29)

In this study, the frequency of caries in proximal surfaces was higher than in occlusal, lingual, and buccal surfaces of teeth in both groups and especially in primary teeth. This might be due to difficulty in maintaining oral hygiene on proximal surfaces. However, Chestnutt et al. and Hannigan et al. reported that the frequency

of caries was higher on occlusal surfaces. This difference can be related to the method of examination in the present study and the studies of Chestnutt et al. and Hannigan et al. In this study, along with the clinical examination, the radiographic examination was performed to diagnose interdental caries, while in the studies of Chestnutt et al. and Hannigan et al. only a clinical examination has been performed. (30-31)

According to the results of this study, the most prevalent state of caries in permanent and primary teeth was incipient and advanced, respectively. Lack of attention to decayed primary teeth led to the progression of incipient caries to advanced caries. The high prevalence of advanced caries in primary teeth indicates the need to expand control and prevention programs. (20-22)

Results of this study showed that the frequency of caries decreases as the age of participants increases. The higher prevalence of caries in young patients can be related to poor health cooperation. The result of the present study is different from the studies of Lucchese et al. and Shrestha et al., who claimed that the age of patients was not related to the prevalence of caries. (19,21) In our study, no relationship was observed between gender and dental caries prevalence, which is similar to the study of Shrestha et al., Lucchese et al. (19,21) While in the study of Enaia et al. Soumas et al., Kanaya et al. the prevalence of white spot was more frequent in males than females. (20,24,32)

In the present study, the most frequent permanent teeth with dental caries were first molars; and the least frequent teeth with dental caries were lateral incisors. For primary teeth, the most frequent teeth with dental caries were first primary molars (D) and the least frequent teeth with dental caries were primary canines (C). The first molar tooth erupts at an earlier age than other permanent teeth; it is located in a more posterior position than other teeth and has deeper pits and fissures. Therefore, it can be expected that the most frequent teeth with dental caries were first molars. Anterior teeth have dental caries less frequently because they

are more accessible to maintain oral health and also have smaller interdental contacts than the posterior teeth. Therefore, the permanent lateral incisors and primary canines had fewer dental caries. (20-24,33-34)

Plaque accumulation in permanent teeth was 68.59% and in primary teeth was 61.24%. Shrestha et al. and Gupta et al. also reported similar plaque accumulation rates in orthodontic patients. (21,22) Uncontrolled accumulation of bacterial biofilms on or around the orthodontic appliances can be associated with dental caries. (21)

According to previous studies, plaque accumulation is more on the molars and premolars than the anterior teeth; and is more on proximal surfaces than the facial surfaces, and the least amount of plaque accumulates can be found on the lingual surfaces. While in this study, the anterior teeth showed more plaque accumulation than posterior teeth, and also, the plaque accumulation on facial surfaces was more than on proximal surfaces. These divergent results can be due to the different orthodontic treatments. In the previous studies, patients received fixed orthodontic treatment, however, in this study patients underwent removable orthodontic treatment. (21,22) One of the limitations of the current study is that the type of appliance was not determined.

## Conclusion

In this study, the prevalence of dental caries in participants undergoing removable orthodontic appliances was 21.2%. Dental caries were most common on proximal surfaces and were the least common on the lingual surface. The most prevalent state of caries in permanent and primary teeth was incipient and advanced, respectively. The relation between dental caries and age was significant. The most frequent permanent teeth with dental caries were first molars, and the least frequent teeth with dental caries were lateral incisors. For primary teeth, the most frequent teeth with dental caries were first primary molars and the least frequent teeth

with dental caries were primary canines. The prevalence of dental plaque in both permanent and primary teeth was most common on labial surfaces and was the least common on the lingual surface. The most frequent permanent teeth with a dental plaque were lateral incisors, and the least frequent teeth with a dental plaque were second premolars. For primary teeth, the most frequent teeth with a dental plaque were primary incisors and the least frequent teeth with dental caries were second primary molars. Developments in reducing dental caries show a slow but hopeful movement to improve oral health, especially in children, and dentists should make the necessary recommendations to the patients so they can maintain good oral hygiene during their orthodontic treatment.

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None

#### *Authors' contributions*

**Maryam Ghamgosar:** Conceptualization, Methodology, Writing - Review & Editing  
**Erfaneh Afsai:** Resources, Investigation, Visualization  
**Maryam Tavangar:** Methodology, Visualization  
**Farideh Darabi:** Writing - Original Draft, Data Curation  
**Dina Maleki:** Funding acquisition, Project administration, Supervision  
**Reza Tayefeh Davaloo:** Writing - Review & Editing Resources

#### *Conflict of Interests*

The authors declare no conflict of interest.

#### *Ethical declarations*

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#### *Availability of data and material*

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request

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