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INCIDENCE OF DENTAL CARIES DURING FIXED ORTHODONTIC TREATMENT IN PETRA JAYA DENTAL CLINIC: A RETROSPECTIVE STUDY

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ABSTRACT

Objectives: The purpose of the present study was to investigate the incidence of dental caries during fixed orthodontic treatment and the effect of gender, ethnicity, age at start of treatment, duration of treatment and frequency of oral hygiene instructions on the incidence of dental caries. **Materials and Method:** The retrospective study was conducted using selected orthodontic patient records (*n*=115) from 2017-2018. Records of new carious lesions which developed during the treatment process were identified. Number of caries and the teeth they are located were recorded. Independent variables were collected by chart abstraction. **Results:** Gender, ethnicity, age at the start of treatment and duration of treatment were not significantly associated with caries development. **Conclusions:** The incidence of dental caries in patients treated with fixed orthodontic appliances were moderately high. This problem warrants significant attention from both patients and providers that should result in increased emphasis on oral hygiene reinforcement and effective caries preventive measures. The risk of developing caries lesions during orthodontic treatment should not be underestimated by both orthodontists and patients.

Keywords: Dental Caries, Oral Health, Orthodontic Treatment

INTRODUCTION

Dental caries is one of the complications of orthodontic treatment. Caries is a reversible multifactorial process of tooth demineralization and remineralization. It's also known as tooth decay or disease where bacterial processes damage hard tooth structure. These tissues progressively break down, producing dental caries i.e. cavities. Two groups of bacteria are responsible for initiating caries: Streptococcus mutans and Lactobacillus. If they are left untreated, the disease can lead to pain, pulp necrosis and tooth loss. (Chang, Walsh & Freer, 1997 ; Sukhia, Ayub & Gandhi, 2006).

Caries or enamel decalcification is a serious problem for orthodontic patient as shown by previous records suggested high prevalence of caries in patients receiving fixed orthodontic treatment (FOT), with the cause being difficulty and negligence in oral hygiene maintenance (McGuinness, 1992). In orthodontics, caries usually occurs on smooth surfaces, affecting 2 to 97% of all orthodontic patients (Gontijo,Cruz Rde & Brando, 2007; Boersma, 2005). Orthodontic patients can find it difficult to maintain adequate oral hygiene around fixed appliances. The decline in oral hygiene that often accompanies orthodontic treatment might lead to an increased risk for development of caries lesions. The severity of the resultant dental caries can range from development of opaque WSL, or decalcification, to loss of surface integrity of enamel and cavitation (Gorelick, Geiger & Gwinnett,1982; Mizrahi, 1982; Richter *et al.*, 2011).

Orthodontic appliances physically alter the microbial environment (Balenseifen & Madonia, 1970; Bloom & Brown,1964; Corbett *et al.*, 1981; Mattingly e*t al.*, 1983; Rosenbloom & Tinanoff, 1991; Scheie, Arneberg & Krogstad,1984).Increased proliferation of the facultative bacterial population, including Streptococcus mutans, leads to a decrease in pH that tips the demineralization-remineralization balance toward mineral loss

(demineralization), which in turn can lead to WSL development and eventually to cavitation and caries extending into the dentin (Chatterjee & Kleinberg, 1979; Pinkham, 1989; Featherstone, 2003; Featherstone *et al.*, 2007).

The present study was designed to investigate the dental caries incidence during FOT and the effect of gender, ethnicity, age at start of treatment, duration of treatment and frequency of oral hygiene instructions on the incidence of dental caries. This study sought to aid orthodontists to be aware of the caries incidence and to decide whether current preventive therapy provided is adequate. The result of this study can help to emphasize the need for good oral hygiene instructions, motivation and meticulous caries-prophylactic measures such as professional tooth cleaning and topical fluoride application during the FOT process.

RESEARCH METHODOLOGY

Ethical approval for this study was obtained from Medical Review & Ethics Committee (MREC) Malaysia (NMRR-19-541-46467). One hundred fifteen patient records were selected by applying the inclusion and exclusion criteria from patients treated in the Orthodontic Clinic in the Petrajaya Dental Clinic between 2017 and 2018.

Inclusion criteria for record selection consist of patients who (1) underwent comprehensive orthodontic treatment with full fixed appliances on labial tooth surfaces; (2) had all fixed orthodontic treatment completed (debonded) in 2017-2018; (3) had no dental structural abnormalities, veneers, or other reconstructions; (4) had complete treatment log information in their charts.

Exclusion criteria for record selection consist of patients (a) with ongoing fixed orthodontic treatment; (b) who underwent removable orthodontic appliance treatment only; (c) whose appliances were removed prematurely before completion of orthodontic treatment; (d) who were transferred from other orthodontic specialist clinic (transfer case).

Data collection from deidentified patient charts included gender, race, age at initiation of orthodontic treatment and treatment length. Treatment length was defined as the period between the start of full fixed appliance therapy and the removal of all active fixed appliances. A limited phase 1 treatment before comprehensive treatment was not included in treatment-time calculation. Frequency of oral-hygiene instructions after the initial oral hygiene instructions was recorded from progress notes in the chart. From the patients' charts, records of new carious lesions which developed during the treatment process were identified. Number of caries and the located teeth were recorded.

Statistical analysis was done by using SPSS version 16.0. The statistical analysis including frequency distribution, cross tabulation and chi-square test was used to find the association between dental caries and gender, race, age group, treatment length and frequency of oral hygiene instructions, and the p-value was set at $p<0.05$.

RESULTS

The present study comprised of 115 orthodontic patients including 82 (71.3%) females and 33 (28.7%) males. The age of the subjects ranged from 12 to 30 years with mean age 16.43 years. The frequency distribution of subjects with respect to age group, gender and ethnicity is given in Table 1.

Table 1: Demographic profile of Subjects

Demographic profile		***n* (%)**
Age (years)	<14	7 (6.1)
	14-16	70 (60.9)
	17-19	28 (24.3)
	>19	10 (8.7)
Gender	Male	33 (28.7)
	Female	82 (71.3)
Ethnicity	Malay	40 (34.8)
	Chinese	61 (53.0)
	Indian	3 (2.6)
	Iban	6 (5.2)
	Bidayuh	4 (3.5)
	Melanau	1 (0.9)
	Others	0 (0.0)

The present study depicted the incidence of dental caries as 34.8% (Table 2) with the mean 0.61 and standard

deviation 1.19. (Table 3) Among 115 patients, 40 patients (34.8%) had one or more carious tooth/teeth in the oral cavity.

Table 2: Frequency according to presence of cavitated lesions

Carious teeth	Frequency	Percentage
No	75	65.2
Yes	40	34.8
Total	115	100.0

Table 3: Frequency according to the number of cavitated lesions

No. of caries	Frequency	Percentage	Mean	Standard deviation
0	75	65.2	0.61	1.19
1	25	21.7		
2	10	8.7		
3	2	1.7		
6	2	1.7		
7	1	0.9		
Total	115	100.0		

The study showed that the distribution of caries occurrence was highest in age group 14-16 years i.e. 60.0%. However, there was no association between the age group and occurrence of dental caries (Table 4).

Occurrence of dental caries among male and female patients was 30.0% and 70.0% respectively. However, there was no statistically significant association in caries occurrence between gender groups (Table 4).

In a total of 115 orthodontic patients, the occurrence of dental caries was 62.5% in Chinese, 27.5% in Malay, 5.0% in Iban, 2.5% in Bidayuh, 2.5% in Melanau and 0% in Indian patients. However, there was no significant association between the ethnicity and caries occurrence (Table 4).

The recorded number of oral-hygiene instructions between provider and patient was significantly associated with development of cavitated lesions (p=0.017). A decrease was shown for the number of cavitated lesions for patients having more than 2 oral-hygiene discussions (12.5%) versus those with whom oral hygiene was not discussed after the initial oral hygiene instructions (52.5%). (Table 4)

According to the duration of orthodontic treatment, subjects undergoing treatment for less than 25 months duration had 10.0%, 25-35 months had 50.0%, 36-45 months had 30.0%, and more than 45 months had 10.0% occurrence of dental caries. However, there was no association between the duration of orthodontic treatment and caries occurrence (Table 4).

Table 4: Determine associated factors towards dental caries during FOT.

Independent variable		Carious teeth				
		No		Yes		*p*-value [a]
		n	%	n	%	
Age (years)	<14	5	6.7%	2	5.0%	0.924
	14-16	46	61.3%	24	60.0%	
	17-19	17	22.7%	11	27.5%	
	>19	7	9.3%	3	7.5%	
Gender	Male	21	28.0%	12	30.0%	0.821
	Female	54	72.0%	28	70.0%	
Ethnicity	Malay	29	38.7%	11	27.5%	0.345
	Chinese	36	48.0%	25	62.5%	
	Indian	3	4.0%	0	0.0%	

	Iban	4	5.3%	2	5.0%	
	Bidayuh	3	4.0%	1	2.5%	
	Melanau	0	0.0%	1	2.5%	
	Others	0	0.0%	0	0.0%	
	0	57	76.0%	21	52.5%	0.017
	1-2	16	21.3%	14	35.0%	
	>2	2	2.7%	5	12.5%	
Treatment length (months)	<25	11	14.7%	4	10.0%	0.543
	25-35	28	37.3%	20	50.0%	
	36-45	24	32.0%	12	30.0%	
	>45	12	16.0%	4	10.0%	
[a]*P*-value was derived from Pearson chi-square test						

With regards to the quadrant involved, the first quadrant was the most affected (17.4%) whereas the fourth quadrant was the least affected (7.0%). The upper teeth (1st and 2nd quadrants) were more affected than the lower teeth (3rd and 4th quadrants). (Table 5)

Table 5: Frequency of dental caries according to the quadrant involved

Quadrant involved	***n* (%)**
First	20 (35.1%)
Second	17 (29.8%)
Third	12 (21.1%)
Fourth	8 (14.0%)

The maxillary right first molars (16) were the most affected teeth (8.7%). The least affected teeth were the maxillary right first premolars, mandibular anteriors, mandibular right premolars, mandibular left first premolars and mandibular third molars (0%). (Table 6)

Table 6: Frequency of dental caries according to type of tooth

Type of tooth involved	***n* (%)**
Upper right first molar (16)	10 (14.3%)
Lower left first molar (36)	7 (10.0%)
Upper right central incisor (11)	5 (7.1%)
Upper left lateral incisor (22)	5 (7.1%)
Lower left second molar (37)	5 (7.1%)
Upper right lateral incisor (12)	4 (5.7%)
Lower right first molar (46)	4 (5.7%)
Lower right second molar (47)	4 (5.7%)
Upper right second premolar (15)	3 (4.3%)
Upper left central incisor (21)	3 (4.3%)
Upper left second molar (27)	3 (4.3%)
Upper left third molar (28)	3 (4.3%)
Upper canines (13,23)	2 (2.9%)
Upper right second molar (17)	2 (2.9%)
Upper left premolars (24,25)	2 (2.9%)
Upper left first molar (26)	2 (2.9%)
Upper right third molar (18)	1 (1.4%)
Lower left second premolar (35)	1 (1.4%)
Upper right first premolar (14),	0 (0%)
Lower anteriors (31,32,33,41,42,43)	0 (0%)
Lower left first premolar (34)	0 (0%)
Lower right premolars (44,45)	0 (0%)
Lower third molars (38,48)	0 (0%)

DISCUSSION

The present study indicates that carious lesions remains a significant problem during fixed orthodontic

treatment. The overall incidence found in the present study was 34.8% which falls in the mid-range of the reported figures in the previous literature, which range from 2 to 97% (McGuinness, 1992; Lovrov, Hertrich & Hirschfelder,2007;Gontijo, Cruz Rde & Brando, 2007). Richter *et al.*, (2011) reported the incidence of new white-spot lesions (WSL) during orthodontic treatment in 72.9% subjects, and the incidence of new cavitated lesions in this population was 2.3%. The highest incidence of WSLs reported in the previous literature (97%) was probably due to the early identification of the presence of WSLs that were not clinically visible as the study used Quantitative Light-induced Fluorescence (QLF) to evaluate the presence of WSLs.

In the present study, we aimed at analysing the effect of age at start of treatment, gender, ethnicity, frequency of oral hygiene instructions and treatment length on the incidence of dental caries.

The results were non-significant in relation to gender while considering the incidence of carious lesions and this finding was similar to the results of Richter *et al.*, (2011). However, some studies reported significant gender differences and indicated that males were having greater risk of developing lesions (Boersma *et al.*, 2005 ; Chapman *et al.*, 2010).

As for the age group distribution, the present study reveals that there was no significant association between age at the start of treatment and incidence of new carious lesions, consistent with the results of Richter *et al.* (2011). However, Chapman *et al.*, (2010) showed that younger patients were at higher risk for caries development than the adults.

The results were non-significant in relation to ethnicity while considering the incidence of carious lesions. A study by Chapman *et al.*, (2011) showed that the white ethnic group was at higher risk for caries development during fixed orthodontic treatment.

In the current study, duration of treatment was found to have no significant association with the formation of carious lesions. Richter *et al.*, (2011) found that longer treatment duration was not significantly related to increase cavitated lesions. Lovrov, Hertrich & Hirschfelder (2007) were unable to find an impact of the treatment length on the prevalence of WSLs. However, some studies found increased prevalence of caries with the time period of orthodontic treatment (Tufekci *et al.*, 2011; Chapman *et al.*, 2010).

The number of times that orthodontic care providers offered oral-hygiene instructions was significantly associated with development of new cavitated lesions (p=0.017). The frequency of oral-hygiene discussions was associated with lesser number of carious lesions. The importance of repeating the instruction in order to increase the compliance was shown by Ashkenazi *et al.*, (2012) who showed that a significant positive co-relation was found between compliance with preventive measures and number and frequency of recall appointments in which patients receive reinforcement. However, Richter *et al.* (2011) found that the number of oral hygiene conversations increased concurrently with the development of both WSL and cavitated lesions (parameter estimate, 1.88).

With regards to the most affected teeth, it was found in the present study that the maxillary right first molars were the most affected teeth. Similar findings were found by some previous investigators who have reported the most affected teeth to be the maxillary first molars [22]. However, some studies have reported different results, with the most affected teeth reported to be either the maxillary canines or the maxillary lateral incisors (Gorelick, Geiger & Gwinnett, 1982 ; Tufekci *et al.*, 2011; Ogaard, 1989; Chapman *et al.,* 2010).

This study accounted for only independent variables that were readily available in the patients' charts. It was by nature limited due to a retrospective design. No information on patients' socio-economic status, frequency of consulting the dental clinic, prophylactic fluoride therapy, oral hygiene practices and diet habits was available. The relation between new carious lesions and many other variables (e.g. oral hygiene & food habits) were evaluated in other studies. Shrestha *et al.*, (2013) found that large proportion of orthodontic patients consume sweets foodstuff, junk food and snacks in between meals and very few patients practice special oral hygiene measures (interdental brush, fluoride mouthwash).

Unfortunately for this retrospective study, only cavitated carious lesions were recorded. No information on reversible white spot lesions (WSL) was available from the patients' charts. Previous retrospective studies used pre-treatment and post treatment intraoral photographs

to determine the incidence of labial caries lesions in patients who underwent comprehensive orthodontic treatment with full fixed appliances. However, the photographic method would result in underestimation of reporting the WSL. Some have argued that it is relatively poor for assessing individual lesions longitudinally (Lovrov, Hertrich & Hirschfelder, 2007; Richter *et al.*, 2011). This is due to varying photographic conditions and artefacts between that points: lighting, angulation, and magnification. Intraoral photographs can only provide partial view of the labial surfaces of teeth (Ellwood & O' Mullane, 1994).

Gorelick *et al.* (1982) compared orthodontically treated patients with untreated controls. Tufekci *et al.* (2011) compared orthodontic patients in control and treatment group at 6 and 12 months into treatment by control group. Although their study had the benefit of comparisons with a control group, it was cross-sectional in design. What was reported to be the "incidence" of white-spot development was actually the "prevalence" of lesions in the 2 or 3 groups.

The high prevalence and incidence of carious lesions during and after orthodontic treatment with fixed appliances warrants a more detailed investigation of this phenomenon in a prospective randomized controlled clinical trial by using a direct method of assessing early caries lesions with well-documented charting.

CONCLUSION

Caries and decalcification continue to be a serious problem as shown by a moderately-high incidence of new cavitated carious lesions (34.8%) in patients treated with fixed orthodontic treatment. Sex, age, ethnicity and treatment length were not associated with lesion development, but a significant association was evidenced with frequency of oral hygiene instructions. The maxillary right first molars were the most affected teeth.

This widespread problem of caries development is an alarming challenge and warrants significant attention from both patients and providers that should result in greatly increased emphasis on oral hygiene reinforcement and effective caries preventive measures. Orthodontists should be aware of the high risk of dental caries and provide intensive oral hygiene instructions and monitoring.

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