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Journal's Office: Oral and Dental Diseases Research Center, Kosar Blvd, Kerman, Iran, 7618836555

TelFax: +98 34 32133440

Email: johkmu@kmu.ac.ir

Email: johkmu@yahoo.com

www.johoe.kmu.ac.ir

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Farzanegan Radandish Co.

Postal Code: 81465-1798, Isfahan, Iran

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How many times is the optimum dental floss frequency in people with normal periodontium? A randomized controlled single blind clinical trial

Hoda Shamsaddin DDS, MSc¹, Amin Motamedi DDS, MSc²

Original Article

Abstract

BACKGROUND AND AIM: Due to the inadequacy of a toothbrush in cleaning of interdental areas and further advanced developing of the disease in this area, dental flossing seems essential. However, the developing of people's using dental floss as a habit is difficult. The purpose of this paper is to determine the use of dental floss frequency in reducing plaque and the optimal dental floss daily use frequency in people with a healthy periodontium.

METHODS: In this study, 44 dental students of School of Dentistry, Kerman, Iran, with healthy periodontal or at most a few bleeding on probing (BOP) areas were investigated. Scaling and root planning was performed for all subjects at baseline as well as necessary trainings about how to use the toothbrush and dental floss were instructed. In terms of using dental floss frequency, participants were divided into four groups of 22 each G1, G2, G3, and G4 which were meant to be used dental floss in every second day, a day, 2 or 3 times a day, respectively. At baseline, total plaque index (TPI), internal plaque index, and internal bleeding index were evaluated after 3 and 6 weeks. The collected data were analyzed by SPSS, statistical tests ANOVA, and paired t-test.

RESULTS: In this study, there was a significant reduction in plaque index after 6 weeks ($P < 0.050$) however there was no significant difference between groups in terms of the interdental bleeding index (IBI).

CONCLUSION: According to the results of this study, if a person with normal periodontal tissues uses the toothbrush and dental floss properly, using dental floss in every other day is sufficient to maintain the gingival healthy.

KEYWORDS: Plaque Index, Bleeding Index, Gingivitis, Dental Floss

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Today it is specified that the plaque, gingivitis, and more depth probing are found in the areas between the teeth. Furthermore, the progress of periodontal disease is more quickly in the area between the teeth,^{1,2} and the toothbrush is not effective in removing the plaque between teeth surfaces that is why the dental floss as an adjunct tool for cleaning between dental plaque levels is recommended seriously, and it is effective in reducing gingivitis, bleeding on probing (BOP), and reduction of pocket depth in areas between teeth.^{3,4}

Although in numerous articles, effects of plaque control devices in interdental areas are determined, and the kinds of floss in terms of quality,⁵ the way that dental floss is used and the use of devices to maintain the dental floss are compared,⁶ and also dental floss is compared to other interdental plaque control devices such as interdental brushes,⁷ toothpick, and electrical interdental cleaning devices. However, in references, in order to control the disease, there is not any information about the frequency use of these interdental devices optimum. It is observed that only 8% of adults use dental floss in the UK.⁸

1- Assistant Professor, Department of Pediatric Dentistry, School of Dentistry, Kerman University of Medical Sciences, Kerman, Iran

2- Periodontist, Private Practice, Kerman, Iran

Correspondence to: Hoda Shamsaddin, DDS, MSc

Email: h.shamsaddin@gmail.com

In the study of Chen and Rubinson,⁹ in the United States, it was observed that 20% of housewives, 11% of men, and 6% of children use dental floss. American Dental Association (ADA) reports by using dental floss, the plaque between the teeth may be removed up to 80%.¹⁰ Oral hygiene practices is poor among the university students. So, to improving oral hygiene practices education and promotion is required.¹¹

The most important problem in the use of interdental devices is the ability of patients and their motivation. Using dental floss is difficult for patients, particularly in the areas in which the interdental contact is tight. Brushing is accepted as a part of everyday life and health habits but just using the toothbrush to prevent the gum disease and periodontal disease is not enough. The internal plaque formation begins where the toothbrush cannot access it. In other words, people leave the most plaque in interdental surfaces. Using the toothbrush once in every 24-48 hours is sufficient to maintain periodontal health. Since, the most of the people have skills less than ideal, it has been shown that by using the toothbrush twice daily periodontal health is better provided, but using the toothbrush 3 times or more in a day will not improve dental health than twice in a day.¹² Due to the lack of the data regarding the daily optimum frequency use of dental floss and difficulty of using dental floss as a habit, it seemed necessary to do this research to determine the lowest possible frequency use of dental floss to create the most impact on periodontal health.

Methods

In this study, randomized controlled single blind clinical trial, 44 subjects were recruited on a voluntary basis with a requirement of at least 20 teeth. The participants who had used of systematic antibiotics, mouthwash, anticoagulants, those who had gingival hyperplasia (by reason other than drugs), smokers, those who received orthodontics treatment, periodontal surgery, and who had

performed scaling in the last 3 months were not included. In intra-oral examination fixed prosthesis areas, or class 2, class 3 repairs were not considered in calculating the index.

Before starting the study, above mass and plaque, under gingival of patients was removed, and then Bass brushing technique and the way of using dental floss were instructed to the patients. In split mouth approach, each left and the right semi teeth were considered sample unit. 50% of the study populations used dental floss in the half of their mouths every second day and on the other half used once daily. Another 50% used dental floss in the half of their mouths, twice a day and another half their mouth 3 times a day of dental floss. Every sample unit was assigned randomly to a group using software.

Plaque index O'leary was measured by using plaque disclosing tablets. Zero (0) score indicates the absence of plaque and one (1) indicates that there was a layer of plaque in the vicinity of the marginal of gingiva. Total plaque index (TPI) was calculated by dividing the number of plaque levels on a total number of levels and by multiplying the result to gain a percentage of plaque levels.

Interdental plaque index (IPI): After calculating the overall plaque index, in the form simply by considering the area of distobuccal levels and mesiobuccal (MB) containing plaque, IPI: Index plaque between teeth which we have named IPI, was calculated by dividing the total number mesial or distal surface of a plaque on the total levels and multiplied its results by 100.

Interdental bleeding index (IBI) was measured by using a wooden toothpick between all teeth except the third molars. The wooden toothpick inserted in the space between the teeth horizontally and by pressing the papilla between teeth was moved 2 mm toward apical. The side of toothpick was toward occlusal. The presence or absence of hemorrhage at any site was recorded within 15 seconds with the numbers zero or one (0 or 1), respectively. IBI ratio of

area of hemorrhage was measured on a number of areas.¹³

The participants were asked to use dental floss n times before tooth brushing in a day according to their groups. The participants brushed based on the bass technique two times in a day in all 6 weeks. The IBI and IPI of patients were determined at baseline and at the end of the 3rd and 6th weeks. Toothpaste, toothbrushes, and dental floss were same for everyone. The participants should use dental floss once in a day or every other day, when the dental floss should be used two times in a day before teeth brushing in the morning and at night, and when the dental floss should be used the three times in a day, before teeth brushing in the morning and at night, and the dental floss was used without teeth brushing in the afternoon. The sample size of 22 patients was calculated in groups each. 44 people (including 88 half jaws) were assigned randomly according to the following intervention groups. We used data from similar articles¹⁴ and statistical formula to estimate the sample size with repeated measures assumptions. Alpha level 0.050, power 0.900, SD1 0.22, and SD2 0.31 were used to estimate the sample size. Comparison of four intervention groups was analyzed by using repeated measurement ANOVA. Significant of $P < 0.050$ was considered.

Ethical clearance was permitted by Ethics Committee of Kerman University of Medical Sciences (ethical code: k/88/236), Iran. There is no ethical problem even if you do not use dental floss for two weeks, gingivitis is reversible and it was described to the participants in this study. In the present study, the lack of using floss was very short time. Authentic studies have been carried out with this method in references.¹⁵

Results

In this study, 44 dental students were studied with healthy periodontal or maximum with BOP in eight sites. Finally, there is no significant difference between groups which they were evaluated in terms of the index after three and 6 weeks ($P > 0.050$).

Table 1 shows the comparison between four groups which are listed in the index. As it can be seen in the first column of the right side of the table, the rate of P between groups is greater than 0.050 in comparison to all variables. Changes in these variables were not significant among the four groups.

Table 2 shows the comparison between baselines TPI, IPI, and IBI and same variables after 6 weeks in each group. The collected data were analyzed by SPSS (version 17; SPSS Inc., Chicago, IL, USA), statistical tests ANOVA, and paired t-test.

Table 1. Comparison of total plaque index, interdental plaque index, and interdental bleeding index among the four groups

Comparison of TPI, IPI, and IBI	Mean square	P
Comparison of baseline TPI among the four groups	94.632	0.592
TPI compared among the four groups after 3 weeks	36.389	0.736
TPI compared among the four groups after 6 weeks	45.218	0.568
Comparison of baseline IPI among the four groups	119.554	0.777
IPI compared among the four groups after 3 weeks	28.107	0.928
IPI compared among the four groups after 6 weeks	92.911	0.494
Comparison of baseline IBI among the four groups	1.935	0.684
IBI compared among the four groups after 3 weeks	0.637	0.401
IBI compared among the four groups after 6 weeks	1.206	0.246

Level of significance was $P < 0.050$.

TPI: Total plaque index; IPI: Interdental plaque index; IBI: Interdental bleeding index

Table 2. Comparison of baseline total plaque index, interdental plaque index, and interdental bleeding index and same variables after 6 weeks in each group

Group	Variable (baseline compare to 6 weeks)	Mean differences	P
G1	TPI	9.186	< 0.001*
G1	IPI	8.214	0.026*
G1	IBI	0.501	0.369
G2	TPI	11.985	< 0.001*
G2	IPI	12.537	0.010*
G2	IBI	0.663	0.096
G3	TPI	5.832	0.042*
G3	IPI	7.805	0.021*
G3	IBI	0.630	0.167
G4	TPI	9.209	0.012*
G4	IPI	13.962	< 0.001*
G4	IBI	0.407	0.132

*P < 0.050

TPI: Total plaque index; IPI: Interdental plaque index; IBI: Interdental bleeding index

Discussion

In the present study, the rate of TPI was reduced in all groups after three and 6 weeks. These results are conducted by Yost et al.,¹⁴ Rosing et al.,¹² and Zimmer et al.¹⁶

The compliance of participants has been represented in the study. Of course, at beginning of the study, subjects were selected from the dental students that also provided easier education and compliance and then ordinary patients who were admitted to the school of dentistry. Furthermore, dental students have less dental anxiety compares to public, so lower calculus index and better oral health condition were presented.¹⁷

It also began the study with 44 participants. Every 44 participants were attended until the end of the study. This work also represents the aspirations of the participants and the training which has been given. According to the results of the study, the use of dental floss was daily for 1, 2, or 3 times a day or every other day in people with healthy periodontium, twice a day brushing is improved TPI, IPI and stability of IBI, and it maintains periodontal health in 6 weeks. So, in those with healthy periodontium and good habits of brushing and using dental floss is satisfactory every other day (seems necessary). It is not easy to develop a habit of

using dental floss, in which it can be recommended to use it every other day.

There is unreliable evidence that flossing plus brushing may be associated with a small amount of plaque reduction at 1 and 3 months. No studies showed the effectiveness of flossing plus brushing for preventing dental caries.¹⁸

Scaling and root planning was conducted before starting the research project. And educated health instructions to all patients who had an almost completely intact from the beginning of the study were offered to them. Maybe that's why there was not observed significant differences between groups for IBI. If the scaling and root planning was not done before the study, it could be observed IBI differences between groups and therefore, we could have seen the effects of frequency of using dental floss on IBI. As regards, IBI was not increased after 6 weeks in groups, and it was remained very low at baseline and all four methods show the effectiveness of the use of dental floss. Generalizability of these results is slightly because healthy people were enrolled. Scaling and root planning was done before the study. The participants were dental students and brushing was also quite the standard. Moreover, all regions studied had lacked overhang or marginal subgingival

restorations. Maybe in areas that factors caused increased plaque accumulation, using more of dental floss can be improved. In addition, participants have healthy periodontium or maximum areas of BOP. So, maybe those with more extensive disease or periodontitis disease or people with increased pocket depth. The use of dental floss in controlling the condition has more effects. These study also had some limitations which can be mentioned the following: Unilateral chewing food, using dental floss before the study, such as despite the disruptions.

Conclusion

This study shows that individuals with healthy periodontium can brush and flossing properly, using dental floss every other day is enough to maintain healthy interdental areas.

Conflict of Interests

Authors have no conflict of interest.

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Oral health and school performance in elementary students: A cross-sectional study in a group of Iranian students, Tehran, Iran

Seyed Jalal Pourhashemi DDS, MS¹, Mehresa Paryab DDS, MS²,
Kiarash Kheirandish DDS³, Mohammad Javad Kharazi-Fard DDS, PhD⁴

Original Article

Abstract

BACKGROUND AND AIM: Dental health plays a key role in the overall health status and quality of life in children. Consequences of dental diseases in children may result in impairments of daily life activities. The aim of this study was to assess the relationships between dental health and educational performances in elementary students.

METHODS: A total of 300 elementary students from the second to fifth grades in ninth district of Tehran, Iran, were included in this study according to inclusion criteria. Questionnaire gathering information about the students' demographic background, medical and dental histories was sent to their parents. The students' academic performances were assessed based on the school absence in relation to dental problems, their school grades and doing homework. Oral health status was assessed based on the World Health Organization (WHO) standards using caries and oral hygiene indices. Data were analyzed by the Pearson's correlation and linear regression analysis. All statistical levels were made at 0.05 for the Pearson's correlation and 0.1 for linear regression analysis.

RESULTS: School test grades and school absences due to dental problems were statistically associated with oral hygiene index (OHI) of the students ($P = 0.010$ and $P = 0.040$, respectively). The indices of dental caries in primary or permanent teeth were not significantly associated with school performances ($P \geq 0.140$). The analysis revealed that the factors i.e., housing status and living with the parents are statistically associated with the oral health indices ($P = 0.050$ and $P = 0.080$; respectively) and on the other hand with school performances ($P = 0.020$ and $P = 0.010$; respectively).

CONCLUSION: Children with poorer oral health status were more likely to perform poorly in school. Socio-economic status of the students affects negatively both school performances and oral health care. Also, oral health status and dental problems may cause deterioration in educational conditions.

KEYWORDS: Students, Oral Health, Dental Caries, School, Performance

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Oral health is an important component of general health.¹ It has been well established that oral health may affect several domains of child growth,² development and socio-physical functions such as feeding, and breathing, speaking, smiling and social adaptation.³ Dental caries may result in pain, infections and tooth loss.⁴ These

consequences are associated with disturbed nutrition and poor growth. It has also been found that dental problems are associated considerable decrease in student's presence in school and poor social contact with their friends.⁵⁻¹³ Parents may also miss days from work because of their children's dental problems.¹² The impact of oral health on the child's life is so great that educational

1- Associate Professor, Department of Pediatrics Dentistry, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

2- Assistant Professor, Department of Pediatrics Dentistry, School of Dentistry, International Campus, Tehran University of Medical Sciences, Tehran, Iran

3- Private Practice, International Campus, Tehran University of Medical Sciences, Tehran, Iran

4- Assistant Professor, Epidemiologist, Dental Research Center, Tehran University of Medical Sciences, Tehran, Iran

Correspondence to: Mehresa Paryab, DDS, MS

Email: drmparyab@yahoo.com

achievement measures such as school performance can be included as a good proxy indicator of oral health.^{5,7}

Evidence suggests that the people of the lower socioeconomic status may have more children and a second job and no time for special planning of dental care. This issue is of great importance for children under 12 years who need direct parental supervision on dental care and dental office visits⁵. Some more investigations are necessary to assess this hypothesis.

In Iran, a high percentage of children experience dental problems,¹⁴ but limited data are available on dentally related school absence and performances. The purpose of this study was to assess the association of dental problems on the school performance of elementary students by consideration of their socio-demographic characteristics and access to care determinants. The result of this study may improve the parental attitude toward the oral health importance in relation to their child's school performance.

Methods

This cross sectional study was approved by the Ethics Committee of Tehran University of Medical Sciences, Iran, and involved five different boys' elementary schools in ninth district of Tehran during 2013. The schools included in this study were selected through a multistage cluster stratified random sampling from a low socio-economic district and not covered by any school-based program of preventive dentistry. Each child was given a code to avoid bias.

Based on the results of the pilot study on 50 subjects and using the "sample size determination for comparing two proportions," 500 students from the second to fifth grades were invited to participate in our study. A consent form and a two-section questionnaire comprised of 25 questions were sent to their parents.

The first section of the questionnaire gathered information about demographic

background and medical and dental history of the child and family. The second section included three questions about the school absences of the students and their performance in doing homework in relation to dental problems or treatment. The validity of the questionnaire was assessed by an expert committee consisting of one specialist in dental public health and three pediatric dentists and their responses were used to improve the questionnaire's accuracy. The test-retest repeatability (a 2 week interval) of the questionnaire was measured by kappa coefficient and our result showed an excellent agreement between the test-retest responses and a weighted kappa of 0.93.

The questionnaire with two or more unanswered questions ($n = 40$) or students with systemic, psychological or developmental problems ($n = 60$) and those with uncompleted consent form ($n = 100$) were excluded from this study. Of those invited, 300 students with informed parental consent were included in oral examination. The examiner was prepared for detection of caries and indexing of oral hygiene [decayed, missing, or filled teeth (DMFT), dmft, oral hygiene index (OHI)] according to world health organization (WHO) diagnostic criteria for epidemiological surveys by an expert dentist.¹⁵

Dental examinations were performed in the school's medical room using flat dental mirrors under daylight supported by a headlight. Teeth were cleaned from food accumulation using necessary gauze. The indices of caries and oral hygiene for each child were recorded in a dental chart. Data of the students' school grades included the summated scores of mathematics, bio-sciences, language and humanitarian arts; which each student obtained.

Data were analyzed using the SPSS (version 16, SPSS Inc., Chicago, IL, USA) by Pearson's correlation and regression analysis. The $P < 0.050$ was considered as significant.

Results

A total of 300 students participated in this study. Participants were in the age range of 7-14 years old with a mean $\pm$ standard deviation (SD) age of 9.6 ± 1.58 years. The main data obtained from the students' dental history are shown in table 1.

The descriptive statistics for school performances of the students and oral examinations are presented in tables 2 and 3. As shown, 6.33% of children ($n = 25$) missed at least 1 school day/year for dental problems. Also, 9.7% of children who experienced dental pain and infections in the last year were more likely to have problems in completing their homework. According to the oral examination of students, the mean OHI was 0.83 (SD = 0.058) and ranged from 0-4. Mean DMFT and mean dmft was 1.27 and 3.62, respectively. DMFT ranged from 0-9

and dmft ranged from 0-13.

The results of Pearson's correlation analysis between indicators of oral health and school performances (Table 4) showed that school test grades and school absences because of dental problems were statistically associated with OHI of the students ($P < 0.050$). No relation was found between the indices of school performances and DMFT or dmft ($P > 0.050$). Also, the performance of students in completing homework was significantly affected by the school absences because of dental problems or treatments ($P < 0.050$). The statistical analysis showed that when the school absences because of dental problems increased, the number of days missed for dental treatments increased as well; and the students with dental problems and absences were less likely to do all the required homework.

Table 1. Dental history of the students ($n = 300$) in the study

Dental history	Percentage
No dental visits	14.0
Only one dental visit	40.0
Last dental visit in more than 2 years ago	23.3
Experience of pain	23.0
Dental appointment due to dental pain or infections	54.3
Irregular tooth brushing	58.3
No fluoride mouthwashes	85.3

Table 2. School performance of the students ($n = 300$) in the study

Indices of school performance	Students [n (%)]
Number of days of school absences because of dental treatment in the past year	No absence: 278 (92.7)
	1-day: 14 (4.7)
	2 days or more: 7 (2.3)
	Unanswered: 1 (0.3)
Number of days of school absences because of dental pain and infections in the past year	No absence: 288 (96.0)
	1-day: 8 (2.7)
	2 days or more: 4 (1.3)
Difficulty with homework due to dental pain	Yes: 29 (9.7)
	No: 271 (90.3)

Table 3. The mean caries and oral health indices of the students ($n = 300$) in the study based on the oral examinations

Oral health indices	Minimum	Maximum	Mean $\pm$ SD
DMFT*	0	9	1.27 ± 1.68
dmft**	0	13	3.62 ± 3.05
OHI***	0	4	0.83 ± 0.58

*Total number of permanent carious teeth, filled teeth and extracted teeth due to caries, **Total number of primary carious teeth, filled teeth and extracted teeth due to caries, ***Total sum of calculus and debris indices

OHI: Oral hygiene index; DMFT: Decayed, missing, or filled teeth; SD: Standard deviation

Table 4. The association between indicators of oral health and school performance of the students (n = 300) in the study based on the Pearson's correlation analysis

School performances	Indicators of oral health					
	DMFT*		dmft**		OHI***	
	Pearson's correlations	P	Pearson's correlations	P	Pearson's correlations	P
School test grades	-0.08	0.140	0.010	0.790	-0.14	0.010
Performance in completing homework	-0.01	0.820	0.050	0.330	0.06	0.240
Absences because of dental pain and infections	-0.02	0.670	0.080	0.160	0.11	0.040
Absences because of dental treatment	-0.02	0.640	-0.005	0.930	0.05	0.390

*Total number of permanent carious teeth, filled teeth and extracted teeth due to caries, **Total number of primary carious teeth, filled teeth and extracted teeth due to caries, ***Total sum of calculus and debris indices

OHI: Oral hygiene index; DMFT: Decayed, missing, or filled teeth

Table 5. The association between some environmental factors and oral health indices of the students (n = 300) in the study based on the regression analysis

Environmental factors	Indicators of oral health					
	DMFT*		dmft**		OHI***	
	Beta coefficient	P	Beta coefficient	P	Beta coefficient	P
Order of child in the family	0.08	0.220	0.28	< 0.001	0.06	0.230
Number of children	0.02	0.640	-0.08	0.260	0.01	0.860
Going to the kindergarten	-0.05	0.340	0.09	0.070	-0.05	0.310
Living with parents	-0.03	0.490	0.01	0.900	-0.10	0.080
Frequency of tooth brushing	-0.10	0.070	-0.17	0.003	-0.16	0.004
Using fluoride mouthwashes	0.06	0.230	-0.08	0.140	0.04	0.470
Insurance coverage	0.05	0.310	0.01	0.790	0.01	0.780
Father's age	-0.08	0.290	-0.07	0.330	0.07	0.190
Mother's age	0.19	0.001	-0.19	0.005	0.06	0.260
Father's education	-0.08	0.160	0.01	0.860	-0.08	0.160
Mother's education	-0.02	0.620	0.06	0.290	-0.08	0.150
Housing status	-0.001	0.990	0.15	0.008	0.10	0.050
Number of follow-up dental visits	0.10	0.060	0.04	0.420	0.01	0.850

*Total number of permanent carious teeth, filled teeth and extracted teeth due to caries, **Total number of primary carious teeth, filled teeth and extracted teeth due to caries, ***Total sum of calculus and debris indices

OHI: Oral hygiene index; DMFT: Decayed, missing, or filled teeth

In the assessment of the association between some socio-demographic characteristics and oral health indices, the analysis of Pearson's correlation revealed that the students with infrequent tooth brushing, poorer socio-economic status and those who did not live with their parents had higher OHI ($P = 0.040$, $P = 0.050$ and $P = 0.080$; respectively). There was no statistically significant association between OHI and other factors ($P > 0.100$) (Table 5).

The regression analysis of the effect of socio-demographic characteristics on school performance indices showed a significant statistical association between school performance of the students and their

educational ranking, living with their parents, parental education and housing status; as students who lived with their parents and students from the families with higher socio-economic status and educational levels obtained higher test grades ($P = 0.010$, $P = 0.020$ and $P = 0.040$; respectively).

Discussion

Several findings highlight the importance of oral health in childhood not only for improving dental functioning in adulthood but also for the likely extended benefits for child's educational achievements and psychosocial development.

Dental caries is a common chronic

childhood disease just like asthma, diabetes and obesity.⁴ Studies have shown that chronic diseases may negatively affect the children's socio-cognitive development such as their school performance. This can be due to an increase in school absence.^{8,16} Thus, it has been determined that one of the most important goals for healthy people in 2020 is to reduce children's dental problems and increase their access to preventive dental care through effective policies and public health interventions.¹¹

This study was designed to assess the school performance of the elementary-aged boys in relation to caries and oral hygiene indices. The results showed that most of the students with poor status of oral hygiene have more poor school performances. Some preceding investigations revealed that poor oral health alone is not a significant affective factor; likewise, general health and social status have higher predicting values.^{8,9} The reason could be the different socio-economic status.

On the contrary, in several studies from various countries, the oral health status has been found as an important factor which may be associated with the students' performances.^{6,7,12,13} In a study by Blumenshine et al.⁸ the parents of students that reported an overall poor oral health of their children also explained more complicated school performance. Garg et al.¹³ and Muirhead and Marcenes⁷ showed that dental caries can be an affective factor on the student's school scores. In findings by Weissenbach et al.⁶ several oral health indices including DMFT, dmft and OHI had a statistically significant relationship with school performance.

In the present study, OHI was found to be statistically associated with the number of days missed from school and student's test grades. It is consistent with the results obtained by Seirawan et al.¹² They also found that dental problems are associated with the student's school absences and school grades, but the number of dental caries was not too important.

These two studies were conducted in students from lower socio-demographic families.

In an analysis on the association between the oral health indices and some socio-demographic characteristics, the frequency of tooth brushing and dental visits and socio-economic level of the family like the housing status were the main factors which had statistically significant relationship with oral health. It appears that the children from families with lower socio-economic status may have less dental home care like tooth brushing and higher levels of OHI. They also have less school attendance and school grades. Consequently, dental problems and more school absences result in the student being less likely to do homework as required.

The data from questionnaires showed that a large percentage of students did not have regular dental visits in the last year, and about 25.0% of them did not have any dental appointment in the past 2 years. The moderate status of OHI (mean = 0.83) and high rate for the need of emergency treatment confirm these issues.

The statistical analysis showed that when school absences due to dental problems increase, the number of days missed for dental treatments are increased as well; it is a fact that in Iran, organized public centers who introduce the free or low-charge dental services are open during school hours. These families usually arrange appointments with these centers. This leads to school absences for dental treatment. These findings are in agreement with studies by Gift et al.⁵ Blumenshine et al.⁸ and Jackson et al.¹⁰

However, Weissenbach et al.⁶ stated that oral health status are in relation to school performance and social status of parents is not so important. It should be kept in mind that school performances of students are influenced by several socio-demographic and general health factors. In cross-sectional studies, one cannot evaluate the exact interaction of the factors. The results of the

current study showed that the socio-economic status of the students such as housing status of the family and living with both parents had significant effects on their indices of oral health and school performances. Therefore, students with poor socio-economic status will have lower performance in schools and simultaneously have lower oral health. On the other hand, the analysis also revealed that OHI was significantly associated with the school performance. So, dividing the effects of the socio-economic status and the oral health factors on the school performances of the students' needs a longitudinal study.

Another error is unobserved confounding factors that may influence the oral health status and schooling outcomes.¹⁷⁻²⁴ Lifestyle of the family like nutrition and psychosocial performances are other important confounding factors which were not evaluated. Guarnizo-Herreno and Wehby¹¹ showed that students with poor oral health had a lower social relationship with their siblings, and they were less happy. Also the psychosocial status of the students can affect oral health care and, on the other hand, their school performances.

The studied subjects were a group of Iranian students from moderate to low socio-economic families. Also, because of some cultural limitations, only boy students were included in the current study. Thus, the results cannot be generalized to other

children with different socio-economic conditions or girl students.

Nevertheless, this study provided baseline data in an Iranian population to declare the importance of oral health in relation to the socio-cognitive performance of children and merits special considerations are given to their oral hygiene and dental caries status. It is suggested to design studies to evaluate this issue considering more confounding factors in different samples.

Conclusion

1. Children with poorer oral health status were more likely to experience school absences and perform poorly in school
2. The socio-economic status of the family is an important factor affecting oral health status and school performance.

Conflict of Interests

Authors have no conflict of interest.

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Microleakage assessment of one- and two-step self-etch adhesive systems with the low shrinkage composites

Razieh Hoseinifar DDS, MS¹, Hamid Kermanshah DDS, MS²

Original Article

Abstract

BACKGROUND AND AIM: Different studies evaluating one-step self-etch (SE) adhesive systems show contradictory findings, so the aim of this study was to compare the microleakage of one-step SE adhesive systems and CLEARFIL SE BOND (CSB) (that serves as the “gold-standard” SE adhesive) with low shrinkage composites.

METHODS: In this in vitro study, Class V cavities with the occlusal margin in enamel and cervical margin in cementum were prepared on the buccal and lingual surfaces of 36 human premolars and molars (72 cavities). The enamel surfaces of the cavities were etched with 37% phosphoric acid and then the specimens were divided into six groups of 6 (12 cavities) and the cavities were restored according bellow: Group 1 (Kalore-GC + G-Bond), Group 2 (Grandio + Futurabond NR), Group 3 (Aelite LS Posterior + All Bond SE), Group 4 (Kalore-GC + CSB), Group 5 (Grandio + CSB), and Group 6 (Aelite LS Posterior + CSB). All the specimens were thermocycled for 2000 cycles (5-55 °C) and then placed in 0.5% basic fuchsin dye for 24 hours at 37 °C and finally sectioned and observed under the stereomicroscope. Data were analyzed using Kruskal-Wallis, Mann-Whitney, and Wilcoxon tests at a $P < 0.050$ level of significance.

RESULTS: In comparison between occlusal and gingival margins in each group, microleakage in occlusal margins was significantly less than the gingival margins (except Kalore + CSB) ($P > 0.050$). There were no significant differences in microleakage among two-step and one-step SE adhesive systems on both the occlusal and gingival margins.

CONCLUSION: According to this study, two-step SE adhesive system (CSB) did not provide better marginal seal than the one-step SE adhesive systems.

KEYWORDS: Composite Resins, Adhesives, Polymerization

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The main reason for clinical failure of composite fillings is significantly related to the occurrence of marginal leakage, which eventually leads to marginal discoloration, recurrent caries, and post-operative sensitivity.¹ Marginal sealing ability in composite restorations is achieved by the mutual work of the bonding agent as well as the restorative material. A suitable bond can oppose and withstand the contraction stress during polymerization of composite resin and insure retention and marginal adaptation of the

restored teeth.^{2,3}

The first bonding protocol that revealed a clinically acceptable result involved the complete removal of the smear layer by an “etch-and rinse” or “total-etch” approach.¹ Although long-term clinical success has been achieved with total-etch systems, but by using this approach, the quality of resin-dentin adhesion may be technique sensitive.⁴

The demand for simplified adhesive procedures led to the development of the alternative “self-etch (SE)” approach by Watanabe et al.⁵ This approach eliminates the

1- Assistant Professor, Department of Operative Dentistry, School of Dentistry, Kerman University of Medical Sciences, Kerman, Iran

2- Associate Professor, Dental Research Center AND Laser Research Center AND Department of Operative Dentistry, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

Correspondence to: Razieh Hoseinifar, DDS, MS

Email: r_hoseinifar@yahoo.com

rinsing phase and there is no need to application of the primer in particular conditions of wetness due to the SE adhesives' water content; reduced technique-sensitivity of the material and post-operative sensitivity of patients, and the risk of making errors during application diminished. As a result, their popularity is increasing.^{6,7}

Two-step SE adhesive systems were introduced into the market in the late 1990s. They are based on the separate application of SE primer and hydrophobic resin.⁶

Analysis of the clinical trials demonstrate that SE adhesives with good clinical performance and proper bonding to dentin, belong to the group of "mild" SE adhesives ($\text{pH} \geq 2$).⁸ Mild SE adhesives demineralize the dentin enough to provide micro-mechanical retention, while leaving hydroxyl apatite within the hybrid layer to enable additional chemical interaction.⁹ Mild two-step SE adhesives are like three-step etch and rinse adhesives in terms of low annual failure rates.¹ In this context, CLEARFIL SE BOND (CSB) has been the most tested adhesive and is often used as a control group because of its satisfactory clinical performance.¹

Further simplification has been achieved by introducing one-step SE adhesives that combine SE primer and hydrophobic resin into one application. These adhesives are more acidic and more hydrophilic than two-step SE adhesives.^{1,6} Although studies show that one-step SE adhesives may not perform as well as two-step SE adhesive systems and their bond strength is relatively low,^{10,11} but different clinical trials and laboratory studies evaluating SE systems show contradictory findings, and it seems that the bonding effectiveness of these adhesives is material dependent.^{4,8}

The latest generation of one-step SE adhesives have performed better as they have superior characteristics in comparison with their earlier versions.¹ In addition, the marginal seal of composite restorations, also

affected by the polymerization shrinkage of composites, and one strategy to control polymerization contraction stress is the use of low-shrinkage composites,¹² so the aim of this research was to compare the microleakage of one-and two-step SE adhesive systems with the low shrinkage methacrylate-based composites of the same company in Class V cavities.

The null hypothesis tested was that there are no differences among microleakage of the adhesive systems tested.

Methods

36 extracted intact human premolars and molars, free of cracks, decalcifications, or caries were immersed in 0.5% chloramine-T for 1-week and then stored in normal saline solution until use. Class V cavities (mesiodistal width of 3 mm, occlusogingival length of 3 mm and 1 mm in to dentin deep) were prepared, with the gingival margin 1 mm below the cemento-enamel junction, using a tapered fissure diamond bur (Tiz Kavan, Tehran, Iran) with a water cooled high speed hand piece on the buccal and lingual surfaces of the teeth. New burs were used after every five preparations. Materials used in this study with their chemical compositions are listed in table 1.

The prepared teeth were randomly divided into six groups of 6 teeth each (12 cavities). In all groups, the enamel part of the cavity was etched with 37% phosphoric acid (Total Etch, Ivoclar Vivadent) for 20 seconds, rinsed for 15 seconds and slightly air dried to achieve moist surface and then were restored as follows.

Group 1: G-Bond (one-step SE) (GC Corporation, Tokyo, Japan) was applied using a microbrush and leaved undisturbed for 10 seconds. Then, thoroughly air dried for 5 seconds. Another layer of G-Bond was applied and the process repeated again, and then cured for 20 seconds using the LED curing unit (Guilin Woodpecker Medical Instrument Co., China) with an intensity of 900 mw/cm². The light intensity of the curing

unit was periodically checked with a light meter (LED Radiometer Demetron, Kerr, USA). Then each cavity was filled with three layers of Kalore-GC (GC Corporation, Tokyo, Japan) A3.5 shade composite, the first layer on the axial wall, the second layer extended from gingival wall to occlusal, and the third layer extended from occlusal wall to gingival, with each layer not being more than 2 mm thickness and each increment was separately light cured for 40 seconds.

Group 2: Futurabond NR (one-step SE) (Voco Cuxhaven, Germany) was applied for 20 seconds and air dried for 5 seconds. Another layer of bonding was applied and the process was repeated again, and then cured for 20 seconds. Then each cavity was filled with three layers of Grandio (Voco Cuxhaven, Germany) A3.5 shade composite.

Group 3: All Bond SE (one-step SE) (Bisco Inc., Schaumburg, IL, USA) was applied and agitated for 5-10 seconds. Then gently air dried from the distance of 5 cm for 5 seconds (without visible movement of the material). Then with greater pressure, thoroughly air dried for 5 seconds. Another layer of bonding was applied and the process repeated again, then cured for 20 seconds. Then each cavity was filled with three layers of Aelite LS Posterior (Bisco Inc., Schaumburg, IL, USA) A3.5 shade composite.

Group 4: The CSB primer (two-step SE) (Kuraray Medical Inc., Okayama, Japan) was applied for 20 seconds and gently air-dried. The adhesive was then applied and dispersed with a mild air stream, and light cured for 20 seconds. Then each cavity was filled with three layers of Kalore-GC A3.5 shade composite.

Group 5: Following the same bonding procedure applied in group 4, each cavity was filled with three layers of Grandio A3.5 shade composite.

Group 6: Following the same bonding procedure applied in group 4, each cavity was filled with three layers of Aelite LS Posterior A3.5 shade composite. After finishing with

fine-grit finishing diamond burs (Diatech Dental AG, Heerbrugg, Switzerland) and polishing with sequential disks (OptiDisc, Kerr, USA), all specimens were stored in distilled water at 37 °C for 24 hours.

The teeth were thermocycled (Malek Teb, Iran) at 2000 cycles at a temperature 5 °C and 55 °C, a dwell time of 30 seconds in each bath and a transfer time of 10 seconds. The apices of the teeth were then sealed with sticky wax, and whole surfaces of the teeth except a 1 mm wide zone around the margins of each restoration were coated with two layers of nail polish. The teeth were then immersed in a solution of 0.5% basic fuchsin for 24 hours at 37° C. Following immersion, the teeth were washed with distilled water, dried and embedded in self-curing acrylic resin (Acropars, Iran), and sectioned longitudinally in a buccolingual direction through the center of the restoration using a low speed diamond disc (Presi, MECATOME, T201A, France) under constant water irrigation.

The sections were examined under stereomicroscope (Nikon, 30-DS, SMZ800, Tokyo, Japan) at ×10 and ×40 magnification and degree of dye penetration at occlusal and gingival margins was then scored according to the following criteria:³

0 = No evidence of dye penetration

1 = Dye penetration into half extension of the occlusal or gingival wall

2 = Dye penetration into more than half extension of the occlusal or gingival wall, without reaching the axial wall

3 = Dye penetration into the axial wall

Data were analyzed by SPSS software (version 18, SPSS Inc., Chicago, IL, USA) using the Kruskal-Wallis test and Mann-Whitney test. The difference between the occlusal and gingival dye penetration scores in each group was analyzed by the Wilcoxon test at a $P < 0.050$ level of significance.

Results

Data showing the dye penetration scores for

the occlusal and gingival margins of the restorations are shown in table 2.

When comparing the microleakage between gingival and occlusal margins in each group, there were significantly more dye penetration at the gingival wall than occlusal wall ($P < 0.050$) except Kalore + CSB (Table 3).

There were no significant differences in microleakage among three groups of 1-3 (restored with one-step SE) on both occlusal

($P = 0.860$) and gingival margins ($P = 0.070$). Also, there were no significant differences in microleakage among three groups of 4-6 (restored with two-step SE) on both occlusal ($P = 0.860$) and gingival margins ($P = 0.090$) (Table 4).

There were no significant differences in microleakage among two-step and one-step SE adhesive systems on both the occlusal and gingival margins ($P > 0.050$) (Table 5).

Table 1. Materials used in this study and their composition

Material	Composition	Manufacturer	Batch #
CSB (two-step SE)	Primer: MDP, HEMA, hydrophilic dimethacrylate, photoinitiator, water bond: 10-MDP, Bis-GMA, HEMA, hydrophilic dimethacrylate, microfiller, photoinitiator	(Kuraray Medical Inc., Okayama, Japan)	01531A
Futurabond NR (one-step SE)	Liquid A: methacryl phosphorus acid ester and carbonic acid modified methacrylic ester Liquid B: water, ethanol, silicon Part I-Ethanol, sodium benzenesulfinate dehydrate	(Voco Cuxhaven, Germany)	610458
All Bond SE (one-step SE)	Part II-Bis (Glyceryl 1,3 dimethacrylate) phosphate; hydroxyethylmethacrylate, biphenyl dimethacrylate	(Bisco Inc., Schaumburg, USA)	0600010905
G-Bond (one-step SE)	4-MET, phA-m, DMA, ethanol, water, filler, photo-initiator, stabilizer	(GC Corporation Tokyo, Japan)	0507279
Grandio	Resin matrix: Bis-GMA, TEGDMA, Filler: Fluorosilicate glass, SiO ₂	(Voco Cuxhaven, Germany)	1106467
Aelite LS Posterior	Resin matrix: Ethoxylated Bis-GMA, Filler: Glass filler, amorphous silica	(Bisco Inc., Schaumburg, USA)	0900001308
Kalore-GC	Resin matrix: DX-511 monomer, UDMA, dimethacrylate co-monomers Filler: (30-35 wt% prepolymerized filler, 20-30 wt% fluoroaluminosilicate glass, 20-33 wt% strontium/barium glass, 1-5 wt% silicon dioxide nanofiller)	(GC Corporation Tokyo, Japan)	1004121

10-GDP: 10-methacryloxydecyl dihydrogen phosphate; HEMA: Hydroxyethyl methacrylate; UDMA: Urethane dimethacrylate; TEGDMA: Triethyleneglycol-dimethacrylate; Bis-GMA: Bisphenol A-glycidyl methacrylate; SE: Self-etch; CSB: CLEARFIL SE BOND

Table 2. Microleakage score of different adhesive systems and composite restorations

Groups		Occlusal margins				Gingival margins			
		Score 0 [n (%)]	Score 1 [n (%)]	Score 2 [n (%)]	Score 3 [n (%)]	Score 0 [n (%)]	Score 1 [n (%)]	Score 2 [n (%)]	Score 3 [n (%)]
Grandio	CSB	10 (83)	2 (17)	0 (0)	0 (0)	5 (42)	5 (42)	2 (17)	0 (0)
	Futurabond NR	10 (83)	2 (17)	0 (0)	0 (0)	2 (17)	7 (58)	3 (25)	0 (0)
Kalore-GC	CSB	9 (75)	3 (25)	0 (0)	0 (0)	7 (58)	4 (34)	1 (8)	0 (0)
	G-Bond	9 (75)	3 (25)	0 (0)	0 (0)	3 (25)	6 (50)	3 (25)	0 (0)
Aelite LS	CSB	9 (75)	3 (25)	0 (0)	0 (0)	2 (17)	6 (50)	4 (34)	0 (0)
Posterior	All Bond SE	9 (75)	3 (25)	0 (0)	0 (0)	2 (17)	5 (42)	4 (34)	1 (8)

CSB: CLEARFIL SE BOND

Table 3. Wilcoxon test results for comparing microleakage scores of occlusal and gingival margins

Filling materials	Adhesive systems	Margin	P
Kalore-GC	CSB	Occlusal	0.350
		Gingival	
	G-Bond	Occlusal	0.010
		Gingival	
Grandio	CSB	Occlusal	0.030
		Gingival	
	futurabond NR	Occlusal	0.001
		Gingival	
Aelite LS Posterior	CSB	Occlusal	0.003
		Gingival	
	All Bond SE	Occlusal	0.002
		Gingival	

CSB: CLEARFIL SE BOND

Table 4. Effect of filling material on microleakage scores of occlusal and gingival margins

Margin	Adhesive systems	Filling materials	P
Occlusal	One-step SE	Kalore-GC	0.860
		Grandio	
	Two-step SE	Aelite LS Posterior	0.860
		Kalore-GC	
Gingival	One-step SE	Grandio	0.070
		Aelite LS Posterior	
	Two-step SE	Kalore-GC	0.090
		Grandio	
		Aelite LS Posterior	

SE: Self-etch

Table 5. Effect of adhesive systems on microleakage scores of occlusal and gingival margins

Margin	Filling materials	Adhesive systems	P
Occlusal	Kalore-GC	CSB	> 0.999
		G-Bond	
	Grandio	CSB	> 0.999
		Futurabond NR	
Gingival	Aelite LS Posterior	CSB	> 0.999
		All Bond SE	
	Kalore-GC	CSB	0.090
		G-Bond	
	Grandio	CSB	0.250
		Futurabond NR	
	Aelite LS Posterior	CSB	0.660
		All Bond SE	

CSB: CLEARFIL SE BOND

Discussion

Marginal sealing is a significant factor influencing the longevity of composite restorations.¹³ In this investigation, in each group, there were significantly more dye penetration at the gingival wall than at the occlusal wall except Kalore + CSB; which is in agreement with the previous study results that demonstrated less microleakage at the occlusal margins than at the gingival margins.^{3,7,13} Different clinical and laboratories studies demonstrated that selective etching of enamel margins with 37% phosphoric acid before using SE adhesives provide better marginal integrity and increase bond strength.^{8,14,15}

Abdalla and Garcia-Godoy reported better marginal adaptation of Futurabond NR in Class V cavities when an adhesive resin was applied following enamel etching with 37% phosphoric acid.⁴ Moreover, the GC Corp for G-Bond recommends the use of phosphoric acid to ensure a good enamel bond.¹⁰ Also, in this study, before using SE adhesives, enamel was etched with 37% phosphoric acid for 15 seconds.

Furthermore, more dye penetration at the gingival margin was expected as the bond strength to enamel is usually higher than the bond strength to dentin and dentin is a less favorable bonding substrate, while enamel makes a uniform bonding substrate that consists of almost 90% inorganic material, dentin is a complex substrate with < 50% inorganic material, and high water content (21%) offering a moist surface that impairs the bonding mechanism. Moreover, the tubular structure of dentin makes it a complex substrate.^{16,17}

But in Kalore + CSB group, no significant differences were detected between gingival margins and occlusal margins. Some studies reported that Aelite and Grandio composites have higher elastic modulus and polymerization contraction stress.¹⁸⁻²⁰ According to Hooke's law, polymerization contraction stress is determined by the elastic

modulus and the volumetric shrinkage of the material. Since the viscoelastic properties, is considered as the most influential factor on stress development, their high elastic modulus and stiffness result in high contraction stress levels.^{18,19,21}

On the other hand, Kalore showed low polymerization shrinkage due to the presence of DX511 monomer (a monomer with low number of C = C double bonds and high molecular weight).²² The combination of the strong bond produced by CSB and low polymerization shrinkage of Kalore decreased gingival microleakage.

CSB has repeatedly been shown to be excellent performer in clinical and laboratory studies.⁹ CSB as a two-step SE adhesive with an almost pH of 2 contains the functional monomer 10-methacryloyloxydecyl dihydrogen phosphate, which has the ability to adhere to hydroxyl apatite tightly. In addition, its calcium salt hardly dissolved in water.^{9,23,24}

But, in the current study, there were no statistically significant differences in microleakage among CSB and three single-step SE adhesive systems (G-Bond, All Bond SE and Futurabond NR), which is in agreement with the results of some of the previous studies reporting that the microleakage of two-step SE adhesives is not significantly different from one-step SE adhesives.²⁵⁻²⁷

However, Frankenberger and Tay evaluated the microleakage of CSB, Adhe SE, I Bond, and Xeno III, in Class II composite restorations and reported that marginal seal of two-step SE adhesives at gingival margin was significantly better than one-step SE adhesives.¹¹ Osorio et al. evaluated the microleakage of CSB and Etch and Prime 3.0 in Class V composite restorations and reported that the degree of microleakage at the gingival margins for CSB was significantly lower than that of Etch and Prime 3.0.²⁸ This finding was not in agreement with the current study results.

Microleakage of composite restorations is affected by bonding type and polymerization shrinkage of composite.³ G-Bond is a mild (pH = 2) SE adhesive, demineralizes the dentin surface only slightly and produces approximately no exposure of the collagen fibers yielding an extremely thin adhesive interface (300 nm or less), but, in the “nano interaction zone” the 4-methacryloyloxyethyl (MET) monomer may react with residual hydroxyl apatite to form an insoluble calcium compound, that result in a durable and strong interface that is less likely to be enzymatically deteriorated.^{7,29}

Moreover, G-Bond contains 5% filler. Studies reported that filled adhesives demonstrated significantly less microleakage and higher bond strength than unfilled adhesives.^{30,31}

The favorable clinical performance and strong bond of Futurabond NR is also reported. Futurabond NR contains poly functional adhesive monomers that could react with remaining hydroxyl apatite. Moreover; Futurabond is a nano filled adhesive which forms a thicker adhesive layer and a more flexible interface. Such a flexible intermediate resin layer may absorb stress resulting from polymerization shrinkage of resin composite.⁴ Another contributing factor to such desirable performance of Futurabond NR is the presence of Ormocer in the bonding agent. Ormocer was reported to have a calcium complexing function which improved the bond strength to tooth structure.⁴

In the current study, two layers of one-step SE adhesives were used.

Different studies reported better marginal adaptation of one-step SE adhesives when double application of bonding were used due to several mechanisms.^{32,33} As the first layer of bonding agent begins to etch dentin, it may be rapidly buffered by hydroxyl apatite, so that additional layers of unpolymerized comonomers may improve the etching ability of adhesives.

On the other hand, by applying more coats of adhesive, the thickness of the adhesive layer increases enough to prevent oxygen inhibition of its entire thickness, resulting in better polymerization.³⁴ Moreover, composite resins used in this study were methacrylate-based low shrinkage composites. Grandio is a highly filled nano hybrid composite (87.0% by weight and 71.4% by volume) and its low polymerization shrinkage (1.6%) is due to its nano structures.³⁵

Kalore is a nano-hybrid resin composite that contains high molecular weight urethane dimethacrylate monomer (DX-511). It is based on a recently developed DuPont technology. The DuPont molecule, DX-511, is compatible with the current composite and bonding systems. This monomer has a long rigid molecular core and flexible arms in the structure. The long rigid core prevents monomer deformation and reduces polymerization shrinkage. The molecular weight of this monomer is 895 which is twice that of urethane dimethacrylate (UDMA) or bisphenol A-glycidyl methacrylate (Bis-GMA). The combination of low number of C = C double bonds and high molecular weight reduces its polymerization shrinkage (1.7).^{22,36}

Aelite LS Posterior is a highly filled hybrid resin composite (88.5% by weight and 74.0% by volume) and its low polymerization shrinkage (1.39) is due to its high filler content.²¹ In the current study, samples were only subjected to 2000 thermal cycles, thus the application of mechanical load cycling are suggested in future research.

Conclusion

According to this study, two-step SE adhesive system (CSB) did not provide better marginal seal than the one-step SE adhesive systems.

Conflict of Interests

Authors have no conflict of interest.

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Head and face injuries and helmet use among injured motorcyclists with road accidents in Isfahan, Iran

Azam Dadkhah DDS¹, Zahra Saied-Moallemi DDS, PhD²,
Mohammad Sadegh Alem-Rajabi DDS³

Original Article

Abstract

BACKGROUND AND AIM: The study aimed to assess the frequency of head and face injuries in motorcyclists who had an accident and to find out the relationship between helmet use and frequency of these injuries.

METHODS: A cross-sectional study with multi-stage sampling method provides data on the injured motorcyclists with road accidents. Data came from a registration form which has documented information of each injured person who had a road accident and hospitalized in the biggest hospital of Isfahan University of Medical Sciences, Iran (Al-Zahra). All the registration forms were surveyed for hospitalization period, treatment costs, severity of injury, and date of accident during 2010 (n = 1626). Later, among the list of injured motorcyclists during the last 3 months of the registration form, 125 cases were randomly selected and interviewed by phone regarding occurrence of the head and face injuries and whether wearing helmet during the accident. Confidence intervals (CI), Chi-square, and Phi and Cramer's correlation coefficient were applied. The ethical approval was provided.

RESULTS: Accident by motorcycle was 31.0% of all road accidents. The frequency of motorcycle accidents was higher in the autumn and among 21-25 year olds. The mean period of hospitalization was 4.3 days and the mean of hospital costs was about 9000000 Rials [about 8200 United States dollar (USD), in 2010]. Of motorcyclist, 35.0% reported they were helmeted when they had the accident. The frequency of head and face injuries was 51.0% among all the injured motorcyclists, 22.0% and 78.0% among the helmeted and non-helmeted motorcyclists, respectively (P = 0.009, r = -0.267).

CONCLUSION: Motorcycle accidents comprise a large number of road accidents and cause substantial morbidity and financial impact for the community members. Head and face injuries are the most common trauma in motorcyclists, and the injury rate is higher among non-helmeted motorcyclists.

KEYWORDS: Helmet, Motorcycle, Accident, Costs, Hospital, Head Injury, Facial Trauma

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Accidents, both natural and man-made, lead to a great amount of years of life lost.¹ Road accidents are the part of man-made accidents.² The increase in road traffic injuries (RTI) and death caused by motor vehicles is the growing problem for the public, worldwide.³ This public health concern leads to about 1.2 million death and 20-50 million disabilities,

annually.⁴ Among these mortalities, the majority are related to road accidents in countries with a low to moderate economic status.⁵ Based on the previous studies, Iran had the highest rank of accidents and RTI in comparison with other countries, with 44 RTI deaths per 100000 populations.^{6,7}

Among all kinds of motor vehicles, motorcycles play a significant role to cause

1- MSc Student, Department of Pediatric, School of Dentistry, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

2- Assistant Professor, Torabinejad Dental Research Center AND Department of Oral Public Health, School of Dentistry, Isfahan University of Medical Sciences, Isfahan, Iran

3- MSc Student, Department of Oral Medicine, School of Dentistry, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

Correspondence to: Zahra Saied-Moallemi, DDS, PhD

Email: smoallemi@mui.ac.ir

transportation accidents.^{8,9} The risk of injury and death in motorcycle accidents are 3 and 16 times/mile more than the cars, correspondingly.^{10,11} Similar to many other Asian countries, motorcycle is the most common vehicle for transportations in Iran.¹² Studies showed in recent years, Iran has been confronting about 10.0% increase in number of mortality and injuries caused by road accidents.¹³

Head and leg injuries are the most prevalent injuries among those who experienced a motorcycle accident.^{9,14} Head injuries are detected as the reason for half or more of all death in motorcyclist in crashes.¹⁵ The use of a helmet significantly decreased the mortality rate due to damages to the head,¹⁶ this rate is 3-4 times less than the mortality rate of those who did not use it.¹⁷ On the other hand, not wearing the helmet have resulted in a significantly higher incidence of cranial injury and death among patient involved in motorcycle crashes. The put helmets as the best way to decrease motorcycle deaths and injuries.¹⁸ In addition, helmet use reduces the average of hospitalization cost per casualty by 6000 United States dollar (USD).¹⁹ Legislation of helmet law in California decreased 35.0% of the total cost of medical care, mostly (73.0%) costs of hospitalization due to casualties with head injury.²⁰

RTIs are one of the most important cause of death, disability, hospitalization expenses, and economical costs to the society,²¹ in addition, road accidents make psychological damages on the motorcyclists, their families, and their society;^{1,21} therefore, the World Health Organization (WHO) has focused for future research on this field.²² Isfahan, Iran, one of the biggest cities in the country, has heavy traffic and high number of motor vehicles, especially motorcycles. The road accident in the city is one of the highest in the country. The aim of this study was to assess the frequency of head and face injuries in motorcyclists who had an accident and to

find out the relationship between helmet use and frequency of these injuries.

Methods

This is a cross-sectional study with multi-stage sampling method was conducted on a representative sample of injured motorcyclists with a road accident during the year of 2010. At the first stage, a registration form was assessed to provide data of all road accidents including motorcycle accidents. This form is based on the article 92 of the Fourth Development Plan of Iran Governance. According to this law, all public and private hospitals must to urgently do acceptance and treatment for all inpatients and outpatients who have been injured due to road accidents and referred to them. The casualty's information, then, is documented and registered by Deputy of Treatment of Universities of Medical Sciences.

In the present study, among all hospitals of Isfahan, the Al-Zahra Hospital, the biggest and the central hospital, was selected because of its high referral frequency and high accuracy of its registration forms that makes possible to define types of accidents separately (motorcycle, car, or pedestrian accidents). To find out the impact of different seasons on the frequency of motorcycle accidents, the registration forms of whole year of 2010 (from the beginning of Dey, 1388 to the end of Azar, 1389) were evaluated. A total number of 1626 cases from the whole registration forms of the Al-Zahra Hospital were assessed by one of the researchers to find out the information about motorcycle accidents during the year.

The registration forms provided data for each injured motorcyclist consisting of his name, date of accident (month and year), hospitalization duration (day), and hospitalization costs including the costs of medical equipments, medications, paraclinic and laboratory services, and a part of payments to the hospital's physicians as fee for service (2k)-not including their salary. In

addition, severity of injury was evaluated as superficial (< 6 h hospitalization), severe (more than 6 h hospitalization), organ impairment (amputation of any part of body because of the accident during the hospitalization time), or death (during hospitalization).

In the second stage, a sub-sample of cases was randomly selected from all documented motorcycle accidents during the last 3 months. Based on the statistical evaluation 95 cases were assumed, and then considering the probability of the unavailability of subjects and deficiency in patient's files, as observed in the pilot study, the sub-sample were increased to the 125 cases (30.0% more). Choosing the last 3 months of year was for avoiding recall bias among motorcycles about detailed information of their accidents. After going to the Al-Zahra Hospital, the patient files of these cases were requested from Medical Records Department of the hospital and looked for casualty's age, accurate type of injury, and his telephone number. The incomplete patients' files were excluded and a number of 107 patients' files provided data for final phase of study.

In the third stage, one of the researchers who had been trained and calibrated for the purpose of study called the phone number of each case and interviewed with him. In a few cases that the injured motorcyclist had died due to the accident or was absent when calling, the interviewer talks with his close relative who was present at home and informed about the accident. A total of 97 subjects participated (response rate = 91.0%). The questions was about type of accident (to make certain about accident by motorcycle), type of injury and injured site of the body, and whether the casualty had used helmet while accident.

Statistical evaluation was performed through SPSS software (version 16, SPSS Inc., Chicago, IL, USA) for descriptive analyses. Confidence intervals (CI) and Chi-square test were used. To find out the correlation between

head and face injuries and helmet use the Phi and Cramer's correlation coefficient was applied. The ethical approval was obtained from Research Committee of Dentistry Institute of Isfahan University of Medical Sciences (no 390151).

Results

The findings of this study showed that motorcycle casualties constitute 31.0% of the total road accident casualties in the Al-Zahra Hospital. The highest rate of motorcycle accidents in the year occurred during the autumn (29.3%; 95% CI = 26.9-31.5) and in the Mehr (the 1st month of the autumn) (11.3%; 95% CI = 9.7-12.8). The lowest rate of motorcycle accidents was in the winter (18.6%; 95% CI = 16.7-20.5) (Figure 1). The highest rate of motorcycle accidents occurred in the age group of 21-25 years (35.0%). In addition, most of the accidents (75.0%) happened among people younger than 30 year olds. The mean of hospitalization time due to motorcycle accidents in the Al-Zahra Hospital was 4.3 days [standard deviation (SD) = 8.7]. Duration of hospitalization has ranged from 1 to 213 days, while more than half of the casualties (55.0%) had been hospitalized for 1 day (median = 1). Only one patient was hospitalized for a very long time (213 days).

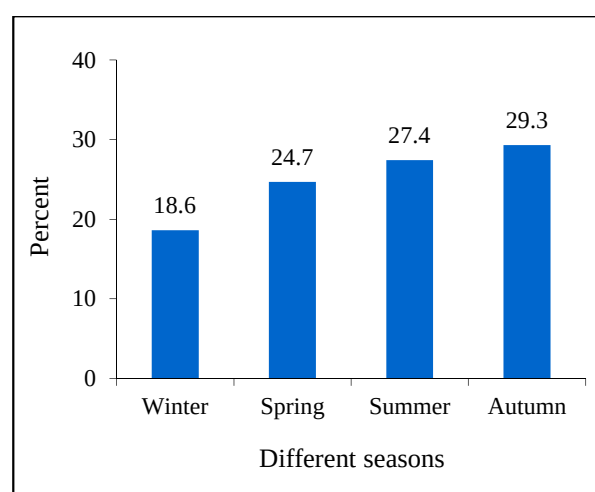


Figure 1. Percentages of motorcycle accidents among motorcyclists hospitalized in the Al-Zahra Hospital during different seasons

Many of the injuries (61.3%) during the accidents were described as severe (Table 1). Accidents occurred during the summer, and the autumn were more severe than the accidents during other seasons ($P = 0.003$). No differences were found for severity of injuries regarding age and marriage status of motorcyclists ($P > 0.050$). 3.0% of the hospitalized motorcyclists had died during hospitalization. This death rate was not constitute those had died immediately after the accident and not refer to the hospital.

Table 1. Severity of injuries among motorcyclists hospitalized in the Al-Zahra Hospital

Severity of injury*	n (%)
Superficial	575 (35.4)
Severe	997 (61.3)
Organ impairment	4 (0.2)
Death	50 (3.1)
Total	1626 (100)

*Severity of injury was evaluated by a treatment expert in the treatment Deputy of Isfahan University of Medical Sciences as superficial (< 6 h hospitalization), severe (more than 6 h hospitalization), organ impairment (amputation of any part of body because of accident during the hospitalization time), or death (during hospitalization)

The mean medical cost of motorcycle accidents was 8842558 Rials per casualty (about 8200 USD in 2010). The expenses have included medications (16.0%), medical equipments (16.0%), paraclinic and laboratory services (59.0%), and the rest were for payments to the hospital physicians. Head and face injuries constituted half of the injuries (50.5%) among the sub-sample of motorcyclists hospitalized in the Al-Zahra Hospital (Table 2). Face injuries, per se, occurred in the 28.0% of motorcycle accidents.

Table 2. Types of injuries due to motorcycle accidents among a sub-sample of motorcyclists hospitalized in the Al-Zahra Hospital

Injured site	n (%)
Head and face only	45 (41.2)
Head and face along with other parts of the body	9 (9.3)
Other parts of body except head and face	48 (49.5)

Of the sub-sample of motorcyclists, 35.0% had wearing a helmet when they had the accident. No differences were found for wearing the helmet regarding age and marriage status of motorcyclists ($P > 0.050$). Helmet use among helmeted motorcyclists had reduced head and face injuries by 55.0% compared to those were not helmeted (Figure 2). An estimation of Phi and Cramer's correlation coefficient reveals a statistically significant reverse correlation between head and face injuries and helmet use ($P = 0.009$, $r = -0.27$).

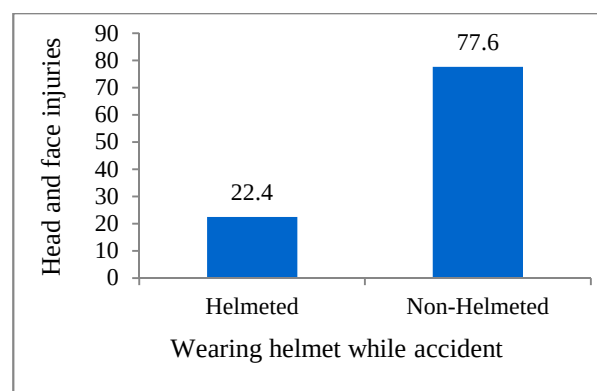


Figure 2. Percentages of head and face injuries among motorcyclists hospitalized in the Al-Zahra Hospital according to their helmet use Phi and Cramer's correlation coefficient ($P = 0.009$, $r = -0.27$)

Discussion

The findings of the present study showed that casualties due to motorcycle accidents constitute one-third of the casualties due to the road accidents in Isfahan. The average duration of hospitalization was 4 days. Most of the motorcycle accidents occurred during autumn and among the young people. Half of the body injuries affected head and face area while only 35.0% of the motorcyclists had wearing a helmet during driving. The results showed wearing a helmet have decreased head and face injuries in half.

Casualties due to motorcycle accidents make one-third of the total road accident casualties. The results showed a lower rate of motorcycle accidents in Isfahan compared

with other study in other city that half of the hospitalized casualties were motorcyclists.⁶ The high rate of motorcycle accidents may be attributed to unsafe design and specific structure of motorcycle. Not using safety equipment such as helmet by motorcycle drivers face them in more potential danger than other drivers.

The findings showed that the highest rate of motorcycle accidents occurred during the autumn, especially its 1st month (Mehr), and the lowest rate was during the season of winter, especially in its first and almost the coldest month (Dey). The reason for the high accident rate in Mehr may be attributable to increase in load of traffic and rush hour which coincides with the opening of schools and universities in Iran. Decreasing in accidents during the winter may be due to getting cold, rainy, and snowy weather, which reduces the use of motorcycles. These findings are in line with the findings of another study in Iran that reported the lowest rate of mortality due to motorcycle accidents occurred in Dey, while the highest rate was during the summer and autumn (Tir, late Shahrivar, and early Mehr).²³ In other countries such as China²⁴ and Turkey,²⁵ most of the accidents have been happened during the summer and spring.

Most of the motorcycle accidents occurred among younger motorcyclists in this study. This finding is similar to the other findings in Iran.^{26,27} While in India²⁸ and Saudi Arabia,²⁹ youth and middle-age people were the main injured group in traffic accidents, in the US the majority of the motorcycle accidents occurred among elder people.³⁰ The higher risk of motorcycle accident among the youth in Iran will face the country to the economical, emotional and social dilemmas.

The mean length of hospitalization for motorcycle casualties was 4.3 days which is similar to the findings of Coben et al. who reported 5-days duration of hospitalization for this group of casualties.³⁰ It is notable that this time forms only a part of the time, which

motorcyclists miss their job and social activities. Most of the casualties need to stay at home for more rest after discharge from hospital. This inflicts more indirect expense and costs on the society.

The average medical charge among our injured motorcyclists was 9000000 Rials (8200 USD in 2010). Although different studies in Iran and the US depends on the place and time of the study, have found different medical costs, however, these research have shown that motorcycle accidents compel heavy expenses on the family and societies in general.^{30,31} This is notable that medical charge is a part of total cost due to the accident. A plenty of other expenses such as overhead costs, ambulance, manpower, as well as, absence from the workplace for injured person and relatives should be considered.

Of motorcyclists in this study, 35.0% reported to had used a helmet when the accident. This is similar to the finding of Zamani-Alavijeh et al. reported a 33.0% of helmet use by motorcyclists.³² However, another study in Tehran, Iran, showed that only 9.0% of motorcyclist had used a helmet.¹² In the other countries, the helmet wearing is different; 20.0% in Spain, 56.0% in Pakistan, and 90-99% in Vietnam.^{33,34} The reason for different percentages of using helmet by motorcyclist may be due to cultural behaviors and mandatory motorcycle helmet law. While despite the obligatory law to use helmet, only one-third of Iranian motorcyclists have wearing the helmet during driving; legislation, administration, and controlling for more restrict safety laws, as well as public education programs on helmet use is crucial.

Here, injuries to head and face formed half of the total trauma happened in the motorcyclists. These injuries comprised 22.0% of the total trauma among those who used a helmet and 78.0% among those who had not worn it. It seems that helmet use can result in more than three-fold decreasing in head and

face injuries. Physical trauma occurred in the face region of the motorcyclists was 28.0%. The similar results found elsewhere.³⁵ Their findings also showed trauma to the face of casualties with a helmet was 37.0%, while of those without a helmet was 54.0%. Liu et al. reported that the use of a helmet resulted in a 42.0% decrease in head trauma.³⁶ A study by Hemmati et al. on motorcycle casualties showed 83.0% and 14.0% of head and neck trauma and face injury, respectively.⁸ Rutledge and Stutts reported that the risk of head trauma in motorcyclists with a helmet was two-fold less than those without a helmet.³⁷

The above-mentioned findings show the head and face injuries are among the most common kind of trauma in motorcycle casualties, and helmet use can decrease head and face injuries and consequently death due to the brain trauma among motorcyclists.

This study has benefitted from a hospital-based study; therefore, the generalization of the findings for the frequency of the head and face injuries among injured motorcyclists should be considered with caution. Particularly, because the Al-Zahra Hospital is a center for the maxillofacial surgery and accepts head and face injury cases more than

other hospitals. On the other hand, the injured motorcyclists who died immediately after motorcycle accidents were not included in this study while one of the most frequent injuries in these casualties may be head and face injuries.

Conclusion

Motorcycle accidents comprise a large number of road accidents and cause substantial morbidity and financial impact for the community members. Young adults who constitute a major part of the manpower in the country are highly involved in these accidents. Head and face injuries are the most common trauma in motorcyclists, and the injury rate is greater among non-helmeted motorcyclists. Stricter laws and more facilities for motorcyclists to use the helmet in order to reduce the frequency of head and face injuries are warranted.

Conflict of Interests

Authors have no conflict of interest.

Acknowledgments

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Shear bond strength of different adhesive systems to normal and caries-affected dentin

Niloofer Shadman DDS, MSc¹, Shahram Farzin-Ebrahimi DDS, MSc¹,
Elaheh Mortazavi-Lahijani DDS, MSc¹, Ahmad Ghaderi²

Original Article

Abstract

BACKGROUND AND AIM: According to the effect of the adhesive and substrate type on the bond strength, examination of the adhesive is required in all aspects. The aim of this study was to evaluate the shear bond strength of different adhesive systems to normal dentin (ND) and caries affected dentin (CAD) in permanent teeth.

METHODS: Thirty extracted molars with small occlusal caries were selected. After preparation and determination of ND and CAD by caries detector, teeth were divided into three groups and treated with one of the two tested adhesives: Single Bond 2 (SB2), Scotchbond Universal with etch (SBU-ER), and Scotchbond Universal without etch (SBU-SE). Then composite (Filtek Z-250 XT) were attached to the surfaces and cured. After water storage (24 hours) and thermocycling (500 cycles 5-55 °C), bond strength was calculated and failure modes were determined by stereomicroscope. The data were analyzed by one-way ANOVA and post-hoc test [Tukey HSD (honest significant difference)] and with $P < 0.050$ as the level of significance.

RESULTS: Only SBU-ER had significantly higher shear bond strength than SBU-SE in ND ($P = 0.027$) and CAD ($P = 0.046$). Bond strength in SBU-ER the highest and in SBU-SE had the lowest amounts in CAD and ND. There was no significant difference in each group between ND and CAD.

CONCLUSION: The 2-step etch-and-rinse adhesive (SBU-ER) had higher bond strength to ND and CAD than the self-etch adhesive (SBU-SE).

KEYWORDS: Dentin Bonding Agent Normal, Caries-Affected Dentin, Shear Bond Strength Test

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Dental caries is the most common pathological change in dentin. Cardiology research indicated that the caries dentin has two layers: outer layer [caries infected dentin (CID)] and inner layer [caries affected dentin (CAD)]. The outer layer contains bacteria and is highly demineralized. In fact, some irreversible changes occurred in the collagen fibrils, but the inner layer, CAD, has the potential of remineralization. It is partially demineralized, without bacteria and with

reversible collagen changes.^{1,2} So, it should be maintained during the clinical treatments.³ Although a wide area of the cavity floor after caries removal is CAD,^{1,3} whereas the most in vitro researches conducted on the normal dentin (ND) and because of the histological difference between them, study on CAD is necessary. CAD contains the collagen fibrils with lower collagen cross-linkages, bigger apatite crystallites,^{4,5} and wider crystal spaces in the intertubular dentin. The matrix of the peritubular dentin in CAD contain

1- Assistant Professor, Oral and Dental Diseases Research Center AND Kerman Social Determinants on Oral Health Research Center AND Department of Operative Dentistry, School of Dentistry, Kerman University of Medical Sciences, Kerman, Iran

2- MSc Student, Department of Operative Dentistry, School of Dentistry, Kerman University of Medical Sciences, Kerman, Iran

Correspondence to: Ahmad Ghaderi, DDS, MSc

Email: ahghaderi62@yahoo.com

mucopolysaccharide or glycoprotein molecules which can interfere with the adhesion.⁴

The interface between the adhesive and CAD in comparison with ND, is wider and more complicated,⁴ and some mineral deposits exist in the dentin tubules of CAD such as White lock, it avoid complete penetration of resin monomers in tubules and formation of the resin tags due to the acid resistance of obturated tubules.⁵ Therefore, the formed hybrid layer on CAD is not only thick but also poorer in quality.⁴ In addition, large quantities of water in deeper demineralized areas in CAD interfere with the penetration of resin monomers and bonding process. Also, CAD contains the materials which interfere with the bonding process by producing and developing the free radicals thus leading to the lesser polymerization of the resin monomers.¹

The created hybrid layer by adhesive systems in CAD becomes thick but porous.⁴ Also, CAD's hardness is lower than ND because of more porosity in the intertubular dentin,⁶ which is due to the loss of mineral materials. This demineralization and porosity lead to the cohesive weakness. The bond strength of CAD is lower than that of ND due to the microstructural changes in dentin.⁴

Another effective factor in the bond strength between the adhesive resin and dentin is the type of adhesive system. The current adhesive systems are classified to etch-and-rinse (ER) and self-etch (SE) systems.⁷ ER systems are technique sensitive because of the multiple steps.⁸ In these systems, phosphoric acid 35-37% causes a complete removal of the smear layer, collagen fibrils exposure, and dentin demineralization. It is shown that there is a discrepancy between the depth of demineralization and the resin penetration.¹ In SE adhesives, simultaneously demineralization and resin penetration is occurred, and they are less technique sensitive.⁸ Shear bond strength test was one

of the most widely used mechanical properties test and is a maximum force at adhesive joint before fracture occurs.⁹

There are several studies of shear bond strength in CAD and ND with controversial results,^{7,10} which some studies were shown higher bond strength of ND^{11,12} or CAD^{10,13} in ER adhesives, but in some other studies, there did not see significant difference in bond strength of them.^{8,14}

Scotchbond Universal (SBU) is a novel adhesive which the manufacturer claims that it has less technical sensitivity due to the polyalkenoic acid compound¹⁵ and applicable in both ER and SE methods. Thus, there were not done any study about its efficacy on CAD, the purpose of this study was the evaluation of shear bond strength of this novel adhesive in ER and SE methods and one ER adhesive [Single Bond 2 (SB2)] in CAD and ND. The null hypothesis is there was no significant difference in shear bond strength of the mentioned adhesives is ND and CAD.

Methods

This experimental study was done on the 30 freshly human extracted molar teeth which had occlusal caries that extending approximately halfway through the dentin. After removing calculus and soft tissue, occlusal enamel and the caries of occlusal surface (by using diamond fissure burs, Tiz Kavan, Iran) were removed under running water to reach superficial flat dentinal surface. The samples were excluded if the obtained area reaches to deeper dentin. Affected caries removal was done by visual examination and a comparatively sharp explore and staining by using caries detector (Kuraray Medical Inc., Sakazu, Kurashiki, Okayama, Japan).

According to the manufacturer's recommendations, caries detector solution was applied on the surface for 10 seconds and then washed. Therefore, the soft and dark-red stained and the harder pink-stained

dentin were considered as CID and CAD, respectively. After above mentioned procedure, there was enough amount of ND and CAD area in each sample. Efficiency of CAD area was examined by a periodontal probe (at least 2 mm in diameter). To create flat levels and standard smear layer, a 600 grit silicon carbide sand paper was used. Then, the teeth were mounted up to the cemento-enamel junction in the self-cure acrylic resin (Acropars, Iran) in a way that the occlusal surface of the teeth was located horizontally.

Finally, the samples were randomly divided into three groups for each type of adhesive. Group 1: Adper™ SB2 (2-step ER, 3M, ESPE, USA). Group 2: Scotchbond Universal without etch (SBU-SE) (1-step SE, 3M, ESPE, USA). Group 3: Scotchbond Universal with etch (SBU-ER) (2-step ER, 3M, ESPE, USA). The adhesives were used according to the manufacturer instruction (Table 1).

Curing was done by a quartz-tungsten-halogen unit (Demetron LC, Kerr, USA) with 600 mw/cm² intensity (The device intensity was checked by radiometer). Then, the micro

hybrid composite (Filtek Z-250 XT, Shade: B1, 3M, ESPE, USA) was placed on the bonded area by a clear plastic cylindrical tube (2 mm diameter and 2 mm height) in two layers and each layer was cured for 20 seconds. After removing the tubes, samples were stored in distilled water in an incubator at 37 °C for 24 hours then were thermocycled for 500 cycles (5-55 °C).

The shear bond strength test (Blade type) was done by the Universal Testing Machine (Testometric M350-10 CT, Lancashire, United Kingdom) with 0.5 mm/min crosshead speed with a chisel-shaped device. The shear bond strength was calculated in megapascal.

Mode of failure was identified by two examiners by observed the debonded surface levels separately by a stereomicroscope (Olympus, DP12, Germany) at × 40 magnification. Finally, the type of failure (cohesive/adhesive or mixed) was identified. To compare the shear bond strength in each group used one-way ANOVA analysis and post-hoc test [Tukey HSD (honest significant difference)]. $P < 0.050$ was set as the level of significance.

Table 1. Composition and application techniques of the tested materials

Material	Type	Manufacturer	Composition	Application technique
Adper™ Single Bond 2	2-step ER adhesive	3M, ESPE, USA	Etchant: 35% phosphoric acid Adhesive: Bis-GMA, HEMA, ethanol, water, ethanol	Etching: 15 seconds, Rinse:10 seconds, blot dry, apply 2 coats of adhesive with gentle agitation, gently air thin: 5 seconds, cure for 20 seconds SE mode: adhesive 20 seconds, gently air thin: 5 seconds, cure: 20 seconds
Scotchbond Universal	1-step SE or 2-step ER adhesive	3M, ESPE, USA	10-MDP, HEMA, Vitrebond copolymer, filler, ethanol, water, initiators, silane	ER mode: Scotchbond etchant Gel: 15 seconds, Rinse: 10 seconds, blot dry, adhesive 20 seconds, gently air thin: 5 seconds, cure: 20 seconds
Filtek Z-250 XT	Light curing nano Hybrid resin composite	3M, ESPE, USA	BIS-GMA, UDMA, BIS- EMA, PEGDMA, TEGDMA, zirconium, silica	-
Ultra Etch	Etching agent	Ultradent, USA	35% phosphoric acid	-

ER: Etch-and-rinse; SE: Self etch; 10-MDP: 10-methacryloyloxydecyl dihydrogen phosphate; HEMA: Hydroxyethyl methacrylate; UDMA: Urethane dimethacrylate; TEGDMA: Triethylene glycol dimethacrylate; Bis-GMA: Bisphenol A-glycidyl methacrylate; PEGDMA: Polyethylene glycol dimethacrylate; Bis-EMA: Ethoxylated bisphenol-A glycol dimethacrylate

Table 2. Shear bond strength data in MPa and mean percentage of failure mode

Adhesive	Normal dentin					P	Caries-affected dentin				
	MPa (mean $\pm$ SD)	A (%)	M (%)	CC (%)	CD (%)		MPa (mean $\pm$ SD)	A (%)	M (%)	CC (%)	CD (%)
SB2	20.16 $\pm$ 9.61*	70	30	0	0	0.32 (NS)	20.17 $\pm$ 9.53*	20	30	20	30
SBU-SE	18.93 $\pm$ 3.23**	80	0	0	2	0.91 (NS)	18.84 $\pm$ 7.83**	30	60	10	0
SBU-ER	26.88 $\pm$ 4.63***	10	60	10	20	0.44 (NS)	27.70 $\pm$ 5.71***	0	90	10	0

A: Adhesive; M: Mix; CC: Cohesive in composite; CD: Cohesive in dentin; SB2: Single Bond 2; SBU-SE: Scotchbond Universal without etch; SBU-ER: Scotchbond Universal with etch; MPa: Megapascal; NS: Not significant; SD: Standard deviation

*, ** and *** for each row, means designated by the same sign are not significantly different ($P > 0.050$), NS: Not significantly different between normal and caries-affected dentin ($P > 0.050$)

Results

Results of the present study showed significant differences in ND ($P = 0.022$) and CAD ($P = 0.038$) groups for types of adhesive systems. There were no significant differences in each group between ND and CAD. SBU-ER had significantly higher bond strength than SBU-SE in ND ($P = 0.027$) and CAD ($P = 0.046$), but there was no significant statistical difference between groups SB2 and SBU-SE, also between groups SB2 and SBU-ER in ND and CAD ($P > 0.050$). Most of the failure mode in groups SB2, SBU SE, and SBU-ER, were adhesive, adhesive, and mix, respectively in ND. Also in CAD, the major of failure mode in all groups were mixed. The results of bond strength and failure modes are shown in table 2.

Discussion

Tooth loss is directly related to oral health, and the protection of tooth tissue is one of the main goals of restorative dental treatments. On the other hand, because of a large area of the bonding substrate after removal of carious dentin, is CAD that can remineralize, keep this tissue seems necessary in dental treatment.¹ Considering the effect of the substrate on the performance bond,⁴ the performance of different adhesive systems to ND and CAD was evaluated in this study.

The results of the present study show that Only SBU-ER had significantly higher shear bond strength than SBU-SE in ND ($P = 0.027$)

and CAD ($P = 0.046$). Bond strength in SBU-ER had the highest and in SBU-SE had the lowest amounts in CAD and ND. There was no significant difference in each group between ND and CAD. The null hypothesis was partially confirmed in some aspects.

In this study, to differentiate between CAD or CID, caries detector (Kuraray Medical Inc., Sakazu, Kurashiki, Okayama, Japan) was used beside the visual and tactile examination. Yokota et al. in a study showed that after a complete rinse of the surface after caries detector usage, no undesirable effect on the bond strength of adhesives to the ND was observed.¹⁶

In our study, there was no significant statistical difference in bond strength between ND and CAD in each group. Based on the study of Wei et al. the bond strength of SB2 in ND and CAD was the same.⁴ There are some studies on the ER adhesives with the similar results too.^{14,17} On the other hand, Arrais et al.¹¹ reported that the bond strength to ND in SB was higher than CAD. Unlike Nakornchai et al.¹³ and Tosun et al.¹⁰ study which indicated higher bond strength of CAD than ND. Difference in result can be related to the difference in the technique sensitivity of ER adhesives,^{7,17} as well as the difference in the methodology.¹⁸ Also in the study of Omar et al., it is shown that thermocycling led to the significant decreasing of the bond strength in ND, but not in CAD in the ER adhesives.¹⁹ Due to the minerals that occluded the tubules in CAD,

further penetrating of water to the interface was avoided.²⁰ This can explain the similarity between the two group results in our study.

In ER adhesives, phosphoric acid can dissolve the mineral deposits in tubules and intertubular dentin of CAD which leads to a better penetration of the resin monomers.²¹ Scanning electron microscopy images present the resin tags with the lateral branches and tubular anastomosis that probably increases the bond strength. The hybrid layer in CAD is thicker than that of ND. The resin tags are shorter and more disorder.⁷ The partial demineralization of the intertubular dentin in CAD which allows deeper penetration of the phosphoric acid or the acidic monomers rather than ND can be a factor of the thicker hybrid layer in CAD.¹⁷

According to the results of this study, the bond strength of SBU SE was not different significantly in CAD and ND groups, which is similar to many studies.^{6,8,13} Methacryloyloxydecyl dihydrogen phosphate (MDP) monomer presence in SBU compound leads to durable chemical bond with tooth structure. In CAD, the formation of water tree and water droplets occurs less than ND due to the closing tubules by the minerals.²¹ However, there are some studies indicating a considerable decrease in the bond strength in CAD rather than ND by applying self-etch adhesives.^{11,12,19} In addition to lack of resin tag formation in CAD, a decrease in the modulus of elasticity and the cohesive strength of dentin can lead to this decrease.²²

The difference between SBU and SB in the relative replacement of the dimethacrylate monomers with 10-MDP monomer, which provides the acidity and demineralization capability of SBU simultaneously.²³ In addition, the presence of Vitrebond™ Copolymer of polyalkenoic acid in SBU make a desirable bond in dentin in the states of either dry or wet conditions,²⁴ which is applicable as SE and ER according to the manufacture's claim. The hybrid layer

thickness in SBU-ER type was measured in 2.0-2.6 μm by wet bonding and 1.4-2.4 μm by dry bonding, whereas it is 0.2-0.4 μm by self-etch method.²³

In our study, SBU-ER in ND and CAD, showed a significant higher bond strength than SBU-SE, which is in agreement with some other studies,^{3,17} and related to unique composition of SBU.²⁴ Using the phosphoric acid causes a significant improvement of the interface morphology by forming a thicker hybrid layer and longer resin tags. Removing the smear layer and smear plug by using acid leads to the easy penetration of the adhesives.⁵ Also, Munoz et al. study showed a higher bond strength in the ER method than the self-etch method in SBU.²⁵ The reason of the lower bond strength in all in one adhesives is mentioned by Perdigao et al. as the lack of sufficient polymerization of the adhesive due to oxygen inhibition by the so thin adhesive layers.²⁰

Using all-in-one adhesives in multilayers can increase the bond strength which is resulted from various mechanisms simultaneously. The first layer of adhesive, which the beginner etching of dentin substrate may become buffer quickly by hydroxyapatite and the extra layers of adhesives may increase the etching ability by increasing concentration of the acid content. In addition, using more layers make the adhesive layer thicker (so avoid of oxygen inhibition in the whole thickness) with higher mechanical properties and resistance to polymerization shrinkage stresses.⁵

Mode of failure in the shear tests is influenced by the mechanic of test and the stress distribution during force applying and does not show the bond efficiency necessarily. In this study, the difference in mode of failure may result from the different mechanical properties of adhesives, as well as the different attributes of the formed interfaces in adhesives.⁴ In ND, the most common failure mode in SBU-SE was adhesive (80%) and in CAD the most

common failure mode in SBU-ER were mixed (90%) that can explain the results in their groups. The limitation of this study was difficulties in samples collection with at least 2 mm in diameter CAD and same depth of dentin in all samples.

Conclusion

Within the limitations of this study, it was concluded that shear bond strength in CAD was similar to ND in self-etch and etch-and-

rinse adhesives.

Conflict of Interests

Authors have no conflict of interest.

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Relationship between temporomandibular joint dysfunction and psychological distress among students of Babol University of Medical Sciences and Technology, Iran

Abdolhamid Al-Havaz DDS, MD¹, Sina Safari DDS, MD²,
Neda Mohammadpour DDS, MD³, Farzan Kheirkhah DDS, MD⁴,
Mina Motalleb-Nezhad DDS, MD⁵, Majid Arian DDS⁶

Original Article

Abstract

BACKGROUND AND AIM: Temporomandibular joint (TMJ) dysfunction is a condition which affects the TMJ and muscles of mastication in the stomatognathic system and the associated structures. Several studies have indicated that approximately 60-70% of people suffer from at least one of the symptoms of temporomandibular disorder (TMD) in their life while only 5% need treatment. Some of evidence have suggested that myofascial pain, functional somatic syndromes are critical conditions of muscle pain which may be resulted from the psychosocial factors. The purpose of this epidemiological study was to evaluate the prevalence of relationship between TMDs, and psychological distress among university students at Babol University of Medical Sciences and Babol University of Technology, Iran.

METHODS: This study conducted due to diversity in prevalence reports and to follow the standardized diagnostic method of research in this field. In this cross-sectional descriptive-analytical (wrong term) research, 592 students at different universities in Babol were selected using stratified sampling method. Information about the signs and symptoms of TMD was collected by dental students and through completing the research diagnostic criteria (RDC) for TMD questionnaire. The data were analyzed using χ^2 , t-test, and Student's test.

RESULTS: Between the subjects (28.9%) had at least one type of TMD and the difference between two sex groups was statistically significant. About 5.7% of subjects had moderate to severe symptoms of depression and the difference between two sex groups was statistically significant. In this study, the relationship between depression symptoms and non-specific physical symptoms (NPS) (either with or without pain) with TMD was not statistically significant.

CONCLUSION: In this study, no significant relationship was observed between depression symptoms, as well as NPS (with or without pain) and TMD ($P = 0.682$).

KEYWORDS: Temporomandibular Joint Disorder, Depression, Prevalence, Psychological Distresses

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Temporomandibular joint (TMJ) dysfunction is a condition which affects the TMJ and muscles of mastication in the stomatognathic system and the associated structures.¹

Temporomandibular disorder (TMD) can affect people at any age; however, its prevalence is higher among women and individuals within the age range of 20-45 years. Several studies have indicated that

1- Assistant Professor, Department of Prosthodontics, School of Dentistry, Babol University of Medical Sciences, Babol, Iran

2- Assistant Professor, Department of Prosthodontics, School of Dentistry, Kerman University of Medical Sciences, Kerman, Iran

3- Assistant Professor, Department of Oral Medicine, School of Dentistry, Ardabil University of Medical Sciences, Ardabil, Iran

4- Associate Professor, Department of Psychiatry, School of Medicine, Babol University of Medical Sciences, Babol, Iran

5- Professor, Department of Oral Medicine, School of Dentistry, Babol University of Medical Sciences, Babol, Iran

6- Prosthodontist, Department of Prosthodontics, School of Dentistry, Ardabil University of Medical Sciences, Ardabil, Iran

Correspondence to: Majid Arian, DDS

Email: dr.arian_majid@yahoo.com

approximately 60-70% of people suffer from at least one of the symptoms of TMD in their life while only 5% need treatment.^{2,3}

TMD has multi-factorial causes and its symptoms include pain in the TMJ and in the areas around the ear, cervical spinal cord, head, face, fatigue in muscles of mastication and facial-cervical-cranial ones, and limited range of motion in mandible with the presence of joint sounds.² Spasm of masticatory muscles is a painful symptom in TMD which is due to tension, contraction, fatigue, or the presence of parafunctional habits such as bruxism and nail biting.²⁻⁴ Various studies on different population have indicated that these habits are initiated or intensified by emotional stresses. Patients with TMD have lower pain thresholds and greater sensitivity to experimental pain when compared with age- and gender-matched pain-free controls. Numerous explanations such as central sensitization, neuroendocrine, and autonomic dysregulation have been offered to explain these differences, but more psychological explanations have received less attention.²⁻¹⁰

Pieces of evidence have suggested that myofascial pain, functional somatic syndromes, fibromyalgia, and chronic fatigue syndrome are critical conditions of muscle pain which may be resulted from the psychosocial factors.¹¹ Myofascial pain and discomfort coincide with the occurrence of tension and stress and cause excessive muscle activity. Such tension ultimately might lead to parafunctional habits. Therefore, psychosocial factors such as anxiety, stress, and depression can play an important role in TMD pathogenesis.¹¹

The purpose of this epidemiological study was to evaluate the prevalence of TMDs and psychological distress among university students at Babol University of Medical Sciences and Babol University of Technology, Iran.

Methods

This study was a cross-sectional descriptive-

analytical research (this is true term: Teacher Sorting and the Plight of Urban Schools: A Descriptive Analysis. Educational Evaluation and Policy Analysis 2002 24: 37-62) with ethical code no 5169. A number of 592 students at different universities in Babol (65 student majoring in medical sciences, 90 in dentistry, 110 in paramedical sciences, 57 in nursing, and 270 in industrial engineering) were selected using stratified sampling method. Sample size calculation formula:

$$N = z^2 \cdot P(1-P)/d^2 = (1.96)^2 \times 0.05 \times 0.95 / (0.02)^2 = 456$$

After completing the demographic information form, collecting the written consent form, and providing medical and dental records from the subjects, the signs and symptoms of TMD were examined in all the subjects.

Information about the signs and symptoms of TMD, which were calibrated through clinical examination by the prosthodontist and psychologist, was collected by dental students and through completing the research diagnostic criteria (RDC)/TMD questionnaire which has a high degree of validity and reliability. A new system known as the RDC for TMD is the standardized criteria for research, based on the available knowledge on TMJ pathology. The diagnostic criteria are proposed for both clinical research and for epidemiological work.

The objective of the authors was to maximize the reliability and minimize the variability of the examination methods and clinical judgment. The system comprises two classification axes. The first axis (clinical aspects of TMDs) contemplates three groups: Group 1. muscle diagnosis; Group 2- disc displacement; and Group 3- arthralgia, arthritis, and arthrosis. The second axis in turn contemplates disabilities related to pain and the psychological condition of the patient. The classification criteria include: Intensity of pain and degree of disability (according to

the severity of chronic pain grading scale). Depression [according to the symptom checklist-90-revised (SCL-90R); depression and vegetative symptoms scale] and limitations related to mandibular function and RDC/TMD explanation.⁹

Finally, the obtained data were scored using RDC/TMD booklet. The extremely early stages of intra-articular disorders, which cannot be diagnosed by conventional clinical examinations, were not recorded.

The part related to the evaluation of mental health condition was a questionnaire with 32 questions, among which 20 questions were related to symptoms of depression and 12 were related to non-specific physical symptoms (NPS). Finally, after calculating the scores, they were classified as normal for scores less than 2, moderate for scores between 2 and 3, and severe for scores more than 3.

The data were analyzed using SPSS software (version 18, SPSS Inc., Chicago, IL, USA) and χ^2 and t-test, Student's test by a statistician and the level of significances set at 0.05.

Results

In this study, 592 students were randomly selected (215 male and 377 female) (Table 1).

Out of the total studied population, 171 subjects (28.9%) were suffering from at least one type of TMD, among whom 98 subjects (57.3%) were female and 73 (42.7%) were male. The difference between the two sex groups was statistically significant ($P = 0.040$).

The most common symptom between the population of TMD was a click (31.6%) while the most common TMD subgroup found in this study was group 2 disorders (disc dislocation) (23.3%) (Table 2).

Table 1. Frequency of age groups in the study

Age group (year)	Age (year)	n (%)
	Mean $\pm$ SD	
Under 19 (group 1)	1.44 $\pm$ 0.517	335 subjects (56.6)
20-29 (group 2)	1.44 $\pm$ 0.517	251 subjects (42.4)
Above 30 (group 3)	1.44 $\pm$ 0.517	6 subjects (1.0)

SD: Standard deviation

Table 2. Frequency of temporomandibular disorder subtypes based on research diagnostic criteria/Temporomandibular disorder (RDC/TMD)

Clinical TMD	n (%)
Group 1	
Myofascial disorders	3 (0.5)
Myofascial disorders with limited maximum opening	1 (0.2)
Group 2 (right joint)	
Disk displacement with reduction	106 (17.9)
Disk displacement without reduction, with limited maximum opening	0 (0.0)
Disk displacement without reduction, without limited maximum opening	0 (0.0)
Group 2 (left joint)	
Disk displacement with reduction	109 (18.4)
Disk displacement without reduction, with limited maximum opening	0 (0.0)
Disk displacement without reduction, without limited maximum opening	0 (0.0)
Group 3 (right joint)	
Arthralgia	3 (0.5)
Osteoarthritis	9 (1.5)
Osteoarthrosis	23 (3.9)
Group 3 (left joint)	
Arthralgia	2 (0.3)
Osteoarthritis	7 (1.2)
Osteoarthrosis	23 (3.9)

TMD: Temporomandibular disorder

Among population, 5.7% of the subjects had moderate to severe symptoms of depression. In this study, 8.5% of women and 0.9% of men had signs and symptoms of clinical depression, which were statistically significant ($P < 0.010$). The degree of depression symptoms among subjects was within 3.7-5, while this value was 0-3.30 for NPS with pain and 0-2.80 for NPS without pain.

Among 171 TMD patients, 7.0% were suffering from some degrees of depression symptoms (moderate to severe). Among these 171 subjects, 4.1% had moderate to severe NPS (with pain). In this study, the relationship between depression symptoms and NPS (either with or without pain) with TMD was not statistically significant, whereas a significant relationship was observed between the symptoms of depression and NPS ($P < 0.010$).

Among TMD patients, 10.3% of dentistry students, 14.3% of nursing students, 20.0% of paramedical sciences students, and 3.4% of students in different departments of Babol University of Technology indicated moderate to severe depression symptoms, while these symptoms were not observed among students at School of Medical Sciences. The

observed difference between the mentioned schools was statistically significant ($P = 0.039$) (Figure 1).

Moreover, 3.4% of dentistry students, 15.0% of paramedical students, 7.1% of nursing students, and 2.3% of students in different departments of Babol University of Technology were suffering from TMD and also experiencing moderate to severe degrees of NPS (with pain); however, these symptoms were not observed among students at School of Medical Sciences. The observed difference between the above-mentioned schools was not statistically significant.

Among the TMD patients, 15.0% of paramedical students, 7.1% of nursing students, and 1.1% of students at different departments of Babol University of Technology experienced moderate to severe NPS (without pain), while these symptoms were not observed among the students of other schools of Babol University of Medical Sciences. The observed difference between Babol University of Technology and Babol University of Medical Sciences was statistically significant ($P < 0.001$).

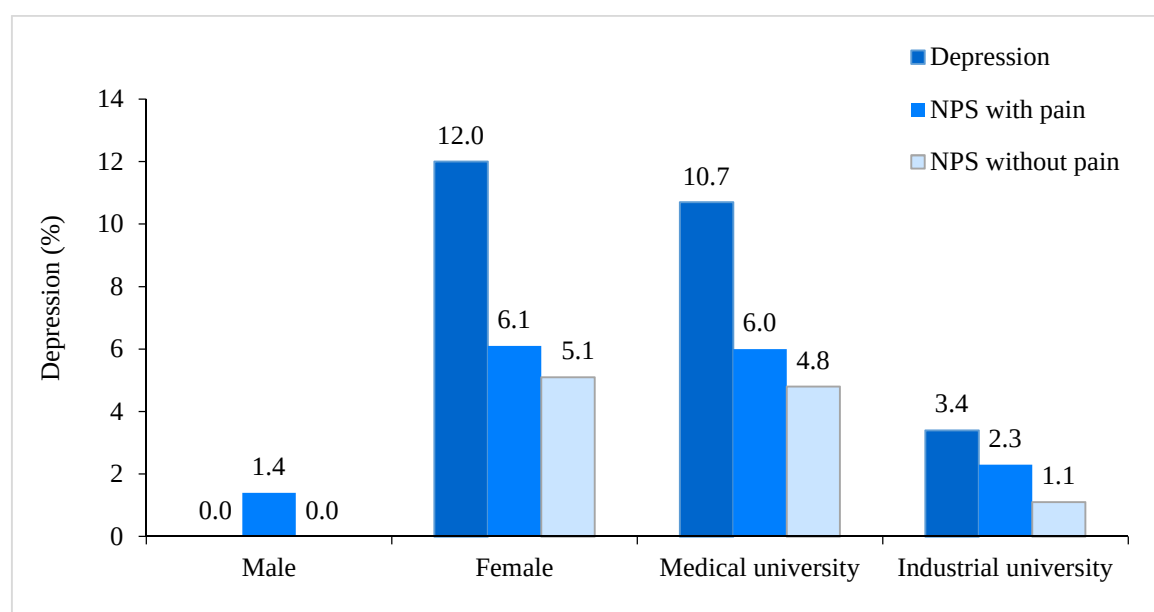


Figure 1. The relationship between depression as well as non-specific physical symptoms (with or without pain) and other variables

$P < 0.050$ between male and female subjects

Discussion

Results of this study suggested the 28.9% prevalence of TMD among university students at Babol Universities of Medical Sciences and Babol University of Technology.

Otuyemi et al.¹² reported the prevalence of TMD among 308 students of medical and dental sciences as 42.0%. Nomura et al.¹³ also reported the prevalence of TMD among the students at University of Sao Paulo, Brazil, as 53.2%. The great difference in the reported prevalence of TMD may be due to the difference in assessment techniques, also lack of the same definition for TMD and clinical criteria, and specific background in the studies, details of the studied course, the time at which the questionnaire was given to the volunteers, and different racial and environmental conditions.

In the present study, women showed a higher prevalence of TMD than men, which was in agreement with other studies.^{12,13} The higher prevalence of TMD in women may be due to physiological characteristics, especially hormonal and structural changes in connective tissue and muscles. The higher laxity in these tissues which is related to estrogen level could explain the fact that these tissues have less ability to provide support against the functional pressures that lead to TMD.⁴ The most common TMD subgroup founded in this study was group 2 disorder (disc dislocation), while in the study by Manfredini et al.,¹⁴ group 3 disorders were more common among the TMD patients seeking treatment.

In another study by Yap,¹⁵ group 1 disorders had the highest prevalence in the population of patients seeking TMD treatment. In two above-mentioned studies, people seeking treatment were examined, however, in our investigation all of the subjects were examined, which could have no TMD sign and symptoms and not seeking treatment, this could explain the differences in the findings of these studies.

Among investigated subjects (5.7%) had symptoms of clinical depression. In the

present study, the relative frequency of depression symptoms was generally higher among TMD patients than the population without the TMD. In this study, 8.5% of women and 0.9% of men had symptoms of clinical depression. Unlike the percent study Minghelli et al.¹⁶ showed that 30.5% of the studied students had anxiety or depression. Most of the present participants with depression were women, as was the case in other studies. As compared with men, women are more likely to report depressive symptoms and have a higher rate of psychosomatic illnesses.

In the present study, the relationship between signs and symptoms of depression and NPS (with or without pain) with TMD was not statistically significant. Wahlund et al.¹⁷ conducted a study on two groups of adolescents (a group with TMD and a group of healthy individuals), and the results indicated no significant difference between the control group and the one suffering from TMD in terms of emotional dissatisfaction. It was also suggested that chronic TMD pain in adults was not merely followed by an emotional condition. Ferrando et al.¹⁸ studied coping and distress along with TMJ properties in 114 patients who had TMD and the results demonstrated that the patients who had muscle disorder showed higher levels of psychological distress. Yap et al.¹⁵ reported that 39.0% of TMD patients seeking treatment were clinically suffering from depression, and 55.0% had moderate to severe somatization. Unlike the present study, the population in the above study consisted of the patients seeking treatment; this point along with different racial and environment issues can explain the difference between the results of the mentioned and the present study.

Osterberg and Carlsson¹⁹ performed a study on a group of 70-year-old patients and reported that TMD was significantly related to public health, bruxism, and psychosomatic problems. Castrillon et al.²⁰ reported a

significant relationship between pain intensity in TMD and somatization degree. Sherman and Turk²¹ suggested that, because of the relationship between TMD and biopsychosocial issues, the studied patients were not only affected by biomedical aspects but also sought treatment for this reason.

The difference in there ported results about the prevalence of clinical depression and NPS at different ages among TMD patients and the relationship between signs and symptoms of depression and NPS (with or without pain) with TMD could be resulted from the difference in assessment techniques (data collection method and variables types) as well as the difference in the sampling technique (random or non-random, similarity of the studied age groups, sample size, unhealthy or healthy subjects, and gender distribution).²²

It was observed in this study that there was a significant relationship between depression signs and symptoms and NPS. This finding was in agreement with the results reported by Yap's et al. study,²³ which indicated a significant relationship between depression and NPS.

In this study, the difference between sex groups in signs and symptoms of depression and the NPS level (without pain) in the patient with TMD, was statistically significant, whereas the difference in the NPS level (with pain) between the two sex groups with TMD patients was not statistically significant.

Phillips et al.²⁴ found that the two sex groups were not similar to each other in terms of biopsychosocial variables. Yap et al.²³ also found that the prevalence of depression and NPS among Asian patients was comparable within the two sex groups.

In the study by In the study by Kuttilla et al. it was concluded that TMD and depression were higher in women than in men.²⁵ In general, the higher prevalence of depression signs and symptoms and NPS (without pain) among women may be due to

their emotionality, paying more attention to physical and hormonal changes, menstruation, and social and emotional status.

In this study, a significant relationship was observed between depression signs and symptoms and NPS level (without pain) such that these quantities were more significant among paramedical students than others while the NPS level (with pain) did not significantly correlated to the students' field of study.

A study was conducted by Minghelli et al.¹⁶ in which the relationship between TMD symptoms and anxiety as well as depression was examined in three student groups majoring at health, education, management, and engineering schools. The results demonstrated no statistically significant relationship between the students of different schools.

The higher prevalence of depression signs and symptoms and the NPS level (without pain) among the paramedical students participating in this study was observed in women than men. According to various studies and also the present work, the prevalence of signs and symptoms of depression and NPS level (without pain) is more common in women; therefore, signs and symptoms of depression and NPS (without pain) are more prevalent among students of paramedical sciences than other fields.

Finally, we suggest the investigating conducted to assessment of psychosocial distresses in TMD patients.

Conclusion

In this study, no significant relationship was observed between depression symptoms as well as NPS (with or without pain) and TMD. In the studied patients with TMD, no relationship was observed between age and depression signs and symptoms, as well as NPS. Among women with TMD, the prevalence of depression symptoms and NPS (without pain) was more than men. Furthermore, students of paramedical sciences

had more signs and symptoms of depression and NPS (without pain) than other students.

Conflict of Interests

Authors have no conflict of interest.

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Repair of a furcation perforation with mineral trioxide aggregate: A case report with 6 year follow-ups

Nahid Mohammadzadeh-Akhlagi DDS, MS¹, Ehsan Esnaashari DDS, MS²

Case Report

Abstract

BACKGROUND AND AIM: One of the most common reasons for the failure of endodontic treatment is root perforation. Perforations might occur due to carious lesions, tooth resorption or they might be iatrogenic during endodontic treatment or in most cases they might occur during post space preparation.

CASE REPORT: A 31-year-old female patient presented with a complaint of chronic pain on tooth #30 during last 6 months and sensitive to bite since a few days ago. There was a mild swelling on the gingival tissue in the furcation area in the intraoral examination, with a narrow strip-shaped pocket measuring 3 mm in depth. Radiographic examination revealed an incomplete root canal treatment of the tooth. A prefabricated post had been placed in the distal root, with an incorrect path toward the furcation area. There was a small radiolucency in the furcation area and a pronounced radiolucency around the mesial root of the tooth. After removal of the post, hemorrhage was observed in the furcation area. The diameter of the perforation was approximately 1 mm. The perforated area was sealed with Pro Root mineral trioxide aggregate (MTA). In the next session when setting of MTA was evaluated and confirmed, retreatment of the tooth was done. After 6 months, no swelling or sensitivity was observed and after 6 year follow-ups radiographic examination revealed that the lesion had almost resolved.

CONCLUSION: In the present case, the lesion of furcation perforation was small in size, but the time interval between the occurrence of perforation and the repair procedure was long, success was achieved due to the control of the aseptic conditions, control of hemorrhage and proper placement of the repair material, which was confirmed in the 6 year follow-ups.

KEYWORDS: Furcal Perforation, Mineral Trioxide Aggregate, Delay Perforation Rapier

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One of the most common reasons for the failure of endodontic treatment is root perforation. Perforations might occur due to carious lesions, tooth resorption or they might be iatrogenic during endodontic treatment or in most cases they might occur during post space preparation.¹ A large number of factors influence the prognosis of perforated teeth, including the duration of the presence of perforation, perforation size and its location relative to the crest of the alveolar bone, presence of a periapical lesion and the time interval between the occurrence of

perforation and the repair procedure.²

Therefore, the perforated tooth will have a better prognosis if the perforation is small, is more apical to the alveolar crest and is repaired as soon as possible. In addition, strip perforations have the worst prognosis due to lack of access to the site, close proximity with the alveolar bone and a large size.³

A wide variety of materials are used for the repair of perforations, including amalgam, zinc-oxide eugenol (ZOE), ionomer restorative materials, resin-modified glass-ionomers (Gristore),⁴ calcium enriched mixture cement⁵ and mineral trioxide aggregate (MTA).⁶ MTA

1- Associate Professor, Department of Endodontics, Islamic Azad University, Dental Branch, Tehran, Iran

2- Assistant Professor, Department of Endodontics, Islamic Azad University, Dental Branch, Tehran, Iran

Correspondence to: Ehsan Esnaashari, DDS, MS

Email: ehsan_dmd@yahoo.com

was introduced by Arens and Torabinejad as an appropriate perforation repair material.² It has exhibited less leakage compared to the materials mentioned above in various leakage studies, including fluid filtration, dye leakage, and bacterial leakage studies. It can induce cementogenesis and osteogenesis at perforation site, leading to the regeneration of periodontium.⁶ In addition, in cases not directly accessible for perforation repair and when it is not possible to control hemorrhage, MTA can serve both as a physical barrier and as a repair material. MTA is commonly the material of choice to repair root perforations.^{7,8}

The aim of this article is to report a case of root perforation in the function area due to improper placement of a post, its repair, and its 6 year follow-ups.

Case Report

A 31-year-old female patient presented with a complaint of chronic pain on tooth #30 during last 6 months and sensitive to bite since a few days ago. The patient was systemically healthy, with no swelling in the facial area and enlargement of lymph nodes on extraoral examinations and patient could not remember the time of previous treatment. There was a mild swelling on the gingival tissue in the buccal furcation area in the intraoral examination, with a narrow strip-shaped pocket measuring 3 mm in depth; probing was normal on other tooth surfaces. The tooth was sensitive to percussion and painful on palpation. In addition, the tooth had an ill-fitting crown.

Radiographic examination revealed an incomplete root canal treatment of the tooth (Figure 1). A prefabricated post had been placed in the distal root, with an incorrect path toward the furcation area. In addition, a silver cone was located in the mesiolingual canal and a broken instrument in mesiobuccal canal. There was a small radiolucency in the furcation area and a pronounced radiolucency around the mesial root of the tooth.



Figure 1. Pre-treatment X-ray

During the first session, the tooth prosthetic crown was removed. After isolation of the tooth and removal of the amalgam from the tooth crown and the pulp chamber space, the post was vibrated by an ultrasonic device (EMS- Piezon Airflow, Switzerland) for 5 min and removed from the root canal space by a hemostat. After removal of the post, hemorrhage was observed in the furcation area, which was controlled by a cotton pellet impregnated with 2.5% sodium hypochlorite for 30 s. The diameter of the perforation was approximately 1 mm. The perforated area was sealed with Pro Root MTA (Dentsply Maillefer, Ballaigues, Switzerland) using messing gun (Dentsply Maillefer, Ballaigues, Switzerland) and compressed lightly with a small wet cotton pellet. Temporary dressing was placed in the area after placement of a piece of the wet cotton pellet. The patient was cautioned that there might be pain and swelling in the area. Immediately after the perforation repair procedure, two 400 mg ibuprofen tablets were prescribed, and the patient was advised to take 1 tablet very 4-6 h in case of pain. In order to control the possible swelling the patient was instructed to take amoxicillin if any swelling accrues in the days after the treatment.

During the second session, recovery of gingival inflammation was observed but the tooth was still painful and sensitive to percussion. After placement of a rubber dam and removal of the temporary dressing, setting of MTA was evaluated and confirmed. Subsequently, the silver cone and

broken instrument were removed from the mesial canals using a Steiglitz forceps (Pulpdent Corporation Watertown, MA, USA). Gutta-percha was removed from the coronal thirds of the canals using #4 Gates-Glidden drills (Dentsply, Tulsa Dental, Tulsa, Ok, USA) and chloroform (Merck, Darmstadt, Germany) and K-Flexofiles (Dentsply Maillefer, Ballaigues, Switzerland) #35 to #20 from the apical thirds of the canals. An attempt was made to establish apical patency using a #10 file. Patency was not established in the distal root canal (Figure 2). Working length (WL) was determined by an apex locator (J. Morita, Kyoto, Japan) and radiographic examination. The canals were debrided up to Flexofile #20. Debridement was completed by ProTaper rotary files (Dentsply Maillefer, Ballaigues, Switzerland) up to #F2 along with 1% sodium hypochlorite as an irrigation solution. The patency of mesial canals and WL of the distal canal were ensured using a #10 file between rotary files. After each file during canal preparation, 2 ml of 1% sodium hypochlorite was used for irrigation. After debridement of the canals, calcium hydroxide (Merck, Darmstadt, Germany) dressing was placed in each root canal using a #30 K-file and packed using #25 and #30 pluggers.

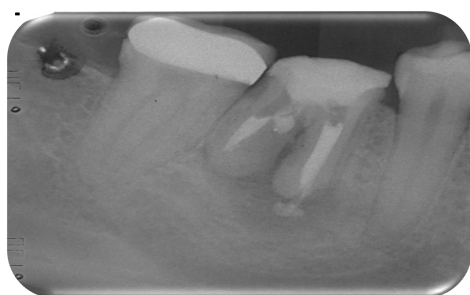


Figure 2. During treatment X-ray

During the third session after a month, when the patient had no sign and symptom and the canals were once again irrigated with 1% sodium hypochlorite after isolation and calcium hydroxide was removed with a #30 K-file. Final canal irrigation was carried out

using 2 ml of ethylene diamine tetraacetic acid (EDTA) (Asiachemiteb, Tehran, Iran), followed by 1 ml of 5.25% sodium hypochlorite in order to remove the smear layer. Finally, the WL was confirmed by a master cone and radiography and the canals underwent a final rinse with 5 ml of normal saline. The canals were obturated with a standard #30 gutta-percha cone (META BIOMED Co., Chungbuk, South Korea) in the mesial canal and #35 in the distal canal along with AH-26 sealer (Dentsply Maillefer, Ballaigues, Switzerland). A temporary dressing of zonalin was placed. The final post-treat radiograph showed over extended of sealer in mesial canals.



Figure 3. Post-treatment

One week later, the coronal restoration was placed by the patient's dentist without post placement (Figure 3). The first follow-up visit was scheduled for 6 months after root canal treatment. During the follow-up session, no swelling or sensitivity was observed, and radiographic examination revealed that the overfilled sealer and lesion had almost resolved. At the 18 months follow-up, the patient reported that the prosthetic crown had been placed 1-year after the root canal treatment. Clinical examination revealed proper interproximal and occlusal contacts and the clinical and radiographic examination results were normal. No signs and symptoms were observed at 6 months, 2, 4 and 5 and 6 year follow-ups and the periapical lesion had completely repaired (Figures 4-7). The tooth was completely functional with its prosthetic crown.

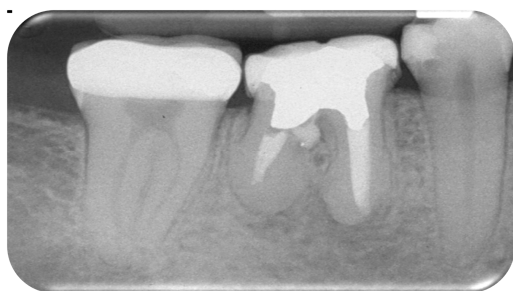


Figure 4. Post-treatment after 6 months

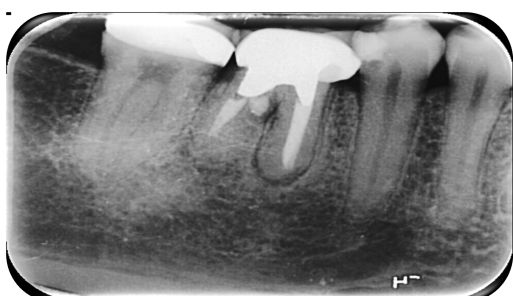


Figure 5. Post-treatment after 2 years

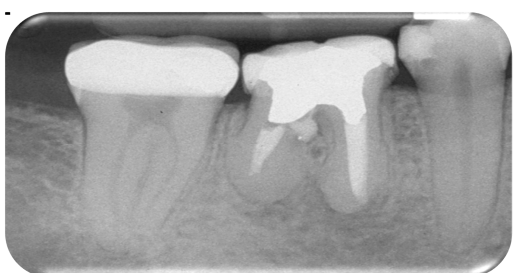


Figure 6. Post-treatment after 4 years

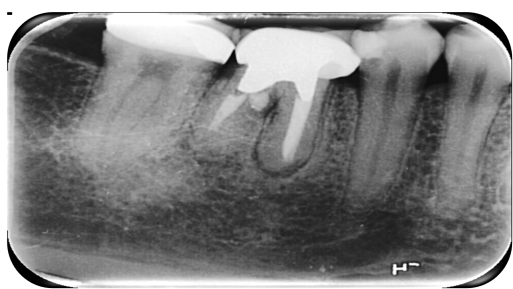


Figure 7. Post-treatment after 6 years

Discussion

Furcal perforation might occur during root canal therapy, with detrimental effects on treatment results (1;2). Perforations might occur during canal preparation or post space preparation due to inattention to the root long axis. One of the most important

considerations in the repair of perforations is the time interval between the occurrence of perforation and the repair procedure; the success rate increases with a decrease in this time interval.^{9,10}

A study by Benenati et al.¹¹ showed that even delayed perforation repair probably results in recovery on the condition that there is no contamination. In the case presented here, recovery was achieved by creating optimal conditions despite a long time interval between the occurrence of perforation and the repair procedure. One of the considerations during perforation repair is the contamination of dentin around the perforation area, and the area should be disinfected. In cases in which the perforated area is small, sodium hypochlorite is a suitable disinfecting agent. Researchers have recommended the use of 2.5% sodium hypochlorite to this end. Care should be exercised not to extrude sodium hypochlorite in the periodontium due to its pathologic potential. In the present case, too, this material was used for disinfecting the area and controlling the hemorrhage. In most perforation cases, there is hemorrhage during retreatment due to the formation of a granulomatous tissue in the area. Creation of a dry environment improves direct visibility of the area and proper placement of the repair material.¹² In such cases, 2.5% sodium hypochlorite is used to control hemorrhage.^{2,13}

Research has shown less microleakage around MTA compared to amalgam and glass-ionomer. Therefore, MTA is the material of choice in the repair of perforations in the furcation area and the root.³ Contamination of furcation area with blood can influence the quality of the final restoration and retention and sealing ability of MTA. The success rate increases if the lesion around the perforation area is small in size.^{12,14} In the present case, the lesion of furcation perforation was small in size, but the time interval between the occurrence of perforation and the repair procedure was

long, success was achieved due to the control of the aseptic conditions, control of hemorrhage and proper placement of the repair material, which was confirmed in the 6 year follow-ups.

A proper technique for remove the smear layer which is clinically applicable is the use of 1 ml 17.0% EDTA, followed by 1 ml 5.25% sodium hypochlorite, each for 1 min.¹⁵ In the present case, this regimen was used for final irrigation.

Various studies¹⁶⁻¹⁸ have shown that subsequent to root canal treatment the final

coronal restoration should be placed as soon as possible in order to prevent coronal leakage and treatment failure. In the present case, the final restoration was placed 1 week after treatment.

Conflict of Interests

Authors have no conflict of interest.

Acknowledgments

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Unusual presentation of primary mandibular gingival squamous cell carcinoma in young male: A case report

Nishat Sultan MDS¹, Jyoti R. Rao MDS²

Case Report

Abstract

BACKGROUND AND AIM: Squamous cell carcinoma (SCC) is usually considered a disease of older people. Recently, there is a change in the occurrence of such lesions in young patients and lacking the established risk factors.

CASE REPORT: A 21-year-old male reported with an innocuous gingival growth over lower incisors since a month. Within 15 days he noticed another gingival growth in same region lingually. The growths were mildly tender with no suppuration. The associated teeth were non-mobile and vital. The radiographic findings were insignificant. An excisional biopsy was performed under local anesthesia. The stained H and E section showed a hyper-parakeratinized stratified squamous surface epithelium with underlying connective tissue with collagen fibers, fibroblasts, blood vessels and areas of dense chronic inflammatory cell infiltrate. Epithelium exhibited features of dysplasia. There was a breach in the continuity of the basement membrane and the malignant epithelial cells were seen invading the connective tissue in form of thin cord.

CONCLUSION: The histopathological study confirmed the diagnosis of well differentiated SCC. Oral SCC is not a disease of the elderly anymore. We also reviewed the literature of SCC in young patients. Thus biopsy is mandatory for any non-resolving gingival growth.

KEYWORDS: Gingival Overgrowth, Interdental Papilla, Squamous Cell Carcinoma, Gingival Neoplasm, Mandible

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Localized gingival enlargements may indicate many local and systemic conditions.¹ Of all the tumors arising in the oral cavity, more than 90.0% are squamous cell carcinoma (SCC). The overall incidence of gingival carcinoma is < 10.0%.² In general; the etiology of malignancies is multifactorial. In spite of the established evidence associating tobacco and alcohol consumption with oral cancer, many of the younger patients with SCC claim to have never smoked or consumed alcohol excessively.³

Because of this changing trend, researchers are curious to investigate this clinical entity, whether it is just a variant of the lesion seen in older patients or it is a

distinct lesion, whether the etiology, clinical course and prognosis are same for the two. The purpose of the present report is to describe one such gingival lesion in an otherwise healthy adult.

Case Report

A 21-year-old male reported with a painless labial gingival overgrowth of 1-month duration between his lower front teeth. Within 15 days, he noticed another gingival growth at the same location, lingually. His oral hygiene was very good. All the teeth were asymptomatic at the time of presentation. He did not have any drug history. He smoked cigarette 2 or 3 times over the past 1-year only. Before that he was a non-smoker and the

1- Assistant Professor, Department of Periodontology, School of Dentistry, Jamia Millia Islamia, New Delhi, India

2- Professor, Department of Periodontics, Goa Dental College and Hospital, Goa, India

Correspondence to: Nishat Sultan, MDS

Email: nishat_sultan@rediffmail.com

patient was not smoking at the time of presentation. There was no significant family history of malignancy.

On examination, there was a single, isolated 1.5×1.0 cm, reddish-pink gingival growth present between 32 and 33. The lesion was firm, fixed and non-mobile (Figure 1). Lingually, there was an isolated gingival growth about 0.7×0.7 cm. It was sessile, firm, ovoid, reddish pink, smooth surfaced and non-fluctuant (Figure 2). Both the growths were mildly tender on digital pressure with no discharge and no blanching on pressure. The teeth were non-mobile and vital. There were no signs of involvement of regional lymph nodes. Radiographic examination showed no signs of abnormal bony destruction. All the routine blood tests were within normal limits. An excisional biopsy of both the growths was performed under local anesthesia. Healing was uneventful for the lingual biopsy; however, the labial biopsy site showed minute lobulations during the healing phase.



Figure 1. Clinical appearance of the labial gingival growth at the initial presentation

The stained H and E section showed a hyper-parakeratinized stratified squamous surface epithelium with underlying connective tissue with collagen fibers, fibroblasts, blood vessels and areas of dense chronic inflammatory cell infiltrate. Epithelium exhibited features of dysplasia like acanthosis, altered nuclear-cytoplasmic ratio, basilar hyperplasia and individual cell keratinization. There was a breach in the

continuity of the basement membrane and the malignant epithelial cells were seen invading the connective tissue in form of thin cord. All the features were suggestive of "well differentiated SCC" (Figure 3).



Figure 2. Clinical appearance of the lingual gingival growth at the initial presentation

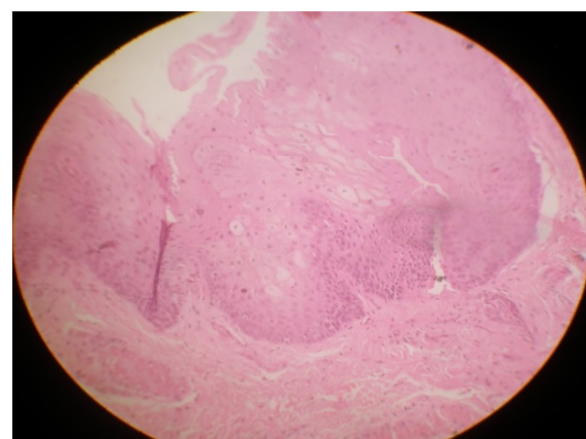


Figure 3. Histopathological section showing well-differentiated Squamous cell carcinoma (H and E, original magnification $\times 40$)

The patient was referred to Super-Speciality Cancer Hospital where the slides were re-interpreted. More elaborate investigations ruled out the possibility of a metastasis in the body. A wide excision of lower gingivobuccal sulcus with marginal mandibulectomy was performed under general anesthesia along with extraction of teeth 41, 31, 32, 33 and 34 (Figure 4). The histopathological examination re-confirmed the pre-operative diagnosis of a well differentiated SCC (T1N0) of left lower gingivobuccal sulcus. The patient is reviewed

regularly and no evidence of residual neoplastic disease has been detected during 3 years of postsurgical periodic clinical follow-up examination.



Figure 4. Clinical image after wide excision of lower gingivobuccal sulcus with marginal mandibulectomy

Discussion

There is an enormous data related to overall SCC of the mouth, but relatively little is known about the primary gingival SCC. The pioneers Krolls and Hoffman in their extensive review showed that people < 40 years old accounted for only 2.7% of patients presenting with oral cavity and oropharyngeal cancers.⁴ Of more than 1000 patients, only 5 patients were < 30 years, among which just a single patient (< 18 years) had a well differentiated SCC of the alveolus. Martin-Granizo et al. studied 505 patients (< 40 years) of oral SCC of oral cavity retrospectively, and found a relatively higher proportion (8.2%) of SCC.⁵

Kuriakose et al. in their retrospective review, reported 4 cases of gingival SCC out of 37 subjects in the age group of 21-34 years, 27 subjects had none of the traditional etiologic factors of tobacco and alcohol abuse.³ Thompson et al. performed a retrospective review over a 30 years period and documented 20 cases of oral SCC in patients < 20 years.⁶

Adolescent oral SCC of gingiva is exceptionally rare. Few case reports have been

documented in relatively young adults with localized gingival SCC in absence of the traditional risk factors associated with SCC.⁷⁻¹⁰ To our knowledge, about 8 cases of gingival SCC have been included in the literature in patients ranging from 4-18 years of age and a predilection for maxillary gingiva was seen.⁹

Our case is an addition to the literature of SCC of gingiva in mandibular arch in young adult. With respect to tobacco and alcohol abuse, it is estimated that smoking and alcohol account for about 75.0% of all cases of oral cancers, but the significance of these factors in young adults is still controversial. Franceschi et al. in their case-control study reported that smoking is a strongly associated with oral cancers in older patients but its role as etiologic agent in young adults is not very significant.¹¹ This is shared by other descriptive studies too.^{3,12} Sasaki et al. evaluated clinicopathological features of oral SCC in young adults (< 40 years). Only 6.6% were < 40 years. Tongue (51.3%) comprised the most common site and gingiva were the least frequent site of SCC.¹³

Udeabor et al. retrospectively studied 977 patients diagnosed histologically of oral and oropharyngeal SCC over 20 years. Various clinical, histological and demographic factors were compared with that of patients younger and older than 40 years. The floor of the mouth comprised the most common site of occurrence (39.5% cases). Younger patients had a better prognosis in terms of long-term overall survival from oral and oropharyngeal SCC.¹⁴ Few case reports of gingival SCC have also been reported in pediatric and adolescents (age 7-14 years).¹⁵⁻¹⁷

The case presented here is SCC of the anterior mandibular gingiva. Based on the clinical picture and the age of the patient, various benign lesions in its differential diagnosis such as fibrous epulis, peripheral giant cell granuloma, fibroma, or peripheral ossifying (cementifying) fibroma were considered. Histopathological examination is fundamental to establish the malignant nature

of this apparently innocuous looking lesion. Carcinomas of the gingiva in particular tend to present with benign features, and this leads to delays in diagnoses or even misdiagnoses.

Our case report further illustrates the need for vigilance in evaluating and managing an apparent inflammatory oral lesion in young patients. Oral SCC in young patients lack the best known risk factors as seen in SCC in older adults. Further research is needed to investigate the possible confounding or potentiating factors, including genetic, hereditary, dietary, and possible demographic factors in SCC in younger patients. The significance of the present case is as follows:

1. A case of well differentiated SCC of gingiva is reported which is a very rare site of

occurrence, in a young adult, in the absence of the characteristic clinical features associated with SCC, 2. It stresses upon the importance of histopathologic examination as clinical stage at diagnosis is the main predictor of survival of patients with gingival carcinomas, 3. Complete excision of the lesion and an extended follow-up is mandatory.

Conflict of Interests

Authors have no conflict of interest.

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